REPORT

REVISED FINAL WORK PLAN
GASCO SEDIMENTS CLEANUP ATION

Prepared for

NW Natural

Prepared by

Anchor QEA, LLC

March 1, 2010

REVISED FINAL WORK PLAN

GASCO SEDIMENTS CLEANUP ACTION

Prepared for

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LIST OF ACRONYMS AND ABBREVIATIONS

µg/kg	micrograms per kilogram
µg/L	micrograms per liter
µm	micrometers
1,1-DCE	1,1-dichloroethylene
ADCP	acoustic Doppler current profiler
AIR	Area Identification Report
AOC	Administrative Settlement Agreement and Order on Consent
AOPC	Area of Potential Concern
APE	Area of Potential Effects
ARARs	applicable and relevant and appropriate requirements
AST	aboveground storage tank
AWQC	Ambient Water Quality Criteria
BA	Biological Assessment
BAZ	Biologically Active Zone
BERA	Baseline Ecological Risk Assessment
BHHRA	Baseline Human Health Risk Assessment
bgs	below ground surface
BiOp	Biological Opinion
BHC	benzene hexachloride
BMP	best management practices
BNSF	Burlington Northern Santa Fe Railroad Company
BSAF	biota sediment accumulation factors
BTEX	benzene, toluene, ethylbenzene, xylenes
BTU	British Thermal Unit
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
cfs	cubic feet per second
cis-DCE	cis-1,2-dichloroethylene
CLP	Contract Laboratory Program
cm	centimeter
COCs	chemicals of concern
COI	chemical of interest
COPC	chemical of potential concern

CPD	City of Portland datum
CQA	Construction Quality Assurance
CQAP	Construction Quality Assurance Plan
CRBG	Columbia River Basalt Group
CRD	Columbia River Datum
CVOC	chlorinated volatile organic compounds
CWA	Clean Water Act
cy	cubic yard
DAR	Design Analysis Report
DEQ	Oregon Department of Environmental Quality
DNAPL	dense non-aqueous phase liquid
DOE	Washington State Department of Ecology
DQOs	data quality objectives
DSL	Department of State Lands
EE/CA	Engineering Evaluation/Cost Analysis
EMS	Environmental Management System
ESA	Endangered Species Act
FAMM	Fuel and Marine Marketing
FFS	Focused Feasibility Study
FSP	Field Sampling Plan
GLISP	Guild's Lake Industrial Sanctuary Plan
GPM	gallons per minute
GWFFS	Groundwater Focused Feasibility Study
HASP	Health and Safety Plan
HPAH	high molecular weight PAH
HQ	Hazard Quotient
JSCS	Joint Source Control Strategy
KI	Koppers, Inc.
LMRP	Long-term Monitoring and Reporting Plan
LNG	liquefied natural gas
LPAH	low molecular weight PAH
LWG	Lower Willamette Group
MCL	Maximum Contaminant Levels
MFA	Maul Foster & Alongi, Inc.
mg/kg	milligrams per kilogram

mg/L	milligrams per liter
MGP	Manufactured Gas Plant
MHW	Mean High Water
MNR	monitored natural recovery
MOU	Memorandum of Understanding
msl	mean sea level
N/m^2	Newtons per square meter
NAPL	nonaqueous phase liquid
NAVD88	North American Vertical Datum of 1988
NCP	National Contingency Plan
ng/kg	nanograms per kilogram
ng/L	nanograms per liter
NGVD29/47	National Geodetic Vertical Datum of 1929
NMFS	National Marine Fisheries Services
NOAA	National Oceanic and Atmospheric Administration
NPDES	National Pollutant Discharge Elimination System
NPL	National Priorities List
NRDA	Natural Resource Damage Assessment
NRIU	Natural Resources Inventory Update
OHW	Ordinary High Water
OPA	Oil Protection Act
OSHA	Occupational Safety and Health Administration
PacTerm	Pacific Terminal Services, Inc.
PAH	polycyclic aromatic hydrocarbon
PBRA	Probable Benthic Risk Area
PBTs	persistent bioaccumulative toxins
PCBs	Polychlorinated biphenyls
PCE	tetrachloroethene
PEC	Probable Effects Concentration
PG&C	Pacific Gas & Coke
PGE	Portland General Electric
pg/L	picograms per liter
PNO	Pacific Northern Oil
ppm	parts per million
PRD	Portland River Datum

PRGs	preliminary remediation goals
PRPs	potentially responsible parties
QA/QC	quality control/quality assurance
QAPP	Quality Assurance Project Plan
RAOs	Remedial Action Objectives
RBCs	risk-based concentrations
RCRA	Resource Conservation and Recovery Act
Rhone-Poulenc	Rhone Poulenc AG Company
RI/FS	Remedial Investigation/Feasibility Study
RM	river mile
ROD	Record of Decision
SCSR	Site Characterization Summary Report
sec	second
SEF	Sediment Evaluation Framework
SHAs	special habitat areas
SHPO	State Historic Preservation Officer
Siltronic	Siltronic Corporation
SLLI	Star Link Logistics
SLV	screening level values
SOW	Statement of Work
SQ	Screening Quotients
SSPA	SS Papadopulos
SVOC	semivolatile organic compounds
SWAC	Surface-area Weighted Average Concentration
TBCs	to be considered initiatives
TCE	trichloroethene
TCLP	toxic characteristic leaching procedure
TDP	Transportation and Disposal Plan
THPO	Tribal Historic Preservation Officer
TOC	total organic carbon
trans-DCE	Trans-dichloroethylene
tsf	ton per square foot
TSS	total suspended solids
TZW	transition zone water
U.S. Moorings	U.S. Army Corps of Engineers Moorings Station

USACE	U.S. Army Corps of Engineers
UST	underground storage tank
VOCs	volatile organic compounds
WBZ	water bearing zone
WQC	Water Quality Criteria
WQMP	Water Quality Monitoring Plan

1 BACKGROUND

In 2000, the U.S. Environmental Protection Agency (EPA) added the Portland Harbor Superfund Site (Portland Harbor Site) to the National Priorities List (NPL) pursuant to the Comprehensive Environmental Response, Compensation, and Liability Act of 1980, as amended, 42 U.S.C. § 9601, et seq. (CERCLA or Superfund; EPA 2001c). The Portland Harbor Study Area currently encompasses approximately 10 miles (river mile [RM] 1.9 to 11.8) of the Lower Willamette River in Portland, Oregon and including the offshore areas adjacent to the NW Natural "Gasco" and Siltronic Corporation (Siltronic) properties (Figure 1.1-1). In fall 2001, EPA and 10 of the Superfund Site's potentially responsible parties (PRPs), including NW Natural, entered into an Administrative Order on Consent for Remedial Investigation/Feasibility Study (RI/FS), CERCLA-10-2001-0240 (EPA 2001c) for the Portland Harbor Site. The RI/FS will characterize the nature and extent of contamination, assess the ecological and human health risks at the Portland Harbor Site, and evaluate feasibility alternatives for cleanup. The Administrative Order on Consent allows Early Actions to be conducted to address known risks at specific locations within the Portland Harbor Site.

Contaminants found in shoreline and/or offshore media adjacent to the NW Natural Gasco and Siltronic properties led to a determination by EPA that a cleanup adjacent to these properties is necessary to protect the public health, welfare, or the environment. Accordingly, NW Natural and Siltronic entered into the Administrative Settlement Agreement and Order on Consent (AOC; Docket No. CERCLA 10-2009-0255) with the EPA on September 9, 2009, to conduct an Engineering Evaluation/Cost Analysis (EE/CA), and to design a final remedy for the Gasco Sediments Site within the Portland Harbor Site. The Order contemplates that construction of the remedy would be under a Consent Decree with EPA after the issuance of the Portland Harbor Site Record of Decision (ROD). Additional investigation to fill identified data gaps will be conducted as part of the design phase. The area that will be subject to remedial actions at the Gasco Sediments Site will be referred to as the Project Area in this document.

As described in the Statement of Work (SOW) attached to the AOC, the Project Area will be determined in a series of iterative evaluation steps that are intended to make the remedial design for the Project Area consistent with EPA's proposed remedy for the Portland Harbor Site remediation. The current general Project Area for the Gasco Sediments Site is described in Section 1.2.1, and the Project Area is generally defined as those in-water sediments on or

adjacent to the Gasco and Siltronic properties where Manufactured Gas Plant (MGP) wastes and chlorinated volatile organic compounds (CVOCs) are present in the Lower Willamette River.

The goal of the Project Area cleanup will be to implement a final remedy that addresses all current and anticipated in-water Removal/Remedial Action Objectives (RAOs) defined in the SOW. The selected remedy will be included in the Portland Harbor Site ROD for the Project Area. Therefore, the Project Area remedy design will be refined as necessary to address future changes to the Portland Harbor Site RAOs and information presented in the Portland Harbor Site FS, EPA's proposed plan and the ROD to develop a remedial design that is consistent and fully integrated with the Portland Harbor Site remedy. As described in Section 1.2.2, prior to initiation of the Gasco remedy, all necessary upland source controls will be conducted at the NW Natural Gasco and Siltronic facilities in coordination with the Oregon Department of Environmental Quality (DEQ) to prevent recontamination. EPA, DEQ, and other government agencies agreed in a Memorandum of Understanding (MOU) that DEQ would be the lead agency for work relating to the upland portion of the Portland Harbor Site. The Project Area remedy will be designed and implemented to minimize interference with ongoing marine operations and to allow flexibility in continued waterfront use.

1.1 Work Plan Introduction and Goals

This Work Plan has been prepared on behalf of NW Natural in coordination with Siltronic to fulfill the requirements of Section 3 of the SOW attached to the AOC. The goal of the work defined by this Work Plan (i.e., this project) is the design of a final remedy at the Gasco Sediment Site so that construction of the remedial action can begin expeditiously following issuance of the ROD for the Portland Harbor Site. It is anticipated that remedial action will be implemented under a consent decree after EPA issuance of the ROD. In support of the design development, further Project Area characterization, studies, and analysis will be conducted for this project. The design will include preference for removal of in-river materials containing "substantial product" (as defined in Section 3.6.2.1 of the SOW and discussed in Section 4.6.3.1 of this Work Plan), such as dense non-aqueous phase liquid (DNAPL) and tar, but will also include a complete evaluation of other available active remedial options (e.g., containment and enhanced monitored natural recovery [enhanced MNR]) and MNR.

1.2 Project Context

This section describes conceptually how the Gasco cleanup project fits into the other Portland Harbor and upland Gasco property remediation activities (i.e., programmatic sequence) to provide a context for the project. The sequencing description is useful for understanding the overall project goal for the work to be performed under the AOC. This section also describes risk management principles that will help guide the work under the AOC. New information may be learned or changed circumstances may lead to changes in the sequencing or the agency lead roles discussed below.

1.2.1 General Project Area

As discussed in the SOW, the Project Area at the Gasco Sediments Site will be determined in a series of iterative evaluation steps that are intended to make it consistent with the Portland Harbor Site remediation. For discussion purposes, the general area currently under consideration for the Project Area is shown in Figure 1.2-1, consistent with Figure 1 in the SOW. This figure shows subareas where visible product is often, but not always, present (shown in dark green), areas associated with bioassay toxicity (shown in green), areas where total polycyclic aromatic hydrocarbon (PAH) concentrations are above the Probable Effects Concentration (PEC; shown in light green), and approximate areas where transition zone water (TZW) or surface water concentrations of trichloroethene (TCE), cis-1,2-dichloroethylene (cis-DCE), or vinyl chloride are above the relevant Joint Source Control Strategy (JSCS) Screening Level Values. There are no specific expectations with regard to remediation in any of these areas; rather, EPA and NW Natural and Siltronic intend that remedial design for these areas will be consistent with the Portland Harbor Site RI/FS and ROD, except as may otherwise be required under the SOW.

1.2.2 Programmatic Sequencing

The appropriate sequencing of remedial measures at the Project Area is critical to maximize the effectiveness of the overall Portland Harbor Site remedy and minimize the potential for recontamination. Four distinct phases of work under DEQ and EPA direction are anticipated to occur in the following sequence (see Figure 1.2-2):

1. Gasco and Siltronic facility groundwater/DNAPL source control (DEQ lead)
2. Upland remedial actions (DEQ lead)

3. Gasco Sediments Site final sediment remedy – phased (EPA lead), design of which is the subject of this Work Plan
4. Portland Harbor Site remedy (EPA lead)

1.2.2.1 Groundwater/DNAPL Source Control

The Gasco property groundwater/DNAPL source control work needs to be completed first to prevent recontamination of any sediment remedy. A focused FS for the Gasco property source control work has been completed, and an interim source control action is currently under design. The DEQ has requested implementation of a vertical barrier technology to prevent DNAPL migration in conjunction with a groundwater extraction and treatment system. A DNAPL extraction system may also be included in upland source controls, depending upon the findings of the planned DNAPL Removal Pilot Program. NW Natural believes the hydraulic containment system should be constructed as soon as the design is approved, but that the vertical barrier and DNAPL extraction system should be more thoroughly evaluated in the context of the overall upland property FS. Any interim measures are expected to be part of an overall upland final remedy. Additional upland source control for the Gasco property potentially includes stormwater, pending the findings of ongoing stormwater sampling.

Upland source control at the Siltronic property includes enhanced in situ bioremediation in the source area for CVOC impacts. The Siltronic Focused Feasibility Study (FFS) for groundwater and TZW impacted by CVOCs has been reviewed by DEQ (the supporting remedial investigation is still under review). It is Siltronic's goal that upland source controls for MGP-related groundwater and DNAPL impacts will also, along with Siltronic's CVOC source area enhanced in-situ bioremediation, provide source control for the CVOC groundwater plume.

NW Natural and Siltronic will continue to work under DEQ oversight on upland source control actions related to the Gasco and Siltronic properties. The goal is for upland sources to be controlled to the greatest extent practicable before or during Project Area sediment remedy implementation so that post-remedy sediment recontamination is not predicted and that sediment RAOs can be achieved and maintained.

1.2.2.2 Upland Remedial Actions

The Gasco RI and risk assessment reports are currently being reviewed by DEQ, and the upland FS is in the preliminary planning phase. The upland FS will include evaluations of technologies and remedial alternatives to address upland soils, DNAPL, groundwater, and stormwater. The remedial actions selected will be integrated with the source control actions discussed above into an overall permanent remedy addressing all matrices and pathways posing risk at the Gasco and Siltronic properties. The goal is to implement the upland work prior to placement of the final Project Area sediment caps and dredge covers.

In the past, for the purpose of defining DEQ versus EPA-led work, water line equivalent to 13.3 feet NAVD88 (Mean High Water; MHW) as the boundary at the Portland Harbor Site. Thus, remedial work in riverbank soils above this line was evaluated in coordination with DEQ. For project-specific reasons, riverbank remediation construction will take place simultaneously with the Project Area construction so that a continuous fully integrated slope from Ordinary High Water (OHW; 20 feet NAVD88) to permanently submerged sediments consistent with both riverbank and sediment designs can be constructed at one time with one set of river water quality protection measures. As such, for purposes of planning and efficiency, per the SOW, EPA will oversee both the sediment and riverbank remediation work (top of bank riverward). EPA oversight of sediment construction and riverbank remediation work will: 1) extend from the river sediments up to the top of the bank slope ending where the generally level portions of the upland property begins; 2) result in a continuous fully integrated slope from the top of the riverbank to permanently submerged sediments; and 3) be constructed at one time with one set of river water quality protection measures consistent with both riverbank and sediment designs.

The combined riverbank and sediment cleanup work will include one comprehensive Endangered Species Act (ESA) evaluation in consultation with National Marine Fisheries Services (NMFS; i.e., one Biological Assessment [BA]) that will cover both the sediments and riverbank remediation work up to the top of the bank. The EE/CA will include evaluation of removal of sediments underlying the sloping portion of the bank, also known as the “wedge” area.

1.2.2.3 Portland Harbor Site Remedy

The Portland Harbor Site RI is almost complete and the Portland Harbor Site FS phase is beginning. A proposed final Gasco Sediments Site remedial alternative will be prepared so that it can be described in EPA's Proposed Plan for the Portland Harbor Site. The Proposed Plan will describe the recommended Portland Harbor Site remedy and is subject to public comment and review. After public comment, the remedy decision will be documented in the ROD for the Portland Harbor Site. Once the ROD is completed, further source control work will continue, and the remedial design and remedial action phase of work for Portland Harbor Site will begin. One goal of this Gasco Sediments project is that the Project Area design will be complete and ready for construction as the first or one of the first in a series of final sediment remedial actions throughout Portland Harbor.

The design for the Project Area discussed in this Work Plan will rely on the Portland Harbor Site risk assessment and FS information as it becomes available to develop a design for the Project Area that is consistent and fully integrated with the Portland Harbor Site remedy. Consequently, key points of information feedback between the Portland Harbor Site process and this cleanup action include:

- The Portland Harbor Site Draft Baseline Risk Assessment (BERA) will be used to refine the cleanup areas for the Gasco Sediments Site EE/CA
- The Portland Harbor Site Draft FS, including RAOs and preliminary remediation goals, will be used to develop the Gasco Sediments Site preliminary design alternative.

1.3 Risk Management Framework

The Project Area cleanup goal is to design a remedy consistent with the ROD that will reduce key human and ecological risks cost-effectively in consideration of Project Area characteristics, resulting in a cleanup that is protective of public health and the environment and meets all federal and state applicable and relevant and appropriate requirements (ARARs). The risk lines of evidence used in the Portland Harbor Site ROD will guide risk management for the Project Area. The design will also use a risk management framework consistent with EPA guidance (EPA 1988 and 2005) on developing sediment remedies and specifically recognizes the risk management goals for the project throughout the evaluation and design process. The risk management-related approaches that are specifically important to this project and are consistent with guidance include:

- The Project Area cleanup boundary will be consistent with the draft or final Portland Harbor BERA.
- Remedial alternatives will be evaluated with regard to total net risk reduction within the overall framework of the NCP remedy selection criteria.
- The Portland Harbor risk assessment protocols, procedures, data, and outcomes will be used whenever possible to set cleanup boundaries and evaluate risk reduction, unless their use would cause an unacceptable delay to the Project Area remediation.
- Remedial alternatives will be evaluated for long-term effectiveness for a range of technologies including dredging, capping, enhanced MNR and MNR.
- Remedial alternatives will include combinations of technologies that are tailored to physical, chemical, and other conditions of the Project Area.
- The short-term risks (e.g., sediment resuspension, waterborne releases, and dredge residuals) posed by different dredge methods (i.e., hydraulic and clam shell) and the installation and removal of various containment systems (i.e., sheetpile and coffer dam) will be evaluated.
- Because some of the risk is related to biota exposures, migration pathways, bioavailability, and future exposure (e.g., sediment stability under various river current and vessel propeller scour conditions) will be evaluated when predicting risk reduction.
- Future exposures and risks posed by the potential presence of mobile product in sediment will be evaluated.
- Removal of "substantial product" (as defined in Section 4.6.3.1) from the Project Area for off-site disposal, where consistent with the other risk management framework approaches will be preferred.

1.4 Work Plan Organization

The remainder of this Work Plan is organized into the following sections:

- Section 2 – Summary of Existing Information
- Section 3 – Project Remedial Action Objectives and ARARs
- Section 4 – Work to be Performed
- Section 5 – Project Schedule
- Section 6 – References

2 SUMMARY OF EXISTING INFORMATION

This section summarizes available data for the Project Area and adjacent upland areas pertaining to its physical description, history, current operations, recent and ongoing remedial activities, and ongoing and historical sources of contamination. This information provides the context for the current understanding of the nature and extent of contamination within and adjacent to the Project Area and the foundation for the conceptual site model discussed at the end of Section 2.

Numerous environmental investigations and studies have been conducted within the Project Area and the adjacent upland Gasco and Siltronic properties. The primary relevant investigations include:

- RI of the Gasco property conducted by HAI under a 1994 agreement for RI/FS between NW Natural and DEQ. The Gasco RI work is documented in the *Final Remedial Investigation/Feasibility Study Work Plan* (HAI 1995; Gasco RI), additional focused work plans targeting specific data needs, and the *Gasco RI Report* (HAI 2007a).
- Characterization of the "tar body" identified immediately offshore a portion of the Gasco property, as documented in the *Removal Action Work Plan* (Anchor 2004a) and the plans and design documents for the EPA-selected remedy for the tar body as documented in the *Removal Action Project Plan* (Anchor 2005). Post-construction characterization of the Tar Body Removal Action Area and subsequent monitoring, as documented in the associated work plans (Anchor 2006a, 2008b) and monitoring reports (Anchor 2007d, 2008c, and 2009b).
- Nearshore source control evaluation conducted on the Gasco property during 2001, as documented in the *NW Natural "Gasco" Site Draft Screening Level Nearshore Source Control Evaluation Results* Report (Anchor 2001).
- The Gasco Phase 1 and Phase 2 Offshore Groundwater Investigations, TZW Study, Cyanide Surface Water Investigation, and Seepage Study conducted on or offshore of the Gasco property by Anchor QEA from July 2006 to October 2007. These activities are documented in a series of field sampling plan documents, work plans, and data reports. The *Offshore Investigation Report* (Anchor 2008b) presents a comprehensive description of the investigation activities and findings.
- Design studies conducted in support of the Gasco and Siltronic source control action, including groundwater flow modeling, TarGost DNAPL evaluation, DNAPL migration evaluation, and geotechnical investigations, as documented in the groundwater source

control design reports, Preliminary Design Report (Anchor 2008e), and associated technical memoranda.

- Source control evaluation reports including *Gasco Source Control Data Gaps Evaluation* (Anchor 2006d), which compiles and screens upland source data along Segments 1 (south) and 2 (north) along the Gasco shoreline; and *Source Control Evaluation Report "Segment 3" Siltronic Property Related to NW Natural "Gasco" Site* (Anchor QEA 2009a), which compiles and screens upland source data along Segment 3 (entirely on the Siltronic property) for MGP-related chemicals.
- RI of the Siltronic property (Siltronic RI) conducted by Maul Foster & Alongi, Inc. (MFA) under an agreement for RI/FS between Siltronic and DEQ. The Siltronic RI is documented in the Siltronic RI Report (MFA 2007).
- In-river characterizations adjacent to the Siltronic property to characterize the offshore impacts related to Siltronic property releases of trichloroethene (TCE) and its degradation byproducts, as documented in the letter titled "Results of In-River Sediment and Groundwater Investigation, Siltronic Corporation, 7200 NW Front Avenue, Portland, Oregon, ECSI # 183" (MFA 2005a) and *Supplemental Investigation Report* (MFA 2005b).
- Rhone-Poulenc property source control evaluation, as documented in the *Draft Source Control Evaluation Report* (AMEC 2008a).
- RI of the Portland Harbor Superfund Site (Portland Harbor Site RI), which is described in greater detail below in Section 2.7.1. The *Comprehensive Round 2 Site Characterization Summary and Data Gaps Analysis Report* (*Comprehensive Round 2 Report*; Integral et al. 2007) documents the activities and findings of the first two of the three major data collection events conducted as part of the Portland Harbor Site RI. The *Draft Portland Harbor Site RI*, currently in preparation by the Lower Willamette Group (LWG), will be a comprehensive review of all three events. The Portland Harbor draft BERA and draft Baseline Human Health Risk Assessment (BHHRA) have been submitted to EPA. The Portland Harbor Site RI will include the majority of the offshore data collected during the above-described Gasco, Siltronic, and Rhone-Poulenc property investigations.

Routine groundwater monitoring is conducted within upland Gasco and Siltronic properties adjacent to the Project Area to monitor environmental conditions at these locations, and this monitoring includes data collection related to Rhone-Poulenc investigations, and the results are submitted to DEQ by the various responsible parties. The most recent monitoring data that were not included in the above-described investigation reports are presented in the

Environmental Monitoring Report for the Third and Fourth Quarter (HAI 2009) (Gasco), file entitled "Siltronic Quarterly Monitoring Data" submitted to the DEQ by MFA (data through November 2008, MFA 2009a), and the *Spring 2007 Groundwater Data Submittal Rhone-Poulenc-Portland Site* (AMEC 2008b). Where applicable, this information was included in the appropriate sections of this summary of existing conditions.

In addition, long-term monitoring of the tar body removal action area offshore of the Gasco property has been ongoing since early 2006 pursuant to that project's *Monitoring and Reporting Plan* (Anchor 2006a; 2008b). Monitoring results are presented in a series of event-specific and annual data evaluation monitoring reports. This monitoring program is discussed further in Section 2.7.2.3 below.

Section 2.9 of this Work Plan summarizes data and analysis presented in the above-listed reports. Consistent with the SOW requirements for the Work Plan, this summary is not intended to be a comprehensive data report. Rather, it relies on original reports prepared for the individual Gasco, Siltronic, and Rhone-Poulenc projects and broader Portland Harbor Site for the detailed information to assess cleanup alternatives and develop a selected remedy design. Important figures, tables, and overall data summaries from these reports were used or adapted in the Work Plan to illustrate known information and data gaps. The original reports contain greater detail. As discussed in Section 4.4.2, a comprehensive data compilation and screening will be conducted as part of the actual work to be performed for the project.

2.1 Project Area Location and Description

The Gasco Sediments Site is located along the western bank of the Lower Willamette River within the Portland Harbor, a heavily industrialized reach downstream and north of downtown Portland, Oregon. As shown on Figure 1.2-1, the Project Area includes a portion of the federally-maintained Lower Willamette River navigational channel, which is currently authorized to a 40-foot depth. The Project Area is adjacent to the Gasco and Siltronic properties located between RM 6 and RM 6.7. The general Project Area extends from the river sediments up to the top of the bank slope, ending where the generally level portions of the Gasco Sediments Site begin (as defined in the SOW). As discussed in Section 1.2-1, the Project Area shown in Figure 1.2-1 is presented for discussion purposes. The final Project Area will be determined in a series of iterative evaluation steps intended to make the sediment cleanup area consistent with the Portland Harbor Site remedy.

The Project Area is within the Guild's Lake Industrial Sanctuary Plan (GLISP), which is zoned for industrial use (City of Portland 2001). The GLISP is intended to preserve and enhance industrial land in the Guild's Lake area. Over many decades, public and private investments have occurred within this area in infrastructure, such as marine, rail, and highway facilities, as well as investments in industrial physical plants.

The following sections present additional description of the Gasco and Siltronic properties' features.

2.1.1 Gasco Property

The Gasco property comprises 44.65 acres along the western bank of the Lower Willamette River. The property, situated approximately 2,000 feet upriver of the St. John's Bridge, is generally rectangular in shape (Figure 2.1.1-1). Property boundaries include the Lower Willamette River to the northeast; a Burlington Northern Santa Fe Railroad Company (BNSF) railroad right-of-way to the southwest; a property line shared with Siltronic to the southeast; and a property line shared with the U.S. Army Corps of Engineers (USACE) Moorings Station (U.S. Moorings) to the northwest. US Highway 30 (NW St. Helens Road), a former rock quarry, an automobile impound yard, and the Tualatin hills lie beyond the BNSF right-of-way to the southwest.

Surface features of the property include buildings, storage tanks, and equipment used in industrial activities currently ongoing (Figure 2.1.1-1). The property ranges from mostly paved or gravel-covered in the southwestern, western, and central portions of the property, to mixed grass and trees in the northern and southeastern portions of the property. The southeastern portion of the property (former effluent pond area) occupies approximately 10 undeveloped acres, and is primarily covered with grasses and trees, with a small (approximately 3/4-acre) seasonal pond feature (Figure 2.1.1-1).

Additional features include a utility easement that crosses the southwestern portion of the property. Utilities that exist within the easement include oil, gasoline, natural gas, water, and sewer pipelines.

The ground surface at the property slopes gradually northeastward towards the Lower Willamette River with surface elevations ranging from approximately 38 feet above mean sea level (msl-City of Portland datum) at the southwestern portion of the property to approximately

23 to 30 feet msl at the top of the riverbank. The riverbank, composed both of areas of riprap and areas of non-armored soils, slopes steeply to an elevation of approximately 5 to 8 feet msl, below which exists the shoreline with a more gradual slope. (Different vertical datum used by various studies and there relationship are discussed more in Section 2.2.2).

2.1.2 Siltronic Property

The Siltronic property (shown on Figure 2.1.2-1) comprises approximately 80 acres along the western bank of the Lower Willamette River. It is located immediately upstream of the Gasco property and borders the BNSF railroad right-of-way to the southeast and southwest. Figure 2.1.2-1 shows Siltronic industrial operations and other defining features of the property as discussed in this section. Siltronic industrial operations include two fabrication buildings (FAB1 and FAB2) and the associated wastewater treatment plant, an administration building, equipment used in industrial processes currently ongoing at the property (silicon wafer fabrication), additional storage buildings, a Portland General Electric (PGE) substation, and paved parking areas. A narrow greenbelt runs the full length of the site along the riverfront. A City of Portland utility easement, approximately 100 feet wide, divides the site from the northwest to the southeast and contains underground utilities for natural gas, fuel, water and sewer pipelines, and cables for electrical and telephone service. West of the utility easement, the property from southwest to southeast remains undeveloped, consisting of trees, mixed grasses, open space, and the northwest drainage pond.

The Siltronic property is generally flat, with elevations slightly lower in the southeastern portion of the property. The general property elevation is approximately 33 feet msl, and the elevation along the Gasco/Siltronic property line is similar. The riverbank, composed of riprap, slopes steeply to an elevation of approximately 5 to 8 feet msl, below which is the shoreline with a more gradual slope.

2.1.3 Other Nearby Properties

The following properties (shown on Figure 2.1.3-1) are located immediately beyond the BNSF railroad right-of-way: beyond the berms are the Star Link Logistics (SLLI, formerly known as Aventis Crop Science and Rhone-Poulenc AG Company [Rhone-Poulenc]), ESCO Corporation, Gould-NL Industries, and Arkema (formerly known as Atofina and Pennwalt) properties. The US Moorings property (also shown on Figure 2.1.3-1) is located immediately downstream of the

Gasco property. Each of these properties is currently undergoing an environmental investigation and/or cleanup.

2.2 Physical Site Setting

This section summarizes available information pertaining to the physical setting of the Project Area, including descriptions of hydrogeology, hydrology, river characteristics, shoreline conditions, and climate data.

2.2.1 Hydrogeology

This section presents information on the geology and groundwater flow system in the Project Area and adjacent upland areas. The hydrogeology of the Gasco and Siltronic properties is described in the *Gasco RI Report* (HAI 2007a), and the *Offshore Investigation Report* (Anchor 2008b). Groundwater hydrology data are collected during routine environmental monitoring events at the Gasco and Siltronic properties, and the results are presented in environmental monitoring reports (HAI 2009). A site-specific ModFlow groundwater flow model has been prepared to support source control design (SSPA 2008). The following sections summarize the findings presented in these reports.

2.2.1.1 Geologic Setting

The geologic units of interest underlying the Project Area and adjacent upland areas can be subdivided as follows, from youngest to oldest: 1) surficial fill deposits; 2) alluvial deposits; and 3) Columbia River Basalt Group (CRBG) (HAI 2007a). The distribution of these units is shown in detailed geologic cross-sections in Figures 2.2.1-2 through 2.2.1-6, which are based on the cross-section locations shown on Figure 2.2.1-1. The cross-sections were recently prepared based on geologic data from the remedial investigations and the investigations completed to support source control design at the Gasco and Siltronic properties. As illustrated in Figures 2.2.1-2 through 2.2.1-6, the primary difference between the shoreline geologic sequence and the upland geology is the absence of the upland fill layer in shoreline and riverbed areas. The shoreline slope is typically covered with a riprap layer that extends from top of bank to the river edge. Riverbed and sediments properties are discussed further in Section 2.2.3.

The *Gasco RI Report* (HAI 2007a) and the *Offshore Investigation Report* (Anchor 2008b) describe the location and composition of each of the geologic units in detail. A summary is presented in the following sections, by geological unit.

Surficial Fill Deposits

Large upland areas of the Gasco and Siltronic properties have been extensively filled through time, beginning with initial property development. Much of the fill at the Gasco property, especially in the northwestern and central areas, consists of poorly graded sands and silty sands that were likely hydraulically placed river-dredge material. Other areas of fill contain lampblack and/or pencil pitch material, solidified tars, oil, quarry reject rock, and building debris, which were incorporated into the fill when these areas were brought to current grade (HAI 2007a).

In addition to the overall build-up of ground surface elevations, filling activities at the Gasco property have resulted in the removal of two site drainage features, including a creek in the central portion of the property (parallel to the river) and a drainage feature/low area formerly located adjacent to the lampblack storage area, where surface water runoff and MGP wastes were discharged prior to construction of the effluent ponds in 1941 (HAI 2007a).

At the Siltronic property, the fill was found to consist of dredged materials, as well as imported quarry rock. Further, in places the fill has been found to contain impacts potentially attributable to re-distribution of MGP residues at the property and/or as a function of a multitude of sources that may have impacted dredged sediments prior to placement on the property. All fill-related activities at the Siltronic property were conducted by others after NW Natural sold the portion of the Siltronic property that it owned in 1962 (HAI 2007a).

Alluvial Deposits

Quaternary-age alluvial deposits are found underlying the surficial fill and range in thickness from approximately 30 feet near St. Helens Road to 190 feet thick adjacent to the Lower Willamette River near the eastern corner of the Gasco property/northern corner of the Siltronic property. Figures 2.2.1-2a through 2.2.1-2c show the varying thickness of alluvium near the river channel. The alluvial deposits thin towards the eastern corner of the Siltronic property (HAI 2007a).

As shown on Figures 2.2.1-2 through 2.2.1-6 the alluvium is composed of interbedded sand and silt layers, with a basal gravel layer present at the basalt contact in many areas. The cross-sections show that the alluvium is divided into two primary zones, an upper fine to medium sand and a lower medium sand. The upper fine to medium sand is shown as a green colored layer on the cross-sections and the lower medium sand is shown with green cross hatch pattern

on the cross-sections. The hydrogeologic setting section (Section 2.2.1.2) describes in more detail the contrasting hydrogeological properties of these two layers of alluvium. Soil borings completed in shoreline and offshore river areas indicate that the alluvium unit in shoreline and riverbed areas is similar in lithology to upland areas (Anchor 2008b).

Columbia River Basalt Group

The oldest and lowermost geologic unit of interest at the Project Area consists of the CRBG. The Miocene-age CRBG, composed of a series of individual lava flows, generally forms the base (bedrock) of the Portland Basin and outcrops immediately to the southwest of the Project Area in the Tualatin Hills. The confined bedrock aquifers in the Columbia River Basalts have historically been of significance regionally (HAI 2007a).

Figure 2.2.1-7 presents a bedrock surface elevation map. As shown on this figure, the basalt surface dips steeply to the northeast, with the top of the basalt occurring at a depth of approximately 35 feet below ground surface (bgs) near the southern corner of the Gasco property to depths of 215 feet bgs near the eastern corner of the Gasco property. Although, in general, the bedrock surface is anticipated to dip steeply from the Tualatin Hills towards the Lower Willamette River, undulations in the surface are observed (HAI 2007a), as depicted on Figure 2.2.1-7.

2.2.1.2 Hydrogeologic Setting

Groundwater occurs in three principal hydrologic zones beneath the Project Area and adjacent upland areas. These zones include the following, listed from top to bottom: 1) unconfined surficial fill water-bearing zone (WBZ); 2) semi-confined alluvial WBZ; and 3) confined bedrock aquifers in the CRBG (HAI 2007a). The general distribution of these zones is illustrated on Figure 2.2.1-2 through 2.2.1-6.

The *Gasco RI Report* (HAI 2007a), *Environmental Monitoring Report for the Third and Fourth Quarter 2008* (HAI 2009), and *Offshore Investigation Report* (Anchor 2008b) presents data on groundwater occurrence across the Project Area. The findings indicate the following general pattern of groundwater flow: groundwater in the surficial fill WBZ and alluvium WBZ is recharged from underflow originating in the hills west of the Project Area and from infiltration of incident precipitation. The surficial fill WBZ and the alluvium WBZ discharge to the Lower Willamette River.

Since 1995, groundwater elevation data have been collected in upland wells on a quarterly basis as part of the routine environmental monitoring program for the Gasco property. Water level maps and groundwater level data tables across the Project Area are presented in the *Environmental Monitoring Report for the Third and Fourth Quarter 2008* (HAI 2009) Figures 2.2.1-8 through 2.2.1-11 depict groundwater levels measured on December 4, 2008.

The *Gasco RI Report* (HAI 2007a) and the *Offshore Investigation Report* (Anchor 2008b) describe groundwater occurrence in the Project Area. The reports describe the properties of each hydrologic zone, including the relationship between each unit and the Lower Willamette River. A summary is presented below.

Surficial Fill WBZ

The saturated thickness of the surficial fill WBZ typically ranges from 1 to 5 feet at locations adjacent to the Lower Willamette River, to between 5 and 25 feet thick at the central and western portions of the upland property areas. At certain locations, the existence of saturated conditions appears seasonally dependent (HAI 2007a).

As depicted on Figure 2.2.1-8, the general groundwater flow direction within the surficial fill WBZ is to the northeast, toward the Lower Willamette River. The *Gasco RI Report* (HAI 2007a) notes some localized variability with regard to the flow direction near the southern portion of the Siltronic property where an apparent groundwater divide is present. Groundwater south of the divide appears to flow south and southwest toward North Doane Lake while groundwater north of the divide appears to flow north toward the Gasco property and the Lower Willamette River (HAI 2007a).

The horizontal hydraulic gradient across the upland areas was found to range from 0.015 to 0.020. A downward vertical gradient between the surficial fill WBZ and the alluvial WBZ was reported, ranging from 0.052 to 0.392. Hydraulic conductivity of the surficial fill WBZ was estimated based on slug testing results. Estimated conductivities ranged from 9.7×10^{-5} centimeter per second (cm/sec) to 9.1×10^{-3} cm/sec, with an anomalously low hydraulic conductivity of 2.4×10^{-6} cm/sec measured at a well within the effluent pond area (HAI 2007a).

Alluvial WBZ

As described in the Geologic Setting section (Section 2.2.1.1), the upland alluvium is divided into an upper fine sand and a lower medium sand. The basal gravel is present in some areas

between the bottom of the lower medium sand and basalt bedrock. As shown on the geologic cross-sections in Figures 2.2.1-2 through 2.2.1-6, the upper fine sand unit contains a higher percentage of low permeability silt interbeds. There are fewer silt interbeds in the underlying medium sand unit, but a silt aquitard is present in the medium sand, as further explained below. The upper fine sand is shown on the geologic sections with a green solid color, and the lower medium sand is shown with a green hatch pattern.

The cross-sections also show that the depth to bedrock increases from north to south along the river shoreline, so the thickness of the alluvium increases correspondingly as the bedrock deepens. As shown on Figures 2.2.1-2a through 2.2.1-2c, the thickness of the upper fine sand unit thickens from north to south along the shoreline.

A silt aquitard is present within the lower medium sand unit. Based on mapping of data from site borings, the aquitard is continuous but variable in thickness across the Project Area between elevation -100 and -120 feet City of Portland datum (CPD). (The vertical data used in various studies and their relationships are discussed in Section 2.2.2).

Pilot extraction wells PW3-85 and PW3-118 were installed in 2007 at the locations shown on the Figure 2.2.1-1. The pilot wells were pump tested at varying discharge rates for the purpose of determining aquifer properties. The pump test results were used in the preparation of a ModFlow groundwater model for the Project Area (SSPA 2008). Site-specific groundwater elevation data from the monitoring wells were used to calibrate the model. Based on the pump test and model results, the hydraulic conductivity of the upper fine sand unit of the alluvium is about 0.004 cm/sec. The hydraulic conductivity of the lower medium sand unit is estimated to be 0.07 cm/sec.

For the purpose of preparing potentiometric surface maps, the alluvial WBZ has been subdivided into three units: the upper (typically shallower than 85 feet bgs), intermediate (typically 85 to 125 feet bgs), and lower (typically greater than 125 feet bgs) intervals. For the purpose of mapping groundwater elevations, hydrology data from monitoring wells generally screened in these elevation ranges were contoured together. This convention is continued in the following discussion,

The typical groundwater flow direction in the upper alluvial WBZ is north-northeast towards the Lower Willamette River, with a substantial flattening of the gradient within 300 feet of the

riverbank where a very flat, tidally influenced gradient exists. Very low gradients are common within the zone 300 feet from the river shoreline, with an occasional reversal of flow direction (i.e., away from the Lower Willamette River) being noted (HAI 2007a). Figure 2.2.1-9 depicts groundwater elevations in the upper alluvial WBZ, as measured in December 2008.

Groundwater flow in the intermediate alluvial WBZ is generally northeast, towards the Lower Willamette River, with an average hydraulic gradient measured to be 0.010 (HAI 2007a). Figure 2.2.1-10 depicts groundwater elevations in the intermediate alluvial WBZ, as measured in December 2008.

The interpretation of flow direction with in the lower alluvial WBZ is limited by the small number of wells screened in this zone. However, there is some evidence that this zone has a more northerly component than the shallower alluvial zones (HAI 2007a). Figure 2.2.1-11 depicts groundwater elevations in the lower alluvial WBZ, as measured in December 2008.

Vertical gradients between the upper and intermediate alluvial WBZ in wells at the Gasco property are reported to typically range from -0.002 to -0.02 (upward) and between 0.002 and 0.07 (downward), with the downward gradient occurrence predominating. Vertical gradients between the upper and intermediate alluvial WBZ in wells at the Siltronic property are reported to typically range from 0.03 to 0.12 (downward) and -0.03 (upward). A predominantly upward vertical gradient is typical between the lower and intermediate alluvial WBZ on both the Siltronic and Gasco properties (HAI 2007a).

Confined Columbia River Basalt Aquifer

WBZs within the CRBG zone are not monitored in the Project Area (HAI 2007a).

Relationship between Groundwater and River Elevations

Discharge to the river is mostly through the alluvial WBZ, which extends out under the river bottom. Hydrology monitoring of upland wells and the Lower Willamette River water levels has shown that there is a very good hydraulic connection between the upland alluvial WBZ and the Lower Willamette River. Water levels in the nearshore upland wells screened in the alluvium respond nearly instantaneously to fluctuations in river levels. Water levels in the nearshore wells also fluctuate at nearly the same magnitude as the river levels. Thus, the groundwater levels in the nearshore alluvial WBZ wells are continuously changing in response to the diurnal tidal fluctuations in the river.

The surficial fill WBZ is not linked to river levels in the same way as the alluvial WBZ. The only linkage seen between the river and surficial fill WBZ is in those wells immediately adjacent to the river, in cases where the well is screened in nearshore fill. Although seasonal groundwater discharge from the surficial fill to the river is expected, there appears to be a degree of isolation between the fill and the Lower Willamette River. The silt layer likely impedes groundwater flow into the river; however, the tidal response seen in the alluvial fill indicates that it does not act as a complete barrier to flow (HAI 2007a).

Groundwater Discharge to the Project Area

Two areas of iron (ferric hydroxide) staining have been observed along the riverbank, which might indicate the presence of either high elevation groundwater seeps or surface discharge. Iron staining is present across a 25-foot length of rock located above high tide level on rock material overlying fine-grained beach material immediately south of the main Fuel and Marine Marketing (FAMM)/Koppers, Inc. (KI) dock walkway. Iron staining is also present beneath the WR-107 stormwater and industrial wastewater outfall (shown on Figure 2.1.1-1), along the path of outfall discharge to the Lower Willamette River, which appears to be solely due to this outfall discharge. Groundwater seepage discharge has not been observed in either location during quarterly riverbank inspections, suggesting that discharge is seasonal or was historical (HAI 2007a), but is no longer frequent enough to be considered an active pathway.

At or below water surface, offshore seepage studies were conducted in the Project Area as part of the LWG Round 2 sampling for the Portland Harbor Superfund Site RI and for the *Offshore Investigation Report* (Anchor 2008b). Offshore investigations conducted by Anchor QEA used multiple lines of evidence to measure the amount of groundwater that discharges from the upland portion of the Project Area through river sediment and to the river. The offshore investigations conducted by Anchor QEA deployed ultrasonic seepage meters installed at the mudline to directly measure seepage rates through the transition zone into the river. These seepage data were combined with seepage data from previous LWG studies. Data from the two studies were combined to estimate a range of total seepage rates from 225 to 253 gallons per minute (GPM) in the Project Area (Anchor 2009b). These seepage rates are consistent with the average groundwater discharge rate determined in capture zone studies conducted using the upland ModFlow model. The *Offshore Investigation Report* (Anchor 2008b) notes that considerable variation in seepage rates was observed across the Project Area, ranging from strongly positive to net negative fluxes to the Lower Willamette River over the periods of meter deployment. In addition, there was no consistent correlation between seepage rate fluctuations

over time at each station and river level or rainfall, although there were some marginal correlations noted for brief periods at a subset of the meter stations. However, the seepage rate generally decreased with distance from the shoreline (Anchor 2009b).

Groundwater/Surface Water Transition Zone

The mixing zone underlying a surface waterbody where hydraulic conditions change from a groundwater-dominated system to a surface water-dominated system is referred to as the groundwater/surface water transition zone. Water in this area is termed "transition zone water" or TZW.

The definition of the groundwater/surface water transition zone used for this project will be consistent with that used for the Portland Harbor Site, as presented in the *Portland Harbor Programmatic Work Plan* (Integral et al. 2004), which states:

> "The groundwater/surface water transition zone (Transition Zone) is the interval where both groundwater and surface water comprise some percentage of the water occupying pore space in the sediments. The physical and biochemical properties of water within the Transition Zone reflect the effects of mixing between groundwater and surface water that occurs within the sediments. The Transition Zone is significant to the RI/FS because it is the location where important chemical and biological transformation processes occur that affect the properties of chemicals that may be present in groundwater, and it encompasses the sediment bioactive zone where benthic infaunal ecological receptors reside.
>
> The zone of mixing between groundwater and surface water that defines the size of the Transition Zone exhibits temporal and spatial variability due to changes in gradients between the surface water and groundwater. The depth and degree of mixing is anticipated to be relatively small in shallow river sediments that are in contact with the shallow groundwater flow system. In these areas, relatively high groundwater hydraulic heads within the shallow groundwater flow system adjacent to the river dominate the river stage fluctuations. High river stages will change the relative hydraulic gradient and thus reduce the discharge rate from the shallow groundwater flow system through the sediments, but will not likely result in a significant overall increase in the depth of mixing of surface water with groundwater. Groundwater is expected to comprise a greater percentage of the water in the shallower water bioactive zone than deeper water locations where the deeper flow systems discharge to the river."

2.2.2 Hydrology

The hydraulic conditions of the Lower Willamette River were studied by the LWG during the Portland Harbor Site RI/FS process and the information collected was presented in several documents developed as part of the RI process. A short description of regional datum, regional surface water hydrology, and Lower Willamette River hydrodynamics is presented below as described in the *Portland Harbor Programmatic Work Plan* (Integral et al. 2004) and the *Comprehensive Round 2 Report* (Integral et al. 2007). For more detailed information, please see the original reference documents.

Regional Datum

River stage is recorded relative to a specific elevation or datum. Several vertical datum are used in the Lower Willamette River area and, thus in the data presented in this Work Plan. Consistent with the Portland Harbor remediation project, the bathymetric data referenced herein are presented relative to the North American Vertical Datum of 1988 (NAVD88). Groundwater levels, as well as other geologic and hydrogeologic data (geologic cross-sections, etc.), which were taken from other source reports, are presented relative to the CPD, consistent with the presentation in the original report.

Other common datum include the National Geodetic Vertical Datum of 1929 through the Pacific Northwest Supplemental Adjustment of 1947 (NGVD29/47) (also referred to as the Sea Level Datum of 1929 or MSL), the Columbia River Datum (CRD), and the Portland River Datum (PRD). The relationship between these datum is depicted on Figure 2.2.2-1, and explained in detail in the *Portland Harbor Programmatic Work Plan* (Integral et al. 2004). In summary, the PRD is used for river stage data reported at the Morrison Bridge Gauge (RM 12.8). The USACE defines PRD as 1.55 feet above NGVD29/47 and CRD (as defined at the Morrison Bridge) as 1.85 feet above NGVD29/47 (USACE 1991; David Evans and Associates, Inc. [DEA] 2001 as referenced in Integral et al. 2004). The NAVD88 is a benchmark specific correction to NGVD29/47; in the Lower Willamette River, NAVD88 is 3.15 feet below NGVD29/47. The CPD datum is 1.37 feet below NAVD.

Regional Surface Water Hydrology

The hydraulic conditions of the Willamette and Columbia Rivers influence river stage in the Project Area. In its natural state, highest water on the Columbia River typically occurs during spring snowmelt in late May or early June, followed by receding water levels with lowest water

typically occurring during October and early November. Due to the size of its drainage basin, the Columbia River stage is not affected by localized precipitation events (Integral et al. 2004).

The Lower Willamette River is a major tributary to the Columbia River. The Lower Willamette River stage follows the same seasonal pattern, with highest flows typically seen between September and early November. Unlike the Columbia, the Lower Willamette River is affected by localized precipitation events (Integral et al. 2004). These trends are depicted on Figures 2.2.2-2 through 2.2.2-4 (Integral et al. 2007), which show plots of daily river stage data, daily mean discharge data, and average annual discharge from October 1, 1972 through June 30, 2006.

The most apparent influence of the Columbia River on Lower Willamette River stage is during spring, when high water in the Columbia River acts as a hydraulic dam to the Lower Willamette River, resulting in rises in river stage. This effect diminishes with the reduction in Columbia River level in the summer (Integral et al. 2004).

These two rivers are, in turn, affected by the operation of a series of federal and non-federal dams along their length. The dams reduce spring high water flows through the retention and storage of water in reservoir pools at each dam. The stored water is released during the summer and fall, increasing river levels above their naturally occurring low water stage. During winter snow and rain events, the reservoir capacity is used to dampen hydrographic peaks and valleys by storing water and releasing it at the end of the storm (Integral et al. 2004).

Tidal action also has a strong effect on hydraulic conditions in the Project Area, most strongly when the river is at a low stage. There are two high tides and two low tides daily. Tidal action can influence water levels by up to 3 feet in the Portland Harbor. The combination of large tide flood tides and low river stage commonly results in a reversal of river flow.

Lower Willamette River Hydrodynamics

Both collection of empirical information (flow measurements) and hydrodynamic/sediment transport modeling are being used for the Portland Harbor Site RI to support the understanding of the river hydrodynamics in the Lower Willamette River. Flows were measured during three time-series bathymetric surveys using an Acoustic Doppler Current Profiler (ADCP). The ADCP data provided a snapshot of current observations across a range of flow and tidal conditions. The data were used to develop and calibrate a preliminary hydrodynamic model for the Portland Harbor Site RI/FS (Integral et al. 2007). The empirical data and preliminary

modeling show that river velocities near the Project Area are higher in the deeper, channel areas and decrease towards the shoreline. Empirical data and preliminary modeling show higher river currents during most high flow conditions (under both mid-ebb and mid-flood tides), and reverse flow during low flow/mid-flood tide conditions. The preliminary model is currently under revision for the Portland Harbor Site FS.

2.2.3 Lower Willamette River Characteristics

The characteristics of the Lower Willamette River were studied by the LWG during the Portland Harbor Site RI/FS process, and the information collected is presented in several documents developed as part of the RI process. A short description of bathymetry, sediment texture, and sediment transport characteristics of the Lower Willamette River is presented below, derived from the *Portland Harbor Programmatic Work Plan* (Integral et al. 2004) and the *Comprehensive Round 2 Report* (Integral et al. 2007). The original documents contain greater detail.

2.2.3.1 Bathymetry

The LWG has conducted four major mulitbeam bathymetric surveys of Lower Willamette River riverbed elevations, including the Project Area, in support of the Portland Harbor Site RI/FS process. Surveys were conducted in January 2002, July to September 2002, May 2003, and February 2004. In 2009, the National Oceanic and Atmospheric Administration (NOAA) conducted a multibeam survey of the Lower Willamette River. The 2009 data were used to develop the bathymetry map shown on Figure 2.2.3-1. As shown on this figure, the riverbank in the Project Area drops sharply from the uplands to channel depth, where the riverbed deepens to elevation of -45 to -55 feet NAVD88.

2.2.3.2 Sediment Physical Characteristics

The *Comprehensive Round 2 Report* (Integral et al. 2007) discusses the sediment texture, sediment stability, and suspended sediment data collected across the Lower Willamette River. The following subsections summarize information presented in this report that pertains to the Project Area.

Sediment Texture

The LWG collected texture data (grain size, specific gravity, and total solids) from sediment samples collected in the Lower Willamette River as part of the RI. Additional sediment texture data were available from non-LWG sources. The LWG used the combined data sets to develop

the sediment texture and sediment total organic carbon (TOC) maps shown on Figures 2.2.3-2 and 2.2.3-3, respectively. As shown on these maps, much of the nearshore portions of the Project Area contain 60 to 80 percent or higher fines, while areas in the navigational channel are dominated by sands. Finer grained material is generally associated with low-energy areas (such as nearshore areas) and coarser grained material in high-energy or dredged areas. This pattern is consistent with the hydrodynamic patterns discussed above. Higher TOC is often associated with finer grained sediments at many sites. However, at the Project Area, the MGP wastes in the sediment add to the TOC content and obscure any such relationship, if it exists. A map of subsurface sediment texture is shown on Figure 2.2.3-4.

Sediment Stability

Sediment erosion rates and critical erosion stress values for Lower Willamette River sediments were measured directly as part of the Portland Harbor Site RI hydrodynamic data collection, and the results were summarized in the *Comprehensive Round 2 Report* (Integral et al. 2007). A Sedflume system was used to subject the sediment cores to various flows to produce shear stresses ranging from 0.1 to 10 Newtons per square meter (N/m^2) on the sediment surface. Erosion rates were measured under these conditions, and the data were used to calculate critical erosion velocity shear stress values (defined as the shear stress causing erosion at 10^{-4} cm/s) from 0 to 25 cm below the mudline at 5-cm depth intervals (Integral et al. 2007). One Sedflume core was taken along the Gasco/Siltronic shoreline at approximately the property boundary.

This information, along with the fine-grained nature of the sediments noted above, suggests that the shoreline sediments are in a relatively stable or net depositional environment under typical flow conditions. This is also consistent with observations during the Tar Body Removal action post-construction monitoring (Anchor 2007d, Anchor 2008d, Anchor QEA 2009b), which indicated a several cm layer of fines that was deposited on top of the sand caps placed over a portion of the Project Area and was present two years later. Portland Harbor Site FS modeling will help determine to what extent extreme flow conditions might cause erosional events at or near the Project Area.

However, per Integral et al. (2007) this portion of the river "…narrows to an average cross-sectional area of approximately 57,000 square feet (Map 4.5-2) [shown on Figure 2.2.3-5 of this Work Plan]. This stretch of river is a relatively high-energy sediment transport zone. Suspended sediments are likely transported through this reach, but the degree of bedload sediment deposition and transport is likely a function of temporally varying hydrology." It

appears that many of these LWG observations apply more readily to the river channel and, given the observations about fine sediment deposition and stability, temporal variability of the hydrology appears to be a key factor for sediment stability. Thus, under some future flow conditions some apparently stable nearshore fine sediments may erode.

In addition, local prop wash scour in front of and near the main dock at the Project Area would be expected due to barge and ship docking. Fuel barges (more frequently) and large ocean-going ships (less frequently) dock here. However, the degree and extent of prop wash scour near the dock has not been formally measured or estimated.

Suspended Sediment

Table 4.4-1 of the *Comprehensive Round 2 Report* (Integral et al. 2007) presents total suspended solids (TSS) and TOC data collected from Lower Willamette River surface water samples in support of the hydraulic modeling. During April 2006, six vertically and horizontally integrated surface water samples were collected at east, west, and mid-channel points along a transect at RM 6.3. Three samples were collected during mid-flood tide and three during mid-ebb tide. The TSS results ranged from 7 to 9 milligrams per liter (mg/L). TOC results ranged from 1.8 to 2.1 mg/L. The Portland Harbor Site RI will also present an additional round of surface water sampling, and this information will be included in future summaries when available.

The *Comprehensive Round 2 Report* (Integral et al. 2007) also presents in situ suspended particle size measurements collected from a sampling station located on the east side of the Lower Willamette River at RM 6.3. The maximum grain size range was measured at 4.1 micrometers (μm), 40.66 μm, and 274.53 μm for the d10, d50, and d90 percentile grain size distributions, respectively.

2.2.4 Shoreline Conditions and Structures

This section discusses shoreline conditions and structures for the Gasco and Siltronic properties, by property.

2.2.4.1 Gasco Property

As described previously, the shoreline slopes steeply from the upland areas of the Gasco property to the Lower Willamette River, with some riverbank areas armored with riprap and other areas not armored. A shallow shelf extends from the dredged navigational channel to the

toe of the shoreline slope except in a small area where the tar body removal action (described in Section 2.7.2.3) occurred. This shelf is about 100 feet wide and very gently sloped (approximately 9H:1V). It acts to buttress the existing riprap armor on the shoreline and minimizes undercutting and toe erosion. The steeper (designed at 2.5H:1V) shoreline slope in the tar body removal area was designed with a 12- inch cap layer overlain by a 6-inch armor layer (Anchor 2005).

Average monthly river stages, as measured at the Portland Harbor from 1973 to 1990 and converted to the CPD, range from a low of approximately 6.3 feet msl during August and September, to a high of 10.9 feet msl during May and June (USACE 1991). Several structures are located along the shoreline, including the NW Natural Gasco Dock and Outfall WR-107. Figure 2.1.1-1 shows the locations of key shoreline structures. Information pertaining to the shoreline presence of MGP materials and sheen, sediment erosion/accretion, and shoreline structures is presented below. The photographs presented in Figures 2.2.4-1 through 2.2.4-3 illustrate recent shoreline conditions.

Shoreline MGP Materials and Sheen

NW Natural has implemented a river surface and shoreline inspection program since 1998. The scope of the program, inspection frequency, and results are summarized in the *Gasco RI Report* (HAI 2007a). As described in the *Gasco RI Report*, the program monitors the river surface for the presence of sheen and evaluates the shoreline for the presence of tar, oil, discoloration, wildlife, groundwater seeps, or other items of interest. The inspections documented the presence of a body of tar adjacent to the shoreline in the area of boring B-29 and the presence of rounded tar "pebbles and cobbles" along the beach downstream of this area. The tar body was removed in 2005 under the non-time critical removal action described in Section 2.7.2.3. Some areas of tar "pebbles and cobbles" remain along the beach. A sporadic sheen has been noted periodically on the river surface during late summer/early fall, during seasonal low river stage (below 6 to 8 feet msl). The sheen is typically in the form of "short-lived half dollar-sized blebs" produced during the escape of gas (likely methane from decomposition) from underlying sediments (HAI 2007a).

In addition, a large sheen was noted in September 2007 near the Siltronic property line. NW Natural subsequently installed a boom and instituted regular inspections for sheen in this area. During the monitoring period from September 2007 through July 2009, smaller, quickly dissipating sheens have been identified in this area, but none equaling the lateral extent of the

September 2007 event. A larger sheen that extended beyond the limits of the boomed area was observed on August 4, 2009. Though the exact source of the sheen could not be determined, NW Natural is preparing a proposal to DEQ that would extend the overall boomed area further upriver and downriver of the Gasco/Siltronic property boundary.

Shoreline Sediment Erosion/Accretion

Diver observations and sampling in the location of the former Tar Body Removal Action Area indicate that up to 12 cm of sandy silt material were deposited in the nearshore pilot cap area during winter 2005/2006 high flow conditions (Anchor 2008d). Additional diver observations and sampling conducted through August 2009 have shown that this depositional layer has consistently remained between 8 to 12 cm. Concurrent observations and sampling at locations channel ward of the pilot cap area within the navigation channel have consistently showed a depositional layer of sandy silt material from 2 to 5 cm. Monthly visual monitoring of the nearshore area adjacent to the pilot cap area has shown no signs of accretion. It is unknown to what extent this may have occurred along the rest of the property's shoreline.

Currently, there is some potential for erosion of soils from the shoreline to the river. The majority of the shoreline on the property is vegetated or covered with riprap. However, some locations of minimally vegetated soils exist downstream of the KI pipeline and that could be transported to the river, if erosion occurs.

Shoreline Structures

Major shoreline features (shown on Figure 2.1.1-1) on the Gasco shoreline include:

- The main NW Natural dock (which includes both fixed and floating portions)
- Outfall WR-107
- An abandoned loading dock in disrepair and a narrow pedestrian pier upstream of Outfall WR-107
- An emergency slide for deploying spill containment booms is located downstream of the KI pipeline
- A pedestrian pier located downstream of the emergency slide.

The *Gasco RI Report* (HAI 2007a) summarizes the historical and current uses of the main dock and outfall structures. Additional shoreline feature observations are presented in the *Updated Bank Stabilization Alternative Analysis*, Appendix F of the *Groundwater Focused Feasibility Study* (GWFFS; Anchor 2007f), which evaluated alternatives for interim upload source controls.

Constraints due to the presence of these structures will need to be factored into the cleanup action design.

The NW Natural Gasco dock has existed in the central shoreline area since 1936. The dock is actively used by KI and FAMM for import and export of products related to their operations. KI operates an aboveground pipeline running from the dock to a storage tank in its lease area to pump liquid coal tar pitch received via barge. Pipelines for fuel transport run between the dock and several tanks on the FAMM lease area. Additional details of these operations are presented below in Section 2.5.1. A second dock was removed from the south end of the shoreline in 1957 (HAI 2007a).

Outfall WR-107 is located in the southeastern portion of the Gasco shoreline. It discharges stormwater collected from approximately 3.4 acres of the FAMM lease area within two tank berms. Water from this area is pumped through a single oil water separator operated by FAMM and flows into a final sump prior to discharge through WR-107. Stormwater collected in a sump on the FAMM fuel loading dock is pumped through an oil-water separator also operated by FAMM prior to discharge onto the ground in the eastern portion of the two tank berms. Truck wash water draining through a catch basin at the FAMM truck wash station also flows into the sump in the western tank berm and is included in the discharge through WR-107. Process water from LNG operations and groundwater seepage into the LNG containment basin on the Gasco property is treated prior to discharge to the City of Portland's sewer system under a City of Portland permit. Currently, no treated process water from the LNG operation or basin is being discharged from Outfall WR-107. Two other small stormwater outfalls are located in shoreline areas; permits are not required for discharges associated with these outfalls (HAI 2007a). The *Gasco RI Report* (HAI 2007a) and the *Source Control Data Gaps Evaluation* (Anchor 2006d) summarize the stormwater systems and permits related to Outfall WR-107.

2.2.4.2 Siltronic Property

The *Draft Siltronic Conceptual Site Model* (attached to the *Comprehensive Round 2 Report;* Integral et al. 2007) summarizes the shoreline structures present or historically present along the shoreline of the Siltronic property. A tug fueling dock was in operation between approximately 1930 and 1950 (Figure 2.1.2-1). The fueling dock had two large aboveground fuel tanks. The fueling dock is no longer present. In addition, two docks were removed from the northeastern portion of the shoreline in 1957 (Figure 2.1.2-1).

Three outfalls are located along the Siltronic property shoreline (shown on Figure 2.1.2-1). One combined stormwater/NPDES outfall (WR-66) is located in the northwest corner of the property. This outfall discharges DEQ-permitted effluent from Siltronic operations and stormwater directly to the river. It is a fully submerged outfall that is supported in place by pilings. Two stormwater outfalls (WR-67 and WR-287) are located in the northeastern portion of the shoreline. These outfalls discharge stormwater directly to the river. Stormwater is also discharged from the Administration Building parking lot to the river via a connection to the City of Portland's outfall OF-22C. The *Draft Siltronic Conceptual Site Model* (attached to the *Comprehensive Round 2 Report;* Integral et al. 2007) summarizes the permits related to these outfalls.

2.2.5 Climatology

As part of the Gasco RI, climate and meteorological data and descriptive information were compiled from NOAA's National Weather Service office in Portland, the Portland International Airport weather station, and from a weather monitoring station established on the Gasco property in December 2001. Details are provided in the *Gasco RI Report* (HAI 2007a), from which the following summary was obtained.

> ***"Local Climate***
> The climate of Portland, Oregon is classified as a modified west coast marine climate. Portland is located approximately 65 miles inland from the Pacific Ocean and midway between the Coast Range and the Cascade Range. The Coast Range (30 miles west of Portland) provides the Portland area limited shielding from Pacific Ocean storms, while the Cascade Range (30 miles east of Portland) provides a barrier to moisture-laden westerly winds, resulting in moderate rainfall for the region. Further, the Cascades act as a barrier inhibiting the movement of cold air masses from arctic regions into western Oregon. However, such cold masses do occasionally make it eastward to the Portland area through the Columbia River Gorge.
>
> Temperatures in the Portland area are generally mild. Temperatures below zero degrees, typically caused by easterly winds emanating from the Columbia Gorge, have occurred only six times in the past 125 years. Typical temperatures during winter reach to 40s during the day, dropping to the mid 30s at night. Spring typically brings wet and cool weather in March and April, while May and June become warmer and drier. Temperatures in May and June typically range in the 60s and 70s. Summer in Portland typically has sustainable daily temperatures reaching the 80s. Northwesterly winds during the summer tend to bring cool air

from the Pacific Ocean down along the Columbia River, with a lowering effect on temperatures. Temperatures over 100 degrees are rare. Rains and cooler temperatures typically begin occurring in Portland in mid-October, with highs in the 50s and 60s.

Destructive storms are not common in the Portland area. Surface winds seldom exceed gale force [wind speeds sustained at 50 miles per hour (mph)]. Thunderstorms can occur any time, but are not common. Thunderstorms during Winter and Spring are weak, typically producing brief gusty winds and small hail. On the northeast side of Portland, which includes the Portland Airport weather monitoring station, the prevailing wind direction generally follows the orientation of the Columbia Gorge, with east-southeastern or northwestern predominant wind direction throughout the year. Hourly average wind speeds at the Portland Airport monitoring station range from a low of 6.5 mph in September and October, to a high of 10 mph in January.

Ninety percent of the annual precipitation in Portland occurs from October through May, falling mainly as rain. Nine percent of annual rainfall occurs between June and September, with only 3% of this in July and August. Average annual rainfall in the Portland area is 36.3 inches at the airport. Monthly average rainfall varies from 0.63 inches in July, to 6.13 inches in November. The greatest monthly rainfall measured at the Portland Airport was 12.83 inches in January 1953."

Site-Specific Wind Direction and Speed

Beginning December 16, 2001, weather parameters (wind speed, wind direction, outside temperature, and precipitation) have been collected at the Gasco property on a one-half hour basis (through February 2002) to an hourly basis (March 2002 to 2007) at a weather station mounted in the vicinity of the carbon treatment unit west of the former tar pond [effluent pond] area. Daily and monthly summaries of weather data collected during 2005 are included in Appendix J [of the *Gasco RI Report*]. Additionally, a monthly summary of rainfall, average wind speed, and dominant wind direction, based on all data collected to date, is included within Appendix J [of the *Gasco RI Report*].

Weather station monitoring data collected to date (Appendix J [of the *Gasco RI Report*]) indicate wind speeds at the property ranging from a monthly average low of 1.7 miles per hour (October 2002) to a monthly average high of 4.5 miles per hour (December 2001).

A wind direction chart included in Appendix J [of the *Gasco RI Report*] depicts the frequency of occurrence of wind direction at the Gasco as measured during

each hourly monitoring event since March 15, 2002. To date (through December 2005) it appears the predominant wind direction in late Winter and early Spring (December through March) is north, while the remainder of the year the predominant wind direction is south and southeast. The preceding suggests that wind direction in the vicinity of the Gasco property is influenced by the Tualatin Mountains, which trend north and south and are located immediately west of the site."

2.3 Habitat Description

Section 2.0 of the Draft BERA (Windward 2009) presents details of the ecological habitat types and species present within the Portland Harbor Site. Additional information on bank and riparian habitat is presented in the City of Portland's 2008 Natural Resources Inventory Update (NRIU) (City of Portland 2008). The 2008 NRIU is a proposed draft and subject to revision. The following sections present a brief summary of the general types of open-water and bank/riparian habitat present in the Project Area, based on information provided in these sources. The original documents include greater detail.

Numerous organisms are present in and make use of the Lower Willamette River. The draft BERA (Windward 2009) divides them into the following general groups: benthic invertebrates, fish, wildlife, amphibians and reptiles, and aquatic plants. Each group makes an important contribution to the health and function of the river based on its trophic level, its abundance, and its interaction with the physical environment. A very detailed discussion on the species present and their habitat use is presented in the draft BERA (Windward 2009) and is not reiterated herein.

2.3.1.1 Open-Water Habitat

Open-water habitat in the Lower Willamette River is characterized by a developed navigation channel and shoreline. Most open-water habitat in the Portland Harbor Site is in the main river channel, but also includes several shallower backwater sites. However, shallow water habitat in the Project Area is limited to the nearshore area between the shoreline and navigational channel. The deep open water provides foraging habitat for fish and wildlife that feed in the water column. Shallow water habitats provide refuge for juvenile salmonids as well as greater foraging opportunities for birds and mammals (Integral et al. 2007).

The Draft BERA (Windward 2009) describes the three types of open-water habitat of the Lower Willamette River as: 1) unconsolidated sediments in the deeper water (greater than approximately 20 feet CRD) of the navigation channel and lower channel slopes; 2) unconsolidated sediments in water depths less than 20 feet CRD in gently sloping nearshore areas (e.g., beaches and benches) and on the upper channel slopes; and 3) developed shoreline (e.g., rock riprap, sheetpile, bulkheads). Each of these three habitats types is present in the Project Area.

The Draft BERA (Windward 2009) provides further description of the open-water habitat as follows:

> "The navigation channel habitat is subject to variable (seasonal and annual) hydrodynamic forces, the impacts of navigation, natural sediment deposition, bed load transport/erosion, and periodic navigational dredging. These forces vary spatially throughout the system, largely as a function of the channel cross-sectional area, resulting in both relatively stable and unstable sedimentary environments and patchy infaunal and epibenthic communities that are characteristic of the local physical regime. The physical sedimentary regimes are a function of hydrodynamic conditions caused by the local riverbank morphologies in nearshore areas, and overall channel characteristics in more open water habitats. Areas away from frequent anthropogenic disturbance support infaunal invertebrate communities that are characteristic of large river systems. Conversely, exposed nearshore areas, particularly around active berths, docks, and boat ramps, tend to have more limited benthic communities due to the greater physical disturbance in these areas. The hard surfaces of the developed shoreline provide habitat for an epibenthic community."

2.3.1.2 Bank and Riparian Habitat

As shown on Figures 2.2.4-1 through 2.2.4-3, Project Area shoreline bank conditions are different between the Gasco and Siltronic properties. The NRIU (City of Portland 2008) classified bank habitat to be primarily vegetative riprap, with an approximately 1,100-foot beach area along the northeastern shore of the Gasco property (Figure 2.3.1-1). A second beach area is located off-site, adjacent to the Siltronic property (Figure 2.3.1-1).

Bank and riparian habitat is described in the NRIU (City of Portland 2008) as follows:

> "The beaches and near-shore shallow water areas provide important habitat for salmonids that are listed as threatened species under the Endangered Species Act, including Lower Columbia River Chinook salmon and Lower Columbia River steelhead trout (ODFW 2005). Fish assemblages within this reach are expected to be oriented more toward non-native warm-water fish and opportunistic indigenous fish that do not appear to be as adversely affected by development as salmonid species. These species include peamouth, largescale sucker, and carp, which were found in abundance adjacent to shorelines by Farr and Ward (1993). Developed shoreline areas provide habitat opportunities for warm-water species, particularly bass and sunfish (ODFW 2005). The open water of the Lower Willamette River provides feeding areas for birds such as ducks, cormorants, gulls, herons; and mammals such as river otter and mink. Insectivores such as swallows and bats also forage over the water. A wildlife migration corridor crosses the river in this reach providing a connection between Forest Park and Smith and Bybee Wetlands."

The NRIU (City of Portland 2008) mapped special habitat areas (SHAs) at a coarse level and includes areas federally designated as Critical Habitat . SHAs within or near the Project Area include the Lower Willamette River and associated beaches and shallow water area and the BNSF railroad bridge. These areas are included in BERA for the Lower Willamette River.

2.4 Human Access and Use

Information related to human access and use of Portland Harbor Superfund Site areas was compiled and presented in the *Comprehensive Round 2 Report* (Integral et al. 2007). A summary of information pertaining to the Project Area is presented below. The *Portland Harbor BHHRA* was submitted to EPA in September 2009. The BHHRA provides an updated description of the physical and biological setting of the area as it pertains to potential human uses, including specialized groups that may use the river for various activities.

> "Portland Harbor and the Lower Willamette River have served as a major industrial water corridor for more than a century. Industrial use of the Study Area and adjacent areas has been extensive. The majority of the Study Area is currently zoned for industrial land use and is designated as an "Industrial Sanctuary" on the Portland Comprehensive Plan Map (City of Portland 2001). The Portland industrial sanctuary policy is designed to encourage the growth of industrial activities in the city by preserving some industrial land primarily for manufacturing purposes. The Guild's Lake Industrial Sanctuary Plan (GLISP) is intended to preserve and enhance industrial land in the Guild's Lake area generally bounded by Vaughn Street on the south, the St. Johns Bridge on the

north, Highway 30 on the west, and the Lower Willamette River on the east (City of Portland 2001).

Much of the shoreline in the Study Area includes steeply sloped banks covered with riprap or constructed bulkheads, with human-made structures such as piers and wharves over the water in various locations. A comprehensive update of Portland's Willamette Greenway Plan and related land use policies and zoning (The River Plan) is underway, addressing all of the Lower Willamette River front in Portland (City of Portland 2001b). The plan update may affect land use practices in Portland Harbor, but it will not affect the "Industrial Sanctuary" designation.

People interact with the riverine environments in a number of ways. Worker activities that may include contact with sediments and surface water at industrial and commercial facilities in the Study Area are limited in the shoreline areas due to the sparse beach areas and high docks associated with most of the facilities.

The exact extent to which commercial fishing occurs within the Study Area is currently not known. No reports of commercial fisheries for anadromous salmonids on the Lower Willamette River have been found. A limited commercial crayfish fishery exists in the Lower Willamette River. However, non-commercial fishing is conducted throughout the Lower Willamette River basin and within the Study Area, both by boaters and from locations along the banks. A news story by The Oregonian and the limited interviews by ATSDR suggest that the groups most likely to be catching and eating fish from the Lower Willamette River are immigrants from Eastern Europe and Asia, African-Americans, and Hispanics. These same sources also suggest that the most consumed species are carp, brown bullhead (a catfish), crappie, and smallmouth bass (ATSDR 2002). Other sources (CRITFC 1994) suggest that Native Americans fish in the Lower Willamette River. The Lower Willamette River provides a ceremonial and subsistence fishery for Pacific lamprey (particularly at Willamette Falls) and spring Chinook salmon for Native American tribes. Many areas in the Lower Willamette River are also important currently for cultural and spiritual uses by local Native Americans." (Integral et. al 2007).

The Lower Willamette River is used by both adults and children for boating, water skiing, swimming, and other recreational water activities that result in exposure to surface water. Of these activities, exposure to surface water would occur to the greatest extent while swimming in the river. Swimming would likely occur primarily within recreational beach areas, which are not present in the Project Area (Integral et al. 2007).

Figure 2.4-1 shows potential human uses areas within the Project Area, as designated in the *Comprehensive Round 2 Report* (Integral et al. 2007). Two areas of dockside worker potential exposure beaches were identified within the Project Area. Exposures to shoreline sediments and river water are also considered possible in this area through non-beach recreational activities (e.g., boating, fishing, etc.). Upland access to the shoreline and dock structures in the Project Area is controlled by fences, locked gates, and 24-hour security.

2.5 Current Site Use

This section describes current operations at the Gasco and Siltronic properties, by property. This section also discusses potential access or operational constraints that these operations may have on a sediment remediation design.

2.5.1 Gasco Property

The *Gasco RI Report* (HAI 2007a) describes current operations on the Gasco property. These operations include LNG storage, coal tar and pencil pitch distribution, and marine fuel storage and distribution. The following summary of these operations is derived from the *Gasco RI Report* (HAI 2007a). The industrial facilities referenced are shown on Figure 2.1.1-1.

Liquefied Natural Gas Storage

The central portion of the Gasco property is currently used by NW Natural as an LNG storage and distribution facility. NW Natural (then NW Natural Gas Co.) constructed the LNG storage tank on the Gasco property in 1969. This LNG storage facility is used to liquefy natural gas during times of low peak demand for storage until the gas is needed during times of peak demand, typically during the winter heating season. In addition to the LNG storage tank, NW Natural maintains LNG storage control and distribution facilities at the property. The portion of the property used for LNG storage was formerly used as the tar processing area and was the location of the former naphthalene plant, tar thickeners, and aboveground relief holders (HAI 2007a). These operations occur mostly away from the shoreline and would have little impact on a sediment remedy. The exception is Outfall WR-107, which would need to be factored into any sediment remedy.

Coal Tar and Pencil Pitch Distribution

KI leases the southwestern portion of the NW Natural property at 7540 NW St. Helens road. KI operates a coal tar pitch distillation plant. The KI plant imports coal tar pitch and related

products via rail tank cars and bulk cargo ships. KI either stores or remanufactures these products prior to distribution. As of 2005, the management of solid pencil pitch has reportedly been primarily phased out. Liquid coal tar pitch is received by KI at the NW Natural dock where it is pumped from the ocean-going size ship, through an above-ground heated pipeline to a storage tank on the KI lease (HAI 2007a). The location of the KI pipeline is shown on the map on Figure 2.1.1-1. Both the ship docking, as well as continued use of the dock and the pipeline will need to be factored into any sediment remedy.

Marine Fuel Storage and Distribution

Pacific Terminal Services, Inc. (PacTerm), under contract with FAMM, operates a fuel storage and distribution facility at the northern portion of the NW Natural property. From 1965 until FAMM leased the area in 1999, Pacific Northern Oil (PNO) operated the distribution facility. The terminal receives, stores, blends, and ships marine fuels and lubricants, using both barge and truck for transport. FAMM uses two aboveground storage tank (AST) farms for storage and distribution of fuel. Pipelines for fuel transport run between the dock and several tanks on the property. The portion of the property leased by FAMM contains former MGP oil ASTs, the former briquette storage building area, and spent oxide storage pile area (HAI 2007a). Both barge docking, as well as continued use of the dock and pipelines will need to be factored into any sediment remedy. In addition, one of the FAMM tanks and the office building are very close to the top of the shoreline and would need to be factored into the upper extents of any shoreline remediation/stabilization.

2.5.2 Siltronic Property

As described in the *Siltronic RI Report* (MFA 2007), current operations at the Siltronic property consist of production of silicon wafers from silicon crystals. Siltronic has operated at its current location since 1980. Currently, all ingots are shipped to the property from Germany or purchased. Silicon wafer manufacture involves ingot slicing, lapping, etching, polishing, epitaxy, and cleaning operations. This process is highly susceptible to vibrations. The creation of vibrations, for example during sheetpile driving, would need to be fully considered in any design. Similarly, the Siltronic outfalls, to the extent they are affected by the remedy, would need to factor into any design.

2.6 Historical Project Area and Adjacent Uses

This section presents a summary of historical uses of the Project Area and adjacent upland areas. The following sections summarize the authorization history of the Lower Willamette River navigation channel and dredging history; past and present owners, operators, and major tenants of the Gasco and Siltronic properties; and a summary of historical filling and shoreline modification activities.

2.6.1 LWR Navigation Channel History

The *Comprehensive Round 2 Report* (Integral et al. 2007) summarizes the Lower Willamette River navigational channel authorization history and major deepening. The following information was summarized from this report.

The Lower Willamette River federal navigation project was authorized in June 1878 though the Rivers and Harbors Act. The project was intended to deepen and maintain parts of the Columbia and Lower Willamette Rivers to a 20-foot CRD minimum depth. The navigational channel of both rivers has been deepened at various times since. Authorizations affecting the Lower Willamette River depth occurred as follows: 25 feet CRD in 1899, 30 feet CRD in 1912, 35 feet CRD between 1930 and 1935, and the current authorization of 40 feet CRD in 1962.

The channel is approximately 600 feet wide in the vicinity of the Project Area, as shown on Figure 1.2-1. The sediment elevations are shown in Figure 2.2.3-1. The channel boundary runs very near the face of the existing dock. Generally, any areas shoreward of the dock face are outside of the navigation channel.

2.6.2 PG&C MGP Operations and Byproduct Generation

The *Gasco RI Report* (HAI 2007a) describes historical MGP and operations and byproduct generation operations conducted by the Portland Gas and Coke Company (PG&C) upland of the Project Area. Figure 2.6.2-1 shows the general location of activities referenced herein. The following summary of these operations is derived from the *Gasco RI Report* (HAI 2007a).

PG&C purchased the Gasco property (then undeveloped) in approximately 1910. PG&C constructed an oil MGP, known as the Gasco property, on the property in 1912 and 1913, with operations beginning in late 1913 and ending in 1956. Company records indicated that site preparation involved the filling of approximately 10 acres of low-lying land with 205,381 cubic

yards (cy) of dredged material originating from the Lower Willamette River. PG&C production areas were located along the western portions of the property (e.g., present day KI Lease and LNG Plant areas) and extending to riverbank areas in the center of the property (e.g., present day FAMM Lease area). MGP waste and residue was historically managed in the eastern corner (effluent discharge, effluent ponds, and lampblack storage) and northern corner (spent oxide and gas purifier waste storage piles) of the property (HAI 2007a).

PG&C owned a portion of the property immediately to the south of the existing site (much of the current Siltronic property) from 1939 until 1962, during which time company records and aerial photograph review indicate waste management activities were conducted on a portion of that property. Specifically, these waste management activities were limited to the northern portion of the Siltronic property and occurred between approximately 1941 and 1956, although subsequent redistribution of MGP wastes by others during filling is suspected (HAI 2005d as cited in HAI 2007a). No MGP production areas were located on the footprint of the current Siltronic property. PG&C transferred its interest in the Siltronic portion of the property in 1962 (HAI 2007a).

The plant initially produced town gas and pressed lampblack briquettes. The Gasco MGP used the "Pacific Coast Oil Gas Process," which involved thermal cracking of oil at near atmospheric pressure in a cylindrical shell containing heated refractory checker brick. Heavy oils were introduced to the gasified vessel after pre-heating the checker brick to 2,000°F. These oils were then thermally cracked as they moved downward through the gasifier. This process generated the following products and byproducts: oil gas, lampblack, tar, and light oil (HAI 2007a).

Additional manufacturing processes were added over the years as follows: the gasification process was modified to optimize aromatic generation and light oil recovery for use as a fuel additive in 1923; tar recovery and refining were incorporated to provide tar for use as a road binder in 1925; a coking plant began production of electrode grade coke and high BTU gas in the 1930s; and finally, a coke oven was installed to generate electrode grade coke and high BTU oil gas in 1941 (HAI 2007a). These processes generated the following products and byproducts: oil gas, coke, tar, and creosote oil (HAI 2007a).

Spent oxide (also called purifier box waste) was also generated. Spent oxide is generated from the use of iron oxide (iron-impregnated wood chips) or lime as solid reactants for the removal of sulfur from the oil gas. Spent oxide is primarily a blend of iron sulfides, sulfur, iron oxides

and wood substrate and/or lime; however, spent oxide material may also contain hydrocarbons that passed through the upstream gas processing equipment, as well as cyanides that would be removed from the gas along with the sulfur (HAI 2007a).

Economic recovery of many of these byproducts was possible, which reduced the quantities of waste from the property. The Gasco plant refined the gasification byproducts to produce the following products:

- Lampblack briquettes
- Soft pitch
- Specification tars and tar distillates
- Specification creosote
- Hard pitch
- Electrode grade pitch
- Crude naphthalene
- Crude benzene
- Motor fuel
- Toluene
- Xylene
- Solvent naphtha (HAI 2007a)

Much of the Gasco MGP was shut down when natural gas became available in the 1950s. The last full year of plant operation occurred in 1955. With the arrival of natural gas, PG&C changed its name to Northwest Natural Gas Company (now NW Natural). The Northwest Natural Gas Company constructed a LNG storage facility at the property in the late 1960s, at which time most of the old gasification plant was demolished and associated underground utilities were removed. All remaining structures were removed in the 1970s, with the exception of oil storage ASTs and an administration building (HAI 2007a).

2.6.3 Siltronic Property

The *Siltronic RI Report* (MFA 2007) describes property ownership and historical operations on the Siltronic property prior to PG&C activities in 1941. The Siltronic property was assembled from three parcels. The ownership history is summarized in Table 2-1 of the Siltronic RI (MFA 2007). The property was essentially undisturbed lowlands prior to 1900. The Astoria and

Columbia River Railroad constructed a double-track railroad bridge across the Doane Lake and Lower Willamette River in 1908 (MFA 2007).

During the 1930s, the former tug refueling dock was located near the upstream end of the Siltronic property, near the existing Administration Building, . A pipeline connected the dock to the PG&C property; however, the products transferred via this pipeline (shown on Figure 2.1.2-1) are not known. This dock is referred to as the "Western Transportation facility" (shown on Figure 2.1.2-1), because Western Transportation owned the dock from 1943 to 1968. A title search indicated that the refueling station may have been previously operated by Porter Industrial Company, the Union Oil Company of California, and Standard Oil of California (MFA 2007).

2.7 Recent and Ongoing Remedial Activities and Investigations

2.7.1 Portland Harbor Remediation

LWG is undertaking a substantial study of the Portland Harbor Site under a September 2001 EPA AOC for Remedial Investigation/Feasibility Study (EPA 2001c, 2003, 2006). The objectives of the Portland Harbor Site RI/FS are as follows:

- Investigate the nature and extent of contamination for the Portland Harbor Site
- Identify sources of contamination that contribute, or have contributed, to unacceptable risk in Portland Harbor Site
- Assess potential risk to human health and the environment
- Develop and evaluate potential remedial alternatives to reduce risks to acceptable levels
- Recommend a preferred alternative for cleanup.

The RI is intended to address the first three objectives, while the final two will be addressed in the FS. An outline of activities to be undertaken by the LWG in support of the RI/FS are presented in the *Portland Harbor Site RI/FS Programmatic Work Plan* (Integral et al. 2004), which was approved by the EPA in June 2004. A series of Field Sampling Plans (FSPs), Quality Assurance Plans (QAPPs), field sampling reports (or cruise reports), and site characterization summary reports (SCSRs) document the field sampling activities.

The LWG conducted major data collection activities in three sampling rounds from summer 2004 through winter 2008, with the overall objectives of: 1) characterization of the physical system of the Lower Willamette River within the Portland Harbor Site; and 2) assessment of the

nature and extent of contamination in sediment, surface water, TZW, stormwater, and biota in the Portland Harbor Site. Round 1 and Round 2 activities were documented in the *Comprehensive Round Report* (Integral et al. 2007), which was submitted to EPA on February 21, 2007. The Portland Harbor Site RI Report, under preparation at the time of writing, assembles data collected by LWG (including the Round 1 through 3 sampling efforts) and others to present a comprehensive analysis of the nature and extent of contamination and conceptual site model and to identify sources of contamination in the Study Area. A BHHRA and BERA are included as attachments to the Portland Harbor Site RI Report. The Portland Harbor Site FS is being started at this time and is expected to be completed in late 2010.

2.7.2 Gasco Property

2.7.2.1 Upland Remediation

Remedial investigations at the Gasco property were conducted between 1994 and 2006 and as noted in Section 2 additional monitoring has taken place since that time. The overall RI objective was to define the nature and extent of MGP-related impacts to the property. Specific objectives of the Gasco RI are as follows:

- Identify chemicals of interest (COIs) for the property
- Determine the media that have been affected by COIs
- Characterize the nature and extent of the COIs in the affected media at the property;
- Identify migration pathways for the COIs and determine the direction and rate of migration of the COIs in the affected media
- Obtain information and data that can be used in an assessment of the risks to human health and the environment posed by COIs at the property
- Obtain information and data that can be used in an FS to select appropriate remedial actions to address potentially unacceptable risks at the property.

HAI summarized the Gasco RI findings in the 2007 *Gasco RI Report* (HAI 2007a) and submitted the report to DEQ for review this same year. Anchor QEA completed and submitted to DEQ the third revision to the Gasco risk assessment, *Baseline Level III Ecological and Human Health Risk Assessment,* in 2004 (Anchor 2004b). DEQ has not as yet commented on these documents. Once NW Natural receives comments, the upland FS and subsequent remediation is expected to commence and be completed on the timeline generally discussed in Section 1.2.2.

2.7.2.2 Upland Source Controls

Under DEQ oversight and direction, NW Natural is designing groundwater/DNAPL source control measures at the Gasco and Siltronic properties immediately adjacent to the Project Area. This source control work is under DEQ Order No. ECVC-NWR-00-27 to NW Natural and Siltronic. The source control effort has broken the shoreline into Segments 1 and 2 shown on Figure 2.2.1-1. These two shoreline segments cover the entire length of the Gasco shoreline and a portion of the Siltronic shoreline. Source control physical RAOs for shoreline Segments 1 and 2 are:

- Groundwater – Prevent discharge of upland groundwater to the Lower Willamette River, as measured by analyzing groundwater hydrology data from site wells and the river.
- DNAPL – Prevent the migration of upland DNAPL to the river.

At DEQ's request, the following clarifications apply to the above RAOs:

- Source control measure alternatives have been evaluated specific to mitigating migration to the Lower Willamette River along shoreline Segments 1 and 2 by DNAPL in the surficial fill WBZ and alluvial WBZ, and contaminated groundwater in the alluvial WBZ.
- DNAPL removal will be included to the extent necessary to control and contain the potential movement from former effluent management areas on the NW Natural and Siltronic properties that could result from the operation of the hydraulic containment system.

On behalf of NW Natural, Anchor QEA prepared and submitted the *Preliminary Design Report* to DEQ in June 2008 (Anchor 2008e). This report describes proposed groundwater and DNAPL source control measures for Segments 1 and 2. NW Natural plans to complete interim design of the Segment 1 and Segment 2 source control measures in 2009 and complete final design and implement the source control measures as soon as possible thereafter.

The primary source control component is a groundwater containment system using shoreline extraction wells. A DEQ-required vertical barrier component is included in the preliminary design as an additional means to prevent migration of DNAPL into the river. NW Natural is currently discussing the timing and need for the vertical barrier to determine the contents of the Interim Design. The sequencing and integration of the groundwater/DNAPL source control

work with the activities covered under this Work Plan, as well as the general timeline, are discussed above in Section 1.2.2.

2.7.2.3 Gasco Early Action and Long-Term Monitoring

NW Natural has conducted a number of actions associated with the removal of a "tar body" from the Project Area under an Administrative Order on Consent (Order) entered with the EPA on April 28, 2004 (Docket No. CERCLA 10-2004-0068). The extent of the tar body was defined during design characterization sampling conducted in 2004, as described in the *Removal Action Work Plan* (Anchor 2004a). The tar body was removed from an area of riverbank and nearshore sediment adjacent to the Gasco property under a non-time critical removal action conducted during summer and fall 2005. The construction activities were evaluated by NW Natural in the *Removal Action Completion Report* (Anchor 2006b) and by EPA in the *Gasco Early Removal Action Construction Oversight Report* (Parametrix 2006), and the findings of those reports will be considered during development of the EE/CA.

Since 2005, NW Natural has implemented monitoring program in the area where the tar body was removed and an interim pilot cap was placed. The objectives of the monitoring program are: 1) to monitor the performance of the remedy with respect to the RAOs identified in Section II of the SOW attached to the Order; and 2) to evaluate the performance of the engineered pilot cap as a method to minimize chemical movement from underlying sediments. As the removal was an interim action, this program is not intended to monitor a permanent remedy.

The monitoring program is presented in the EPA-approved *Monitoring and Reporting Plan* (Anchor 2006a). Following two years of implementation, a revised monitoring approach was proposed to the EPA in March 26, 2008 entitled *Proposed Revised Long-Term Pilot Cap Monitoring Approach – NW Natural "Gasco" Site* (Anchor 2008c). EPA approved the revised monitoring approach in an April 30, 2008 letter to NW Natural.

The first two years of monitoring (i.e., Year 0 and Year 1) included:

- Sampling and analysis of bulk pilot cap sediment, pilot cap porewater, discrete and time-integrated near-bottom surface water, and depositional sediment
- Annual diver reconnaissance surveys
- Bathymetry surveys approximately coincident with each monitoring event
- Visual monitoring

The Year 2 and current Year 3 monitoring has included:

- Sampling and analysis of discrete near-bottom surface water and depositional sediment
- Annual diver reconnaissance surveys
- Bathymetry surveys approximately coincident with each monitoring event
- Monthly visual monitoring.

The Year 0, Year 1, and Year 2 monitoring activities are documented in the following reports:

- *Annual Data Evaluation Monitoring Report – Year 0 Long-Term Pilot Cap Monitoring* (Anchor 2007d)
- *Annual Data Evaluation Monitoring Report – Year 1 Long-Term Pilot Cap Monitoring* (Anchor 2008d)
- *Annual Data Evaluation Monitoring Report – Year 2 Long-Term Pilot Cap Monitoring* (Anchor QEA 2009b)

The Year 3 Event 1 monitoring event was conducted during August 2009 and the data summary report is currently being developed. The Year 3 Event 2 monitoring event is scheduled for November/December of 2009.

2.7.3 Siltronic Property Source Control

Source control activities are ongoing on the Siltronic property under an agreement between DEQ and Siltronic. Installation of enhanced in situ bioremediation has been completed in the source area (i.e., the former TCE underground storage tank [UST] area). To date, the RAO 1 for the source area (concentrations of TCE below injection threshold of 1 percent of solubility limit, or 11,000 μg/L) has been met in all of the 23 performance monitoring wells located in the source area (MFA 2010). RAO 2 (concentrations of TCE and its degradation products below JSCS screening level values [SLVs]) has been met in four of the 10 performance monitoring wells located at the riverbank (MFA 2009c).

2.8 Sources – Historical and Current

The following sections summarize the current understanding of the sources (historical and current) of impacts to the Project Area and the status of source control. Current and historical operations on the adjacent upland properties are discussed above in Sections 2.5 and 2.6, respectively. This section addresses potential sources of contamination associated with these

operations that may have impacted the Project Area. This section also discusses impacts from sources originating from the Rhone-Poulenc property and contamination from upstream river sources.

2.8.1 Gasco Upland Sources

The operations associated with the Gasco property discussed in Sections 2.5 and 2.6 have led to potential contaminant sources located within as well as upgradient of the Project Area, as described below.

2.8.1.1 Historical Discharges and Source Pathways

The following subsections describe operations and/or events that have potentially led to impacts in the Project Area. This description is primarily derived from the 2007 *Gasco RI Report* (HAI 2007a). The list of overwater releases is derived from the results of a document search reported in the *Draft Siltronic Conceptual Site Model* (attached to the *Comprehensive Round 2 Report;* Integral et al. 2007).

MGP Waste Management/Potential Contaminant Sources

Between 1913 and 1941, waste materials that had not been developed into marketable byproducts were discharged to or placed within low-lying areas of the property, with drainage features leading from the production area to the Lower Willamette River. Prior to 1925, when tar refining operations began, the only waste materials that were marketed were lampblack briquettes. In addition, some amounts of tar were being burned as fuel. However, this left quantities of tar and oil as waste. After 1925, with increasing uses of byproducts, volumes of tar and oil wastes would have diminished (HAI 2007a).

During plant expansion in the 1930s and 1940s, two effluent settling ponds were constructed in the southern property area in order to minimize oily discharge to the river. Additional areas were used for byproduct storage and incorporation into fill (HAI 2007a). These activities are depicted on Figure 2.6.2-1 and are described below.

Former Northern Spent Oxide/Gas Purifier Waste Storage Pile

A review of historical records during the RI indicated that this stockpile contained up to approximately 80,000 cy of spent iron oxide material mixed with wood waste when MGP activities ceased in 1956. A majority of the stockpile was removed in the 1972 to 1975

timeframe, and was reportedly disposed at a sanitary landfill. Records indicate the presence of a former waste water outfall in this portion of the property, although its location was not identified on company plans (HAI 2007a).

Former Effluent Discharge/Lowland Area

A review of historical records during the RI indicated the primary facility sewer outfall was formerly located south of the current southernmost FAMM fuel storage area and discharged directly to the Lower Willamette River. Records indicate lampblack storage and effluent discharge to this area. RI activities confirmed the presence of MGP byproducts in the area of former discharge. A surface tar body in river sediments was removed from this area in 2005, as described above in Section 2.7.2.3 (HAI 2007a).

Filling of the effluent discharge/low lying area begin in 1972 with the placement of large rock along the present shoreline and in-filling behind. Records show that the area was filled with imported quarry rock blended with tar from this area and the adjacent effluent pond area (HAI 2007a).

Former Effluent Pond Area

A review of historical records during the RI indicated that the two effluent ponds (one large approximately 2.50-acre pond and one small, narrower approximately 0.5-acre pond) were located on the Gasco property and began operation in 1941. The former effluent pond area was susceptible to flood inundation and periodic submergence beneath the river. The larger pond was designed to overflow into the western end of the narrower pond via a weir. This pond, in turn was designed to discharge to the Lower Willamette River via a weir. The discharge was located near the current Gasco and Siltronic property line. In 1951, this outlet was apparently blocked and overflow directed to a lowland area of the Siltronic property (HAI 2007a).

Filling of the smaller pond began in 1966 and was completed by 1973. Fill material included dredged material, and a light colored material that appears to have been imported. Filling and reconfiguration of the large settling pond began in 1973. Records indicate that quarry rock and spent oxide material was mixed with tar. Boring data indicates that the fill used to form the embankment between the river and effluent ponds did not contain tar, while areas further inland contain fill mixed with tar (HAI 2007a).

Other Historical Site Uses/Contaminant Source Areas

Other historical uses and contaminant source areas on the Gasco property are shown on Figure 2.6.2-1 and are summarized below.

Koppers Coal Tar Pitch Distillation

As described within a 1994 *Site Inspection Prioritization Report* prepared for the EPA by URS Consultants, Inc., KI's predecessor, Koppers Company, Inc. (Koppers), operated a coal tar distillation facility at the southern portion of the property (7540 NW St. Helens Road) from 1966 to 1973. During the 1966 to 1973 timeframe, Koppers produced chemical oil, creosote, and pitch from coal tar distillates (URS 1994). From 1974 through 1977 Koppers manufactured electrode grade pitch, a product derived from both coal tar and petroleum residuals. From 1977 through the present, Koppers, and now KI, has used the facility as a terminal for the bulk transfer and distribution of liquid creosote coal tar and solid coal tar pitch (HAI 2007a).

Koppers reportedly generated approximately 1,500 gallons of wastewater per day during the time that the plant was used as a coal tar distillation facility (CDM 1987). Koppers land-disposed these wastewaters at the eastern portion of their facility, a location immediately southwest of the former tar settling ponds, coinciding with the location of the current pencil pitch storage structure (Figure 2.6.2-1). The Koppers land disposal area is depicted in 1966, 1968, and 1972 aerial photographs of the property, as suggested by the presence of apparent above-ground piping and staining. Surface staining is apparent across the Koppers lease area as depicted in a 1972 aerial photograph (HAI 2007a).

PNO/FAMM Tank Farm Area

The southernmost tank farm in the PNO/FAMM Lease Area includes the original ASTs that were used for storage of petroleum feedstock during MGP operations. These tanks were reconditioned and since 1965 have been used by PNO/FAMM for storage of marine fuel. Evidence of a minor, apparently non-MGP-related petroleum release associated with the tank farm has been identified at one location within this tank farm (HAI 2007a).

MGP and Koppers Operational Areas

Most MGP operational areas and the Koppers operational areas of the property were located along the western portion of the Gasco property in the area currently occupied by the KI Lease Area and the LNG plant (Figure 2.1.1-1). Impacts attributable to spills and leaks related to various operational areas of the property are apparent based on the identification of shallow soil impacts, including oil (HAI 2007a).

Groundwater

Several of the above-described operations have led to impacts in the underlying surficial fill and upper alluvial WBZs. Dissolved phase and free phase (i.e., NAPL) impacts were identified during RI activities. As discussed in the Gasco RI (HAI 2007a), the areas in the immediate vicinity of such operations were found to be more significantly affected. However, due to local hydrogeological conditions (described in Section 2.2.1.2), dissolved phase plumes extend from these source areas into the surficial fill and upper alluvial WBZs that underlay the Project Area. Section 2.9.6 presents further discussion of the nature and extent of these plumes.

Potential sources of contamination associated with the Gasco property were identified during the Gasco RI and are subdivided into two general areas: 1) process or operational areas; and 2) byproduct and residue placement areas. These areas are located within or upgradient of the Project Area and are potential sources of contamination to WBZs underlying the Project Area. The locations of these source areas are depicted on Figure 2.6.2-1 and are identified below.

The historical and/or current process areas are identified as:

- Former retort area
- Former tar processing area
- Former light oil plant/Koppers plant/current KI tank farm
- Former Koppers/current KI pencil pitch storage area
- Former naphthalene plant
- Former coke oven area
- Former pitch plant/tar loading area

The byproduct and residue placement areas are identified as:

- Former lampblack storage/effluent discharge area
- Former spent oxide storage area
- Former effluent settling ponds/southern fill area
- Former Koppers land disposal area
- Former MGP byproduct incorporation into fill (HAI 2007a)

Current sources associated with these areas are described in Section 2.8.1.2.

Overwater Spills

Overwater spills are unpermitted releases that occur directly into the waterway. Documented overwater spills in the Project Area related to historical operations at the Gasco property are as follows:

- Coal tar pitch dust (Koppers in 1969)
- Several gallons of fuel oil (PNO in 1998)
- Several gallons of oily water (NW Natural in 2000)
- Several gallons of coal tar pitch (Koppers in 2003) (Integral et al. 2007)

2.8.1.2 Current Discharges and Source Pathways

Overland Transport/Direct Discharges

There is no or minimal potential for direct over-land transport of chemicals of concern (COCs) in soils on the property to the Lower Willamette River because it is generally flat and soils or graveled areas allow infiltration of any water potentially providing such transport. Also, the open ditch that previously carried stormwater to the WR-107 outfall was hard-piped in 2005 and backfilled with clean sand. Direct discharge spills have occasionally happened in the past as noted above, but in general procedures are in place for current operations to minimize or prevent such direct discharges (Integral et al. 2007).

Riverbank Erosion

Currently, there is some potential for erosion of soils from the shoreline to the river. The majority of the shoreline on the property is vegetated or covered with riprap. However, some locations of minimally vegetated soils exist downstream of the KI pipeline and that could be transported to the river, if erosion occurs. NW Natural proposed a shoreline stabilization plan in 2003 (Anchor 2003), which DEQ did not comment on. NW Natural then revised that plan and presented it as an appendix in the GWFFS (Anchor 2007f). DEQ did not approve that plan, and as described in Section 1, riverbank remediation including minimizing erosion is now being handled through the work described in this Work Plan.

Stormwater Discharge

Stormwater management across the Gasco property is described in detail in the *Gasco Source Control Data Gaps Evaluation* (Anchor 2006d), from which the following summary is taken. The additional stormwater sampling proposed in this document is ongoing and is expected to confirm the nature and extent of this potential source.

Much of the Gasco property consists of unpaved soils where stormwater infiltrates and/or small ponds are created in the rainy season that dissipates over the summer. NW Natural has one combined stormwater/process water outfall (WR-107, shown on Figure 2.1.1-1) that discharges to the river embankment. Water from south and southeastern portions of the property discharges to this outfall. Stormwater and any groundwater that seeps into the LNG containment basin is removed and treated in an on-site carbon adsorption system (a permitted wastewater treatment system). This treated water was formerly discharged through outfall WR-107 to the river, but is now discharged with a permit to the City sewer system. Stormwater from the FAMM lease area also drains to WR-107. Of the 10 acres in this area, approximately 3.4 acres is collected and treated by an oil/water separator prior to being discharged via WR-107 under the FAMM NPDES permit. Stormwater from the remaining 6.6 acres of FAMM lease area mostly infiltrates into the soil (Anchor 2006d).

Stormwater from the NW Natural LNG operations area also drains to Outfall WR-107. Until very recently, stormwater from the KI lease area drained to Doane Creek and discharged to the river via City Outfall 22C, which is upriver of the property. Stormwater from the Koppers lease area is collected within catch basins. With the exception of several catch basins in the gate entry area, this stormwater is treated by an oil/water separator and then stored in six stormwater storage tanks that have a total capacity of 220,000 gallons. This water is tested and batch-discharged. Formerly this water was discharged at the KI outfall located immediately south of the property through a culvert leading to Doane Creek under the KI NPDES permit (Anchor 2006d). However, this water is now batch-discharged under permit to the City sewer system. This leaves just one small area served by a catch basin in the KI area that discharges via normal drainage to Doane Creek.

In summary, the sources of water discharged from the property include a once-annual discharge of non-contact cooling water from the LNG operations (currently going to City sewer); stormwater runoff; any groundwater seepage that may be removed from sumps installed within the FAMM storage tank containment basins and the LNG containment basin (currently going to the City sewer); and sumps within the tank farm in the KI lease area (currently going to City sewer except for one catch basin). Formerly there was a drainage ditch feeding WR-107, but this was hard piped in 2005, and the drainage ditch was filled with clean sand. There is no longer contact between soil in the ditch and stormwater or process water discharging through WR-107 (Anchor 2006d).

Groundwater

Based on Siltronic RI results (MFA 2007), and consistent with RI results at the Gasco property (HAI 2007a), the most significant potential for contaminant migration in groundwater occurs within the alluvial WBZ. As noted in Section 2.2.1.2, there is a direct relationship and discharge of groundwater in the alluvial WBZ to the river. Conversely, while groundwater discharge from the surficial fill WBZ to the Lower Willamette River is expected, it appears that a degree of isolation exists between these features and this is not likely a major contaminant migration pathway. However, because the fill unit is partially within the saturated zone, and groundwater elevation data suggest flow towards the river, this unit has also been evaluated as a potential contaminant migration pathway to the river (Anchor QEA 2009a). The nature and extent of groundwater contamination discharging to the river has been well investigated and is presented in detail in Section 2.9.6.

Ongoing DNAPL discharge to Lower Willamette River sediments has not been observed. However, because DNAPL has been identified at several limited locations proximate to the shoreline at levels likely greater than residual saturation, there is a possibility of future DNAPL migration to or below river sediments in these localized areas (Anchor 2007f). The *Offshore Investigation Report* showed that DNAPL is only present in sediments at relatively shallow depths indicative of historical direct discharge to the river surface and direct placement. Consequently, deep subsurface migration of DNAPL from the uplands to deep river sediments has not been observed (Anchor 2009b). The nature and extent of DNAPL presence along the shoreline is discussed in Section 2.9.6.1.1 and presence in the sediments is presented in Section 2.9.4.

2.8.2 Siltronic Property

The operations associated with the Siltronic property discussed in Sections 2.5 and 2.6 have led to potential contaminant sources located within as well as upgradient of the Project Area, as described below.

2.8.2.1 Historical Discharges and Source Pathways

The following subsections describe operations and/or events associated with operations on the Siltronic property that have potentially led to impacts in the Project Area. This description is primarily derived from the 2007 *Gasco RI Report* (HAI 2007a).

MGP Waste Management/Potential Contaminant Sources

MGP waste management activities occurred on the Gasco property throughout the plant's life (1913 through 1956), while MGP waste management activities on the adjacent Siltronic property occurred between approximately 1941 and 1956 (PG&C owned the property from 1939 to 1962). Historical MGP waste management activity on the Siltronic property is summarized below. Locations are shown on Figure 2.1.2-1.

Former 400-foot Wide Lowland Area:

Immediately south of the common Siltronic/Gasco property line, this approximate 10-acre area received tar and tar/oil/water emulsifications from Gasco effluent pond overflow and from direct placement of MGP residuals from the clean-out of the effluent ponds. Clean-out activities, conducted to maintain capacity within the effluent ponds, reportedly involved removal of tarry wastes from the base of the Gasco ponds, with placement within the adjacent Siltronic lowland area. Based on operational history, these placement activities would have occurred between 1941 and 1956, while overflow discharges apparently began in 1951 and also would have ended in 1956. Tar thickness measurements made in 1960 (2 to 6 feet of tar across much of the area) indicate that approximately 40,000 cubic yards of tarry materials may have been present in this area subsequent to cessation of all MGP-related activities at the Gasco property, which occurred in 1956 (HAI 2005d, as referenced in HAI 2007a).

Former Depression or Excavation

South of the former lowland area, approximately 2 to 3 feet of tar was identified at the base of this approximate 0.5-acre apparent excavation when evaluated in 1960 (HAI 2005d, as referenced in HAI 2007a). This feature was first observed in aerial photographs dated 1955. Estimates based on tar thickness measurements made in 1960 indicate approximately 2,000 cubic yards of tarry materials may have been present in this area subsequent to cessation of all MGP-related activities at the Gasco property. The function of this depression/excavation is unknown, but the presence of tar suggests it was used for MGP waste management activities (HAI 2007a).

Former Southern Spent Oxide/Gas Purifier Waste Storage Pile

Company records indicate an estimated 34,000 cy stockpile of spent oxide/gas purification wastes were formerly stored immediately south of the common Siltronic/Gasco property line near the western corner of the Siltronic property. Aerial photographs indicate the stockpile was

present at this location between 1952 and 1966, several years after NW Natural sold the property in 1962 (HAI 2005d, as referenced in HAI 2007a). The final disposition of this material is unknown (HAI 2007a).

Other Historical Site Uses/Contaminant Source Areas

Other historical uses and contaminant source areas on the Siltronic property are shown on Figure 2.1.2-1 and are summarized below.

Olympic Pipeline Petroleum Release(s)

The Olympic Pipeline uses two product lines (diesel and kerosene; gasoline) within a utility corridor that traverses the western Gasco property and the central portion of the Siltronic property. Line failure suggesting the presence of product release and soil and groundwater impacts was identified near the western corner of the Siltronic property in 1979 (Figure 2.1.2-1), proximate to the 400-foot-wide former lowland area (HAI 2005d, as referenced in HAI 2007a). At that time, an approximate 2,000-foot section of pipeline as present beneath the pre-fill ground surface (approximately 20 feet below the existing grade) was bypassed and a new section of pipeline was installed (approximately 6 feet below the existing grade) (HAI 2007a).

Western Transportation Petroleum Release(s)

Western Transportation operated a petroleum fueling dock at the eastern corner of the Siltronic property between approximately 1930 and 1950 (Figure 2.1.2-1). Possible surface staining was noted on a 1970 aerial photograph, and petroleum impacts to soil, likely attributable to these activities, have been identified (HAI 2005d as referenced in HAI 2007a).

Siltronic-Related Releases

TCE leaked from an UST system operated by Siltronic at the northern portion of the property resulting in soil and groundwater impacts. Related COIs include TCE and degradation products, and possibly tetrachloroethene (PCE) as an impurity within TCE. Other releases associated with Siltronic operations (1980-1997), also on the northern portion of the property, include chromium solution, acids, caustics, and organic wastewater releases or spills (HAI 2005d, as referenced in HAI 2007a), none of which resulted in documented impacts to soil or groundwater. A spill of TCE is also suspected to have occurred that discharged through Siltronic's process/stormwater discharge, which resulted in the CVOC Area 2 in sediments shown in Figure 1.2-1.

Filling Activities

Filling activities were conducted on the Siltronic property between 1966 and 1975. Filling involved placement of 1.5 million cy of material on the property, including approximately 700,000 cy of dredge spoils from unidentified locations and 800,000 cy of material imported from a quarry (PDC 1985, as referenced in HAI 2007a). Depending upon origin, dredged sediments could reasonably have been impacted by many different sources of potential contamination, including ship traffic, industrial operations (such as MGP, wood treating facilities, shipyards, pesticide manufacturing, or petroleum terminals, agricultural activities, or urban runoff). During the time of filling activities, the property was owned by Mr. Victor Rosenfeld and Mr. H.A. Anderson, and Mr. Gilbert Schnitzer (HAI 2007a; Integral et al. 2007).

In addition to possible sources of impact from the dredged sediments or other imported materials used as fill, observations of tar or oil during various investigations or construction activities at the Siltronic property, as well as dark soils visible in aerial photographs between 1967 and 1971 suggest the possibility that MGP-related wastes from the 400-foot-wide lowland area may have been redistributed and combined with fill placed at various portions of the Siltronic property during filling activities (1966 to 1975), after NW Natural sold the property in 1962 (HAI 2005d, as referenced in HAI 2007a).

2.8.2.2 Current Discharges and Source Pathways

Overland Transport/Direct Discharge

Substantial investigation by Siltronic and NW Natural indicate that over-land transport of either TCE or MGP-related waste impacts is not a significant pathway (Integral et al. 2007). There are currently no operations or water-dependent uses on the Siltronic property that occur near or over water that would have a high potential for direct discharge to the river.

Riverbank Erosion

During site improvements in the 1970s, the riverbank was armored with riprap, and erosion where these bank reinforcement measures are intact is expected to be minimal. In 1998, Siltronic repaired a portion of the bank that had been damaged during the 1996 flood and added geotextile fabric and additional riprap (Integral et al. 2007). Although actual erosion of the riverbank appears unlikely, riverbank soil chemistry information was identified as a potential data gap to fully assess the current potential for this pathway in the *Segment 3 Source Control Evaluation* (Anchor QEA 2009a). DEQ has not yet commented on this document.

Stormwater/Process Water Discharge

Siltronic's process-related wastewater is treated on site and discharged to the City of Portland sanitary sewer in accordance with Permit No. 469.001, or to the Lower Willamette River via outfalls in compliance with the requirements of Siltronic's NPDES permit (Integral et al. 2007).

Stormwater runoff at the Siltronic property is collected within catch basins and is subsequently conveyed to the Lower Willamette River via three on-site Siltronic outfalls: Fab 1, Fab 2, and Admin Building outfalls. One exception is the Siltronic administration building parking lot stormwater runoff, which is piped off-site to the southeast where it discharges to the Lower Willamette River via City of Portland storm sewer Outfall 22C. Outfall 22C drains a large mixed use industrial and open space basin in addition to the Siltronic administration building parking lot (Anchor QEA 2009a).

The *Segment 3 Report* (Anchor QEA 2009a) indicated that there were relatively low exceedances of JSCS screening levels for surface water/stormwater. However, exceedances of these screening levels did occur in all outfalls. These data are described more in Section 2.9.10.

Groundwater

Groundwater flows towards the river within the surficial fill and upper WBZs. Two distinct types of groundwater sources to river have been identified. These include the following:

1. A TCE plume related to one or more releases near former UST system on the Siltronic property. A portion of the property has been impacted by TCE and its degradation products, including cis-DCE, isomers of DCE, and vinyl chloride. The TCE-related impacts in so called "Area 2" do not appear to be related to the known groundwater plume, but instead are likely to be the result of a historical release to the Siltronic stormwater system discussed above.
2. An MGP plume that is essentially continuous with the one present on the Gasco property containing PAHs and aromatic volatile organic compounds (VOCs; such as benzene, toluene, ethylbenezene and xylene [BTEX]), as well as cyanide is present in the surficial fill and alluvial WBZs adjacent to the riverbank.

The nature and extent of both plumes and their discharges to the river have been well investigated and are discussed in Section 2.9.6.

Former MGP waste conveyance channels, as well as other deep utilities crossing the property (e.g., the stormwater line leading to City of Portland Outfall 22C, and the former 96-inch stormwater line) are potential preferential pathways for groundwater transport of shallow groundwater contaminants to the Lower Willamette River. The investigations of these potential pathways have not yielded any evidence to suggest the presence of preferential groundwater contaminant transport to the river along these features. However, DEQ has not concurred that these potential features have been completely evaluated.

2.8.3 Rhone-Poulenc Property

The *Segment 3 Report* (Anchor QEA 2009a) summarizes potential sources originating from the Rhone-Poulenc property (shown on Figure 1.1-1). The following summary is derived from this report.

Rhone-Poulenc operated a pesticide formulation and manufacturing facility upgradient of the Siltronic property (and the Project Area) from 1943 until 1990. Since 2001, the Rhone-Poulenc property has been owned by SLLI. Manufactured products were stored on the Rhone-Poulenc site in ASTs and USTs, as well as designated storage areas. Most historical releases occurred in the Rhone-Poulenc plant areas where the materials were stored, manufactured, packaged, or transported. These areas include tank farm locations, loading areas, plant storage facilities and associated sumps, and line systems (AMEC 2008a).

Figure 2.8.3-1 and 2.8.3-2 from the *Draft Source Control Evaluation Report* (AMEC 2008) contain maps delineating 1,2,-dichlorobenzene and chlorobenzene groundwater plumes sourced from the former Rhone-Poulenc property that extend across the Siltronic property to the Lower Willamette River shoreline. Other chemicals associated with former Rhone-Poulenc operations, including TCE and its degradation products, have also been detected in the Siltronic Alluvial WBZ. Section 2.9.6 describes the nature and extent of this plume.

2.8.4 Upstream Sources

Historical and ongoing releases to the Lower Willamette River are documented from numerous sources. The *Comprehensive Round 2 Report* (Integral et al. 2007) details sources of contamination in the Lower Willamette River upstream of the Project Area. As discussed previously, the Lower Willamette River in the vicinity of the Project Area is generally non-depositional in the navigation channel but more prone to sedimentation and at least short-term stability in

nearshore environments. This sedimentation has and is resulting in sediment contamination from upstream sources as evidenced by substantially elevated polychlorinated biphenyl (PCB) and DDx levels present in Project Area sediments, despite the fact that these chemicals are not associated with the Gasco or Siltronic properties. The nature and extent of these chemicals in sediments is discussed more in Section 2.9.3 and briefly summarized below.

As summarized in Section 2.2.4.1, a consistent depositional layer of sandy silt has been identified in the Tar Body Removal Action Area following the high flow period in 2005/2006. Analytical results of the depositional sediment overlying areas where pilot cap and fringe cover sand was placed show the presence of COCs associated with upstream sites (e.g., DDT and PCBs). The long-term monitoring reports (Anchor 2007d, 2008c, 2009b) contain additional detail.

Sediment trap data collected by LWG as part of the Portland Harbor Site RI process directly downstream from the Project Area also showed the presence of COCs associated with upstream sites (e.g., DDT, DDD, and PCBs).

2.9 Nature and Extent of Contamination

This section presents a summary of the nature and extent of contamination, sediment toxicity testing, and biota sampling in the vicinity of the Project Area, to the extent known, including chemical/toxicity information that is or potentially is relevant to a future remedy. As stated in Section 3.3 of the SOW, this section was developed in accordance with the following requirements:

> "This will be an initial summary, and more detailed mapping including comparison to screening levels shall be conducted for the Project Area Identification and Data Gaps QAPP. The Work Plan description of existing information will not be a comprehensive data report, and it will rely on original reports from LWG, Siltronic and NW Natural for detailed information, as needed to conduct investigations and design. Important figures, tables, and overall data summaries shall be included in the Work Plan as necessary to illustrate known information and data gaps."

Given the number of media results in the vicinity of the Project Area, where possible based on data presented in available reports, the data presentation for each of the media are limited to the following indicator chemicals related to Gasco and Siltronic property releases: naphthalene,

benzene, free cyanide (in water matrices), and total cyanide. These chemicals are generally the most mobile, have the largest areal extents, and encompass the various releases that are documented from the properties in the vicinity of the Project Area over time. In water matrices, free cyanide is the bioavailable and toxic form of cyanide and therefore, is most important in assessing potential impacts to the river. Consequently, this document emphasizes the extent and concentrations of free cyanide in water matrices. However, total cyanide is also presented to provide general information on the nature and extent of potential sources of free cyanide to the river. In general, measurements indicate that total cyanide is not being converted to measurable levels of free cyanide in any water matrix sampled in the Project Area. The Siltronic property releases also included TCE and its associated degradation byproducts, so this information is also summarized, where available. As required by the SOW, all COCs identified in Section 2.9.2 were mapped to assist in the evaluation of sediment quality.

2.9.1 Data Quality Review and Categorization

In accordance with the SOW, existing chemistry data used in this nature and extent summary were reviewed to establish whether the data fall into the Category 1 or Category 2 data categories used in the *Portland Harbor Programmatic Work Plan* (Integral et al. 2004). The categories are defined as:

- **Category 1.** Category 1 data are of known quality and are considered acceptable for use in decision making for the project. There is sufficient information on these data sets to confidently verify that the data, along with associated data qualifiers, accurately represent chemical concentrations present at the time of sampling.
- **Category 2.** Category 2 data are of generally unknown or suspect quality. The quality assurance and quality control (QA/QC) information shows that data quality is poor or suspect, or essential QA/QC data (e.g., surrogate recoveries, matrix spike/matrix spike duplicates) are either incomplete or lacking.

Project decisions will be based on analyses using Category 1 data that have had an EPA-approved level of data validation. Category 1 data are used to describe the nature and extent of contamination and to evaluate contaminant loading, fate, and transport.

2.9.2 Chemicals of Concern

Based on the above listed potential sources of COCs, as well as those chemicals currently being identified as COCs for this region of the harbor for the Portland Harbor risk assessment process (i.e., not Gasco- or Siltronic-specific COCs), the current COC list for the Project Area includes:

- Benzene, toluene, ethylbenzene, xylenes (BTEX)
- PAHs (naphthalene, acenaphthylene, acenaphthene, fluorene, phenanthrene, anthracene, fluoranthene, pyrene, benzo(a)anthracene, chrysene, benzofluoranthenes, benzo(a)pyrene, indeno(1,2,3-c,d)pyrene, dibenzo(a,h)anthracene, and benzo(g,h,i)perylene), extended to include 2-methylnaphthalene
- Dibenzofuran and carbazole
- Cyanide (including total cyanide in sediment and total, available, and free forms in water samples)
- Zinc
- TCE
- cis-DCE
- Trans- 1,2 dichloroethylene (trans-DCE)
- 1,1 dichloroethylene (1,1-DCE)
- Vinyl chloride
- PCBs
- DDTs
- DDDs
- DDEs
- Diesel range hydrocarbons
- Residual range hydrocarbons
- Alpha-, beta- and gamma-BHCs (benzene hexachlorides)
- Endrin Ketone

2.9.3 Sediment Quality

This section summarizes available sediment data for the Project Area and serves to provide the context for the current understanding of the nature and extent of contamination within and adjacent to the Project Area and data that will be used in future deliverables to delineate the horizontal and vertical extent of contaminated sediment that will require cleanup. As noted above, the COCs reviewed and mapped in sediment included the full list of COCs identified in Section 2.9.2. Sediment is defined to include those materials that are at or below 13.3 feet

NAVD88, generally consistent with the LWG sediment database. Given the project boundaries have not yet been identified (which will be the focus of the Project Area Identification Report [AIR] as described in Section 4.4), the sediment quality summary presented in this section is inclusive of all data collected on both sides of the Lower Willamette River navigation channel from RM 5 to 7 to capture all potential relevant data. The AIR will focus the data screening on a smaller areal extents consistent with identified impacts to the Project Area from upland Gasco and Siltronic property releases.

Numerous sediment quality investigations have been conducted within the Project Area adjacent to the Gasco and Siltronic properties. These investigations included the following:

- Initial phase of RI activities and subsequent additional preliminary investigations (HAI 2007a; Anchor 2001)
- Tar Body characterization summarized in the *Removal Action Work Plan* (Anchor 2004a).
- Nearshore source control evaluation, as documented in the NW Natural "Gasco" Site *Draft Screening Level Nearshore Source Control Evaluation Results Report* (Anchor 2001).
- Various sequential offshore investigations conducted on or offshore of the Gasco property, as documented in the *Offshore Investigation Report* (Anchor 2009b).
- In-river investigations adjacent to the *Siltronic RI Report* (MFA 2005a, 2005b)
- Portland Harbor Site RI activities, including all three rounds of data as will be reported in the upcoming Draft RI. (Note that although the Portland Harbor RI Report has not been issued the complete data set in the RI has been made publicly available and was used for this effort.)
- Long-term monitoring of the tar body removal action area offshore of the Gasco property, as discussed in the Year 0, Year 1, and Year 2 *Data Evaluation Monitoring Reports – Long-Term Pilot Cap Monitoring* (Anchor 2007d, Anchor 2008d, Anchor QEA 2009b)
- Post-dredge characterization conducted as part of the Tar Body Removal Action, as documented in the *Removal Action Completion Report* (Anchor 2006b)

Because dredging has occurred as part of the Tar Body Removal Action within the Project Area, data from the dredging prism (i.e., sediment that was dredged and is no longer present) were removed from this data set and are not presented on sediment quality tables or figures. A relatively thin pilot cap (approximately 1.0 foot thick) and fringe cap (0.5 foot thick) exist in the removal area and surrounding area. Given the relatively thin nature of these caps, sediment samples that were collected prior to capping (i.e., post- dredge but pre-cap) are still plotted at

their "as sampled" intervals, because they still represent in many cases a substantial portion of surface interval as defined below. Further evaluation will be completed as part of Project Area Identification and Data Gaps process (Section 4.5) to isolate these samples and analyze them separately from the overlying surface sediment data set, as necessary.

The discussion of existing sediment data is first categorized by the COC being evaluated and then spatially by depth (e.g., surface versus subsurface). The sediment data included in this Work Plan are presented consistently with the Portland Harbor RI depth interval definitions, which use a 0 to 30 cm sediment depth interval to define the risk assessment exposure but includes a database query rule of 0 to 40 cm to be representative of the 0 to 30 cm exposure depth. Subsurface sediment is defined as any sediment sample collected that does not initiate at the mudline or extends 40 cm below the mudline. To assist in the evaluation of vertical concentration gradients, sediment concentrations are mapped in a number of progressively deeper intervals as follows:

1. 0 to 40 cm surface – any sample that starts at the mudline and ends no further than 40 cm below mudline
2. 0 to greater than 40 cm subsurface – samples that start at the mudline and extend deeper than 40 cm below mudline (i.e., represents large composited intervals extending from the mudline)
3. 0.1 to 4 foot subsurface – samples that start some depth below the mudline and extend no further than 4 ft below mudline
4. 4 to 8 foot subsurface – samples that start below 4 feet and extend no further than 8 feet below mudline
5. 8 to 12 foot subsurface – samples that start below 8 feet and extend no further than 12 feet below mudline
6. 12 to 16 foot subsurface – samples that start below 12 feet and extend no further than 16 feet below mudline
7. Greater than 16 foot subsurface – samples that start below 16 feet below mudline and extend deeper

Due to the sheer number of data points (approximately 500,000 in the vicinity of the Project Area), the sediment quality results are tabulated based on general statistical observations including frequency of detections, range of detected concentrations, and spatial trends in concentrations both vertically and horizontally. The statistical observations are summarized in Table 2.9.3-1 to Table 2.9.3-2, and figures portraying the maximum concentration for each COC

within each of the aforementioned depth intervals are provided in Appendix A. The specific sampling depth interval for each of the maximum concentrations is provided on the maps to provide more specific delineation of the identified concentrations within the intervals chosen. Samples that initiated with one depth interval (e.g., 4 to 8 foot) and extended to the next depth interval (e.g., 8 to 12 foot) were plotted in the deeper depth interval.

The distributions of some of the key COCs identified within the Project Area are described in the following sections.

2.9.3.1 Benzene, Toluene, Ethylbenzene and Xylene

BTEX are volatile organic chemicals found in petroleum derivatives such as gasoline and are typically found near petroleum and natural gas production and distribution sites. Summaries of the surface and subsurface BTEX concentrations are provided below. Although there are discernable patterns in the distribution of individual BTEX compounds, these are plotted for this exercise as total BTEX given that there is a general co-occurrence of these compounds in the Project Area. Summaries of the surface and subsurface BTEX concentrations are provided below.

2.9.3.1.1 Surficial Sediment BTEX Concentrations

A total of 184 samples of surficial sediment were collected and analyzed for BTEX chemicals and 95 of these samples contained detectable concentrations (Table 2.9.3-1). BTEX concentrations ranged from 0.075 to 260,200 μg/kg and the average concentration was 7,283 μg/kg. The highest surficial sediment concentrations of BTEX in the Project Area occur in and immediately adjacent to the tar body removal area and much lower surficial sediment concentrations are found west (downstream) of this area.

2.9.3.1.2 Subsurface Sediment BTEX Concentrations

A total of 477 samples of subsurface sediment were collected and analyzed for BTEX chemicals and 298 of these samples contained detectable concentrations (Table 2.9.3-2). BTEX concentrations ranged from 0.068 to 1,130,000 μg/kg and the average concentration was 19,000 μg/kg. Elevated subsurface concentrations of BTEX exist throughout the Project Area.

2.9.3.2 Polycyclic Aromatic Hydrocarbons (PAHs)

PAHs are chemical compounds that consist of fused aromatic rings and do not contain heteroatoms or other constituents. PAHs occur in oil, coal, and tar deposits and are produced as byproducts of fuel burning (whether fossil fuel or biomass). Summaries of the surface and subsurface PAH concentrations are provided below. Although there are a few discernable patterns in the distribution of individual PAH compounds, these are plotted for this exercise as total PAHs given that there is a general co-occurrence of these compounds in the Project Area. Summaries of the surface and subsurface PAH concentrations are provided below.

2.9.3.2.1 Surficial Sediment PAH Concentrations

A total of 496 samples of surficial sediment were collected and analyzed for PAHs and 492 of these samples contained detectable concentrations (Table 2.9.3-1). PAH concentrations ranged from 4.7 to 63,000,000 μg/kg, and the average concentration was 280,000 μg/kg. The highest surficial sediment concentrations of PAHs in the Project Area occur between the Gasco shoreline and the navigation channel line and much lower concentrations are generally found outside this area.

2.9.3.2.2 Subsurface Sediment PAHs Concentrations

A total of 630 samples of subsurface sediment were collected and analyzed for PAHs and 609 of these samples contained detectable concentrations (Table 2.9.3-2). PAH concentrations ranged from 0.39 to 53,300,000 μg/kg and the average concentration was 820,000 μg/kg. Elevated concentrations of PAHs exist throughout the Project Area in subsurface sediment.

2.9.3.3 Cyanide

Cyanide is any chemical compound containing the cyano group (carbon triple bonded to nitrogen). Cyanide is frequently found in association with MGPs. Summaries of the surface and subsurface total cyanide concentrations are provided below.

2.9.3.3.1 Surficial Sediment Cyanide Concentrations

A total of 69 samples of surficial sediment were collected and analyzed for cyanide and 56 of these samples contained detectable concentrations (Table 2.9.3-1 and Table 2.9.3-2). Cyanide concentrations ranged from 0.07 to 16 milligrams per kilogram (mg/kg) and the average concentration was 1.6 mg/kg. The highest surficial sediment concentrations of cyanide in the

Project Area occur adjacent to the tar body removal area, with slightly lower concentrations within the tar body removal area. Lower concentrations are generally found outside this area. However, cyanide surface sediment data are sporadic or even fairly limited in some portions of the Project Area. Given that subsurface concentrations of cyanide on the northern end of the shoreline are relatively high in some intervals, it is possible that elevated cyanide levels exist in surface sediments in this area as well.

2.9.3.3.2 Subsurface Sediment Cyanide Concentrations

A total of 218 samples of subsurface sediment were collected and analyzed for cyanide and 159 of these samples contained detectable concentrations (Tables 2.9.3-1). Cyanide concentrations ranged from 0.03 to 27 mg/kg and the average concentration was 1.5 mg/kg. Extant data shows elevated concentrations of subsurface cyanide primarily exist between the Gasco shoreline and the navigation channel, although subsurface data from the navigation channel is somewhat limited. The highest subsurface levels in this nearshore area are found at the northern end of the Project Area.

2.9.3.4 TCE, DCE, 1, 1-DCE, and Vinyl Chloride

TCE was used at the Siltronic facility during silicon wafer preparation and cleaning. Dichloroethylene (DCE) is a degradation product of TCE and is composed of three isomers, cis-1,2-DCE and trans-1,2-DCE, and 1,1-DCE. Vinyl chloride is a degradation product of cis-1,2-DCE. Summaries of the surface and subsurface TCE, DCE, and vinyl chloride concentrations are provided below.

2.9.3.4.1 Surficial Sediment TCE, DCE, 1,1-DCE, and Vinyl Chloride Concentrations

A total of 141 to 149 samples of surficial sediment were collected and analyzed for TCE, DCE and vinyl chloride, whereas 35 surface sediments were analyzed for 1,1-DCE (Table 2.9.3-1). There were only a small number of surface sediment samples with detectable concentrations, and detected concentrations ranged from 0.1 to 0.9 μg/kg (Table 2.9.3-1). All surficial sediment samples with detected concentrations of these chemicals are in the general vicinity of where the VOC plume and VOC outfall discharge from the Siltronic property near the Gasco/Siltronic property line.

2.9.3.4.2 Subsurface Sediment TCE, DCE, 1,1-DCE, and Vinyl Chloride Concentrations

A total of 230 to 430 samples of subsurface sediment were collected and analyzed for TCE, DCE, 1,1-DCE, and vinyl chloride and a small percentage of the samples contained detectable chemical concentrations (less than 10 to 20%). The detected concentrations ranged from 0.1 to 1,900,000 µg/kg (Table 2.9.3-2). Similar to the surface sediment results, subsurface sediment samples with detected concentrations of these chemicals are in the general vicinity of where the VOC plume and outfall discharge from the Siltronic property adjacent to the Gasco/Siltronic property line.

2.9.3.5 Polychlorinated Biphenyls

No potential sources of PCBs have been identified at the Gasco or Siltronic properties. Summaries of the surface and subsurface PCB concentrations are provided below.

2.9.3.5.1 Surficial Sediment PCB Concentrations

A total of 105 to 339 samples of surficial sediment were collected and analyzed for PCB as congeners and Aroclors, respectively. PCBs were detected in 98 of the 105 samples analyzed for PCB congeners and in 183 of the 339 samples analyzed for Aroclors (Table 2.9.3-1). The total detected concentrations were similar and ranged from 1.0 to 5,870 µg/kg, with average concentrations of 187 and 78 µg/kg for the congener and Aroclor analyses, respectively. The maximum PCB concentration was identified within Willamette Cove on the opposite side of the navigation channel from the Project Area and is therefore not considered representative of Project Area conditions. As discussed in Section 2.9,3, the AIR (Section 4.4) will focus on screening data of smaller areal extents associated with the Project Area. Elevated concentrations of PCBs occur between the Gasco and Siltronic shorelines and the navigation channel, however the concentrations are similar to those observed in the channel and elsewhere in the Lower Willamette River.

2.9.3.5.2 Subsurface Sediment PCB Concentrations

A total of 27 to 342 samples of subsurface sediment were collected and analyzed for PCBs and congeners and Aroclors, respectively. PCBs were detected in 26 of the 27 sample analyzed for PCB congeners and in 151 of the 342 samples analyzed for Aroclors (Table 2.9.3-2). The total detected concentrations were similar and ranged from 0.02 to 2,769 µg/kg, with average

concentrations of 236 and 128 µg/kg for the congener and Aroclor analyses, respectively. Elevated subsurface concentrations of PCBs occur occasionally between the Gasco and Siltronic shorelines and the navigation channel; however, the concentrations are similar to those observed elsewhere in the Lower Willamette River.

2.9.3.6 DDT, DDE and DDD

DDT or dichlorodiphenyltrichloroethane is one of the most well-known synthetic organochlorine pesticides. Commercial DDT was a mixture of several closely related isomeric compounds and DDE (dichlorodiphenyldichloroethylene) and DDD (dichlorodiphenyldichloroethane). DDE and DDD are also the major metabolites and breakdown products of DDT in the environment. No potential sources of DDx have been identified at the Gasco or Siltronic properties. Summaries of the surface and subsurface DDT, DDE, and DDD concentrations are provided below.

2.9.3.6.1 Surficial Sediment DDT, DDE, and DDD Concentrations

A total of 366 to 368 samples of surficial sediment were collected and analyzed for DDT and its metabolites (i.e., DDE and DDD). DDT was detected in 288 of these samples. These detected concentrations ranged from 0.08 to 490 µg/kg and the average concentration was 28 µg/kg. Similar ranges of DDE and DDD were measured (Table 2.9.3-1). Elevated concentrations of DDT and its metabolites occur between the Gasco and Siltronic shorelines and the navigation channel.

2.9.3.6.2 Subsurface Sediment DDT, DDE, and DDD Concentrations

A total of 345 samples of subsurface sediment were collected and analyzed for DDT and its metabolites, and DDT was detected in 122 samples. Detected concentrations of DDT ranged from 0.09 to 1,900 µg/kg and averaged 62 µg/kg (Table 2.9.3-2). Similar ranges of DDE and DDD were measured. Elevated subsurface concentrations of DDT and its metabolites occur between the Gasco and Siltronic shorelines and the navigation channel.

2.9.4 Product Observations Summary

Areas with substantial presence of product in sediments is a line of evidence related to potential mobility of chemicals in the future. Visual observations in sediment cores will be the primary parameter used for this line of evidence. The term “substantial” product is intended to 1) target

product that is related to potential future mobility; and 2) indicate a preference for removal as defined by RAO 1 (see Section 3.1). Substantial product is discussed and defined in Section 3.6.2.1.

As required by the SOW, the extent of substantial product was identified through the review of all visual observations recorded on currently available core logs for cores collected in the Project Area. Figure 2.9.4-1 presents a map showing the sediment coring locations with an indication of whether substantial presence of product was observed at each location. For locations where substantial product was identified, the deepest depth interval where such product was identified is indicated.

2.9.5 Biological Testing

This section summarizes the available analytical results from bioassay and bioaccumulation testing of benthic organisms. Extensive biological sampling was performed by LWG throughout the Portland Harbor Site. Study results relevant to assessing potential risk from sediment at the Project Area are reported in the *Comprehensive Round 2 Report* (Integral et al. 2007) and the BERA (Windward 2009). The LWG includes three types of benthic invertebrate tissue information (field-collected data, laboratory-exposed organism data, and predicted values) in the BERA (Windward 2009). Field-collected benthic tissue samples were obtained for crayfish,[1] clams (*Corbicula fluminea*), freshwater mussels (Western pearlshell [*Margaritifera falcata*] and winged floater [*Anodonta nuttalliana*]), and epibenthic invertebrates and zooplankton were collected with multiplate samplers.

The LWG collected benthic community grab samples from 22 locations in the fall of 2002; only one sample was obtained in the reach between RM 6 and 7 just downstream from the Gasco property (Figure 2.9.5-1). These samples were collected to provide information on community structure, including relative abundance of taxa. Additionally, the LWG conducted surveys in 2002 and 2005 of the epifaunal communities present in the Portland Harbor Site by deploying artificial multiplate samplers in the water column for approximately 6 weeks and identifying the species that colonized the substrate. A single multiplate sampler was deployed adjacent to the Gasco and Siltronic property boundary (Figure 2.9.5-2). In general, Chironomid larvae, oligochaetes, and *Corophium* sp. dominated the benthic community collected on the multiplate

[1] Crayfish were not identified to species; however, only one crayfish species, the western freshwater crayfish (*Pacifastacus leniusculus*), is known to occur in the Portland Harbor study area.

samplers throughout the Portland Harbor Site. Other common epifaunal invertebrates were sponges and bryozoans.

The LWG conducted two benthic invertebrate tissue sampling events in the Portland Harbor Site in 2005 (Windward and Integral 2005). The benthic invertebrates observed in the two field efforts were similar to the organisms collected in 2002 and included chironomids, oligochaetes, clams, flatworms, and dragonfly larvae. *Corbicula fluminea* was the most common larger benthic invertebrate and was collected at all 33 locations in the Portland Harbor Site. Two other larger mollusks, tentatively identified in the field as western pearlshell mussel (*Margaritifera falcata*) and winged floater (*Anodonta nuttalliana*), were collected at 17 and two locations, respectively. Sampling locations for field-collected clams and worms are shown on Figure 2.9.5-2. Station BT015 was located adjacent to the Gasco and Siltronic property boundary and Station BT014 was located immediately downstream from the Gasco property (BT014).

Field-collected clam and mussel tissue samples were analyzed for butyltins, dioxins and furans, metals, PAHs, PCB congeners, organochlorine pesticides, phenols, phthalates, and semivolatile organic compounds (SVOCs). Crayfish tissue samples were analyzed for the same list with the substitution of PCB aroclors in place of the butyltin analysis. Multiplate-collected organisms were analyzed for dioxins and furans, metals, PCB congeners, organochlorine pesticides, and SVOCs. All tissue residue data are presented in Attachment 4 of the BERA. (Windward. 2009)

Laboratory exposure of the freshwater oligochaete (*Lumbriculus variegatus*) and Asiatic clam (*Corbicula fluminea*) was also performed (Windward and Integral 2005) for bioaccumulation testing. See Section 2.9.5.2 below for discussion of these results.

2.9.5.1 Bioassay Testing

In multiple rounds of the Portland Harbor Site RI/FS, 269 surface sediment samples collected from the Portland Harbor Site and upriver reference sediments were submitted for toxicity testing. Surface sediment sampling locations for bioassay testing are presented in Figure 2.9.5-3. A total of 30 stations were collected adjacent to the Gasco and Siltronic properties. Toxicity testing was performed to support the development of one or more predictive models characterizing the relationship between sediment chemistry and benthic invertebrate toxicity in the Portland Harbor Site. Two whole-sediment toxicity testing protocols were employed: 10-day *Chironomus tentans* and the 28-day *Hyallela azteca* sediment toxicity tests. The growth endpoint was determined, per EPA's problem formulation, as the total mass of survivors in a

sample. Toxicity was established based on statistically significant differences ($p \leq 0.05$) between test and negative control sample responses and exceedances of reference thresholds based on survival and growth in the upriver reach.

Bioassay results for the 10-Day *Chironomus* Sediment Toxicity Test for the locations between RM 6 and 7 are summarized in presented in Attachment 6 of the BERA (Windward 2009).

The results of the amphipod and midge toxicity tests were compared to batch-specific negative controls to identify sediment samples with significantly greater responses (one-tailed, parametric or non-parametric *t*-test, with $\alpha = 0.05$ comparison-wise). The toxicity test results for samples with significantly greater mortality or reductions in growth were then compared to the low and high reference thresholds derived from reference envelope samples to identify those samples that exhibited toxicity. A toxicity test result below the low reference threshold was considered a non-adverse effect (Level 1, per EPA's definition); results above the high reference threshold were considered indicative of adverse effects (Level 3, per EPA's definition); results between the low and high reference thresholds were considered uncertain (Level 2, per EPA's definition). EPA further classified toxicity test results that were not significantly different from controls as Level 0. These classifications are applicable to individual organisms or sediment samples and cannot be directly linked to population-level effects without consideration of spatial or temporal scale. Figures2.9.5-4 and 2.9.5-5 results of the two toxicity tests for the 269 stations in the Portland Harbor Site.

As shown in Figures2.9.5-4 and 2.9.5-5 of the 30 sediment samples along the western shore between RM 6 and RM 7 tested for bioassay toxicity, 56 percent of the *C. dilutus* mortality and 63 percent of the *C. dilutus* growth tests exceeded either the low or high reference threshold. For the same river reach, 23 percent of the *H. azteca* mortality and 20 percent of the *H. azteca* growth tests exceeded either the low or high reference threshold. In addition, there is a cluster of exceedances of the "high" thresholds in areas associated with higher levels of total PAHs within the Project Area.

2.9.5.2 Bioaccumulation Testing

To assess potential impacts of sediment to growth and mortality of clams in the Portland Harbor Site, LWG completed bioaccumulation tests with clams (*C. fluminea)* and worms (*Lumbriculus variegatus*). Tissue samples of commercially available clams and worms were exposed to surface sediments collected from the stations shown in Figure 2.9.5-2. These tests

included surface sediments collected adjacent to the Gasco and Siltronic property boundary and just downstream from the Gasco property. Chemical analysis data for bioaccumulation testing and tissue testing of benthic tissue are presented in Attachment 4 of the BERA (Windward 2009).

The results of the bioaccumulation tests were used to estimate growth rate of clams exposed to sediments by comparing final tissue weights for test and control samples to the initial control biomass estimates. Clams exposed to sediment samples collected in the vicinity of the Gasco and Siltronic property boundary (RM 6.3) as well as near the Rhone-Poulenc outfall (RM 6.9) were among a set of nine sites (out of 33) that exhibited less growth than those in the control group (60 to 79 percent of the growth in the negative control group). It is noted that these differences are difficult to interpret as the biomass measurements were not replicated for further statistical testing.

2.9.6 Groundwater Quality

This section presents the groundwater quality both in the upland properties adjacent to the Project Area, as well in the offshore area within the Project Area. The following sections provide separate summaries for the Gasco property, Siltronic property, Rhone-Poulenc property, and offshore area within the Project Area. It also includes a summary of the former Rhone-Poulenc property located immediately to the south of the Siltronic property. It discusses the variety of historical and potential ongoing sources of contamination from each property that affect groundwater quality in the Project Area.

2.9.6.1.1 DNAPL

MGP DNAPL and tar are present in the subsurface on the Gasco and Siltronic properties. Figures 2.9.6-1, 2.9.6-2, and 2.9.6-3 show the lateral extent of DNAPL in the fill and alluvium on both properties. These maps were prepared by HAI based on extensive upland site characterization completed during the Gasco remedial investigation and during TarGost investigations requested by DEQ as part of source control evaluation. The DNAPL present on both sites is an ongoing source of dissolved contamination in the fill and alluvial WBZs, including PAHs, BETX free cyanide, and total cyanide. Note that free cyanide is the available toxic form of cyanide in water, and therefore is the best indication of potential impacts in the river. The DNAPL boundaries on the Siltronic property may be modified at a later date depending upon the findings of the current upland remedial investigation being conducted on

Siltronic property by HAI on behalf of NW Natural. The physical and chemical properties of the DNAPL are described in detail in the *Gasco RI Report* (HAI 2007a).

2.9.6.2 Gasco Property Groundwater Quality

The *Gasco RI Report* (HAI 2007a) describes the nature and extent of groundwater contamination in the upland portion of the Gasco property and is the primary reference for this summary. Two WBZs, the surficial fill and the alluvial, are discussed in this Work Plan. The basalt WBZ, which underlies the alluvial WBZ, is briefly discussed but is not impacted by contamination from the Gasco property. As discussed in Section 2.9, the extent of groundwater contamination at the properties is discussed in terms of three representative COCs—benzene, naphthalene, and cyanide (both free and total forms). Note that free cyanide is the available toxic form of cyanide in water, and therefore is the best indication of potential impacts in the river.

2.9.6.2.1 Surficial Fill Water-Bearing Zone

Isoconcentration contours of dissolved benzene, naphthalene, and free and total cyanide in the surficial fill WBZ are presented on Figures 2.9.6-4 through 2.9.6-7. Concentrations of benzene and naphthalene range up to 120 mg/L and 18 mg/L, respectively, in the southwest portion of the property. Benzene and naphthalene concentrations decline from the southwest corner of the property toward the river shoreline. Free cyanide was detected in three of 10 samples collected in the surficial fill WBZ with the highest concentration, 0.113 mg/L in the northeast corner of the property in the location of the former spent oxide storage pile, but are much lower over the rest of the property. Total cyanide concentrations range up to 8 mg/L and are also centered in the northeast corner of the property.

2.9.6.2.2 Alluvial Water-Bearing Zone

Isoconcentration contours of dissolved benzene, naphthalene, and total cyanide in the alluvial WBZ are presented on Figures 2.9.6-8 through 2.9.6-11. Concentrations of benzene and naphthalene range up to 21 mg/L and 20 mg/L, respectively, in the area of the former effluent ponds; however, concentrations are much lower over the rest of the property. The observed TZW concentrations are discussed in Section 2.9.7. Free cyanide was detected in one of nine samples at 0.0282 mg/L. Total cyanide concentrations are also highest in the area of the former effluent ponds.

2.9.6.2.3 Basalt Water-Bearing Zone

Dissolved phase contamination and/or DNAPL have not been found to have migrated to the basalt, as evidenced by a lack of chemical impacts such as benzene and naphthalene within the basal portions of the alluvial WBZ. As such, WBZs within the basalt have not been a target of RI activities and any such zones do not undergo routine monitoring.

2.9.6.3 Siltronic Property Groundwater Quality

The primary references for this summary include the *RI Workplan – Historic Manufactured Gas Plant Operations, Siltronic Corporation Property* (HAI 2007b), and the *Siltronic RI Report* (MFA 2007).

The *Siltronic RI Report* (MFA 2007) documented two areas of impacts to the Lower Willamette River from TCE and its degradation byproducts. The combined CVOC impacts map prepared by MFA is shown on Figure 2.9.6-12. The southernmost area is the groundwater plume of TCE and its degradation products that extends from the former UST area west of Siltronic FAB 2 several hundred feet into the Lower Willamette River, where the plume discharges into the Lower Willamette River in an area designated by Siltronic as Area 1. The offshore area of TZW designated as Area 1 is shown on Figure 2.9.6-12.

The second impacted area is believed by Siltronic to have originated in the Siltronic stormwater sewer system as a single discharge into the river in the TZW area designated by Siltronic as Area 2. Groundwater data from upland monitoring wells located on the Gasco property just north of the Siltronic property line contain low concentrations of CVOCs. These data indicate that the Siltronic CVOC plume extends onto the Gasco property, at least near the Lower Willamette River shoreline; but that data was not available at the time that MFA developed the map on Figure 2.9.6-12. The TZW CVOC concentrations in offshore Areas 1 and 2 are described in more detail in Section 2.9.8.4.

Groundwater on the Siltronic property also contains MGP-related chemicals. Maps of benzene, napthalene, and total cyanide concentrations were included in the *RI Workplan – Historic Manufactured Gas Plant Operations, Siltronic Corporation Property* (HAI 2007b). Based on existing data, these maps are considered generally representative of the extent of MGP-related chemicals in groundwater at the Siltronic property. For this Work Plan, six figures are reproduced from HAI 2007b. Figures 2.9.6-13 to 2.9.6-18 are maps of the benzene, napthalene, and total cyanide

concentrations in the surficial fill and alluvial WBZs on the Siltronic property. These maps also show the locations of borings planned for the Siltronic upland Remedial Investigation that is currently being conducted by HAI on behalf of NW Natural. The data from the ongoing Siltronic RI is currently being evaluated so the benzene, napthalene, and cyanide isoconcentration contours depicted on Figures 2.9.6-13 to 2.9.6-18 are considered preliminary. Revised maps of these chemicals will be presented in the Siltronic RI report being prepared by HAI.

Review of the isoconcentration contours on Figures 2.9.6-13 to 2.9.6-18 shows that the highest concentrations of all three chemicals are in the northeastern portion of the Siltronic property. Former effluent ponds that were part of Gasco MGP operations overflowed to the northeastern portion of what is now the Siltronic property, as described in Section 2.8 of this Work Plan. The former effluent pond area on the Siltronic property is characterized by the highest groundwater concentrations of MGP related chemicals. Figures 2.9.6-13 to 2.9.6-18 also indicates that the highest benzene and total cyanide groundwater concentrations are in the fill WBZ in comparison to the underlying alluvial WBZ. However, concentrations of these chemicals in groundwater near DNAPL in the alluvial WBZ are likely to be in the same range as those shown in the fill WBZ.

2.9.6.4 Rhone-Poulenc Property Groundwater Quality

The Rhone-Poulenc property source control evaluation, as documented in the *Draft Source Control Evaluation Report* (AMEC 2008a) describes the nature and extent of groundwater contamination in the upland portion of the Rhone-Poulenc property and is the primary reference for this summary. The locations of the monitoring wells sampled for this evaluation are shown on Figures 2.8.3-1 and 2.8.3-2.

The evaluation of potential constituent migration pathways is organized into three informal regions of the Lower Willamette River as presented in the deep gravel hydrogeologic zone letter (AMEC 2007). These regions have been established based on the geologic, hydrogeologic, and chemical conditions in each region. These regions are identified on Figures 2.8.3-1 and 2.8.3-2 and are based on the following:

- Region 1 bounds the shallower part of the distal, dissolved-phase plume (identified by AMEC as the Rhone-Poulenc source control program constituent of potential concern

[COPC] plume), and it extends from the upstream lateral boundary of the plume to the northern edge of a gravel-covered bench on the eastern wall of the buried valley.

- Region 2 encompasses that portion of the buried valley downstream of Region 1 where groundwater in the deep gravel hydrogeologic zone contains 1,2-dichlorobenzene at or near the 130 µg/L screening level. Region 2 bounds the "deep" part of the Rhone-Poulenc source control program COPC plume in groundwater in the deep gravel hydrogeologic zone.
- Region 3 consists of the area bounding the northern side of potentially Rhone-Poulenc -related constituents detected in samples from on-shore borings on the Siltronic and NW Natural/Gasco properties and from deep borings off-shore of the Siltronic property.

Anchor QEA's review of the groundwater quality tables in AMEC's *Draft Source Control Evaluation Report* shows that groundwater samples from many of the monitoring wells on the Siltronic property have had detections of numerous chemicals that are sourced from the former Rhone-Poulenc property. Several herbicides, including 2,4-D, have been detected in one or more of the wells at well clusters RP-7, RP-11, and RP-24. Dioxin/furans have been detected in one or more of the wells at well clusters RP-7, RP-11, and RP-24. Figures 2.8.3-1 and 2.8.3-2 reproduced from the AMEC *Draft Source Control Evaluation Report* contain maps delineating 1,2,-dichlorobenzene and chlorobenzene plumes sourced from the former Rhone-Poulenc property that extend across the Siltronic property to the river shoreline. This is not intended to be a complete description of all of the VOCs, SVOCs, pesticides, and herbicides that have been detected. From this review of the data it is apparent that the plumes sourced from the former Rhone-Poulenc property extend across the Siltronic property to the Lower Willamette River shoreline. It is likely that these chemicals have both historically discharged and currently discharge to Lower Willamette River sediments.

2.9.6.5 Groundwater Quality – Offshore

The *Offshore Investigation Report* (Anchor 2009b) describes the groundwater quality nature and extent in the offshore portion of the Gasco property. Additional information for offshore groundwater quality, specific to the Siltronic property, was gathered from the results of the *In-River Investigation Report* (MFA 2005a), the *Supplemental Investigation Report* (MFA 2005b), and the *Siltronic RI* (MFA 2007).

Groundwater samples were obtained at the following planned depths below mudline in the shoreline GS borings: 4 to 6 feet, 9 to 11 feet, and at approximate 25-foot intervals to the bottom

of each boring. The actual sample depth intervals varied slightly due to conditions at each boring location. For upland boring GS-00, the first sample was obtained at the 23 to 27-foot depth interval, the depth of the water table. Soil and sediment samples were also obtained in each boring. The sampling locations are illustrated on Figure 2.9.6-19.

The groundwater concentrations of benzene, naphthalene, and cyanide are shown on 3-dimensional fence diagrams in Figures 2.9.6-20 through 2.9.6-22, respectively. These three figures illustrate that the concentrations of these constituents are highest in the samples collected closest to the shoreline (GS-01 through GS-12). Concentrations generally decrease significantly with depth and distance from shore.

The distribution of benzene in offshore groundwater is reflective of both historic direct discharge of MGP residuals to the river and groundwater transport from upland sources. The distribution of benzene concentrations on Figure 2.9.6-20 indicates elevated benzene concentrations in shallow groundwater samples associated with DNAPL at borings GS-08, -09, and -10. In those borings, there are also elevated benzene concentrations at depth that do not appear connected to DNAPL in sediments. These higher benzene concentrations at depth are likely due to groundwater transport from the former effluent settling pond area, where similarly high concentrations are present. Figures 2.9.6-23 through 2.9.6-26 present benzene concentrations in transects A-A′ (closes to the shoreline) through D-D′ (farthest from the shoreline). The profiles also show that benzene concentrations decline rapidly with distance from shore, and that the distal end of the benzene groundwater plume is generally between transects C-C′ and D-D′.

The nature and extent of naphthalene in offshore groundwater shares some characteristics with the pattern of the benzene plume. Figure 2.9.6-27 shows high naphthalene concentrations associated with shallow sediment DNAPL in shoreline transect A-A′, similar to nearshore benzene occurrence. Figures 2.9.6-28 and 2.9.6-29 show that naphthalene also occurs at depth further offshore in transects B-B′ and C-C′, with groundwater transport resulting in higher naphthalene concentrations in the deepest groundwater samples. This trend does not extend to transect D-D′ (Figure 2.9.6-30). Crude naphthalene was manufactured as a product at the property. The differences in distribution of the naphthalene plume may be a result of operations associated with that product. There is insufficient information on historical waste handling practices for the benzene and naphthalene products to determine exactly if or how those practices have influenced the nature and extent of groundwater contamination.

The subsurface profile sheets Figures 2.9.6-31 through 2.9.6-34 show the distribution of free cyanide in groundwater offshore. Free cyanide was not detected in most of the groundwater samples. Free cyanide was detected below the quantitation limit for the analysis in several samples in Profile A-A′ (Figure 2.9.6-31) and it was detected further offshore in four samples in Profile B-B′ (Figure 2.9.6-32), one sample in Profile C-C′ (Figure 2.9.6-33). Free cyanide was not detected in any samples in Profile D-D′ (Figure 2.9.6-34).

Figures 2.6.9-35 through 2.6.9-38 show that total cyanide is present in groundwater in all transects at generally all depths sampled. The distribution of total cyanide appears to reflect three general upland source areas as evidenced by the comprehensive 3-D view of the total cyanide plume shown in Figure 2.9.6-22. The first source is groundwater transport from two upland source areas: the upland former spent oxide storage pile area on the north end of the shoreline and the former upland effluent settling pond area. The former effluent pond area was backfilled with a mixture of soil, spent oxide solids, and tar. The second source is direct discharge of liquid wastes to areas that appear to have drained to the river on the south end of the property, and direct placement of spent oxides on the shoreline on the north end of the property.

Review of the vertical concentrations in the borings reflects the effects of the two sources. For example, at location GS-B2 on Figure 2.9.6-38, the total cyanide concentrations in the shallow TZW samples are over 2,000 μg/L, reflecting the source from direct discharge from the spent oxide piles to shallow sediments. However, the total cyanide concentrations at depth decrease from a high of 330 μg/L in the sample from a depth of 140 feet below mudline, to only 4 μg/L in the sample obtained from 23 to 27 feet below mudline. These concentration distributions indicate that total cyanide is sourced both from direct discharge to the river and groundwater transport. This is also consistent with the distributions of total cyanide in bulk sediment samples found by the LWG and others as mapped in the *Comprehensive Round 2 Report*, where the highest bulk sediment cyanide concentrations in surface sediments occur immediately off the former spent oxide pile area.

2.9.7 Transition Zone Water and Groundwater Seep Quality

This section summarizes the available analytical results from TZW and groundwater seeps that have the potential to pose risk within the Project Area. For the purposes of this Work Plan, TZW is defined consistent with that used for the Portland Harbor Site, as identified in Section

2.2.1.2. The definition for a seep will also be consistent with that used for the Portland Harbor Superfund Site, with a seep being defined as groundwater discharge above the Lower Willamette River water line. This groundwater may be discharged from local shallow groundwater systems, perched groundwater, or return flow from tidally influenced back storage.

The primary focus area of the transition zone for the Project Area is the surface sediment mixed layer, which is known to vary throughout the site depending on physical and biological regimes present (Integral et al. 2007). The LWG sampled the upper 30 cm of the sediment as an operational definition of this mixed layer, but in many cases it likely does not extend that deep. The mixed layer is characterized by TZW samples collected in the shallow (0 to 38 cm below mudline) sediments. Deeper (greater than 90 cm below mudline) TZW samples are also discussed herein to lend insight into observed chemical distribution patterns and to support an assessment of potential TZW loading impacts to surface water and surface sediment.

The TZW data set discussed in this section was generated from the following sources, which are expected to have delineated the majority of TZW contamination offshore of the Gasco and Siltronic properties:

- LWG 2004 Pilot Study results, discussed in detail in Appendix B of the *Portland Harbor Site RI/FS Groundwater Pathway Assessment Sampling and Analysis Plan* (Integral 2005), the attached Discharge Mapping FSP (Integral 2005), and the *Round 2 Groundwater Assessment Sampling and Analysis Plan Addendum 1 to the Transition Zone Water Field Sampling Plan* (Integral 2006a). The sampling locations are shown on Figure 2.9.7-1.
- LWG Round 2 TZW sampling results, discussed in detail in the *Portland Harbor Site RI/FS Round 2 Groundwater Pathway Assessment Transition Zone Water Sampling Field Sampling Report* (Integral 2006b) and the *Portland Harbor Site RI/FS Round 2 Groundwater Pathway Assessment Transition Zone Water Site Characterization Summary Report* (Integral 2006c). The sampling locations are shown on Figure 2.9.7-1.
- Siltronic offshore groundwater pathway investigation TZW sampling results discussed in detail in R*esults of In-River Sediment and Groundwater Investigation* (MFA 2005), collected by Siltronic. The sampling locations for the Area 1 and Area 2 investigations are shown on Figures 2.9.7-2 and 2.9.7-3.
- Gasco offshore groundwater pathway investigation TZW sampling results discussed in detail in the *Offshore Investigation Report* (Anchor 2009b), collected by NW Natural. The sampling locations are shown on Figure 2.9.6-19.

- Gasco pilot cap monitoring TZW sampling results presented in the Year 0, Year 1 and Year 2 *Long-Term Pilot Cap Monitoring Evaluation* reports (Anchor 2007d, Anchor 2008d and Anchor QEA 2009b), collected by NW Natural. The sampling locations are shown on Figures 2.9.7-4 through 2.9.7-8 for each monitoring event.

The groundwater seep data set discussed in this section was generated from a seep reconnaissance survey conducted by LWG during Round 1 of the Portland Harbor Site RI/FS (GSI 2003) to support the BHHRA and conceptual site model. This survey documented readily identifiable groundwater seeps based on visual observations. Two groundwater seeps occurring through backfill surrounding outfalls were identified just upstream from the Project Area. These seep locations were located at City of Portland Outfalls 22B and 22C, which are located directly north and south of the railroad bridge at RM 6.89 and 6.82. Because these seeps are on the extreme margin of the Project Area, they are not discussed further. No seeps were identified at the Gasco or Siltronic properties.

Two general types of sampling techniques were used to collect the TZW samples as described in detail in the *Portland Harbor Site RI/FS Groundwater Pathway Assessment Sampling and Analysis Plan* (Integral 2005), the *Supplemental Investigation Report* (MFA 2005), the Gasco *Offshore Investigation Report* (Anchor 2008b), and the Pilot Cap *Monitoring and Reporting Plan* (Anchor 2006a):

- Small-volume peepers were used in the LWG 2004 Pilot Study sampling 0 to 30 cm below mudline
- Push-point samplers
  - Trident Probe® used in the LWG 2004 Pilot Study and LWG Round 2 investigation studies sampling 0 to 38 and 90 to 150 cm below mudline.
  - GeoProbe®11 used in Gasco offshore pathway investigation studies sampling 0 to 91 cm and 0 to 6,300 cm (not discussed herein due to depth extending far below the mixed layer) below the mudline.
  - Piezometer used in the Gasco offshore pathway investigation and pilot cap monitoring TZW sampling studies sampling various depths between 0 to 30 cm below mudline.

Results for all analytes, sampling methods, and sampling depths for samples collected on behalf of the LWG and Siltronic are summarized in Table C1-12 in Appendix C of the Portland Harbor

Site RI/FS *Comprehensive Round 2 Report* (Integral et al. 2007). Results for all analytes, sampling methods, and sampling depths for sample collected on behalf of NW Natural are summarized in Table 1.3 and Table 2.3 of the Gasco *Offshore Investigation Report* (Anchor 2009b) and Table 4 of the Gasco *Year 1 Annual Data Evaluation Monitoring Report* (Anchor 2008d).

This TZW nature and extent discussion relies on existing information summaries and figures from the documents referenced above. Most of the analytes in the referenced documents were selected from the Portland Harbor Round 2 COPCs identified by screening the full TZW data set against human health and ecological screening levels. A total of 80 individual analytes and calculated sums (total xylenes, total DDE, total DDD, total DDT, and dioxin TEQ) were identified as exceeding one or more screening criteria for results obtained on behalf of LWG and Siltronic. The results of each of the above TZW investigations are summarized below.

2.9.7.1 Portland Harbor Site RI/FS Comprehensive Round 2 Report TZW Nature and Extent Summary

PAHs in TZW

Total PAH values observed in TZW throughout the Portland Harbor Site cover a large concentration range, varying between 0.003 µg/L and 1,200 µg/L in filtered samples and between 0.003 µg/L and 15,050 µg/L in unfiltered samples. The highest concentrations of total PAHs in TZW appear between RM 6 and 7 offshore of the Gasco and Siltronic properties, as is apparent in the color distribution of the concentration indicators and on the inset histograms of Figure 2.9.7-9.

Figure 2.9.7-9 presents the low molecular weight PAHs (LPAHs, comprised of 2-methylnapthalene, maphthalene, acenaphthylene, acenaphthene, fluorene, phenanthrene and anthracene) and high molecular weight PAHs (HPAHs, comprised of fluoranthene, pyrene, benzo(a)anthracene, chrysene, benzo(x)fluoranthenes, benzo(a)pyrene, indeno(1,2,3-c,d)pyrene, dibenzo(a,h)anthracene and benzo(g,h,i)perylene) concentrations adjacent to the Gasco and Siltronic properties. Figure 2.9.7-10 provides concentrations plots for the individual PAHs adjacent to the Gasco property. This figure shows that lighter PAHs tend to be present in higher concentrations in TZW (as would be expected) as seen throughout the Portland Harbor Site. Human health or chronic ecological screening levels for both LPAH and HPAH were exceeded in TZW samples collected offshore of the Gasco and Siltronic properties (Figure 2.9.7-9). Additional discussion and analysis of PAH trends are presented in the *Portland Harbor Site*

RI/FS Round 2 Groundwater Pathway Assessment Transition Zone Water Site Characterization Summary Report (Integral 2006c), including comparison to sediment results, equilibrium analysis, and consideration of upland concentrations and the physical pathway.

Additional discussion and analysis of PAH trends are presented in the *Portland Harbor Site RI/FS Round 2 Groundwater Pathway Assessment Transition Zone Water Site Characterization Summary Report* (Integral 2006c), including comparison to sediment results, equilibrium analysis, and consideration of upland concentrations and the physical pathway.

BTEX in TZW

Figure 2.9.7-11, with supporting detail in Figures 2.9.7-12 and 2.9.7-13 present the measured total BTEX concentrations in TZW over the Project Area. The upper half of Figure 2.9.7-13 presents the total BTEX concentration, and the lower half presents the relative contribution of each BTEX constituent in the form of a pie chart. The figures show a large range of detected total BTEX concentrations in the TZW samples over the Project Area, varying between 0.11 μg/L and 1,600 μg/L. The highest total BTEX concentrations were measured offshore of the Gasco and Siltronic property line. These stations exhibit higher proportions of benzene and ethylbenzene, with a pattern indicating the possibility of a higher proportion of xylenes in the areas closest to shore.

Total Cyanide in TZW

Free cyanide was not analyzed in the Portland Harbor Site RI/FS Round 2 samples. This investigation reported only total amenable cyanide concentrations. The sampling results for total cyanide in TZW collected offshore of the Gasco and Siltronic properties are shown in Figure 2.9.7-14. Only unfiltered samples were collected, although it is known that cyanide is present in the sediments in this area. Total cyanide concentrations in TZW range from 0.006 mg/L to 0.69 mg/L (with one outlier at 23.1 mg/L). Except for the outlier these concentrations are generally lower than those in the nearshore groundwater monitoring wells at the Gasco and Siltronic properties. The outlier occurs at the north end of the Gasco property offshore of the area where the former spent oxide pile was present in the uplands. Cyanide concentrations in the three deeper TZW samples (90 to 150 cm below mudline) collected offshore of the Gasco and Siltronic properties were comparable to the concentrations observed in the 0 to 38 cm below mudline samples.

Pesticides in TZW

The sampling results for the DDx compounds collected offshore the southern portion of the Siltronic property is shown in Figure 2.9.7-15. Both filtered and unfiltered samples were collected. The filtered and unfiltered concentrations of DDD, DDE, and DDT were very similar ranging from 0.15 to 0.185 μg/L for DDD, 0.013 to 0.015 μg/L for DDE, and 0.0078 to 0.0098 μg/L for DDT.

2.9.7.2 Siltronic Supplemental Investigation Report TZW Nature and Extent Summary

TCE and its degradation products were detected in TZW samples above risk-based screening levels in two separate and distinct areas, identified as Area 1 and Area 2. Area 1 is generally located offshore of upland monitoring well WS-12-125/161. Area 2 is located downstream of Area 1 and offshore of upland monitoring well WS-14-125. The approximate areas of surface water and TZW impacts above screening criteria in Areas 1 and 2 are depicted in Figures 2.9.7-2 and 2.9.7-3.

Concentrations of benzene in TZW samples exceeded screening levels at nine locations (GP-54, GP-64, GP-67, GP-68, GP-69, GP-70, GP-73, GP-76, and GP-81). All of these locations are in Area 2, as depicted in Figure 2.9.7-3. A TZW sample from location GP-68 contained the highest concentration of benzene (3840 μg/L), followed by GP-67 (2560 μg/L) and GP-81 (1,010 μg/L).

Concentrations of naphthalene in TZW samples exceeded screening levels at 14 locations (GP-44, GP-54, GP-64, GP-67, GP-68, GP-69, GP-70, GP-71, GP-73, GP-74, GP-76, GP-81, GP-82, and GP-84). All of these locations are in Area 2, as depicted in Figure 2.9.7-3, with the exception of GP-44, which is in Area 1, and GP-74, which is approximately 150 feet farther out into the channel from location GP-65. A TZW sample from location GP-73 contained the highest concentration of napthalene (13,700 μg/L), followed by GP-71 (12,400 μg/L) and GP-68 (12,300 μg/L).

Free cyanide (the toxic form) concentrations in TZW samples were not analyzed. Concentrations of total cyanide in TZW samples were detected ranging from 0.0337 mg/L (GP-82) to 0.356 mg/L (GP-64).

2.9.7.3 Gasco Offshore Investigation Report TZW Nature and Extent Summary

The TZW samples were collected from a depth of 30 to 60 cm below mudline in all locations during the offshore groundwater pathway investigations as reported in the Gasco *Offshore Investigation Report* (Anchor 2009b).

As part of the offshore investigation, TZW was sampled during an initial investigation to determine the potential discharge zones of upland COIs and subsequently (at the request of DEQ) over a wide range of tidal fluctuations to determine if there is an inverse correlation between river elevation and COI concentrations in TZW.

Each of the stations sampled during the tidal study were approximately co-located with shallow sediment TZW samples collected during the Phase 2 offshore investigation. The TZW concentrations observed during both investigations are summarized below for each of the COIs to determine if there were any apparent visual correlations.

The nature and extent of MGP-related COIs in offshore groundwater and TZW are described in detail in Section 2.9.6.5. The nature and extent of MGP-related COIs in TZW is represented by subsurface profiles of benzene, naphthalene, free cyanide, and total cyanide. Figures 2.9.6-23 through 2.9.6-26 show the benzene concentrations in offshore TZW for the four offshore Profiles A-A' through D-D'. Figures 2.9.6-27 through 2.9.6-30 show the naphthalene concentrations, Figures 2.9.6-31 through 2.9.6-34 show the free cyanide concentrations, and Figures 2.9.6-35 through 2.9.6-38 show the total cyanide concentrations.

2.9.7.4 Gasco Pilot Cap Monitoring TZW Nature and Extent Summary

This section presents a summary of the nature and extent of chemicals in TZW from the samples collected during the Tar Body Removal Action post-construction long-term pilot cap monitoring conducted offshore of the Gasco property. The *Year 1 Annual Data Evaluation Monitoring Report* is the primary reference for this summary (Anchor 2008d).

Evaluation of the COC data shown in Figures 2.9.7-4 to 2.9.7-8 indicates that the only consistent observable spatial trend across the pilot cap monitoring stations is the general similarity in COC concentrations and distributions. Napthalene, acenapthene, acenapthylene, fluorene, naphthalene, phenanthrene, and benzene consistently showed the highest TZW concentrations

across all monitoring stations over time. These are the most mobile PAH and BTEX compounds. The TZW showed a different distribution of PAHs relative to the pilot cap sediments. This inconsistency could be due to the mobility of more soluble PAHs such as acenapthene and acenapthylene and/or chemical migration from documented groundwater discharge in the pilot cap area.

The COI concentrations neither consistently increase over time at any of the pilot cap monitoring stations, nor do they show concentration trends that can be linked to potential seasonal effects.

2.9.8 Surface Water Quality

Near-bottom surface water quality sampling has been conducted during several investigations in the Project Area and the results are provided in the following reports: *Offshore Investigation Report* (Anchor 2009b), annual long-term pilot cap data evaluation reports (Anchor 2007d, Anchor 2008c, and Anchor QEA 2009b), the *Comprehensive Round 2 Report* (Integral et al. 2007), and *Supplemental Investigation Report* (MFA 2005b). The results of these investigations are briefly summarized below.

2.9.8.1 Offshore Investigation Report

On behalf of NW Natural, Anchor conducted a series of investigations in the Lower Willamette River offshore of the Gasco property during the period from July 2006 to October 2007. Results are reported in the *Offshore Investigation Report* (Anchor 2009b). Near-bottom surface water investigation specific objectives included:

- Evaluating the potential for transport of cyanide measured in groundwater and TZW to surface water and any conversion to free cyanide under select river conditions.
- Collecting data that may be useful for assessing in-river risks from cyanide (i.e., low tide versus high tide conditions and/or river current velocity and direction).

Work completed to achieve these objectives includes:

- Mini-piezometers were installed at three offshore locations.
- A total of 12 near-bottom river water samples were obtained at the mini-piezometer locations, and tested for unfiltered alkalinity, chloride, sulfate, TSS, and metals.

- Lower Willamette River water samples were collected at 20 offshore locations as part of the cyanide surface water investigation. At each location, water samples were collected from three depths: near surface, mid-depth, and near-bottom. Samples were collected from all three depths for each of three tidal periods: ebb, slack high, and slack low. A total of 180 river water samples were tested for total cyanide, amenable cyanide, free cyanide, selected metals, and conventional parameters.

The near-bottom surface water samples were successfully collected at three monitoring stations co-located with the mini-piezometers as shown on Figure 2.9.6-19. The conventionals and metals analytical results are summarized in Table 2.5 of the *Offshore Investigation Report* (Anchor 2009b). The near-bottom surface water concentrations did not show a consistent correlation with the co-located TZW concentrations, indicating that the transport pathway between these media is incomplete.

The cyanide surface water investigation included the collection of 20 water samples from the Lower Willamette River at the stations shown in Figure 2.9.6-19. Two upriver sample locations and two downriver stations were also sampled to evaluate background levels and dilution of potential cyanide sources. Analytical results show that there were no detects of free cyanide in river water collected at any depth or tide interval. Free cyanide is the most relevant species with respect to potential exposure of receptors to surface water. There were very few detects of other cyanide species in the overall data set (less than 5 percent detection frequency of all filtered and unfiltered samples for all cyanide species at all depth and tide intervals for a total of 780 tests).

The analytical results are provided in Table 3.5 of the *Offshore Investigation Report* (Anchor 2009b). Cyanide in any form was not detected in any samples upriver from the property (stations GSW-19 and GSW-20), including all depths and all tide events, suggesting that there is no detectable concentrations of cyanide (of any form) in surface water upriver from the Gasco property. Cyanide in any form was also not detected at upriver stations GSW-19 and GSW-20 sampled during conditions of reverse river flow, as recorded by ADCP during the time of sampling.

There was one series of surface water samples with detections of both unfiltered amenable and total cyanide (but not free cyanide) at the two downriver stations farthest away from the property (GSW-01 and -02) during downstream river flow. Cyanide was not detected in any

form, however, in the dissolved fractions from these samples. The measured concentrations of unfiltered amenable and total cyanide downstream are minimal (at or below the reporting limit of 10 μg/L). In addition, the most downstream station still adjacent to the property (GSW-03) had no detects of any species of cyanide in surface water.

2.9.8.2 Tar Body Removal Action Long-Term Monitoring

As described in Section 2.7.2.2, NW Natural entered into an Order with EPA on April 28, 2004 to perform a removal action at the "Gasco property" (EPA 2004). The Order required that NW Natural perform a number of actions associated with removing a tar body from the riverbank and nearshore sediment adjacent to the Gasco property.

Since completion of the remedy in late 2005, the post-removal action field monitoring requirements has included the collection of near-bottom surface water quality overlying the pilot cap to evaluate whether the identified area of preferential groundwater discharge through the pilot cap area contributes to elevated surface water chemical concentrations relative to "other concentrations" in the vicinity of the Gasco property but outside the pilot cap area. Near-bottom surface water has been collected at nine pilot cap monitoring stations (Figures 2-9.8-1), as well as a single downstream and three upstream stations. Sampling during the Year 0 and Year 1 monitoring included the collection of both time-integrated (using semi-permeable membrane devices) and discrete (grab sample) near-bottom surface water. For reasons specified in the revised monitoring approach (Anchor 2008c), time-integrated sampling was discontinued following the Year 1 sampling. The samples were analyzed for total and dissolved organic carbon; TSS; total, free and amenable cyanide; sulfides; total and dissolved iron; PAHs; and BTEX (Anchor 2006a).

The discrete near-bottom surface water concentrations for Year 0 (three events), Year 1 (two events), and Year 2 (two events) are summarized in Table 3 of the *Annual Data Evaluation Monitoring Report, Year 2 Long-Term Pilot Cap Monitoring* and presented in Figures 2.9.7-4 to 2.9.7-8. Comparison of the near-bottom surface water concentrations identified in the pilot cap area versus the upstream (PCM-13, PCM-19, and PCM-20) and downstream (PCM-01) ambient locations showed no observable differences in the COC concentrations during the high river discharge events. The Year 2 Event 2 intermediate discharge and Year 0 Event 2 low discharge generally showed pilot cap PAH, COC, and benzene concentrations that were elevated above the ambient concentrations observed at upstream and/or downstream ambient stations. This

concentration difference was not identified during the Year 1 Event 2 and Year 2 Event 1 intermediate discharge or Year 1 Event 2 low discharge monitoring.

2.9.8.3 LWG Portland Harbor Site Investigation

The *Comprehensive Round 2 Report* (Integral et al. 2007) presents an analysis of all data collected by the LWG since 2001 and includes analysis of 130 surface water samples from 25 point and transect stations. Water samples were collected during three sampling events in 2004 and 2005. One surface water sample location (W012) is located adjacent to the Gasco property, and one additional location (W015) is located upriver of the Siltronic property (Figure 2.9.8-2). The next nearest sampling location (W009) is located approximately one-half mile downriver from the Gasco property.

The specific objectives of the sampling program identified in the Surface Water FSP (Integral 2004) included collection of surface water chemistry to characterize the nature and extent of contamination, including contaminant distribution and identification of potential sources to the river. Both the Gasco and Siltronic properties were identified as sites with groundwater pathways to the Lower Willamette River.

Notable results for the two stations in the vicinity of the Project Area (stations W012 and W015) include:

- Total DDTs were detected for all three sampling events at station W015 with results ranging from 2,600 to 5,250 pg/L. One higher total DDT result from the overall investigation was reported at an upstream sampling location.
- The highest PAH concentrations during each sampling event were reported at station W015, with the highest result reported as 231 ng/L.

2.9.8.4 Siltronic In-River Investigation

On behalf of Siltronic, MFA completed characterization of the upland and in-river impacts from TCE associated with the release from former USTs stored on the Siltronic property. The results of the characterization, along with data from work completed in 2004, are described in the *Supplemental Investigation Report* (MFA 2005b). The objectives of the study included the characterization of the impacts to surface water by collecting near-bottom surface water samples co-located with TZW samples. The sampling locations are shown on Figure 2.9.7-2 and 2.9.7-3.

TCE and its degradation products were detected in TZW samples above risk-based screening levels in two separate and distinct areas, identified as Area 1 and Area 2. Area 1 is generally located offshore of upland monitoring well WS-12-125/161. Area 2 is located downstream of Area 1 and offshore of upland monitoring well WS-14-125. The approximate areas of surface water and TZW impacts above screening criteria in Areas 1 and 2 are depicted in 2.9.7-2 and 2.9.7-3. Area 1 TZW impacted by TCE and its degradation products did not result in significant impacts to near-bottom surface water as evidenced by the lack of detections of TCE and its degradation products above the screening criteria. Area 2 transition water impacted by TCE and its degradation products resulted in very limited impacts to surface water.

2.9.9 Nearshore Soils Quality

2.9.9.1 Gasco Property

As described in Section 2.2.4 and shown in Figures 2.2.4-2 and 2.2.4-3, the majority of the Gasco property riverbank is vegetated or covered with riprap. However, some locations of minimally vegetated soils and unarmored steep banks exist that could be eroded and transported to the Lower Willamette River. The *Gasco Source Control Data Gaps Evaluation* (Anchor 2006d) evaluated bank soil quality from previous investigations to determine the chemical concentrations in bank soils. The area defined as the riverbank is shown by the gray shading in Figure 2.9.9-1 and includes the area from approximately elevation +8 feet to elevation 24 feet NAVD88. This elevation zone includes the sloped area of the bank where erodible soils could be transported directly to the Lower Willamette River and constitutes the likely vertical surface that would be inundated by the river under the majority of flow conditions. Areas lower than this are frequently inundated and were not evaluated because they are considered aquatic sediments that are already present in the Lower Willamette River.

Surface soil samples collected along the Gasco property shoreline are shown in Figure 2.9.9-1 and include the following:

- Eleven surface soil samples were collected in November of 1998 at areas of exposed soil along the bank adjacent to the Lower Willamette River. Samples were collected at approximately 200-foot intervals, as well as from areas where discoloration was identified (HAI 1998). The samples were tested for PAHs, arsenic, and cyanide.
- Seventy-three soil borings have been installed since 1995 and sampled for surface and subsurface soil COCs. Several boring locations (B-29, B-53, B-54, and B-56) were near the top of the bank slope, and the results of the uppermost surface soil from these borings

were evaluated. The samples were all tested for PAHs. TPH and cyanide were each tested at one location (B-29 and B-56, respectively). Samples from locations B-53, B-54, and B-56 were also tested for BTEX.

- Two monitoring wells were installed in 1995 (MW-04 and MW-05) and surface soil samples were taken at these locations near the top of the riverbank. The samples were both tested for PAHs. TPH and cyanide were also tested at MW-04.

The above surface soil data was reviewed and screened against JSCS Table 3-1 criteria in the *Gasco Source Control Data Gaps Evaluation* (Anchor 2006d). A summary of the results for the representative COCs is as follows:

- PAHs exceed the JSCS criteria in 11 of 14 samples across the length of the shoreline of the property. Exceedances were generally consistently identified for naphthalene, as well as additional PAHs. Three samples (SS-8, SS-11, and B-56; Figure 2.9.9-1), however, did not exceed screening criteria for any compound tested. Two stations, SS-1 and SS-6, had slightly elevated concentrations above screening criteria for only two PAH compounds (benzo(g,h,i)perylene and indeno(1,2,3-cd)pyrene).
- BTEX compounds were not identified at concentrations greater than method reporting levels at any of the three surface soil sampling locations where these compounds were tested.
- Total cyanide was detected in seven of the 11 surface bank soil samples collected that ranged between 0.58 and 56 mg/kg. The JSCS does not have a criterion for cyanide, preventing a comparison to Table 3-1 criteria.

The data were also screened against the MacDonald et al. (2000) Probable Effects Concentration (PEC) value of 22,800 μg/kg for total PAH because the JSCS does not have a total PAH criteria. (Note that JSCS criteria include PECs for individual PAHs, thus the use of the PEC total PAH value is consistent with JSCS and is useful for summarization purposes.) Figure 2.9.9-1 presents the screening quotients for each station for total PAH using this value. The total PAH concentrations exceeded the criterion in seven of 14 bank soil sample locations along the central portion of the shoreline.

2.9.9.2 Siltronic Property

As described in Section 2.2.4 and shown in Figure 2.2.4-1, the full length of the property's shoreline is stabilized with rock riprap designed to prevent riverbank erosion. In addition,

areas above the OHW line are permanently vegetated. Consequently, direct contact between river water and site soils and/or erosion of embankment soils via surface water sheet flow into the river is not expected to be a substantial pathway of contaminant migration. Bank soils adjacent to the Siltronic property were evaluated in the *Updated Phase I Site Characterization Summary Report* (HAI 2005), the *RI Proposal* (HAI 2006), and *Gasco RI Report* (HAI 2007a). The *Segment 3 Source Control Evaluation Report* (Anchor QEA 2009a) used the information in these reports to determine the potential chemical concentrations related to previous MGP operations on the property that potentially could be transported to the Lower Willamette River via bank erosion.

To evaluate the potential for chemical migration pathway via erosion of bank soils, HAI collected five surface (upper 3 inches bgs) samples along the upper shoreline (Samples S-1 through S-5) in August 2001 (Figure 2.9.9-2) and analyzed them all for PAHs and total cyanide. The sample from location S-1 was also tested for TPH. The soils at all surface sample locations (S-1 through S-5) were found to consist of brown, gravelly, silty sand. No field screening evidence of potential impact (i.e., discoloration, suspect odor, or sheen) was observed at any surface soil location. All surface soil sampling locations were well landscaped (grass ground-cover) with a lack of erosional features. A summary of the results for the representative COCs is as follows:

- Napthalene was not identified at concentrations greater than method reporting level (0.067 mg/kg) at any of the five surface soil sampling locations.
- Total cyanide was not identified at concentrations greater than method reporting level (0.02 mg/kg) at any of the five surface soil sampling locations.

Total PAH concentrations ranging from 0.71 to 2.14 parts per million (ppm) were identified at locations S-1 through S-3, while no PAHs were identified at concentrations greater than method reporting levels at the S-4 and S-5 locations.

2.9.10 Stormwater Quality

Stormwater quality discharging to the Project Area from the Gasco and Siltronic properties and just upstream from the Siltronic property (outfalls shown on Figure 2.9.10-1) has been evaluated as part of the Portland Harbor Site RI investigation activities and by NW Natural and Siltronic. A summary of the findings is provided below for the Gasco and Siltronic property.

2.9.10.1 Portland Harbor Site RI/FS Round 3a and 3b Data Report

Data collected as part of the Portland Harbor Site RI/FS process at Outfall WR-107 on the Gasco property, as shown in Figure 2.9.10-1, include four composite water samples (collecting a mean flow-weighted concentration over one storm event) and one sediment trap sample (collected over the entire 3 to 6 month sampling period) (Anchor and Integral 2008). Naphthalene was detected in one of four composite water samples at a concentration of 0.05 µg/L and a concentration of 8,400 µg/kg was measured in the sediment sample. Total PCBs were detected in all three composite samples they were measured in and the sediment trap sample, with concentrations ranging from 510 to 4,420 pg/L for composite water and 120 µg/kg in the sediment trap sample. Pesticides were only measured in the sediment trap sample at this location and were non-detect for all DDx pesticides except 4,4' DDE, which was detected but N-qualified.

Data collected as part of the Portland Harbor Site RI/FS process at Outfall WR-67 on the Siltronic property as shown in Figure 2.9.10-1 includes six composite water samples (collecting a mean flow-weighted concentration over one storm event) and one sediment trap sample (collected over the entire 3 to 6 month sampling period). Naphthalene was non-detect in all composite water samples and was not measured in the sediment trap sample due to limited sample mass. Total PCBs were detected in all five composite samples they were measured in and the sediment trap sample, with concentrations ranging from 344 to 4,950 pg/L for composite water and 107 µg/kg in the sediment trap sample.

2.9.10.2 NW Natural Gasco Property Source Control Investigations

Under direction from DEQ, NW Natural recently conducted catch basin sampling on the Gasco property (Anchor 2008g) to evaluate potential sources of unacceptable levels of stormwater chemicals to the Lower Willamette River. In summary, the sampling approach involved:

- Collection of representative catch basin sediments
- Analysis of catch basin sediments for property COIs and the assessment of the potential impacts to surface sediment quality from the potential transport of solids from the property to the Lower Willamette River
- Catch basin sediment screening so that analytical results can be used to refine the property-specific stormwater analytical suite

Sediment samples were collected by hand from locations shown on Figure 2.9.10-2 and as described below:

- Sample SS-D1 represents solids from containment basin D1 and any material entering from the sump on the fuel loading dock
- Sample SS-D2 was a composite of sediment from two catch basins at the truck wash area
- Sample SS-E1 is a discrete sample of material present in catch basin SS-E1-C
- Sample SS-E2 contained material composited from catch basins SS-E2-A and SS-E2-B in the graveled area near the LNG office building and areas containing ASTs and piping related to product conveyance

PAHs were detected in all samples. All PAH compounds were detected at levels above the MacDonald PECs (2000) in samples SS-D1 and SS-D2 with the exception of naphthalene in sample SS-D2. PAH compounds were also detected above the MacDonald PECs (2000) in the other two samples, SS-E1 and SS-E2. Specifically, the HPAH compounds pyrene, indeno(1,2,3-c,d)pyrene, and benzo(g,h,i)perylene were detected in sample SS-E1 above the MacDonald PEC (2000) screening level and the LPAH compound acenaphthylene and most of the HPAH compounds were detected in sample SS-E2 above the MacDonald PEC (2000) screening levels. There are no screening level criteria for the DEQ bioaccumulative sediment SLVs for PAH compounds.

There are no screening criteria for any of the BTEX compounds. Benzene was not detected in any sample and toluene was detected in samples SS-D1 and SS-D2 in the FAMM lease area. Low levels of ethylbenzene, m,p-xylene, o-xylene, and total xylene were detected in samples from SS-D1 and SS-D2.

Cyanide was detected at levels ranging from 0.1 and 0.4 mg/kg in samples SS-D2, SS-E1, and SS-E2 and a concentration of 7.6 mg/kg was reported in sample SS-D1; however, there are no screening criteria for cyanide.

2.9.10.3 Siltronic Property

The *Segment 3 Report* (Anchor 2009a) focused on discussions of exceedances of three representative COCs (naphthalene, benzene, and total cyanide). Of these chemicals, five stations exceeded the human health-based criteria for naphthalene with Screening Quotients (SQs; defined as concentration divided by criteria) in the 11 to 100 range (Figure 2.9.10-3). Only

one station in this group, City Outfall 22C taken on August 13, 2002, exceeded the human health-based criterion for naphthalene and also exceeded the ecological receptor criterion for naphthalene with SQs in the 1 to 10 range. This same sample also exceeded the human health-based criteria for benzene with SQs in the 1 to 10 range. Five stations exceeded the human health-based criteria with SQs in the 1 to 10 range; four of these stations exceeded criteria for naphthalene and one station exceeded for benzene. Exceedances of screening criteria also occurred for select other chemicals as described in the appendices of the Segment 3 report.

2.9.11 Suspended Sediment Quality

This section summarizes the in-river suspended sediment quality data as measured by sediment trap sampling conducted within the direct vicinity of the Project Area. In-river sediment trap sampling was performed by the LWG during the Portland Harbor RI Round 3A investigation and NW Natural as part of Tar Body Removal Action.

The objective of the Round 3A investigation was to measure the sediment trap mass accumulation and concentrations of sediment-bound chemicals that enter the Portland Harbor Site from upstream sources, chemical concentrations associated with regional sources within the Portland Harbor Site, and concentrations of sediment-bound chemicals that migrate downstream from the Portland Harbor Site (Anchor 2006c). To achieve these objectives, sediment traps were deployed and maintained on both sides of the Lower Willamette River at approximately RM 1.9, 6, 11.5, and 15.7. The sampling station at RM 6 is located offshore the U.S. Moorings property directly downstream from the Gasco property (Figure 2.9.11-1). The sediment traps were left in place between 3 and 4 months for four quarters in late 2006 and throughout 2007 as part of the Round 3A RI activities. A detailed description of field efforts associated with sediment trap deployment and recovery is included in the sediment trap data report (Anchor 2008f) and in the respective FSRs for the initial deployment and each collection quarter (Anchor 2006e, Anchor 2007a, c, and f, Anchor 2008a).

The sediment trap sampling performed by NW Natural was to meet the EPA Action Memorandum (EPA 2005a) requirements to perform baseline and action specific monitoring in the vicinity of the Removal Action Area for tar body-related related contaminants suspending and settling in the vicinity of the Removal Action Area. This sampling included baseline sampling that was conducted prior to initiation of the removal action activities and monitoring following completion of the construction. For the purposes of this Work Plan, only the baseline

results are discussed given the post-construction monitoring results are not considered representative of upriver suspended sediment quality.

The sediment trap sampling locations are shown in Figure 2.9.10-1 and the results are summarized in Table 2.9.11-1. A brief summary of the results for each of the investigations is included below for the following COCs: napthalene, benzene, total cyanide, total PAHs, TCE and its degradation byproducts, DDxs, and total PCBs. The Lower Willamette River flow conditions were measured during the Round 3A quarterly deployment to facilitate an evaluation of how different flow conditions may affect the observed concentrations. The flows ranged from approximately 20,000 to 140,000 cubic feet per second (cfs) during the first quarter, 20,000 to 80,000 cfs during the second quarter, 10,000 to 25,000 cfs during the third quarter, and consistently around 10,000 cfs during the fourth quarter. The discussion of results summarizes the observed concentrations relative to these variable flow conditions.

2.9.11.1 Napthalene Concentrations

Napthalene concentrations were detected during each Round 3A quarter and at each baseline monitoring station and ranged from 50 to 630 μg/kg. The concentrations at LW3-ST005 were very similar (i.e., 55 and 58 μg/kg) during the higher first and second quarter flow conditions and slightly more elevated (i.e., 120 μg/kg) during the lower flow conditions encountered during the fourth quarter.

2.9.11.2 Benzene Concentrations

Benzene concentrations were non-detect during the first, second and third quarter Round 3A sampling activities.

2.9.11.3 Total Cyanide Concentrations

Total cyanide concentrations ranged from non-detect to 19.8 mg/kg.

2.9.11.4 Total Polycyclic Aromatic Hydrocarbons (TPAHs) Concentrations

TPAH concentrations were detected during each Round 3A quarter and at each baseline monitoring station and ranged from 2,400 to 11,000 μg/kg. The concentrations at LW3-ST005 were very similar (i.e., 4,000 and 4,100 μg/kg) during the higher first and second quarter flow

conditions and more elevated (i.e., 11,000 µg/kg) during the lower flow conditions encountered during the fourth quarter.

2.9.11.5 TCE, DCE, 1,1-DCE, and Vinyl Chloride Concentrations

There were no detections of TCE and its degradation products during all four monitoring quarters of the Round 3A investigation.

2.9.11.6 DDD, DDT, and DDE Concentrations

Total DDD, DDT and DDE concentrations were detected during each Round 3A quarter and ranged from 2.4 J to 18 µg/kg, 2 to 5.9 J µg/kg, and 2.1 to 9 µg/kg, respectively. The concentrations at LW3-ST005 were very similar for each total DDx compound during the higher first and second quarter flow conditions and more elevated during the lower flow conditions encountered during the fourth quarter.

2.9.11.7 Total PCB Concentrations

Total PCB congener concentrations were detected during each Round 3A quarter and ranged from 10,600 to 25,300 ng/kg. The concentrations at LW3-ST005 were very similar (i.e., 10,600 J and 11,300 J ng/kg) during the higher first and second quarter flow conditions and more elevated during the lower flow conditions encountered during the third and fourth quarter.

2.10 Conceptual Site Model

The conceptual site model is based on the findings described in the various investigation reports referenced in Section 2.0. The existing nature and extent of contamination of the various media within the Project Area (Section 2.9) were evaluated with respect to the current and historical land uses (Section 2.5 and Section 2.6), the physical site setting (Section 2.2), information about known historical and potential ongoing sources (Section 2.8), and human use and ecology in the Project Area to establish the potential linkages between known and suspected sources of contamination, transport mechanisms, and receptors. The results of this evaluation are summarized in Tables 2.10-1 through Table 2.10-4 that show the impacted media, COIs, and potentially known pathways for the identified historical and current upland and overwater areas at the Gasco and Siltronic properties. A general description of the findings for each of the potential migration pathways to the Lower Willamette River is provided below.

2.10.1 Overland Transport/Direct Discharge

Based on the sources identified in Section 2.8, direct discharge is currently a known minor pathway for the Gasco property. Currently, there is no or minimal potential for direct overland transport of COCs in soils on the either property to the Lower Willamette River because the area is generally flat and soils or graveled areas allow infiltration of any water potentially providing such transport. Direct discharge spills have occasionally happened at Gasco in the past and via outfalls at Siltronic as noted above, but in general procedures are in place for current property operations to minimize or prevent such direct discharges.

Historically, direct discharge was a known pathway for both the Gasco and Siltronic properties due to various operations involving discharge of MGP wastes and chlorinated solvents (via an outfall) into the river via various operations. In addition, spills have also occasionally occurred at both properties.

2.10.2 Riverbank Erosion

Based on the shoreline conditions and structures identified in Section 2.2.4 and the sources identified in Section 2.8, riverbank erosion is currently a potential pathway and incomplete pathway adjacent to the Gasco and Siltronic properties, respectively. Currently at Gasco, there is some potential for erosion of soils containing chemicals in shoreline to the Lower Willamette River. The majority of the shoreline on the property is vegetated or covered with riprap. However, some locations of minimally vegetated soils exist that could be transported to the Lower Willamette River, if erosion occurs. At Siltronic although actual erosion of the riverbank appears unlikely due to the high degree of armoring, riverbank soil chemistry information was identified as a potential data gap to fully assess the current potential for this pathway in the *Segment 3 Source Control Evaluation* (Anchor QEA 2009a).

Historically, riverbank erosion likely occurred periodically at both properties and contributed to the deposition of chemical laden soils to sediments in nearshore areas. For the Gasco property, such events were historically minor as compared to large scale reworking of the shoreline using materials containing MGP wastes and other direct discharges to the sediments. For the Siltronic property, the same issues with regards to MGP wastes occurred historically and historical evidence suggests this was mainly confined to the downstream end of the Siltronic property.

2.10.3 Groundwater Pathway

Based on the source findings presented in Section 2.8 and groundwater quality findings presented in Section 2.9.6, groundwater is currently and historically a known pathway to the Lower Willamette River sediments for both the Gasco and Siltronic properties. At the Gasco property and the downstream end of the Siltronic property, MGP-related COC concentrations in shoreline groundwater are elevated in both the surficial fill and alluvial WBZs. Elevated concentrations have been identified both deep beneath the Willamette River and in Willamette River TZW. This plume is attributed mostly to historical tar settling ponds and former effluent pond overflow area.

It is important to note that while total cyanide is readily detected in groundwater, free cyanide (the toxic form) generally is not. For example, out of 101 groundwater samples collected along the top of the shoreline (GS-01 through GS-12; Figure 2.9.6.19) and 101 groundwater samples collected within the river during the Phase 1 and Phase 2 offshore investigation (GS-B1 through GS-B9, GS-C1 through GS-C9, and GS-D1 through GS-D5; Figure 2.9.6.19), a total of 203 total cyanide concentrations were detected, but only 15 free cyanide detections were identified (Anchor 2008b). Thus, the main issue for Lower Willamette River exposures is whether total cyanide will convert to free cyanide in the Lower Willamette River at levels of concern. Surface water and TZW sampling investigations have been conducted that targeted evaluating the potential for transport of cyanide measured in groundwater and TZW to surface water and any conversion to free cyanide under a range of river conditions. The analytical results from these investigations show that there were no detects of free cyanide in river water collected at any depth or tide interval and very few detects of free cyanide in TZW. These data indicate that although the pathway for total cyanide is known, there does not appear to be a risk from free cyanide in TZW and surface water. The method reporting limit attained by the laboratory for these investigations is usually 10 μg/L, which is slightly above the threshold criterion of 5.2 μg/L.

Elevated total cyanide groundwater concentrations are generally higher offshore the northeast corner of the Gasco property in the location of the former spent oxide storage pile. This former storage pile is considered the primary historical source of total cyanide on the Gasco property, but spent oxide was either known or appears to have been present in other areas of the property contributing to elevated total cyanide concentrations in other locations as well. Total cyanide in groundwater appears to be lower in the upstream shoreline of Siltronic, and it is expected that

the ongoing Siltronic RI related to MGP wastes will help clarify the nature and extent of cyanide in groundwater in this area

Surface water sampling near the Siltronic and Gasco properties indicate sporadic detections of potentially MGP-related chemicals in surface water. It is clear from TZW data that discharge of these chemicals occurs to surface water, but these data are confounded by other mechanisms such as sediment resuspension that contributes to chemical levels in surface water. Thus, it is difficult to determine to what extent groundwater discharges of MGP-related chemicals cause surface water risks.

Elevated TCE and byproduct groundwater and TZW concentrations were identified in to the northwest portion of the Siltronic property. The elevated concentrations are attributed to a historical leak in a TCE UST.

Elevated 1,2-dichlorobenzene and chlorobenzene chemicals concentrations were identified in deep groundwater on the Siltronic property. In addition, these compounds were also detected in TZW offshore the Gasco and Siltronic properties. The elevated concentrations are attributed to sources in upland areas on the Rhone-Poulenc property.

2.10.4 Stormwater Discharge

Based on the source findings presented in Section 2.8, stormwater is currently a known minor pathway to the river for both the Gasco and Siltronic properties. Source control investigations at the Gasco property and stormwater sampling by LWG recently identified PAHs and several other chemicals in stormwater discharges and catch basin solids indicating the stormwater to surface water pathway is known. Additional stormwater monitoring is being conducted at the Gasco property to determine the nature and magnitude of this source pathway. Similarly, for Siltronic, the existing data indicate a number of MGP-related and other chemicals are present in stormwater.

Historically, although there is no direct evidence for this, it is assumed that stormwater was one of several pathways through which MGP related chemicals were discharged to the Lower Willamette River. These discharges were likely minor in comparison to historical direct discharges described above. Source control investigations at the Siltronic property identified elevated TCE and byproduct concentrations near the discharge location of outfall along the

northeast corner of the property (termed Area 2). This represents an isolated historical discharge via a stormwater conveyance.

2.10.5 River Transport into the Project Area

This pathway is defined as chemicals entering the Project Area from other upstream sources and contributing to in-river risks within the Project Area. This is a known pathway to sediments adjacent to both the Gasco and Siltronic properties. Historical and ongoing releases to the Lower Willamette River are documented from numerous upstream sources. The Project Area is generally non-depositional in the channel but more prone to sedimentation and at least short term stability in nearshore environments. This sedimentation has and is resulting in sediment contamination from upstream sources as evidenced by substantially elevated PCB and DDx levels present in Project Area sediments, despite the fact that no sources of PCBs or DDx have been identified at the Gasco or Siltronic properties. In addition, deposition has been consistently identified in the Tar Body Removal Action Area where the pilot cap was placed and these depositional sediments show the presence of COCs associated with upstream sources (e.g., DDT and PCBs).

3 PROJECT REMEDIAL ACTION OBJECTIVES AND ARARS

This section discusses the RAOs for the project, as well as the potential ARARs and to be considered initiatives (TBCs) that will be used to develop preliminary remedial goals and evaluate remedial alternatives. Because the goal of this project is to design a final remedial alternative that can be included in the Portland Harbor Proposed Plan, the RAOs will be consistent with the RAOs for the Portland Harbor Site. RAOs as described in the SOW, as well as the most recent RAOs being discussed for the Portland Harbor Site FS, are discussed below. The last subsection presents potential ARARs and TBCs.

3.1 SOW Remedial Action Objectives

Section 3.2 of the SOW presents RAOs that were consistent with the draft Portland Harbor Site RAOs at the time this section of the SOW was developed. Those SOW RAOs for the Project Area for final remedial design are:

1. Removal of sediments containing substantial amounts of product (e.g., solid "tar" and/or DNAPL) that may serve as potential future source of risk material, unless it can be shown that the costs of such removal are clearly disproportionate to the degree of risk reduction to be attained through physical removal as compared to other remedial options for the same material. "Substantial" is defined in Section 3.6.2.1 of the SOW.
2. Reduce human health risks to acceptable levels from direct contact with and incidental ingestion of COCs in Project Area sediments.
3. Reduce COC concentrations in Project Area sediments to levels that would result in acceptable risks to humans that eat fish and shellfish from Portland Harbor in the absence of other sources of chemicals in the river.
4. Reduce COC fluxes from Project Area sediments such that human health risks would be at acceptable levels for direct contact with and incidental ingestion of Project Area surface water in the absence of other sources of chemicals in the river.
5. Reduce ecological risks to acceptable levels from contact with and ingestion of COCs in Project Area sediments or prey from the Project Area in the absence of other sources in the river.
6. Reduce COC fluxes from Project Area sediments such that ecological risks would be at acceptable levels for direct contact with and ingestion of Project Area surface water in the absence of other sources of chemicals in the river.
7. Reduce the migration of contaminants at unacceptable levels from the Project Area to the Lower Willamette River.

8. Reduce COC fluxes through Project Area sediments so that recontamination of Project Area sediments to unacceptable levels does not occur.

Per the SOW, definitions of terms such as "reduce risks" and "acceptable levels" are intended to be consistent with the Portland Harbor Site RI/FS Work Plan or as modified by the Portland Harbor Site RI/FS process. COCs are defined as those chemicals related to historical and present Project Area sources that are found to pose risk at the Project Area following methods consistent with the Portland Harbor risk assessment process. The final Portland Harbor ROD will select performance standards and cleanup levels based on protectiveness and compliance with ARARs. The Portland Harbor Site FS will also consider "background" following EPA guidance (EPA 2002a) on the use of background in RI/FS evaluations and other relevant EPA Superfund guidance.

Removal of significant amounts of mobile product in sediment is expected to control mobilization of source material that might result in potential risks over the long term as described by RAO1. However, it should be noted that removal of all product in sediments is not necessary to meet this objective and may not be technically feasible given practical limitations of sediment removal, which will be further evaluated as described in Section 4.7.7. None of the above precludes the evaluation or selection in the EE/CA of removal options for sediments that do not contain substantial amounts of product. Removal may be a cost-effective alternative (as determined in the EE/CA) for various types of Project Area sediments.

RAO7 and 8 relate to preventing recontamination of the Project Area from upland or other sources. In addition, it should be recognized that recontamination from potential harbor-wide sources must also be evaluated in the project EE/CA and design documents. These potential sources include ongoing upland sources from other upstream and nearby sites, as well as potential sources from upstream sediment remediation (particularly dredging) projects. The EE/CA and design documents will address the appropriate sequencing of Project Area construction and Gasco and Siltronic source control activities with these potential harbor-wide sources such that recontamination of the Project Area remedy is prevented or minimized. Such sequencing will be consistent with the findings of the Portland Harbor Site FS, Proposed Plan, and ROD to the extent possible, recognizing that the Project Area represents a potential recontamination risk to other downstream sites. Cleanup alternatives may include sequencing Project Area construction in whole or part, dredging earlier and waiting to place a permanent cap, or other sequencing to prevent recontamination consistent with upstream and nearby

source controls and sediment remediation timelines. Such sequencing will be consistent with the findings of the Portland Harbor Site FS, Proposed Plan, and ROD to the extent that this document is available in a timely fashion. EPA will oversee both the sediment and riverbank work conducted as part of the SOW with riverbank work being defined as the bank area up to the top of the bank slope and ending where the generally level portions of the Project Area begin. This work will include evaluation of removal of sediments underlying the sloping portion of the bank, also known as the "wedge" area.

The above RAOs will apply within the boundary determined for the project. Establishment of that boundary within the wider Portland Harbor Site sediment cleanup is discussed more in Section 1.2.2.

3.2 Current Draft Portland Harbor RAOs and Management Goals

Per the SOW, if through the Portland Harbor Site RI/FS process, the RAOs for the Portland Harbor Site are changed or revised, then RAOs for this project will be revised. The RAOs for Portland Harbor have not been finalized. NW Natural anticipates that the SOW RAOs will need to be revisited and potentially revised in the Project AIR and Data Gaps QAPP or EE/CA (the next project deliverables). The goal of any such revision would be to follow the intent of the SOW RAOs identified in Section 3.1 and at the same time make them as consistent as possible with the Portland Harbor Site RAOs.

EPA's currently proposed eight RAOs for the Portland Harbor Site FS, as identified in its RAOs letter to the LWG dated September 30, 2009, are presented below. These RAOs include a separate groundwater RAO for addressing risks to human health and a groundwater RAO focused on ecological receptors. EPA notes that these RAOs will be refined based on the results of the BERA and BHHRA. These RAOs will be used to evaluate remedial action alternatives in the Portland Harbor Site FS and as the basis for the evaluation, design, and implementation of upland source control actions being performed under DEQ oversight.

EPA's three currently proposed three management goals for the Portland Harbor Site, as identified in EPA's RAOs letter to LWG, dated September 30, 2009, are also presented verbatim in this section. EPA defined the management goals as those that must be evaluated in the Portland Harbor Site FS to ensure a successful remedy and that will require integration with other regulatory mechanisms to implement. EPA anticipates that these regulatory mechanisms will include but are not limited to State of Oregon Water Quality and Environmental Cleanup

programs. EPA does not expect specific, numeric preliminary remediation goals (PRGs) and remediation goals to be developed for these management goals by the LWG for their part in developing the Portland Harbor Site FS for the in-water portion of the Portland Harbor Site. They will be considered in the development of in-water remedial alternatives, assessing compliance with ARARs including section 404 of the Clean Water Act (CWA) and the ESA and as part of the evaluation of long-term effectiveness and permanence, implementability, and compatibility with anticipated future uses. EPA expects that upland source control measures will be the primary actions for protecting beneficial uses of groundwater, including potential water supply use, and that such controls will be conducted to achieve RAOs established for the in river portion of the Portland Harbor Site.

RAO 1: Reduce to acceptable levels human health risks from exposure to contaminated sediments[2] resulting from incidental ingestion of and dermal contact with sediments, and comply with identified ARARs.

This RAO applies to direct human health sediment exposure scenarios found to have an unacceptable risk in the risk assessment. The goal for this RAO is to reduce risks to human health from COC concentrations in contaminated sediments through sediment remedies at the Portland Harbor Site, comply with chemical-specific ARARs identified for the Portland Harbor Site, and protect beneficial uses of the Lower Willamette River at the Portland Harbor Site.

RAO 2: Reduce to acceptable levels human health risks from indirect exposures to COCs through ingestion of fish and shellfish that occur via bioaccumulation pathways from sediment and/or surface water and comply with identified ARARs.

This RAO applies to fish and shellfish consumption scenarios found to have an unacceptable risk in the risk assessment. The goal is to reduce risks to human health through sediment remedies that protect humans from indirect exposures to COCs through eating fish and shellfish exposed to COCs via bioaccumulation and bioconcentration, comply with chemical-specific ARARs identified for the Portland Harbor Site, and protect the beneficial uses of the

[2] Sediments are defined as soils, sand, organic matter, or minerals that accumulate on the river bottom. For purposes of describing the RAOs, sediment also includes the interstitial water and TZW that is influenced by groundwater and surface water and thus can also be contaminated by groundwater, surface water, or chemicals dissolving off of the sediments. Sediments extend up to the MHW mark (13.3 feet NAVD88) along the banks (including beach sediments) within the Portland Harbor Superfund Site. Riparian soils are found along the riverbanks from the MHW mark to the OHW mark (20 feet NAVD88).

Lower Willamette River at the Portland Harbor Site. This RAO is expected to contribute to the reduction and elimination of Portland Harbor PCB fish consumption advisories. It is recognized that reduction and elimination of the Portland Harbor fish advisory can only be achieved when conducted in conjunction with other Portland Harbor source controls and other PCB reduction efforts conducted under other regulations and programs within the Lower Willamette River watershed, as described in the source control management goal of EPA's September 30, 2009 letter to LWG.

RAO 3: Reduce risks from COCs in surface water at the Portland Harbor Site to acceptable exposure levels that are protective of human health risks from ingestion of, inhalation of, and dermal contact with surface water; protect the drinking water beneficial use of the Willamette River at the Portland Harbor Site; and comply with identified ARARs.

This RAO applies to direct human health surface water exposure scenarios found to have an unacceptable risk in the risk assessment and the protection of the drinking water beneficial use of the Lower Willamette River. The goal is to reduce risks from COC concentrations in surface water, to the extent practicable, through sediment remedies that protect humans from the ingestion of and dermal contact with surface water, comply with chemical specific ARARs identified for the Portland Harbor Site, and protect the beneficial uses (domestic/private water supply) of the Lower Willamette River at the Portland Harbor Site.

RAO – Human Health Groundwater: Reduce to acceptable levels human health risks resulting from direct exposure to contaminated groundwater and indirect exposure to contaminated groundwater through fish and shellfish consumption, and comply with identified ARARs.

This RAO applies to human health risks via exposure to contaminated groundwater plumes that exceed ARARs and indirect exposure to COCs in groundwater plumes discharging to the Lower Willamette River found to have an unacceptable risk in the risk assessment based on fish and shellfish consumption with the understanding that groundwater plumes will be controlled to achieve ARARs and risk-based remediation goals through upland source control actions. The goal for this RAO is to reduce risks to human health from COC concentrations in contaminated groundwater through sediment remedies at the Portland Harbor Site, comply with chemical-specific ARARs identified for the Portland Harbor Site, and protect beneficial uses of groundwater and the Lower Willamette River at the Portland Harbor Site. For

groundwater plumes that are controlled through effective upland source control measures, this RAO would apply to groundwater plumes downgradient of the source control measure.

RAO 4: Reduce to acceptable levels the risks to ecological receptors resulting from the ingestion of and direct contact with contaminated sediments and comply with identified ARARs.

This RAO applies to all ecological receptors found to have an unacceptable risk in the risk assessment via direct sediment exposure. The goal is to reduce risks to ecological receptors from COC concentrations in contaminated sediments and groundwater through sediment remedies at the Portland Harbor Site, prevent unacceptable effects on the survival, growth, and reproduction of ecological receptors at the Portland Harbor Site, and comply with chemical-specific ARARs identified for the Portland Harbor Site.

RAO 5: Reduce to acceptable levels risks to ecological receptors from indirect exposures through ingestion of prey to COCs in sediments via bioaccumulation pathways from sediment and/or surface water and comply with identified ARARs.

This RAO applies to all ecological receptors found to have an unacceptable risk in the risk assessment through ingestion of prey. The goal is to reduce risks from COCs through sediment remedies that protect ecological receptors from exposures to COCs through consumption of fish and shellfish, benthic organisms, and other prey items exposed to COCs via bioaccumulation and bioconcentration; comply with chemical-specific ARARs identified for the Portland Harbor Site; and protect the beneficial uses of the Lower Willamette River. This RAO is expected to contribute to reduction of prey ingestion related ecological risks through reduction in sediment chemical contributions to fish tissue. It is recognized that reduction of and elimination of these risks can only be achieved when conducted in conjunction with other Portland Harbor source controls efforts conducted under other regulations and programs within the Lower Willamette River watershed, as described in the source control management goal of EPA's September 30, 2009 letter to LWG.

RAO 6: Reduce risks from COCs in surface water at the Portland Harbor Site to acceptable exposure levels that are protective of ecological receptors based on the ingestion of and direct contact with surface water and comply with identified ARARs.

This RAO applies to all ecological receptors found to have an unacceptable risk in the risk assessment through exposure to surface water. The goal is to reduce the risk from COC concentrations in surface water to the extent practicable, through sediment remedies that prevent unacceptable effects on survival, growth, and reproduction of ecological receptors; comply with identified chemical-specific ARARs; and protect the beneficial uses of the Lower Willamette River.

RAO – Ecological Groundwater: Reduce to acceptable levels the risks to ecological receptors resulting from the ingestion of and direct contact with contaminated groundwater and indirect exposures through ingestion of prey via bioaccumulation pathways from groundwater, and comply with identified ARARs.

This RAO applies to all ecological receptors found to have an unacceptable risk in the risk assessment via exposure to contaminated groundwater plumes discharging to the Lower Willamette River and through ingestion of prey with the understanding that groundwater plumes will be controlled to achieve ARARs and risk-based remediation goals through upland source control actions. The goal is to reduce risks to ecological receptors from COC concentrations in contaminated groundwater through sediment remedies at the Portland Harbor Site; prevent unacceptable effects on the survival, growth, and reproduction of ecological receptors at the Portland Harbor Site; and comply with chemical-specific ARARs identified for the Portland Harbor Site. For groundwater plumes that are controlled through effective upland source control measures, this RAO would apply to groundwater plumes downgradient of the source control measure.

Management Goal 1 – Ensure sediment cleanup activities consider, complement, and are compatible with upland and upstream source control efforts designed to prevent recontamination by COCs in groundwater, stormwater, soil erosion, upstream sources, and overwater activities at the Portland Harbor Site. Also ensure that these activities are consistent with the RAOs for the site and allow in water remedies at the site to proceed in a timely manner.

This management goal recognizes that a successful site remedy includes the implementation of effective in-water remedies and upland source control measures. The goal is to have a sediment cleanup that is compatible with upland and upstream source controls that prevent sediment recontamination after cleanup. This goal must also consider sequencing and other approaches

in conducting sediment remedies that will minimize downstream migration of contaminants and prevent recontamination of downstream response actions. Further, sediment remediation activities should not hinder upland source control actions and water quality programs being implemented by DEQ. Upland and upstream source identification and control is being regulated and directed by DEQ, including working with individual parties within and outside Portland Harbor. The goal of these source controls is to reduce risk and prevent the unacceptable recontamination of cleaned up sediments. Upland source control activities need to be implemented in a timeframe and manner that reduces risk and minimizes the potential for recontamination by COCs in groundwater, stormwater, soil erosion, and over water activities at, and upstream from the site and are consistent with and facilitate the achievement of site cleanup goals and compliance with ARARs. The FS will include an evaluation of the potential for in-river risks and recontamination from ongoing upland and upstream sources as allowed by existing data and information. The FS will estimate, as existing information allows, the source reduction levels on a site-wide basis that would be expected to meet various sediment and water PRGs including the uncertainty of such estimates.

The FS will not attempt to estimate the source reduction actually provided by various individual potential, planned, or implemented source controls at properties along the river or the watershed as a whole. With regards to riparian soils, there may be cost savings by integrating sediment remedies along the shoreline with upland riparian source control efforts. Upland source control efforts will address riparian soils that are likely to have a direct effect through the erosion of bank material upon sediments and surface water below the mean high water mark. Factors that will be considered to determine if riparian soils are likely to have a direct effect on sediments include the characteristics of the river bank, the presence of contamination, and the status of upland source control efforts.

Management Goal 2 – To the maximum extent practicable, minimize the long-term transport of COCs in the Willamette River from the site to the Columbia River and the Multnomah Channel.

The goal is to prevent the migration of sediment COCs at levels that would potentially pose unacceptable risks to human health and ecological receptors downstream of the site. Sediment cleanup alternatives will be evaluated in the FS under the long term effectiveness criterion to clearly estimate, as existing information allows, whether unacceptable downstream transport would be minimized (or not) by each alternative. Minimization of downstream COC transport

will be a clear sub-criterion presented in the FS under the more general long term effectiveness criterion.

Management Goal 3 – Clean up contaminated sediments in a manner that promotes habitat and that will support a healthy aquatic ecosystem and the conservation and recovery of threatened and endangered species.

The goal is to ensure that sediment cleanup alternatives selected for the site consider the benefits of re-establishing ecological habitats in those areas remediated to support a diverse ecosystem. Sediment remedial actions must comply with ARARs, including CWA compensatory mitigation and Section 404(b)(1) analysis and the ESA. Other potential ARARs may include the Marine Mammal Protection Act and the Migratory Bird Treaty Act. The need for habitat mitigation in conjunction with the remedial action alternatives will be evaluated for each detailed sediment cleanup alternative in the FS under the long-term effectiveness and compliance with ARARs criteria and cost estimate analysis. For each detailed alternative, the FS will evaluate reasonably anticipated future land use with respect to habitat, including potential restoration activities under the Natural Resource Damages Assessment (NRDA) process. The FS will also clearly describe the degree to which habitat mitigation needs to be included to meet substantive requirements of potential ARARs. For each detailed alternative, the FS will clearly describe whether habitat mitigation needs to be included to meet the substantive requirements of potential ARARs. This aspect of the FS will not include evaluation of any potential or needed habitat restoration activities under the NRDA provisions of CERCLA, the CWA, and the Oil Protection Act (OPA).

3.3 RAO Performance Goals and Measurement Methods

When discussing RAOs, it is important to consider how attainment of those RAOs (i.e., performance) will be assessed and the specific measurement methods that will be used in that assessment. Given that the goal is to have SOW RAOs that are consistent with the Portland Harbor Site process, and performance goals and measurements methods for those RAOs are currently in flux, it is difficult to specify at this time the specific performance goals and measurement methods that will be used for the SOW RAOs. However, each of the existing SOW RAOs is reviewed briefly here to discuss potential general goals and methods for each. As the SOW RAOs are refined, final goals and methods will need to be selected.

SOW RAO 1. Removal of sediments containing substantial amounts of product (e.g., solid "tar" and NAPL) that may serve as potential future source of risk material, unless it can be shown that the costs of such removal are clearly disproportionate to the degree of risk reduction to be attained through physical removal as compared to other remedial options for the same material. "Substantial" is defined in Section 3.6.2.1 of the SOW.

The performance goals and measurement methods for substantial product are relatively well defined already in the SOW. This includes a clear definition of substantial product (defined in the SOW and detailed in Section 4.7.3.1 of this Work Plan). The general performance goal for assessing alternatives in the EE/CA would be that after implementation, instances of substantial product would no longer be present at the Project Area, except where there is a disproportionate cost for such removal per the SOW. The measurement method is also well defined and uses visual observations of cores, which are compared against the substantial product definition. The SOW also specifies that the edges of the area with substantial product will be defined by the cores that do not contain substantial product.

SOW RAO 2. Reduce human health risks to acceptable levels from direct contact with and incidental ingestion of COCs in Project Area sediments.

Performance relative to this RAO would most directly be determined by comparing chemical concentrations in surface sediments expected for various EE/CA alternatives to sediment preliminary remediation goals PRGs from the Portland Harbor Site FS that represent acceptable levels of human health risk from direct contact with and incidental ingestion of sediments.

The measurement methods would specify the PRG levels to be used that equate to cancer risk and Hazard Quotient (HQ) levels used in the Portland Harbor Site FS. Given the current status of PRG and Area of Potential Concern (AOPC) development within the wider Portland Harbor Site, it appears that that PRGs back calculated from BHHRA risk estimates equal to an HQ of 1 or a cancer risk level of approximately in the 10--6 will be judged to meet this RAO. PRGs would be compared to estimated sediment concentrations in EE/CA alternatives in the 0 to 30 cm depth layer (a reasonable exposure depth for people) and over those areas where direct contact exposure to sediments was found to be a known and significant pathway in the BHHRA (i.e., excluding areas in the Lower Willamette River navigation channel). Per the Portland Harbor Site AOPC process directed by EPA (letter to LWG dated June 23, 2009), the PRG would be applied such that the Surface-area Weighted Average Concentration (SWAC) for the beach

meets the PRG (i.e., the PRG would not be applied on a point-by-point basis in these direct contact areas).

SOW RAO 3. Reduce COC concentrations in Portland Harbor Site sediments to levels that would result in acceptable risks to humans that eat fish and shellfish from the harbor in the absence of other sources of chemicals in the river.

Performance relative to this RAO in the EE/CA would most directly be determined by comparing EE/CA alternative estimated chemical concentrations in surface sediments to Portland Harbor Site sediment PRGs that represent acceptable levels of human health risk via bioaccumulation pathways.

The measurement methods would specify the PRG levels to be used that equate to cancer risk and HQ levels used in the Portland Harbor Site FS. Given the current status of PRG and AOPC development within the wider Portland Harbor Site, it appears that PRGs back-calculated from BHHRA risk estimates equal to a cancer risk level of approximately 10-4 (at consumption rates used in the BHHRA) would be used. The HQ level and consumption rate, or equivalent, has not yet been specified by EPA. Lower non-cancer or cancer risk performance goals could be identified by EPA for the Portland Harbor Site-wide AOPC that might apply to the Gasco Sediments Site, but in no case would these be expected to be below those risk levels created by bioaccumulation in biota from upland and upstream chemical sources to the water column uncontrollable by NW Natural or Siltronic. The PRG would be compared to estimated sediment concentrations for EE/CA alternatives in the Biologically Active Zone (BAZ). The PRG would be applied where bioaccumulation exposure was found to be a known and significant pathway in the BHHRA. The PRG would be applied on a spatial scale using SWACs appropriate to the exposure consistent with the BHRRA, which would be expected to be the entire Portland Harbor Site for wide-ranging species, 1 RM for mid-range species (e.g., small mouth bass), and 1 RM excluding the river channel for shellfish.

SOW RAO 4. Reduce COC fluxes from Portland Harbor Site sediments such that human health risks would be at acceptable levels for direct contact with and incidental ingestion of site surface water in the absence of other sources of chemicals in the river.

Performance relative to this RAO in the EE/CA would most directly be determined by comparing EE/CA alternative estimate chemical concentrations in surface water (assuming other sources to the water column are zero) to surface water PRGs and criteria that represent

acceptable levels of human health risk via incidental ingestion or and dermal contact with surface water.

The measurement methods would specify the PRG levels to be used that equate to cancer risk and HQ levels used in the Portland Harbor Site FS. Given the current status of PRG development within the wider Portland Harbor Site, it appears that would likely be set at an HQ of 1 and a cancer risk level of 10-6 using exposure assumptions from the BHHRA. However, in no case would these be expected to be below those risk levels created by upland and upstream chemical sources to the water column not controllable. Although the LWG does not agree that consumption of untreated drinking water is a beneficial use of the Lower Willamette River, EPA has directed the LWG to compare untreated surface water to Safe Drinking Water Act Standards (i.e., Maximum Contaminant Levels or MCLs) in the BHHRA and has indicated that it will likely consider MCLs an ARAR for surface water. Therefore, it appears likely that in the EE/CA, sediment alternatives would be judged to meet the RAO relative to MCLs based on the estimated water column concentration achieved with the alternative, assuming other sources to the water column are zero. Comparisons of surface water concentrations estimated for EE/CA alternatives to surface water PRGs and criteria will be made on a scale appropriate to exposures in the BHHRA. For beach users, this includes comparison on a site-wide scale as well as regional access point exposure areas. For divers, this includes site-wide and ½ river mile exposure areas. For comparisons to MCLs this includes vertically integrated samples over the entire Project Area.

SOW RAO 5. Reduce ecological risks to acceptable levels from contact with and ingestion of COCs in Portland Harbor Site sediments or prey from the site in the absence of other sources in the river.

Performance relative to this RAO in the EE/CA would most directly be determined by comparing EE/CA alternative chemical concentrations in surface sediments to sediment PRGs that represent acceptable levels of ecological risk from ingestion of and direct contact with sediments and ingestion of prey contacting the sediments.

Measurement methods would specify the PRG levels to be used that equate to HQ levels used in the Portland Harbor Site FS. Given the current status of PRG development within the wider Portland Harbor Site, it appears that would likely be set an HQ of 1. These PRGs would be applied in the BAZ of surface sediment. These measurement methods will be applied in areas

where ecological exposures to surface sediment were found to be a known and significant pathway in the BERA. The PRGs would be applied on a spatial scale appropriate to the exposure, which varies depending on the receptor and pathway (direct contact vs. prey ingestion) in question.

SOW RAO 6. Reduce COC fluxes from Portland Harbor Site sediments such that ecological risks would be at acceptable levels for direct contact with and ingestion of site surface water in the absence of other sources of chemicals in the river.

Performance relative to this RAO in the EE/CA would most directly be determined by comparing EE/CA alternative estimate chemical concentrations in surface water (assuming other sources to the water column are zero) to surface water PRGs and criteria that represent acceptable levels of ecological risk via surface water.

The measurement methods would specify the PRG levels to be used that equate to HQ levels used in the Portland Harbor Site FS. Given the current status of PRG development within the wider Portland Harbor Site, it appears that would likely be set an HQ of 1. However, in no case would these be expected to be below those risk levels created by uncontrollable upland and upstream chemical sources to the water column. The EE/CA alternatives would also be compared to ecological surface water Ambient Water Quality Criteria (AWQC), which is a potential ARAR. The EE/CA sediment alternatives would be judged to meet the RAO relative to PRGs and AWQC based on the estimated water column concentration achieved with the alternative, assuming other sources to the water column are zero. Comparisons of surface water concentrations estimated for EE/CA alternatives to surface water PRGs and criteria will be made on a scale appropriate to exposures in the BERA.

RAO 7. Reduce the migration of contaminants at unacceptable levels from the Portland Harbor Site to the Willamette River.

Performance relative to this RAO in the EE/CA would most directly be determined by estimating the potential for erosion, resuspension, and downstream transport of contaminated sediments for each alternative.

Measurement methods would specify estimating a chemical load leaving the Project Area (at some set downstream boundary) during and after construction of each alternative. Alternatives

that reduced the total downstream loading over the short and long term to a greater extent would be preferred in the alternatives selection (and as consistent with meeting other RAOs). Estimates would be made using appropriate modeling or other estimation tools and assuming a reasonable range of river flow conditions. Depending on the status of the Portland Harbor fate and transport modeling, this model could be used.

RAO 8. Reduce COC fluxes through Portland Harbo Site sediments so that recontamination of site sediments to unacceptable levels does not occur.

Performance relative to this RAO in the EE/CA would most directly be determined by estimating for each alternative the flux of chemicals from groundwater and subsurface sediments and the resulting long-term concentrations in surface sediments and comparing that concentration to sediment PRGs.

Measurement methods would include estimating the long term sediment chemical concentration via specified sediment/groundwater flux models. The results of the models would be compared to the same PRGs as described for other RAOs, because these represent acceptable risk levels. The models would use information on subsurface sediment quality, groundwater quality, and groundwater seepage rates and would include an assessment of the expected reductions in groundwater concentrations and/or seepage rates expected to be provided by groundwater source controls currently under design.

3.4 Applicable or Relevant and Appropriate Requirements and To Be Considered Initiatives

Pursuant to CERCLA §121(d), ARARs and TBC guidelines will be identified that are relevant to the RAOs above. On-site response actions (i.e., those taken within the Portland Harbor Site) do not require compliance with the administrative requirements of other laws (such as permit applications, reporting obligations, and record keeping requirements). CERCLA does require compliance with the substantive elements of the laws (such as monitoring requirements or concentration limits) for Superfund on-site response actions, to the extent practical considering the circumstances of the situation. ARARs may be waived by EPA under certain circumstances. Administrative requirements, however, do apply to off-site actions (such as a material sent off site for further management). Potential ARARs and TBCs, consistent with those being considered for the Portland Harbor Site, are presented in Table 3.1-1. Table 3.1-2 presents

proposed numeric levels and methods of application for the ARARs consistent with the measurement methods discussed above for RAOs. These tables will be updated as ARARs for the Portland Harbor Site are finalized.

Potential ARARs are divided into the following categories:

- **Chemical-specific Requirements.** These are health- or risk-based concentration limits or ranges for contaminants in different media.
- **Action-specific Requirements.** These are controls or restrictions on particular types of activities such as the Clean Water Act regulating discharges of dredged and fill material into waters of the United States.
- **Location-specific Requirements**. These are restrictions on activities based on the characteristics of a site or its immediate environment.

4 WORK TO BE PERFORMED

This section describes the work to be performed under the AOC as identified in the SOW, as well as project roles and responsibilities, coordination activities between the various parties, RAOs, key decision factors, community involvement, and criteria that will govern project work.

4.1 Project Roles and Responsibilities

This section defines the project roles and responsibilities for NW Natural, Siltronic, and their currently identified contractors for work performed under the AOC and associated SOW. The project roles and responsibilities for each of these parties are described in the following subsections.

4.1.1 NW Natural

NW Natural has the responsibility for managing completion of the work, including selection of consultants and contractors to perform the work, except as related to performance of work in Area 1 adjacent to the Siltronic property. NW Natural designates Bob Wyatt as the Project Coordinator for the work.

NW Natural designates Anchor QEA, LLC as the lead consultant for managing completion of the work identified in the SOW. Anchor QEA will manage the necessary coordination between NW Natural, Siltronic, EPA, and DEQ; develop all submittals defined in the SOW; and manage completion of all field activities and subsequent data evaluation outside of Area 1. Anchor QEA designates Carl Stivers as the Project Manager, Ryan Barth as the Assistant Project Manager, and John Verduin as the lead engineer. This team will be supported by Sevenson Environmental Services, Inc. (Sevenson) on issues related to feasibility and constructability of alternatives in the EE/CA and development of the design.

4.1.2 Siltronic

Siltronic has responsibility for performing any applicable work in Area 1 adjacent to the Siltronic property. Siltronic will develop any field sampling or other work plans related to the Area 1 work, collect any data related to the Area 1 work, and prepare reports associated with their data collection. Siltronic designates Tom McCue as its Project Manager for the work and James Peale as the primary technical lead on Area 1 work. Bob Wyatt and the NW Natural

consultant team will coordinate as necessary with Tom McCue to incorporate the Area 1 work into the SOW deliverables.

Applicable cleanup activities performed in Area 1 by Siltronic are anticipated to be conducted concurrently and integrated with cleanup activities conducted by NW Natural throughout the remainder of the Project Area in order to effectively conduct design and cleanup as a single project. This is true to the extent that the remedies selected for various conditions at the site (i.e., a dissolved CVOC plume versus MGP product containing sediments) are technically compatible in time span and type of contractors involved. For example, a natural attenuation remedy for a CVOC plume would extend over time much longer than an active removal remedy for MGP contamination, assuming that removal of CVOC contaminated sediments along with MGP contaminated sediments did not fully address CVOC plume contamination. Similarly, certain CVOC remedies might require specialized equipment and expertise that are not available through more standard contractors that might cost effectively remove relatively larger amounts of MGP contaminated sediments. Regardless of these technical compatibility issues, the intent is to design and implement a comprehensive project that addresses all of the project RAOs. Completion of all remediation within the Project Area as a single project will avoid the additional potential short term impacts.

4.2 Ongoing Coordination

NW Natural and Siltronic will coordinate teleconferences (meetings where EPA and NW Natural agree that a meeting is warranted) with EPA, DEQ, the Tribes, and the Natural Resource Trustees to discuss the status of work described in the SOW. After approval of the Work Plan, these teleconferences or meetings will occur monthly, if needed. DEQ, the Tribes, and the Trustees will submit their comments on SOW-required deliverables to EPA. EPA will provide the comments to NW Natural and Siltronic to be addressed.

To coordinate with upland source control actions on the Gasco and Siltronic properties, NW Natural and Siltronic will coordinate quarterly teleconferences (meetings where EPA, DEQ, and NW Natural agree that a meeting is warranted) with EPA and DEQ or written updates will be provided in place of such teleconferences or meetings. Consistent with the February 2001 MOU (EPA and DEQ 2001), DEQ will provide upland source control documents to EPA for review, to ensure consistency and compatibility with the contemplated in-water dredging and cap designs for recontamination analysis.

NW Natural and Siltronic will also coordinate meetings and other means of information exchange with partner agencies, including EPA, DEQ, and the Natural Resource Trustees for the purposes of ensuring that substantive requirements are met consistent with partner agency interpretation of those requirements, particularly concerning ESA compliance with NMFS. NW Natural and Siltronic will engage with NMFS through EPA as follows:

- Immediately prior to EE/CA development
- During EE/CA review to solicit specific input from NMFS on the evaluation and selection of preferred alternative and a BA of the preferred alternative
- During Preliminary Design review including the preparation of a revised BA based on EE/CA-level BA comments from NMFS
- During Interim Design review including preparing any updates to BA determinations as appropriate
- During Final Design, as necessary

As discussed in Appendix B, NW Natural and Siltronic will also consult with the State Historic Preservation Officer (SHPO), Tribal Historic Preservation Officer (THPO) of the Confederated Tribes of the Warm Springs Reservation and Confederated Tribes of the Umatilla Indian Reservation, and the cultural resource program managers for the Nez Perce Tribe, Confederated Tribes of the Grand Ronde community of Oregon, Confederated Tribes and Bands of the Yakama Nation, and the Confederated Tribes of the Siletz Indians of Oregon to facilitate compliance with Section 106 of the National Historic Preservation Act and implementing regulations at 36 CFR 800. NW Natural and Siltronic will consult as necessary with the THPOs and cultural resource managers prior to and during development of the EE/CA and design documents. The consultation will be directed toward obtaining information that Tribes may be able to share regarding cultural resources at or in the vicinity of the research area, receiving comments on the identified Area of Potential Effects (APE), presenting evidence regarding the need or lack thereof for monitoring cultural resources during the cleanup activities, as well as identifying any more general Tribal cultural resource issues or concerns at the Project Area.

4.3 Immediate Data Gathering Efforts

The SOW outlines a process whereby, after EPA approval of the Work Plan, a comprehensive review and screening of data will be conducted to identify any data gaps that need to be filled to complete the EE/CA and design. Based on the existing information summary in this Work Plan, NW Natural has identified a critical data gap that does not need to wait for this more

formal process to be initiated. Specifically, additional information is needed to estimate the potential reduction in groundwater seepage rates through sediments that would be provided by the upland groundwater extraction and treatment system currently under design. Further, collection of such information is expected to be relatively time consuming both in terms of evaluation set up, data collection, and subsequent data processing and modeling.

Consequently, NW Natural submitted a draft *Capture Zone Field Test Plan* (Anchor QEA 2009c) to EPA on September 23, 2009 prepared by Anchor QEA. That plan describes methods to measure the offshore area of seepage control that will be induced by the shoreline source control extraction wells. This information will be used to inform the dredge and cap design for the sediment cleanup, particularly as noted above for RAO 8. To accomplish this, the plan proposes to conduct a field test to measure the offshore area of seepage control using piezometers installed in offshore sediments while operating three extraction wells that are proposed to be constructed in shoreline Segment 2. These offshore piezometer measurements will be used to help adjust and calibrate the Gasco property groundwater model to better predict the offshore seepage rates across various offshore areas under various upland extraction well and pumping rate scenarios.

4.4 Project Area Identification Report and Data Gaps QAPP

The Project AIR and Data Gaps QAPP will be submitted to EPA in accordance with the schedule contained in Section 5 after approval of this Work Plan. The purpose of this document is to build upon the existing information summary in the Work Plan to:

- Set the project boundaries based on a risk framework consistent with the Portland Harbor Site RI/FS process
- Identify any data gaps relevant to refining project boundaries, conducting the EE/CA, and conducting the design
- Describe field sampling, analytical, and QA/QC procedures for filling identified data gaps.

4.4.1 Project Area Identification

4.4.1.1 Overview of Iterative Project Area Identification Process

The Project Area will be identified in an iterative fashion through the course of data gathering, alternatives evaluation, and design. The initial Project Area identification will be based on

currently available lines of evidence from the Portland Harbor Site RI/FS and presented in the AIR. This version of the boundary will be used to help identify the preliminary lateral and vertical extent of the project cleanup area, as well as data gaps.

An interim refined cleanup area identification will be determined after the lines of evidence are finalized in the Portland Harbor Site RI and BERA. The interim area will be presented in the Project Area EE/CA following methods discussed in Section 4.6.3. This refined boundary will be used to refine lateral and vertical extent for the evaluation of remedial alternatives. Internal subareas within the boundary will be considered to help in the identification of combination alternatives within the overall area (e.g., capping in one subarea vs. dredging in another subarea).

A proposed final Project Area will be determined after the Portland Harbor Site FS is available and this proposed final Project Area will be presented in the Project Area Preliminary Design as described in Section 4.7.1. The proposed final Project Area boundary will be used for the basis of remedial design and identified for inclusion in the EPA Portland Harbor Proposed Plan. The final ROD RAOs will also apply to this proposed final Project Area.

4.4.1.2 Initial Project Area Identification for the Project AIR and Data Gaps QAPP

At the present time, the Portland Harbor BERA and FS are not completed and they will not be available at the expected time of the initial or interim Gasco Project AIR and Data Gaps QAPP development. To help identify data gaps in the Project AIR and Data Gaps QAPP the following preliminary lines of evidence will be used to develop preliminary lateral and vertical extents for the cleanup:

- The lateral and vertical extent of substantial product in sediment.
- The use of currently available lines of evidence to evaluate where unacceptable risk exposure may be identified in the Portland Harbor Site ROD, but where substantial product is not present.
- The use of currently available lines of evidence for Portland Harbor Site baseline and/or background conditions.

Consistent with the available harbor risk assessment process lines of evidence the nature and extent of contamination will be presented and mapped in the Project AIR and Data Gaps QAPP.

This summary of existing bulk sediment, TZW, riverbank soils, and water media chemistry will be compared to ecological and human health screening levels consistent with the in-process Portland Harbor Site BERA and RI/FS, including but not limited to:

1. Existing ecological sediment quality guidelines used in the Portland Harbor risk assessment process that represent a range of levels including, but not limited to, low or no effects levels as well as levels at which some effects are expected.
2. Estimated sediment PRGs from the Portland Harbor Site RI/FS process for persistent bioaccumlative toxins (PBTs) that are protective of humans and wildlife that consume aquatic biota from the Lower Willamette River.
3. Estimated sediment PRGs from the Portland Harbor Site RI/FS process that are protective of humans from direct contact with and incidental ingestion of COCs in sediments.
4. Estimated water PRGs and screening levels from the Portland Harbor Site RI/FS that are protective of ecological receptors and human health from direct contact with and ingestion of water media. These include, but are not limited to, those values currently under consideration for Portland Harbor screening values including human health and ecological AWQC, residential tap water SLVs from EPA's Regional Screening Level Tables, and Drinking Water MCLs.
5. Conservative water screening levels or, if available, estimated PRGs or management goals from the Portland Harbor Site RI/FS that are protective of receptors related to groundwater plumes.
6. Background levels in sediment and water.
7. Empirical bioassay data and sediment quality models developed from such data.

Per the SOW, all screening values and estimated PRGs used will be reviewed and approved by EPA before their use. NW Natural will submit tables of proposed values to be used in this screening before submittal of the Project AIR and Data Gaps QAPP with sufficient time to be incorporated into the Project AIR and Data Gaps QAPP screening. Existing data will be plotted on Project Area maps. Locations with concentrations above the screening, background levels, and estimated PRGs identified above will be indicated on these maps.

Per the SOW, these screening maps will be further evaluated and refined as specific levels are identified in the Portland Harbor Site process for delineating AOPCs in the Project Area where substantial product is not present. AOPCs have been identified for the Portland Harbor Site by EPA on a preliminary basis at this time. It is understood by EPA and LWG that these AOPCs

will be refined as the FS proceeds to completion. Consequently, a full list of methods for identifying the Project Area is not clearly defined at this time. Currently, AOPC delineation in Portland Harbor Site has focused on four key "AOPC rules" within which all other substantial unacceptable risks are contained. They are also differentiated from site-wide ubiquitous low level risks. These rules were defined by EPA in a letter to the LWG dated June 23, 2009, as follows:

1. Map Small Mouth Bass Total PCB PRG at a 10^{-4} cancer risk level using the by-river mile hill topping approach. The PRG equates to 29.54 μg/kg dry weight total PCBs achieved on a SWAC basis by river mile. Use a replacement value equal to the PRG in the hill topping routine.
2. Map a site-wide hilltop that provides a site-wide target SWAC of 17 μg/kg Total PCBs, which represents one estimate of background. Use 17 μg/kg as the replacement value in the hill topping routine.
3. Map the tribal fisher direct contact PRG for 10^{-6} cancer risk; hill topping by direct contact sub areas. This PRG equates to a benzo(a)pyrene concentration of 423.25 μg/kg dry weight.
4. Add the "common" Probable Benthic Risk Areas (PBRAs), which are the areas that both EPA and LWG currently agree exhibit benthic risks.

The letter also states:

> "Although the AOPCs were identified based on total PCBs, benzo(a)pyrene and benthic risk, there are other chemicals that pose risk as the Portland Harbor site such as organochlorine pesticides and chlorinated dibenzo dioxins and furans. However, because other chemicals posing risk to human health or the environment are generally collocated with total PCBs, benzo(a)pyrene and probable benthic risk areas, they were not used in the AOPC identification process but will still need to be considered in the Portland Harbor FS. In addition, it should be noted that areas outside of the individual AOPCs also pose an unacceptable, although generally lower level, risk throughout the current study area. These areas will be evaluated as part of a site-wide AOPC. Finally, the AOPCs were identified prior to completion of the baseline human health and ecological risk assessments; the results of these risk assessments will also need to be considered in the development of final AOPCs for Portland Harbor site."

Consistent with EPA's direction on the Portland Harbor Site, the screening analysis described in this section for the ecological, human health and background screening levels will be filtered to

determine areas consistent with these four key AOPC mapping rules. These filtered areas will be combined with the map identifying substantial product areas. Finally, these combined maps will be evaluated for contamination that may not be related to historic Gasco and Siltronic property discharges. Such an evaluation is generally consistent with the upstream and downstream extents of the expected Project Area depicted in Figure 1 of the SOW. For example, a relatively large contiguous area of PCB contamination exists extending from well upstream of, and down into the immediate vicinity of, the Gasco and Siltronic property shorelines. Given that historic PCB discharges are not associated with Gasco and Siltronic operations, the upstream boundary of initial Project Area will not be extended significantly upstream of Figure 1 of the SOW on the basis of exceedance of PCB PRGs. Similarly, areas exceeding one or more of the four EPA mapping rules have been identified downstream of the Gasco site property by EPA and LWG. There is a spatial break between the downstream extent of these EPA and LWG AOPCs and the Gasco site, which can also been seen in Figure 1 of the SOW. Furthermore, many other sites with potential PAH and other chemical impacts exist along this downstream shoreline. Consequently, the initial Project Area extent is not expected to be extended substantially downstream from that shown in Figure 1 of the SOW, but smaller refinements of the downstream and upstream initial Project boundaries may be possible based on the detailed application of EPA's four key mapping rules above to all site-specific data, and this will be considered in the Project AIR.

With regards to the PBRAs, EPA and LWG recognize that there are additional potential benthic risk areas that may need to be further considered. Once these issues are resolved, it is possible that the PBRAs could expand. If these resolutions are made in time for inclusion in the Project AIR, the newer PBRAs will be included.

Similarly, EPA has recently made preliminary comments to LWG on the contents of the Portland Harbor Site risk assessments that include requested revisions to the list of COCs. Some changes in methods that may result in revised PRG levels, which in turn could result to changes in AOPC delineations using the four key AOPC rules listed in this section. It is not anticipated that these revisions will be available in time for the Project AIR, but rather are expected to be incorporated into the project EE/CA.

It is fully recognized that this initial set of parameters will be used as a starting point for the later Project Area refinements for the EE/CA and final Project Area identification for the design. As additional information from the Portland Harbor Site RI/FS becomes available, more

detailed Project Area definition will be conducted and the area, and any subareas within it, will be refined.

4.4.1.3 Riverbank Remedy and Source Control Areas and Volume Determination for Project AIR and Data Gaps QAPP

The riverbank is included in the Project Area to facilitate consistencies between riverbank remediation, source control work, and the in-river sediment cleanup. The need for riverbank work will be determined by:

1. The need for soils remediation consistent with the upland risk assessment and upland FS
2. The need to control sources of contaminants from the riverbank to the river including:
    a. Processes of soil erosion
    b. Leaching of chemicals due to shallow groundwater movement through the bank
    c. Stormwater infiltration and discharge through riverbank soils

The process for determining the work needed in the riverbank areas and volumes that are included in the project are described further in Section 4.6.3.10. For the preliminary determination of areas and volumes to be included in the Project AIR and Data Gaps QAPP, existing data that extends landward up to (but not beyond) the top of bank will be reviewed. This area will also be included in the data gaps identification (Section 4.4.2). Any data or known determinations consistent with soil remediation and source control actions that extend landward of the top of bank will not be included in the Project AIR and Data Gaps QAPP or subsequent EE/CA. Such data and activities will be included in the DEQ determinations for uplands source controls and remediation. Although this riverbank area will be included in the Project AIR and Data Gaps QAPP, there may not be a need for remediation or source controls along all portions of the riverbank. The areas of riverbank that require remediation or source controls will be identified in the Interim Project Area Identification (Section 4.6.3) portion of the EE/CA and Data Report.

The application of the in-river lines of evidence discussed in Section 4.4.1.2 were not developed for use in preliminary Project Area identification when applied to riverbank soils.

4.4.2 Identify Data Gaps

The Project AIR and Data Gaps QAPP will review existing information used to define the project boundary per Section 4.6.3 and then identify any data gaps that will be filled by the collection and analysis of field samples relevant to conducting the EE/CA per Section 4.4.3, conducting the design per Section 4.7, and refining the Project Area boundary for both the EE/CA and design per the iterative approach described in Section 4.4.1.1.

More specifically, data gap identification will focus on problem definition and will result in collection of data of adequate quality and technical content as necessary to:

- Determine spatial and volumetric extents of contamination posing unacceptable risk
- Refine the project boundary
- Evaluate remedial alternatives on a consistent basis in the EE/CA
- Prepare project designs
- Evaluate potential human health and ecological risks consistent with the Portland Harbor risk assessment process lines of evidence resulting from exposure to sediment, TZW, riverbank, groundwater, surface water, and biota contamination
- Evaluate recontamination potential to the Project Area by: 1) riverbank and in-water contaminated sediments and water media outside of the Project Area; and 2) upland sources of contamination
- Determine engineering characteristics of the Project Area sediments including consistency, dredgeability, potential slope stability issues related to dredging, and potential sediment consolidation issues associated with capping
- Evaluate potential water quality effects associated with dredging, sheetpile installation and removal, capping, or disposal technologies
- Evaluate technologies for sediment remediation including capping, dredging, treatment including any necessary treatability testing, and disposal (on-site and off-site)
- Evaluate technologies for TZW remediation
- Evaluate potential impacts to threatened or endangered species, other biological receptors, and the potential habitat benefits and impacts of the remedy

Data gaps identification will fully consider data collected by NW Natural and Siltronic in addition to evaluations conducted by the LWG for the Portland Harbor Site RI/FS, which will be particularly relevant to issues of contaminant levels in sediment, biota, surface water, and TZW;

recontamination potential; sediment dredgeability and consolidation potential; water quality effects; treatability testing; and biological impacts.

Although the intent is to identify all data needed to complete the project, once the preferred alternative is selected via the EE/CA, there may be a need for some additional specific data collection to support design work.

Although other data gaps may be eventually identified and all data needs are subject to confirmation in the data gaps analysis, based on preliminary reviews of existing data, it appears the following types of data needs could be identified:

- Collection of additional sediment bioassay data to refine the project boundary in the iterative process discussed in Section 4.4.1.1, because substantial spatial gaps exist for existing sediment bioassay data in some potential Project Areas and sediment bioassays are a strong line of risk evidence.
- Collection of bulk sediment chemistry at least at bioassay locations; this may also be an independent data need to fill spatial or volume gaps.
- Coring for visual observations of DNAPL/product in key areas to fill spatial or volume data gaps.
- Geotechnical or chemical mobility (e.g., leachate, elutriate, or other tests) testing to support EE/CA alternatives evaluation and/or design.
- Riverbank soils chemistry data.

Another specific characterization data gap that will be considered is the extent of existing chemistry information under the docks adjacent to the Gasco property and the potential need for additional information in that area. Because of the difficulty of sampling under docks (e.g., sampling equipment not having access to some areas or dock elevations too low to facilitate sampling), this has generally not been undertaken by the LWG or NW Natural. Existing assumptions are that chemistry and product levels under the docks are similar to those areas immediately adjacent, which have been sampled on both the riverward and shoreward (i.e., behind the dock) sides of the docks. This assumption will be further evaluated to determine the extent to which it might impact EE/CA decisions if it were wrong. Where it appears that EE/CA decisions could be substantially altered (see the next paragraph), there may be a need for select sampling underneath the dock to confirm or refute this assumption.

Defining spatial/volume data gaps will not rely on any specific statistical or spatial evaluation techniques, although these may be considered. The overall objective driving spatial gap identification is whether or not inclusion of the additional spatial information could reasonably change the selection of the preferred alternative in the EE/CA. This can be gauged by estimating changes in defined areas and volumes (using methods defined in Section 4.4.1.1) that would be provided by additional data and relating those changes to general unit cost estimates (e.g., for dredging, capping, etc.).

4.4.3 Data Gaps QAPP

The procedures that NW Natural and Siltronic plan to implement when conducting all field activities will be detailed in the Project AIR and Data Gaps QAPP. The QAPP will ensure that sample collection and analytical activities are conducted in accordance with technically acceptable protocols so that data meet data quality objectives (DQOs). The QAPP provides DQOs and methods for meeting those objectives and contains a Field Sampling Plan (FSP), which describes procedures for planning and executing field activities. NW Natural and Siltronic's contractors will also prepare a Health and Safety Plan (HASP) that is designed to protect personnel from physical, chemical, and other hazards posed by field sampling efforts.

The Data Gaps QAPP will define site-specific DQOs and detail methods and QA/QC procedures for collecting and analyzing samples needed to fill the data gaps identified through the process described in Section 4.4.2. The QAPP will also describe the personnel, project organization, data handling, data validation, and database development procedures. The QAPP will describe the QA/QC protocols necessary to achieve required DQOs. The QAPP will be prepared in accordance with Section 4.8.1.

The Data Gaps FSP will define in detail the sampling and data-gathering methods that will be used for the design characterization. It will include sampling objectives, a detailed description of sampling activities, sample locations, sample analysis, sampling equipment and procedures, sampling schedule, station positioning, sample handling (e.g., sample containers and labels, sample preservation), and chain-of-custody procedures.

The Data Gaps HASP will be prepared in accordance with Section 4.8.2.

4.5 Data Collection and Reporting

Data will be collected and reported consistent with the Project AIR and Data Gaps QAPP described in Section 4.4. The data collection, analyses, data validation, and database development will be conducted per the schedule in Section 5. Data will be reported in the EE/CA.

Upon request by EPA, EPA or its authorized representatives may take split and/or duplicate samples. NW Natural and Siltronic will notify EPA not less than 14 days in advance of any sample collection activity, unless shorter notice is agreed to by EPA. EPA may take any additional samples that EPA deems necessary. Upon request, EPA will allow NW Natural and Siltronic to take split or duplicate samples of any samples EPA takes as part of its oversight.

4.6 EE/CA and Data Report

The EE/CA and Data Report will be submitted in accordance with the schedule contained in Section 5. This section describes how the cleanup action alternatives will be developed and how the alternatives will then be compared and ranked to assess their relative performance at meeting specific objectives associated with the evaluation criteria of effectiveness, implementability, and cost. This section also describes how the preferred cleanup action alternative will be identified. The section concludes with a description of the steps that will be taken to conduct a BA of the effects of the preferred alternative on species listed and proposed for listing under the ESA.

The EE/CA will include the following sections to support the evaluation process:

- RAOs
- Potential ARARs and TBCs
- Interim Project Area Identification
- Screening of Technologies
- Development of Alternatives
- Comparative Evaluation of Alternatives
- Preferred Alternative

Each of these steps is discussed in more detail later in this section. The EE/CA will be consistent with EPA's guidance for the conduct of non-time critical removal actions.

The EE/CA shall include a development and evaluation of alternatives, as well as a thorough evaluation of all criteria considered under an FS. The above outline and this approach are consistent with the goal of including the preferred alternative design in the Portland Harbor Site Proposed Plan. Based on data obtained in the previous sampling efforts and work to be performed under the SOW, and in consideration of EPA's guidance for RI/FS and EE/CAs, NW Natural and Siltronic will prepare a technical briefing for EPA, DEQ, the Tribes, and the Trustees on the proposed removal alternatives that will be presented by NW Natural and Siltronic in the EE/CA. After the technical briefing and any EPA comments on the briefing, NW Natural and Siltronic will submit a first draft of the EE/CA.

If the Portland Harbor Site RI/FS and Proposed Plan process is sufficiently on schedule to meet the desired sequence of activities as discussed in Section 1.2.2 and shown in Section 5, then public comment on the Project Area remedy will occur as part of the Portland Harbor Proposed Plan public comment process. Given the currently envisioned schedule, information from the Project Area remedy could be incorporated into the Portland Harbor Proposed Plan at a design level of detail (either interim or final design depending on the exact timing of the Portland Harbor Proposed Plan).

NW Natural and Siltronic will assist EPA, as requested, before and during the comment period with its community relations activities concerning the EE/CA or Portland Harbor Site Proposed Plan, as they specifically relate to issues on the Project Area. NW Natural and Siltronic will also assist EPA in compiling the Administrative Record before and during the public comment period. If, based on public comments received, EPA determines additional data or analyses are required to complete the Project Area remedy EE/CA or design, NW Natural and Siltronic will collect such data or perform such analyses as determined necessary by EPA.

4.6.1 Remedial Action Objectives

The RAOs were identified in Section 3.1. The final design remedy will focus on achieving these RAOs while continuing operations of the operating pier and upland support facility and minimizing disruptions to ongoing operations. Per the SOW, if through the RI/FS process, the RAOs for the Portland Harbor Site are changed or revised, RAOs for this project will be revised.

4.6.2 Potential ARARs and TBCs

The potential ARARS and TBCs were discussed in Section 3.3 and identified in Table 3.3-1 and Table 3.3-2, respectively, which will be updated as ARARs and TBCs for the Portland Harbor Site are finalized.

A complete list of potential chemical-, location-, and action-specific ARARs and TBCs will be developed once EPA comments on potential ARARs and TBC are obtained and following the selection of cleanup action alternatives in the EE/CA.

4.6.3 Interim Project Area Identification

Alternatives development will be focused on the Project Area, as defined in this section. The Portland Harbor Site RI and risk assessment information, if approved by EPA, will be used to refine the preliminary Project Area defined in the Project AIR and Data Gaps QAPP into an interim Project Area for the purposes of the EE/CA as described in Section 4.6.3. Specific criteria based on the Portland Harbor risk information will be used to develop the interim Project Area, and later the final Project Area for the design. This information will also be used to identify subareas to assist in evaluation of combination alternatives in the EE/CA. The expected risk information to be used in Project Area and subarea refinement for the EE/CA is defined in the following subsections.

4.6.3.1 Substantial Presence of Product

As described in the SOW, substantial presence of product in sediments is a line of evidence related to potential mobility of chemicals in the future. Visual observations in sediment cores will be the primary parameter used for this line of evidence. The term "substantial" product is intended to: 1) target product that is related to potential future mobility; and 2) indicate a preference for removal as defined by RAO 1 (Section 3.1). The definition of substantial product does not include every incidence of product observation at the Project Area. As defined in the SOW, the working definition of "substantial presence of product" is those sediments that meet the following criteria based on core observations:

1. Criterion 1: Bands of product, layers of product, "saturated" sediments, "stained" sediments, and/or seams of product that are greater than 2 inches thick.

2. Criterion 2: Any layer or seam of product, regardless of thickness, that is clearly defined as liquid DNAPL that is also mobile (i.e., "oozes" or "drips" out of the core during core observations).

Modifying factors to these criteria are:

1. If the top 5 feet of a core has no substantial product under Criterion 1, then deeper product should be judged as "not substantial," even if relatively thick layers of product exist at greater depths.
2. If there are any seams of mobile liquid DNAPL (not solid or semisolid tar) per Criterion 2, then this is substantial product regardless of depth and the characteristics of overlying sediments.

As described in the SOW, the following is NOT defined as substantial presence of product:

- Any layers of non-mobile product (i.e., bands, layers, saturated sediments, stained sediments) that are less than 2 inches thick
- Petroleum odors that are not associated with visual evidence of product beyond sheens and blebs
- Sheens that are not associated with more substantial visuals of product
- Isolated product blebs or spots not associated more substantial visuals of product

An additional Criterion 3 will consider whether the 5 feet of overlying relatively clean material includes any sediment that would be expected to be removed as part of USACE maintenance dredging in the navigation channel. If so, the 5-foot depth requirement should be judged from the depth to which maintenance dredging would occur.

The perimeter of the area with "substantial presence of product" will be defined by cores that do not contain substantial product.

Also, as noted in RAO 1 in Section 3.1, substantial product will be removed unless it can be shown that the costs of such removal are clearly disproportionate to the degree of risk reduction to be attained through physical removal as compared to other remedial options for the same material. If substantial product will not be removed, it must be shown that alternative approaches are substantially less costly as well as equally, if not more, effective at meeting all of

the other RAOs, particularly those that relate to creating acceptable sediment risk and preventing downstream migration of contaminants.

If additional sediment cores are proposed as part of the data gaps sampling investigation, visual observations will be made during core logging to identify the substantial product. These findings would then be used to revise the substantial product map shown in Figure 2.9.4-1.

4.6.3.2 Benthic Toxicity Bioassays

Bioassay locations exhibiting toxicity will be considered to be within the project boundary consistent with Portland Harbor Site criteria for evaluation of bioassays. Bioassay results will be directly interpreted by sampling location to help define areas of sediments.

4.6.3.3 Benthic Toxicity Models

The benthic toxicity models may provide sediment chemical concentrations at which benthic toxicity can occur that can be applied directly to project sediment chemistry data. Toxicity model definitions and sediment chemical thresholds defined by the Portland Harbor Site process will be used.

4.6.3.4 Human Health Shellfish Consumption

The chemical concentrations in shellfish tissue expected to cause human health shellfish consumption risks will be used in the Portland Harbor BHHRA to back-calculate target sediment concentrations via biota sediment accumulation factors (BSAFs) or similar food web modeling relationships. Areas above target sediment concentrations can be mapped based on these calculated sediment thresholds. A wide range of sediment thresholds are possible based on varying exposure scenarios (i.e., shellfish consumption rates), cancer risk levels, and BSAFs. The range of thresholds and a reasonable number of increments along that range will be mapped.

4.6.3.5 Human Health Direct Sediment Exposures

Sediment concentrations expected to cause direct contact human health risks will be determined for the BHHRA and can be directly used to determine sediment areas posing risk via this pathway.

4.6.3.6 Sediment Probable Effects Concentrations

These existing sediment PEC guidelines will be used in the BERA and can be applied directly to Project Area sediment data to map sediment areas associated with potential benthic risks.

4.6.3.7 Portland Harbor "Baseline" PAH Levels

The Portland Harbor Baseline PAH levels may be important to the determination of the project boundary as it relates to some types of low level diffuse contamination occurring within and around the Project Area, but not necessarily related to the Project Area.

4.6.3.8 Groundwater Plume Concentrations

TZW concentrations in groundwater plume areas will be screened in the Portland Harbor risk assessment process against water quality criteria, and areas that exceed this screening or a similar screening conducted on more recent data may be included in the interim Project Area. When RAOs and performance standards for groundwater plume areas are developed for the Portland Harbor Site FS, they will be used for interim Project Area identification.

4.6.3.9 Other Potential Lines of Evidence

The Portland Harbor BERA and BHHRA were recently submitted to EPA. These risk assessments will be reviewed to determine any additional lines of evidence that may be relevant to the Project Area. Any such lines of evidence will be evaluated in the Project AIR and Data Gaps QAPP and evaluated in a manner consistent with the Portland Harbor process and the draft risk assessments.

4.6.3.10 Riverbank Remedy and Source Control Determination

As discussed in Section 1.2.2, riverbank soils will be included in the Project area definition to the extent that riverbank soils require remediation consistent with the uplands risk assessment and uplands FS and/or require control of sources from riverbank soils to the river. In addition, where the need for such actions extends landward of the top of bank as defined in Section 1.2.2, these actions will be included in the DEQ determinations for uplands source controls and remediation and not included in the sediment interim Project Area definition or subsequent sediment EE/CA evaluations or design. Sediment based risk measures otherwise described in Section 4.6.3 are not appropriate for application to riverbank soils. EPA has stated these alternatives need to be included as part of EPA's EE/CA, Action Memo and/or Portland Harbor

Site proposed plan process in order for EPA to review and oversee riverbank alternative implementation,

The following remedial approaches are expected to be preferred to address each of the upland remedial and riverbank source control needs discussed in Section 4.6.3.10, although other remedial approaches may be evaluated in the EE/CA:

1. Combinations of removal and capping for areas requiring soil remediation.
2. Stabilization for areas requiring control of soil erosion source control
3. Control and/or diversion of shallow groundwater from entering the riverbank for areas requiring groundwater source control
4. Capping of the bank with an impermeable surface for areas requiring stormwater infiltration source controls.

In each case, identification of areas requiring these actions will be made consistent with an upland remedial and source control approach as defined at the time of the EE/CA development.

Where multiple issues exist for a particular riverbank segment, the overall remedy would include multiple measures that address each issue (e.g., capping for stormwater control, new armoring for erosion control, and a shallow collection trench for groundwater control).

The following criteria will be used as risk management tools to determine the need for, areas of, and design of, riverbank remedy and source controls:

1. If substantial product is identified in riverbank cores and is contiguous with sediment substantial product (as indicated by sediment cores), the volume of riverbank soils that will be removed, if feasible, will extend landward into the riverbank until contiguous product has been removed, unacceptable risk exposure reduction has been achieved, or a vertical line drawn from the top of the bank (as defined in Section 2.2) is reached. Some product may not be removed because the vertical line at the top of bank is reached, the product extends too deep to be integrated into the sediments dredge prism, or for other feasibility or risk management reasons. In these cases, the remaining product will be capped using a engineered system that reduces potential contaminant flux and product seepage to acceptable levels consistent with the design approach typically used for a sediment cap and is “habitat friendly.”

2. If a riverbank segment is identified as unstable and DEQ determines that the segment presents an ongoing source, the segment will be stabilized and controlled.
3. If a riverbank segment that contains contaminated soils[3] is identified that is subject to shallow groundwater infiltration and DEQ determines that the segment presents an ongoing source that is not already controlled by ongoing upland groundwater source controls, additional control measures will be identified.
4. If a riverbank segment that contains contaminated soils is identified and DEQ determines that the segment presents an ongoing source that is not controlled by ongoing upland source control measures, additional control measures will be identified.

In addition to the specific criteria noted above, riverbank slope soils may need to be regraded to achieve stable slopes that can be integrated into the sediments dredge prism. This may include bank areas that do not contain contiguous substantial product or otherwise require source control measures. Such regraded areas will not be required to meet any of the criteria of removal or source controls as outlined above, but will include measures to ensure that stable riverbank slopes are constructed.

Riverbank areas on the Siltronic property will be included in riverbank remediation efforts to the extent that they are adjacent to the sediments remediation area.

4.6.3.11 Determination of Areas and Volumes

All of the lines of evidence will generate information that can be used to map areas associated with risk on a station-by-station basis either directly (e.g., observations of product in cores and bioassays) or via extrapolated sediment and/or TZW concentrations (e.g., benthic toxicity model, human health shellfish consumption, and other thresholds), which are equivalent to PRGs. This information will be mapped using simple spatial approaches, rather than complex geostatistical techniques that may take additional time to negotiate and determine.

Each individual line of evidence discussed above (i.e., presence of substantial product, benthic toxicity bioassays, benthic toxicity models, human health shellfish consumption, human health direct sediment exposures, PECs [and/or sediment values that are protective of benthic

[3] Contaminated soils will be defined consistent with upland remedy and source control approach (soil PRGs or equivalent).

macroinvertebrates], baseline levels, and TZW related concentration thresholds) will be individually mapped and then combined in GIS "overlays" to define the project boundary. Consideration will be given to the relative weights of each line of evidence. In general, areas that appear to pose risk based on stronger lines of evidence or where multiple lines of evidence overlap will guide boundary delineation. EPA will approve (through the Portland Harbor Site RI/FS process) relative weights of various lines of evidence for ecological risk as well as the approach for human health evaluation.

Sediment volumes will be determined in a similar manner, by applying information directly (e.g., product observations in cores) or use of sediment chemistry thresholds. It is important to note that determination of these volumes does not necessarily imply a current or ongoing risk with these buried sediments considering that they may be isolated and not available for ongoing exposures to people or ecological receptors.

As discussed in Section 4.6.3 the interim Project Area for the EE/CA will be later refined for the preliminary design based on the findings of the Portland Harbor Site FS and eventually will be included in the EPA Proposed Plan for Portland Harbor.

4.6.4 Key Technical Issues

There are a number of key technical issues that will affect the cleanup action alternatives development and screening. Each of these is described below.

4.6.4.1 Material Disposal Requirements

The EE/CA will include development of disposal requirements for dredged sediment. While this is not a final determination, these requirements are expected to include:

- A method to determine whether any removed materials are or contain a Resource Conservation and Recovery Act (RCRA) hazardous waste ("Hazardous Wastes") or should be specially managed as a non-hazardous waste (e.g., disposed at a Subtitle C facility as a non-hazardous waste) ("Special Wastes"), specifically:
  - Evaluation of TCE, cis-DCE, trans-DCE, 1,1-DCE, and vinyl chloride concentrations to determine whether dredged sediments contain F002 waste.
  - Use of toxic characteristic leaching procedure (TCLP) criteria for MGP-related constituents (e.g., benzene, phenols, chromium, and lead).

- A process for testing removed materials to determine whether the materials are Hazardous Wastes or Special Wastes.
- A health and safety process to control worker exposures to the material during the entire removal, handling, treatment (if necessary), transport, and disposal procedure that is consistent with waste determinations.

Hazardous Wastes will be transported to and disposed of at an appropriately permitted Subtitle C facility. Special Wastes will be disposed of at a Subtitle C facility as non-hazardous waste.

Materials that are neither Hazardous Waste nor Special Waste ("Cleanup Materials") may be transported to and disposed of at a Subtitle D landfill, but only if it holds a permit by the state allowing the facility to accept such material. EPA, NW Natural, and Siltronic acknowledge that, to protect groundwater, OAR 340-093-0170(3)(d) requires an Oregon solid waste landfill receiving cleanup materials contaminated by hazardous substances to develop a "special waste management plan" for the landfill approved by DEQ allowing the landfill to accept such material. Handling of remediation wastes for the Project Area is described below and will be more fully detailed in the EE/CA.

4.6.4.1.1 Determination Method

The method for characterizing dredged material as a Hazardous Waste or a Special Waste is described in this section.

The method to determine that MGP-related material should be managed as a Special Waste will be based on the absence of TCE and associated CVOC chemicals and exceedance of TCLP criteria for any MGP-related constituent. If TCLP criteria are exceeded at the time the material leaves the Project Area, then the material will be designated Special Waste and transported to a Subtitle C facility. If not, the material would be disposed of as Cleanup Material at a Subtitle D facility that meets the requirements described above. This method applies to both untreated and post-treatment materials, if treatment is proposed. Consequently, an untreated material may meet this definition, but, upon treatment may be determined to no longer meet this definition. In the event that treatment, including treatment in barges, changes the definition, the material would no longer be designated a Special Waste.

The method to determine that sediments impacted only by TCE and associated CVOC chemicals contain F002 Hazardous Waste will be based on concentrations of TCE, cis-DCE,

trans-DCE, 1,1-DCE, and vinyl chloride that exceed DEQ-approved risk-based concentrations (RBCs) to be developed for incidental ingestion, dermal contact, and inhalation by landfill workers. The RBCs will be developed based upon potential exposure scenarios for workers at hazardous and non-hazardous landfills. Information supporting the potential exposure scenarios will be based upon standard operating and safety procedures for workers and materials management at potential material disposal facilities.

If TCE, 1,1-DCE, or vinyl chloride are detected in dredged material at concentrations below these RBCs, but the material exceeds TCLP criteria for TCE, 1,1-DCE, or vinyl chloride, the material will be designated as a characteristic Hazardous Waste. This method applies to both untreated and post-treatment materials. If following treatment, including treatment in barges, the material no longer exceeds the RBCs or the TCLP criteria for TCE and associated CVOCs, the material would be determined not to contain F002 Hazardous Waste and not to be a characteristic Hazardous Waste. If the material is determined to contain F002 Hazardous Waste or to be a characteristic Hazardous Waste because of TCE and associated CVOCs, it would be disposed of at a Subtitle C facility. If not, the material would be disposed of as Cleanup Material at a Subtitle D facility that meets the requirements described above.

It is specifically recognized that co-mingling of TCE and associated CVOC chemicals with MGP-related constituents and materials occurs in the Project Area. Therefore, three scenarios are possible:

1. If it is determined that the concentrations of TCE, cis-DCE, trans-DCE, 1,1-DCE, or vinyl chloride in the co-mingled material exceed DEQ-approved RBCs developed for the landfill exposure scenario, the material will be designated as and disposed of as F002 Hazardous Waste.
2. If it is determined that TCE, 1,1-DCE, or vinyl chloride exceed TCLP criteria, the co-mingled material will be designated and managed as Characteristic Hazardous Waste. If it is determined that one or more MGP-related constituents exceed TCLP criteria, the co-mingled material will be designated and managed in accordance with applicable state Hazardous Waste laws.
3. If it is determined that the co-mingled material is not F002 Hazardous Waste and not a characteristic Hazardous Waste, then the material would be managed as Cleanup Material.

In addition, exceedance of TCLP criteria for any chemical other than those associated with MGP-related material or TCE and associated CVOCs would result in the material being designated characteristic Hazardous Waste.

Also, if material containing either type of chemicals meets the following additional definitions of characteristic waste, then it will be designated and disposed of as a characteristic Hazardous Waste:

- Ignitability – Ignitable wastes are those that can create fires under certain conditions, are spontaneously combustible, or have a flash point less than 60°C (140°F) as defined in 40 CFR §261.21.
- Corrosivity – Corrosive wastes are acids or bases (pH less than or equal to 2, or greater than or equal to 12.5) that are capable of corroding metal containers as defined in 40 CFR §261.22.
- Reactivity – Reactive wastes are unstable under "normal" conditions. They can cause explosions, toxic fumes, gases, or vapors when heated, compressed, or mixed with water as defined in 40 CFR §261.23.

4.6.4.1.2 Testing Process

The sediments and related materials will be sampled and tested during the data gaps sampling (Section 4.5) per the above methods to determine their designation as Hazardous Waste, Special Waste, or Cleanup Materials. The sediments within the project boundary will be delineated into management units. Management units will be defined as the smallest volume of sediment that:

1. Can be reasonably separated and handled during construction as a discrete unit (e.g., a barge load, although larger volumes may also meet this definition).
2. Can have a single representative composite sample that can be expected to reasonably represent that unit.

Management units will be consistent with procedures in the *Northwest Regional Sediment Evaluation Framework (*SEF*)* (USACE et al. 2006), which defines the smallest reasonable unit as 5,000 to 10,000 cy, depending on sediment homogeneity. Specifically, each unit will be sampled for disposal characterization prior to dredging by taking three cores within the unit (consistent with the SEF) that will be composited into a single sample. If appropriate, the composite sample may be split and some of the subsamples may be bench-scale treated before testing. The

number of subsamples would be determined by the number of treatment methods or options under consideration. These subsamples will then be tested per the method described above.

In addition, confirmatory testing will be conducted during construction. The testing will be tiered and phased to minimize the potential for construction delays, while ensuring that appropriate disposal determinations have been made based on the pre-construction testing described above. The tiers of testing will be:

- **Tier 1.** The first three barge loads (each barge load anticipated to hold 1,000 cy to 2.500 cy of sediment) will be tested by obtaining representative subsamples during the barge loading and combining them into a composite sample. The exact number of and method of obtaining samples will be detailed in the design documents. Each of these three samples will be analyzed per the methods described above on a quick turnaround and results evaluated. If results are consistent with the pre-testing determinations for these management units and with EPA approval, one in every 10 subsequent barge loads will be tested in a similar manner.
- **Tier 2**. If the results of the next three tested barge loads (i.e., one in every ten barge loads tested after a total of 30 barge loads have gone to disposal) are consistent with pre-testing determinations for these management units and with EPA approval, one in 20 subsequent barge loads will be tested in a similar manner.
- **Tier 3.** Continue testing one in 20 barge loads unless results are inconsistent with pre-testing determinations for the unit in question.

If at any tier of testing, results are inconsistent with pre-testing determinations, then additional testing of subsequent barge loads and/or additional management of the material may be determined by EPA in coordination with the project team. Additional management may include activities such as enhanced mixing of materials in the barge to increase sediment homogeneity, additional mixing to distribute any stabilization (treatment) materials, addition of more or different stabilizing materials, or a determination that certain dredge units should be re-designated for disposal. After additional management, confirmatory testing would follow the same tiered and phased protocol as noted above.

4.6.4.1.3 Health and Safety Procedures Related to Disposal Determinations

At each point in the removal, handling, treatment (if necessary), transport, and disposal process the status of material present at each location in the process will be determined and made clear

to all personnel present. Where the material has been designated (either by pre-construction testing or during construction confirmatory testing, where applicable) as Hazardous Waste or Special Waste, all health and safety procedures (including staff training) will be consistent with handling of such wastes. Where material is determined to not be Hazardous Waste or Special Waste, all health and safety procedures will be at least consistent with handling of contaminated non-hazardous wastes. Due to its particular characteristics, MGP waste may be handled using procedures similar to Hazardous Wastes to ensure health and safety. Changes in these procedures will be consistent with any changes in the status of the materials during the removal, handling, treatment, transport, and disposal process. For example, for material that is a Hazardous Waste or Special Waste prior to treatment, Hazardous Waste health and safety protocols will be followed through all steps through treatment completion. Once the material is determined to be non-hazardous after treatment, either by confirmatory testing or the establishment that particular treatment steps yield non-hazardous waste based on EPA's determinations from previous batches, then health and safety procedures consistent with the handling of non-hazardous waste Cleanup Materials may be employed after that time where protective of health and safety. The appropriate procedures for each designation as it relates to specific health and safety regulations and standard practice will be defined in the construction HASP, which will be part of the design documents.

The health and safety procedures and staff training for Hazardous Waste and Special Wastes will be identical throughout the transport, handling, treatment (if necessary), and disposal process.

4.6.4.1.4 Decontamination and Prevention of Material Loss

Decontamination of workers and equipment will take place regardless of waste designations prior to any site egress (landfill, transload facility, or Project Area). For example, trucks hauling material to the landfill from the transload facility would need to be decontaminated externally before leaving the transload or landfill. The truck bed would require decontamination after each load should the truck be released to do other work between loads. For dedicated trucks and barges, this could occur at the end of the project. Pre- and post-sampling data will be required for any transload facility and/or the Project Area itself to ensure material loss or movement from non-designated areas has not occurred. Should significant increases in chemical concentrations occur, those areas represented by elevated samples will have material removed and replaced (e.g., gravel shoulders, catchments).

4.6.4.2 Dock Removal and Usage Evaluations

The cost effectiveness of potential dock removal and/or limiting dock usage during construction will be fully evaluated and considered in the project EE/CA. This will include evaluation of alternatives that consider the full costs of dock replacement, potential limits on dock usage, and the costs of lost business resulting from those alternatives. Also, the EE/CA will include a comparison of the short-term and long-term effectiveness of remedial alternatives that include dock removal or limited usage to those that do not.

Consistent with this risk management framework, substantial cost of dock removal will be weighed against the amount of product underneath the dock that could be removed (in the event that deep cores cannot be taken underneath the dock, substantial product depths will be interpolated from surrounding cores on at least the upstream, downstream, and riverward side), and the long-term effectiveness of dock removal as compared to other actions, in the context of a final remedy evaluation. Other factors that will be specifically considered include:

- Limitations for sediment removal related to dock stability
- Extent to which various technologies and alternatives can be adapted to minimize business interruptions
- Technologies for cleanup under existing docks while in place such as:
  - Sediment removal
  - Capping in place
  - In-place stabilization
  - In situ treatment
  - Others as identified

The extent to which these technologies address the permanent effectiveness evaluation criteria will be evaluated in detail in the EE/CA.

4.6.4.3 Upland Source Controls

Cleanup alternatives will be evaluated in the context of upland groundwater source controls, which will be implemented by this time, including:

- Reviewing groundwater seepage rate reductions as measured or predicted for upland source control performance

- Applying the most up-to-date estimates of groundwater seepage rates and chemical concentrations (as measured or extrapolated) for evaluation of attenuation (i.e., MNR), capping, and dredging alternatives and their long-term effectiveness.
- Evaluating attenuation rate predictions for groundwater and TZW that will not be directly remediated by upland source controls.

This evaluation will also need to show how proposed riverbank remediation and/or stabilization (which will be implemented at the same time as the sediments remedy implementation) will prevent recontamination of sediments.

4.6.5 Screening of Technologies

EPA guidance for Non-Time Critical Removal Actions (EPA 1993) states that "only the most qualified technologies that apply to the media or source of contamination" need to be screened and evaluated. Drawing on past sediment remediation project experience nationally and in Region 10, as well as the previous Gasco Tar Body Removal Action, the following technologies will be considered:

- MNR or Enhanced MNR
- In situ capping
- Dredging combined with the following auxiliary technologies:
  - Transport
  - Materials handling (i.e., treatment)
  - Disposal

This list will be compared to technologies screened more globally in the Portland Harbor Site FS. Preliminary screenings of technologies and alternatives by subarea of the Project Area are expected to be available before this EE/CA is started (see schedule in Figure 5-1). If the Portland Harbor process retains additional technologies, they will be fully considered in the EE/CA.

4.6.5.1 Monitored Natural Recovery

Per EPA's sediment remediation guidance (EPA 2005b), MNR is a remedy for contaminated sediment that typically uses ongoing, naturally occurring processes to contain, destroy, or reduce the bioavailability or toxicity of contaminants in sediment. MNR may rely on a wide range of naturally occurring processes to reduce risk to human and/or ecological receptors.

These processes may include physical, biological, and chemical mechanisms that act together to reduce the risk posed by the contaminants. Depending on the contaminants and the environment, this risk reduction may occur in a number of different ways including destruction (degradation or transformation) of chemicals, reduced mobility or toxicity, burial, and/or dispersion. A variation of MNR is enhanced MNR where one of the driving mechanisms (usually burial) is accelerated. A common method of enhanced MNR is the placement of a thin layer of sediment over the affected area.

The EE/CA will assess the degree and spatial extent to which MNR or enhanced MNR can be expected to be suitable remedy that meets the RAOs. This will involve modeling of chemical fate and transport within and around the Project Area to determine how quickly and to what level chemical concentrations in surface sediments where organisms and people are exposed can be expected to decrease over time. It is anticipated that the chemical fate and transport model being developed by the LWG will also be used for this project. The bioaccumulation portion of this model will not be used because that model only evaluates levels in tissue on a Portland Harbor Site-wide basis, which would not relate to cleanup of this specific Project Area by itself. To the extent that this model is not available, other models or estimation methods may be employed. This modeling will be supported by a thorough evaluation of empirical information to determine whether MNR has occurred historically. This information may include (but is not limited to) evaluations of sediment samples taken over time and evaluations of concentration profiles in cores. The timeframes for acceptable MNR or enhanced MNR will be set to be consistent with those being developed for the Portland Harbor Site.

4.6.5.2 Capping Technologies

In situ caps isolate contaminated sediments from the environment by use of natural or constructed products. Caps are comprised of two main components:

1. Chemical isolation component. This portion of the cap reduces the flux of the solids and dissolved contaminants to the overlying water column to acceptable levels. The chemical isolation component is typically made of naturally occurring sands or gravels. Additives such as organoclay or other products have been used to help sequester more mobile contaminants.
2. Erosion protection component. This portion of the cap protects the chemical isolation component from erosion. The gradation and thickness of this layer is such to resist potential erosive forces such as currents, waves, or propeller wash. The erosion

protection layer can either be naturally occurring gravels or boulders or constructed products.

The EE/CA will review various capping technologies and present the advantages and disadvantages of each. The EE/CA will also focus on likely placement techniques for each component. Screening will be used to focus the probable cap technologies and account for the following factors:

- Sediment strength and stability
- Cap site constraints such as slopes, water depths, and currents
- Presence of structures, such as piers, piling, and outfalls, as well as debris
- Navigational constraints
- Short-term water quality impacts during construction
- Erosive environment
- Equipment availability
- Production rates

The experience obtained from the capping activities completed as part of the Gasco Tar Body Removal Action will be used as part of the technology development and screening process.

4.6.5.3 Dredging Technologies

Dredging technologies are used to dislodge and remove contaminated sediments from the waterbody for subsequent transport and disposal. Dredging can be accomplished either using mechanical or hydraulic means. The EE/CA will review the dredging technologies commonly used for contaminated sediment remediation projects in the Pacific Northwest. Screening will be used to focus the probable dredge technologies and account for the following factors:

- Sediment strength and grain size
- Depth of contamination
- Dredge area constraints such as slopes, water depths, and currents
- Presence of structures, such as piers, piling and outfalls, as well as debris
- Navigational constraints
- Short-term water quality impacts during construction
- Equipment availability
- Support equipment and materials required
- Production rates

- Volume of excess water produced that will need to be managed

The experience obtained from the dredging completed as part of the Gasco Tar Body Removal Action will be used as part of the technology development and screening process.

Dredging will be coupled with a number of auxiliary water quality controls and technologies including transportation, treatment, and disposal. Each of those controls and technologies is discussed in more detail below.

4.6.5.4 Water Quality Controls

As dredging occurs, measures will likely be required to minimize and/or contain potential water quality impacts. These potential controls include implementation of dredging BMPs and fish and bird protection measures; permeable, and/or low permeable silt curtains; a barge de-water treatment system(s); and fixed hard containment structures such as sheetpile walls. In addition, a system for sheen and spill prevention and response will be developed. BMPs could include adjustments to dredging techniques and/or equipment, operation times, and production rates.

Screening of water quality controls will focus on the following factors:

- Sediment physical properties, such as grain size, water content, and plasticity
- Geotechnical properties of the sediment subgrade
- Dredging technology used
- Dewatering technology and location (i.e., upland or on barge)
- Predicted water quality impacts associated with dredging
- Volume of excess water produced that will need to be managed
- River hydrodynamic conditions
- Water depth
- Navigational constraints
- Potential secondary impacts associated with implementation of proposed controls (e.g., adverse water quality impacts cause by installation or operation of the control(s))
- Timeline for implementing the control(s)
- Permitting requirements

The experience obtained from the water quality control measures used for dredging completed as part of the Gasco Tar Body Removal Action will be considered during the water quality controls screening and selection process.

4.6.5.5 Dredge Material Handling (Transportation and Treatment) Technologies

4.6.5.5.1 Transportation Technologies

Once the material is dredged, the sediment will need to be handled and transported before disposal. Transport technologies include barges, trucks, rail cars, pipelines, and combinations of the above. An offloading facility may also be required in some combinations where the sediment has to be transferred from the water to upland. Screening of transportation technologies will focus on the following factors:

- Sediment physical properties, such as grain size, water content, and plasticity
- Volume of excess water produced
- Removal technology used
- Production rates
- Equipment availability
- Short-term water quality impacts during construction
- Navigational constraints
- Size and configuration of offloading facility
- Disposal site location
- Disposal site material requirements
- Disposal site permits

Transportation technologies that are sustainable will be promoted, including those that:

- minimize of air toxics emissions and greenhouse gas production
- conserve natural resources and energy

The experience obtained from the transport and handling completed as part of the Gasco Tar Body Removal Action will be used as part of the technology development and screening process.

4.6.5.5.2 Treatment Technologies

EPA guidance (EPA 1993) indicates that, to the extent practical, EE/CA alternatives should consider the CERCLA preference for treatment over containment or land disposal. The EE/CA will identify treatment technologies for screening and inclusion in the alternatives. Based on previous contaminated sediment experience nationally and in Region 10, as well as the Gasco Tar Body Removal Action, sediment treatment will be limited to:

1. Physical treatment – physical force is applied to the sediment or water. Examples of physical treatment include separation technologies such as hydrocyclones, gravity separation, or filtration.
2. Chemical treatment – chemical reactions bring about changes to the sediment or water. Chemical treatment is commonly used in conjunction with physical treatment to enhance contaminant removal or immobilization.

On the basis of past experience, treatment technologies are anticipated to consist only of dewatering or stabilization/solidification. Stabilization/solidification immobilizes contaminants in sediment using chemical treatment. The reaction occurs with the use of such materials as cement, fly ash, or other similar materials. A beneficial side effect of the reaction is the improved handling characteristics of the sediment. Screening of treatment technologies will focus on the following factors:

- Sediment physical properties, such as grain size, water content, and plasticity
- Volume of excess water produced
- Removal and transport technology used
- Production rates
- Equipment availability
- Short-term water quality impacts during construction
- Disposal site location
- Disposal site material requirements

However, to the extent that the Portland Harbor Site FS screens other specific treatment technologies that are applicable to the Project Area, these technologies will also be considered.

4.6.5.6 Disposal Technologies

Per the SOW, sediment dredged from the Project Area will be disposed of outside the Project Area. Off-site disposal of the sediment dredged from the Project Area will likely be at a

permitted, Subtitle C or Subtitle D solid waste landfill. See Section 4.6.4.1 for a description of the material disposal requirements.

Disposal at an off-site landfill will likely require dewatering, offloading, and transport by truck or rail to the landfill. The offloading could occur at the Project Area, but will likely be at an off-site location based on the evaluations conducted during the Tar Body Early Removal Action. Screening of disposal technologies will focus on the following factors:

- Sediment physical properties, such as grain size, water content, and plasticity
- Removal, dewatering, and transport technology used
- Equipment availability
- Disposal site location
- Disposal site material requirements

Disposal technologies and practices that are sustainable and consistent with project needs will be promoted, including those that:

- use "green concrete" (coal combustion products in place of Portland cement)
- include methane recovery from landfills

4.6.6 Development and Screening of Alternatives

Using the list of qualified technologies determined during the screening process, a limited number of cleanup action alternatives will be developed. As required by the National Contingency Plan (NCP), a No Action alternative will be used as a baseline for evaluating and comparing the other alternatives. The alternatives will be based on the qualified technologies, the cleanup action characteristics, the RAOs, and current and future site use requirements.

Anticipated alternatives to be evaluated include:

- No Action
- In situ capping of all substantial presence of product areas and marginal areas with MNR or enhanced MNR of low risk areas
- Removal (likely mechanical) of substantial presence of product areas with off-site disposal and backfill, in situ capping of marginal areas, and MNR of low risk areas. Subalternatives may be developed to include different disposal facilities, where by disposal locations may differ in the two subalternatives (i.e., one landfill in one option and another landfill in another option).

- Removal to the extent possible of substantial product areas and marginal areas and MNR of low risk areas. Subalternatives may be developed to include different disposal facilities.

Alternatives may be added or deleted as more information becomes available during the EE/CA process.

The EE/CA will provide the following information on each alternative:

- Summary of the rationale behind each alternative developed
- Scope of each alternative including the technologies used and anticipated sequencing:
  - Remedial areas, volumes, depths and thicknesses, and other pertinent quantity estimates
  - Equipment and labor to be used
  - Materials to be used
  - Upland facility requirements (staging areas, transfer facility, disposal site, haul routes, etc.)
  - Likely durations and schedule

The EE/CA will screen each of the alternatives against the following criteria:

- **Effectiveness**. Each alternative will be evaluated regarding how well the alternative meets the RAOs and ARARs; how well the alternative reduces mobility, volume, and toxicity; and how well the alternative provides safety to workers, the public, and the environment during construction.
- **Implementability**. Each alternative will be evaluated with regard to its technical feasibility, the availability of necessary resources, and the administrative feasibility.
- **Cost**. The cost of each alternative will be estimated by determining the present worth of each alternative considering direct and indirect capital costs, as well as long-term maintenance and monitoring costs. Per EPA guidance the EE/CA-level cost estimate will be within the range of -30 to +50 percent (EPA 1993). NW Natural may also factor in other financial considerations including but not limited to risk management, insurance costs, and costs associated with marine and upland operation interruptions.

4.6.7 Comparative Evaluation of Alternatives

The EE/CA will assess each alternative against the nine CERCLA criteria described below. The results will be compared to identify the key tradeoffs between them. This comparative evaluation will provide sufficient information to adequately evaluate the alternatives. The No Action alternative will be used as a baseline for the comparisons.

As part of the comparative analysis, each alternative will be ranked for how well it meets each of the criteria. Rankings will be as follows:

- High – alternative meets all of the requirements of a criterion
- Medium – alternative meets most, but not all of the requirements of a criterion
- Low – alternative meets only some of the requirements of a criterion

The nine criteria are:

- Threshold Criteria
  - Overall protection of human health and the environment
  - Compliance with ARARs
- Primary Criteria
  - Long-term effectiveness and permanence
  - Reduction of toxicity, mobility, and volume through treatment
  - Short-term effectiveness
  - Implementability
  - Cost
- Secondary Criteria
  - State and Tribal acceptance
  - Public acceptance

An overview of the threshold and primary criteria is presented below. The Secondary Criteria will be assessed following receipt of EPA comments on the Draft EE/CA.

4.6.7.1 Threshold Criteria

Each alternative must meet the two threshold criteria discussed in this section.

Overall Protection of Human Health and the Environment

This criterion provides an overriding evaluation on the adequacy of the alternative to protect human health and the environment and what measures are required to make the alternative adequate. This criterion will draw on other criteria assessments, especially long-term effectiveness and permanence, and short-term effectiveness.

Compliance with ARARs

The criterion will determine if the alternative is compliant with all federal and state ARARs (see Section 3.4). If an ARAR cannot be met, the basis for justifying a waiver will be presented. ARARs will be consistent with the Portland Harbor Site when available. Appropriate temporal scales, spatial scales, and points of compliance for water quality ARARs will also be evaluated.

4.6.7.2 Primary Criteria

Long-term Effectiveness and Permanence

The highest ranking will be assigned to those alternatives that demonstrate permanence of the actions proposed, stability of the sediments, and lowest potential for recontamination. Determination of long-term effectiveness of combined alternatives will be conducted including, as relevant, sediment and water quality thresholds related to sediment chemical concentrations, sediment resuspension, advective/diffusive flux from sediments to surface water, and fate and transport to biota. Various methods for evaluation of capping effectiveness could include comparison of porewater concentrations to surface water criteria and establishment of site-specific risk-based sediment criteria consistent with the Portland Harbor risk assessment process. Although these methods will be considered, these example methods do not necessarily have to be used in the EE/CA. Performance standards will be consistent with those in the Portland Harbor Site ROD.

Reduction of Toxicity, Mobility, and Volume through Treatment

The highest ranking will be assigned to those alternatives that provide the greatest reduction (collectively) in the mobility, volume, and toxicity of contaminants. The impacts of the alternatives are focused on the effectiveness at reducing the ability of contaminants to move by advection or diffusion, the volume of contaminated sediment in the Project Area after construction, and the toxicity of contaminants in the sediment on ecological or human receptors.

Short-term Effectiveness

The highest ranking will be assigned to those alternatives that present the least risk to workers and have the fewest water quality, quality of life, biota, and operational impacts.

- In keeping with the goal of enhancing the environmental benefits of the selected remedial alternative, technologies and practices that are sustainable and consistent with project needs will be promoted, including:
- Employment of renewable energy and energy conservation and efficiency approaches
- Use of cleaner fuels, diesel emissions controls and retrofits, and emission reduction strategies
- Utilization of water conservation and efficiency approaches
- Incorporation of sustainable site design
- Utilization of reused or recycled industrial materials within regulatory requirements
- Requirements for recycling or reuse of materials generated at or removed from the site
- Use of environmentally preferable purchasing
- Support of greenhouse gas emission reduction technologies
- Use of Environmental Management System (EMS) practices, such as reducing the use of paper by moving to fully electronic transmittal of project documents and implementation of waste reduction and recycling programs at all work sites

Implementability

Implementability will focus on technical and administrative feasibility and availability of materials and equipment. The highest ranking for technical feasibility will be those alternatives that demonstrate technologies with proven project performance, are available from multiple contractors/vendors, and offer the highest reliability and the least risk of delay.

The highest ranking for administrative feasibility will be those alternatives that require the least amount of agency coordination and action. Alternatives that minimize permit and access agreements will be more administratively feasible.

The highest ranking for availability will be those alternatives using technologies that are available from multiple contractors or vendors, where the need for specialized equipment and/or labor is minimized, and the risk from delay is minimized.

NW Natural and Siltronic will conduct a preliminary evaluation of the implementability of the proposed alternatives and coordinate with the Department of State Lands (DSL) during the

early stages of the EE/CA development to discuss the evaluation findings regarding access issues and other landowner concerns for remedy implementation.

Cost

The highest ranking for cost will be alternatives with the lowest present worth cost. Costs will include direct and indirect capital costs as well as long-term maintenance and monitoring costs. Per EPA guidance the EE/CA-level cost estimate will be within the range of -30 to +50 percent (EPA 1993). NW Natural may also factor in other financial considerations including but not limited to risk management, insurance costs, costs associated with marine and upland operation interruptions, and mitigation costs.

4.6.8 Preferred Alternative

The EE/CA will provide a detailed description of the preferred alternative that was determined to best fulfill the evaluation criteria. A Draft BA and Draft CWA 404(b)(1) analysis will be developed for the preferred alternative (see Section 4.6.9).

4.6.9 Biological Assessment and Clean Water Act Analysis

As noted above, the EE/CA will include a Draft BA for the preferred alternative to help facilitate NMFS consultation on substantive requirements for the project, and a CWA draft 404(b)(1) memorandum, to include time for agency reviews and necessary revision to the EE/CA before public review. The BA will identify the presence of threatened, endangered, proposed, or candidate species or their habitat within the vicinity of the Project Area and will comply with the substantive requirements of the ESA. The draft BA will characterize baseline conditions of existing habitat; analyze potential direct, indirect, and cumulative project impacts that the preferred alternative may have on these species and their habitat; and describe BMPs and conservation measures designed to avoid or minimize any negative impacts. The following information will be provided in the BA:

- Introduction and Background
  - Purpose of the BA
  - Project setting
  - Description of the Project Area and the Action Area
  - Project timing
- Project Description

  - Details of the preferred alternative
  - Potential construction methods necessary to implement the preferred alternative
  - Potential conservation/mitigation measures to be used to minimize adverse effects to species and their habitats
- Species Accounts and Uses of the Action Area
  - Listed species that could be in the action area
  - Critical habitat designations
- Environmental Baseline
  - Description of existing biological, physical, and chemical habitat conditions within the Project Area
- Effects of the Proposed Action and Effects Determinations
  - Discussion of potential direct, indirect, and cumulative effects of the proposed action on listed fish species and their critical habitat
  - Regulatory basis for effects determinations
  - Effects determinations for listed species and their critical habitat
- References

Pursuant to dredging, capping, or other filling components of the EE/CA alternatives, NW Natural will submit a draft memorandum with the EE/CA that provides sufficient information to demonstrate compliance with the substantive requirements of Section 404(b) (1) of the CWA. The memorandum will discuss and summarize the content and progress of similar evaluations being conducted for the Portland Harbor Site process, including any progress that has been made between LWG, EPA, and NMFS on the methods and requirements for determining a consistent compliance with ESA and resulting mitigation requirements throughout the Portland Harbor Site. The ramifications of those methods and requirements as specifically applied to the Gasco Sediments Site will be presented and discussed as support for specific proposed elements of the project.

The memorandum will also provide information necessary to demonstrate that the proposed cleanup action technologies and alternatives defined in the draft EE/CA are in compliance with the substantive requirements of CWA Section 404(b)(1). Final specific descriptions of the implementation of the selected alternative will be developed during the design phase. Additionally, the memorandum will document the information gathered regarding

practicability and cost, long- and short-term impacts from all proposed alternatives, minimization of adverse effects, and an analysis of the need for any mitigation.

Specifically, the CWA 404(b)(1) memorandum will contain the following information:

- Introduction
- Summary of Proposed Action
  - Purpose and Need
  - Location and Project Area Information
  - Description of Discharge and Removal Sites
  - Discharge and Removal Methods
  - Timing of Discharge
  - Sources and General Characteristics of Discharge Material
  - Quantity of Material to be Removed and Discharged
- Resource Impact Evaluation Criteria
- Potential Impacts on Physical and Chemical Characteristics of the Aquatic Ecosystem
  - Substrate
  - Suspended Particulates/Turbidity
  - Water Quality
  - Current Patterns, Water Circulation, and Fluctuations
  - Salinity
- Potential Impacts on Biological Characteristics of the Aquatic Ecosystem
  - Threatened and Endangered Species
  - Aquatic Food Web
  - Wildlife
- Potential Impacts on Special Aquatic Sites
  - Sanctuaries and Refuges
  - Wetlands
  - Mudflats
  - Vegetated Willows
  - Riffle and Pool Complexes
- Potential Effects on Human Use Characteristics
  - Municipal and Private Water Supplies

  - Recreational and Commercial Fisheries
  - Water-Related Recreation
  - Aesthetics
  - Parks, Natural and Historical Monuments, National Seashores, Wilderness Areas, Research Sites, and Similar Preserves
- Evaluation and Testing of Discharge Material
- Proposed Actions to Minimize Adverse Effects to the Aquatic Environment
- Factual Determinations
  - Physical Substrate Determinations
  - Water Circulation and Fluctuation Determinations
  - Suspended Particulate Materials and Turbidity Determinations
  - Contaminant Determinations
  - Aquatic Ecosystem and Organism Determinations
  - Determination of Cumulative Impacts on the Aquatic Ecosystem
  - Determination of Secondary Impacts on the Aquatic Ecosystem
- Review of Conditions for Compliance
  - Availability of Practicable Alternatives
  - Compliance with Pertinent Legislation
  - Potential for Significant Degradation of Waters of the United States as a Result of the Discharge of Materials
  - Steps to Minimize Potential Adverse Impacts on the Aquatic Environment
- References

4.7 Design Reports

For the start of the design process, the findings of the EE/CA will be reviewed and compared with the results of the draft Portland Harbor Site FS. The preferred alternative from the EE/CA will be refined and adjusted to be consistent with the draft Portland Harbor Site FS, which may include adjustments to:

- The final areas and volumes of sediments within the project boundary, per the iterative Project Area identification discussed in Section 4.4.1.1
- Areas and volumes addressed by particular remedial technologies within the overall alternative

- Adjustments to the alternatives needed to accurately address effectiveness issues as evaluated on a Portland Harbor Site-wide basis.

It is conceivable that the adjusted alternative might alter the conclusions of the EE/CA regarding selection of the preferred alternative. However, close coordination between Gasco Sediment Site EE/CA and Portland Harbor Site FS development will be conducted throughout both processes with express goal of ensuring that the EE/CA preferred alternative is consistent with the overall expected Portland Harbor Site FS findings. Given NW Natural's and EPA's close involvement in both processes, this goal appears to be readily achievable.

Once EPA has selected the cleanup alternative(s) based on the findings of the EE/CA and Portland Harbor Site FS, the design process will commence. Design reports will be submitted to EPA for review in three levels of development: preliminary design, interim design, and final design. Because NW Natural has not yet determined whether a bid process or design build process will be used, the design documents may not be in the form of plans and specifications. Regardless, the design submittals will be of sufficient detail to adequately describe all aspects of the proposed construction process as further detailed below.

Each phase of the design will include increasingly detailed content for the following design elements noted under Preliminary Design and Interim Design below. Any additional data collection needed to support design will be identified and conducted during the preliminary design. Depending on the data types (and any timeframes typically associated with laboratory or other analyses), the results of any such design level data collection will be presented in either the Preliminary Design or the Interim Design.

4.7.1 Preliminary Design

The Preliminary Design will include an overall explanation of the following as appropriate:

- Performance standards will be developed for all project elements.
- For capping, the Preliminary Design will show capping areas and conceptual slope and cap designs including areas of overlap with the riverbank source control designs.
- For dredging, the Preliminary Design will show dredging areas and conceptual cut thickness and slope angles.
- The extent of groundwater impacts and predicted attenuation rates.

- Proposed disposal technology (on-site or off-site) conceptual design including general disposal location, potential transfer facility locations (if required), handling methods, and transport approaches.
- Annotated outline of Interim Design Analysis Report (DAR).
- Annotated outline of plan drawings.
- Annotated outline of specifications or equivalent descriptions.
- A Draft Water Quality Monitoring Plan and its associated QAPP and FSP. The monitoring plan will detail water quality monitoring to confirm that water quality standards, as defined by substantive requirements of CWA Section 401 water quality certification for compliance with the requirements in CWA Section 404(b)(1) guidelines, are met at the identified compliance boundary during any capping or dredging operations, including dewater return water (if outside a containment feature and as applicable to the design) that may affect the water column outside containment features. Alternatively, depending on the results of the CWA analysis, the monitoring plan may be designed to determine if any temporary allowance for exceedances of water quality standards that are approved for the project are not greater than allowed under the CWA analysis. The Water Quality Monitoring Plan will describe the specific water quality monitoring requirements, including a schedule, sampling locations, sampling intervals, sampling equipment and parameters, analytical methods, key contacts, reporting requirements (including daily reports as applicable), daily contacts for notifications of any exceedances, result summaries, and draft and final Water Quality Monitoring reports.
- A revised BA reflecting ESA agency comments on the Draft BA included in the Draft EE/CA. This BA will be further refined, if necessary, for the Interim Design reflecting the updates of any relevant project elements affecting the BA findings.

4.7.2 Interim Design

The Interim Design will include three separate deliverables as detailed below:

- Interim DAR
- Interim Construction Documents (plans and specifications) and Schedule
- Interim Design Plans

The Interim Design Analysis Report

The DAR will provide the design criteria and the basis of design for the remedy. The document will present technical parameters and supporting calculations upon which the design will be based, including but not limited to design requirements for each remedial action technology to be employed (e.g., dredging, capping, and MNR).

At a minimum, the DAR will contain the following information:

- Cleanup action description including:
  - Cleanup action areas and volumes
  - RAOs
  - Performance standards
  - Site-specific sediment quality objectives
  - Cleanup action details
- Summary of existing conditions including physical, hydrodynamic, wind conditions, geotechnical, sediment quality, and site use information. A discussion of the upland source control measures will also be presented.
- Dredge and Disposal Plan including:
  - The general dredging approach.
  - The basis of the dredge design including performance standards and design objectives and criteria, and additional considerations. The performance standards will be consistent with federal regulations, including requirements of Sections 404 and 401 of the CWA and Section 10 of the Rivers and Harbors Act.
  - The dredge design including details on how the dredge prism was developed, neat line dredge surface, overdredge allowances, addressing areas of partial removal, and anticipated dredge volumes. A discussion of stable cut slopes will also be presented.
  - The anticipated equipment selection.
  - A summary of the sediment transport and disposal referencing the detailed Transportation and Disposal Plan (TDP). The text and the TDP will include identification of potential disposal site location(s), in-water and overland transport routes, transloading facility locations and configurations, and dewatering and/or treatment technologies. A discussion of BMPs, monitoring, and/or analyses necessary to protect personnel and the environment from potential chemical hazards posed by transportation and disposal will be included. Response actions for any spills will be presented. Response actions could include, but are not limited to,

actions to limit contaminant exposure pathways such as right-of-way shoulder soil removal/capping, fringe area capping in water, and other actions deemed necessary.
  - A discussion of the dredging implementation approach, which will detail removal sequencing to minimize residuals and recontamination. Presentation of BMPs to minimize residuals, resuspension, and recontamination will be presented.
  - A discussion of the construction quality control related to dredging including achieving specific dredge depths, minimizing dredge residuals, avoiding impacts on adjacent structures and tenants, achieving no off-site tracking of contaminants during transport, and minimizing short-term water quality impacts. The Construction Quality Assurance Plan (CQAP; described below) will be referenced.

- Capping and Backfill Plan including:
  - A general summary of the cap design
  - The basis of the cap design including performance standards and design objectives and criteria, and additional considerations. The cap design will follow appropriate EPA guidance, including *Guidance for In situ Subaqueous Capping of Contaminated Sediments* (EPA 1996). Performance of capping activities will be consistent with federal regulations, including the requirements of Sections 401 and 404 of the CWA and Section 10 of the Rivers and Harbors Act.
  - Details of the chemical isolation component design necessary to reduce contaminant flux to acceptable levels. If additives are required in the cap, a description of the material will be presented.
  - Details of the armor layer component design necessary to resist wind- and vessel-induced waves, currents, outfall discharges, and propeller wash.
  - Details of cap stability on slopes including appropriate slope inclinations.
  - Details of the bioturbation design component necessary to prevent disturbance to the chemical isolation component.
  - Details of the cap consolidation design component, if necessary.
  - Details of the operational design component including anticipated over placement allowances in the different areas as well as potential impacts of in-water and nearshore structures on cap placement. BMPs related to cap placement will also be presented.
  - Description of potential material sources including physical and chemical goals for the import material.

  - A discussion of the construction quality control related to capping including methods to verify import materials' quality, placed thickness, and impacts to existing structures. The CQAP will be referenced.
  - The estimated cap material quantities for the different components will be presented.
  - A description of equipment selection and placement technologies anticipated for cap construction.
  - General institutional control requirements endemic to the cap design, for later implementation.

- TZW Attenuation. TZW impacts resulting from upland source control actions will be discussed including:
  - Measured and/or predicted attenuation rates and timeframes for reaching RAOs and remediation goals at designated points of compliance.
  - Monitoring scope and schedule.

- Water Quality including:
  - Discussion of the construction water quality criteria to be used during the cleanup action.
  - Presentation of the compliance boundaries to be used during the cleanup action
  - Presentation of the predicted water quality effects during the cleanup action. Estimations of water quality impacts associated with dredging, sediment transport, sediment transloading, and capping will be presented. This analysis will be used to determine the critical areas of potential impacts. BMPs will be presented that mitigate the potential impacts. The Water Quality Monitoring Plan will be referenced for more details.

- Construction Schedule and Sequencing
- Permit Exemption and Applicable or Relevant and Appropriate Requirements including
  - Description of required permits.
  - Description of substantive requirements of permits.
  - Description of ESA compliance requirements.

- Access and Easement Requirements
- Impact Minimization including:
  - Plan for reducing negative effects on the environment and community during the construction phase(s), including alternative fuel usage/emission control usage to the

extent practicable to lower vehicle toxics emissions into surrounding communities beyond the minimums legally required.

- Institutional Controls including analysis and recommendations on institutional controls and/or engineering controls that may need to be implemented to ensure the long-term effectiveness of the remedy, including descriptions of how such controls would be implemented, by whom, and under what circumstances such controls could be removed or terminated (see "Institutional Controls" EPA 2000).
- If appropriate, conduct an update of the analysis regarding post-remedy recontamination of the Project Area by upland sources of contamination, including what source control actions have occurred since the EE/CA analysis and whether additional actions may be necessary to control potential sources of significant recontamination.

Interim Construction Documents and Schedule

The Interim Construction Documents and Schedule will include:

- Construction plans/drawings/sketches and required specifications (note that if NW Natural chooses a design/build approach, specifications may not be needed)
- Proposed locations of processes/construction activity or specific requirements for such locations
- Schedule for construction and implementation of the remedy that identifies major milestones

Interim Design Plans

The Interim Design Plans will include:

- **Draft Construction Quality Assurance Plan.** The CQAP will detail the remediation verification method and approach to quality assurance during construction activities in the Project Area, including compliance with ARARs. The CQAP describes the project-specific components of the performance methods and quality assurance program to ensure that the completed project meets or exceeds all design criteria, plans, and specifications. The draft CQAP will be submitted with the Interim Design and the Final CQAP will be submitted with the Final Design. The Final CQAP will be submitted prior to the start of construction in accordance with the approved construction schedule. The CQAP will describe the methods used to measure compliance with measurement quality objectives (such as performance and method requirements), including target dredge or excavation depths, if appropriate. The CQAP will include, as an attachment, a Draft

Construction Monitoring Plan, which will include a QAPP and FSP. If the selected alternative includes capping, performance monitoring will include characterization of in-place capping materials (e.g., coverage and thickness). If the selected alternative includes dredging or excavation, performance monitoring will be performed to confirm that dredged or excavated material is properly staged, dewatered, and transported to a suitable disposal site and that field construction activities are properly sequenced. The CQAP will provide requirements for the following elements:

- Responsibilities and authorities of all organization and key personnel involved in the remedy construction, including EPA and other agencies.
- Qualifications of the Construction Quality Assurance (CQA) Officer and establishing the minimum training and experience of the CQA Officer and supporting inspection personnel.
- Inspection and verification activities that establish the observations and tests that will be required to monitor the construction and/or installation of the components of the remedy. The CQAP will include the scope and frequency of each type of inspection to be conducted. Inspections will be required to verify compliance with environmental requirements and ensure compliance with all health and safety procedures.
- Performance standards and methods describing activities necessary to implement the cleanup construction. Performance monitoring requirements will be designed to demonstrate that BMPs have been implemented during dredging operations, dredged or excavated material transportation, and cap placement.
- Sampling activities establishing requirements for quality assurance sampling activities, including the sampling protocols, sample size, sample locations, frequency of testing, acceptance and rejection data sheets, and plans for correcting problems as addressed in the project specifications.
- Documentation establishing the reporting requirements for construction quality assurance activities. This will include such items as daily and weekly summary reports, inspection data sheets, problem identification and corrective measures reports, design acceptance reports, and final documentation. A description of the provisions for final storage of all records consistent with the requirements of the AOC will be included.
- Any requirements necessitated by the Biological Opinion (BiOp) terms and conditions as it relates to schedule logistical, sampling issues, turn around times or any other relevant terms or conditions of the BiOp.

- **Revised Draft Construction Water Quality Monitoring Plan (WQMP).** The WQMP will be refined based upon EPA's comments on the WQMP submitted under the Preliminary Design and based on the final Water Quality Monitoring and Compliance Conditions Plan issued by EPA.
- **Draft Transportation and Disposal Plan (TDP).** The purpose of the TDP is to provide plans for managing dredge sediments including:
  - Details regarding the transportation of dredged materials, including loading materials onto barges, dewatering (if required), transferring materials from barges to trucks or rail, and transport by truck or rail to the disposal facility
  - Precautions that will be used while handling sediments and during transport and disposal of the material
  - Contingencies for any spills that might occur
  - Details regarding the disposal of waste materials, including the disposal facility location
- **Draft Outline Long-term Monitoring and Reporting Plan (LMRP)**. The LMRP provides the monitoring and reporting requirements after completion of the cleanup action. For the Interim Design submittal, an outline will be presented. A complete LMRP will be presented as part of the Final Design. The LMRP will present:
  - Monitoring objectives and criteria, as well as the scope related to each key element of the cleanup action
  - The anticipated schedule for the monitoring
  - Potential response actions if certain observations are made as part of the monitoring
- **Construction HASP**. The HASP will include health and safety procedures for all aspects of the construction including construction activities, construction monitoring, and water quality monitoring. The selected contractor that will construct the EPA-approved remedy will prepare a HASP covering their construction activities, and a separate HASP will be prepared for construction oversight monitoring activities (e.g., water quality monitoring activities).

4.7.3 Final Design

The Final Design will include:

- Final DAR
- Final construction documents and schedule

- Final Design Plans, including any mitigation elements
- Operation, Maintenance, and Long-Term Monitoring and Reporting Plan
- Final cost estimate for the action and estimated cost for long-term monitoring
- Final schedule

4.8 Supporting Plans

QAPPs and HASPs will required under the SOW for both data gathering as a part of alternatives evaluation and design, as well as actual construction work as listed above. These documents will adhere to the requirements set forth in the following two subsections.

4.8.1 Quality Assurance Project Plans

NW Natural and Siltronic and/or their contractors will develop project-specific QAPPs for design data gathering and construction monitoring. The QAPPs will be based upon the AOC, SOW, and EPA guidance. All sampling and analyses performed pursuant to the AOC will conform to EPA direction, approval, and guidance regarding sampling, QA/QC, data validation, and chain-of-custody procedures.

The QAPPs will define DQOs and contain FSPs that detail the sampling and data-gathering methods that will be used for each monitoring activity. It will include sampling objectives, a detailed description of sampling activities, sample locations, laboratory analytical methods, sampling equipment and procedures, sampling schedule, station positioning, and sample handling (e.g., sample containers and labels, sample preservation), and chain-of-custody procedures. The QAPPs will describe the QA/QC protocols necessary to achieve required DQOs and analytical procedures, adequate detection limits to meet the DQOs, and data reduction, validation, reporting, and personnel qualifications.

The QAPPs and associated FSPs will be prepared in accordance with, as appropriate, the following guidance:

- *Methods for Collection, Storage and Manipulation of Sediments for Chemical and Toxicological Analyses: Technical Manual* (EPA 2001b) or the most current version or updated guidance
- *EPA's Guidance for Conducting Remedial Investigations and Feasibility Studies under CERCLA* (EPA 1988)

- *Quality Assurance/Quality Control Guidance for Removal Activities: Sampling QA/QC Plan and Data Validation Procedures* (EPA 1990) or the most current version, as guidance for QA/QC and sampling
- *EPA Requirements for Quality Assurance Project Plans (QA/R-5*) (EPA 2001a) and *Guidance on Quality Assurance Project Plans (QA/G-5)* (EPA 2002c) or the most current versions
- For data validation, *Guidance on Environmental Data Verification and Validation, EPA QA/G8* (EPA 2002b), or the most current version
- *EPA Functional Guidelines for Data Review*

NW Natural and Siltronic will only use laboratories that participate in a QA/QC program that conforms with to the following requirements:

- Quality system that complies with *Specifications and Guidelines for Quality Systems for Environmental Data Collection and Environmental Technology Programs* (ANSI 1994).
- An approved QA program, which complies with *EPA Requirements for Quality Management Plans (QA/R-2)* (EPA 2001c) or equivalent documentation as determined by EPA.
- If a laboratory that is not in the EPA Contract Laboratory Program (CLP) is selected, the QAPPs will be consistent with the requirements of the CLP.

NW Natural and Siltronic will provide assurances that EPA has access to laboratory personnel, equipment, and records for sample collection, transportation, and analysis at reasonable times and upon reasonable notice by EPA.

For analyses that requires expedited turnaround times, such as those associated with construction water quality monitoring, NW Natural and Siltronic will make best efforts to find a regional, qualified laboratory that has sufficient capacity, appropriate analytical equipment, and sufficient analytical experience with the media in question that can guarantee the required turnaround time.

Upon request by EPA, NW Natural and Siltronic will have the laboratory analyze samples submitted by EPA for quality assurance monitoring. NW Natural and Siltronic agree that EPA personnel may audit any laboratory that performs analytical work under this SOW. Prior to awarding any work to an analytical laboratory, NW Natural and Siltronic will inform the laboratory that an audit may be performed, and ensure that the laboratory agrees to coordinate with EPA prior to performing analyses.

NW Natural and Siltronic will provide to EPA the QA/QC procedures followed by all sampling teams and laboratories performing data collection and/or analysis. Upon request by EPA, NW Natural and Siltronic will allow EPA or its authorized representatives to take split and/or duplicate samples. NW Natural and Siltronic will notify EPA not less than 14 days in advance of any sample collection activity, unless shorter notice is agreed to by EPA. EPA will have the right to take any additional samples that EPA deems necessary. EPA will use its best efforts to notify NW Natural and Siltronic not less than 14 days in advance of any sample collection activity EPA conducts and allow NW Natural and Siltronic to take split or duplicate samples of any samples it takes as part of its oversight of NW Natural and Siltronic's implementation of the work.

All analytical data collected under the SOW will be provided electronically to EPA.

4.8.2 Health and Safety Plan (HASP)

NW Natural and Siltronic will submit for EPA review and comment a HASP that ensures the protection of the public health and safety during performance of on-site work under the AOC. This HASP will be prepared in accordance with EPA's Standard Operating Safety Guide (PUB 9285.1-03, PB 92-963414, June 1992). In addition, the HASP will comply with all currently applicable Occupational Safety and Health Administration (OSHA) regulations found at 29 C.F.R. Part 1910. A HASP that proposes diver operations will incorporate the relevant diving safety recommendations posted at:
http://yosemite.epa.gov/R10/CLEANUP.NSF/6d62f9a16e249d7888256db4005fa293/31ae45c9c90a674988256e470062ced9/$FILE/Dive%20Safety%206%2022%202005.pdf. NW Natural and Siltronic will incorporate changes to the HASP recommended by EPA and implement the HASP during the cleanup action.

4.9 Community Involvement

If requested by EPA, NW Natural will provide information supporting EPA's community involvement programs related to the work performed pursuant to this AOC and SOW, and will participate in public meetings that may be held or sponsored by EPA to explain activities at the cleanup action or concerning work performed pursuant to the AOC and SOW. EPA will coordinate its community outreach efforts with DEQ.

5 PROJECT SCHEDULE

The detailed schedule for each of the submittals identified in Table 1 of the SOW and the various coordination activities required in the AOC between NW Natural, Siltronic, EPA, DEQ, the Tribes, and the Natural Resource Trustees is provided in Figure 5-1. Although the coordination activities will be scheduled per the frequency identified in the SOW, the activities will be held only if determined to be necessary by the various parties and meetings will be held as a teleconference unless EPA and NW Natural agree that the issues would be better discussed in person. In each of those cases, the location of the meeting (i.e., Seattle vs. Portland) would then be determined.

The detailed schedule in Figure 5-1 was developed in coordination with EPA to minimize the timeline for completion of the AOC and SOW such that the remedy will be designed and approved by EPA to coincide with the Portland Harbor Site ROD. The remedial actions selected through completion of the SOW activities will be integrated with the source control actions discussed in Section 1.3 into an overall permanent remedy addressing all matrices and pathways posing risk at the Gasco and Siltronic properties. The goal is to implement the upland work prior to placement of the final Project Area sediment caps and dredge covers.

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TABLES

Table 2.9.3-1
Surface Sediment Quality Summary Statistics

Compound	Number of Samples	Number of Detections	Number of Non-detections	Minimum Detected Concentration	Maximum Detected Concentration	Average Detected Concentration	Minimum Detection Limit	Maximum Detection Limit
Polycyclic Aromatic Hydrocarbons (PAHs) (µg/kg)								
1-Methylnaphthalene	53	51	2	0.32	380000	15894.25569	0.31 U	0.31 U
2-Methylnaphthalene	407	377	30	0.4	650000	6792.911088	0.39 U	87.4 U
Acenaphthene	496	451	45	0.56	1398820	12376.11588	0.39 U	64.1 U
Acenaphthylene	496	422	74	0.31	285353	2080.772986	1.1 U	64.1 U
Anthracene	496	457	39	0.86	612422	7696.485624	1.63 U	8.74 U
Benzo(a)anthracene	496	486	10	2.1	459601	6820.329239	10 U	57.2 U
Benzo(a)pyrene	496	483	13	1.7	621300	8557.177702	10 U	57.2 U
Benzo(b)fluoranthene	450	441	9	3	342877	5616.972109	10 U	5 U
Benzo(b,k)fluoranthene	147	137	10	15	108000	4314.757664	10 U	5 U
Benzo(e)pyrene	54	54	0	1.8	362778	7603.342593	NA	NA
Benzo(g,h,i)perylene	496	470	26	0.6	521059	6457.938723	10 U	57.2 U
Benzo(k)fluoranthene	434	416	18	0.95	100000	2431.973438	10 U	57.2 U
Benzofluoranthene (total)	31	31	0	291	717060	56039.83871	NA	NA
C1-Chrysene	54	54	0	2.2	147659	3251.47037	NA	NA
C1-Dibenzothiophene	54	50	4	0.84	101060	2133.4308	0.21 U	0.21 U
C1-Fluoranthenes/Pyrenes	54	54	0	3.6	483445	10036.44444	NA	NA
C1-Fluorenes	54	53	1	0.67	148290	3021.260943	0.5 U	0.5 U
C1-Naphthalenes	16	16	0	12	1819519	113989.75	NA	NA
C2-Chrysenes	54	53	1	1.4	42490	1026.984906	0.25 U	0.25 U
C2-Dibenzothiophene	54	51	3	0.79	62583	1455.203725	0.21 U	0.21 U
C2-Fluoranthenes/Pyrenes	54	54	0	2.1	105280	2307.888889	NA	NA
C2-Fluorenes	54	54	0	0.69	74879	1575.549074	NA	NA
C2-Naphthalenes	54	54	0	0.76	789661	15100.47741	NA	NA
C3-Chrysenes	54	50	4	5.2	17094	466.974	0.25 U	0.25 U
C3-Dibenzothiophene	54	49	5	1.7	33235	838.6510204	0.21 U	0.21 U
C3-Fluoranthenes/Pyrenes	54	53	1	1.5	35546	847.754717	0.61 U	0.61 U
C3-Fluorenes	54	49	5	4	38414	1001.330612	0.5 U	0.5 U
C3-Naphthalenes	54	54	0	0.47	283227	5658.760556	NA	NA
C4-Chrysenes	54	45	9	7.3	4066	144.1822222	0.25 U	0.25 U
C4-Dibenzothiophene	16	16	0	15	11744	806.125	NA	NA
C4-Naphthalenes	54	51	3	0.75	91693	2032.120588	0.37 U	0.37 U
Chrysene	496	489	7	3.1	523088	8067.479059	10 U	5 U
Dibenzo(a,h)anthracene	496	446	50	0.4	52802	875.6644619	1.56 U	57.9 U
Fluoranthene	496	491	5	0.8	1588359	22260.61788	13.4 U	19 U
Fluorene	496	454	42	0.39	661823	6539.613216	1.55 U	8.74 U
Indeno(1,2,3-c,d)pyrene	496	471	25	1.2	440201	6012.298684	10 U	57.2 U
LWG RI High Molecular Weight PAH (Reported, not calculated)	425	421	4	2.2	6860000	81839.97173	13.4 U	13.4 U
LWG RI Low Molecular Weight PAH (Reported, not calculated)	425	409	16	1.7	56500000	183945.2853	10 U	57.2 U
LWG RI Total BaPEq (Reported, not calculated)	425	418	7	1.51	803000	9813.011268	10 U	5 U
LWG RI Total cPAHs (Reported, not calculated)	425	418	7	12	2800000	35305.98804	10 U	5 U
LWG RI Total PAH (Reported, not calculated)	425	421	4	4.7	63400000	260648.434	13.4 U	13.4 U
Naphthalene	464	405	59	0.5	50622980	150483.3331	0.73 U	9.2 U

Table 2.9.3-1
Surface Sediment Quality Summary Statistics

Compound	Number of Samples	Number of Detections	Number of Non-detections	Minimum Detected Concentration	Maximum Detected Concentration	Average Detected Concentration	Minimum Detection Limit	Maximum Detection Limit
Perylene	54	54	0	2.2	160789	3375.138889	NA	NA
Phenanthrene	496	478	18	1	2918707	34206.41862	10 U	57.2 U
Pyrene	496	491	5	0.8	1931786	26060.22342	13.4 U	19 U
Total 10 HPAH (U = 0)	496	492	4	2.2	6481073	91188.3802	13.4 U	13.4 U
Total 16 PAH (U = 0)	496	492	4	3.7	62981178	274607.9143	13.4 U	13.4 U
Total 17 PAH (U = 0)	496	492	4	4.7	62981178	279813.0515	13.4 U	13.4 U
Total 6 LPAH (U = 0)	496	480	16	1.28	56500105	188005.0225	10 U	57.2 U
Total Benzofluoranthenes (U = 0)	450	441	9	3.95	400000	7911.078571	10 U	5 U
Total cPAH TEF (7 minimum) (U = 0)	496	489	7	1.62	756078.98	10583.12325	10 U	5 U
Conventional Parameters								
Acid volatile sulfide (mg/kg)	4	2	2	0.9	3.6	2.25	0.7 U	0.7 U
Ammonia (mg/kg)	167	167	0	0.4	1400	94.48502994	NA	NA
Cyanide (mg/kg)	69	56	13	0.07	16	1.646696429	0.08 U	44 U
Sulfide (mg/kg)	162	134	28	0.2	998	31.3238806	0.07 U	1.5 U
Specific gravity (None)	241	241	0	0.88	2.4	1.565767635	NA	NA
Liquid Limit (pct)	7	7	0	28.9	39.8	35.25714286	NA	NA
Total organic carbon (pct)	458	457	1	0.02	19.3	1.883967615	0.05 U	0.05 U
Total solids (pct)	400	400	0	29	95.3	57.92575	NA	NA
Total volatile solids (pct)	22	22	0	2.16	9.52	6.687727273	NA	NA
pH (su)	13	13	0	6.59	7.05	6.826923077	NA	NA
Dioxin Furans (mg/kg)								
1,2,3,4,5,6,7,8-Octachlorodibenzofuran (OCDF)	15	15	0	3.07E-06	0.000100081	3.23E-05	NA	NA
1,2,3,4,6,7,8,9-Octachlorodibenzo-p-dioxin (OCDD)	15	15	0	6.22E-05	0.001253718	0.000391245	NA	NA
1,2,3,4,6,7,8-Heptachlorodibenzofuran (HpCDF)	15	15	0	1.07E-06	1.93E-05	8.54E-06	NA	NA
1,2,3,4,6,7,8-Heptachlorodibenzo-p-dioxin (HpCDD)	15	15	0	7.79E-06	0.000147049	4.36E-05	NA	NA
1,2,3,4,7,8,9-Heptachlorodibenzofuran (HpCDF)	15	11	4	4.03E-07	3.26E-06	1.80E-06	5.841e-006 U	8.026e-006 U
1,2,3,4,7,8-Hexachlorodibenzofuran (HxCDF)	1.50E+01	14	1.00E+00	7.68E-07	1.56E-05	6.95E-06	8.026e-006 U	8.026e-006 U
1,2,3,4,7,8-Hexachlorodibenzo-p-dioxin (HxCDD)	15	9	6.00E+00	2.96E-07	7.03E-07	4.85E-07	5.841e-006 U	8.026e-006 U
1,2,3,6,7,8-Hexachlorodibenzofuran (HxCDF)	1.50E+01	1.40E+01	1.00E+00	2.96E-07	3.36E-06	1.82E-06	8.026e-006 U	8.026e-006 U
1,2,3,6,7,8-Hexachlorodibenzo-p-dioxin (HxCDD)	1.50E+01	10	5.00E+00	6.82E-07	3.70E-06	2.31E-06	5.841e-006 U	8.026e-006 U
1,2,3,7,8,9-Hexachlorodibenzofuran (HxCDF)	1.50E+01	5.00E+00	1.00E+01	1.02E-07	7.94E-07	2.73E-07	5.841e-006 U	8.026e-006 U
1,2,3,7,8,9-Hexachlorodibenzo-p-dioxin (HxCDD)	1.50E+01	1.00E+01	5.00E+00	5.38E-07	1.97E-06	1.26E-06	5.841e-006 U	8.026e-006 U
1,2,3,7,8-Pentachlorodibenzofuran (PeCDF)	1.50E+01	1.40E+01	1.00E+00	5.56E-07	8.18E-06	3.60E-06	8.026e-006 U	8.026e-006 U
1,2,3,7,8-Pentachlorodibenzo-p-dioxin (PeCDD)	1.50E+01	9.00E+00	6.00E+00	2.63E-07	6.46E-07	4.48E-07	5.841e-006 U	8.026e-006 U
2,3,4,6,7,8-Hexachlorodibenzofuran (HxCDF)	1.50E+01	1.10E+01	4.00E+00	2.98E-07	1.89E-06	8.51E-07	5.841e-006 U	8.026e-006 U
2,3,4,7,8-Pentachlorodibenzofuran (PeCDF)	1.50E+01	1.40E+01	1.00E+00	2.65E-07	5.83E-06	1.86E-06	8.026e-006 U	8.026e-006 U
2,3,7,8-Tetrachlorodibenzofuran (TCDF)	1.50E+01	1.10E+01	4.00E+00	8.89E-07	2.05E-05	5.45E-06	1.168e-006 U	1.605e-006 U
2,3,7,8-Tetrachlorodibenzo-p-dioxin (TCDD)	1.50E+01	5.00E+00	1.00E+01	1.80E-07	3.48E-07	2.65E-07	1.168e-006 U	1.947e-006 U
Total Dioxin/Furan (U = 0)	1.50E+01	1.50E+01	0.00E+00	7.47E-05	0.001558688	0.000498036	NA	NA
Total Dioxin/Furan TEQ (Bird) (U = 0)	1.50E+01	1.50E+01	0.00E+00	2.55E-08	2.83E-05	7.61E-06	NA	NA
Total Dioxin/Furan TEQ (Fish) (U = 0)	1.50E+01	1.50E+01	0.00E+00	2.55E-08	7.07E-06	2.84E-06	NA	NA
Total Dioxin/Furan TEQ (International) (U = 0)	1.50E+01	1.50E+01	0.00E+00	1.59E-07	8.38E-06	3.77E-06	NA	NA
Total Dioxin/Furan TEQ (Mammal) (U = 0)	1.50E+01	1.50E+01	0.00E+00	1.13E-07	6.99E-06	3.20E-06	NA	NA

Table 2.9.3-1
Surface Sediment Quality Summary Statistics

Compound	Number of Samples	Number of Detections	Number of Non-detections	Minimum Detected Concentration	Maximum Detected Concentration	Average Detected Concentration	Minimum Detection Limit	Maximum Detection Limit
Total Dioxin/Furan TEQ 1998 (Bird) (U = 0)	15	15	0.00E+00	2.55E-08	2.83E-05	7.61E-06	NA	NA
Total Dioxin/Furan TEQ 1998 (Fish) (U = 0)	1.50E+01	1.50E+01	0.00E+00	2.55E-08	7.07E-06	2.84E-06	NA	NA
Total Dioxin/Furan TEQ 1998 (Mammal) (U = 0)	1.50E+01	1.50E+01	0.00E+00	1.00E-07	8.15E-06	3.53E-06	NA	NA
Total Heptachlorodibenzofuran (HpCDF)	1.50E+01	1.50E+01	0.00E+00	3.03E-06	6.25E-05	2.64E-05	NA	NA
Total Heptachlorodibenzo-p-dioxin (HpCDD)	1.50E+01	1.50E+01	0.00E+00	1.79E-05	0.000365031	0.000101056	NA	NA
Total Hexachlorodibenzofuran (HxCDF)	1.50E+01	1.50E+01	0.00E+00	1.22E-06	3.90E-05	1.80E-05	NA	NA
Total Hexachlorodibenzo-p-dioxin (HxCDD)	1.50E+01	1.50E+01	0.00E+00	2.09E-06	6.47E-05	1.38E-05	NA	NA
Total Pentachlorodibenzofuran (PeCDF)	1.50E+01	1.50E+01	0.00E+00	4.34E-07	5.30E-05	1.32E-05	NA	NA
Total Pentachlorodibenzo-p-dioxin (PeCDD)	1.50E+01	1.20E+01	3.00E+00	3.03E-07	3.03E-06	1.32E-06	5.841e-006 U	8.026e-006 U
Total Tetrachlorodibenzofuran (TCDF)	15	14	1.00E+00	5.00E-07	5.02E-05	1.35E-05	1.168e-006 U	1.168e-006 U
Total Tetrachlorodibenzo-p-dioxin (TCDD)	1.50E+01	1.30E+01	2.00E+00	2.82E-07	3.94E-06	1.71E-06	1.168e-006 U	1.605e-006 U
Dioxin Furans (ng/kg)								
1,2,3,4,5,6,7,8-Octachlorodibenzofuran (OCDF)	7.90E+01	7.70E+01	2.00E+00	0.579	771.04	86.69631169	0.137 U	6.547 U
1,2,3,4,6,7,8,9-Octachlorodibenzo-p-dioxin (OCDD)	7.90E+01	7.90E+01	0.00E+00	11.054	29000	1544.900772	NA	NA
1,2,3,4,6,7,8-Heptachlorodibenzofuran (HpCDF)	7.90E+01	7.80E+01	1.00E+00	0.252	330	33.02523077	0.061 U	0.061 U
1,2,3,4,6,7,8-Heptachlorodibenzo-p-dioxin (HpCDD)	7.90E+01	7.90E+01	0.00E+00	1.315	3800	182.846538	NA	NA
1,2,3,4,7,8,9-Heptachlorodibenzofuran (HpCDF)	7.90E+01	7.10E+01	8.00E+00	0.034	61.036	5.526443662	0.032 U	4.9 U
1,2,3,4,7,8-Hexachlorodibenzofuran (HxCDF)	79	77	2	0.204	242.705	22.55501299	0.479 U	4.9 U
1,2,3,4,7,8-Hexachlorodibenzo-p-dioxin (HxCDD)	79	49	30	0.054	33	2.076512245	0.012 U	7.18 U
1,2,3,6,7,8-Hexachlorodibenzofuran (HxCDF)	79	69	10	0.064	48.614	6.121456522	0.111 U	6.2 U
1,2,3,6,7,8-Hexachlorodibenzo-p-dioxin (HxCDD)	79	76	3	0.081	250	10.71388158	1.216 U	4.9 U
1,2,3,7,8,9-Hexachlorodibenzofuran (HxCDF)	79	39	40	0.0351	24	3.492330769	0.008 U	4.9 U
1,2,3,7,8,9-Hexachlorodibenzo-p-dioxin (HxCDD)	79	69	10	0.073	73	4.228253623	0.009 U	4.9 U
1,2,3,7,8-Pentachlorodibenzofuran (PeCDF)	79	65	14	0.088	138.14	13.11257692	0.017 U	5.454 U
1,2,3,7,8-Pentachlorodibenzo-p-dioxin (PeCDD)	79	50	29	0.061	20.536	2.198424	0.01 U	4.9 U
2,3,4,6,7,8-Hexachlorodibenzofuran (HxCDF)	79	70	9	0.067	47.7	4.040611429	0.01 U	4.9 U
2,3,4,7,8-Pentachlorodibenzofuran (PeCDF)	79	71	8	0.055	47.694	6.528374648	0.028 U	4.9 U
2,3,7,8-Tetrachlorodibenzofuran (TCDF)	79	65	14	0.079	317.593	13.38738462	0.152 U	1.8 U
2,3,7,8-Tetrachlorodibenzo-p-dioxin (TCDD)	79	25	54	0.045	111.091	5.55464	0.00596 U	1 U
LWG RI Total Dioxin/Furan TEQ (Reported, not calculated) (U = 0)	68	68	0	0.0745	223	13.44980147	NA	NA
LWG RI Total PCDD/F (Reported, not calculated)	67	67	0	17.2	40200	2417.725373	NA	NA
LWG RI Total TCDD toxicity equivalent (Reported, not calculated) (U = 0)	102	102	0	0.00197	225	10.1409449	NA	NA
Total Dioxin/Furan (U = 0)	79	79	0	13.757	34456.6	1928.565976	NA	NA
Total Dioxin/Furan TEQ (Bird) (U = 0)	79	79	0	0.0998483	542.1789011	25.63209031	NA	NA
Total Dioxin/Furan TEQ (Fish) (U = 0)	79	79	0	0.0663983	211.9781711	11.9420329	NA	NA
Total Dioxin/Furan TEQ (International) (U = 0)	79	79	0	0.095993	227.921192	15.65573441	NA	NA
Total Dioxin/Furan TEQ (Mammal) (U = 0)	79	79	0	0.0744699	223.2730973	13.81986757	NA	NA
Total Dioxin/Furan TEQ 1998 (Bird) (U = 0)	79	79	0	0.0998483	542.1789011	25.63209031	NA	NA
Total Dioxin/Furan TEQ 1998 (Fish) (U = 0)	79	79	0	0.0663983	211.9781711	11.9420329	NA	NA
Total Dioxin/Furan TEQ 1998 (Mammal) (U = 0)	79	79	0	0.0855233	234.1412391	14.88321839	NA	NA
Total Heptachlorodibenzofuran (HpCDF)	78	78	0	0.641	1300	103.9216346	NA	NA
Total Heptachlorodibenzo-p-dioxin (HpCDD)	78	78	0	1.324	6900	390.5447564	NA	NA
Total Hexachlorodibenzofuran (HxCDF)	78	78	0	0.644	1640	103.7842436	NA	NA

Table 2.9.3-1
Surface Sediment Quality Summary Statistics

Compound	Number of Samples	Number of Detections	Number of Non-detections	Minimum Detected Concentration	Maximum Detected Concentration	Average Detected Concentration	Minimum Detection Limit	Maximum Detection Limit
Total Hexachlorodibenzo-p-dioxin (HxCDD)	78	77	1	0.428	970	59.008	6.4 U	6.4 U
Total Pentachlorodibenzofuran (PeCDF)	78	77	1	0.565	2700	93.51159091	4.9 U	4.9 U
Total Pentachlorodibenzo-p-dioxin (PeCDD)	78	67	11	0.068	133.449	10.25292537	0.0127 U	4.9 U
Total Tetrachlorodibenzofuran (TCDF)	73	70	3	0.299	3878.27	88.79050714	1 U	1 U
Total Tetrachlorodibenzofuran (TCDF)	5	5	0	20.9	67.6	41.2	NA	NA
Total Tetrachlorodibenzo-p-dioxin (TCDD)	78	69	9	0.017	416.466	21.35848551	0.011 U	1 U
Herbicides (µg/kg)								
2,2-Dichloropropionic acid (Dalapon)	112	0	112	NA	NA	NA	0.0662 U	99 U
2,4,5-T (2,4,5-Trichlorophenoxyacetic acid)	112	0	112	NA	NA	NA	0.11 U	99 U
2,4,5-TP (Silvex)	112	1	111	5.4	5.4	5.4	0.11 U	99 U
2,4-D (2,4-Dichlorophenoxyacetic acid)	112	11	101	9	3250	325.2909091	0.0753 U	99 U
2,4-DB (2,4-D derivative)	112	7	105	13	344	89.1	0.111 U	99 U
Dicamba	112	0	112	NA	NA	NA	0.238 U	99 U
Dichlorprop	112	1	111	9.4	9.4	9.4	0.12 U	99 U
Dinoseb	112	0	112	NA	NA	NA	0.152 U	99 U
MCPA	112	2	110	4.14	356	180.07	0.16 U	9600 U
Mecoprop (MCPP)	112	2	110	193	4200	2196.5	0.146 U	9600 U
Metals (mg/kg)								
Aluminum	380	380	0	1630	43300	21245.23684	NA	NA
Antimony	387	262	125	0.02	32.1	0.638362595	0.02 U	8.9 U
Arsenic	450	399	51	0.54	105	4.626390977	10 U	9 U
Barium	55	55	0	82.1	426	171.3109091	NA	NA
Beryllium	60	60	0	0.284	0.9	0.57855	NA	NA
Cadmium	412	351	61	0.03	2.01	0.245911681	0.00189 U	1.1 U
Calcium	42	42	0	5310	53800	10100.95238	NA	NA
Chromium	432	430	2	3.43	220	29.5792093	27.5 U	33.4 U
Chromium VI	38	6	32	0.14	1.4	0.62	0.2 U	1.3 U
Cobalt	42	42	0	11.3	55.5	19.40952381	NA	NA
Copper	432	432	0	4.89	1150	54.28699074	NA	NA
Iron	48	48	0	19100	84900	41895.83333	NA	NA
Lead	432	432	0	1.41	13400	59.06824074	NA	NA
Magnesium	42	42	0	3710	14500	6563.571429	NA	NA
Manganese	61	61	0	307	1440	630.3934426	NA	NA
Mercury	410	381	29	0.0085	65.2	0.273114698	0.008 U	0.1 U
Nickel	430	425	5	4.85	200	25.28185882	13.5 U	29 U
Potassium	42	42	0	670	50000	2640.833333	NA	NA
Selenium	352	159	193	0.04	17	3.209666667	0.03 U	2.7 U
Silver	410	386	24	0.019	4.24	0.341209067	0.02 U	1.8 U
Sodium	42	42	0	563	49000	2502.214286	NA	NA
Thallium	65	43	22	0.053	27	6.713644186	0.397 U	9 U
Tin	1	1	0	3.46	3.46	3.46	NA	NA
Titanium	16	16	0	1520	3200	2129.375	NA	NA
Total Metal (U = 0)	465	452	13	0.14	212464.038	24813.18714	1.3 U	1.3 U

Table 2.9.3-1
Surface Sediment Quality Summary Statistics

Compound	Number of Samples	Number of Detections	Number of Non-detections	Minimum Detected Concentration	Maximum Detected Concentration	Average Detected Concentration	Minimum Detection Limit	Maximum Detection Limit
Vanadium	42	42	0	66.6	152	105.0190476	NA	NA
Zinc	432	432	0	9.7	2010	121.9236111	NA	NA
Organometallic Compounds (µg/kg)								
Butyltin	27	24	3	0.43	4.2	1.598333333	2.3 U	3.1 U
Butyltin (ion)	80	56	24	0.16	95.5	7.09	0.042 U	6 U
Dibutyltin	22	22	0	0.75	13	2.799090909	NA	NA
Dibutyltin (ion)	86	64	22	0.2	253	21.165625	0.04 U	6 U
Dibutyltin chloride	1	0	1	NA	NA	NA	NA	NA
Di-n-Butyltin - synonym with Dibutyltin	5	5	0	1.2	2	1.62	NA	NA
Monobutyltin trichloride	1	0	1	NA	NA	NA	NA	NA
n-Butyltin (ion)	6	6	0	1.1	2	1.35	NA	NA
Tetrabutyltin	108	25	83	0.36	9.3	2.1064	0.095 U	6 U
Tributyltin (ion)	114	111	3	0.49	819	60.41828829	0.079 U	5.8 U
Tributyltin chloride	1	1	0	16	16	16	NA	NA
PCB Aroclors (µg/kg)								
Aroclor 1016	339	0	339	NA	NA	NA	1.1 U	990 U
Aroclor 1221	338	0	338	NA	NA	NA	1.3 U	93.9 U
Aroclor 1232	338	0	338	NA	NA	NA	1.3 U	990 U
Aroclor 1242	339	5	334	8.9	93	43.18	1.1 U	990 U
Aroclor 1248	339	45	294	2.59	159	26.52555556	1.3 U	990 U
Aroclor 1254	340	97	243	1.7	365	40.38371134	0.64 U	990 U
Aroclor 1260	339	167	172	1.3	2610	52.90401198	0.82 U	990 U
Aroclor 1262	269	0	269	NA	NA	NA	0.98 U	9.9 U
Aroclor 1268	269	12	257	2.4	17.6	10.55	0.84 U	9.9 U
Aroclors	277	180	97	1.3	3130	77.587	1.3 U	96 U
Sum of Aroclor 1254 and 1260 (U = 0)	339	182	157	1.3	2975	70.06697802	0.82 U	990 U
Total PCB Aroclors (U = 0)	339	183	156	1.3	3134	78.07836066	1.3 U	96 U
PCB Congeners (ng/kg)								
Dichlorobiphenyls (total)	73	70	3	15.4	68800	3006.641429	133 U	29.5 U
Heptachlorobiphenyls (total)	73	73	0	216	2040000	44055.75342	NA	NA
Hexachlorobiphenyls (total)	73	73	0	276	2020000	48866.78082	NA	NA
LWG RI Dioxin-like PCB congener TEQ (Reported, not calculated) (U = 0)	63	63	0	0.00104	34.1	1.899170159	NA	NA
LWG RI Total PCB Congeners (Reported, not calculated)	62	62	0	1050	5870000	187864.5161	NA	NA
Monochlorobiphenyls (total)	73	63	10	8.44	8380	312.1326984	1.68 U	5 U
Nonachlorobiphenyls (total)	73	71	2	11.8	25500	1044.94507	11.3 U	11.6 U
Octachlorobiphenyls (total)	73	73	0	36.4	500000	10903.1411	NA	NA
PCB-001	73	54	19	4.21	5190	212.4312963	1.68 U	9.83 U
PCB-002	73	61	12	4.89	235	29.75393443	1.68 U	9.71 U
PCB-003	73	62	11	4.91	2950	102.8687097	1.68 U	9.06 U
PCB-004	13	13	0	17.4	308	51.44615385	NA	NA
PCB-004/010	60	45	15	5.43	38300	1849.509556	10 U	93.2 U
PCB-005	13	6	7	0.402	1.29	0.7275	0.568 U	9.83 U
PCB-005/008	60	52	8	9.4	31100	1151.342308	133 U	9.96 U

Table 2.9.3-1
Surface Sediment Quality Summary Statistics

Compound	Number of Samples	Number of Detections	Number of Non-detections	Minimum Detected Concentration	Maximum Detected Concentration	Average Detected Concentration	Minimum Detection Limit	Maximum Detection Limit
PCB-006	73	48	25	6.19	10200	374.3304167	10 U	9.97 U
PCB-007	13	7	6	0.921	2.71	1.877285714	9.06 U	9.83 U
PCB-007/009	60	25	35	5.47	1800	169.1128	10 U	9.97 U
PCB-008	44	22	22	21.4	3690	543.1363636	1260 U	450 U
PCB-009	13	7	6	2.05	5.49	3.401428571	9.06 U	9.83 U
PCB-010	13	7	6	0.655	38.4	6.447714286	9.06 U	9.83 U
PCB-011	73	63	10	11.9	595	132.1571429	113 U	9.87 U
PCB-012/013	73	38	35	4.14	1940	129.0557895	10 U	9.97 U
PCB-014	73	3	70	0.198	0.271	0.242333333	0.173 U	9.97 U
PCB-015	73	67	6	8.64	13800	456.0229851	133 U	9.96 U
PCB-016	13	13	0	25.4	111	44.68461538	NA	NA
PCB-016/032	60	57	3	7.35	7770	786.5994737	11.3 U	2.53 U
PCB-017	73	67	6	5.88	20300	835.8325373	11.3 U	66.5 U
PCB-018	91	60	31	8.06	12900	1017.439333	11.6 U	66.5 U
PCB-018/030	13	13	0	62.9	254	111.4384615	NA	NA
PCB-019	73	70	3	5.22	86800	2290.427714	11.3 U	66.5 U
PCB-020/021/033	60	58	2	7.06	5040	564.8968966	11.6 U	3.85 U
PCB-020/028	13	13	0	134	559	264	NA	NA
PCB-021/033	13	13	0	42.9	156	83.1	NA	NA
PCB-022	73	71	2	4.95	2850	322.8371831	11.3 U	11.6 U
PCB-023	73	11	62	0.254	20.1	6.280090909	0.112 U	9.83 U
PCB-024	13	5	8	0.584	1.66	1.1112	0.163 U	9.83 U
PCB-024/027	60	50	10	2.32	13900	495.4264	11.3 U	66.5 U
PCB-025	73	64	9	4.71	11300	323.66375	11.3 U	66.5 U
PCB-026	60	54	6	6.45	12100	468.33	11.3 U	66.5 U
PCB-026/029	13	13	0	19.7	66.5	39.62307692	NA	NA
PCB-027	13	13	0	7.54	161	24.04	NA	NA
PCB-028	91	76	15	15.7	14300	1171.607895	11.6 U	280 U
PCB-029	60	18	42	2.94	40.3	12.445	1.66 U	66.5 U
PCB-030	60	5	55	1.04	215	72.898	1.66 U	66.5 U
PCB-031	73	72	1	11.5	16400	1017.818056	11.6 U	11.6 U
PCB-032	13	12	1	21.2	117	45.03333333	0.209 U	0.209 U
PCB-034	73	33	40	0.885	346	41.20209091	1.67 U	9.83 U
PCB-035	73	50	23	2.16	307	23.7362	1.68 U	9.06 U
PCB-036	73	15	58	0.418	24.4	4.8568	0.42 U	9.83 U
PCB-037	73	71	2	6.13	1660	239.5132394	11.3 U	11.6 U
PCB-038	73	42	31	0.3	2830	114.0277143	1.68 U	9.83 U
PCB-039	73	26	47	1.27	84.8	13.065	0.222 U	9.83 U
PCB-040	60	51	9	4.69	2640	288.6115686	11.3 U	4.98 U
PCB-040/041/071	2	2	0	253	284	268.5	NA	NA
PCB-040/071	11	11	0	83.2	304	153.2818182	NA	NA
PCB-041	11	11	0	12.8	53.5	25.30909091	NA	NA
PCB-041/064/071/072	60	59	1	17.5	17400	1632.862712	11.6 U	11.6 U

Table 2.9.3-1
Surface Sediment Quality Summary Statistics

Compound	Number of Samples	Number of Detections	Number of Non-detections	Minimum Detected Concentration	Maximum Detected Concentration	Average Detected Concentration	Minimum Detection Limit	Maximum Detection Limit
PCB-042	13	13	0	53.6	188	97.4	NA	NA
PCB-042/059	60	58	2	5.57	7720	681.987931	11.3 U	11.6 U
PCB-043	13	12	1	7.03	28.7	15.2475	9.73 U	9.73 U
PCB-043/049	60	60	0	19.7	61400	2937.573333	NA	NA
PCB-044	91	70	21	17.3	19100	1734.684286	11.6 U	710 U
PCB-044/047/065	13	13	0	218	2320	583.7692308	NA	NA
PCB-045	71	64	7	6.7	2960	234.6051563	11.3 U	4.98 U
PCB-045/051	2	2	0	75	913	494	NA	NA
PCB-046	73	65	8	4.13	3870	171.5203077	11.3 U	5 U
PCB-047	60	60	0	16.5	156000	4278.58	NA	NA
PCB-048	13	13	0	27.5	112	58.04615385	NA	NA
PCB-048/075	60	53	7	6.82	4740	420.9041509	11.3 U	4.98 U
PCB-049/069	13	13	0	129	669	296.1538462	NA	NA
PCB-050	60	34	26	2.19	4620	236.0797059	1.67 U	66.5 U
PCB-050/053	13	13	0	35.4	583	108.6692308	NA	NA
PCB-051	71	69	2	5.35	69000	1502.678116	11.3 U	66.5 U
PCB-052	44	25	19	230	6110	1249.48	1110 U	400 U
PCB-052/069	60	60	0	22.2	37600	3031.295	NA	NA
PCB-053	60	59	1	5.54	57300	1550.321864	11.3 U	11.3 U
PCB-054	73	61	12	1.34	23600	656.3683607	1.67 U	66.5 U
PCB-055	73	43	30	1.89	737	46.06069767	0.496 U	9.83 U
PCB-056	13	13	0	84.1	337	163.3769231	NA	NA
PCB-056/060	60	59	1	9.38	8770	681.82	11.6 U	11.6 U
PCB-057	73	36	37	0.866	997	62.20725	0.585 U	9.83 U
PCB-058	73	33	40	0.976	545	42.86018182	0.331 U	9.83 U
PCB-059/062/075	13	13	0	14.9	115	36.65384615	NA	NA
PCB-060	13	13	0	29.6	172	67.88461538	NA	NA
PCB-061/070	60	59	1	21.2	14600	1603.737288	11.6 U	11.6 U
PCB-061/070/074/076	13	13	0	309	2200	685.5384615	NA	NA
PCB-062	60	1	59	9.8	9.8	9.8	1.66 U	66.5 U
PCB-063	73	60	13	1.72	475	63.18483333	11.3 U	66.5 U
PCB-064	13	13	0	64.5	343	143.5153846	NA	NA
PCB-065	60	5	55	2.85	14.4	6.952	1.66 U	66.5 U
PCB-066	44	30	14	192	4720	1069.233333	130 U	650 U
PCB-066/076	60	59	1	19	11200	1301.80678	11.6 U	11.6 U
PCB-067	73	57	16	1.7	422	55.49298246	11.3 U	9.06 U
PCB-068	73	51	22	1.25	1690	74.05235294	1.68 U	9.83 U
PCB-072	13	10	3	2.73	8.85	6.103	9.06 U	9.83 U
PCB-073	73	31	42	1.04	4800	277.7535484	0.277 U	9.83 U
PCB-074	60	59	1	8.2	6630	561.2040678	11.6 U	11.6 U
PCB-077	74	67	7	1.85	801	105.1831343	3.36 U	5.34 U
PCB-078	73	4	69	12.4	31	21.225	0.268 U	9.83 U
PCB-079	73	55	18	3.18	1050	57.19309091	1.68 U	9.83 U

Table 2.9.3-1
Surface Sediment Quality Summary Statistics

Compound	Number of Samples	Number of Detections	Number of Non-detections	Minimum Detected Concentration	Maximum Detected Concentration	Average Detected Concentration	Minimum Detection Limit	Maximum Detection Limit
PCB-080	73	1	72	12.8	12.8	12.8	0.287 U	9.83 U
PCB-081	74	51	23	0.245	91.4	10.17923529	0.673 U	9.83 U
PCB-082	73	67	6	5.35	1470	241.9438806	11.3 U	54 U
PCB-083	71	15	56	3.34	357	51.288	1.66 U	9.71 U
PCB-083/099	2	2	0	923	1270	1096.5	NA	NA
PCB-084	13	13	0	60.2	657	180.5615385	NA	NA
PCB-084/092	60	60	0	21.1	48100	2362.73	NA	NA
PCB-085/116	71	69	2	5.39	1950	322.3031884	11.3 U	11.6 U
PCB-085/116/117	2	2	0	128	379	253.5	NA	NA
PCB-086	60	27	33	4.22	541	51.01074074	1.68 U	66.5 U
PCB-086/087/097/108/119/125	13	13	0	176	1900	502.0769231	NA	NA
PCB-087/117/125	60	59	1	12.1	16000	1103.959322	11.6 U	11.6 U
PCB-088	11	0	11	NA	NA	NA	0.252 U	9.83 U
PCB-088/091	62	61	1	9.67	30000	1067.722459	11.3 U	11.3 U
PCB-089	73	54	19	3.17	347	42.06666667	1.68 U	9.06 U
PCB-090/101	60	60	0	56.3	143000	5745.533333	NA	NA
PCB-090/101/113	13	13	0	294	3070	897.6923077	NA	NA
PCB-091	11	11	0	38.4	114	80.9	NA	NA
PCB-092	13	13	0	65	492	175.0076923	NA	NA
PCB-093	60	0	60	NA	NA	NA	1.66 U	66.5 U
PCB-093/095/098/100/102	2	2	0	1760	2210	1985	NA	NA
PCB-093/100	11	11	0	10.7	22.6	17.54545455	NA	NA
PCB-094	73	55	18	3.3	13600	379.6618182	11.3 U	9.83 U
PCB-095	11	11	0	193	667	434.9090909	NA	NA
PCB-095/098/102	60	60	0	40.7	127000	4927.763333	NA	NA
PCB-096	73	59	14	3.3	8610	199.7061017	11.3 U	66.5 U
PCB-097	60	58	2	13.1	9680	885.1793103	11.6 U	9.31 U
PCB-098	11	3	8	0.738	1.67	1.239333333	0.227 U	9.83 U
PCB-099	71	71	0	25.1	61300	2105.033803	NA	NA
PCB-100	60	52	8	5.33	26900	853.4769231	11.3 U	66.5 U
PCB-101	31	10	21	510	3510	1336	180 U	900 U
PCB-102	11	11	0	9.97	31.7	21.20636364	NA	NA
PCB-103	73	64	9	5.98	11700	315.3609375	11.3 U	66.5 U
PCB-104	73	24	49	0.78	2890	183.975	0.21 U	9.83 U
PCB-105	105	73	32	7.84	4970	588.6115068	10.1 U	550 U
PCB-106	13	2	11	0.233	0.418	0.3255	0.276 U	9.83 U
PCB-106/118	61	61	0	16.9	36000	2511.347541	NA	NA
PCB-107/109	60	54	6	5.04	2380	250.6748148	11.3 U	66.5 U
PCB-107/124	13	13	0	9.21	109	27.89307692	NA	NA
PCB-108/112	60	56	4	4.74	13000	484.0042857	11.3 U	4.98 U
PCB-109	13	13	0	18.2	144	47.74615385	NA	NA
PCB-110	71	71	0	33.6	48500	3279.746479	NA	NA
PCB-110/115	2	2	0	943	3170	2056.5	NA	NA

Table 2.9.3-1
Surface Sediment Quality Summary Statistics

Compound	Number of Samples	Number of Detections	Number of Non-detections	Minimum Detected Concentration	Maximum Detected Concentration	Average Detected Concentration	Minimum Detection Limit	Maximum Detection Limit
PCB-111	13	6	7	0.492	3.89	1.526166667	0.449 U	9.83 U
PCB-111/115	60	46	14	3.59	340	55.15478261	1.68 U	5 U
PCB-112	13	0	13	NA	NA	NA	0.195 U	9.83 U
PCB-113	60	33	27	3.11	489	62.11636364	1.66 U	66.5 U
PCB-114	74	66	8	0.444	250	34.57627273	0.999 U	9.73 U
PCB-115	11	0	11	NA	NA	NA	0.152 U	9.83 U
PCB-117	11	7	4	5	24.9	12.41571429	9.57 U	9.83 U
PCB-118	44	22	22	240	2820	730.2727273	130 U	670 U
PCB-119	60	54	6	5.62	8460	318.5092593	11.3 U	4.98 U
PCB-120	73	39	34	1.43	634	40.01461538	1.68 U	9.83 U
PCB-121	73	16	57	0.464	560	71.642	0.568 U	9.83 U
PCB-122	73	53	20	2.48	122	26.09471698	1.68 U	9.83 U
PCB-123	74	65	9	0.381	311	32.83801538	1.81 U	9.71 U
PCB-124	60	51	9	3.04	856	97.82431373	11.3 U	5 U
PCB-126	74	61	13	0.237	315	18.26954098	0.862 U	9.83 U
PCB-127	73	3	70	1.81	219	75.47666667	0.163 U	9.83 U
PCB-128	31	16	15	200	980	432.1875	110 U	570 U
PCB-128/162	60	58	2	9.2	19300	800.802931	11.3 U	11.6 U
PCB-128/166	13	13	0	56.2	476	173.1769231	NA	NA
PCB-129	60	55	5	4.38	7980	300.1676364	11.3 U	4.98 U
PCB-129/138/160/163	2	2	0	2930	3320	3125	NA	NA
PCB-129/138/163	11	11	0	498	1570	1076.909091	NA	NA
PCB-130	73	70	3	5	11400	400.1521429	11.3 U	12.5 U
PCB-131	73	19	54	3.67	104	16.24263158	1.66 U	9.73 U
PCB-132	13	13	0	136	1010	374.7692308	NA	NA
PCB-132/161	60	59	1	23.3	75000	2535.038983	15.1 U	15.1 U
PCB-133	13	13	0	10.4	121	32.87692308	NA	NA
PCB-133/142	60	55	5	5.01	8800	368.1583636	11.3 U	4.98 U
PCB-134	11	11	0	27.9	81.2	57.60909091	NA	NA
PCB-134/143	62	59	3	5.27	19600	634.8023729	11.3 U	4.98 U
PCB-135	60	59	1	13.2	63200	1963.894915	11.3 U	11.3 U
PCB-135/151	11	11	0	194	637	404.9090909	NA	NA
PCB-135/151/154	2	2	0	867	1520	1193.5	NA	NA
PCB-136	73	72	1	12.5	68600	1653.531944	11.3 U	11.3 U
PCB-137	73	67	6	4.48	3750	166.7801493	11.3 U	4.98 U
PCB-138	31	20	11	280	7880	1906.5	120 U	620 U
PCB-138/163/164	60	60	0	75.9	380000	11109.885	NA	NA
PCB-139/140	13	13	0	7.23	83.5	25.61230769	NA	NA
PCB-139/149	60	60	0	67	410000	11329.81167	NA	NA
PCB-140	60	45	15	4.41	1060	84.83022222	1.68 U	66.5 U
PCB-141	73	73	0	15.3	105000	2346.378082	NA	NA
PCB-142	13	3	10	0.554	1.23	0.872333333	0.12 U	9.83 U
PCB-143	11	2	9	1.45	3.23	2.34	0.105 U	9.83 U

Table 2.9.3-1
Surface Sediment Quality Summary Statistics

Compound	Number of Samples	Number of Detections	Number of Non-detections	Minimum Detected Concentration	Maximum Detected Concentration	Average Detected Concentration	Minimum Detection Limit	Maximum Detection Limit
PCB-144	73	69	4	7.82	26000	597.5418841	11.3 U	4.98 U
PCB-145	73	12	61	0.177	116	15.58133333	0.0756 U	9.83 U
PCB-146	13	13	0	96.5	1020	291.8076923	NA	NA
PCB-146/165	60	59	1	16.9	55700	1986.49322	13.9 U	13.9 U
PCB-147	60	55	5	6.06	22200	665.2810909	11.3 U	66.5 U
PCB-147/149	13	13	0	402	2940	1086.307692	NA	NA
PCB-148	73	46	27	2.26	1600	84.44673913	1.68 U	9.83 U
PCB-150	73	44	29	2.07	2260	87.3525	1.68 U	9.83 U
PCB-151	60	60	0	19.8	172000	4460.908333	NA	NA
PCB-152	73	36	37	0.789	2720	114.9024722	1.67 U	9.83 U
PCB-153	91	82	9	85.7	473000	10563.81463	150 U	790 U
PCB-153/168	13	13	0	452	3370	1286.153846	NA	NA
PCB-154	71	63	8	5.14	9710	334.685873	11.3 U	66.5 U
PCB-155	73	13	60	0.319	311	45.31269231	0.166 U	9.83 U
PCB-156	63	62	1	2.21	24500	735.36	5.55 U	5.55 U
PCB-156/157	11	11	0	44.6	160	102.4545455	NA	NA
PCB-157	63	60	3	0.708	1240	71.77696667	2.08 U	5.95 U
PCB-158	13	13	0	42.8	356	130.6	NA	NA
PCB-158/160	60	58	2	8.69	35800	1056.534655	11.3 U	11.6 U
PCB-159	73	45	28	2.31	8830	282.67	10.1 U	5.04 U
PCB-160	11	0	11	NA	NA	NA	0.0865 U	9.83 U
PCB-161	13	0	13	NA	NA	NA	0.0755 U	9.83 U
PCB-162	13	8	5	1.27	9.65	4.11625	9.06 U	9.83 U
PCB-164	13	13	0	32.2	225	92.56923077	NA	NA
PCB-165	13	6	7	0.737	3.49	1.765666667	0.576 U	9.83 U
PCB-166	60	26	34	3.27	85.9	18.74	1.68 U	5.17 U
PCB-167	74	73	1	1.15	10100	265.6963014	5.28 U	5.28 U
PCB-168	60	30	30	2.28	841	54.48233333	1.68 U	66.5 U
PCB-169	74	14	60	0.447	16	4.236714286	0.151 U	9.83 U
PCB-170	104	91	13	1.43	223000	3969.567363	120 U	620 U
PCB-171	60	59	1	7.08	57400	1543.477627	11.3 U	11.3 U
PCB-171/173	13	13	0	50.7	433	160.0153846	NA	NA
PCB-172	73	71	2	7.35	35500	806.2774648	11.3 U	4.98 U
PCB-173	60	45	15	3.7	5160	181.1177778	1.68 U	5.08 U
PCB-174	73	73	0	31.3	235000	5166.29589	NA	NA
PCB-175	73	62	11	2.43	10600	268.4087097	11.3 U	66.5 U
PCB-176	73	72	1	5.2	32400	705.4227778	11.3 U	11.3 U
PCB-177	73	73	0	17.6	132000	2980.124658	NA	NA
PCB-178	73	72	1	9.27	49800	1122.930139	11.3 U	11.3 U
PCB-179	73	72	1	18	113000	2493.431944	15.5 U	15.5 U
PCB-180/193	13	13	0	343	3680	1281.692308	NA	NA
PCB-181	73	44	29	3.39	659	45.57409091	1.68 U	9.71 U
PCB-182	13	8	5	1.18	38.3	8.42375	9.06 U	9.83 U

Table 2.9.3-1
Surface Sediment Quality Summary Statistics

Compound	Number of Samples	Number of Detections	Number of Non-detections	Minimum Detected Concentration	Maximum Detected Concentration	Average Detected Concentration	Minimum Detection Limit	Maximum Detection Limit
PCB-182/187	60	60	0	45.5	308000	7981.503333	NA	NA
PCB-183	71	71	0	19.9	155000	3281.192958	NA	NA
PCB-183/185	2	2	0	369	1120	744.5	NA	NA
PCB-184	73	15	58	0.325	88.3	11.43753333	0.437 U	9.83 U
PCB-185	71	66	5	5.91	26000	625.1330303	11.3 U	9.06 U
PCB-186	73	7	66	0.606	30.1	8.733714286	0.117 U	9.83 U
PCB-187	44	30	14	236	4510	1105.833333	130 U	680 U
PCB-188	73	24	49	0.474	389	32.231	1.66 U	9.83 U
PCB-189	74	71	3	0.371	8030	178.6550845	1.59 U	3.53 U
PCB-190	73	72	1	6.99	46500	1005.272361	11.3 U	11.3 U
PCB-191	73	62	11	1.81	8930	225.5158065	11.3 U	5.08 U
PCB-192	73	2	71	57.3	60.4	58.85	0.287 U	9.83 U
PCB-193	60	56	4	5.86	26200	743.53875	11.3 U	4.98 U
PCB-194	73	73	0	15.1	117000	2573.736986	NA	NA
PCB-195	73	71	2	7.73	49800	1159.528592	11.3 U	21.6 U
PCB-196	13	13	0	39	738	200	NA	NA
PCB-196/203	60	60	0	21.3	148000	3681.12	NA	NA
PCB-197	71	56	15	3.44	4520	128.63125	1.68 U	5.08 U
PCB-197/200	2	2	0	39.1	219	129.05	NA	NA
PCB-198	60	47	13	5.11	6450	219.7408511	1.68 U	5.08 U
PCB-198/199	13	13	0	114	1680	453	NA	NA
PCB-199	60	59	1	28.3	122000	3183.652542	17.1 U	17.1 U
PCB-200	71	65	6	3.82	15600	382.6261538	11.3 U	4.98 U
PCB-201	73	67	6	3.74	14200	351.8664179	11.3 U	4.98 U
PCB-202	73	70	3	5.84	17000	434.7184286	11.3 U	4.98 U
PCB-203	13	13	0	61.6	909	267.8461538	NA	NA
PCB-204	73	8	65	1.73	27.3	7.9925	0.32 U	9.83 U
PCB-205	73	57	16	3.63	5230	147.8931579	1.68 U	9.73 U
PCB-206	73	71	2	11.8	20100	777.8605634	11.3 U	11.6 U
PCB-207	73	59	14	6.12	2550	100.7669492	1.68 U	5.08 U
PCB-208	73	69	4	4.03	3590	188.7749275	11.3 U	4.98 U
PCB-209	73	71	2	8.86	9460	446.5850704	11.3 U	11.6 U
Pentachlorobiphenyls (total)	73	73	0	267	620000	24851.26027	NA	NA
Tetrachlorobiphenyls (total)	73	73	0	172	475000	20454.90411	NA	NA
Total PCB Congener (U=0)	105	98	7	32.443	5308389.1	114891.3607	310 U	370 U
Total PCB Congener TEQ (Bird) (U = 0)	105	83	22	3.89E-05	49.33481	6.276164934	130 U	670 U
Total PCB Congener TEQ (Fish) (U = 0)	105	83	22	1.95E-05	1.754425	0.084611634	130 U	670 U
Total PCB Congener TEQ (Mammal) (U = 0)	105	83	22	0.0001167	32.24977	1.409443902	130 U	670 U
Total PCB Congener TEQ 1998 (Bird) (U = 0)	105	83	22	3.89E-05	49.33481	6.276164934	130 U	670 U
Total PCB Congener TEQ 1998 (Fish) (U = 0)	105	83	22	1.95E-05	1.754425	0.084611634	130 U	670 U
Total PCB Congener TEQ 1998 (Mammal) (U = 0)	105	83	22	3.89E-05	33.02424	1.470817092	130 U	670 U
Total PCB Co-planar Congener (U = 0)	105	83	22	3.89	24111.4	1269.863289	130 U	670 U
Trichlorobiphenyls (total)	73	73	0	51.4	150000	8676.331507	NA	NA

Table 2.9.3-1
Surface Sediment Quality Summary Statistics

Compound	Number of Samples	Number of Detections	Number of Non-detections	Minimum Detected Concentration	Maximum Detected Concentration	Average Detected Concentration	Minimum Detection Limit	Maximum Detection Limit
Pesticides (µg/kg)								
2,4'-DDD (o,p'-DDD)	315	230	85	0.048	616	15.86823043	0.0272 U	9.4 U
2,4'-DDE (o,p'-DDE)	315	80	235	0.0384	55.3	5.80956875	0.0288 U	9.2 U
2,4'-DDT (o,p'-DDT)	315	165	150	0.0639	92.5	5.740217576	0.0403 U	9.7 U
4,4'-DDD (p,p'-DDD)	369	315	54	0.18	1600	35.50456508	0.0467 U	9.9 U
4,4'-DDE (p,p'-DDE)	368	286	82	0.052	880	10.46896154	0.0438 U	99 U
4,4'-DDT (p,p'-DDT)	369	282	87	0.077	490	25.58637589	0.0525 U	9.9 U
Aldrin	368	74	294	0.0178	380	15.15737703	0.0264 U	96 U
alpha-BHC	364	44	320	0.0087	1.67	0.493197727	0.0158 U	9.9 U
alpha-Chlordane (cis-Chlordane)	364	99	265	0.045	109	2.393852525	0.0281 U	9.9 U
beta-BHC	364	134	230	0.00407	26.4	3.248136343	0.0305 U	9.9 U
beta-Chlordane (trans-Chlordane)	301	95	206	0.026	86	1.872995789	0.0177 U	50 U
Chlordane	56	0	56	NA	NA	NA	11 U	7.44 U
Chlordane (technical)	57	4	53	0.45	0.96	0.745	0.99 U	9.9 U
cis-Nonachlor	315	75	240	0.0308	32.2	2.984522667	0.0352 U	9.7 U
delta-BHC	362	40	322	0.00216	33	3.8781165	0.00131 U	9.9 U
Dieldrin	368	64	304	0.038	31	1.693109375	0.03 U	99 U
Endosulfan sulfate	364	19	345	0.0315	16	2.098026316	0.058 U	99 U
Endosulfan-alpha (I)	364	28	336	0.071	44.1	5.113928571	0.0125 U	9.9 U
Endosulfan-beta (II)	364	57	307	0.0355	235	7.374187719	0.0217 U	99 U
Endrin	364	35	329	0.039	38.6	7.080771429	0.0182 U	99 U
Endrin aldehyde	364	24	340	0.1	99	8.171166667	0.0369 U	99 U
Endrin ketone	360	47	313	0.12	130	6.930893617	0.0248 U	99 U
gamma-BHC (Lindane)	368	55	313	0.0103	22	3.325758182	0.0166 U	9.9 U
gamma-Chlordane	6	0	6	NA	NA	NA	1.2 U	1.3 U
Heptachlor	368	25	343	0.065	4.7	0.89612	0.00277 U	9.9 U
Heptachlor epoxide	364	33	3.31E+02	0.00189	28	2.894426364	0.00439 U	9.9 U
LWG RI Total 2,4' and 4,4'-DDD (Reported, not calculated)	306	275	3.10E+01	0.18	2220	47.90232727	0.0467 U	9 U
LWG RI Total 2,4' and 4,4'-DDD, -DDE, -DDT (Reported, not calculated)	306	281	25	0.052	2310	85.17024555	0.054 U	8.9 U
LWG RI Total 2,4' and 4,4'-DDE (Reported, not calculated)	305	251	5.40E+01	0.052	912	12.32227092	0.0438 U	99 U
LWG RI Total 2,4' and 4,4'-DDT (Reported, not calculated)	306	256	5.00E+01	0.077	490	29.99119141	0.0441 U	8.9 U
LWG RI Total 4,4'-DDD, -DDE, -DDT (Reported, not calculated)	266	242	2.40E+01	0.39	1690	76.60343802	0.054 U	8.9 U
LWG RI Total Chlordanes (Reported, not calculated)	305	184	121	0.054	246	4.864521739	0.0352 U	9.2 U
LWG RI Total Endosulfan (Reported, not calculated)	300	84	216	0.0315	235	4.99214881	0.0444 U	99 U
Methoxychlor	364	53	311	0.077	320	29.63966038	0.031 U	9.9 U
Mirex	283	14	269	0.138	50	6.924357143	0.0303 U	9.7 U
Oxychlordane	315	39	276	0.077	10.7	1.883	0.00617 U	8.62 U
Sum 2,4 DDT, DDE, DDD (U=0)	314	252	62	0.048	616	20.08569206	0.0426 U	9.4 U
Sum 4,4 DDT, DDE, DDD (U=0)	368	329	39	0.052	1693.3	65.02558967	0.054 U	9.9 U
Sum DDD (U=0)	368	319	49	0.18	2216	46.50041066	0.0467 U	9.9 U
Sum DDE (U=0)	366	286	80	0.052	912	12.09401573	0.0438 U	99 U
Sum DDT (U=0)	367	288	79	0.077	490	28.34199271	0.0441 U	9.9 U
Total BHC (U = 0)	367	164	203	0.0103	57.8	4.847514207	0.0688 U	9.9 U

Table 2.9.3-1
Surface Sediment Quality Summary Statistics

Compound	Number of Samples	Number of Detections	Number of Non-detections	Minimum Detected Concentration	Maximum Detected Concentration	Average Detected Concentration	Minimum Detection Limit	Maximum Detection Limit
Total Chlordane (alpha and beta) (U = 0)	362	132	230	0.045	109	3.143378788	0.0281 U	9.9 U
Total Chlordane (alpha and gamma) (U = 0)	362	103	259	0.045	109	2.329819417	0.0281 U	9.9 U
Total DDT (U = 0)	368	329	39	0.052	2309.3	80.41037508	0.054 U	9.9 U
Toxaphene	364	1	363	470	470	470	10.2 U	99 U
trans-Nonachlor	315	92	223	0.0619	137	2.213998913	0.0306 U	8.62 U
Semivolatile Organics (µg/kg)								
1,2,4-Trichlorobenzene	361	1	360	4.4	4.4	4.4	1.6 U	98 U
1,2-Dichlorobenzene	364	14	350	3.2	730	122.2357143	1.4 U	98 U
1,3-Dichlorobenzene	362	3	359	5.3	45	29.43333333	1.8 U	98 U
1,4-Dichlorobenzene	269	11	258	2.7	350	95.10909091	10 U	98 U
2,2'-Oxybis (1-chloropropane)	55	0	55	NA	NA	NA	19 U	98 U
2,3,4,5-Tetrachlorophenol	307	7	300	0.76	9.6	2.871428571	0.26 U	98 U
2,3,4,6-Tetrachlorophenol	47	0	47	NA	NA	NA	100 U	98 U
2,3,5,6-Tetrachlorophenol	165	6	159	0.5	13	3.231666667	0.21 U	98 U
2,4,5-Trichlorophenol	323	4	319	2.8	48	20.2	0.31 U	99 U
2,4,6-Trichlorophenol	317	19	298	0.95	72	14.26473684	0.34 U	99 U
2,4-Dichlorophenol	384	6	378	13	120	47	1 U	900 U
2,4-Dimethylphenol	388	1	387	290	290	290	11 U	98 U
2,4-Dinitrophenol	383	0	383	NA	NA	NA	100 U	980 U
2,4-Dinitrotoluene	384	0	384	NA	NA	NA	1.5 U	99 U
2,6-Dinitrotoluene	384	0	384	NA	NA	NA	10 U	99 U
2-Chloronaphthalene	384	0	384	NA	NA	NA	1.24 U	98 U
2-Chlorophenol	384	1	383	54	54	54	1.9 U	98 U
2-Methylphenol (o-Cresol)	388	2	386	69	179	124	1.5 U	98 U
2-Nitroaniline	384	0	384	NA	NA	NA	10 U	99 U
2-Nitrophenol	384	0	384	NA	NA	NA	1.5 U	99 U
3,3'-Dichlorobenzidine	384	0	384	NA	NA	NA	10 U	99 U
3-Methylphenol & 4-Methylphenol (m&p-Cresol)	13	0	13	NA	NA	NA	12000 U	869 U
3-Nitroaniline	384	0	384	NA	NA	NA	11 U	99 U
4-Bromophenyl-phenyl ether	384	0	384	NA	NA	NA	1.5 U	98 U
4-Chloro-3-methylphenol	384	1	383	3.2	3.2	3.2	1.4 U	98 U
4-Chloroaniline	384	0	384	NA	NA	NA	1.9 U	98 U
4-Chlorophenyl phenyl ether	384	0	384	NA	NA	NA	1.4 U	99 U
4-Methylphenol (p-Cresol)	383	144	239	2.3	1000	129.9895833	1.5 U	98 U
4-Nitroaniline	384	1	383	39	39	39	1.8 U	99 U
4-Nitrophenol	384	0	384	NA	NA	NA	0.0895 U	99 U
Aniline	338	5	333	8.5	17	12.7	1.5 U	98 U
Azobenzene	307	0	307	NA	NA	NA	1.1 U	98 U
Benzoic acid	386	12	374	50	280	148.3333333	100 U	9900 U
Benzyl alcohol	386	28	358	2.5	244	21.77142857	10 U	99 U
Biphenyl (1,1'-Biphenyl)	16	16	0	5	512492	32069.875	NA	NA
bis(2-Chloroethoxy)methane	384	2	382	29	30	29.5	1.4 U	98 U
bis(2-Chloroethyl)ether	384	2	382	7.3	14	10.65	1.9 U	98 U

Table 2.9.3-1
Surface Sediment Quality Summary Statistics

Compound	Number of Samples	Number of Detections	Number of Non-detections	Minimum Detected Concentration	Maximum Detected Concentration	Average Detected Concentration	Minimum Detection Limit	Maximum Detection Limit
bis(2-Chloroisopropyl) ether	329	0	329	NA	NA	NA	1.3 U	99 U
Bis(2-ethylhexyl) phthalate	397	192	205	7.3	3200	188.3235602	100 U	98 U
Butylbenzyl phthalate	389	60	329	3	430	28.14833333	1.6 U	98 U
Carbazole	392	306	86	1.7	56000	836.7183007	1.3 U	87.4 U
Dibenzofuran	412	350	62	0.27	99303	821.0686	0.24 U	87.4 U
Dibenzothiophene	54	51	3	0.28	391684	8097.871569	0.21 U	0.41 U
Diethyl phthalate	397	42	355	1.6	243	14.4952381	10 U	99 U
Dimethyl phthalate	389	7	382	1	49	14.74285714	1 U	98 U
Di-n-butyl phthalate	389	98	291	3.7	1500	35.54183673	10 U	99 U
Dinitro-o-cresol (4,6-Dinitro-2-methylphenol)	384	0	384	NA	NA	NA	1.4 U	980 U
Di-n-octyl phthalate	389	6	383	4	5510	990.8833333	1.3 U	99 U
Hexachlorobenzene	360	141	219	0.056	16.8	1.686092199	0.016 U	98 U
Hexachlorobutadiene	54	0	54	NA	NA	NA	110 U	96 U
Hexachlorocyclopentadiene	384	0	384	NA	NA	NA	100 U	99 U
Hexachloroethane	370	34	336	0.29	11	2.336764706	0.0431 U	98 U
Isophorone	384	0	384	NA	NA	NA	1 U	98 U
Nitrobenzene	384	0	384	NA	NA	NA	10 U	98 U
N-Nitrosodimethylamine	320	0	320	NA	NA	NA	10 U	98.4 U
N-Nitrosodi-N-propylamine	384	1	383	3	3	3	10 U	97 U
N-Nitrosodiphenylamine	388	6	382	2.7	310	57.63333333	1.6 U	98 U
Pentachlorophenol	359	61	298	1.2	420	30.65508197	0.167 U	99 U
Phenol	396	88	308	2.2	96	14.26136364	10 U	96 U
Total Petroleum Hydrocarbons (mg/kg)								
C10-C12 Aliphatic	56	54	2	0.0013	571.373	11.62774444	3 U	3.5 U
C10-C12 Aromatic	2	0	2	NA	NA	NA	3 U	3.5 U
C12-C16 Aliphatic	56	56	0	0.0017	216.546	5.058323214	NA	NA
C12-C16 Aromatic	56	55	1	0.0021	74.962	2.062787273	0.00075 U	0.00075 U
C16-C21 Aliphatic	56	52	4	0.0058	49	2.203653846	0.00075 U	0.00075 U
C16-C21 Aromatic	2	2	0	37	100	68.5	NA	NA
C21-C34 Aliphatic	2	2	0	100	180	140	NA	NA
C21-C34 Aromatic	2	2	0	54	92	73	NA	NA
C8-C10 Aliphatics	2	0	2	NA	NA	NA	3 U	3.5 U
C8-C10 Aromatics	2	0	2	NA	NA	NA	3 U	3.5 U
Diesel Range Hydrocarbons	310	294	16	3.07	39000	948.9764966	10 U	99 U
Gasoline Range Hydrocarbons	193	66	127	1.8	7300	379.8742424	1.4 U	9.9 U
Lube oil	31	31	0	7.96	482	155.1277419	NA	NA
Motor Oil Range	17	17	0	110	12000	2853.823529	NA	NA
Residual Range Hydrocarbons	262	253	9	7.1	18000	909.6268775	120 U	47 U
Total petroleum hydrocarbons	247	243	4	3.07	58600	1567.618272	14 U	450 U
Total Petroleum Hydrocarbons (U = 0)	275	269	6	10.4	117200	3600.228959	130 U	450 U
Volatile Organics (µg/kg)								
1,1,1,2-Tetrachloroethane	141	0	141	NA	NA	NA	0.04 U	6.6 U
1,1,1-Trichloroethane	141	0	141	NA	NA	NA	0.076 U	6.6 U

Table 2.9.3-1
Surface Sediment Quality Summary Statistics

Compound	Number of Samples	Number of Detections	Number of Non-detections	Minimum Detected Concentration	Maximum Detected Concentration	Average Detected Concentration	Minimum Detection Limit	Maximum Detection Limit
1,1,2,2-Tetrachloroethane	141	1	140	3.4	3.4	3.4	0.13 U	7.7 U
1,1,2-Trichloroethane	141	0	141	NA	NA	NA	0.076 U	6.6 U
1,1'-Dichloroethane	141	0	141	NA	NA	NA	0.073 U	6.6 U
1,1'-Dichloroethene	141	0	141	NA	NA	NA	0.08 U	6.6 U
1,2,3-Trichloropropane	141	2	139	0.5	0.86	0.68	0.15 U	7 U
1,2,4-Trichlorobenzene	21	2	19	1.1	1.5	1.3	0.49 U	2.6 U
1,2,4-Trimethylbenzene	8	4	4	147	526	263.5	13.1 U	48.1 U
1,2-Dibromoethane (Ethylene dibromide)	141	0	141	NA	NA	NA	0.066 U	980 U
1,2-Dichlorobenzene	30	3	27	0.16	0.75	0.55	0.11 U	48.1 U
1,2-Dichloroethane	141	3	138	0.35	32	10.90333333	0.04 U	6.6 U
1,2-Dichloroethene, cis-	35	2	33	0.21	0.27	0.24	0.084 U	6.6 U
1,2-Dichloroethene, trans-	141	1	140	0.48	0.48	0.48	0.12 U	6.6 U
1,2-Dichloropropane	141	0	141	NA	NA	NA	0.045 U	6.6 U
1,3,5-Trimethylbenzene (Mesitylene)	8	3	5	34.3	110	75.3	13.1 U	48.1 U
1,3-Dichlorobenzene	24	1	23	98	98	98	0.15 U	2.3 U
1,3-Dichloropropene, cis-	141	0	141	NA	NA	NA	0.04 U	9.2 U
1,3-Dichloropropene, trans-	141	0	141	NA	NA	NA	0.057 U	6.6 U
1,4-Dichlorobenzene	137	2	135	0.38	0.88	0.63	0.14 U	48.1 U
2,3,4,6 and 2,3,5,6-Tetrachlorophenol coelution	173	4	169	1	13	5.575	0.39 U	9.4 U
2-Butanone (MEK)	141	25	116	2.1	15	4.710416667	10 U	9800 U
2-Chloroethylvinyl ether	141	0	141	NA	NA	NA	0.2 U	9.9 U
2-Hexanone (Methyl butyl ketone)	141	0	141	NA	NA	NA	0.82 U	9800 U
4-Isopropyltoluene (4-Cymene)	8	2	6	27.7	37.7	32.7	13.1 U	48.1 U
Acetone	149	16	133	12	72	27	11 U	9800 U
Acrolein	141	0	141	NA	NA	NA	0.7 U	9900 U
Acrylonitrile	141	0	141	NA	NA	NA	0.3 U	9800 U
Benzene	184	67	117	0.075	140000	4572.505284	0.01 U	61 U
Benzo(j,k)fluoranthene	16	16	0	144	374183	24198.75	NA	NA
Bromochloromethane	141	0	141	NA	NA	NA	0.077 U	6.6 U
Bromodichloromethane	141	0	141	NA	NA	NA	0.087 U	6.6 U
Bromoform	141	0	141	NA	NA	NA	0.059 U	6.6 U
Bromomethane	141	0	141	NA	NA	NA	0.48 U	9.2 U
BTEX	113	47	66	0.075	7097	235.2566809	0.02 U	0.43 U
BTEX (U = 0)	184	95	89	0.075	260200	7283.401516	0.02 U	61 U
Carbon disulfide	141	13	128	0.11	1.4	0.546923077	0.17 U	6.6 U
Carbon tetrachloride (Tetrachloromethane)	141	0	141	NA	NA	NA	0.11 U	6.6 U
Chlorobenzene	141	24	117	0.14	710	30.13125	0.072 U	6.6 U
Chloroethane	141	0	141	NA	NA	NA	0.34 U	9.2 U
Chloroform	141	3	138	0.13	0.15	0.14	0.072 U	6.6 U
Chloromethane	141	0	141	NA	NA	NA	0.16 U	9.2 U
Dibromochloromethane	141	0	141	NA	NA	NA	0.087 U	6.6 U
Dibromomethane	141	0	141	NA	NA	NA	0.11 U	6.6 U
Dichlorodifluoromethane	141	8	133	0.2	5	1.70625	0.093 U	6.6 U

Table 2.9.3-1
Surface Sediment Quality Summary Statistics

Compound	Number of Samples	Number of Detections	Number of Non-detections	Minimum Detected Concentration	Maximum Detected Concentration	Average Detected Concentration	Minimum Detection Limit	Maximum Detection Limit
Dichloromethane (Methylene chloride)	149	12	137	0.46	210	63.58833333	0.4 U	980 U
Ethylbenzene	184	62	122	0.11	38000	1665.346452	0.009 U	7.3 U
Hexachlorobutadiene	306	18	288	0.119	35	2.927222222	0.00531 U	91 U
Iodomethane (Methyl iodide)	141	0	141	NA	NA	NA	0.86 U	9.2 U
Isopropylbenzene (Cumene)	149	59	90	0.094	340	21.12888136	0.057 U	6 U
m,p-Xylene	184	57	127	0.08	36000	2024.117719	0.02 U	7.3 U
Methyl isobutyl ketone (4-Methyl-2-pentanone or (MIBK))	141	1	140	0.33	0.33	0.33	0.31 U	9800 U
Methyl tert-butyl ether (MTBE)	141	7	134	0.13	0.69	0.28	0.052 U	9.6 U
Naphthalene	40	24	16	0.89	100000	8306.912083	0.47 U	8.74 U
n-Butylbenzene	8	2	6	21.6	22.3	21.95	13.1 U	48.1 U
n-Propylbenzene	8	3	5	25.3	52.7	40.43333333	13.1 U	48.1 U
o-Xylene	184	73	111	0.13	17000	777.6931507	0.008 U	81 U
sec-Butylbenzene	8	1	7	29	29	29	13.1 U	48.1 U
Styrene	149	5	144	0.21	1.2	0.65	0.094 U	6.6 U
Tetrachloroethene (PCE)	141	0	141	NA	NA	NA	0.11 U	6.6 U
Toluene	184	30	154	0.08	61000	3648.213333	0.02 U	81 U
Total Xylene	113	38	75	0.14	270	18.97631579	0.02 U	0.43 U
Total Xylene (U = 0)	184	75	109	0.14	52000	2295.284133	0.02 U	63 U
trans-1,4-Dichloro-2-butene	141	0	141	NA	NA	NA	0.58 U	9.6 U
Trichloroethene (TCE)	149	5	144	0.11	0.91	0.352	0.082 U	6.6 U
Trichlorofluoromethane (Fluorotrichloromethane)	141	0	141	NA	NA	NA	0.11 U	6.6 U
Vinyl acetate	141	0	141	NA	NA	NA	0.57 U	7.5 U
Vinyl chloride	149	2	147	0.34	0.57	0.455	0.11 U	9.2 U

Notes:

µg/kg micrograms per kilogram dry weight
mg/kg milligrams per kilogram dry weight
ng/kg nanograms per kilogram dry weight
pct percentage
su standard units
U = 0 denotes that nondetected concentration treated as zero in total calculation

Table 2.9.3-2
Subsurface Sediment Quality Summary Statistics

Compound	Number of Samples	Number of Detections	Number of Nondetections	Minimum Detected Concentration	Maximum Detected Concentration	Average Detected Concentration	Minimum Detection Limit	Maximum Detection Limit
Polycyclic Aromatic Hydrocarbons (PAH) (µg/kg)								
1-Methylnaphthalene	37	27	10	0.5	1300000	55247.12444	0.31	0.31
2-Methylnaphthalene	525	430	95	0.39	3800000	61461.44619	0.39	340
Acenaphthene	554	486	68	0.19	3900000	61929.26642	0.18	340
Acenaphthylene	554	440	114	0.2	1500000	13574.11418	0.24	340
Anthracene	554	468	86	0.3	1310000	31951.16748	0.24	340
Benzo(a)anthracene	554	480	74	0.21	772000	20832.70838	0.18	340
Benzo(a)pyrene	554	485	69	0.25	1010000	25183.93678	0.14	340
Benzo(b)fluoranthene	554	463	91	0.42	850000	20064.24551	0.25	340
Benzo(b,k)fluoranthene	59	56	3	4	620000	38906.51786	3	3
Benzo(e)pyrene	22	11	11	2.7	340000	40036.25455	0.18	0.96
Benzo(g,h,i)perylene	554	484	70	0.34	730000	18098.50116	0.26	11.9
Benzo(k)fluoranthene	554	455	99	0.22	540000	10628.45499	0.15	340
C1-Chrysene	22	12	10	0.61	210000	24599.25917	0.25	0.25
C1-Dibenzothiophene	22	10	12	3.7	68000	8412.37	0.21	0.21
C1-Fluoranthenes/Pyrenes	22	13	9	0.84	510000	53861.76462	0.61	0.61
C1-Fluorenes	22	12	10	0.52	150000	16730.16	0.5	0.5
C2-Chrysenes	22	10	12	4.3	97000	13983.43	0.25	0.25
C2-Dibenzothiophene	22	10	12	5.1	140000	20673.41	0.21	0.21
C2-Fluoranthenes/Pyrenes	22	11	11	1.7	210000	27135.88182	0.61	0.61
C2-Fluorenes	22	11	11	0.88	180000	22546.84364	0.5	0.55
C2-Naphthalenes	22	15	7	0.47	1300000	102599.8287	0.37	0.37
C3-Chrysenes	22	10	12	3.5	46000	6859.05	0.25	0.25
C3-Dibenzothiophene	22	9	13	3.9	87000	10336.87778	0.21	26
C3-Fluoranthenes/Pyrenes	22	10	12	6.3	89000	13507.93	0.61	0.61
C3-Fluorenes	22	10	12	5.8	170000	24799.58	0.5	0.5
C3-Naphthalenes	22	12	10	0.55	570000	60054.10167	0.37	0.37
C4-Chrysenes	22	6	16	14	6900	1172.5	0.25	270
C4-Naphthalenes	22	10	12	9.7	290000	36420.27	0.37	0.37
Chrysene	554	472	82	0.51	980000	25183.32498	0.25	340
Dibenzo(a,h)anthracene	554	426	128	0.29	88000	2423.289812	0.28	340
Fluoranthene	554	501	53	0.48	3500000	79340.8017	0.38	340
Fluorene	554	472	82	0.23	1500000	31432.80449	0.21	340
Indeno(1,2,3-c,d)pyrene	554	471	83	0.29	610000	16653.87314	0.16	340
LWG RI High Molecular Weight PAH (Reported, not calculated)	425	404	21	0.48	13400000	317844.1827	0.53	340
LWG RI Low Molecular Weight PAH (Reported, not calculated)	425	413	12	0.23	39900000	663932.6896	0.75	340
LWG RI Total BaPEq (Reported, not calculated)	425	397	28	0.038	1210000	32258.52846	0.28	340
LWG RI Total cPAHs (Reported, not calculated)	425	397	28	0.38	4500000	117196.348	0.48	340
LWG RI Total PAH (Reported, not calculated)	425	416	9	0.39	53300000	966194.6719	0.75	340
Naphthalene	498	413	85	0.39	20000000	242495.7365	0.37	340
Perylene	22	15	7	0.35	140000	11987.67	0.32	0.32
Phenanthrene	554	511	43	0.41	8500000	163810.4554	0.37	340
Pyrene	554	506	48	0.49	4700000	98456.41972	0.37	340

Table 2.9.3-2
Subsurface Sediment Quality Summary Statistics

Compound	Number of Samples	Number of Detections	Number of Nondetections	Minimum Detected Concentration	Maximum Detected Concentration	Average Detected Concentration	Minimum Detection Limit	Maximum Detection Limit
Total 10 HPAH (U = 0)	554	518	36	0.48	13407000	300059.4435	0.53	340
Total 16 PAH (U = 0)	554	534	20	0.39	49547000	758704.7517	0.75	340
Total 17 PAH (U = 0)	554	536	18	0.39	53347000	805180.521	0.75	340
Total 6 LPAH (U = 0)	554	527	27	0.23	36140000	473847.3353	0.44	340
Total Benzofluoranthenes (U = 0)	554	469	85	0.26	1128000	30118.74774	0.25	340
Total cPAH TEF (7 minimum) (U = 0)	554	493	61	0.033	1262430	31710.43301	0.48	340
Conventional Parameters								
Acid volatile sulfide (mg/kg)	4	2	2	19	34	26.5	0.7	0.7
Ammonia (mg/kg)	94	94	0	3.2	703	128.0828723	NULL	NULL
Cyanide (mg/kg)	150	110	40	0.03	26.9	1.191454545	0.05	0.3
Nitrate as Nitrogen (mg/kg)	2	2	0	0.37	0.5	0.435	NULL	NULL
Sulfate (mg/kg)	30	30	0	2.34	1590	88.24533333	NULL	NULL
Sulfide (mg/kg)	122	94	28	0.43	438	32.88031915	0.4	0.8
Specific gravity (none)	320	320	0	1.36	2.74	1.7925625	NULL	NULL
Liquid Limit (pct)	62	13	49	27.3	48.4	34.91538462	0.1	47.6
Total organic carbon (pct)	491	462	29	0.02	35.5	2.117614069	0.05	0.13
Total solids (pct)	563	563	0	41.5	92.3	68.08063943	NULL	NULL
Total volatile solids (pct)	18	18	0	2.16	8.67	5.860555556	NULL	NULL
pH (su)	28	28	0	6.01	7.19	6.785	NULL	NULL
Specific gravity (Ssu)	3	3	0	1.73	1.81	1.756666667	NULL	NULL
Dioxin Furans (ng/kg)								
1,2,3,4,5,6,7,8-Octachlorodibenzofuran (OCDF)	79	58	21	0.014	899	63.7317931	0.0129	10.163
1,2,3,4,6,7,8,9-Octachlorodibenzo-p-dioxin (OCDD)	79	62	17	0.727	28100	937.1698226	0.365	24.056
1,2,3,4,6,7,8-Heptachlorodibenzofuran (HpCDF)	79	60	19	0.01	168.317	26.30393333	0.00983	0.599
1,2,3,4,6,7,8-Heptachlorodibenzo-p-dioxin (HpCDD)	79	65	14	0.053	5460	134.6835385	0.117	2.835
1,2,3,4,7,8,9-Heptachlorodibenzofuran (HpCDF)	79	49	30	0.02	62.976	5.949959184	0.007	0.816
1,2,3,4,7,8-Hexachlorodibenzofuran (HxCDF)	78	59	19	0.014	330.269	23.94901695	0.00399	1.053
1,2,3,4,7,8-Hexachlorodibenzo-p-dioxin (HxCDD)	79	41	38	0.017	10.4	0.839378049	0.003	1.9
1,2,3,6,7,8-Hexachlorodibenzofuran (HxCDF)	79	55	24	0.042	97.019	8.141309091	0.003	65
1,2,3,6,7,8-Hexachlorodibenzo-p-dioxin (HxCDD)	78	57	21	0.008	142	5.647	0.004	3.1
1,2,3,7,8,9-Hexachlorodibenzofuran (HxCDF)	79	24	55	0.0155	22	2.938645833	0.003	0.576
1,2,3,7,8,9-Hexachlorodibenzo-p-dioxin (HxCDD)	79	52	27	0.013	39.7	2.071153846	0.004	1.4
1,2,3,7,8-Pentachlorodibenzofuran (PeCDF)	79	54	25	0.041	243.423	18.53353704	0.003	60.592
1,2,3,7,8-Pentachlorodibenzo-p-dioxin (PeCDD)	79	40	39	0.023	58.293	3.04545	0.004	1.8
2,3,4,6,7,8-Hexachlorodibenzofuran (HxCDF)	79	53	26	0.021	27.563	2.755981132	0.003	0.913
2,3,4,7,8-Pentachlorodibenzofuran (PeCDF)	79	56	23	0.024	88.395	9.235998214	0.003	0.335
2,3,7,8-Tetrachlorodibenzofuran (TCDF)	78	48	30	0.095	203.81	22.29164583	0.00322	0.288
2,3,7,8-Tetrachlorodibenzo-p-dioxin (TCDD)	79	26	53	0.054	42.212	3.128769231	0.002	0.76
LWG RI Total Dioxin/Furan TEQ (Reported, not calculated) (U = 0)	79	71	8	0.00053	178	12.30765915	0.0044	0.026
LWG RI Total PCDD/F (Reported, not calculated)	78	78	0	0.13	65700	1608.972603	NULL	NULL
LWG RI Total TCDD toxicity equivalent (Reported, not calculated) (U = 0)	94	87	7	6.96E-05	178	11.51041193	0.007	0.15
Total Dioxin/Furan (U = 0)	79	71	8	0.052	34953.52	1095.179308	0.736	10.026
Total Dioxin/Furan TEQ (Bird) (U = 0)	79	71	8	5.30E-05	436.7288089	30.24703848	0.736	10.026

Table 2.9.3-2
Subsurface Sediment Quality Summary Statistics

Compound	Number of Samples	Number of Detections	Number of Nondetections	Minimum Detected Concentration	Maximum Detected Concentration	Average Detected Concentration	Minimum Detection Limit	Maximum Detection Limit
Total Dioxin/Furan TEQ (Fish) (U = 0)	79	71	8	5.30E-05	187.7367789	11.66458743	0.736	10.026
Total Dioxin/Furan TEQ (International) (U = 0)	79	71	8	0.00053	171.768871	13.8051417	0.736	10.026
Total Dioxin/Furan TEQ (Mammal) (U = 0)	79	71	8	0.00053	177.9883557	12.31369904	0.736	10.026
Total Dioxin/Furan TEQ 1998 (Bird) (U = 0)	79	71	8	5.30E-05	436.7288089	30.24703848	0.736	10.026
Total Dioxin/Furan TEQ 1998 (Fish) (U = 0)	79	71	8	5.30E-05	187.7367789	11.66458743	0.736	10.026
Total Dioxin/Furan TEQ 1998 (Mammal) (U = 0)	79	71	8	0.00053	200.4394319	13.87847658	0.736	10.026
Total Heptachlorodibenzofuran (HpCDF)	77	69	8	0.018	1420	74.84355072	0.00983	0.052
Total Heptachlorodibenzo-p-dioxin (HpCDD)	77	74	3	0.141	30500	511.4823243	0.081	0.486
Total Hexachlorodibenzofuran (HxCDF)	78	70	8	0.014	592.373	58.38965714	0.00399	0.034
Total Hexachlorodibenzo-p-dioxin (HxCDD)	77	74	3	0.02	4280	73.76736486	0.013	0.056
Total Pentachlorodibenzofuran (PeCDF)	78	66	12	0.01	1625.977	73.74713636	0.003	0.041
Total Pentachlorodibenzo-p-dioxin (PeCDD)	78	56	22	0.023	288	10.55298214	0.004	1.6
Total Tetrachlorodibenzofuran (TCDF)	77	60	17	0.05	3614.17	100.4873267	0.00322	60.9
Total Tetrachlorodibenzo-p-dioxin (TCDD)	77	61	16	0.015	185.67	5.800509836	0.00219	17.9
Herbicides (µg/kg)								
2,2-Dichloropropionic acid (Dalapon)	92	3	89	6.9	16	11.63333333	0.28	300
2,4,5-T (2,4,5-Trichlorophenoxyacetic acid)	92	0	92	NULL	NULL	NULL	0.46	300
2,4,5-TP (Silvex)	97	1	96	2.25	2.25	2.25	0.46	300
2,4-D (2,4-Dichlorophenoxyacetic acid)	97	5	92	7.14	473	128.268	0.32	300
2,4-DB (2,4-D derivative)	92	2	90	49	797	423	0.47	300
Dicamba	92	1	91	3	3	3	1	300
Dichlorprop	92	0	92	NULL	NULL	NULL	0.51	300
Dinoseb	92	0	92	NULL	NULL	NULL	0.64	300
MCPA	92	3	89	1.58	144	52.56	0.67	60000
Mecoprop (MCPP)	92	3	89	1.62	3000	1012.94	0.61	60000
Metals (mg/kg)								
Aluminum	356	356	0	4020	43100	20286.17978	NULL	NULL
Antimony	361	223	138	0.02	14.3	0.499345291	0.03	8
Arsenic	438	422	16	0.5	24.6	3.384028436	4	10
Barium	66	66	0	77.5	220	141.3469697	NULL	NULL
Beryllium	64	64	0	0.279	0.782	0.487171875	NULL	NULL
Cadmium	388	372	16	0.011	7.03	0.290262097	0.069	0.5
Calcium	64	64	0	2810	12500	5553.28125	NULL	NULL
Chromium	436	436	0	3.42	249	25.98855505	NULL	NULL
Chromium VI	5	0	5	NULL	NULL	NULL	1	1.2
Cobalt	9	9	0	16.6	24.6	18.86666667	NULL	NULL
Copper	433	433	0	4.91	801	37.12893764	NULL	NULL
Iron	81	81	0	9410	53900	29728.51852	NULL	NULL
Lead	438	438	0	1.12	3330	32.03438356	NULL	NULL
Magnesium	64	64	0	2310	7560	5213.59375	NULL	NULL
Manganese	64	64	0	206	960	436.078125	NULL	NULL
Mercury	380	361	19	0.004	4.14	0.197880055	0.006	0.122
Nickel	430	430	0	4.18	523	23.57548837	NULL	NULL

Table 2.9.3-2
Subsurface Sediment Quality Summary Statistics

Compound	Number of Samples	Number of Detections	Number of Nondetections	Minimum Detected Concentration	Maximum Detected Concentration	Average Detected Concentration	Minimum Detection Limit	Maximum Detection Limit
Potassium	64	54	10	383	1400	801.1296296	420	1110
Selenium	328	122	206	0.02	14	0.782622951	0.02	9
Silver	385	369	16	0.016	1.6	0.28895393	0.021	0.6
Sodium	64	64	0	167	1230	610.65625	NULL	NULL
Thallium	64	58	6	0.041	9	0.5055	4	8
Titanium	7	7	0	1790	2850	2044.285714	NULL	NULL
Total Metal (U = 0)	456	450	6	0.017	109253.29	23454.40353	0.02	1.2
Vanadium	9	9	0	94.6	136	104.6888889	NULL	NULL
Zinc	433	433	0	16.3	891	108.4316397	NULL	NULL
Organometallic Compounds (µg/kg)								
Butyltin	5	5	0	0.47	1.4	0.84	NULL	NULL
Butyltin (ion)	82	40	42	0.12	39	4.5685	0.041	8.6
Dibutyltin (ion)	82	51	31	0.059	180	15.40596078	0.052	12
Di-n-Butyltin - synonym with Dibutyltin	5	5	0	0.91	2.4	1.842	NULL	NULL
Tetrabutyltin	87	14	73	0.47	8.6	2.476428571	0.094	21
Tributyltin (ion)	87	44	43	0.36	1000	87.52545455	0.2	6
PCB Aroclors (µg/kg)								
Aroclor 1016	342	0	342	NULL	NULL	NULL	0.73	846
Aroclor 1221	342	0	342	NULL	NULL	NULL	0.73	846
Aroclor 1232	342	0	342	NULL	NULL	NULL	0.73	846
Aroclor 1242	342	11	331	3.6	111	35.54545455	0.73	846
Aroclor 1248	342	76	266	1.9	202	44.91315789	0.73	846
Aroclor 1254	342	101	241	1.84	545	69.47217822	0.662	846
Aroclor 1260	342	144	198	2.03	290	51.05583333	0.73	846
Aroclor 1262	313	0	313	NULL	NULL	NULL	0.73	846
Aroclor 1268	313	16	297	1.64	474	81.5525	0.73	846
Aroclors	307	151	156	1.84	1110	129.0221854	0.73	846
Sum of Aroclor 1254 and 1260 (U = 0)	342	149	193	1.84	694	96.43442953	0.73	846
Total PCB Aroclors (U = 0)	342	151	191	1.84	1105	128.9931788	0.73	846
PCB Congeners (ng/kg)								
Dichlorobiphenyls (total)	24	19	5	36	17800	1882.721053	9.53	517
Heptachlorobiphenyls (total)	24	21	3	1040	275000	44529.52381	4.76	4.97
Hexachlorobiphenyls (total)	24	21	3	1680	811000	83805.71429	4.76	4.97
LWG RI Dioxin-like PCB congener TEQ (Reported, not calculated) (U = 0)	27	26	1	6.96E-05	59	4.901732212	0.15	0.15
LWG RI Total PCB Congeners (Reported, not calculated)	27	26	1	2.32	2830000	242728.5696	9.83	9.83
Monochlorobiphenyls (total)	24	20	4	35.3	10200	734.705	4.76	4.97
Nonachlorobiphenyls (total)	24	20	4	45.3	115000	7395.765	4.76	152
Octachlorobiphenyls (total)	24	21	3	288	59800	11312.47619	4.76	4.97
PCB-001	27	23	4	7.34	6220	337.4191304	4.76	4.97
PCB-002	27	21	6	5.88	653	93.14714286	4.76	12.5
PCB-003	27	23	4	14.2	3510	240.6826087	4.76	4.97
PCB-004/010	27	16	11	10.1	2960	299.175	9.53	624
PCB-005/008	27	22	5	17.5	7020	678.3181818	9.53	517

Table 2.9.3-2
Subsurface Sediment Quality Summary Statistics

Compound	Number of Samples	Number of Detections	Number of Nondetections	Minimum Detected Concentration	Maximum Detected Concentration	Average Detected Concentration	Minimum Detection Limit	Maximum Detection Limit
PCB-006	27	14	13	13	1860	243.4142857	9.53	624
PCB-007/009	27	8	19	18.4	1570	249.4375	9.53	624
PCB-011	27	9	18	14.4	485	139.9666667	9.53	624
PCB-012/013	27	13	14	15.1	937	131.0538462	9.53	624
PCB-014	27	0	27	NULL	NULL	NULL	5.07	624
PCB-015	27	20	7	14.4	3470	425.95	9.53	624
PCB-016/032	27	22	5	58.2	3080	783.3909091	4.76	259
PCB-017	27	22	5	31.8	2180	587.8227273	4.76	259
PCB-018	27	22	5	53.1	5120	1058.504545	4.76	259
PCB-019	27	20	7	8.07	463	118.0185	4.76	312
PCB-020/021/033	27	23	4	43.7	3780	913.2913043	4.76	259
PCB-022	27	22	5	17.8	1980	530.1045455	4.76	259
PCB-023	27	1	26	6.81	6.81	6.81	2.54	312
PCB-024/027	27	20	7	9.13	368	90.2115	4.76	312
PCB-025	27	21	6	14.7	2120	263.6761905	4.76	312
PCB-026	27	22	5	26.9	3480	411.1636364	4.76	259
PCB-028	27	23	4	126	6950	1948.521739	4.76	259
PCB-029	27	9	18	2.75	44.4	13.97222222	4.76	312
PCB-030	27	0	27	NULL	NULL	NULL	2.54	312
PCB-031	27	22	5	77.5	7040	1725.340909	4.76	259
PCB-034	27	17	10	5.98	89.4	33.52764706	4.76	312
PCB-035	27	18	9	4.93	156	41.80722222	4.76	312
PCB-036	27	1	26	3.43	3.43	3.43	2.54	312
PCB-037	27	22	5	29.8	1540	485.5727273	4.76	259
PCB-038	27	17	10	4.66	116	35.56058824	4.76	312
PCB-039	27	13	14	4.71	45.3	19.99153846	4.76	312
PCB-040	27	22	5	19.2	3230	498.9863636	4.76	259
PCB-041/064/071/072	27	23	4	168	22900	2933.608696	4.76	259
PCB-042/059	27	23	4	45.4	5980	970.7826087	4.76	259
PCB-043/049	27	23	4	255	43700	4325.869565	4.76	259
PCB-044	27	23	4	151	59500	4968.173913	4.76	259
PCB-045	27	22	5	14	1580	365.3772727	4.76	312
PCB-046	27	22	5	14.6	762	171.1772727	4.76	259
PCB-047	27	22	5	101	9750	1405	4.76	259
PCB-048/075	27	23	4	32.2	3060	584.9173913	4.76	259
PCB-050	27	13	14	4.82	42.3	16.11	4.76	312
PCB-051	27	21	6	12.1	607	166.452381	4.76	312
PCB-052/069	27	23	4	269	127000	8622.826087	4.76	259
PCB-053	27	22	5	32.4	3060	481.7136364	4.76	259
PCB-054	27	14	13	2.76	124	19.62357143	4.76	312
PCB-055	27	18	9	5.64	749	78.35	4.76	312
PCB-056/060	27	23	4	73.3	12300	1709.230435	4.76	259
PCB-057	27	16	11	8.4	274	40.1875	4.76	312

Table 2.9.3-2
Subsurface Sediment Quality Summary Statistics

Compound	Number of Samples	Number of Detections	Number of Nondetections	Minimum Detected Concentration	Maximum Detected Concentration	Average Detected Concentration	Minimum Detection Limit	Maximum Detection Limit
PCB-058	27	15	12	5.62	331	52.82066667	4.76	312
PCB-061/070	27	23	4	241	75600	6362.826087	4.76	259
PCB-062	27	0	27	NULL	NULL	NULL	2.54	312
PCB-063	27	21	6	8.06	1410	178.7052381	4.76	312
PCB-065	27	1	26	4.79	4.79	4.79	2.54	312
PCB-066/076	27	23	4	181	32300	3900.217391	4.76	259
PCB-067	27	20	7	11.5	2010	178.41	4.76	312
PCB-068	27	19	8	5.15	838	114.1215789	4.76	312
PCB-073	27	1	26	27.7	27.7	27.7	2.54	312
PCB-074	27	22	5	71.6	14700	1768.754545	4.76	259
PCB-077	27	24	3	14	1560	258.1958333	1.08	1.54
PCB-078	27	1	26	8.39	8.39	8.39	4.76	312
PCB-079	27	21	6	6.7	1440	154.66	4.76	312
PCB-080	27	0	27	NULL	NULL	NULL	2.54	312
PCB-081	27	19	8	1.17	1320	88.55315789	0.457	259
PCB-082	27	23	4	18.7	18500	1197.608696	4.76	259
PCB-083	27	0	27	NULL	NULL	NULL	2.54	312
PCB-084/092	27	23	4	158	89700	6141.652174	4.76	259
PCB-085/116	27	23	4	31.8	24700	1634.1	4.76	259
PCB-086	27	15	12	4.05	880	82.93133333	4.76	312
PCB-087/117/125	27	23	4	47.8	79400	4694.152174	4.76	259
PCB-088/091	27	23	4	54.9	23900	1726.382609	4.76	259
PCB-089	27	19	8	5.14	1130	113.8442105	4.76	312
PCB-090/101	27	24	3	337	205000	14213.66667	4.76	4.97
PCB-093	27	1	26	685	685	685	2.54	312
PCB-094	27	17	10	6.38	523	63.19882353	4.76	312
PCB-095/098/102	27	24	3	248	160000	10596.95833	4.76	4.97
PCB-096	27	18	9	6.27	924	94.67611111	4.76	312
PCB-097	27	23	4	79.1	61000	3864.678261	4.76	259
PCB-099	27	23	4	206	79700	6105.73913	4.76	259
PCB-100	27	19	8	4.92	489	100.6063158	4.76	312
PCB-103	27	21	6	14.5	1450	228.4904762	4.76	312
PCB-104	27	1	26	25.8	25.8	25.8	2.54	312
PCB-105	27	25	2	0.865	49600	2796.6986	1.01	1.27
PCB-106/118	27	26	1	1.65	162000	9467.191154	2.63	2.63
PCB-107/109	27	23	4	22.5	11300	872.8478261	4.76	259
PCB-108/112	27	22	5	16.5	9040	642.4045455	4.76	259
PCB-110	27	24	3	335	225000	14484.79167	4.76	4.97
PCB-111/115	27	20	7	11.1	3000	214.815	4.76	259
PCB-113	27	14	13	7.94	120	38.01714286	4.76	312
PCB-114	27	22	5	1.78	2790	180.8445455	0.687	259
PCB-119	27	23	4	19.2	4060	416.7521739	4.76	259
PCB-120	27	18	9	5.01	273	54.23722222	4.76	312

Table 2.9.3-2
Subsurface Sediment Quality Summary Statistics

Compound	Number of Samples	Number of Detections	Number of Nondetections	Minimum Detected Concentration	Maximum Detected Concentration	Average Detected Concentration	Minimum Detection Limit	Maximum Detection Limit
PCB-121	27	1	26	3.32	3.32	3.32	2.54	312
PCB-122	27	19	8	6.23	1320	105.8957895	4.76	312
PCB-123	27	21	6	3.74	2190	146.4290476	0.782	259
PCB-124	27	21	6	12.5	5750	398.8190476	4.76	259
PCB-126	27	21	6	1	509	54.3352381	0.696	259
PCB-127	27	1	26	48.6	48.6	48.6	2.54	312
PCB-128/162	27	23	4	23.3	35500	2319.46087	4.76	259
PCB-129	27	23	4	6.12	10200	637.64	4.76	259
PCB-130	27	22	5	27.2	13400	1108.372727	4.76	312
PCB-131	27	3	24	7.92	30.4	15.46666667	2.54	312
PCB-132/161	27	24	3	84	61400	4785.166667	4.76	4.97
PCB-133/142	27	23	4	17.7	5180	565.8565217	4.76	259
PCB-134/143	27	23	4	15.2	11300	878.5173913	4.76	259
PCB-135	27	23	4	80.6	22500	2410.982609	4.76	259
PCB-136	27	23	4	58.1	23500	2325.265217	4.76	259
PCB-137	27	22	5	6.59	11900	706.3631818	4.76	259
PCB-138/163/164	27	24	3	268	189000	16178.08333	4.76	4.97
PCB-139/149	27	24	3	364	122000	13022.625	4.76	4.97
PCB-140	27	19	8	9.15	905	187.7921053	4.76	312
PCB-141	27	24	3	35.8	33100	3143.825	4.76	4.97
PCB-144	27	21	6	34.5	6940	793.952381	4.76	312
PCB-145	27	1	26	70.9	70.9	70.9	2.54	312
PCB-146/165	27	23	4	116	23300	3110.086957	4.76	259
PCB-147	27	22	5	10	4120	324.8681818	4.76	259
PCB-148	27	18	9	4.92	562	94.34333333	4.76	312
PCB-150	27	16	11	11.6	213	61.36875	4.76	312
PCB-151	27	24	3	115	28200	3431.75	4.76	4.97
PCB-152	27	10	17	5.33	182	25.769	2.54	312
PCB-153	27	24	3	366	151000	15834	4.76	4.97
PCB-154	27	22	5	25.8	2150	441.1818182	4.76	312
PCB-155	27	2	25	5.14	8.77	6.955	2.54	312
PCB-156	27	24	3	14.7	20400	1435.8875	0.435	0.978
PCB-157	27	21	6	5.86	4560	308.0838095	0.438	45.8
PCB-158/160	27	23	4	16.8	21200	1658.613043	4.76	259
PCB-159	27	7	20	16.1	765	220.0857143	4.76	312
PCB-166	27	15	12	2.98	916	79.75933333	4.76	312
PCB-167	27	24	3	7	8060	575.7708333	0.494	1.05
PCB-168	27	15	12	4.09	210	41.856	4.76	312
PCB-169	27	6	21	0.495	22.1	4.751666667	0.472	83.6
PCB-170	27	24	3	88.2	33300	4484.633333	4.76	4.97
PCB-171	27	23	4	27.4	8890	1329.417391	4.76	259
PCB-172	27	23	4	18.9	5170	785	4.76	259
PCB-173	27	19	8	5.86	872	137.9931579	4.76	312

Table 2.9.3-2
Subsurface Sediment Quality Summary Statistics

Compound	Number of Samples	Number of Detections	Number of Nondetections	Minimum Detected Concentration	Maximum Detected Concentration	Average Detected Concentration	Minimum Detection Limit	Maximum Detection Limit
PCB-174	27	24	3	121	33600	4863.5	4.76	4.97
PCB-175	27	19	8	7.07	1340	254.1194737	4.76	312
PCB-176	27	23	4	20.9	3760	680.2086957	4.76	259
PCB-177	27	24	3	80	20000	2986.708333	4.76	4.97
PCB-178	27	23	4	37.1	5520	1053.030435	4.76	259
PCB-179	27	24	3	71.1	11700	2162.545833	4.76	4.97
PCB-181	27	15	12	7	482	85.34866667	4.76	312
PCB-182/187	27	24	3	207	36100	6058.166667	4.76	4.97
PCB-183	27	24	3	68.9	18200	2730.745833	4.76	4.97
PCB-184	27	3	24	13.6	27.1	18.36666667	2.54	312
PCB-185	27	23	4	10.9	3690	551.7826087	4.76	259
PCB-186	27	1	26	11.7	11.7	11.7	2.54	312
PCB-188	27	13	14	2.58	51.2	15.45307692	4.76	312
PCB-189	27	22	5	3.33	1190	180.4490909	0.18	99.6
PCB-190	27	23	4	19.8	7090	949.6391304	4.76	259
PCB-191	27	22	5	9.07	1260	196.9759091	4.76	259
PCB-192	27	0	27	NULL	NULL	NULL	2.54	312
PCB-193	27	23	4	15.1	3650	539.2	4.76	259
PCB-194	27	24	3	57	15000	2230.708333	4.76	4.97
PCB-195	27	23	4	24.4	8760	1120.865217	4.76	259
PCB-196/203	27	24	3	88.3	15400	2719.095833	4.76	4.97
PCB-197	27	19	8	5.32	519	114.4221053	4.76	312
PCB-198	27	20	7	8.71	1130	206.5355	4.76	312
PCB-199	27	23	4	81.5	13900	2838.108696	4.76	259
PCB-200	27	23	4	11.6	1810	335.4956522	4.76	259
PCB-201	27	20	7	11.1	1720	382.25	4.76	312
PCB-202	27	21	6	13.9	4180	651.9095238	4.76	259
PCB-204	27	1	26	19.6	19.6	19.6	2.54	312
PCB-205	27	20	7	6.14	676	122.497	4.76	312
PCB-206	27	23	4	30.8	78300	4607.947826	4.76	152
PCB-207	27	22	5	5.47	3760	288.8768182	4.76	259
PCB-208	27	21	6	9.01	32800	1913.671905	4.76	259
PCB-209	27	24	3	33	92600	5285.375	4.76	4.97
Pentachlorobiphenyls (total)	24	23	1	2.32	1220000	81673.6887	4.92	4.92
Tetrachlorobiphenyls (total)	24	21	3	61	426000	42236.2381	4.76	4.97
Total PCB Congener (U=0)	27	26	1	2.32	2769636.78	236480.0306	9.83	9.83
Total PCB Congener TEQ (Bird) (U = 0)	27	25	2	8.65E-05	266.25518	23.99266994	1.3	1.54
Total PCB Congener TEQ (Fish) (U = 0)	27	25	2	4.33E-06	3.680239	0.305653907	1.3	1.54
Total PCB Congener TEQ (Mammal) (U = 0)	27	25	2	2.60E-05	53.4203	4.757060242	1.3	1.54
Total PCB Congener TEQ 1998 (Bird) (U = 0)	27	25	2	8.65E-05	266.25518	23.99266994	1.3	1.54
Total PCB Congener TEQ 1998 (Fish) (U = 0)	27	25	2	4.33E-06	3.680239	0.305653907	1.3	1.54
Total PCB Congener TEQ 1998 (Mammal) (U = 0)	27	25	2	8.65E-05	57.9794	5.00002926	1.3	1.54
Total PCB Co-planar Congener (U = 0)	27	25	2	0.865	67220.78	4152.3278	1.3	1.54

Table 2.9.3-2
Subsurface Sediment Quality Summary Statistics

Compound	Number of Samples	Number of Detections	Number of Nondetections	Minimum Detected Concentration	Maximum Detected Concentration	Average Detected Concentration	Minimum Detection Limit	Maximum Detection Limit
Trichlorobiphenyls (total)	24	20	4	264	38500	9521.2	4.76	259
Pesticides (µg/kg)								
2,4'-DDD (o,p'-DDD)	299	186	113	0.078	1340	39.6077957	0.0277	200
2,4'-DDE (o,p'-DDE)	299	89	210	0.041	69.7	9.056426966	0.0294	570
2,4'-DDT (o,p'-DDT)	299	130	169	0.085	815	19.49484615	0.0389	250
4,4'-DDD (p,p'-DDD)	345	263	82	0.093	4750	101.3565779	0.0415	99
4,4'-DDE (p,p'-DDE)	345	192	153	0.054	500	15.10738021	0.027	340
4,4'-DDT (p,p'-DDT)	345	209	136	0.086	1060	53.88049282	0.049	99
Aldrin	345	46	299	0.119	200	16.18969565	0.0269	49
alpha-BHC	345	30	315	0.074	38	2.757666667	0.0288	49
alpha-Chlordane (cis-Chlordane)	346	71	275	0.064	61	6.209253521	0.0286	160
beta-BHC	345	144	201	0.058	318	6.7635625	0.0291	56
beta-Chlordane (trans-Chlordane)	311	72	239	0.039	46.7	2.316777778	0.0181	610
Chlordane	16	0	16	NULL	NULL	NULL	6.1	320
Chlordane (technical)	37	0	37	NULL	NULL	NULL	0.8	30
cis-Nonachlor	299	65	234	0.069	330	8.274046154	0.0359	180
delta-BHC	342	24	318	0.12	45.4	5.615833333	0.0615	49
Dieldrin	345	13	332	0.077	15.6	3.363692308	0.03	99
Endosulfan sulfate	345	9	336	0.13	3.4	0.661888889	0.058	99
Endosulfan-alpha (I)	345	8	337	0.087	35.8	4.904375	0.0248	110
Endosulfan-beta (II)	345	44	301	0.047	170	5.924863636	0.0218	99
Endrin	350	49	301	0.141	311	24.09977551	0.0367	320
Endrin aldehyde	345	28	317	0.069	166	16.98042857	0.039	99
Endrin ketone	341	46	295	0.17	263	14.1905	0.0253	220
gamma-BHC (Lindane)	350	27	323	0.1	9.6	2.563407407	0.062	160
Heptachlor	350	28	322	0.11	22	2.227428571	0.0262	160
Heptachlor epoxide	350	38	312	0.16	6.3	1.443605263	0.0341	160
LWG RI Total 2,4' and 4,4'-DDD (Reported, not calculated)	310	250	60	0.079	6090	135.706896	0.0415	99
LWG RI Total 2,4' and 4,4'-DDD, -DDE, -DDT (Reported, not calculated)	310	268	42	0.058	6650	190.4444291	0.049	99
LWG RI Total 2,4' and 4,4'-DDE (Reported, not calculated)	310	204	106	0.041	500	18.09593137	0.0389	570
LWG RI Total 2,4' and 4,4'-DDT (Reported, not calculated)	310	215	95	0.085	1880	62.66662326	0.0427	250
LWG RI Total 4,4'-DDD, -DDE, -DDT (Reported, not calculated)	278	237	41	0.08	5260	159.4421646	0.049	14
LWG RI Total Chlordanes (Reported, not calculated)	314	156	158	0.039	335	12.36589103	0.0359	610
LWG RI Total Endosulfan (Reported, not calculated)	310	53	257	0.047	170	5.677849057	0.058	110
Methoxychlor	350	24	326	0.14	513	44.04495833	0.034	1600
Mirex	296	13	283	0.16	240	43.20461538	0.0309	99
Oxychlordane	299	40	259	0.12	130	9.727275	0.0155	99
Sum 2,4 DDT, DDE, DDD (U=0)	299	221	78	0.041	1398.2	48.44978281	0.0389	570
Sum 4,4 DDT, DDE, DDD (U=0)	345	274	71	0.08	5256	148.9723358	0.049	99
Sum DDD (U=0)	345	270	75	0.079	6090	126.0141852	0.0415	99
Sum DDE (U=0)	345	210	135	0.041	500	17.6506619	0.0389	570
Sum DDT (U=0)	345	223	122	0.085	1875	61.86256951	0.0427	250
Total BHC (U = 0)	350	176	174	0.058	363.4	7.162926136	0.0657	160

Table 2.9.3-2
Subsurface Sediment Quality Summary Statistics

Compound	Number of Samples	Number of Detections	Number of Nondetections	Minimum Detected Concentration	Maximum Detected Concentration	Average Detected Concentration	Minimum Detection Limit	Maximum Detection Limit
Total Chlordane (alpha and beta) (U = 0)	346	105	241	0.039	61	5.787285714	0.0286	610
Total Chlordane (alpha and gamma) (U = 0)	346	71	275	0.064	61	6.209253521	0.0286	160
Total DDT (U = 0)	345	289	56	0.058	6654.2	178.2900415	0.049	99
Toxaphene	350	1	349	1900	1900	1900	3.4	16000
trans-Nonachlor	299	46	253	0.054	55.5	8.759804348	0.0312	100
Semivolatile Organics (µg/kg)								
1,2,4-Trichlorobenzene	320	1	319	39	39	39	1.7	3800
1,2-Dichlorobenzene	319	15	304	2.5	210	30.22666667	1.5	3300
1,3-Dichlorobenzene	319	4	315	3.3	25	11.3	1.8	4000
1,4-Dichlorobenzene	158	11	147	2.8	240	42.18181818	2.1	4800
2,2'-Oxybis (1-chloropropane)	12	0	12	NULL	NULL	NULL	19	900
2,3,4,5-Tetrachlorophenol	308	20	288	0.67	860	68.2235	0.25	83
2,3,5,6-Tetrachlorophenol	107	5	102	1.4	450	139.12	0.21	170
2,4,5-Trichlorophenol	309	18	291	0.48	200	22.14888889	0.32	36000
2,4,6-Trichlorophenol	304	14	290	1.3	340	39.67857143	0.31	36000
2,4-Dichlorophenol	334	7	327	7.1	140	48.3	1	10000
2,4-Dimethylphenol	337	0	337	NULL	NULL	NULL	5.5	50000
2,4-Dinitrophenol	398	1	397	678	678	678	17	100000
2,4-Dinitrotoluene	338	1	337	2100	2100	2100	1.5	36000
2,6-Dinitrotoluene	334	0	334	NULL	NULL	NULL	2	7000
2-Chloronaphthalene	342	0	342	NULL	NULL	NULL	1.6	9000
2-Chlorophenol	334	2	332	6	8.9	7.45	1.9	5000
2-Methylphenol (o-Cresol)	341	1	340	10	10	10	1.5	12000
2-Nitroaniline	334	0	334	NULL	NULL	NULL	3	10000
2-Nitrophenol	334	0	334	NULL	NULL	NULL	1.5	10000
3,3'-Dichlorobenzidine	334	0	334	NULL	NULL	NULL	3.7	50000
3-Methylphenol & 4-Methylphenol (m&p-Cresol)	67	1	66	466	466	466	290	12000
3-Nitroaniline	334	0	334	NULL	NULL	NULL	2.5	12000
4-Bromophenyl-phenyl ether	334	0	334	NULL	NULL	NULL	1.6	5000
4-Chloro-3-methylphenol	334	0	334	NULL	NULL	NULL	1.4	10000
4-Chloroaniline	334	2	332	4.6	10	7.3	1.9	10000
4-Chlorophenyl phenyl ether	334	0	334	NULL	NULL	NULL	1.4	5000
4-Methylphenol (p-Cresol)	338	134	204	5.2	800	69.79104478	1.5	7300
4-Nitroaniline	334	0	334	NULL	NULL	NULL	1.8	10000
4-Nitrophenol	334	2	332	5.2	600	302.6	0.37	75000
Aniline	312	11	301	2.6	170	31.43636364	1.5	3800
Azobenzene	309	0	309	NULL	NULL	NULL	1.1	6000
Benzoic acid	334	15	319	50	1400	464.6666667	96	240000
Benzyl alcohol	334	19	315	2.2	3700	202.4157895	2.1	9300
bis(2-Chloroethoxy)methane	334	0	334	NULL	NULL	NULL	1.5	10000
bis(2-Chloroethyl)ether	334	0	334	NULL	NULL	NULL	1.9	6000
bis(2-Chloroisopropyl) ether	322	0	322	NULL	NULL	NULL	1.4	5000
Bis(2-ethylhexyl) phthalate	401	77	324	4.9	10000	401.8105263	2.1	100000

Table 2.9.3-2
Subsurface Sediment Quality Summary Statistics

Compound	Number of Samples	Number of Detections	Number of Nondetections	Minimum Detected Concentration	Maximum Detected Concentration	Average Detected Concentration	Minimum Detection Limit	Maximum Detection Limit
Butylbenzyl phthalate	337	29	308	2.3	650	36.66551724	1.7	5000
Carbazole	388	258	130	1	520000	11003.31284	1.3	130
Dibenzofuran	516	401	115	0.22	230000	4867.930474	0.19	340
Dibenzothiophene	29	19	10	0.57	570000	36905.76158	0.21	0.21
Diethyl phthalate	401	19	382	1.3	1950	463.6684211	1.3	8800
Dimethyl phthalate	337	3	334	0.5	5100	1700.5	1	5000
Di-n-butyl phthalate	337	57	280	3.4	3200	150.245614	3.1	6800
Dinitro-o-cresol (4,6-Dinitro-2-methylphenol)	334	0	334	NULL	NULL	NULL	1.4	50000
Di-n-octyl phthalate	337	2	335	4.9	8.1	6.5	1.4	12000
Hexachlorobenzene	342	74	268	0.066	71	3.990243243	0.0162	7100
Hexachlorobutadiene	26	0	26	NULL	NULL	NULL	8	10000
Hexachlorocyclopentadiene	334	0	334	NULL	NULL	NULL	17	38000
Hexachloroethane	339	25	314	0.207	9.73	1.70068	0.0439	7100
Isophorone	334	0	334	NULL	NULL	NULL	1	10000
Nitrobenzene	338	0	338	NULL	NULL	NULL	2.2	7100
N-Nitrosodimethylamine	306	0	306	NULL	NULL	NULL	6.1	16000
N-Nitrosodi-N-propylamine	334	0	334	NULL	NULL	NULL	2.4	8000
N-Nitrosodiphenylamine	337	24	313	1.7	560	99.9875	1.6	5500
Pentachlorophenol	315	85	230	1	5600	123.68	0.43	50000
Phenol	405	81	324	2.1	347	27.67160494	2	15000
Pyridine	4	0	4	NULL	NULL	NULL	330	36000
Retene	8	8	0	57.7	55500	12998.3375	NULL	NULL
Total Petroleum Hydrocarbons (mg/kg)								
C10-C12 Aliphatic	28	17	11	0.00095	880	74.21971471	0.00075	2.9
C10-C12 Aromatic	6	2	4	4.4	41	22.7	2.5	3.8
C12-C16 Aliphatic	28	16	12	0.001	370	47.80200625	0.00075	2.9
C12-C16 Aromatic	28	17	11	0.00084	230	35.34202294	0.00075	2.9
C16-C21 Aliphatic	28	14	14	0.004	120	38.59914286	0.00075	2.9
C16-C21 Aromatic	6	4	2	60	560	335	2.5	2.9
C21-C34 Aliphatic	6	6	0	3.4	330	174.2333333	NULL	NULL
C21-C34 Aromatic	6	4	2	84	520	321	2.5	2.9
C8-C10 Aliphatics	6	1	5	3.9	3.9	3.9	2.5	3.8
C8-C10 Aromatics	6	1	5	3.8	3.8	3.8	2.5	3.8
Diesel Range Hydrocarbons	332	283	49	1.8	190000	4441.85212	1.3	97
Gasoline Range Hydrocarbons	256	111	145	1.5	21000	720.809009	1.2	100
Motor Oil Range	6	6	0	120	11000	2231.666667	NULL	NULL
Residual Range Hydrocarbons	326	273	53	3.1	110000	2692.275275	3	390
Total petroleum hydrocarbons	305	268	37	1.8	321000	7649.920896	3	390
Total Petroleum Hydrocarbons (U = 0)	326	276	50	3.6	642000	14984.10833	1.2	390
Volatile Organics (µg/kg)								
1,1,1,2-Tetrachloroethane	289	0	289	NULL	NULL	NULL	0.038	8600
1,1,1-Trichloroethane	296	0	296	NULL	NULL	NULL	0.071	8600
1,1,2,2-Tetrachloroethane	296	4	292	0.68	7.3	2.9275	0.12	9700

Table 2.9.3-2
Subsurface Sediment Quality Summary Statistics

Compound	Number of Samples	Number of Detections	Number of Nondetections	Minimum Detected Concentration	Maximum Detected Concentration	Average Detected Concentration	Minimum Detection Limit	Maximum Detection Limit
1,1,2-Trichloroethane	296	0	296	NULL	NULL	NULL	0.071	8600
1,1,2-Trichlorotrifluoroethane	7	0	7	NULL	NULL	NULL	7	800
1,1'-Dichloroethane	296	0	296	NULL	NULL	NULL	0.069	8600
1,1'-Dichloroethene	301	0	301	NULL	NULL	NULL	0.069	8600
1,2,3-Trichlorobenzene	2	0	2	NULL	NULL	NULL	32	3200
1,2,3-Trichloropropane	289	1	288	0.88	0.88	0.88	0.14	15000
1,2,4-Trichlorobenzene	101	0	101	NULL	NULL	NULL	0.23	35000
1,2,4-Trimethylbenzene	63	13	50	64.9	13100	3118.3	12	7530
1,2-Dibromo-3-chloropropane	7	0	7	NULL	NULL	NULL	28	3200
1,2-Dibromoethane (Ethylene dibromide)	289	0	289	NULL	NULL	NULL	0.061	35000
1,2-Dichlorobenzene	168	5	163	1.4	59.6	23.46	0.079	8600
1,2-Dichloroethane	301	5	296	0.055	140	29.287	0.038	8600
1,2-Dichloroethene, cis-	167	12	155	6.1	2200	482.55	0.13	8600
1,2-Dichloroethene, trans-	296	0	296	NULL	NULL	NULL	0.11	9800
1,2-Dichloropropane	296	0	296	NULL	NULL	NULL	0.042	8700
1,3,5-Trimethylbenzene (Mesitylene)	63	13	50	19.2	3860	689.6153846	12	7530
1,3-Dichlorobenzene	105	2	103	0.23	2.5	1.365	0.068	8600
1,3-Dichloropropene, cis-	296	0	296	NULL	NULL	NULL	0.038	8600
1,3-Dichloropropene, trans-	296	0	296	NULL	NULL	NULL	0.053	8600
1,4-Dichlorobenzene	352	16	336	0.36	31	8.946875	0.13	8600
2,3,4,6 and 2,3,5,6-Tetrachlorophenol coelution	201	20	181	0.99	1000	113.7695	0.4	41
2-Butanone (MEK)	301	128	173	1.6	120000	989.3270492	1.4	350000
2-Chloroethylvinyl ether	289	0	289	NULL	NULL	NULL	0.18	86000
2-Hexanone (Methyl butyl ketone)	296	1	295	6.2	6.2	6.2	0.71	350000
4-Isopropyltoluene (4-Cymene)	63	8	55	28	206	114.9125	12	7530
Acetone	359	73	286	3.6	60000	1899.097222	2.1	89000
Acrolein	289	0	289	NULL	NULL	NULL	0.63	350000
Acrylonitrile	289	0	289	NULL	NULL	NULL	0.28	350000
Benzene	408	173	235	0.03	270000	6976.291538	0.01	1470
Bromochloromethane	291	0	291	NULL	NULL	NULL	0.072	8900
Bromodichloromethane	296	0	296	NULL	NULL	NULL	0.082	8600
Bromoform	296	0	296	NULL	NULL	NULL	0.055	20000
Bromomethane	296	0	296	NULL	NULL	NULL	0.45	16000
BTEX	275	192	83	0.068	850000	17667.02231	0.02	31
BTEX (U = 0)	408	245	163	0.068	1130000	20392.73965	0.02	3160
Carbon disulfide	296	71	225	0.12	850	12.90619718	0.069	12000
Carbon tetrachloride (Tetrachloromethane)	301	0	301	NULL	NULL	NULL	0.087	8600
Chlorobenzene	301	42	259	0.14	12	2.50952381	0.062	8600
Chloroethane	296	0	296	NULL	NULL	NULL	0.29	13000
Chloroform	301	8	293	0.078	0.28	0.135375	0.069	8600
Chloromethane	296	0	296	NULL	NULL	NULL	0.14	9600
Cyclohexane	7	0	7	NULL	NULL	NULL	7	1600
Dibromochloromethane	296	0	296	NULL	NULL	NULL	0.082	8600

Table 2.9.3-2
Subsurface Sediment Quality Summary Statistics

Compound	Number of Samples	Number of Detections	Number of Nondetections	Minimum Detected Concentration	Maximum Detected Concentration	Average Detected Concentration	Minimum Detection Limit	Maximum Detection Limit
Dibromomethane	289	0	289	NULL	NULL	NULL	0.098	8600
Dichlorodifluoromethane	296	0	296	NULL	NULL	NULL	0.08	12000
Dichloromethane (Methylene chloride)	359	46	313	0.88	7100	360.0493478	0.17	35000
Ethylbenzene	403	138	265	0.05	140000	7586.193391	0.009	1580
Hexachlorobutadiene	415	17	398	0.265	3.39	0.985117647	0.0297	35000
Iodomethane (Methyl iodide)	289	1	288	7100	7100	7100	0.43	86000
Isopropylbenzene (Cumene)	359	146	213	0.063	19000	754.1710411	0.053	1600
m,p-Xylene	403	128	275	0.05	200000	6088.521953	0.02	21000
Methyl acetate	7	0	7	NULL	NULL	NULL	7	1600
Methyl isobutyl ketone (4-Methyl-2-pentanone or (MIBK))	296	2	294	1	34	17.5	0.27	350000
Methyl tert-butyl ether (MTBE)	296	62	234	0.083	14	0.575467742	0.049	8600
Methylcyclohexane	7	1	6	6.7	6.7	6.7	7	1600
Naphthalene	133	78	55	4.8	18000000	849006.3321	0.17	7530
n-Butylbenzene	63	5	58	18.2	151	60.96	12	7530
n-Propylbenzene	63	6	57	30.4	218	106.0833333	12	7530
o-Xylene	403	157	246	0.04	80000	2602.436943	0.008	1580
sec-Butylbenzene	63	6	57	13	50.9	35.05	12	7530
Styrene	359	7	352	0.15	22000	3378.188571	0.081	8600
Tetrachloroethene (PCE)	301	2	299	0.3	0.34	0.32	0.092	8600
Toluene	403	108	295	0.03	190000	4228.683981	0.01	1600
Total Xylene	275	125	150	0.04	280000	8782.53448	0.02	31
Total Xylene (U = 0)	403	165	238	0.04	280000	7199.475212	0.02	3160
trans-1,4-Dichloro-2-butene	289	0	289	NULL	NULL	NULL	0.5	180000
Trichloroethene (TCE)	364	71	293	0.14	1900000	31014.79268	0.076	14000
Trichlorofluoromethane (Fluorotrichloromethane)	296	0	296	NULL	NULL	NULL	0.097	9200
Vinyl acetate	294	0	294	NULL	NULL	NULL	0.44	86000
Vinyl chloride	364	14	350	0.15	4000	310.15	0.11	15000

Notes:

µg/kg micrograms per kilogram dry weight
mg/kg milligrams per kilogram dry weight
ng/kg nanograms per kilogram dry weight

Table 2.9.11-1

LWG Sediment Trap Analytical Results – Vicinity of Gasco and Siltronic Properties

Location ID:	LW3-ST005	LW3-ST005	LW3-ST005	LW3-ST005	RAA-STBU	RAA-STBM	RAA-STBD
Sample ID:	LW3-ST1005-1	LW3-ST-2005	LW3-ST3005	LW3-ST4-005	RAA-STBU-050817	RAA-STBM-050818	RAA-STBD-050817
Sample Date:	01/30/2007	04/30/2007	08/08/2007	11/13/2007	8/17/2005	8/18/2005	8/17/2005
Conventional Parameters (None)							
Specific gravity	**1.22**	**1.25**	--	**1.2**	--	--	--
Conventional Parameters (mg/kg)							
Sulfide	--	--	--	--	--	--	--
Conventional Parameters (pct)							
Total organic carbon	**3.02**	**3.06**	--	**2.72**	**3.43 J**	**3.59 J**	**3.60 J**
Total solids	**34.3**	**34**	**29.2**	**29.7**	**16.5**	**16.0**	**12.5**
Total cyanide (mg/kg)	--	--	--	--	1.00 U	**2.50**	**19.8**
Grain Size (pct)							
Gravel, Medium	**0.035**	**0**	--	**0.87**	--	--	--
Gravel, Fine	**0.315**	**0.38**	--	**0.85**	**0**	--	--
Sand, Very Coarse	**0.495**	**0.38**	--	**1.55**	**0.29**	--	--
Sand, Coarse	**0.615**	**0.3**	--	**0.42**	**0.50**	--	--
Sand, Medium	**0.815**	**0.33**	--	**0.71**	**0.45**	--	--
Sand, Fine	**2.14**	**0.88**	--	**2.34**	**1.48**	--	--
Sand, Very Fine	**10.7**	**3.6**	--	**6.74**	**2.00**	--	--
Silt, Coarse	**37.9**	**14.4**	--	**22.5**	--	--	--
Silt, Medium	**20.2**	**33.9**	--	**29.5**	--	--	--
Silt, Fine	**13.4**	**20.8**	--	**17.6**	**80.6**	--	--
Silt, Very Fine	**6.98**	**12.3**	--	**12.2**	--	--	--
Clay, Coarse	**2.69**	**6.19**	--	**3.38**	--	--	--
Clay, Fine	**3.23**	**6.85**	--	**5.06**	**16.2**	--	--
Fines (silt + clay)	**84.4**	**94.4**	--	**90.2**	--	--	--
Percent retained 106 micron sieve (#140)	--	--	--	--	--	--	--
Percent retained 75 micron sieve (#200)	--	--	--	--	--	--	--
Percent retained 250 micron sieve (#60)	--	--	--	--	--	--	--
Percent retained 425 micron sieve (#40)	--	--	--	--	--	--	--
Percent retained 850 micron sieve (#20)	--	--	--	--	--	--	--
Metals (mg/kg)							
Aluminum	**34400**	**44600**	--	**42700**	--	--	--
Antimony	**0.18 J**	**0.21 J**	--	**0.16 J**	--	--	--
Arsenic	**4.15**	**4.7**	--	**5.41**	--	--	--
Cadmium	**0.215**	**0.231 J**	--	**0.298**	--	--	--
Chromium	**40.4**	**31.3 J**	--	**34**	--	--	--
Chromium VI	**0.09 J**	0.1 UJ	--	0.21 UJ	--	--	--
Copper	**48.5**	**43**	--	**51**	--	--	--
Lead	**11.9**	**12.7**	--	**19**	--	--	--
Mercury	**0.058**	**0.06**	--	**0.074**	--	--	--
Nickel	**21.4 J**	**25.2**	--	**28.4**	--	--	--
Selenium	**0.24**	**0.24**	--	**0.24**	--	--	--
Silver	**0.565**	**0.153**	--	**0.3**	--	--	--
Zinc	**111**	**127**	--	**166**	--	--	--
Organometallic Compounds (µg/kg)							
Butyltin (ion)	0.37 U	**0.78 J**	--	**1.3 J**	--	--	--
Dibutyltin (ion)	0.9 U	2.4 U	--	**3.4 J**	--	--	--
Tributyltin (ion)	0.17 U	**1.5 J**	--	**13**	--	--	--

Table 2.9.11-1
LWG Sediment Trap Analytical Results – Vicinity of Gasco and Siltronic Properties

Location ID:	LW3-ST005	LW3-ST005	LW3-ST005	LW3-ST005	RAA-STBU	RAA-STBM	RAA-STBD
Sample ID:	LW3-ST1005-1	LW3-ST-2005	LW3-ST3005	LW3-ST4-005	RAA-STBU-050817	RAA-STBM-050818	RAA-STBD-050817
Sample Date:	01/30/2007	04/30/2007	08/08/2007	11/13/2007	8/17/2005	8/18/2005	8/17/2005
Tetrabutyltin	0.21 U	0.21 U	--	0.23 U	--	--	--
Volatile Organics (µg/kg)							
BTEX	**51**	**2600**	**10**	0.26 U	--	--	--
1,1,1,2-Tetrachloroethane	0.16 U	0.23 U	0.27 U	0.13 U	--	--	--
1,1,1-Trichloroethane	0.22 U	0.2 U	0.23 U	0.12 U	--	--	--
1,1,2,2-Tetrachloroethane	0.35 U	0.33 U	0.38 U	0.19 U	--	--	--
1,1,2-Trichloroethane	0.2 U	0.33 U	0.38 U	0.19 U	--	--	--
1,1'-Dichloroethane	0.18 U	0.2 U	0.24 U	0.12 U	--	--	--
1,4-Dichlorobenzene	0.55 U	0.3 U	0.35 U	0.17 U	--	--	--
1,1'-Dichloroethene	0.24 U	0.17 U	0.2 U	0.096 U	--	--	--
1,2,3-Trichloropropane	0.52 U	0.86 U	1 U	0.49 U	--	--	--
1,2-Dibromoethane (Ethylene dibromide)	0.18 U	0.28 U	0.32 U	0.16 U	--	--	--
1,2-Dichloroethane	0.28 U	0.17 U	0.2 U	0.096 U	--	--	--
1,2-Dichloroethene, cis-	0.28 U	0.3 U	0.35 U	0.17 U	--	--	--
1,2-Dichloroethene, trans-	0.17 U	0.25 U	0.29 U	0.15 U	--	--	--
1,2-Dichloropropane	0.19 U	0.28 U	0.33 U	0.16 U	--	--	--
1,3-Dichloropropene, cis-	0.18 U	0.17 U	0.2 U	0.095 U	--	--	--
1,3-Dichloropropene, trans-	0.19 U	0.28 U	0.32 U	0.16 U	--	--	--
2-Butanone (MEK)	**-- R**	**-- R**	**5.4 J**	**-- R**	--	--	--
2-Chloroethylvinyl ether	0.44 U	0.92 U	1.1 UJ	**-- R**	--	--	--
2-Hexanone (Methyl butyl ketone)	11 U	1.8 U	2.1 U	**-- R**	--	--	--
Acetone	17 U	42 U	33 UJ	17 UJ	--	--	--
Acrolein	**-- R**	**-- R**	**-- R**	**-- R**	--	--	--
Acrylonitrile	1.2 U	1.4 U	1.6 U	**-- R**	--	--	--
Benzene	0.13 U	0.24 U	0.28 U	0.14 U	--	--	--
Bromochloromethane	0.29 U	0.53 U	0.62 U	0.31 U	--	--	--
Bromodichloromethane	0.12 U	0.33 U	0.38 U	0.19 U	--	--	--
Bromoform	0.35 U	0.56 U	0.66 U	0.32 U	--	--	--
Bromomethane	0.81 U	1.5 U	1.8 U	0.86 U	--	--	--
Carbon disulfide	0.2 U	0.17 U	0.2 U	0.096 U	--	--	--
Carbon tetrachloride (Tetrachloromethane)	0.15 U	0.22 U	0.25 U	0.13 U	--	--	--
Chlorobenzene	0.18 U	0.15 U	0.18 U	0.086 U	--	--	--
Chloroethane	0.58 U	0.71 U	0.83 U	0.41 U	--	--	--
Chloroform	0.23 U	0.19 U	0.22 U	0.11 U	--	--	--
Chloromethane	0.22 U	0.33 U	0.38 U	0.19 U	--	--	--
Dibromochloromethane	0.29 U	0.29 U	0.33 U	0.17 U	--	--	--
Dibromomethane	0.21 U	0.45 U	0.52 U	0.26 U	--	--	--
Dichlorodifluoromethane	0.17 U	0.2 U	0.23 U	0.12 U	--	--	--
Dichloromethane (Methylene chloride)	0.8 U	3 U	1.8 U	3 U	--	--	--
Ethylbenzene	0.15 U	0.2 U	0.23 U	0.11 U	--	--	--
Iodomethane (Methyl iodide)	0.95 U	1.1 U	1.2 UJ	3.7 U	--	--	--
Isopropylbenzene (Cumene)	0.25 U	0.15 U	0.18 U	0.085 U	--	--	--
Naphthalene	--	--	0.48 U	--	--	--	--
Methyl isobutyl ketone (4-Methyl-2-pentanone or (MIBK))	1.5 U	0.65 U	0.76 U	**-- R**	--	--	--
Methyl tert-butyl ether (MTBE)	0.21 U	0.19 U	0.22 U	0.11 U	--	--	--
m,p-Xylene	0.32 U	0.45 U	0.52 U	0.26 U	--	--	--

Table 2.9.11-1
LWG Sediment Trap Analytical Results – Vicinity of Gasco and Siltronic Properties

Location ID:	LW3-ST005	LW3-ST005	LW3-ST005	LW3-ST005	RAA-STBU	RAA-STBM	RAA-STBD
Sample ID:	LW3-ST1005-1	LW3-ST-2005	LW3-ST3005	LW3-ST4-005	RAA-STBU-050817	RAA-STBM-050818	RAA-STBD-050817
Sample Date:	01/30/2007	04/30/2007	08/08/2007	11/13/2007	8/17/2005	8/18/2005	8/17/2005
o-Xylene	0.17 U	0.17 U	0.2 U	0.096 U	--	--	--
Styrene	0.27 U	0.2 U	0.23 U	0.12 U	--	--	--
Tetrachloroethene (PCE)	0.25 U	0.23 U	0.27 U	0.13 U	--	--	--
Toluene	**51**	**2600**	**10**	0.22 U	--	--	--
Total Xylene	0.32 U	0.45 U	0.52 U	0.26 U	--	--	--
trans-1,4-Dichloro-2-butene	0.95 U	1.3 U	1.5 U	0.69 U	--	--	--
Trichloroethene (TCE)	0.24 U	0.21 U	0.24 U	0.12 U	--	--	--
Trichlorofluoromethane (Fluorotrichloromethane)	1.1 U	0.33 U	0.38 U	0.19 U	--	--	--
Vinyl acetate	**-- R**	**-- R**	**-- R**	**-- R**	--	--	--
Vinyl chloride	0.41 U	0.28 U	0.33 U	0.16 U	--	--	--
Hexachlorobutadiene	1.5 U	1.5 U	--	0.24 U	--	--	--
Aromatic Hydrocarbons (µg/kg)							
1-Methylnaphthalene	--	--	--	--	--	--	--
2-Methylnaphthalene	**21**	**21**	--	**57**	**17**	**220**	**130**
Acenaphthene	**54**	**56**	--	**120**	**30**	**490**	**270**
Acenaphthylene	**22**	**19**	--	**60**	**26**	**440**	**150**
Anthracene	**91**	**100**	--	**260**	**75**	**1100**	**690**
Benzo(a)anthracene	**260**	**290**	--	**760**	**170**	**3700**	**1400**
Benzo(a)pyrene	**350**	**440**	--	**1100**	**270**	**6100**	**2200**
Benzo(b)fluoranthene	**230**	**360**	--	**1100**	**200**	**4200**	**1400**
Benzo(g,h,i)perylene	**270**	**370**	--	**890**	**260**	**5300**	**1900**
Benzo(k)fluoranthene	**190**	**130**	--	**340**	--	--	--
Chrysene	**330**	**370**	--	**940**	**150**	**3000**	**1100**
Dibenzo(a,h)anthracene	**32**	**50**	--	**110**	**31**	**650**	**250**
Fluoranthene	**570**	**530**	--	**1500**	**320**	**6400**	**2400**
Fluorene	**39**	**30**	--	**86**	**21**	**310**	**180**
Indeno(1,2,3-c,d)pyrene	**250**	**330**	--	**830**	**210**	**4900**	**1600**
Naphthalene	**55**	**58**	--	**120**	**50**	**630**	**270**
Perylene	--	--	--	--	--	--	--
Phenanthrene	**380**	**300**	--	**830**	**180**	**3500**	**1600**
Pyrene	**850**	**660**	--	**1600**	**400**	**8000**	**3100**
LWG RI Low Molecular Weight PAH (Reported, not calculated)	**660**	**580**	--	**1500**	--	--	--
LWG RI High Molecular Weight PAH (Reported, not calculated)	**3300**	**3500**	--	**9200**	--	--	--
LWG RI Total BaPEq (Reported, not calculated)	**458**	**590**	--	**1480**	--	--	--
LWG RI Total cPAHs (Reported, not calculated)	**1600**	**2000**	--	**5200**	--	--	--
LWG RI Total PAH (Reported, not calculated)	**4000**	**4100**	--	**11000**	--	**10700**	**2400**
Semi-Volatile Organics (µg/kg)							
1,2,4-Trichlorobenzene	4.4 U	7.7 U	--	8.6 U	--	--	--
1,2-Dichlorobenzene	3.8 U	8.6 U	--	9.6 U	--	--	--
1,3-Dichlorobenzene	4.6 U	8.9 U	--	9.9 U	--	--	--
1-Methylphenanthrene	--	--	--	--	--	--	--
2,3,4,5-Tetrachlorophenol	1.8 U	1.9 U	--	0.7 U	--	--	--
2,3,5,6-Tetrachlorophenol	0.87 U	0.89 U	--	0.57 U	--	--	--
2,3,5-Trimethylnaphthalene	--	--	--	--	--	--	--
2,4-Dichlorophenol	5.2 U	3 U	--	3.3 U	--	--	--
2,4-Dimethylphenol	16 U	17 U	--	**-- R**	--	--	--

Table 2.9.11-1
LWG Sediment Trap Analytical Results – Vicinity of Gasco and Siltronic Properties

Location ID:	LW3-ST005	LW3-ST005	LW3-ST005	LW3-ST005	RAA-STBU	RAA-STBM	RAA-STBD
Sample ID:	LW3-ST1005-1	LW3-ST-2005	LW3-ST3005	LW3-ST4-005	RAA-STBU-050817	RAA-STBM-050818	RAA-STBD-050817
Sample Date:	01/30/2007	04/30/2007	08/08/2007	11/13/2007	8/17/2005	8/18/2005	8/17/2005
2,4-Dinitrophenol	110 U	50 U	--	56 U	--	--	--
2,4-Dinitrotoluene	8.1 U	4.5 U	--	5 U	--	--	--
2,6-Dimethylnaphthalene	--	--	--	--	--	--	--
2,6-Dinitrotoluene	8.1 U	5.9 U	--	6.6 U	--	--	--
2-Chloronaphthalene	11 U	4.8 U	--	5.3 U	--	--	--
2-Chlorophenol	4.9 U	5.9 U	--	6.6 U	--	--	--
2-Methylphenol (o-Cresol)	9.8 U	**7.6 J**	--	5 U	--	--	--
2-Nitroaniline	7.8 U	9.5 U	--	11 U	--	--	--
2-Nitrophenol	7.5 U	4.5 U	--	5 U	--	--	--
3,3'-Dichlorobenzidine	11 U	11 U	--	13 U	--	--	--
3-Nitroaniline	7.5 U	7.4 U	--	8.3 U	--	--	--
4-Bromophenyl-phenyl ether	4.1 U	4.8 U	--	5.3 U	--	--	--
4-Chloro-3-methylphenol	6.1 U	4.2 U	--	4.7 U	--	--	--
4-Chloroaniline	6.1 U	5.6 U	--	6.3 U	--	--	--
4-Chlorophenyl phenyl ether	5.8 U	4.2 U	--	4.7 U	--	--	--
4-Methylphenol (p-Cresol)	**420**	**150**	--	**54**	--	--	--
4-Nitroaniline	9.8 U	5.3 U	--	6 U	--	--	--
4-Nitrophenol	87 U	53 U	--	60 U	--	--	--
Aniline	4.4 U	4.5 U	--	5 U	--	--	--
Azobenzene	6.9 U	3.3 U	--	3.7 U	--	--	--
Benzoic acid	**310 J**	290 UJ	--	320 U	--	--	--
Benzyl alcohol	**18**	6.2 U	--	**9.7 J**	--	--	--
Biphenyl (1,1'-Biphenyl)	--	--	--	--	--	--	--
bis(2-Chloroethoxy)methane	3.8 U	4.5 U	--	5 U	--	--	--
bis(2-Chloroethyl)ether	6.9 U	5.6 U	--	6.3 U	--	--	--
bis(2-Chloroisopropyl) ether	3.5 U	7.7 U	--	8.6 U	--	--	--
Bis(2-ethylhexyl) phthalate	**130**	**140**	--	**150 J**	--	--	--
Diethyl phthalate	11 U	3.9 U	--	**8.1 J**	--	--	--
Butylbenzyl phthalate	4.4 U	9.5 U	--	11 U	--	--	--
Dimethyl phthalate	5.2 U	3 U	--	3.3 U	--	--	--
Di-n-butyl phthalate	10 U	24 U	--	**47**	--	--	--
Carbazole	**14 J**	**23**	--	**84**	--	--	--
Dinitro-o-cresol (4,6-Dinitro-2-methylphenol)	4.9 U	4.2 U	--	4.7 U	--	--	--
Di-n-octyl phthalate	3.5 U	5 U	--	5.6 U	--	--	--
Hexachlorobenzene	0.23 U	0.99 U	--	**0.82**	--	--	--
Dibenzofuran	**7.6**	**6**	--	**20**	--	--	--
Hexachlorocyclopentadiene	44 U	86 U	--	96 U	--	--	--
Hexachloroethane	0.77 U	0.48 U	--	0.27 U	--	--	--
Isophorone	4.6 U	3 U	--	3.3 U	--	--	--
Nitrobenzene	5.8 U	6.5 U	--	7.3 U	--	--	--
N-Nitrosodimethylamine	18 U	18 U	--	21 U	--	--	--
N-Nitrosodi-N-propylamine	9.2 U	7.1 U	--	7.9 U	--	--	--
N-Nitrosodiphenylamine	6.4 U	4.8 U	--	5.3 U	--	--	--
Phenol	**73**	**22 J**	--	18 U	--	--	--
PCB Aroclors (µg/kg)							
Aroclors	5.9 U	**27 J**	--	**21**	--	--	--

Table 2.9.11-1
LWG Sediment Trap Analytical Results – Vicinity of Gasco and Siltronic Properties

Location ID:	LW3-ST005	LW3-ST005	LW3-ST005	LW3-ST005	RAA-STBU	RAA-STBM	RAA-STBD
Sample ID:	LW3-ST1005-1	LW3-ST-2005	LW3-ST3005	LW3-ST4-005	RAA-STBU-050817	RAA-STBM-050818	RAA-STBD-050817
Sample Date:	01/30/2007	04/30/2007	08/08/2007	11/13/2007	8/17/2005	8/18/2005	8/17/2005
Aroclor 1016	4.9 U	5 U	--	2.4 U	--	--	--
Aroclor 1221	4.9 U	5 U	--	2.4 U	--	--	--
Aroclor 1232	4.9 U	5 U	--	2.4 U	--	--	--
Aroclor 1242	4.9 U	**7.7 J**	--	7.8 U	--	--	--
Aroclor 1248	4.9 U	5 U	--	2.4 U	--	--	--
Aroclor 1254	5.9 U	**13**	--	8.3 U	--	--	--
Aroclor 1260	5.5 U	**5.9 J**	--	**21**	--	--	--
Aroclor 1262	4.9 U	5 U	--	2.4 U	--	--	--
Aroclor 1268	4.9 U	5 U	--	2.4 U	--	--	--
PCB Congeners (ng/kg)							
PCB-004/010	**16.6**	14.7 UJ	25 U	40.2 UJ	--	--	--
PCB-007/009	5.01 U	5 U	25 U	10 U	--	--	--
PCB-016/032	**59**	**58.2**	**101**	**137**	--	--	--
PCB-020/021/033	**62.9**	**56**	**121**	**223**	--	--	--
PCB-041/064/071/072	**191**	**151**	**282**	**341**	--	--	--
PCB-042/059	**63.7**	**54.2**	**105**	**137**	--	--	--
PCB-043/049	**207**	**166**	12.5 U	**431**	--	--	--
PCB-048/075	**35.5**	**30.8**	63.6 UJ	**77**	--	--	--
PCB-052/069	**338**	**250**	**432**	**548**	--	--	--
PCB-061/070	**252**	**207**	**512**	**620**	--	--	--
PCB-066/076	**198**	**160**	**450**	**513**	--	--	--
PCB-084/092	**174**	**173**	**333**	**377**	--	--	--
PCB-087/117/125	**153**	**146**	**214**	**266**	--	--	--
PCB-090/101	**449**	**448**	**814**	**964**	--	--	--
PCB-095/098/102	**341**	**329**	**622**	**694**	--	--	--
PCB-106/118	**376**	**375**	**605**	**814**	--	--	--
PCB-107/109	**30.6**	**29**	**55.2**	**66.6**	--	--	--
PCB-108/112	**18.7**	**18.7**	**33.9**	**35.3**	--	--	--
PCB-111/115	**6.83**	**8.38**	12.5 U	**13.6**	--	--	--
PCB-128/162	**79.5**	**72.7**	**141**	**155**	--	--	--
PCB-132/161	**157**	**141**	**275**	**334**	--	--	--
PCB-133/142	**18.8**	**16.6**	43.6 UJ	**45.1**	--	--	--
PCB-134/143	**27.9**	**25.1**	**54.8**	**64**	--	--	--
PCB-135	**78.3**	**77.8**	**172**	**184**	--	--	--
PCB-138/163/164	**622**	**601**	**1010**	**1210**	--	--	--
PCB-139/149	**489**	**500**	**811**	**922**	--	--	--
PCB-146/165	**97.4**	**97.7**	**210**	**254**	--	--	--
PCB-158/160	**58**	**55.4**	**90.4**	**113**	--	--	--
PCB-001	2.54 U	**3.23**	12.5 U	**19.4**	--	--	--
PCB-002	**7.55**	**5**	**11.2 J**	**18**	--	--	--
PCB-003	**7.53**	**4.8**	12.5 U	**16.2**	--	--	--
LWG RI Total PCB Congeners (Reported, not calculated)	**10600 J**	**11300**	**20700 J**	**25300 J**	--	--	--
PCB-005/008	**33.6 J**	**32.5**	**75.7**	**169**	--	--	--
PCB-006	**9.36**	7.77 UJ	25 U	33.5 UJ	--	--	--
PCB-011	**237**	**171**	**293**	**305**	--	--	--
PCB-012/013	5.07 U	5 U	25 U	18.7 UJ	--	--	--

Table 2.9.11-1
LWG Sediment Trap Analytical Results – Vicinity of Gasco and Siltronic Properties

Location ID:	LW3-ST005	LW3-ST005	LW3-ST005	LW3-ST005	RAA-STBU	RAA-STBM	RAA-STBD
Sample ID:	LW3-ST1005-1	LW3-ST-2005	LW3-ST3005	LW3-ST4-005	RAA-STBU-050817	RAA-STBM-050818	RAA-STBD-050817
Sample Date:	01/30/2007	04/30/2007	08/08/2007	11/13/2007	8/17/2005	8/18/2005	8/17/2005
PCB-014	5.01 U	5 U	25 U	10 U	--	--	--
PCB-015	**39**	**41.1**	25 U	**128**	--	--	--
PCB-017	**45.2**	**37.7**	**78.6**	**110**	--	--	--
PCB-018	**91.5**	**89**	**157**	**217**	--	--	--
PCB-019	**19.4**	**17.9**	**54.6**	**55.4**	--	--	--
PCB-022	**44.9**	**41.9**	**81.3**	**150**	--	--	--
PCB-023	2.5 U	2.5 U	12.5 U	5 U	--	--	--
PCB-024/027	**9.73**	**8.91**	**18.1**	**20.9**	--	--	--
PCB-025	**17.9**	**16.1**	26.6 UJ	**51.7**	--	--	--
PCB-026	**28**	**27.1**	**48.3**	**81.4**	--	--	--
PCB-028	**146**	**129**	**262**	**510**	--	--	--
PCB-029	2.5 U	2.5 U	12.5 U	5 U	--	--	--
PCB-030	2.5 U	2.5 U	12.5 U	5 U	--	--	--
PCB-031	**124**	**119**	**242**	**386**	--	--	--
PCB-034	2.5 U	2.5 U	12.5 U	5 U	--	--	--
PCB-035	**4.36**	**4.03**	12.5 U	**8.1**	--	--	--
PCB-036	2.5 U	2.5 U	12.5 U	5 U	--	--	--
PCB-037	**47.1**	**45**	**99.3**	**148**	--	--	--
PCB-038	2.5 U	2.5 U	12.5 U	**7.06**	--	--	--
PCB-039	2.5 U	2.5 U	12.5 U	5 U	--	--	--
PCB-040	**31.2**	**25.7**	**65.4**	**73.4**	--	--	--
PCB-044	**224**	**177**	**360**	**488**	--	--	--
PCB-045	**25.7**	**22.3**	**38.3**	**56.8**	--	--	--
PCB-046	**12**	**11**	21.6 UJ	**27.2**	--	--	--
PCB-047	**94.5**	**77.8**	**242**	**247**	--	--	--
PCB-050	2.5 U	2.5 U	12.5 U	5 U	--	--	--
PCB-051	**18.7**	**15.1**	**54.3**	**56.3**	--	--	--
PCB-053	**40.1**	**31.9**	**76**	**91.6**	--	--	--
PCB-054	**3.27**	**2.54**	**14.8**	**11.1**	--	--	--
PCB-055	**3.33**	**2.88**	12.5 U	**7.42**	--	--	--
PCB-056/060	**114**	**96.1**	**239**	**286**	--	--	--
PCB-057	2.5 U	2.5 U	12.5 U	5 U	--	--	--
PCB-058	2.5 U	2.5 U	12.5 U	5 U	--	--	--
PCB-062	2.5 U	2.5 U	12.5 U	5 U	--	--	--
PCB-063	**7.73**	**6.19**	**18.2**	**21.2**	--	--	--
PCB-065	2.5 U	2.5 U	12.5 U	5 U	--	--	--
PCB-067	**6**	**5.09**	**16.1**	**15.2**	--	--	--
PCB-068	**3.41**	**2.73**	**8.98 J**	**6.47**	--	--	--
PCB-073	2.5 U	2.5 U	12.5 U	**15.2**	--	--	--
PCB-074	**93.1**	**77.2**	**195**	**239**	--	--	--
PCB-077	**24.3**	**21.5**	**48.3**	**50.6**	--	--	--
PCB-078	2.5 U	2.5 U	12.5 U	5 U	--	--	--
PCB-079	**5.35**	**4.64**	12.5 U	**11.5**	--	--	--
PCB-080	2.5 U	2.5 U	12.5 U	5 U	--	--	--
PCB-081	**1.03 J**	0.89 U	7.63 U	**2.4 J**	--	--	--
PCB-082	**48.2**	**44.4**	**95.7**	**115**	--	--	--

Table 2.9.11-1
LWG Sediment Trap Analytical Results – Vicinity of Gasco and Siltronic Properties

Location ID:	LW3-ST005	LW3-ST005	LW3-ST005	LW3-ST005	RAA-STBU	RAA-STBM	RAA-STBD
Sample ID:	LW3-ST1005-1	LW3-ST-2005	LW3-ST3005	LW3-ST4-005	RAA-STBU-050817	RAA-STBM-050818	RAA-STBD-050817
Sample Date:	01/30/2007	04/30/2007	08/08/2007	11/13/2007	8/17/2005	8/18/2005	8/17/2005
PCB-083	2.5 U	2.5 U	12.5 U	5 U	--	--	--
PCB-085/116	**73**	**70.6**	**113**	**135**	--	--	--
PCB-086	2.5 U	2.5 U	12.5 U	5 U	--	--	--
PCB-088/091	**62.6**	**60.2**	**146**	**151**	--	--	--
PCB-089	**4.14**	**4.51**	12.5 U	**9.9**	--	--	--
PCB-093	2.5 U	2.5 U	12.5 U	5 U	--	--	--
PCB-094	**3.14**	**2.61**	**14.7**	**9.89**	--	--	--
PCB-096	**4.78**	**4.54**	12.5 U	**10.3**	--	--	--
PCB-097	**118**	**115**	**201**	**241**	--	--	--
PCB-099	**193**	**188**	**390**	**471**	--	--	--
PCB-100	**6.5**	**5.57**	28.6 UJ	**24.8**	--	--	--
PCB-103	**8.1**	**6.9**	**24.3**	**22**	--	--	--
PCB-104	2.5 U	2.5 U	12.5 U	5 U	--	--	--
PCB-105	**143**	**131**	**255**	**313**	--	--	--
PCB-110	**504**	**488**	**791**	**959**	--	--	--
PCB-113	2.5 U	2.5 U	12.5 U	**10.6**	--	--	--
PCB-114	**9.06**	**6.93**	**16.2**	**17.5**	--	--	--
PCB-119	**12.8**	**11.4**	**28.4**	**31.9**	--	--	--
PCB-120	2.5 U	2.5 U	12.5 U	5 U	--	--	--
PCB-121	2.5 U	2.5 U	12.5 U	5 U	--	--	--
PCB-122	**5.31**	**4.99**	12.5 U	**12.3**	--	--	--
PCB-123	**6.9**	**7.6**	14.3 UJ	**13.9**	--	--	--
PCB-124	**16.6**	**14.7**	**31.3**	**36**	--	--	--
PCB-126	**3**	**3.04**	7.67 U	**5.47**	--	--	--
PCB-127	2.5 U	2.5 U	12.5 U	5 U	--	--	--
PCB-129	**20.9**	**19.9**	**31**	**37.4**	--	--	--
PCB-130	**31.3**	**34.4**	**61.4**	**70.4**	--	--	--
PCB-131	2.5 U	2.5 U	12.5 U	5 U	--	--	--
PCB-136	**77**	**74.5**	**162**	**173**	--	--	--
PCB-137	**21.3**	**21.7**	**38.8**	**48.1**	--	--	--
PCB-140	**4.22**	**4.07**	**13**	**11.4**	--	--	--
PCB-141	**113**	**115**	**255**	**280**	--	--	--
PCB-144	**26.4**	**27.6**	12.5 U	**49**	--	--	--
PCB-145	2.5 U	2.5 U	12.5 U	5 U	--	--	--
PCB-147	**13.9**	**14.7**	**34.7**	**33.7**	--	--	--
PCB-148	2.5 U	2.5 U	12.5 U	**5.89**	--	--	--
PCB-150	2.5 U	2.5 U	**5.82 J**	**6.2**	--	--	--
PCB-151	**142**	**144**	**304**	**337**	--	--	--
PCB-152	2.5 U	2.5 U	12.5 U	5 U	--	--	--
PCB-153	**593**	**603**	**1310**	**1530**	--	--	--
PCB-154	**11.7**	**11.2**	**28.3**	**34.2**	--	--	--
PCB-155	2.5 U	2.5 U	12.5 U	5 U	--	--	--
PCB-156	**47.9**	**47.4**	**115**	**108**	--	--	--
PCB-157	**11.1**	**10.1**	22.5 UJ	**22.8**	--	--	--
PCB-159	**8.31**	**8.4**	**18.2**	5 U	--	--	--
PCB-166	2.5 U	2.5 U	12.5 U	5 U	--	--	--

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LWG Sediment Trap Analytical Results – Vicinity of Gasco and Siltronic Properties

Location ID:	LW3-ST005	LW3-ST005	LW3-ST005	LW3-ST005	RAA-STBU	RAA-STBM	RAA-STBD
Sample ID:	LW3-ST1005-1	LW3-ST-2005	LW3-ST3005	LW3-ST4-005	RAA-STBU-050817	RAA-STBM-050818	RAA-STBD-050817
Sample Date:	01/30/2007	04/30/2007	08/08/2007	11/13/2007	8/17/2005	8/18/2005	8/17/2005
PCB-167	**21.1**	**20.5**	**40.7**	**44.9**	--	--	--
PCB-168	2.5 U	2.5 U	12.5 U	5 U	--	--	--
PCB-169	0.473 U	0.517 U	6.74 U	1.47 U	--	--	--
PCB-170	**155**	**204**	**418**	**472**	--	--	--
PCB-171	**42.2**	**51.2**	**122**	**125**	--	--	--
PCB-172	**28.7**	**37.2**	**84.3**	**82.3**	--	--	--
PCB-173	**3.93**	**5.45**	12.5 U	**12.9**	--	--	--
PCB-174	**169**	**231**	**516**	**521**	--	--	--
PCB-175	**7.4**	**8.92**	**25.2**	**22.6**	--	--	--
PCB-176	**19.7**	**24.5**	**58.8**	**61.4**	--	--	--
PCB-177	**108**	**135**	**368**	**353**	--	--	--
PCB-178	**41.2**	**47.4**	**134**	**119**	--	--	--
PCB-179	**81**	**96.3**	**263**	**262**	--	--	--
PCB-181	2.5 U	2.5 U	12.5 U	**13.5**	--	--	--
PCB-182/187	**240**	**292**	**690**	**735**	--	--	--
PCB-183	**90.8**	**114**	**294**	**306**	--	--	--
PCB-184	2.5 U	2.5 U	12.5 U	5 U	--	--	--
PCB-185	**20.7**	**24.9**	**63**	**62.3**	--	--	--
PCB-186	2.5 U	2.5 U	12.5 U	5 U	--	--	--
PCB-188	2.5 U	2.5 U	12.5 U	5 U	--	--	--
PCB-189	**5.54**	**7.39**	**17.6**	**16.4**	--	--	--
PCB-190	**34.9**	**41.4**	**89.5**	**93.8**	--	--	--
PCB-191	**5.51**	**7.83**	12.5 U	**14.8**	--	--	--
PCB-192	2.5 U	2.5 U	12.5 U	5 U	--	--	--
PCB-193	**19.3**	**25.3**	**54.1**	**54.5**	--	--	--
PCB-194	**87.3**	**150**	**270**	**260**	--	--	--
PCB-195	**36.5**	**57.9**	**139**	**126**	--	--	--
PCB-196/203	**115**	**171**	**296**	**357**	--	--	--
PCB-197	**3.67**	**5.09**	12.5 U	**12.1**	--	--	--
PCB-198	**10.3**	**8.06**	**16.8**	**27.1**	--	--	--
PCB-199	**96.1**	**197**	**331**	**334**	--	--	--
PCB-200	**12.4**	**18.7**	29.9 UJ	**38**	--	--	--
PCB-201	**13.7**	**17**	**47.7**	**44.2**	--	--	--
PCB-202	**26.2**	**29.3**	**62.8**	**67**	--	--	--
PCB-204	2.5 U	2.5 U	12.5 U	5 U	--	--	--
PCB-205	**2.95**	**6.84**	12.5 U	**14**	--	--	--
PCB-206	**62.3**	**445**	**165**	**169**	--	--	--
PCB-207	**7.23**	**9.71**	**20.2**	**17.9**	--	--	--
PCB-208	**18.3**	**57.5**	**41.1**	**45.4**	--	--	--
PCB-209	**77.8**	**284**	**199**	**207**	--	--	--
LWG RI Dioxin-like PCB congener TEQ (Reported, not calculated) (U = 0)	**0.321 J**	**0.324**	**0.0363**	**0.593 J**	--	--	--
Monochlorobiphenyls (total)	**15.1**	**13**	**11.2 J**	**53.6**	--	--	--
Dichlorobiphenyls (total)	**336 J**	**245**	**369**	**602**	--	--	--
Trichlorobiphenyls (total)	**700**	**650**	**1260**	**2110**	--	--	--
Tetrachlorobiphenyls (total)	**1990 J**	**1600**	**3160 J**	**4370 J**	--	--	--
Pentachlorobiphenyls (total)	**2770**	**2700**	**4780**	**5820**	--	--	--

Table 2.9.11-1
LWG Sediment Trap Analytical Results – Vicinity of Gasco and Siltronic Properties

Location ID:	LW3-ST005	LW3-ST005	LW3-ST005	LW3-ST005	RAA-STBU	RAA-STBM	RAA-STBD
Sample ID:	LW3-ST1005-1	LW3-ST-2005	LW3-ST3005	LW3-ST4-005	RAA-STBU-050817	RAA-STBM-050818	RAA-STBD-050817
Sample Date:	01/30/2007	04/30/2007	08/08/2007	11/13/2007	8/17/2005	8/18/2005	8/17/2005
Hexachlorobiphenyls (total)	**2770**	**2740**	**5180 J**	**6070**	--	--	--
Heptachlorobiphenyls (total)	**1470**	**1890**	**4300**	**4530**	--	--	--
Octachlorobiphenyls (total)	**404**	**661**	**1160**	**1280**	--	--	--
Nonachlorobiphenyls (total)	**87.8**	**512**	**226**	**232**	--	--	--
Pesticides (µg/kg)							
2,4'-DDD (o,p'-DDD)	2.6 U	**0.83 J**	--	**5.2**	--	--	--
2,4'-DDE (o,p'-DDE)	0.67 U	0.68 U	--	**0.91 J**	--	--	--
2,4'-DDT (o,p'-DDT)	0.69 U	**0.73 J**	--	2.2 U	--	--	--
4,4'-DDD (p,p'-DDD)	**2.4 J**	**2.5**	--	**13**	--	--	--
4,4'-DDE (p,p'-DDE)	**2**	**2.4**	--	**5 J**	--	--	--
4,4'-DDT (p,p'-DDT)	**2.1 J**	**2.4 J**	--	**9**	--	--	--
Aldrin	**1.1 J**	0.45 U	--	0.21 U	--	--	--
alpha-BHC	0.75 U	0.77 U	--	0.17 U	--	--	--
beta-BHC	0.9 U	0.89 U	--	**0.69**	--	--	--
alpha-Chlordane (cis-Chlordane)	1.2 U	0.68 U	--	0.052 U	--	--	--
beta-Chlordane (trans-Chlordane)	**0.24 J**	**0.53 J**	--	0.52 U	--	--	--
cis-Nonachlor	**0.82 J**	0.25 U	--	1.9 U	--	--	--
trans-Nonachlor	**0.52 J**	**0.3 J**	--	0.34 U	--	--	--
delta-BHC	0.18 U	**0.37 J**	--	0.19 U	--	--	--
Dieldrin	0.84 U	0.86 U	--	0.64 U	--	--	--
Endosulfan-alpha (I)	0.72 U	0.5 U	--	0.24 U	--	--	--
Endosulfan-beta (II)	0.55 U	0.56 U	--	0.052 U	--	--	--
Endosulfan sulfate	1.2 U	0.99 U	--	0.34 U	--	--	--
Endrin	**2.4 J**	0.6 U	--	0.12 U	--	--	--
Endrin aldehyde	**0.38 J**	0.16 U	--	0.071 U	--	--	--
Endrin ketone	0.24 U	0.25 U	--	0.43 U	--	--	--
gamma-BHC (Lindane)	0.44 U	0.99 U	--	0.55 U	--	--	--
Heptachlor	1.2 U	0.45 U	--	0.34 U	--	--	--
Heptachlor epoxide	**2.9 J**	0.39 U	--	**0.66**	--	--	--
Methoxychlor	0.29 U	0.57 U	--	0.58 U	--	--	--
Mirex	0.29 U	0.3 U	--	0.21 U	--	--	--
Oxychlordane	1.1 U	1.1 U	--	0.34 U	--	--	--
Toxaphene	34 U	27 U	--	43 U	--	--	--
LWG RI Total 2,4' and 4,4'-DDD (Reported, not calculated)	**2.4 J**	**3.3 J**	--	**18**	--	--	--
LWG RI Total 2,4' and 4,4'-DDD, -DDE, -DDT (Reported, not calculated)	**6.5 J**	**8.9 J**	--	**33 J**	--	--	--
LWG RI Total 2,4' and 4,4'-DDE (Reported, not calculated)	**2**	**2.4**	--	**5.9 J**	--	--	--
LWG RI Total 2,4' and 4,4'-DDT (Reported, not calculated)	**2.1 J**	**3.1 J**	--	**9**	--	--	--
LWG RI Total 4,4'-DDD, -DDE, -DDT (Reported, not calculated)	--	--	--	--	--	--	--
LWG RI Total Chlordanes (Reported, not calculated)	**1.6 J**	**0.83 J**	--	1.9 U	--	--	--
LWG RI Total Endosulfan (Reported, not calculated)	1.2 U	0.99 U	--	0.34 U	--	--	--
Herbicides (µg/kg)							
2,4-D (2,4-Dichlorophenoxyacetic acid)	11 U	**25 J**	--	44 U	--	--	--
2,4-DB (2,4-D derivative)	**25 J**	620 U	--	24 U	--	--	--
2,4,5-T (2,4,5-Trichlorophenoxyacetic acid)	9.2 U	9.5 U	--	14 U	--	--	--
2,4,5-TP (Silvex)	17 U	9.2 U	--	17 U	--	--	--
2,2-Dichloropropionic acid (Dalapon)	41 U	42 U	--	110 U	--	--	--

Table 2.9.11-1
LWG Sediment Trap Analytical Results – Vicinity of Gasco and Siltronic Properties

Location ID:	LW3-ST005	LW3-ST005	LW3-ST005	LW3-ST005	RAA-STBU	RAA-STBM	RAA-STBD
Sample ID:	LW3-ST1005-1	LW3-ST-2005	LW3-ST3005	LW3-ST4-005	RAA-STBU-050817	RAA-STBM-050818	RAA-STBD-050817
Sample Date:	01/30/2007	04/30/2007	08/08/2007	11/13/2007	8/17/2005	8/18/2005	8/17/2005
Dicamba	13 U	13 U	--	12 U	--	--	--
Dichlorprop	9 U	9.2 U	--	11 U	--	--	--
Dinoseb	46 U	48 U	--	22 UJ	--	--	--
MCPA	7800 U	15000 U	--	3400 U	--	--	--
Mecoprop (MCPP)	6700 U	6800 U	--	840 U	--	--	--
Dioxin Furans (ng/kg)							
2,3,7,8-Tetrachlorodibenzo-p-dioxin (TCDD)	0.013 U	0.145 U	--	0.0211 U	--	--	--
1,2,3,7,8-Pentachlorodibenzo-p-dioxin (PeCDD)	**0.154 J**	0.087 U	--	**0.0464 J**	--	--	--
1,2,3,4,7,8-Hexachlorodibenzo-p-dioxin (HxCDD)	**0.212 J**	0.131 U	--	**0.0692 J**	--	--	--
1,2,3,6,7,8-Hexachlorodibenzo-p-dioxin (HxCDD)	**1 J**	0.772 U	--	**0.459 J**	--	--	--
1,2,3,7,8,9-Hexachlorodibenzo-p-dioxin (HxCDD)	**0.739 J**	0.38 U	--	**0.233 J**	--	--	--
1,2,3,4,6,7,8-Heptachlorodibenzo-p-dioxin (HpCDD)	**24.7**	**17.286**	--	**10.5**	--	--	--
1,2,3,4,6,7,8,9-Octachlorodibenzo-p-dioxin (OCDD)	**255**	**131.823**	--	**103**	--	--	--
2,3,7,8-Tetrachlorodibenzofuran (TCDF)	0.875 U	1.914 U	--	**1.19**	--	--	--
1,2,3,7,8-Pentachlorodibenzofuran (PeCDF)	**0.57 J**	**2.087 J**	--	**1.24 J**	--	--	--
2,3,4,7,8-Pentachlorodibenzofuran (PeCDF)	**0.333 J**	**0.48 J**	--	**0.492 J**	--	--	--
1,2,3,4,7,8-Hexachlorodibenzofuran (HxCDF)	**1.6 J**	**8.083**	--	**1.26 J**	--	--	--
1,2,3,6,7,8-Hexachlorodibenzofuran (HxCDF)	**0.411 J**	**1.212 J**	--	**0.473 J**	--	--	--
1,2,3,7,8,9-Hexachlorodibenzofuran (HxCDF)	0.077 U	0.107 U	--	0.0499 U	--	--	--
2,3,4,6,7,8-Hexachlorodibenzofuran (HxCDF)	**0.311 J**	0.166 U	--	**0.216 J**	--	--	--
1,2,3,4,6,7,8-Heptachlorodibenzofuran (HpCDF)	**3.92 J**	**4.789 J**	--	**1.61 J**	--	--	--
1,2,3,4,7,8,9-Heptachlorodibenzofuran (HpCDF)	**0.509 J**	**1.715 J**	--	0.305 U	--	--	--
1,2,3,4,5,6,7,8-Octachlorodibenzofuran (OCDF)	**13.8**	**14.831 J**	--	**6.77 J**	--	--	--
Total Tetrachlorodibenzo-p-dioxin (TCDD)	**0.795**	0.145 U	--	**0.42 J**	--	--	--
Total Pentachlorodibenzo-p-dioxin (PeCDD)	**0.478**	0.087 U	--	**0.354 J**	--	--	--
Total Hexachlorodibenzo-p-dioxin (HxCDD)	**7.48**	**3.589**	--	**3.49 J**	--	--	--
Total Heptachlorodibenzo-p-dioxin (HpCDD)	**59.9**	**47.832**	--	**26.4**	--	--	--
Total Tetrachlorodibenzofuran (TCDF)	**2.39**	**0.927**	--	**3.39**	--	--	--
Total Pentachlorodibenzofuran (PeCDF)	**3.67**	**5.064**	--	**3.84 J**	--	--	--
Total Hexachlorodibenzofuran (HxCDF)	**7.01**	**12.518**	--	**3.05 J**	--	--	--
Total Heptachlorodibenzofuran (HpCDF)	**12.1**	**13.886**	--	**4.68 J**	--	--	--
LWG RI Total Dioxin/Furan TEQ (Reported, not calculated) (U = 0)	**1.07 J**	**1.42 J**	--	**0.775 J**	--	--	--
LWG RI Total PCDD/F (Reported, not calculated)	**363**	**230 J**	--	**155 J**	--	--	--
LWG RI Total TCDD toxicity equivalent (Reported, not calculated) (U = 0)	**1.39 J**	**1.74 J**	**0.0363**	**1.37 J**	--	--	--
Total Petroleum Hydrocarbons (mg/kg)							
Total petroleum hydrocarbons	**670 J**	**710 J**	--	**890 J**	--	--	--
Diesel Range Hydrocarbons	**65 J**	**100 J**	--	**160 J**	--	--	--
Gasoline Range Hydrocarbons	**11 J**	**13 J**	--	4.5 U	--	--	--
Residual Range Hydrocarbons	**590 J**	**600 J**	--	**730 J**	--	--	--

Notes:

Bold	Detected result
J	Estimated value
U	Compound analyzed, but not detected above detection limit
UJ	Compound analyzed, but not detected above estimated detection limit
R	Rejected

Table 2.10-1
Potential Historical Sources and Transport Pathways Assessment–Gasco Property

Potential Sources	Media Impacted					COIs												Potential Complete Pathway				
						TPH			VOCs													
Description of Potential Source	Surface Soil	Subsurface Soil	Groundwater	Catch Basin Solids	River Sediment	Gasoline-Range	Diesel - Range	Heavier - Range	Petroleum-Related (e.g. BTEX)	VOCs	Chlorinated VOCs	SVOCs	PAHs	Metals	PCBs	Herbicides and Pesticides	Cyanide	Overland Transport	Groundwater	Direct Discharge - Overwater	Direct Discharge - Storm/Wastewater	Riverbank Erosion
Upland Areas																						
Former Retort Area		√	√						√				√						√			
Former Tar Processing Area		√	√						√				√						√			
Former Light Oil Plant/Koppers Co. Plant/Current KI Tank Farm		√	√						√				√						√			
Former Naphthalene Plant		√	√						√				√						√			
Former Coke Oven Area		√	√						√				√						√			
Former Pitch Plant/Tar Loading Area		√	√						√				√						√			
Former Tar Settling Ponds		√	√		√				√				√						√			
Former Koppers Land Disposal Area		√	√						√				√						√			
Former Koppers Co./ Current KI Pencil Pitch Storage Area	√			?	?								√									
Former Spent Oxide Storage Area		√	√						√				√	√			√		√			√
MGP By-Product Incorporation into Fill (on-site and off-site at adjacent Siltronic)	√	√	√	?	?				√				√	√			√		√		√	√
Former Effluent Pond Oveflow Area (off-site at northern end of Siltronic)		√	√		√				√				√						√			
Former Spent Oxide Storage Pile (off site at western corner of Siltronic)		√	?						√				√	√			√		√			
Former Excavation/ Apparent Tar Disposal Area (off-site at Siltronic)		?	?						√				√						√			
Overwater Areas																						
Releases during product transfer from vessels					?		√	√	√				√							√		
Other Areas/Other Issues																						
Historic direct discharge of tar and oil to river					√				√				√					√				

Notes:

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Blank Source, COI and current pathways have been investigated and shown to be not present or incomplete.

UST Underground storage tank

AST Above-ground storage tank

TPH Total petroleum hydrocarbons

VOCs Volatile organic compounds

SVOCs Semivolatile organic compounds

PAHs Polycyclic aromatic hydrocarbons

BTEX Benzene, toluene, ethylbenzene, and xylenes

PCBs Polychorinated biphenols

Table 2.10-2
Potential Current Sources and Transport Pathways Assessment–Gasco Property

Potential Sources	Media Impacted					COIs												Potential Complete Pathway				
						TPH			VOCs													
Description of Potential Source	Surface Soil	Subsurface Soil	Groundwater	Catch Basin Solids	River Sediment	Gasoline-Range	Diesel - Range	Heavier - Range	Petroleum-Related (e.g. BTEX)	VOCs	Chlorinated VOCs	SVOCs	PAHs	Metals	PCBs	Herbicides and Pesticides	Cyanide	Overland Transport	Groundwater	Direct Discharge - Overwater	Direct Discharge - Storm/Wastewater	Riverbank Erosion
Upland Areas																						
Former Retort Area		√	√						√				√						√			
Former Tar Processing Area		√	√						√				√						√			
Former Light Oil Plant/Koppers Co. Plant/Current KI Tank Farm		√	√						√				√						√			
Former Naphthalene Plant		√	√						√				√						√			
Former Coke Oven Area		√	√						√				√						√			
Former Pitch Plant/Tar Loading Area		√	√						√				√						√			
Former Tar Settling Ponds		√	√		√				√				√						√			
Former Koppers Land Disposal Area		√	√						√				√						√			
Former Koppers Co./ Current KI Pencil Pitch Storage Area	√			?	?								√					√				
Former Spent Oxide Storage Area		√	√						√				√	√			√		√			√
MGP By-Product Incorporation into Fill (on-site and off-site at adjacent Siltronic)	√	√	√	?	?				√				√	√			√	√	√		√	√
Former Effluent Pond Oveflow Area (off-site at northern end of Siltronic)		√	√		√				√				√						√			
Former Spent Oxide Storage Pile (off site at western corner of Siltronic)		√	?						√				√	√			√		√			
Former Excavation/ Apparent Tar Disposal Area (off-site at Siltronic)		?	?						√				√						√			
Overwater Areas																						
Releases during product transfer from vessels					?		√	√	√				√							√		
Other Areas/Other Issues																						
Historic direct discharge of tar and oil to river					√				√				√									

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AST Above-ground storage tank

TPH Total petroleum hydrocarbons

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SVOCs Semivolatile organic compounds

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BTEX Benzene, toluene, ethylbenzene, and xylenes

PCBs Polychorinated biphenols

Table 2.10-3
Potential Historical Sources and Transport Pathways Assessment–Siltronic Property

Potential Sources	Media Impacted					COIs												Potential Complete Pathway				
						TPH			VOCs													
Description of Potential Source	Surface Soil	Subsurface Soil	Groundwater	Catch Basin Solids	River Sediment	Gasoline-Range	Diesel - Range	Heavier - Range	Petroleum-Related (e.g. BTEX)	VOCs	Chlorinated VOCs	SVOCs	PAHs	Metals	PCBs	Herbicides and Pesticides	Cyanide	Overland Transport	Groundwater	Direct Discharge - Overwater	Direct Discharge - Storm/Wastewater	Riverbank Erosion
Upland Areas																						
PG&C Disposal Ponds and Adjacent Lowland Areas	?	√	√		√		√	√	√	√		√	√	√			√	√	√	√		
PG&C Disposal Piles	?	√	√		√		√	√	√	√		√	√	√			√	√	√	√		
Potential PG&C Waste Product Fill - WWTP Area	?	√	√		√		√	√	√	√		√	√	√			√	√	√	√		
Potential PG&C Waste Product Fill - Fab 1 and Parking Lot	?	√	√		√		√	√	√	√		√	√	√			√	√	√	√		
Potential Disposal Area		√	√		√		√	√	√	√		√	√	√			√		√	√		
North Drainage Ditch and COP Outfall 22	?	√	√		?		√	√	√	√		√	√	√			√	?	√		√	
Former Western Transportation Tanks		√	√		?		√	√	√	√		√	√						√			
Olympic Pipeline		√	√		?	√	√	√	√	√		√	√						√			
Former TCE USTs		√	√		?					√	√								√			
Kinder Morgan Pumping Station		√	√		?				√										?			
RhonePoulenc AG Company	?	√	√		?					√	√					√			√			
Contaminated Fill	?	?	?		?		?	?	?		?	?	?	?			?		?			?
Overwater Areas																						
Former Western Transportation Dock				√	?	?	?	?				√	√					√				

Notes:

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AST Above-ground storage tank
TPH Total petroleum hydrocarbons
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SVOCs Semivolatile organic compounds
PAHs Polycyclic aromatic hydrocarbons
BTEX Benzene, toluene, ethylbenzene, and xylenes
PCBs Polychorinated biphenols

Table 2.10-4
Potential Current Sources and Transport Pathways Assessment–Siltronic Property

Potential Sources	Media Impacted					COIs												Potential Complete Pathway				
						TPH			VOCs													
Description of Potential Source	Surface Soil	Subsurface Soil	Groundwater	Catch Basin Solids	River Sediment	Gasoline-Range	Diesel - Range	Heavier - Range	Petroleum-Related (e.g. BTEX)	VOCs	Chlorinated VOCs	SVOCs	PAHs	Metals	PCBs	Herbicides and Pesticides	Cyanide	Overland Transport	Groundwater	Direct Discharge - Overwater	Direct Discharge - Storm/Wastewater	Riverbank Erosion
Upland Areas																						
PG&C Disposal Ponds and Adjacent Lowland Areas	?	√	√		√		√	√	√	√		√	√	√			√		√	√		
PG&C Disposal Piles	?	√	√		√		√	√	√	√		√	√	√			√		√	√		
Potential PG&C Waste Product Fill - WWTP Area	?	√	√		√		√	√	√	√		√	√	√			√		√	√		
Potential PG&C Waste Product Fill - Fab 1 and Parking Lot	?	√	√		√		√	√	√	√		√	√	√			√		√	√		
Potential Disposal Area		√	√		√		√	√	√	√		√	√	√			√		√	√		
North Drainage Ditch and COP Outfall 22	?	√	√		?		√	√	√	√		√	√	√			√		√		√	
Former Western Transportation Tanks		√	√		?		√	√	√	√		√	√						√			
Olympic Pipeline		√	√		?	√	√	√	√	√		√	√						√			
Former TCE USTs		√	√		?					√	√								√			
Kinder Morgan Pumping Station		√	√		?				√										?			
RhonePoulenc AG Company	?	√	√		?					√	√					√			√			
Contaminated Fill	?	?	?		?		?	?	?		?	?	?	?			?		?			?

Notes:

Table from Lower Willamette Group Conceptual Site Model Summary Report.

1 All information provided in this table is referenced in the site summaries. If information is not available or inconclusive, a ? may be used, as appropriate. No new information is provided in this table.

√ Source, COIs are present or current pathway is determined to be complete or potentially complete.
? There is not enough information to determine if source or COI is present or if pathway is complete.
Blank Source, COI and current pathways have been investigated and shown to be not present or incomplete.
UST Underground storage tank
AST Above-ground storage tank
TPH Total petroleum hydrocarbons
VOCs Volatile organic compounds
SVOCs Semivolatile organic compounds
PAHs Polycyclic aromatic hydrocarbons
BTEX Benzene, toluene, ethylbenzene, and xylenes
PCBs Polychorinated biphenols

Table 3.1-1
Potential Applicable or Relevant and Appropriate Requirements and To Be Considered Initiatives for the Gasco Sediments Cleanup Action

Regulation	Citation	Applicability/Relevance and Appropriateness
FEDERAL ARARS		
CLEAN WATER ACT	33 U.S.C. §§1251 et seq.	
Federal Water Quality Criteria	CWA §§303 and 304	Chemical-specific—chronic criteria for protection of freshwater aquatic life only, based on RAO # 6 (relevant and appropriate). Chronic National Recommended Water Quality Criteria for the protection of freshwater aquatic life are potentially relevant if state does not have established numeric criterion for specific constituent of concern. If a state has promulgated a WQC for a given chemical and use, the state standard would be relevant and appropriate rather than the federal WQC. *EPA, CERCLA Compliance with Other Laws Manual (Aug. 1988) at § 3.2.3.2*. Once approved by EPA (such as DEQ Table 20), the state WQC is enforced by EPA as the federal WQC for that state. DEQ Table 33A has been adopted by the State but has not yet been approved by EPA. Action-specific (relevant and appropriate): Potentially relevant and appropriate when water is discharged from dewatering or treatment areas at sediment cleanup sites *EPA, Contaminated Sediment Remediation Guidance for Hazardous Waste Sites (Dec. 2005) at 3.3.* See discussion above regarding relationship between federal and state criteria.
Discharge of dredge and fill material	CWA §404, including §404(b)(1) guidelines set forth at 40 CFR Part 230	Action-specific (applicable). Substantive requirements of CWA §404 are potentially applicable in the event of discharges of dredged or fill materials into waters of the U.S.; specifically, dredging, capping, certain enhanced natural attenuation, and construction of in-water or nearshore disposal facilities (including CDFs) in the Willamette River. Unavoidable impacts must be minimized, and impacts that cannot be minimized must be mitigated.
Discharge of pollutants to waters	CWA §401, including 40 CFR Part 121.2(a)(3) and (4)	Action-specific (applicable). State certification process if CWA § 404 jurisdiction triggered, which EPA is responsible for implementing. Potentially applicable to dredging, capping, and nearshore disposal facilities in the Willamette River.
NPDES program	CWA §402 40 CFR Part 125, Subpart A	Action-specific (relevant and appropriate if no state promulgated program). Potentially relevant and appropriate requirement for point source discharges (other than from dredged materials covered under CWA §404 and §401). Where states have been delegated authority for the NPDES program under the CWA, EPA will consult with and apply the state program. *EPA, Contaminated Sediment Guidance at Highlight 3-2*.

Table 3.1-1
Potential Applicable or Relevant and Appropriate Requirements and To Be Considered Initiatives for the Gasco Sediments Cleanup Action

Regulation	Citation	Applicability/Relevance and Appropriateness
FEMA (Federal Emergency Management Act)	42 U.S.C. §§ 5170 et seq. 44 CFR 60.3(d)(3)	Action-specific and location-specific (applicable). This requirement is potentially applicable to remedial activities in upland flood plains and in the Willamette River that would result in increasing flood heights within the floodplain.
RIVERS AND HARBORS ACT OF 1899, Section 10	33 U.S.C. §§401 et seq. 33 CFR parts 320 to 323	Action-specific and location specific (applicable). Substantive requirements of Section 10 would be potentially applicable to construction of any structure within a navigable waterway that would impede navigation and commerce, potentially including capping and construction of CDFs. May overlap with CWA § 404 substantive requirements.
CLEAN AIR ACT	42 U.S.C. §§7401 et seq.	Action-specific. Potentially applicable if dredging and/or excavation activities generate air emissions.
ENDANGERED SPECIES ACT	16 U.S.C. §§ 1531 et seq.	Action-specific and location-specific (applicable). Section 7 of Endangered Species Act "requires federal agencies to ensure that the actions they authorize, fund or carry out are not likely to jeopardize the continued existence of endangered or threatened species, or adversely modify or destroy their critical habitat." *EPA, Contaminated Sediment Guidance at 3-8*. Potentially applicable due to impacts that sediment excavation and/or dredging may have on endangered or threatened species or critical habitat that are present at the site or that may be affected by the action.
MARINE MAMMAL PROTECTION ACT	16 U.S.C. §§1361 et seq. 50 CFR 216	Action-specific and location-specific (applicable). Potentially applicable due to impacts that sediment excavation and/or dredging may have on marine mammals that are present at the site or that may be affected by the action.
HAZARDOUS MATERIALS TRANSPORTATION ACT, U.S. DOT Subchapter C regulations	49 U.S.C. §§1801 et seq. 40 CFR Parts 171-177	Action-specific (applicable). Potentially applicable requirement to any hazardous sediments that are removed (excavated and/or dredged) and shipped off-site for disposal or remediation.
NATIONAL HISTORIC PRESERVATION ACT	16 U.S.C. §§ 470 et seq.	Action-specific and location-specific (applicable). Potentially applicable to dredging and/or excavation activities and requires EPA to consider whether cultural resources included on or eligible for inclusion on the National Register of Historic Places will be affected.

Table 3.1-1
Potential Applicable or Relevant and Appropriate Requirements and To Be Considered Initiatives for the Gasco Sediments Cleanup Action

Regulation	Citation	Applicability/Relevance and Appropriateness
ARCHEOLOGICAL AND HISTORIC PRESERVATION ACT	16 U.S.C. §§469 et seq.	Action-specific and location-specific (applicable). Potentially applicable to dredging and/or excavation activities and requires EPA to consider whether historical and archaeological data may be irreparably lost through dam construction or alteration of terrain, and mandates preservation of the data.
MIGRATORY BIRD TREATY ACT	16 U.S.C. §§703-712 50 CFR §10.12	Action-specific and location-specific (applicable). Potentially applicable to dredging and/or excavation activities, requires EPA to consider whether such activities would result in short-term impacts, if any, on migratory birds that would cause a measurable negative effect of migratory bird populations (as explained in Executive Order 13186, 1/10/01), and specifically prohibits any activity that would be considered "pursue, hunt, take, capture, kill, attempt to take, capture, or kill, possess, offer for sale, sell, offer to barter, barter, offer to purchase, purchase, deliver for shipment, ship, export, import, cause to be shipped, exported, or imported, deliver for transportation, transport or cause to be transported, carry or cause to be carried, or receive for shipment, transportation, carriage, or export, any migratory bird…"
RCRA—Hazardous waste	42 U.S.C. §§6901 et seq.	Action-specific (relevant and appropriate). "Dredged material may be subject to RCRA requirements if it contained a listed waste, or if it displays a hazardous waste characteristic, for example, by the Toxicity Characteristic Leaching Procedure (TCLP). Most states have been authorized in lieu of EPA to implement the RCRA program. RCRA regulations may be potentially ARARs for the storage, treatment, or disposal of the dredged material unless an exemption applies. One such exemption is if CWA 404 applies to the cleanup activity (40 CFR part 261)." *EPA, Contaminated Sediment Guidance at Highlight 3-2.* RCRA requirements would be potentially applicable to the identification of any such dredged material this is a hazardous waste, and off-site management (treatment, storage, and disposal) of such hazardous waste. *CERCLA Compliance with Other Laws Manual (Aug. 1988) at § 2.3*. Addresses all potential storage/disposal scenarios of dredged material that is a hazardous waste, including land disposal, waste piles, surface impoundments and corrective action management units (CAMU). NOTE: hazardous waste management rules adopted by reference in OAR §340-100-0002(1), see below.
RCRA--Solid waste Solid Waste Disposal Facilities	42 U.S.C. §§6901 et seq. 40 CFR 257, Subpart A	Action-specific (relevant and appropriate, state promulgated program would apply). May be potentially relevant and appropriate if a landfill is used for the disposal of non-hazardous "solid waste."

Table 3.1-1
Potential Applicable or Relevant and Appropriate Requirements and To Be Considered Initiatives for the Gasco Sediments Cleanup Action

Regulation	Citation	Applicability/Relevance and Appropriateness
STATE ARARs		**WILL ONLY APPLY IF STATE-PROMULGATED, CONSISTENTLY APPLIED, AND MORE STRINGENT THAN FEDERAL REQUIREMENTS.**
ENVIRONMENTAL CLEANUP ACT	ORS 465.200 et seq. OAR 340-122-0090; OAR 340-122-040	Action-specific (applicable). Includes requisite standards for remedy selection. Does not contain numeric criteria. Potentially applicable to remediation goals, and evaluation and selection of remedial alternatives.
HAZARDOUS WASTE	ORS 466.005 - 465.225; OAR 340-101-0033; OAR 340-104-0339	Action-specific (applicable). Oregon has been authorized by EPA to implement the RCRA Subtitle C Hazardous Waste Program. See description above. Dredged material will be subject to RCRA hazardous waste requirements if it contains a listed waste, or if it displays a hazardous waste characteristic, unless the storage or disposal is subject to CWA § 404.
SOLID WASTE	ORS Chapter 459	Action-specific (applicable). Only applies if upland facility for solid, non-hazardous, waste disposal, handling, treatment, or transfer contemplated. Regulations for the location, design, construction, operation and closure of solid waste management facilities.
AIR QUALITY; Fugitive Emission Requirements, Visible Air Contaminant Limitations	ORS Chapter 468A; OAR 340-226-0100; OAR 340-208-0200, 0210; OAR 340-208-0110	Action-specific (applicable). Prohibits any handling, transporting or storage of materials, or use of a road, or any equipment to be operated, without taking reasonable precautions to prevent particulate matter from becoming airborne. These are special rules for "special control areas," including Multnomah County. Prohibits the emission of any air contaminant from a new source for a period or periods aggregating more than three minutes in any one hour that is equal to or greater than 20% opacity. These are special rules for "special control areas," including Multnomah County. Potentially applicable if stationary sources generate air emissions.
Noise Control	OAR 340-035-0035	Action-specific (applicable). Sets noise standards for equipment, facilities, operations, or activities employed in the production, storage, handling, sale, purchase, exchange, or maintenance of a product, commodity, or service, including the storage or disposal of waste products. This requirement is potentially applicable to some remedial activities.

Table 3.1-1
Potential Applicable or Relevant and Appropriate Requirements and To Be Considered Initiatives for the Gasco Sediments Cleanup Action

Regulation	Citation	Applicability/Relevance and Appropriateness
WATER QUALITY		
State Water Quality Standards	OAR Ch. 340, Div. 041	Chemical-specific – chronic freshwater criteria only, based on RAO #6 (relevant and appropriate). Designates beneficial uses for water bodies and narrative and numeric water quality criteria necessary to protect those uses. In particular, OAR 340-041-0340 designates and defines the beneficial uses that shall be protected in the Willamette Basin. For purposes of state law, Table 20 are the effective criteria unless there is a corresponding criterion under Table 33A, in which case Table 33A is effective. Action-specific: Potentially applicable for discharges to surface water at sediment cleanup sites. *EPA Sediment Cleanup Guidance at Highlight 3-2*. Also potentially applicable to dredge and fill activities through substantial equivalent of section 401 certification.
NPDES / WPCF Permits	OAR Ch. 340 Div. 45.	Action-specific (applicable). Oregon DEQ issues NPDES permits for direct discharges into waters of the state, and Water Pollution Control Facilities (WPCF) permits for discharges of wastewater to the ground. May be potentially applicable to point-source discharges to the Willamette River (other than discharges from dredged materials) or onto the ground during remediation.
STATE HARBOR LINE STATUTE	ORS 778.085	Action-specific and location-specific (applicable). Potentially applicable to construction of any structure or cap on the riverside of the harbor line that constitutes a hazard to or obstruction of navigation.

Table 3.1-1
Potential Applicable or Relevant and Appropriate Requirements and To Be Considered Initiatives for the Gasco Sediments Cleanup Action

Regulation	Citation	Applicability/Relevance and Appropriateness
OTHER CRITERIA, ADVISORIES, GUIDANCE, AND TO BE CONSIDERED INITIATIVES		
Executive Orders for Floodplain and Wetlands Management	Executive Order 11988 and 11990	Executive Order 11988 requires federal agencies to conduct their activities to avoid, if possible, adverse impacts associated with the occupation or modification of floodplains. Executive Order 11990 requires federal agencies to conduct their activities to avoid, if possible, adverse impacts associated with the destruction or modification of wetlands.
Watershed Management & Enhancement and The Oregon Plan	ORS Chapter 541	Establishes the Oregon Plan for "integrating regulatory efforts while fostering incentives and voluntary action for environmental stewardship"; creates the Oregon Watershed Enhancement Board and watershed councils and requires those entities to conduct a watershed enhancement program; creates some funds for watershed enhancement. May be relevant to selection of remedial alternatives.
WY-KAN-USH-MI WA-KISH WIT	www.critfc.org/text/TRP.HTM	The plan's objectives are to halt the decline of salmon, lamprey and sturgeon populations above Bonneville Dam within seven years. To rebuild salmon populations to annual run sizes of four million above Bonneville Dam within 25 years in a manner that supports tribal ceremonial, subsistence and commercial harvests. To increase lamprey and sturgeon to naturally sustaining levels within 25 years in a manner that supports tribal harvests. To achieve these objectives, the plan emphasizes strategies and principles that rely on natural production and healthy river systems. Simply stated, the plan's purpose is to *put fish back in the rivers and protect the watersheds where fish live*. Sets forth the Columbia River Anadromous Fish Plan of the Nez Perce, Umatilla, Warm Springs, and Yakama Tribes; goals: to restore anadromous fishes to the rivers and streams that support historical cultural and economic practices of the tribes, (generally in areas above Bonneville Dam); to emphasize natural production and healthy river system strategies, to protect tribal sovereignty and treaty rights, and to reclaim the anadromous fish resource and the environment on which it depends; geographic scope of the plan extends to Columbia River Basin and Pacific ocean regions where anadromous fish migrate and wherever activities occur that directly affect them. This Plan is a tribal document, and is not necessarily applicable to other sovereigns. It does not include substantive standards and does not expressly apply to the Willamette Basin. However, its content can be generally considered in the development and selection of remedial alternatives.

Table 3.1-2
Proposed Numeric Levels and Application Related to Action Specific Applicable or Relevant and Appropriate Requirements for the Gasco Sediments Cleanup Action

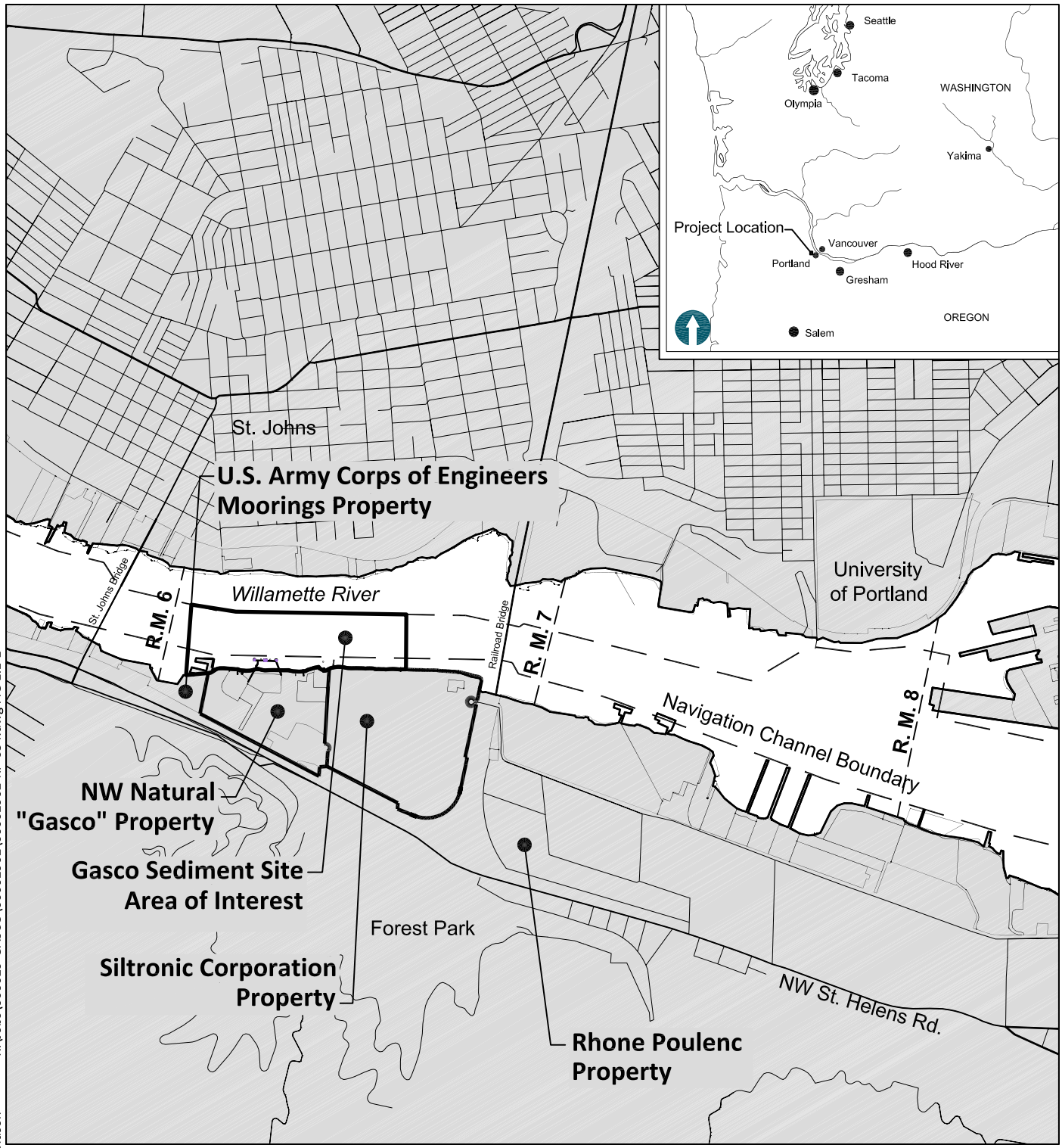
Regulation	Citation	Potentially Related Technologies	Potential Numeric Levels	Proposed Application
FEDERAL ARARS				
CLEAN WATER ACT	33 U.S.C. §§1251 et seq.			
Federal Water Quality Criteria	CWA §§303 and 304	Dredging Excavation (runoff) Capping Covers EMNR Dewater Facilities CADs/CDFs	National Ambient Water Quality Criteria Acute for construction and chronic for long term effectiveness	Construction (Short Term Effectiveness) • Dredging – 300 ft from point of dredging • Capping/Cover/EMNR – 300 ft from point of placement • CDF/Dewater/Excavation – 300 ft from point of discharge Long Term Effectiveness • Dredging - Surface water above new surface (residual layer) • Capping/Cover/EMNR/CAD – Surface water above new sediment surface • CDF – Surface water in front of berm
RCRA	42 USC §6901 et seq.	Dredging, excavation with offsite disposal	Toxicity Characteristic Leaching Procedure Values	During transport, handling, treatment and/or disposal, when the final destination is offsite.
STATE ARARs				
HAZARDOUS WASTE	ORS 466.005 - 465.225	Disposal technologies (offsite disposal)	Yes (see RCRA)	During transport, handling, treatment and/or disposal.

Table 3.1-2
Proposed Numeric Levels and Application Related to Action Specific Applicable or Relevant and Appropriate Requirements for the Gasco Sediments Cleanup Action

Regulation	Citation	Potentially Related Technologies	Potential Numeric Levels	Proposed Application
WATER QUALITY				
State Water Quality Standards	OAR 340-041-0001 to -0061; OAR 340-041-0340 to-0345	Dredging Excavation (runoff) Capping Covers EMNR Dewater Facilities CADs/CDFs	State Surface Water Quality Standards Acute for construction and chronic for long term effectiveness	Construction (Short Term Effectiveness) • Dredging – 300 ft from point of dredging • Capping/Cover/EMNR – 300 ft from point of placement • CDF/Dewater/Excavation – 300 ft from point of discharge Long Term Effectiveness • Dredging - Surface water above new surface (residual layer) • Capping/Cover/EMNR/CAD – Surface water above new sediment surface • CDF – Surface water in front of berm

Note:
The noted Numeric ARAR will be applied at the noted Point of Compliance only where there is a complete pathway related to the exposure in question.
CWA – Clean Water Act
EMNR – Enhanced Monitored Natural Recovery
CAD – Confined Aquatic Disposal
CDF – Confined Disposal Facility (at least partially below normal water line)

FIGURES



NOTE: All locations are approximate.

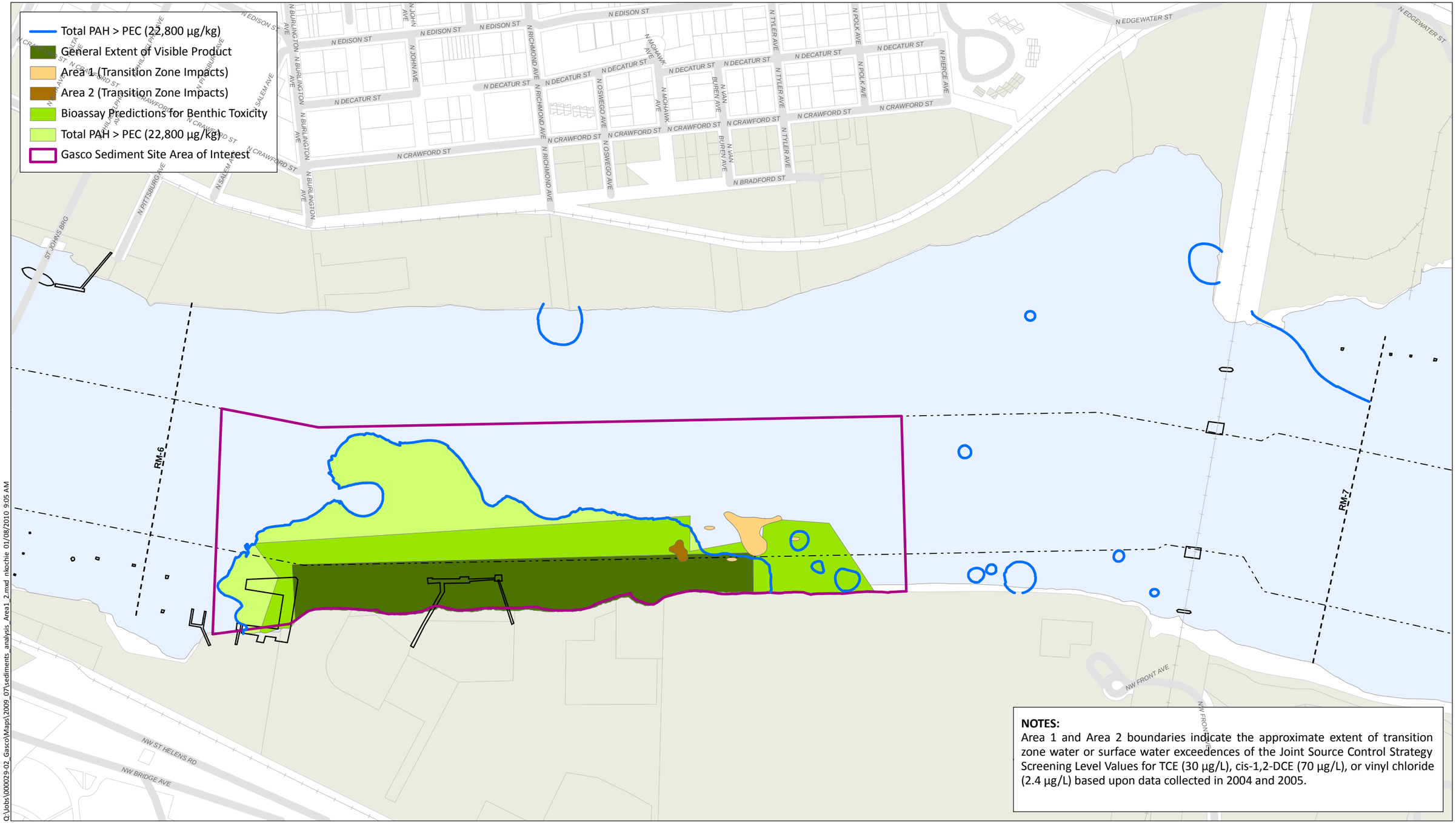
0 2000
Scale in Feet

K:\Jobs\000029-GASCO\00002902\00002902-RP-054.dwg FIG 1.1-1

Jan 11, 2010 9:55am cdavidson

Figure 1.1-1
Site Vicinity Map
NW Natural "Gasco" Site
Gasco Sediment Cleanup Action

ANCHOR QEA



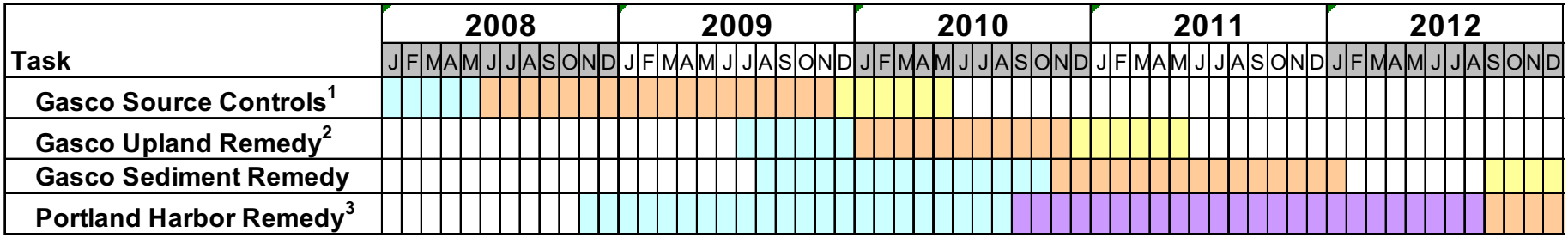
NOTES:
Area 1 and Area 2 boundaries indicate the approximate extent of transition zone water or surface water exceedences of the Joint Source Control Strategy Screening Level Values for TCE (30 µg/L), cis-1,2-DCE (70 µg/L), or vinyl chloride (2.4 µg/L) based upon data collected in 2004 and 2005.

Q:\Jobs\000029-02_Gasco\Maps\2009_07\sediments_analysis_Area1_2.mxd nkochie 01/08/2010 9:05 AM

ANCHOR QEA

Feet
0 190 380 570 760

Figure 1.2-1
Potential Remediation Extents Based on the Data Available as of July 2009
NW Natural "Gasco" Site
Gasco Sediment Removal Action



Footnotes:

Figure 2 is for illustrative purposes only and is not an enforceable schedule under this Administrative Settlement.

- Data Collection and FS Phase
- Design Phase
- Construction Phase
- EPA FS Review, Proposed Plan, and ROD

1. Gasco source controls are being evaluated and implemented by NW Natural through an Order with Oregon DEQ. The noted timeline is estimated and dependent upon the timeliness and content of DEQ comments, over which NW Natural has no control.

2. The Gasco upland remedy is being evaluated and implemented by NW Natural through an Order with Oregon DEQ. The noted timeline is estimated and dependent upon the timeliness and content of DEQ comments, over which NW Natural has no control.

3. The Portland Harbor remedy is being evaluated through an RI/FS conducted by the Lower Willamette Group (LWG), which is under Order with EPA Region 10. EPA is solely responsible for FS Review, the Harbor Proposed Plan, and the Harbor Record of Decision (ROD). The noted timeline is estimated and dependent upon the ability of the LWG to meet the RI/FS submittal timeline, the timeline and content of EPA comments on the RI/FS, as well as EPA's timing for developing the Proposed Plan and ROD. NW Natural has no control over these factors.

12/29/2009 djh K:\Jobs\000029-GASCO\00002902\CorelDRAW figs\SCA\1.2-2.cdr

ANCHOR QEA

Figure 1.2-2
Summary of Programmatic Sequencing
NW Natural "Gasco" Site
Gasco Sediment Cleanup Action

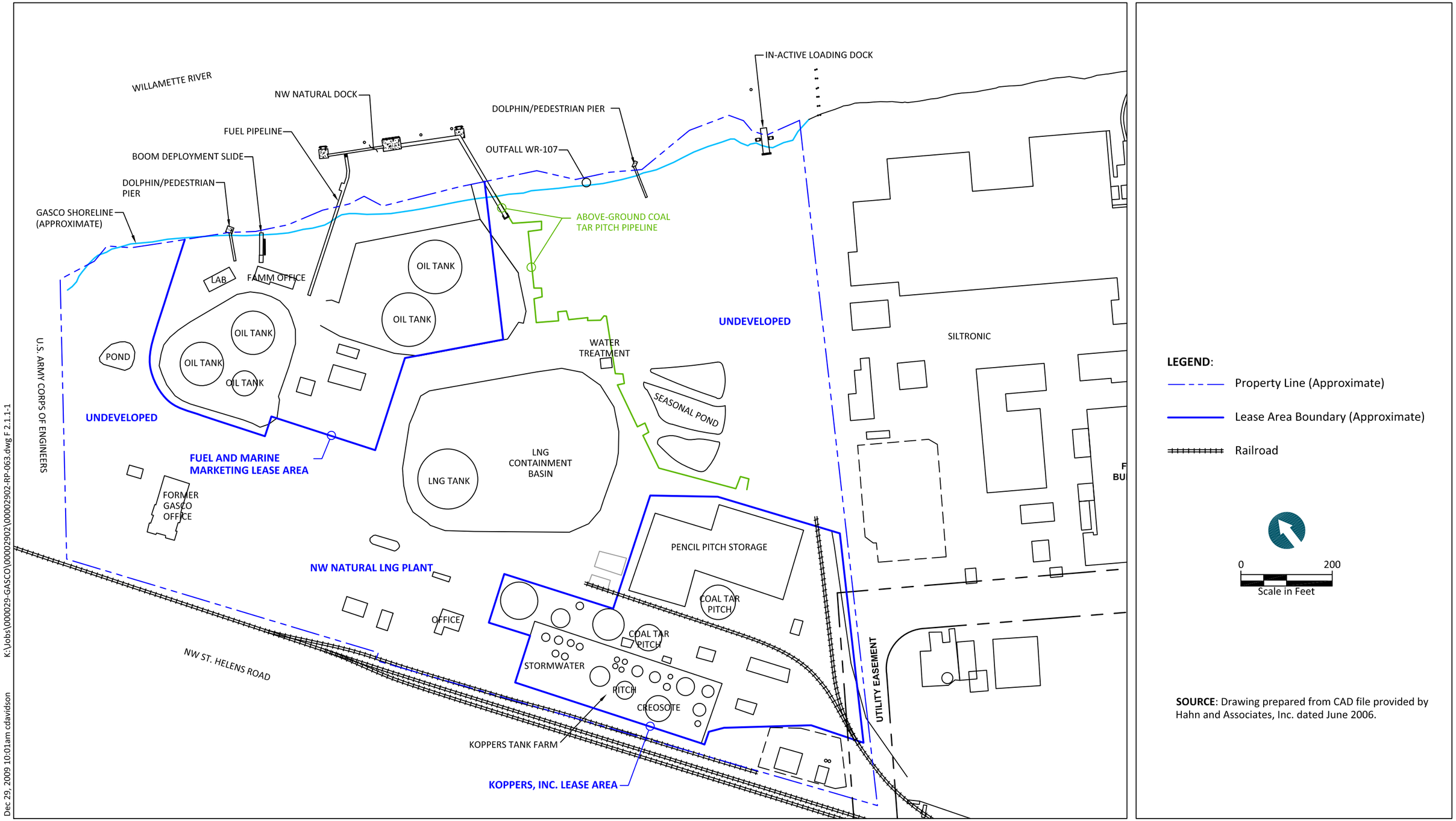


Figure 2.1.1-1
Current Gasco Property Features
NW Natural "Gasco" Site
Gasco Sediment Cleanup Action

ANCHOR QEA

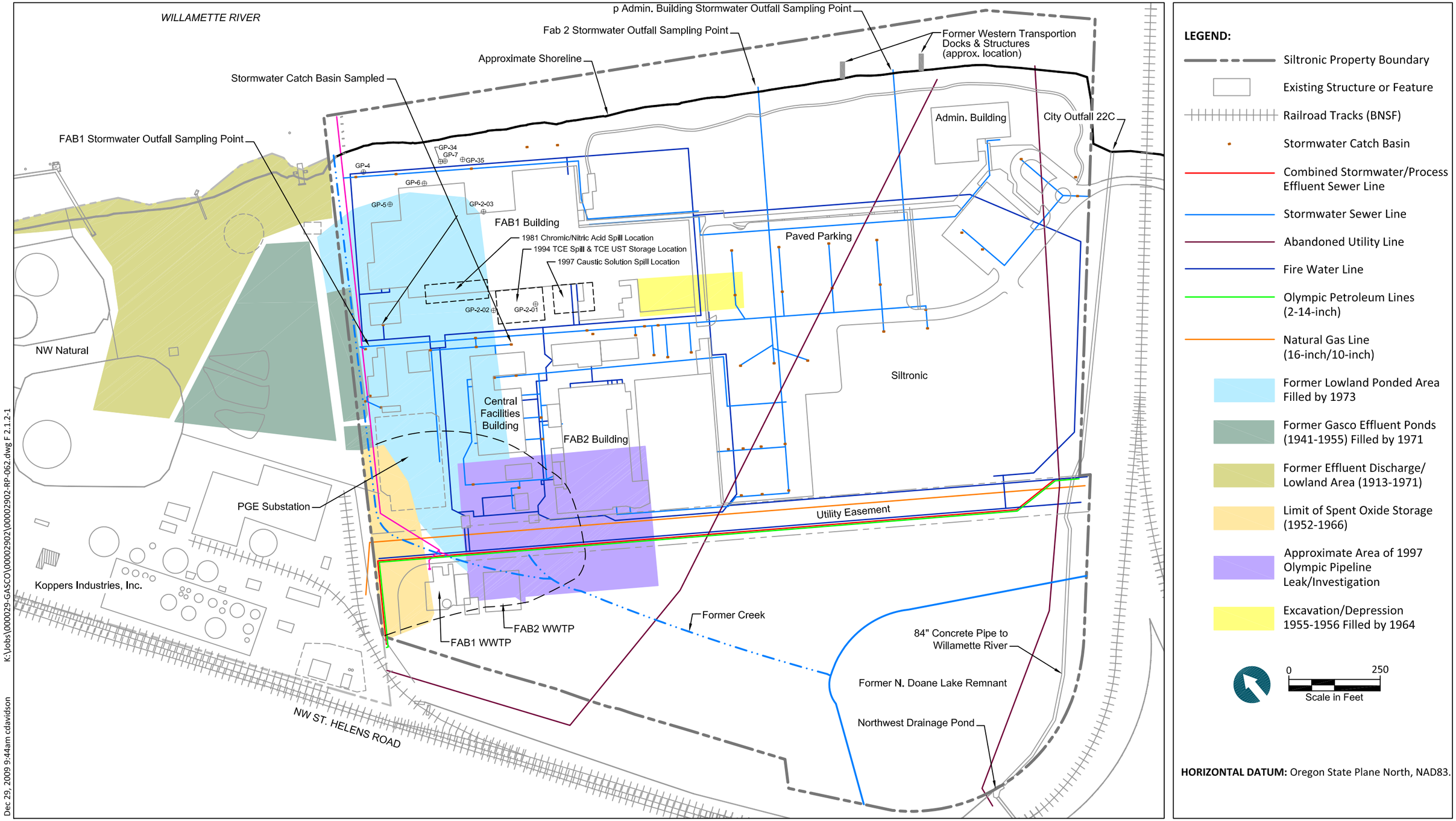


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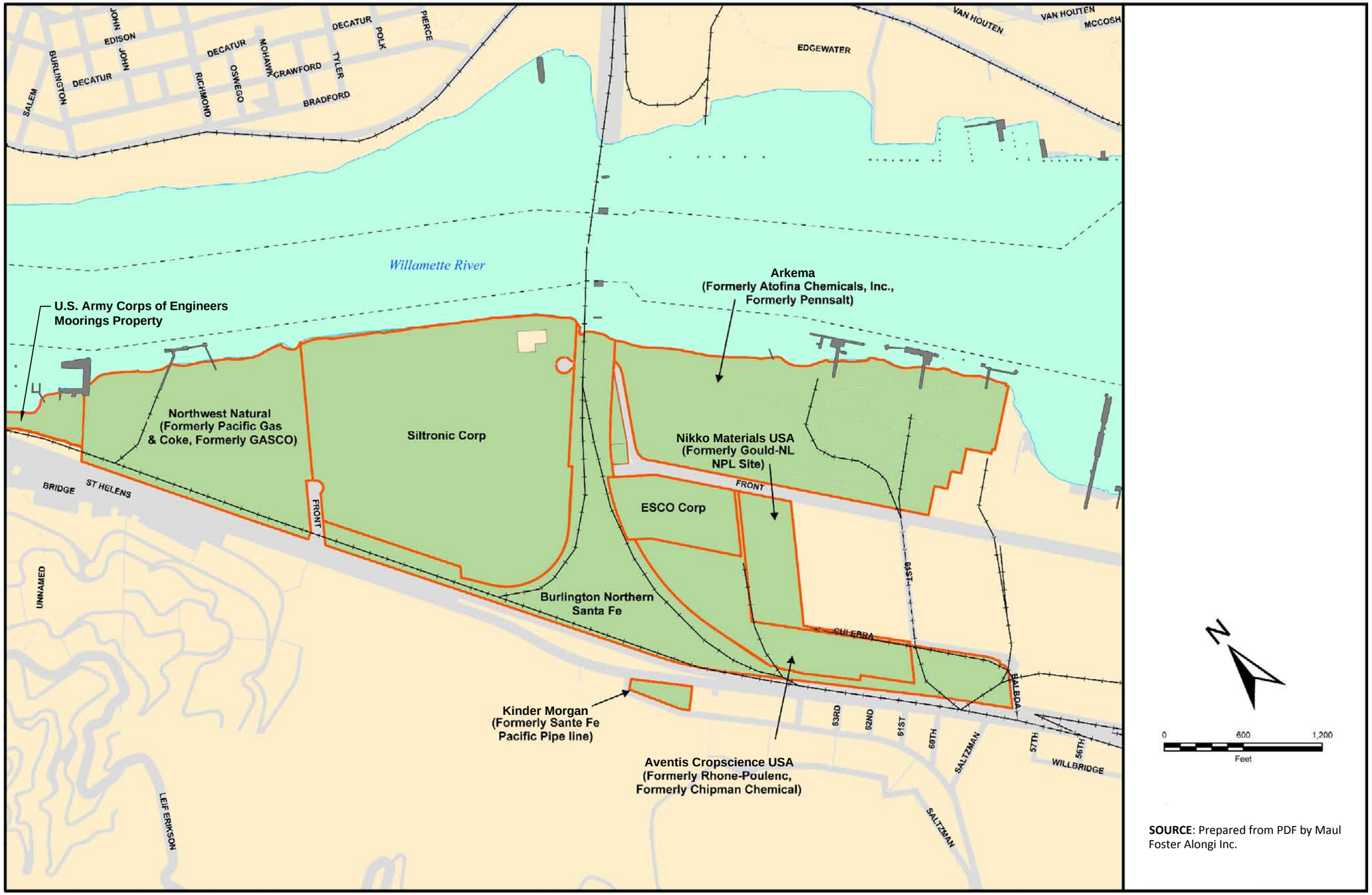
Figure 2.1.2-1
Siltronic Historical and Current Property Features
NW Natural "Gasco" Site
Gasco Sediment Cleanup Action

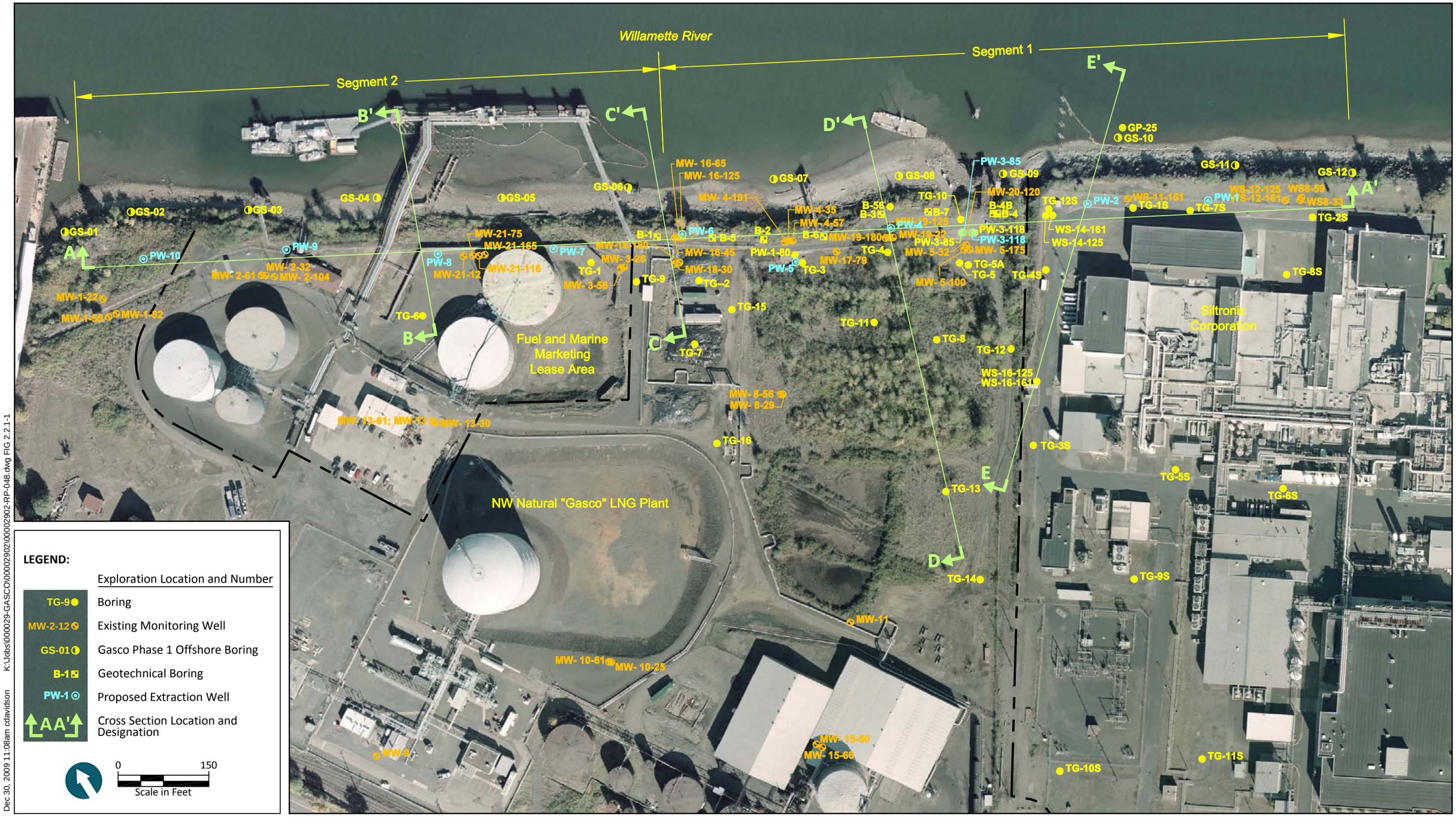


SOURCE: Prepared from PDF by Maul Foster Alongi Inc.

Dec 29, 2009 10:03am cdavidson K:\Jobs\000029-GASCO\00002902\00002902-RP-061.dwg FIG 2.1.3-1

ANCHOR QEA

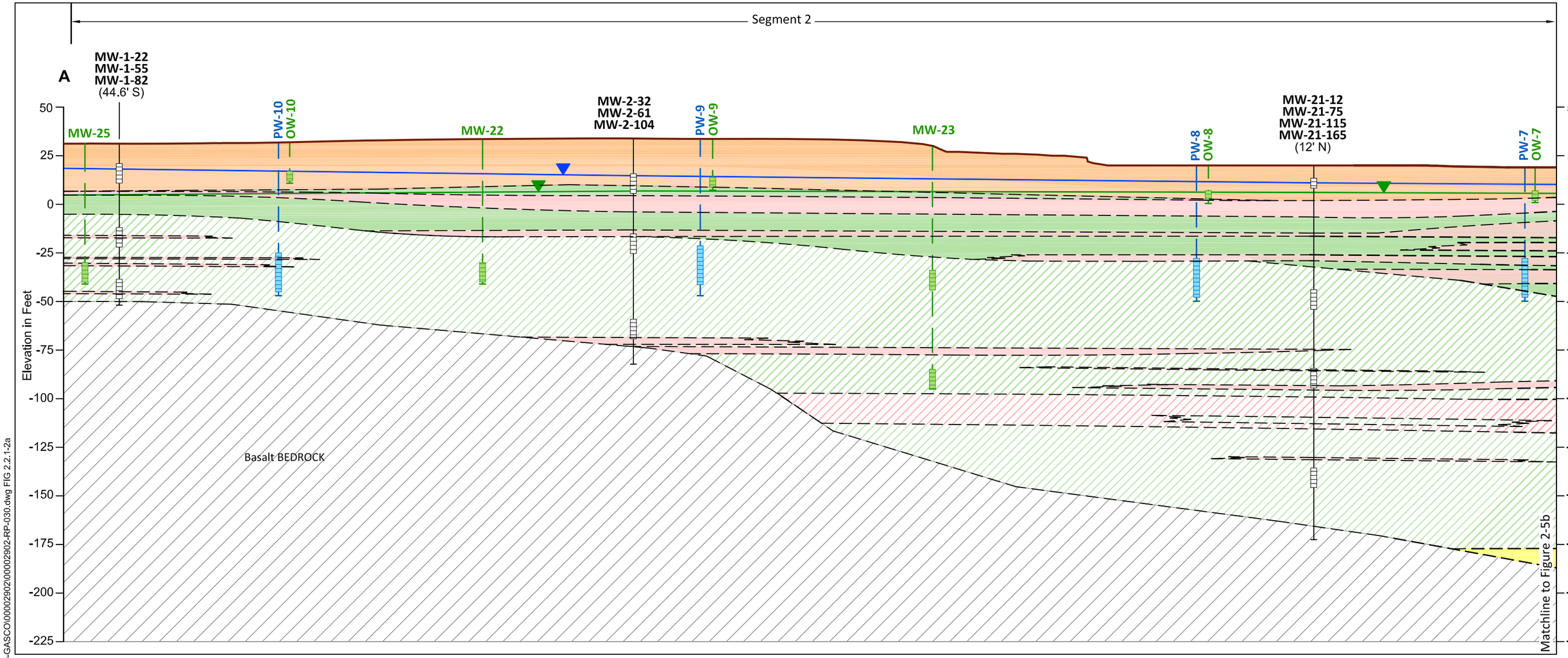
Figure 2.1.3-1
Neighboring Properties
NW Natural "Gasco" Site
Gasco Sediment Cleanup Action



Dec 30, 2009 11:08am ctdavidson K:\Jobs\000029-GASCO\00002902\00002902-RP-048.dwg FIG 2.2.1-1

ANCHOR QEA

Figure 2.2.1-1
Cross-Section Location Map
NW Natural "Gasco" Site
Gasco Sediment Cleanup Action



LEGEND:

- Primarily SILT and SANDY-SILT interbedded with thin sand and silty-sand layers
- Primarily fine to medium grained SAND and SILTY-SAND interbedded with thin silt and sandy-silt layers
- Fill composed of gravel, silt, sand, metal, brick, and concrete debris
- Alluvial GRAVEL, sandy gravel, gravelly sand, and gravelly silt
- Primarily medium grained SAND with generally less than 15% fines.
- Basalt BEDROCK
- Potentiometric Surface of Surficial Fill (measured 9/07)
- Potentiometric Surface of Alluvium (measured 9/07)
- Existing Ground Surface

MW-21-116 — Boring ID

xx — Boring ID

Proposed Extraction Well

Proposed Well or Piezometer

Existing Well or Piezometer

— Well Screen

0 50

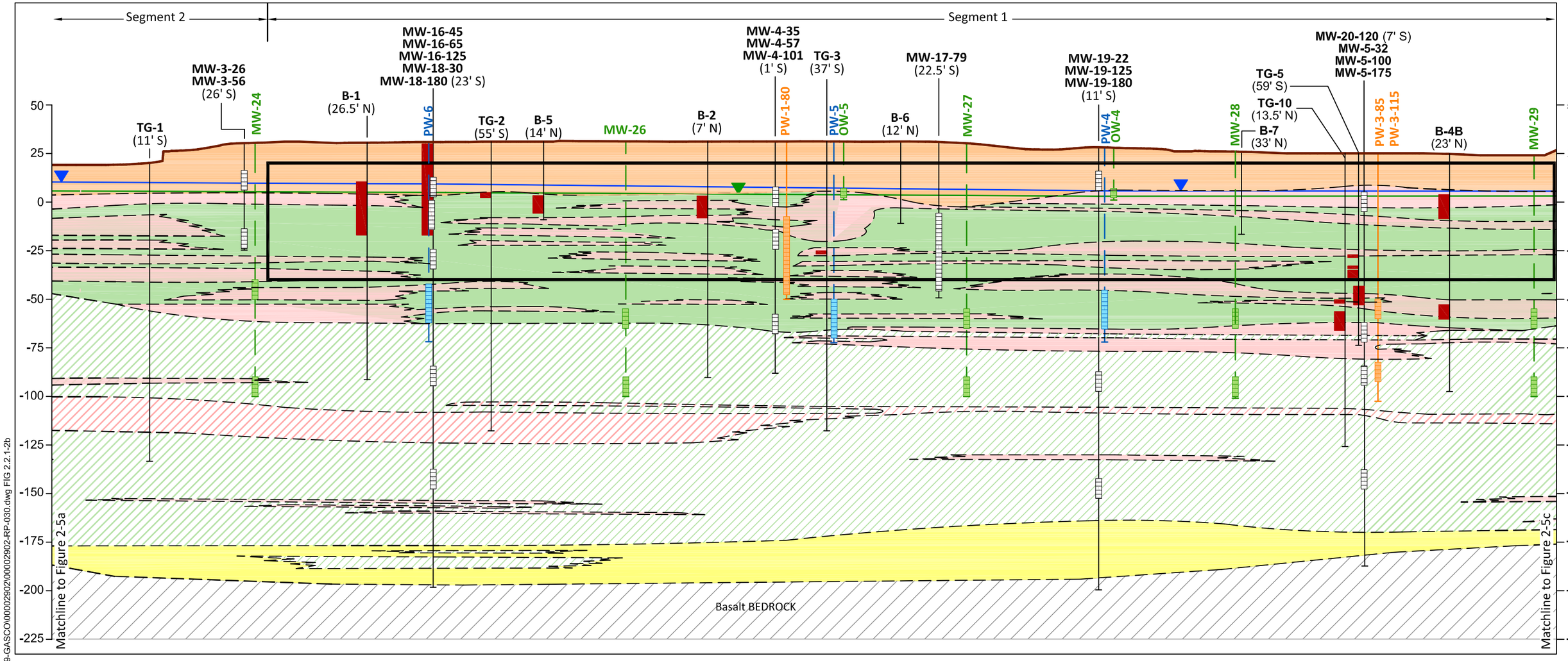
Scale in Feet

NOTES:
Geologic contacts are inferred between borings.

Dec 30, 2009 11:13am cdavidson K:\Jobs\000029-GASCO\00002902\00002902-RP-030.dwg FIG 2.2.1-2a

ANCHOR QEA

Figure 2.2.1-2a
Subsurface Profile A-A'
NW Natural "Gasco" Site
Gasco Sediment Cleanup Action



LEGEND:

- Primarily SILT and SANDY-SILT interbedded with thin sand and silty-sand layers
- Primarily fine to medium grained SAND and SILTY-SAND interbedded with thin silt and sandy-silt layers
- Fill composed of gravel, silt, sand, metal, brick, and concrete debris
- Alluvial GRAVEL, sandy gravel, gravelly sand, and gravelly silt
- Primarily medium grained SAND with generally less than 15% fines.
- Basalt BEDROCK
- Potentiometric Surface of Surficial Fill (measured 9/07)
- Potentiometric Surface of Alluvium (measured 9/07)
- Existing Ground Surface
- Vertical Barrier Wall
- MW-24 — Boring ID
- xx — Boring ID
- NAPL and/or Tar Interval
- Well Screen

Existing Extraction Well
Proposed Extraction Well
Proposed Well or Piezometer
Existing Well or Piezometer

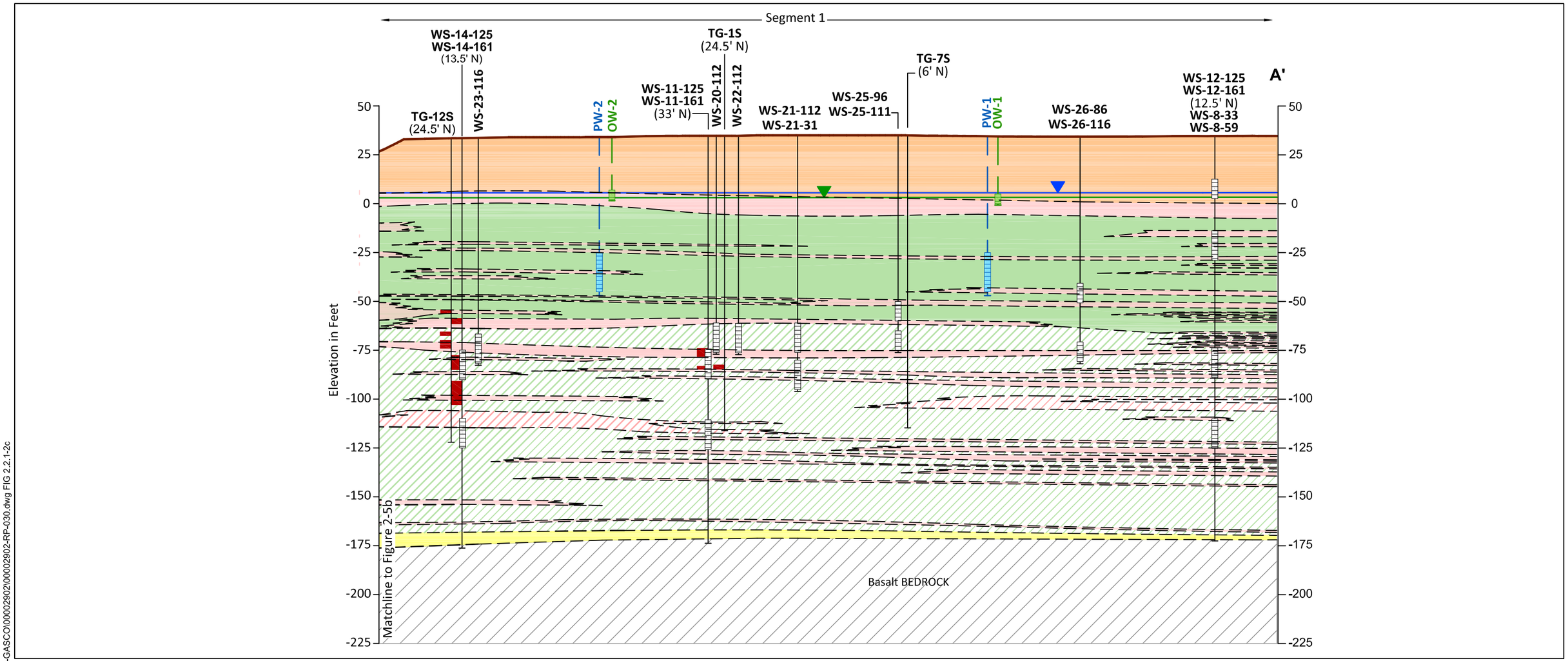
0 50
Scale in Feet

NOTES:
Geologic contacts are inferred between borings.

K:\Jobs\000029-GASCO\00002902\00002902-RP-030.dwg FIG 2.2.1-2b
Dec 30, 2009 11:14am cdavidson

ANCHOR QEA

Figure 2.2.1-2b
Subsurface Profile A-A'
NW Natural "Gasco" Site
Gasco Sediment Cleanup Action



LEGEND:

- Primarily SILT and SANDY-SILT interbedded with thin sand and silty-sand layers
- Primarily fine to medium grained SAND and SILTY-SAND interbedded with thin silt and sandy-silt layers
- Fill composed of gravel, silt, sand, metal, brick, and concrete debris
- Alluvial GRAVEL, sandy gravel, gravelly sand, and gravelly silt
- Primarily medium grained SAND with generally less than 15% fines.
- Basalt BEDROCK
- Potentiometric Surface of Surficial Fill (measured 9/07)
- Potentiometric Surface of Alluvium (measured 9/07)
- Existing Ground Surface
- MW-24 — Boring ID
- xx — Boring ID
- NAPL and/or Tar Interval
- Well Screen

Proposed Extraction Well
Proposed Well or Piezometer
Existing Well or Piezometer

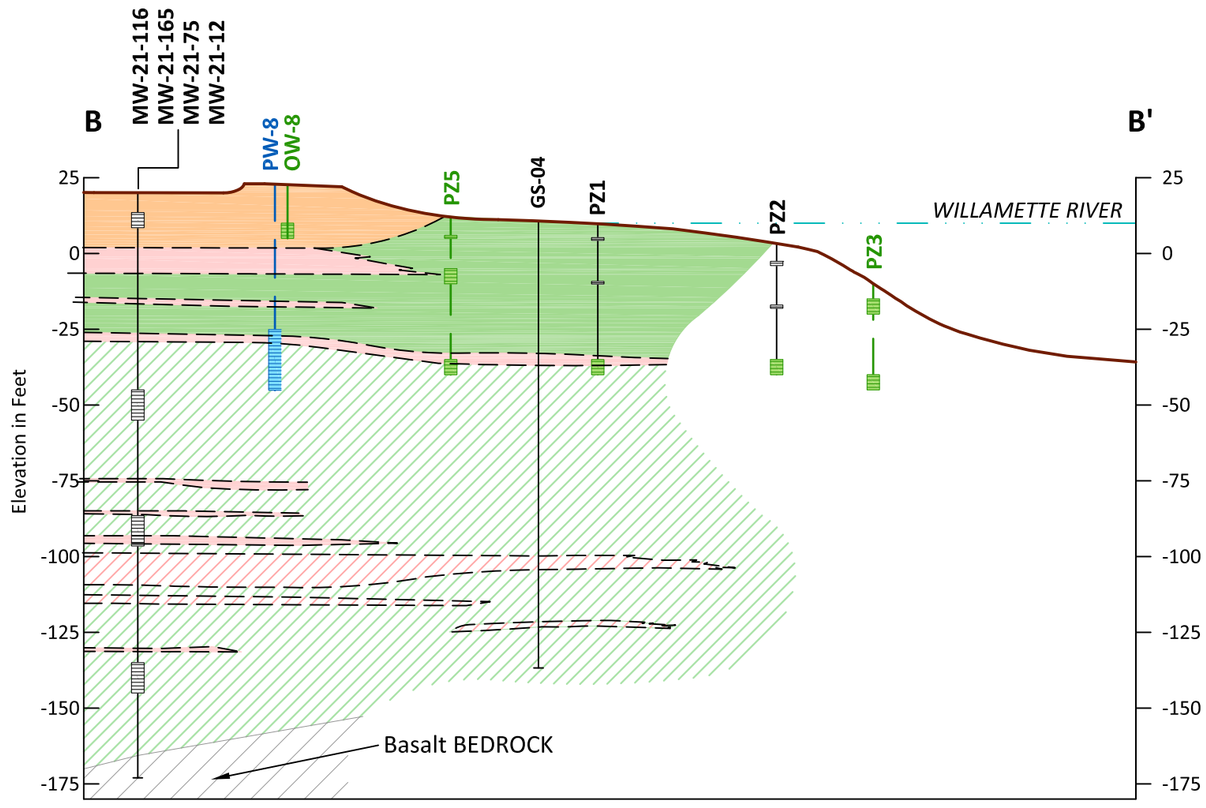
0 50
Scale in Feet

NOTES:
Geologic contacts are inferred between borings.

K:\Jobs\000029-GASCO\00002902\00002902-RP-030.dwg FIG 2.2.1-2c
Dec 30, 2009 11:15am cdavidson

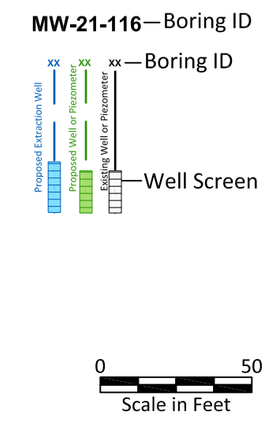
ANCHOR QEA

Figure 2.2.1-2c
Subsurface Profile A-A'
NW Natural "Gasco" Site
Gasco Sediment Cleanup Action



LEGEND:

- Primarily SILT and SANDY-SILT interbedded with thin sand and silty-sand layers
- Primarily fine to medium grained SAND and SILTY-SAND interbedded with thin silt and sandy-silt layers
- Fill composed of gravel, silt, sand, metal, brick, and concrete debris
- Primarily medium grained SAND with generally less than 15% fines.
- Basalt BEDROCK
- Existing Ground Surface
- Approximate Willametter River Elevation

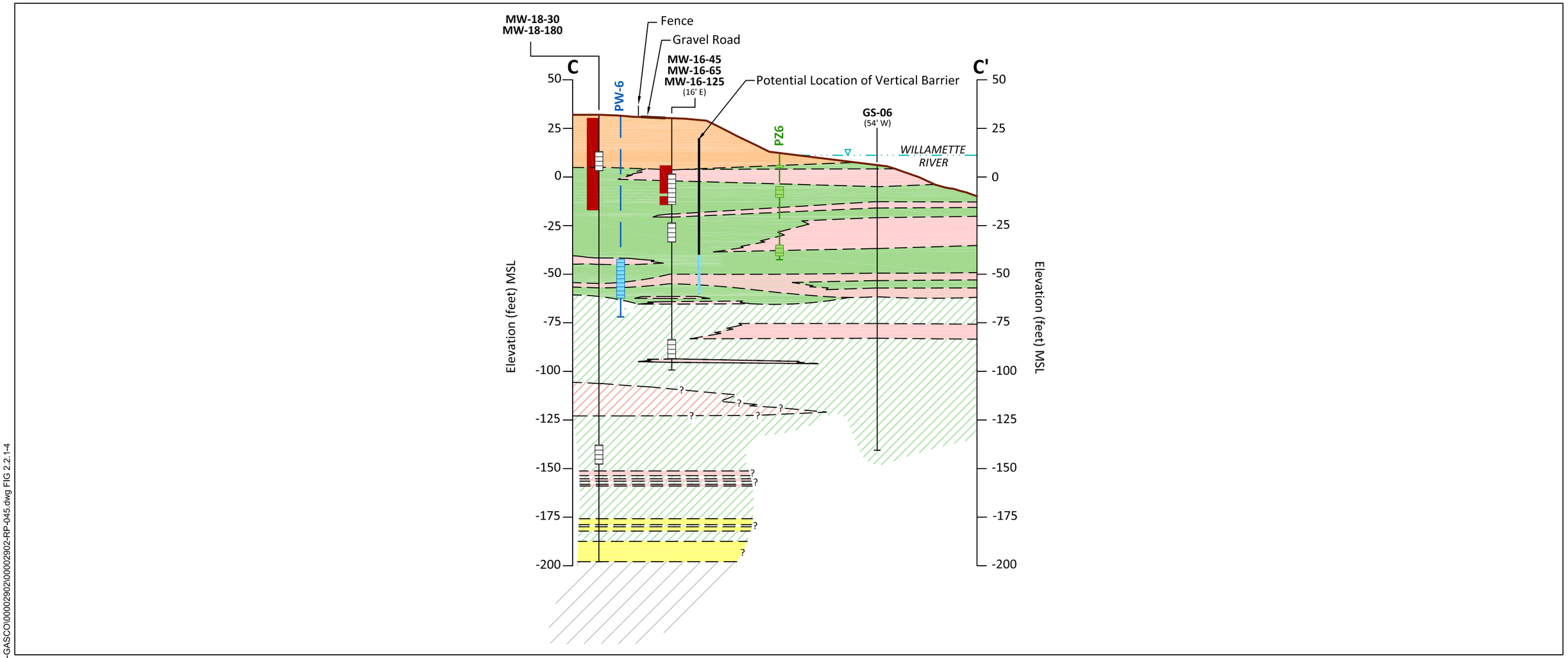


NOTES:
1. City of Portland vertical datum
2. Geologic contacts are inferred between borings.

Dec 30, 2009 11:15am cdavidson K:\Jobs\000029-GASCO\00002902\00002902-RP-045.dwg FIG 2.2.1-3

ANCHOR QEA

Figure 2.2.1-3
B-B'Subsurface Profile B-B'
NW Natural "Gasco" Site
Gasco Sediment Cleanup Action



LEGEND:

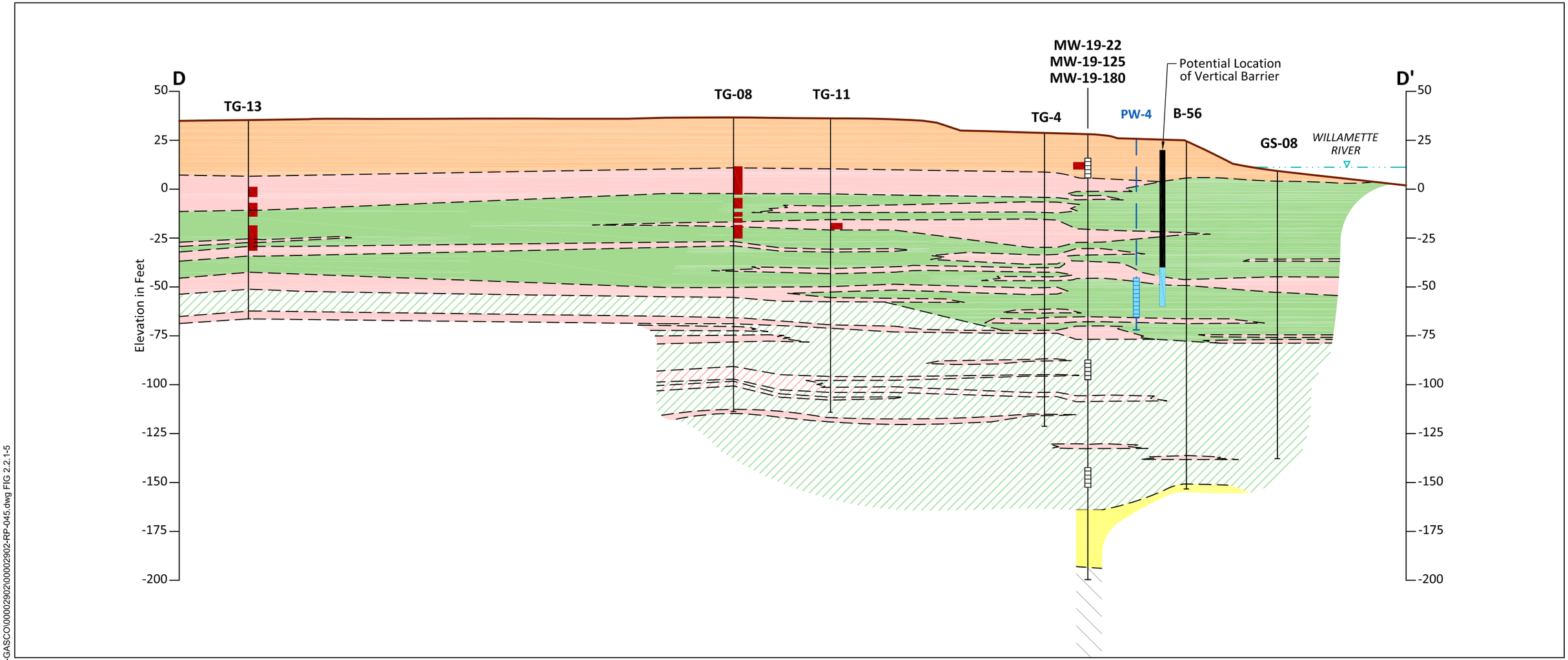
- Primarily SILT and SANDY-SILT interbedded with thin sand and silty-sand layers
- Primarily fine to medium grained SAND and SILTY-SAND interbedded with thin silt and sandy-silt layers
- Fill composed of gravel, silt, sand, metal, brick, and concrete debris
- Alluvial GRAVEL, sandy gravel, gravelly sand, and gravelly silt
- Primarily medium grained SAND with generally less than 15% fines.
- Basalt BEDROCK
- Existing Ground Surface
- Approximate Willamette River Elevation
- MW-18-30 — Boring ID
- xx — Boring ID (Proposed Extraction Well; Proposed Well or Piezometer; Existing Well or Piezometer)
- NAPL and/or Tar Interval
- Well Screen
- 0 50 Scale in Feet

NOTES:
Geologic contacts are inferred between borings.

Dec 30, 2009 11:15am cdavidson K:\Jobs\000029-GASCO\00002902\00002902-RP-045.dwg FIG 2.2.1-4

ANCHOR QEA

Figure 2.2.1-4
Subsurface Profile C-C'
NW Natural "Gasco" Site
Gasco Sediment Cleanup Action



LEGEND:

- Primarily SILT and SANDY-SILT interbedded with thin sand and silty-sand layers
- Primarily fine to medium grained SAND and SILTY-SAND interbedded with thin silt and sandy-silt layers
- Fill composed of gravel, silt, sand, metal, brick, and concrete debris
- Alluvial GRAVEL, sandy gravel, gravelly sand, and gravelly silt
- Primarily medium grained SAND with generally less than 15% fines.
- Basalt BEDROCK
- Existing Ground Surface

MW-21-116 — Boring ID

xx — Boring ID

Proposed Extraction Well

Proposed Well or Piezometer

Existing Well or Piezometer

NAPL and/or Tar Interval

Well Screen

0 50

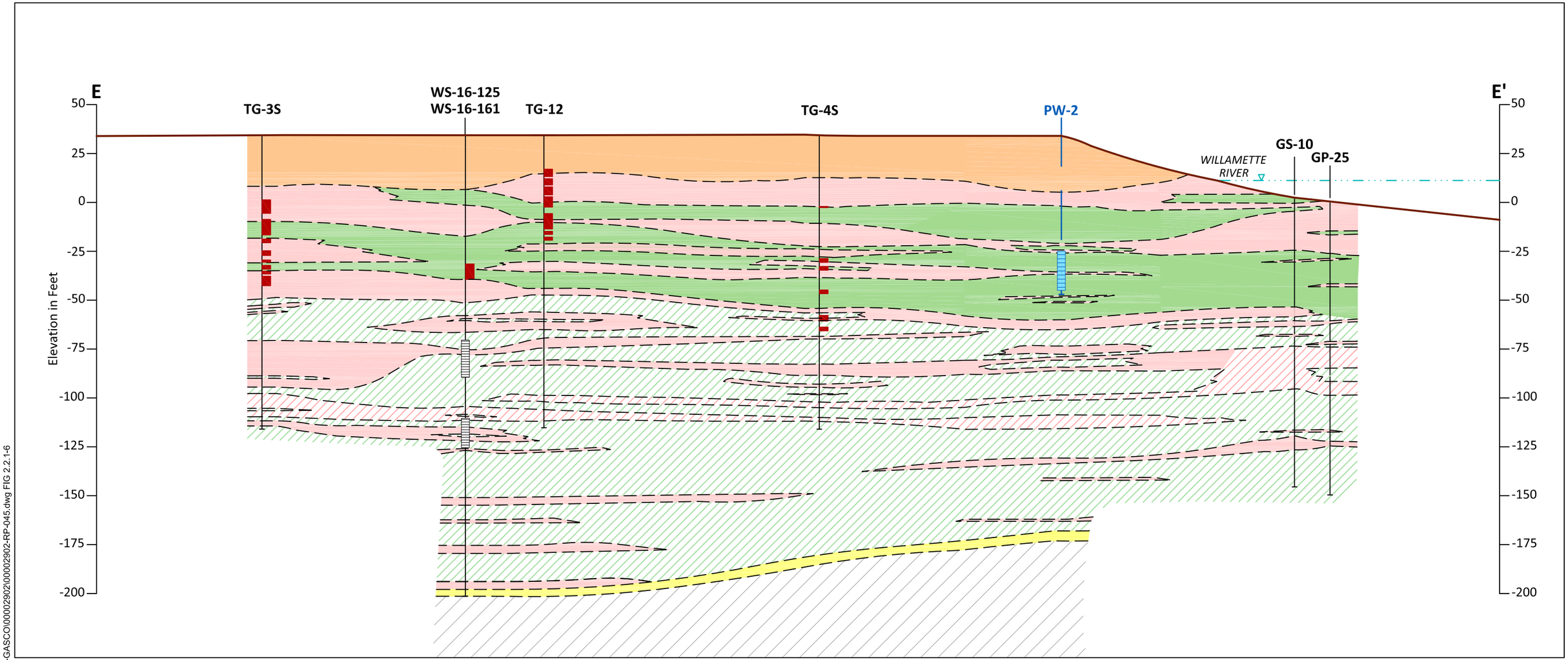
Scale in Feet

NOTES:
Geologic contacts are inferred between borings.

Dec 30, 2009 11:16am cdavidson K:\Jobs\000029-GASCO\00002902\00002902-RP-045.dwg FIG 2.2.1-5

ANCHOR QEA

Figure 2.2.1-5
Subsurface Profile D-D'
NW Natural "Gasco" Site
Gasco Sediment Cleanup Action



LEGEND:

- Primarily SILT and SANDY-SILT interbedded with thin sand and silty-sand layers
- Primarily fine to medium grained SAND and SILTY-SAND interbedded with thin silt and sandy-silt layers
- Fill composed of gravel, silt, sand, metal, brick, and concrete debris
- Alluvial GRAVEL, sandy gravel, gravelly sand, and gravelly silt
- Primarily medium grained SAND with generally less than 15% fines.
- Basalt BEDROCK
- Existing Ground Surface

MW-21-116 — Boring ID

xx — Boring ID

NAPL and/or Tar Interval

Well Screen

Proposed Extraction Well

Proposed Well or Piezometer

Existing Well or Piezometer

0 50

Scale in Feet

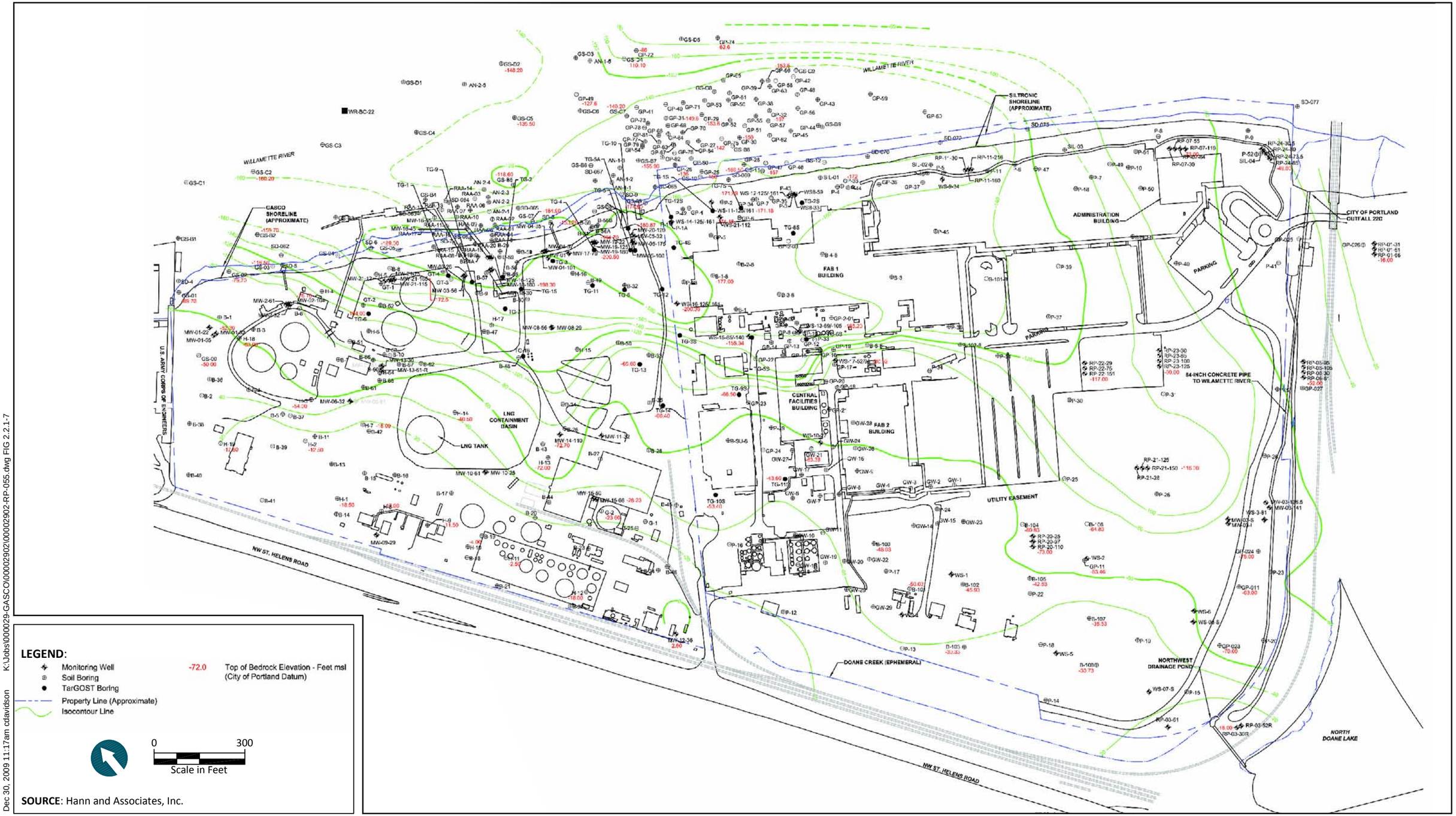
NOTES:
Geologic contacts are inferred between borings.

K:\Jobs\000029-GASCO\00002902\00002902-RP-045.dwg FIG 2.2.1-6

Dec 30, 2009 11:16am cdavidson

ANCHOR QEA

Figure 2.2.1-6
Subsurface Profile E-E'
NW Natural "Gasco" Site
Gasco Sediment Cleanup Action



K:\Jobs\000029-GASCO\0000290\2\0002902-RP-055.dwg FIG 2.2.1-7

Dec 30, 2009 11:17am cdavidson

ANCHOR QEA

Figure 2.2.1-7
Bedrock Surface Elevation
NW Natural "Gasco" Site
Gasco Sediment Cleanup Action

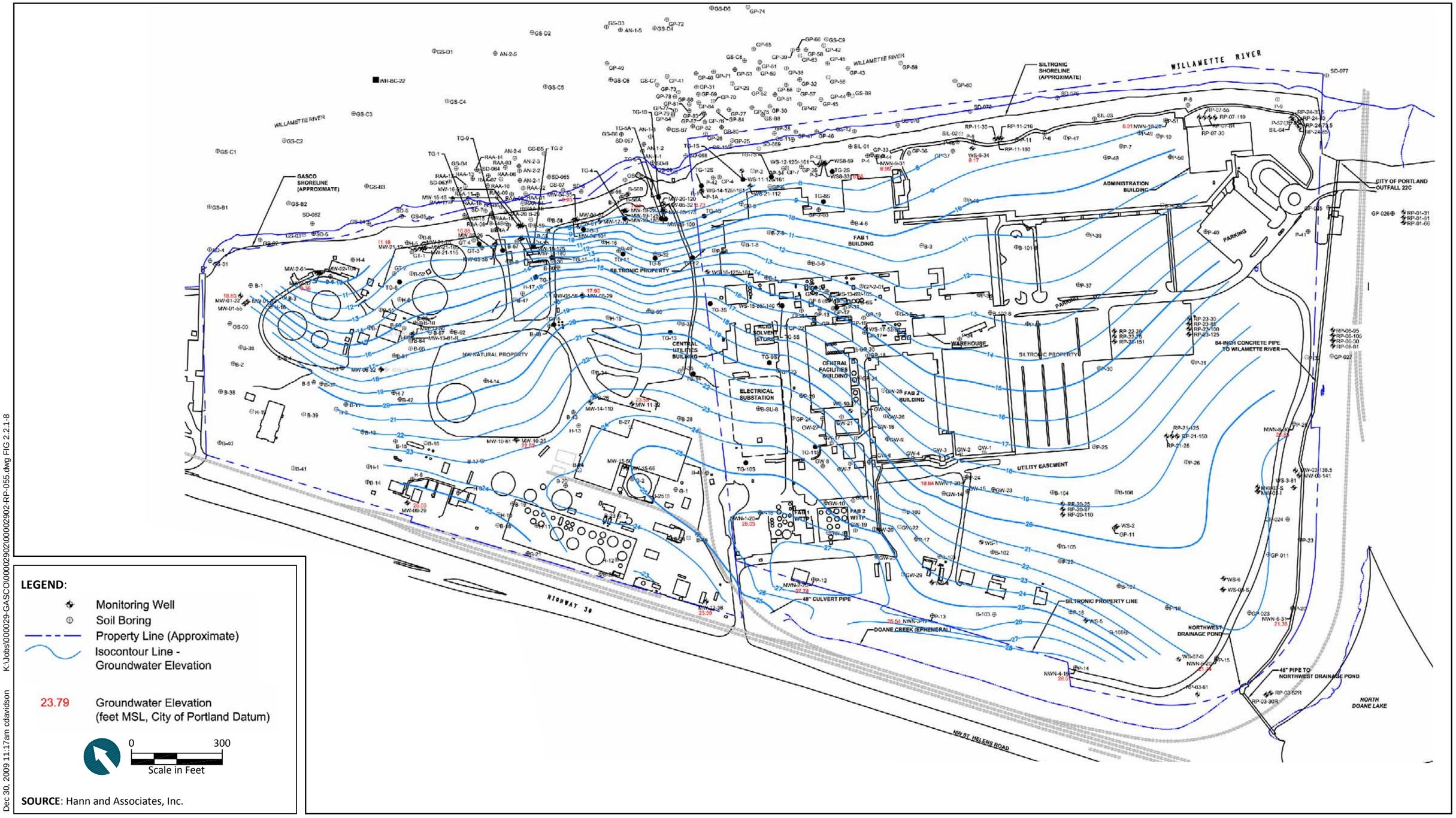
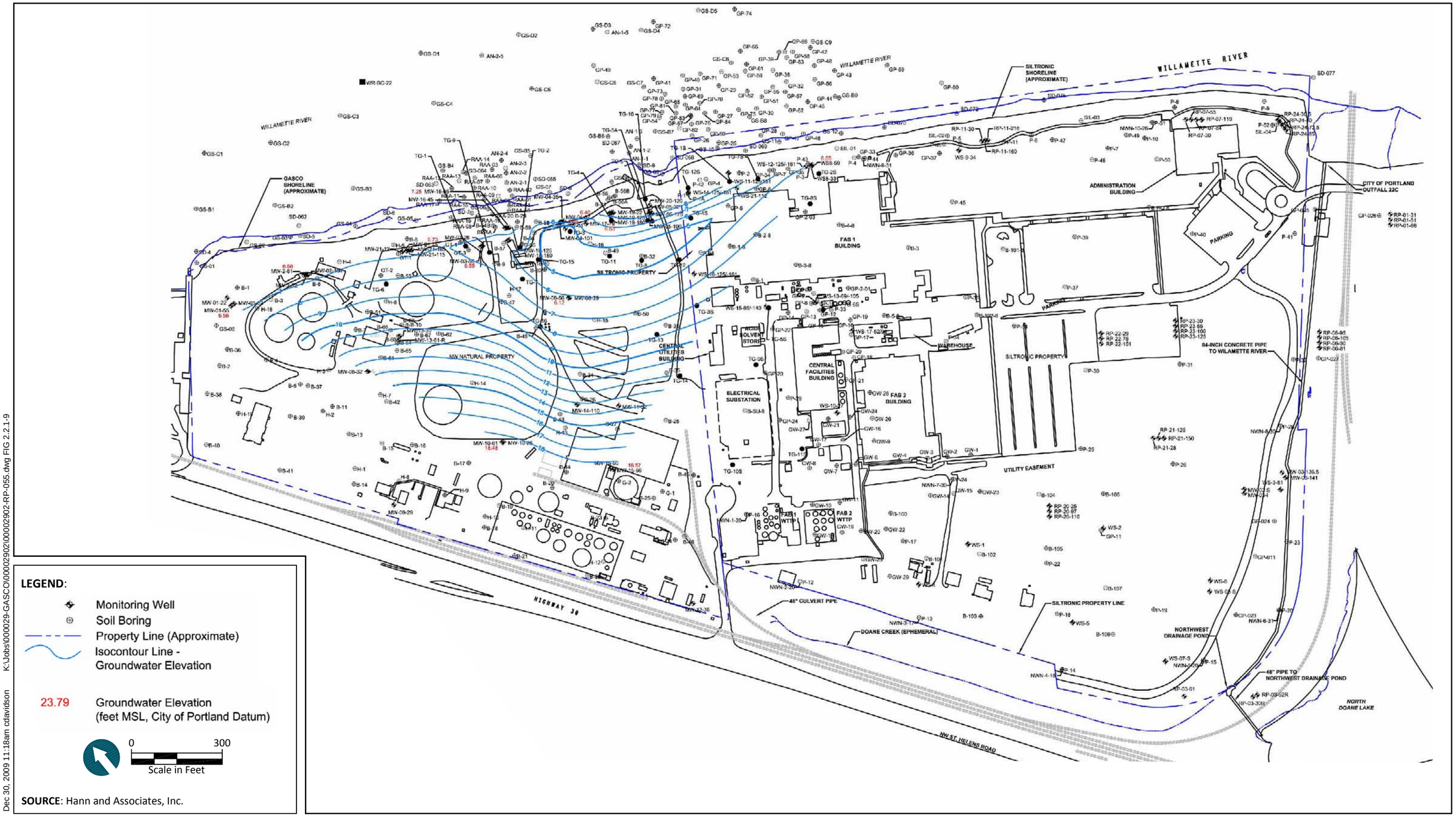


Figure 2.2.1-8
Groundwater Elevation Map - Surficial Fill WBZ Wells December 4, 2008
NW Natural "Gasco" Site
Gasco Sediment Cleanup Action

ANCHOR QEA

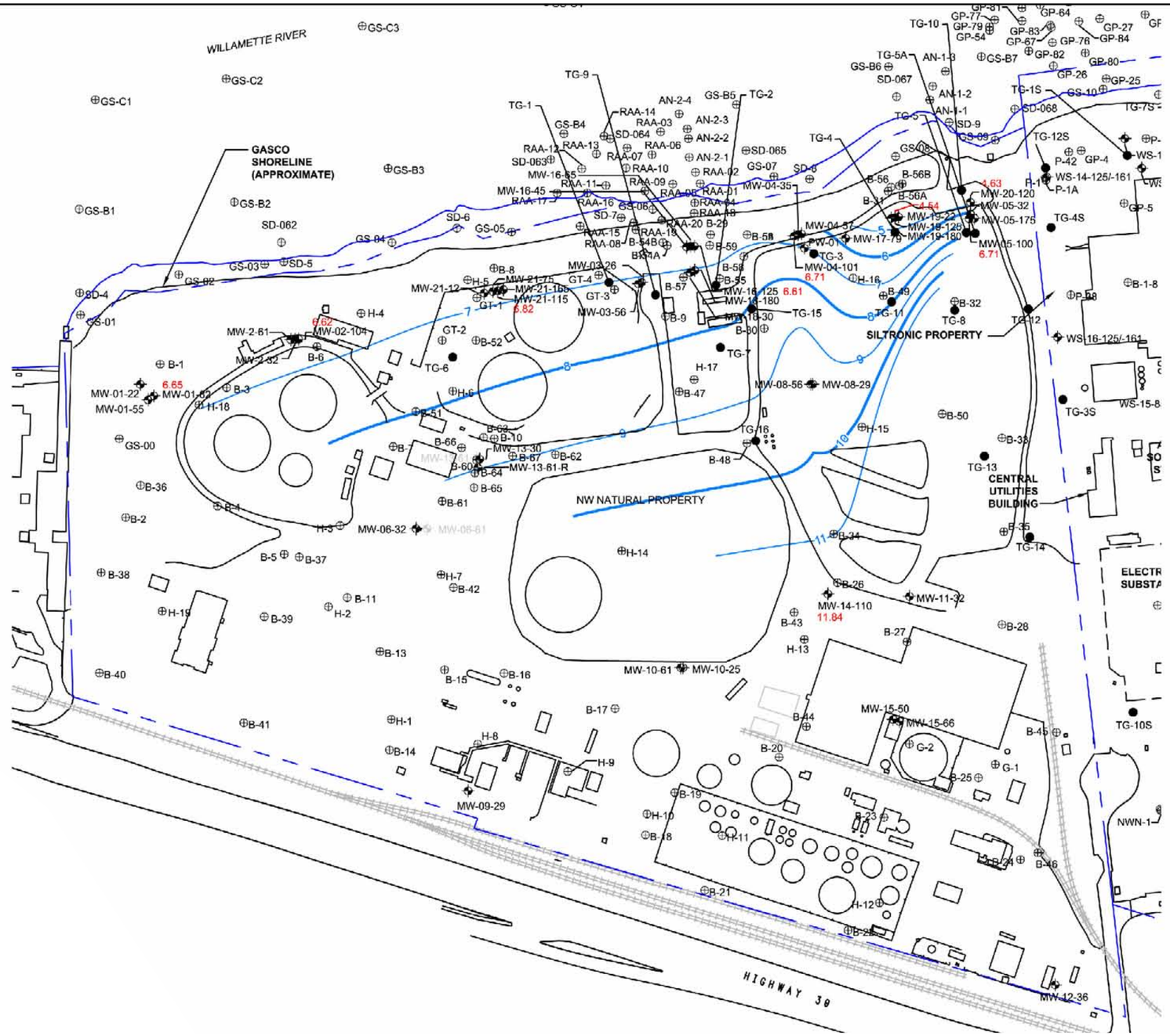


K:\Jobs\000029-GASCO\00002902\00002902-RP-055.dwg FIG 2.2.1-9

Dec 30, 2009 11:18am cdavidson

ANCHOR QEA

Figure 2.2.1-9
Groundwater Elevation Map - Alluvial WBZ Wells to 80' BGS (Upper) December 4, 2008
NW Natural "Gasco" Site
Gasco Sediment Cleanup Action



LEGEND:

- Monitoring Well
- Soil Boring
- Property Line (Approximate)
- Isocontour Line - Groundwater Elevation
- 23.79 Groundwater Elevation (feet MSL, City of Portland Datum)

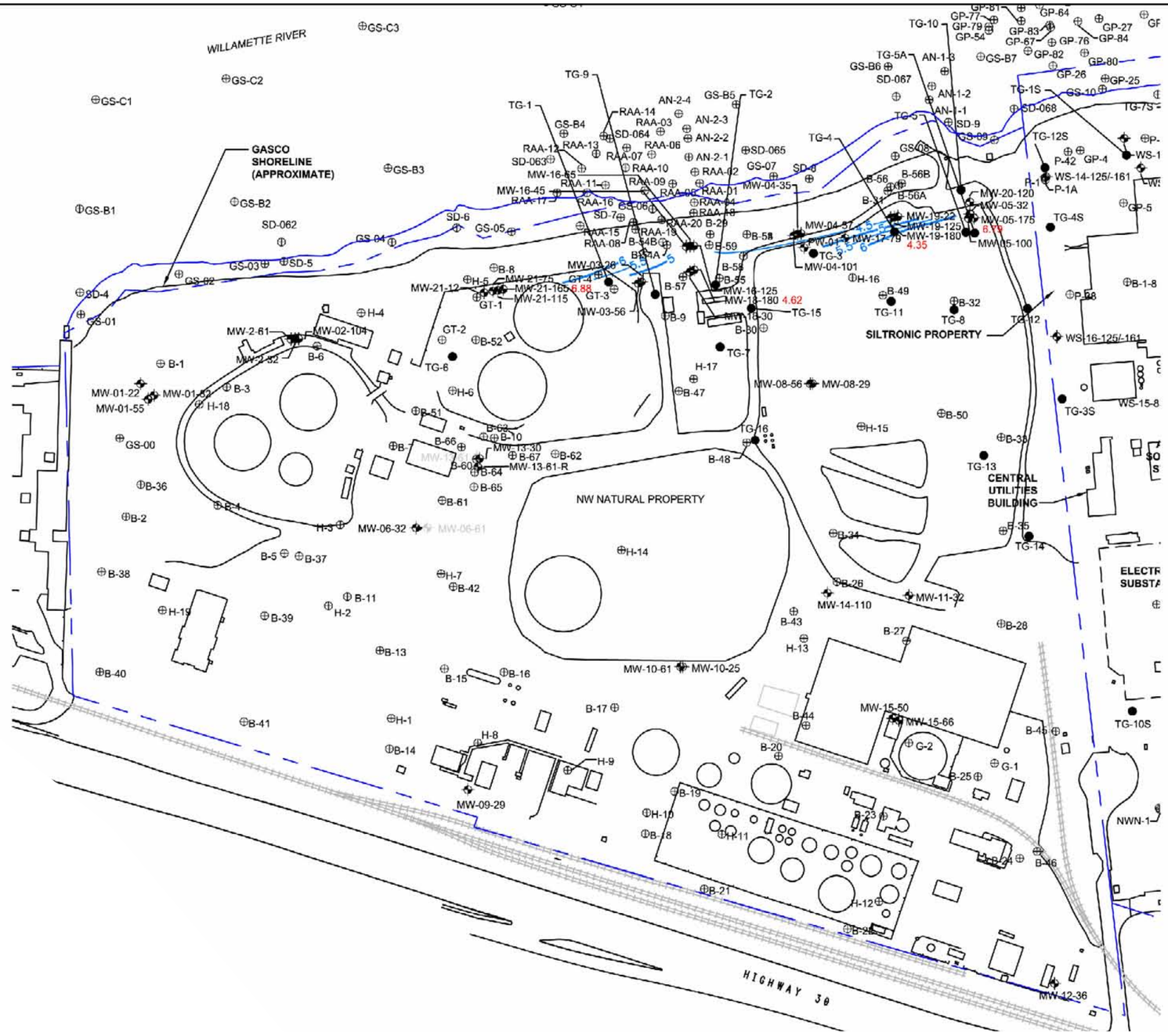
0 300
Scale in Feet

SOURCE: Hann and Associates, Inc.

Dec 30, 2009 11:18am cdavidson K:\Jobs\000029-GASCO\0000290\00002902-RP-055.dwg FIG 2.2.1-10

ANCHOR QEA

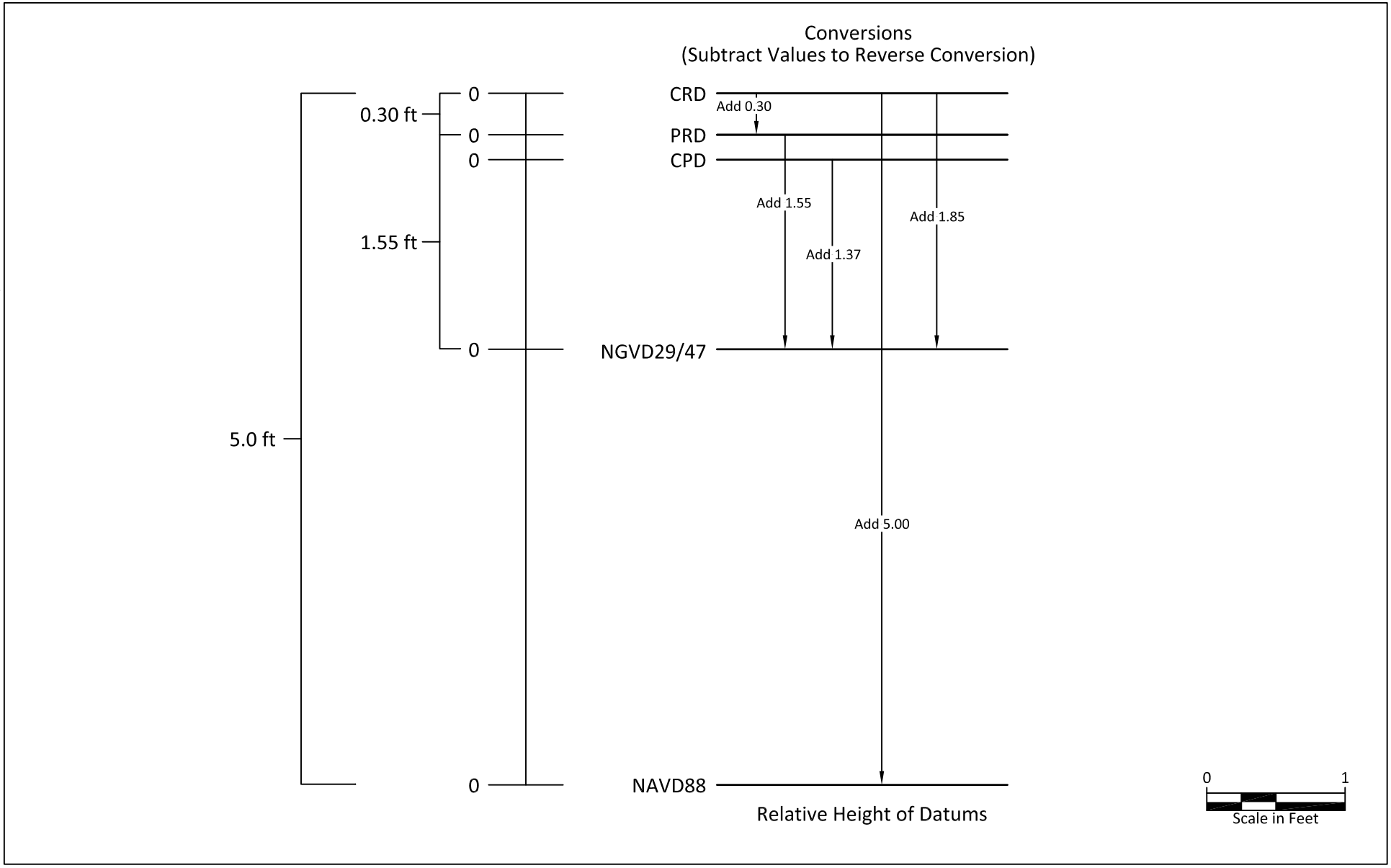
Figure 2.2.1-10
Groundwater Elevation Map - Alluvial WBZ Wells 80' to 125' BGS (Intermediate) December 4, 2008
NW Natural "Gasco" Site
Gasco Sediment Cleanup Action



Dec 30, 2009 11:18am cdavidson K:\Jobs\000029-GASCO\0000290\00002902-RP-055.dwg FIG 2.2.1-11

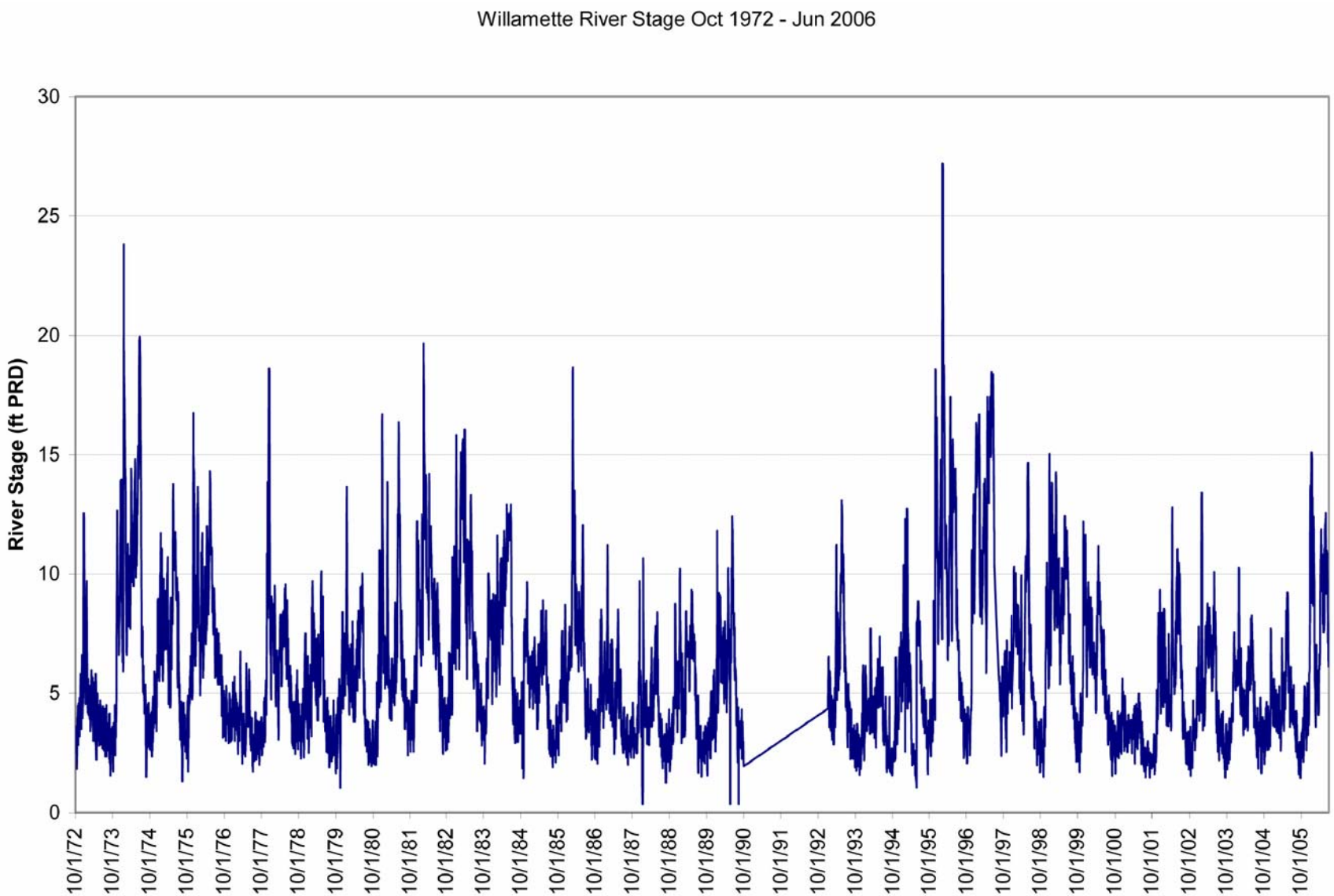
Figure 2.2.1-11
Groundwater Elevation Map - Alluvial WBZ Wells below 125' BGS (Lower) December 4, 2008
NW Natural "Gasco" Site
Gasco Sediment Cleanup Action

ANCHOR QEA



Dec 29, 2009 10:57am cdavidson K:\Jobs\000029-GASCO\00002902\00002902-RP-061.dwg FIG 2.2.2-1

Figure 2.2.2-1
Relative Height of Datums
NW Natural "Gasco" Site
Gasco Sediment Cleanup Action

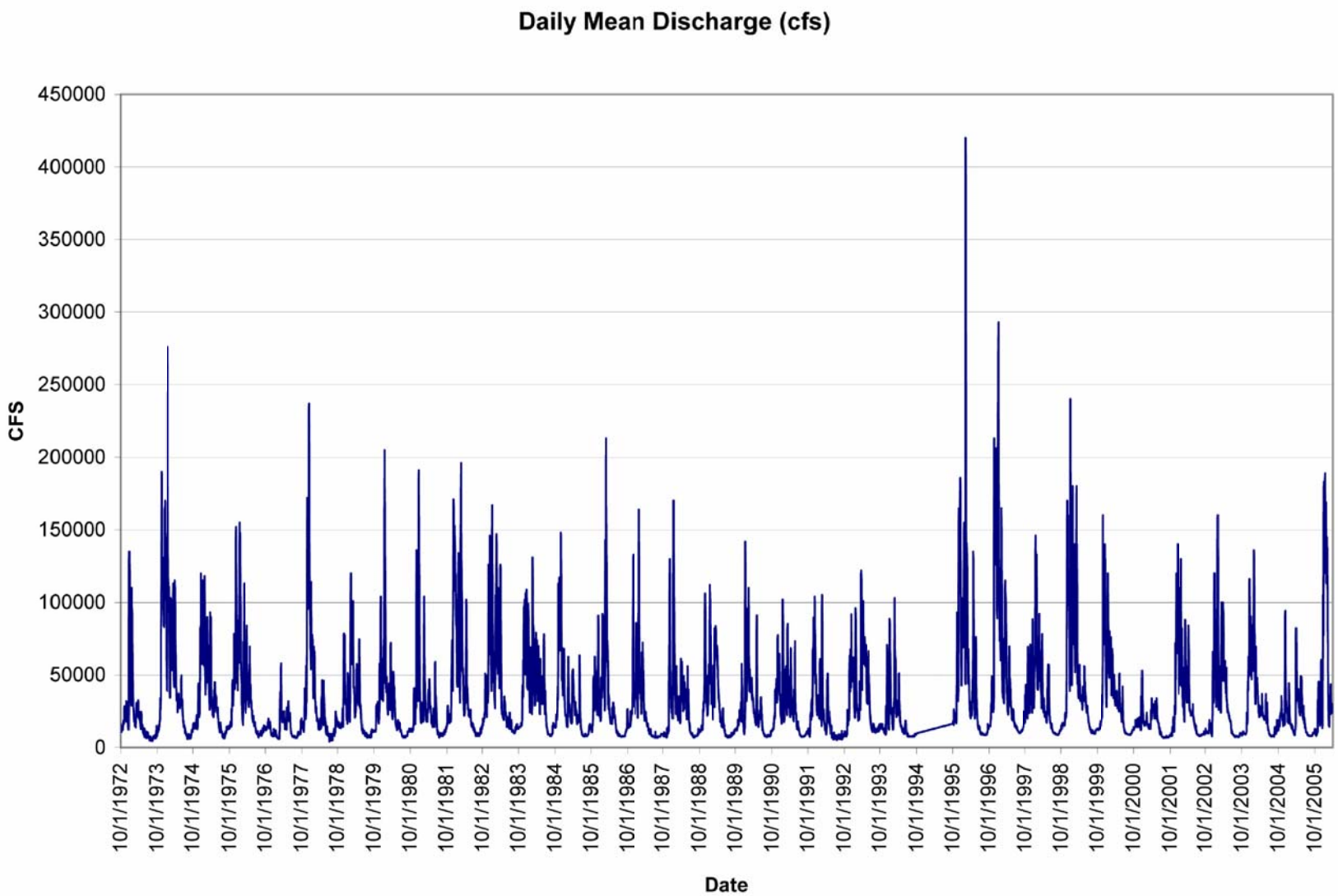


SOURCE: Integral, Consulting Inc. and Lower Willamette Group.

Dec 29, 2009 8:59am cdavidson K:\Jobs\000029-GASCO\00002902\00002902-RP-056.dwg FIG 2.2.2-2

Figure 2.2.2-2
Willamette River Daily River Stage
NW Natural "Gasco" Site
Gasco Sediment Cleanup Action

ANCHOR QEA

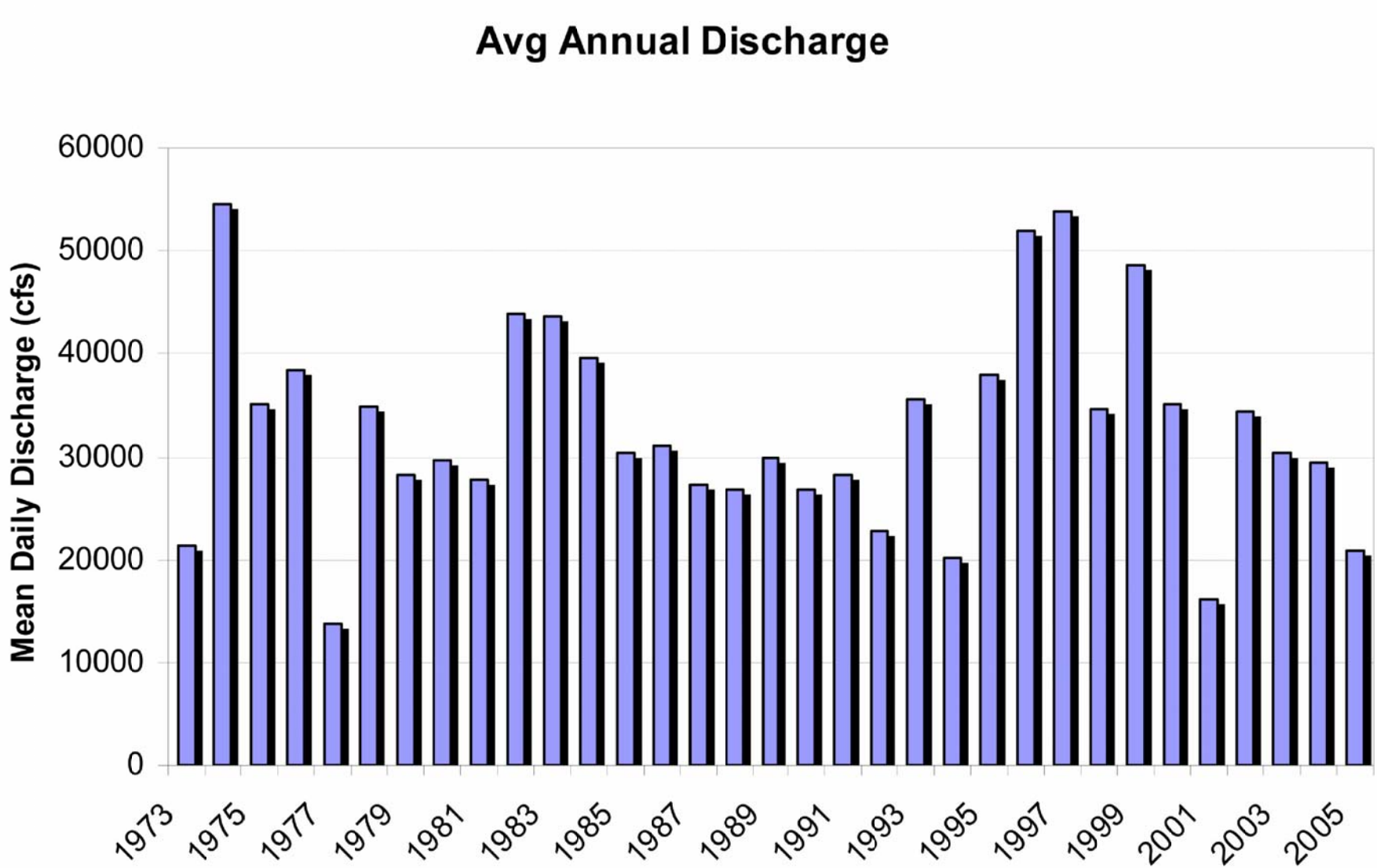


SOURCE: Integral, Consulting Inc. and Lower Willamette Group.

Dec 29, 2009 10:59am cdavidson K:\Jobs\000029-GASCO\00002902\00002902-RP-056.dwg FIG 2.2.2-3

ANCHOR QEA

Figure 2.2.2-3
Willamette River Mean Daily Discharge
NW Natural "Gasco" Site
Gasco Sediment Cleanup Action

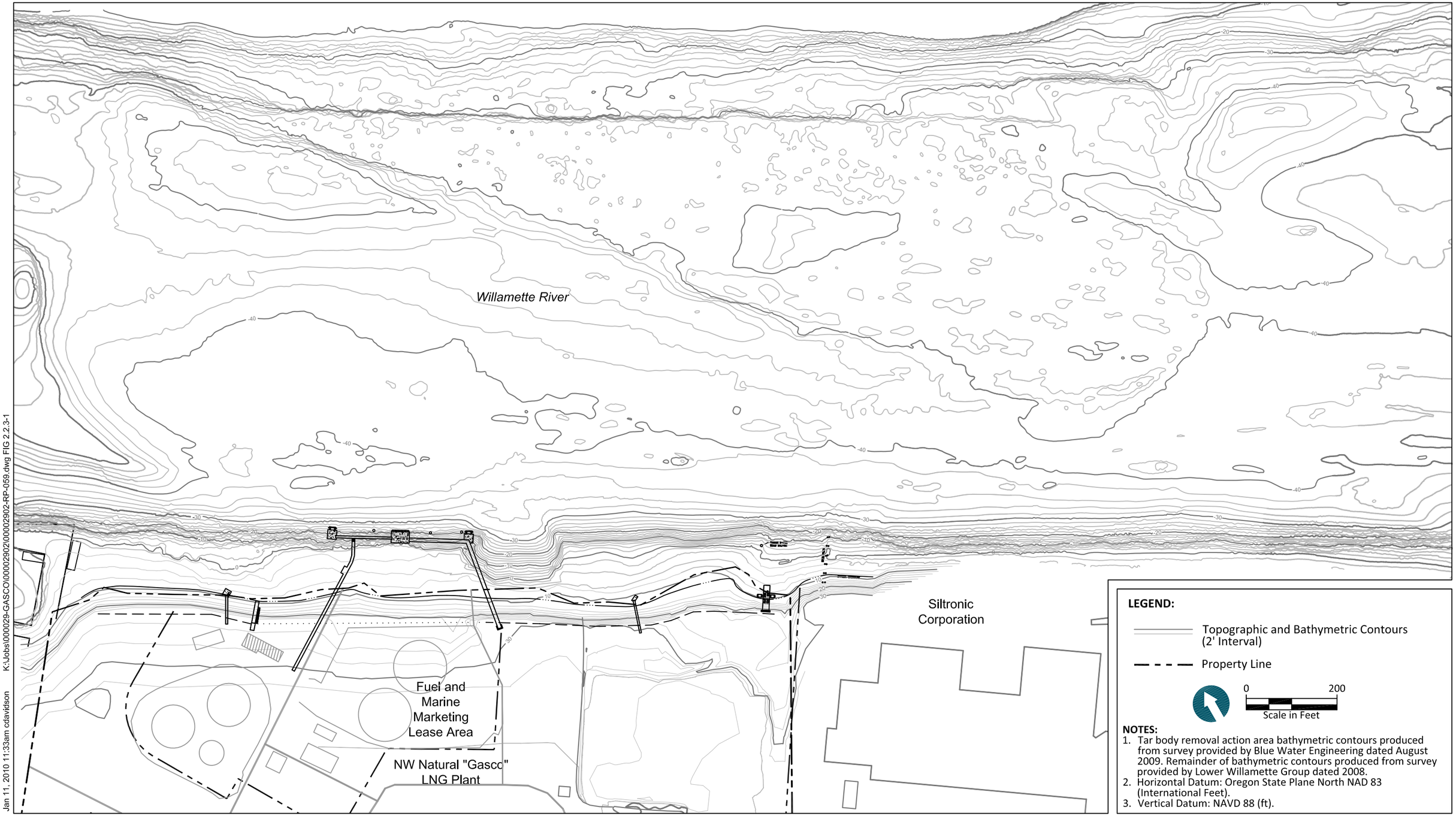


SOURCE: Integral, Consulting Inc. and Lower Willamette Group.

Dec 29, 2009 11:00am cdavidson K:\Jobs\000029-GASCO\00002902\00002902-RP-056.dwg FIG 2.2.2-4

Figure 2.2.2-4
Willamette River Annual Mean Discharge
NW Natural "Gasco" Site
Gasco Sediment Cleanup Action

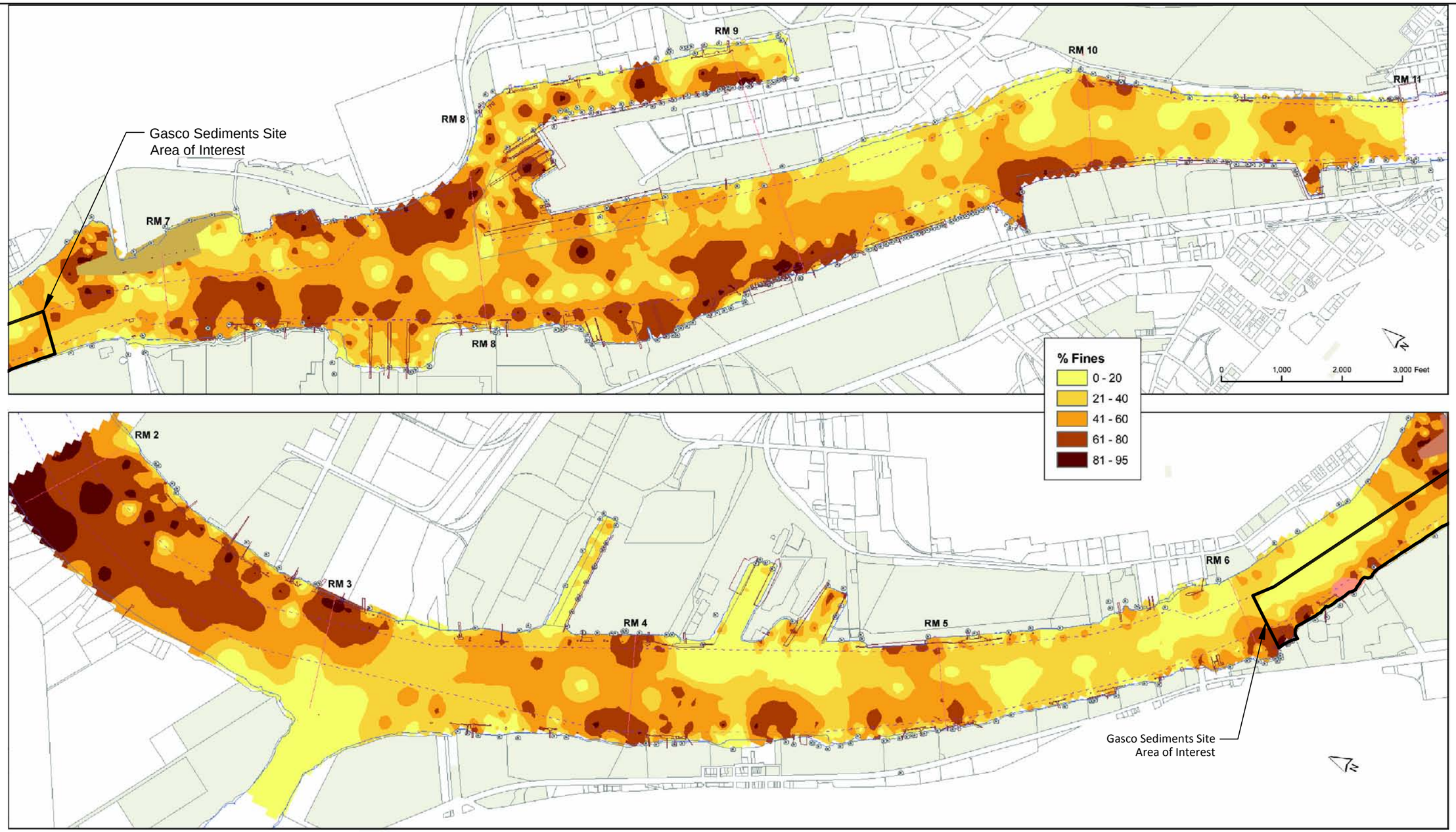
ANCHOR QEA



Jan 11, 2010 11:33am cdavidson K:\Jobs\000029-GASCO\00002902\00002902-RP-059.dwg FIG 2.2.3-1

ANCHOR QEA

Figure 2.2.3-1
2009 Bathymetry
NW Natural "Gasco" Site
Gasco Sediment Cleanup Action



FEATURE SOURCES:
Transportation, Property, or Boundaries: Metro RLIS .
Channel & River miles: US Army Corps of Engineers
Bathymetric Information: David Evans and Associates, Inc.

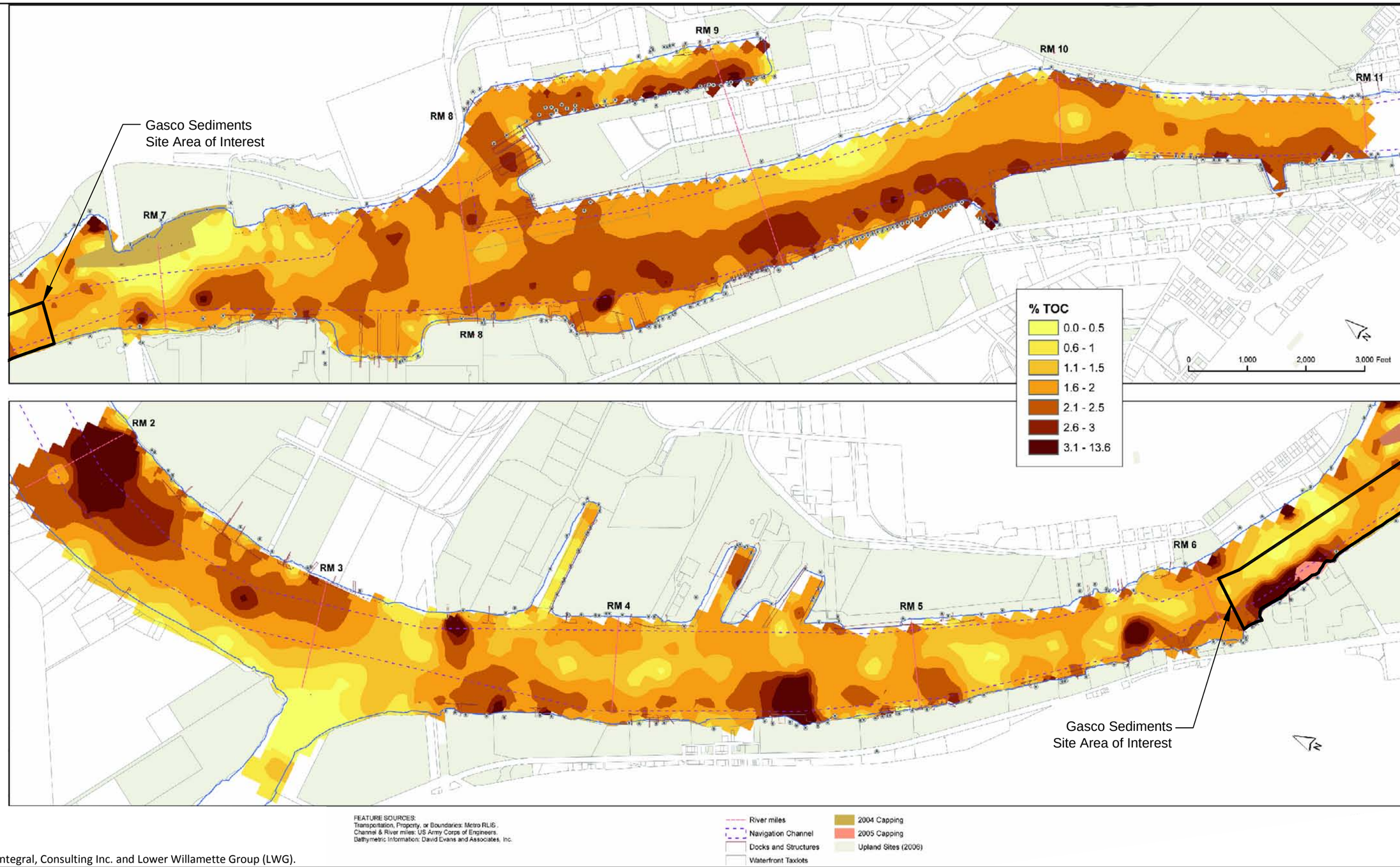
River miles
Navigation Channel
Docks and Structures
Waterfront Taxlots
2004 Capping
2005 Capping
Upland Sites (2006)

SOURCE: Integral, Consulting Inc. and Lower Willamette Group (LWG).

Dec 29, 2009 11:06am cdavidson K:\Jobs\000029-GASCO\0002902\00002902-RP-064.dwg F 2.2.3-2

ANCHOR QEA

Figure 2.2.3-2
Contoured Surface Sediment Texture, Percent Fines
NW Natural "Gasco" Site
Gasco Sediment Cleanup Action

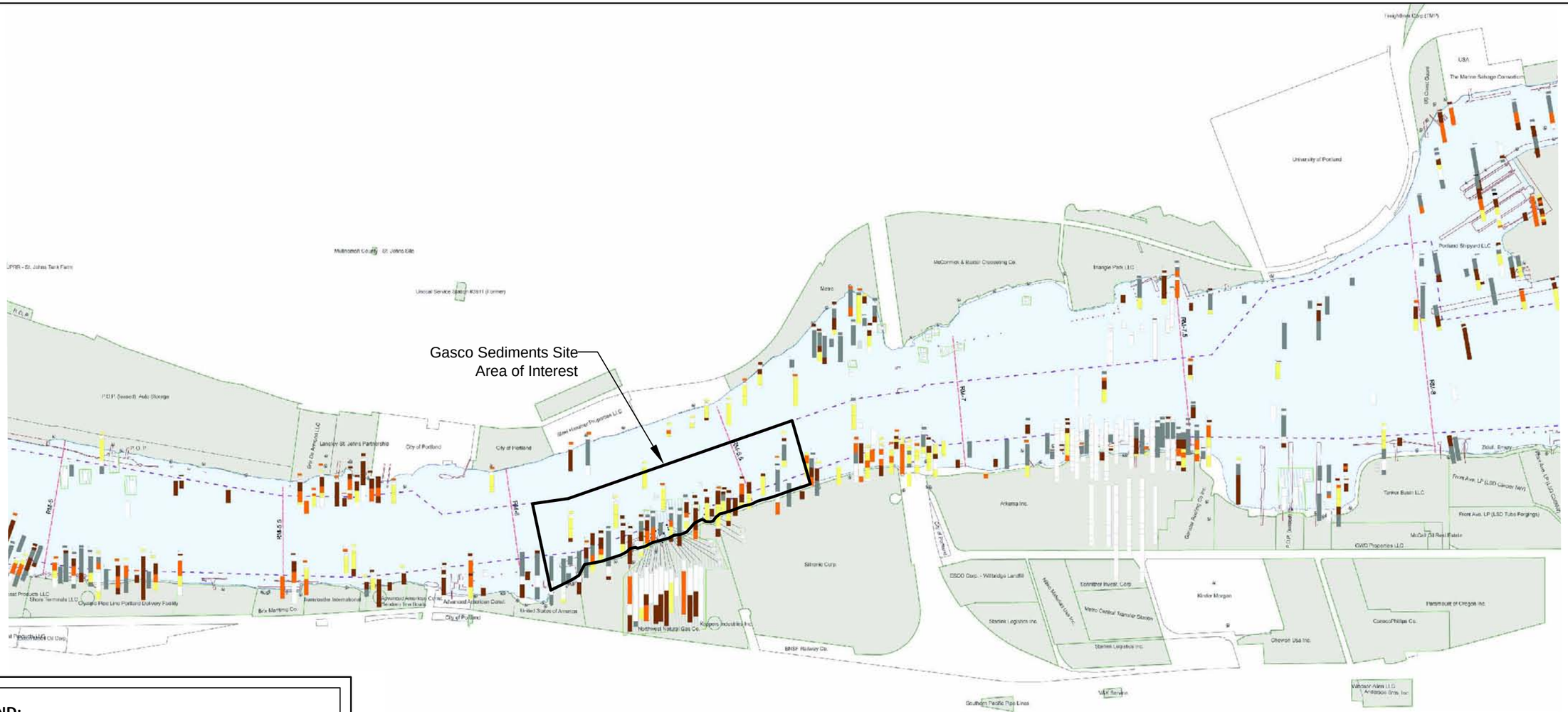


SOURCE: Integral, Consulting Inc. and Lower Willamette Group (LWG).

Dec 29, 2009 11:06am ctdavidson K:\Jobs\000029-GASCO\00002902\00002902-RP-064.dwg F 2.2.3-3

ANCHOR QEA

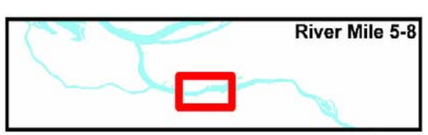
Figure 2.2.3-3
Contoured Surface Sediment Total Organic Carbon Content, Percent TOC
NW Natural "Gasco" Site
Gasco Sediment Cleanup Action



LEGEND:

- Outfalls
- Docks and Structures
- Navigation Channel
- Dredged/Capped Sampes

0 200 400 600 800 Feet

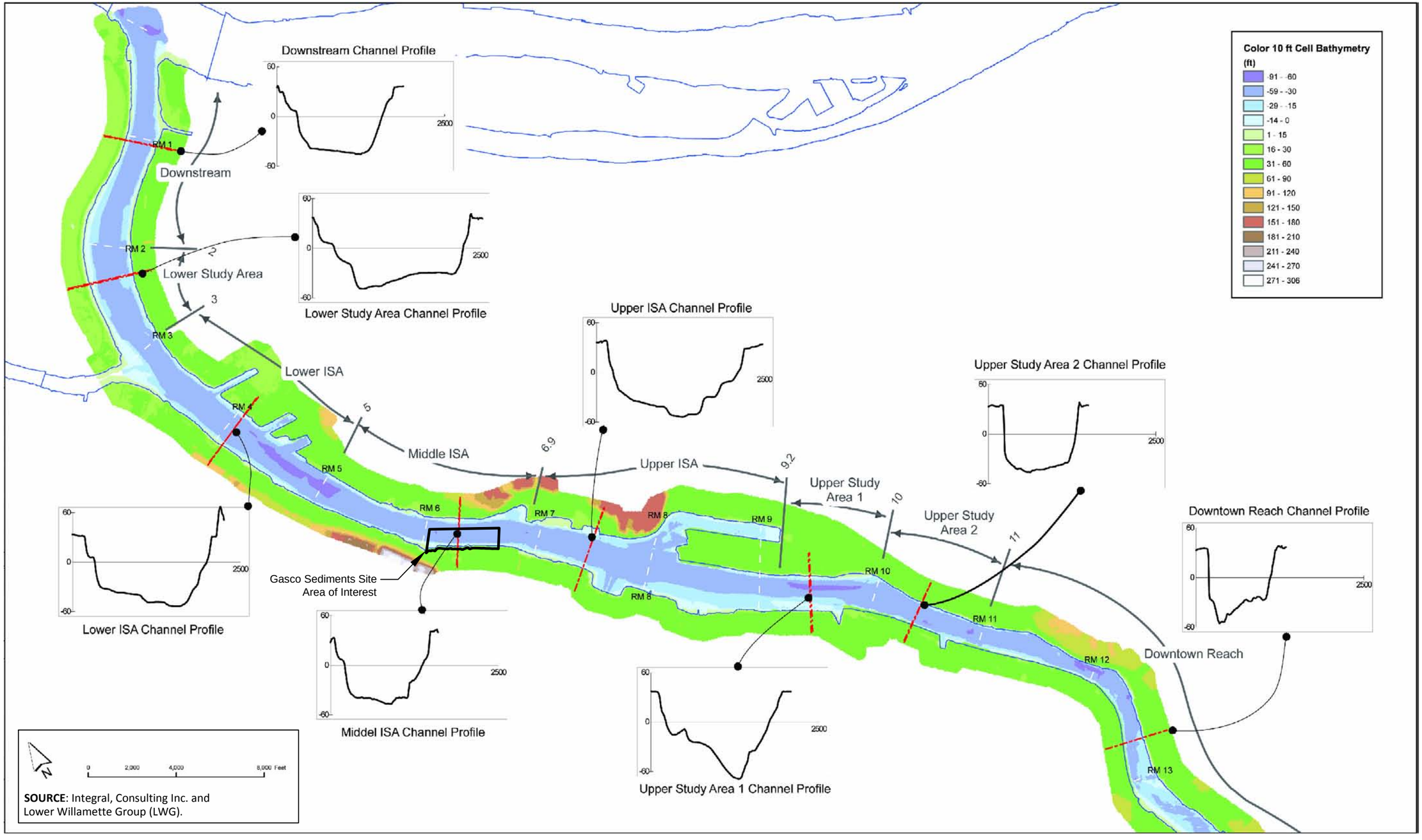


SOURCE: Integral, Consulting Inc. and Lower Willamette Group (LWG).

Dec 29, 2009 11:12am cdavidson K:\Jobs\000029-GASCO\00002902\00002902-RP-064.dwg F 2.2.3-4

ANCHOR QEA

Figure 2.2.3-4
Sediment Texture with Depth, RM 5-8
NW Natural "Gasco" Site
Gasco Sediment Cleanup Action



Dec 29, 2009 11:22am cdavidson K:\Jobs\000029-GASCO\00002902\00002902-RP-064.dwg F 2.2.3-5

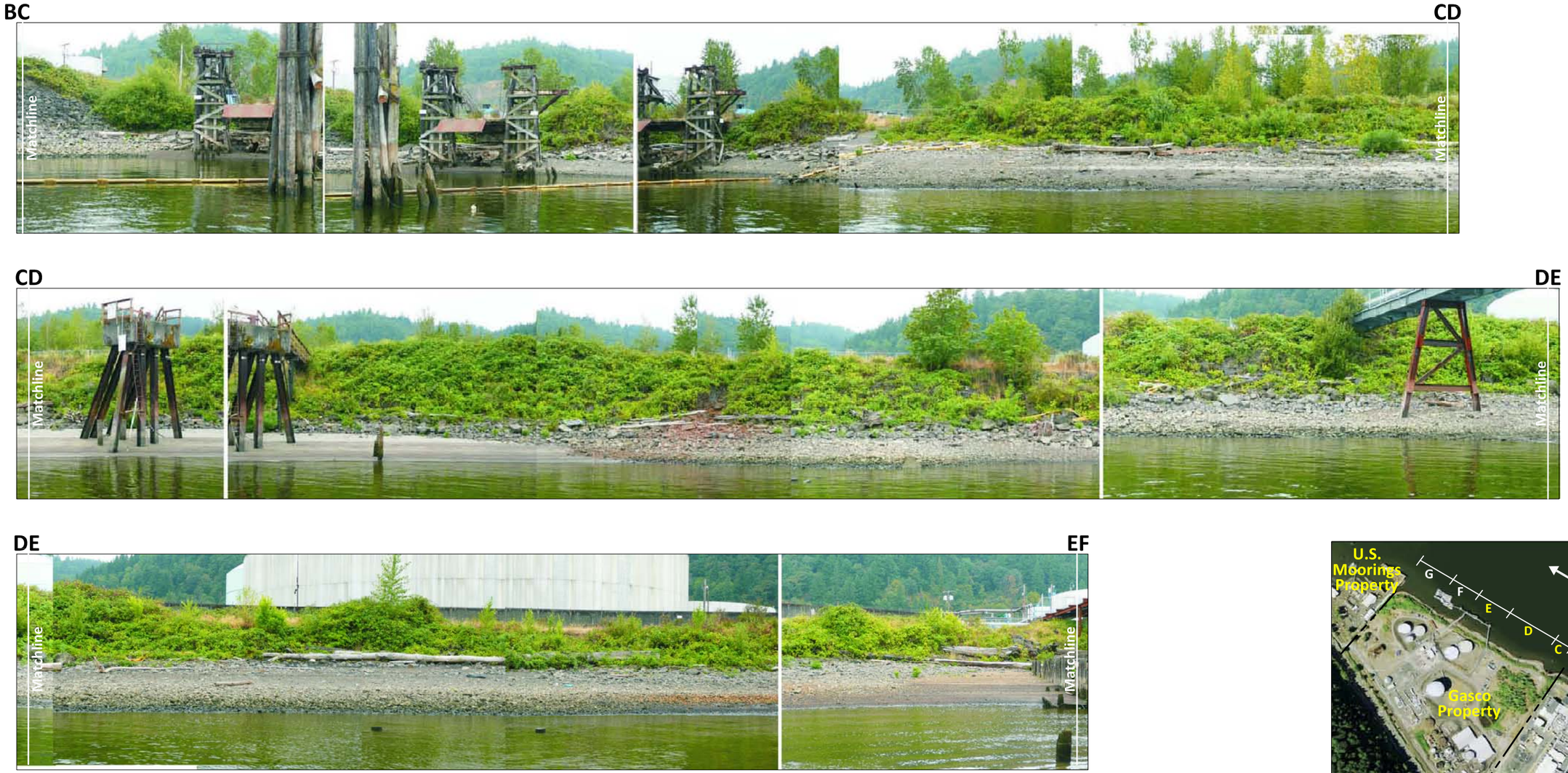
ANCHOR QEA

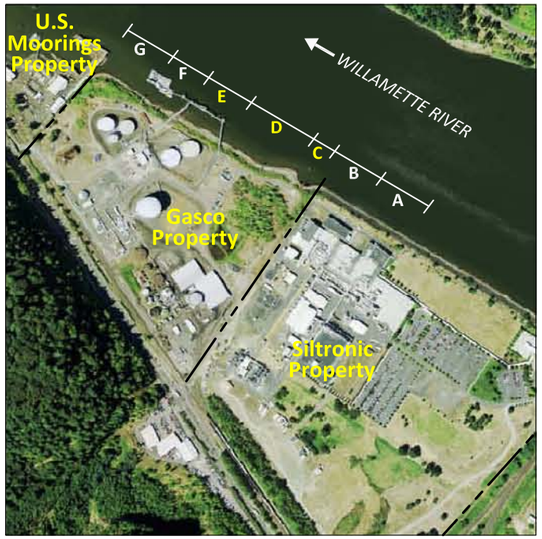
Figure 2.2.3-5
LWR Channel Profiles
NW Natural "Gasco" Site
Gasco Sediment Cleanup Action

Dec 29, 2009 11:25am cdavidson K:\Jobs\000029-GASCO\00002902\00002902-RP-052.dwg FIG 2.2.4-1

ANCHOR QEA

Figure 2.2.4-1
August 8, 2009 Shoreline Photo Reconnaissance Survey - Photo Area AB
NW Natural "Gasco" Site
Gasco Sediment Cleanup Action





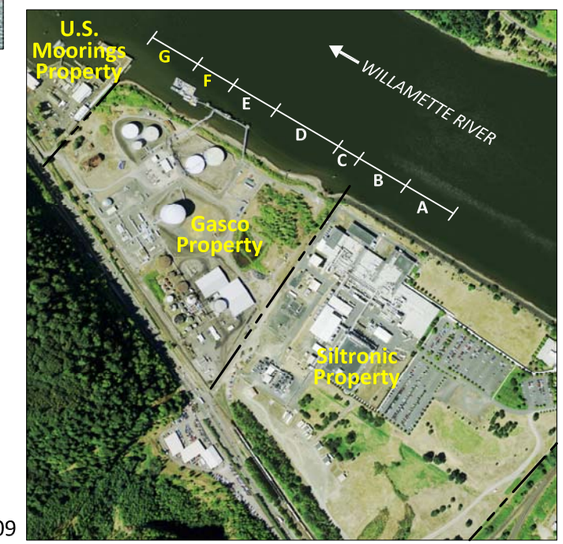
Not to Scale
SOURCE: Google Earth Pro, 2009

Photo Area

Dec 29, 2009 11:26am cdavidson K:\Jobs\000029-GASCO\00002902\00002902-RP-052.dwg FIG 2.2.4-2

ANCHOR QEA

Figure 2.2.4-2
August 8, 2009 Shoreline Photo Reconnaissance Survey - Photo Area CDE
NW Natural "Gasco" Site
Gasco Sediment Cleanup Action



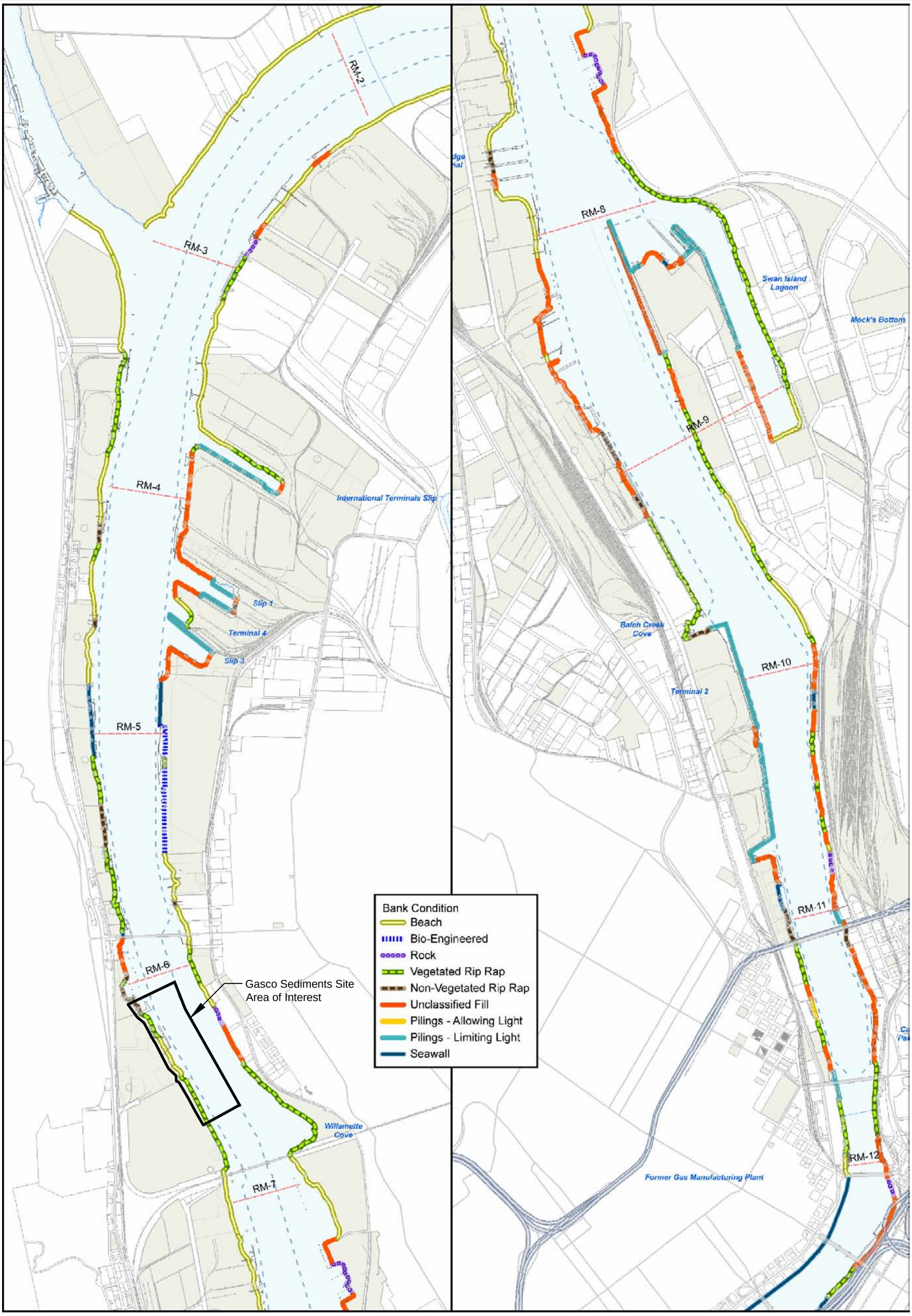
Not to Scale
SOURCE: Google Earth Pro, 2009

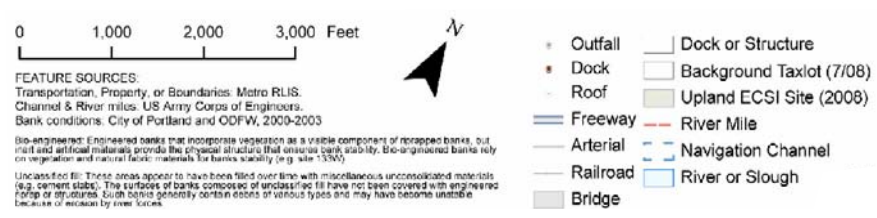
Photo Area

Dec 29, 2009 11:27am cdavidson K:\Jobs\000029-GASCO\00002902\00002902-RP-052.dwg FIG 2.2.4-3

ANCHOR QEA

Figure 2.2.4-3
August 8, 2009 Shoreline Photo Reconnaissance Survey - Photo Area FG
NW Natural "Gasco" Site
Gasco Sediment Cleanup Action





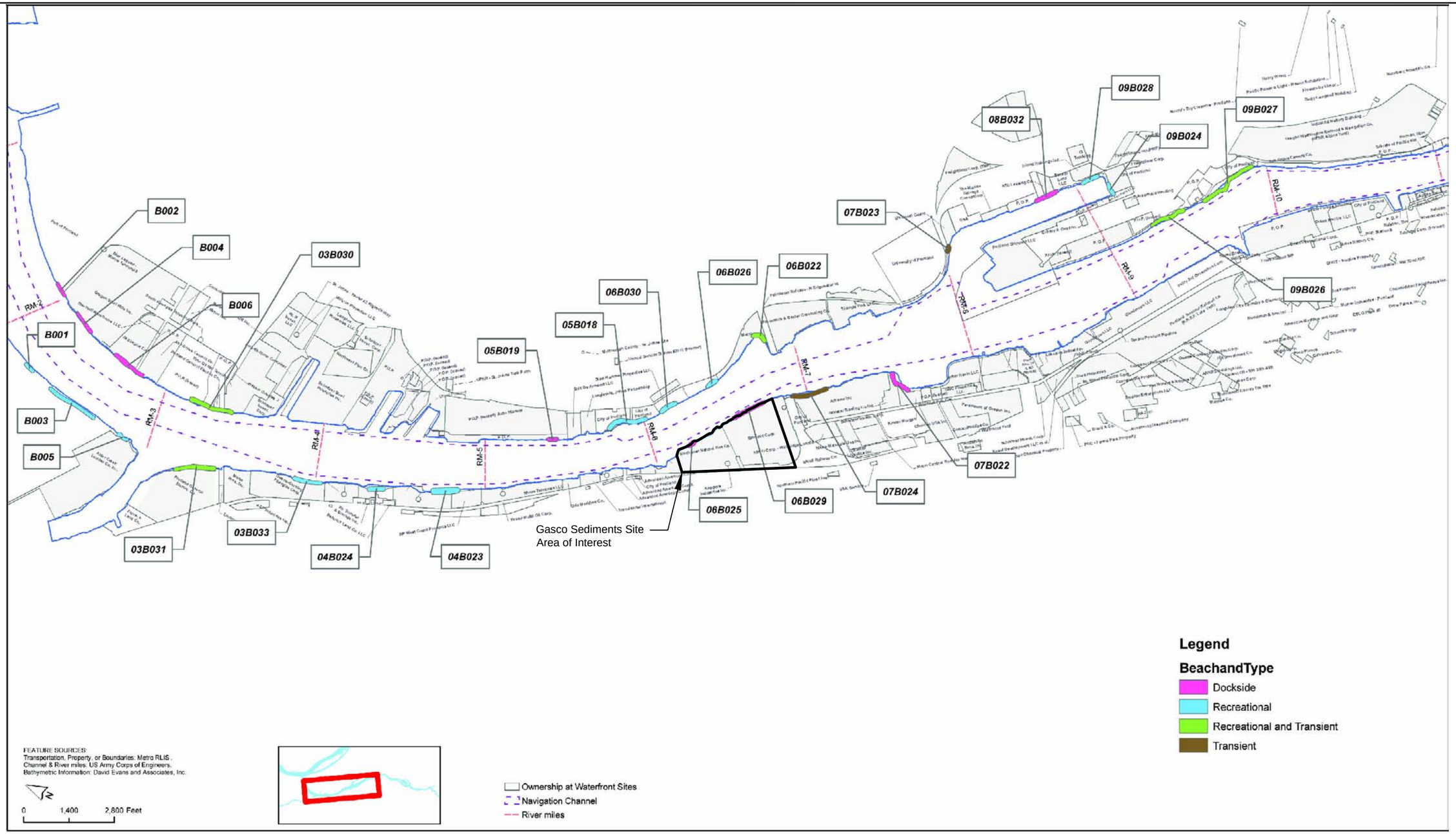
SOURCE: Integral Consulting, Inc.

K:\Jobs\000029-GASCO\00002902\00002902-RP-058.dwg F 2.3.1-1

Dec 29, 2009 8:52am cdavidson

ANCHOR QEA

Figure 2.3.1-1
Water Related Features
NW Natural "Gasco" Site
Gasco Sediment Cleanup Action

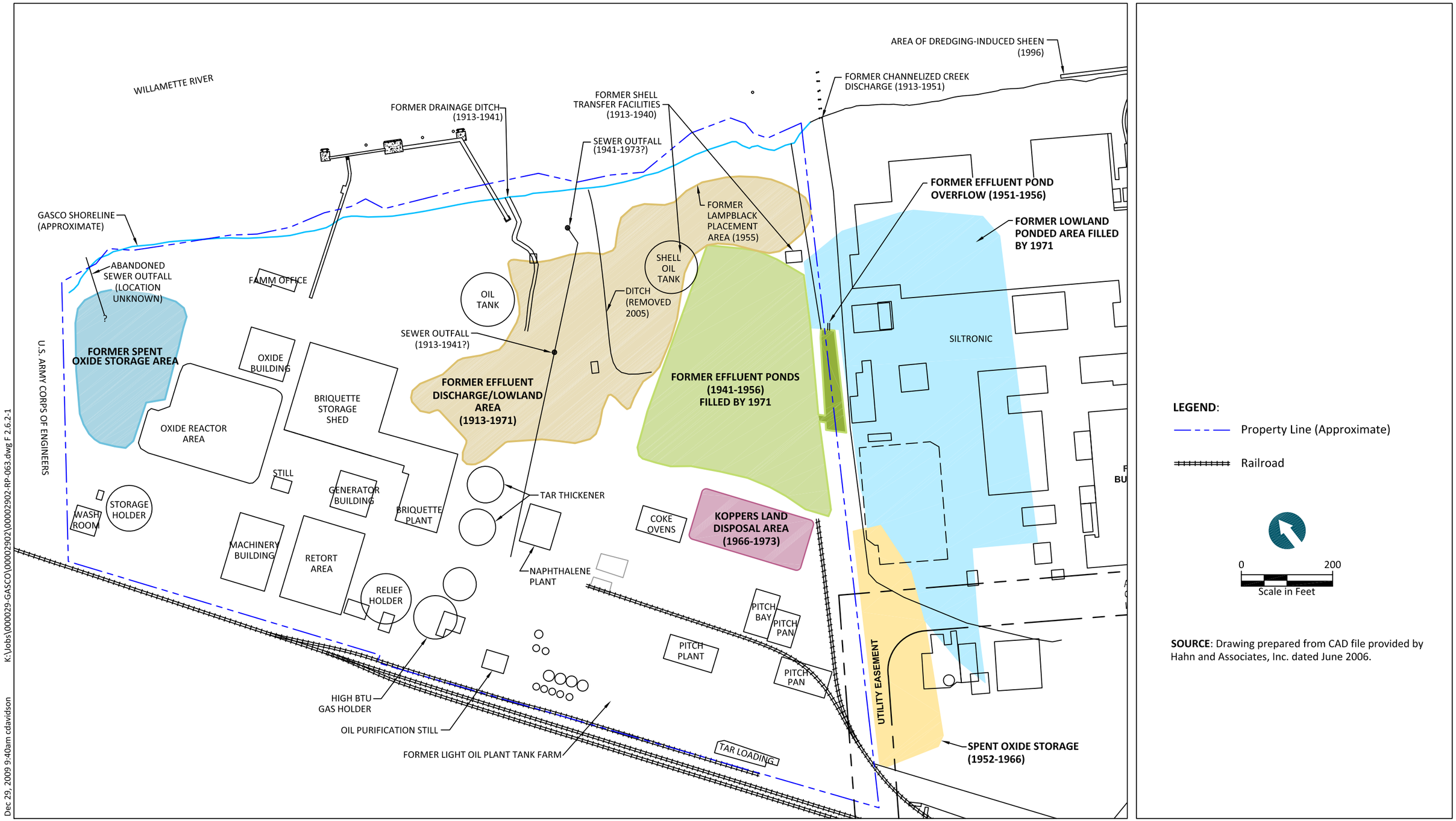


SOURCE: Integral, Consulting Inc. and LWG Lower Willamette Group.

Dec 29, 2009 11:30am cdavidson K:\Jobs\000029-GASCO\00002902\00002902-RP-058.dwg F 2.4-1

ANCHOR QEA

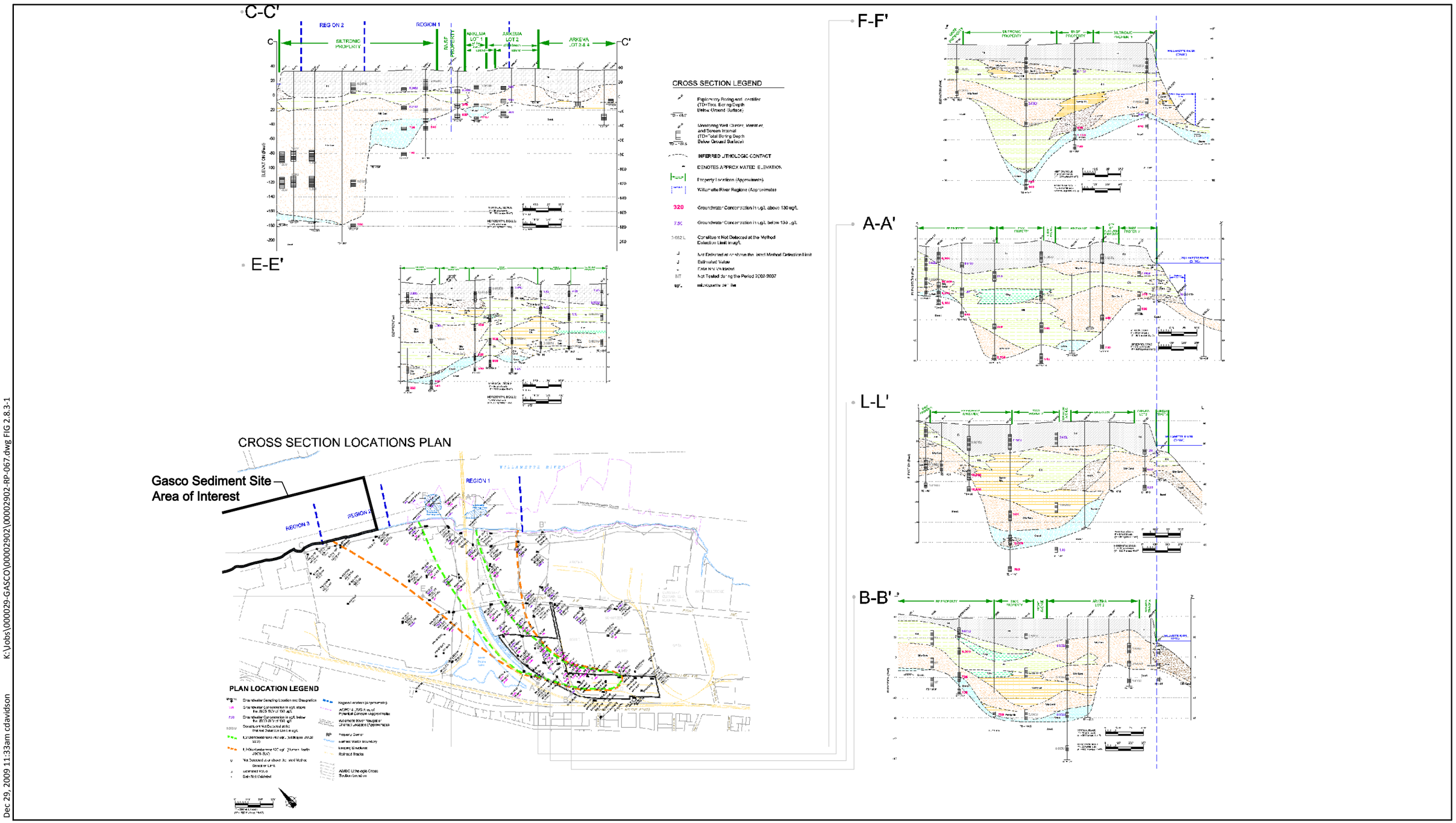
Figure 2.4-1
Designated Potential Human Use Areas and Associated Beach Sediment Samples
NW Natural "Gasco" Site
Gasco Sediment Cleanup Action



Dec 29, 2009 9:40am cdavidson K:\Jobs\000029-GASCO\00002902\00002902-RP-063.dwg F 2.6.2-1

ANCHOR QEA

Figure 2.6.2-1
Gasco Historical Property Features
NW Natural "Gasco" Site
Gasco Sediment Cleanup Action



Dec 29, 2009 11:33am cdavidson K:\Jobs\000029-GASCO\00002902\00002902-RP-067.dwg FIG 2.8.3-1

Figure 2.8.3-1
Rhone Poulenc 1,2-Dichlorobenzene Plume and Cross-Sections
NW Natural "Gasco" Site
Gasco Sediment Cleanup Action

ANCHOR QEA

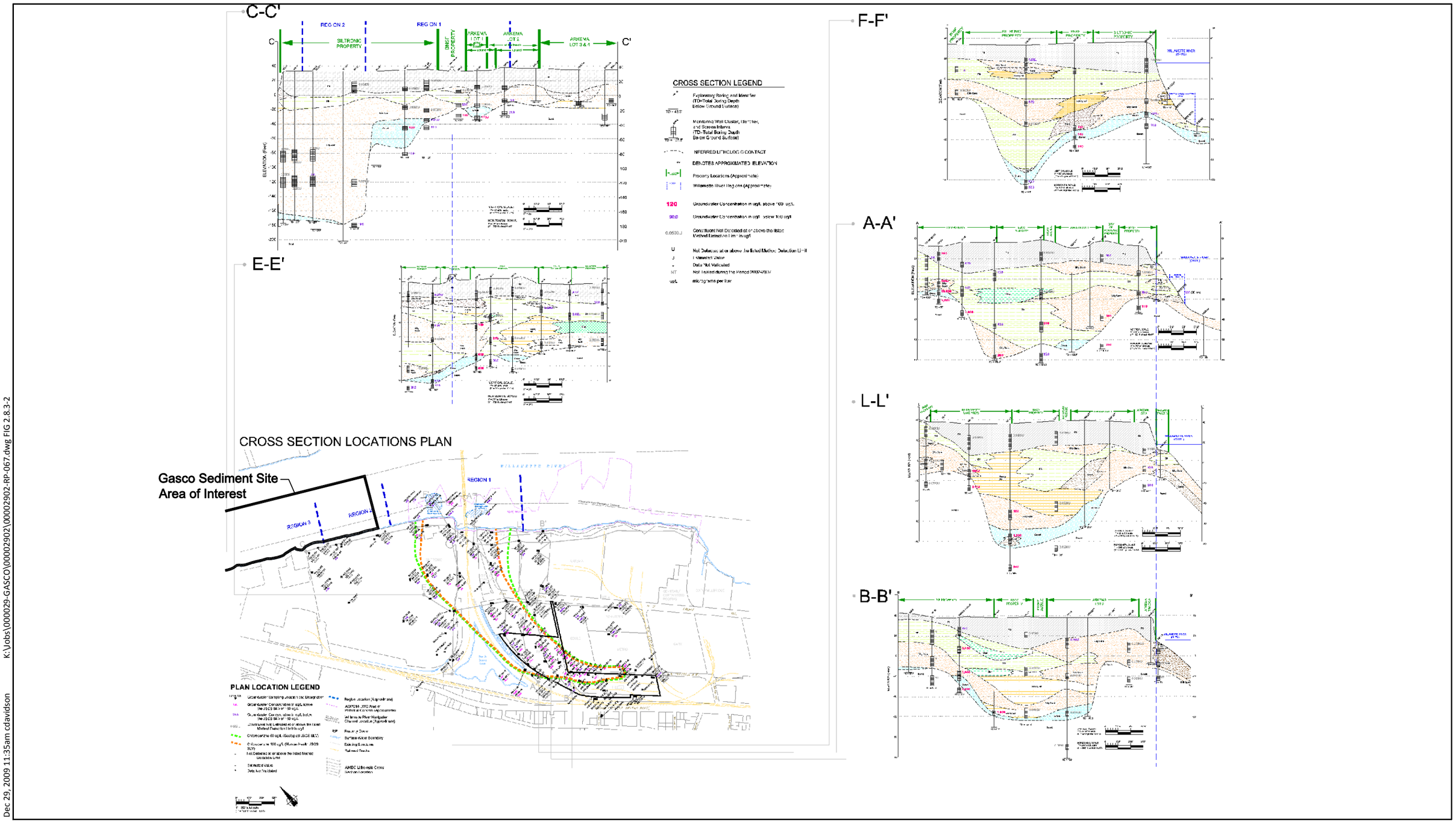
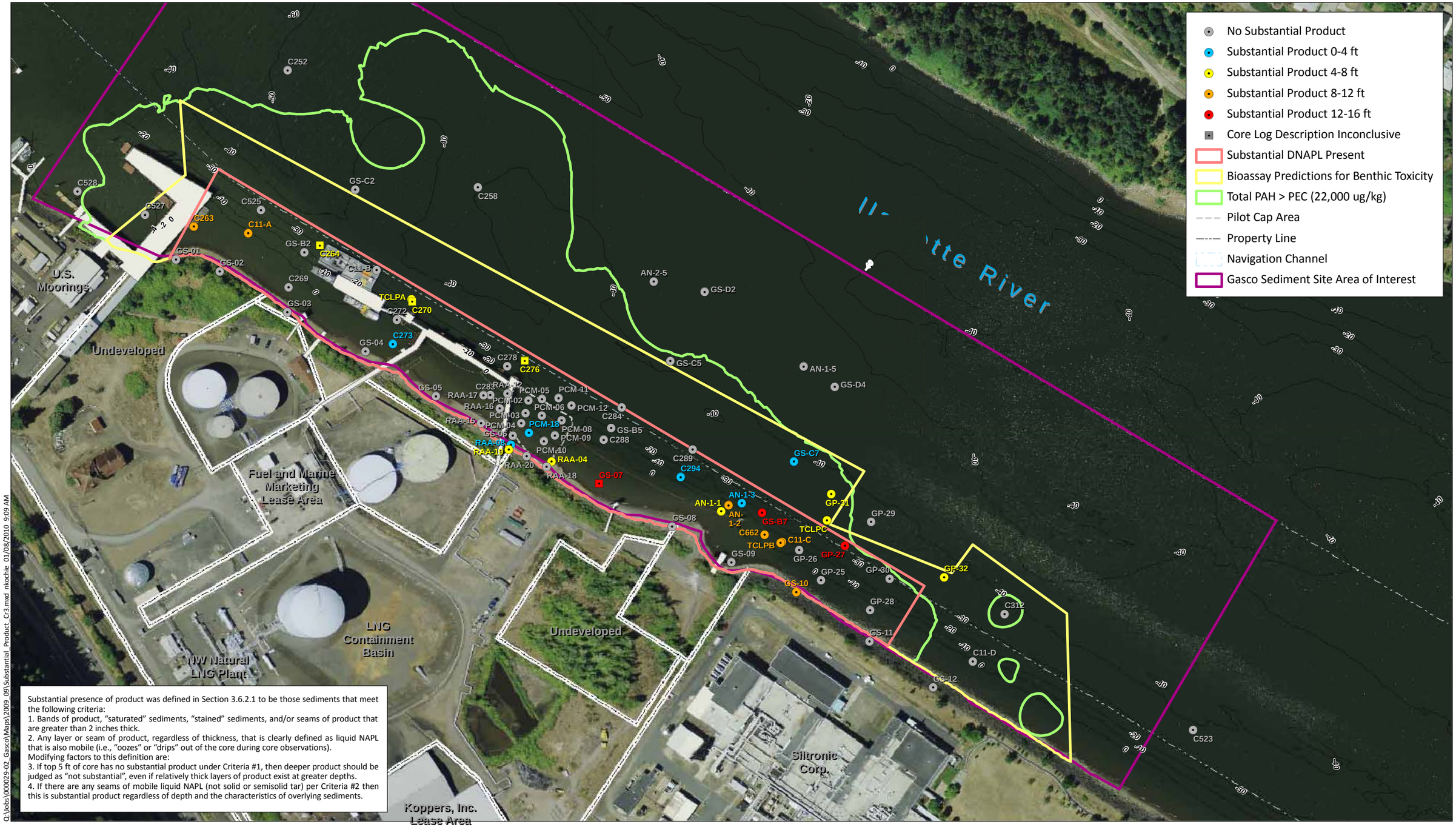


Figure 2.8.3-2
Rhone Poulenc Chlorobenzene Plume and Cross-Sections
NW Natural "Gasco" Site
Gasco Sediment Cleanup Action

ANCHOR QEA



Substantial presence of product was defined in Section 3.6.2.1 to be those sediments that meet the following criteria:
1. Bands of product, "saturated" sediments, "stained" sediments, and/or seams of product that are greater than 2 inches thick.
2. Any layer or seam of product, regardless of thickness, that is clearly defined as liquid NAPL that is also mobile (i.e., "oozes" or "drips" out of the core during core observations).
Modifying factors to this definition are:
3. If top 5 ft of core has no substantial product under Criteria #1, then deeper product should be judged as "not substantial", even if relatively thick layers of product exist at greater depths.
4. If there are any seams of mobile liquid NAPL (not solid or semisolid tar) per Criteria #2 then this is substantial product regardless of depth and the characteristics of overlying sediments.

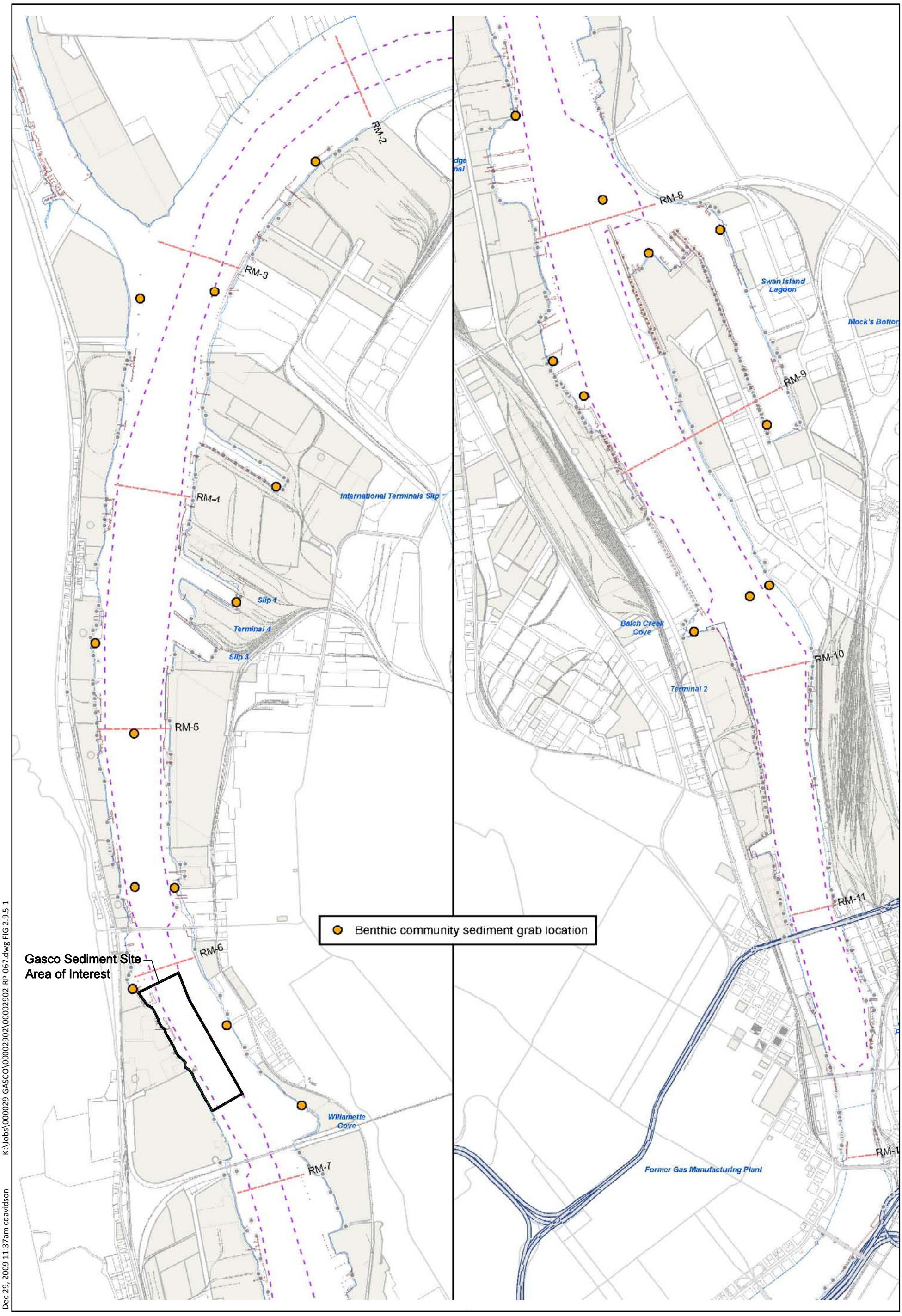
Q:\Jobs\000029-02_Gasco\Maps\2009_09\Substantial_Product_Cr3.mxd nkochie 01/08/2010 9:09 AM

ANCHOR QEA

Notes:
1. Cores collected during the tar body removal action characterization that were within the Removal Action Area were not included in this evaluation.
2. PCM-XX samples collected as part of the long term pilot cap monitoring associated with the Removal Action. A total of 5 monitoring events included coring below cap and all events showed consistent lithology.
3. Core evaluation was only conducted within the shown extents.
4. Maul Foster sediment investigation performed in 2005 offshore of the Siltronics facility did not include core logs preventing criteria evaluation.

Feet
0 225 450

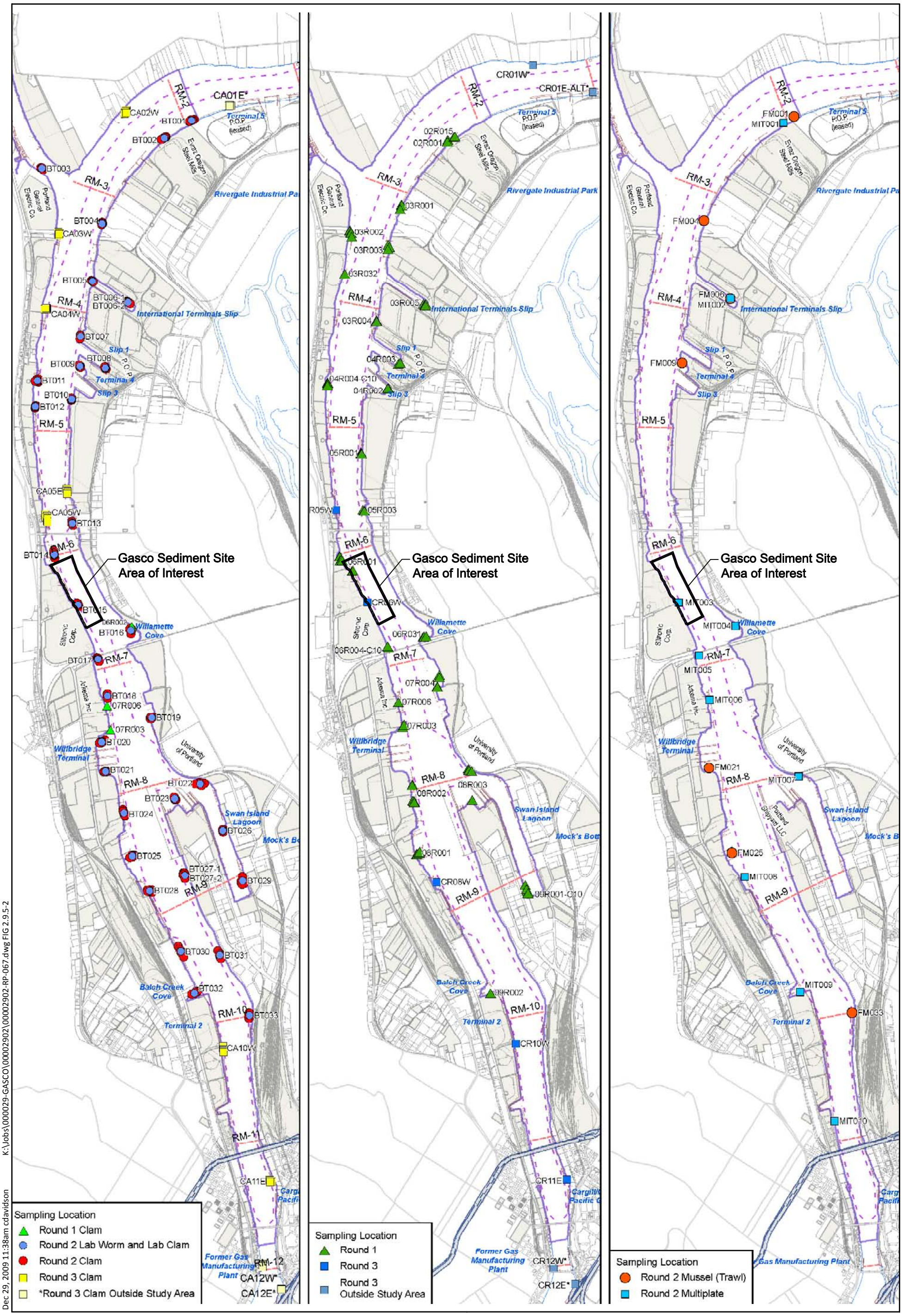
Figure 2.9.4-1
Location of Substantial Presence of Product
Based on Core Log Descriptions
NW Natural "Gasco" Site
Gasco Sediment Cleanup Action



Dec 29, 2009 11:37am cdavidson K:\Jobs\000029-GASCO\00002902\00002902-RP-067.dwg FIG 2.9.5-1

ANCHOR QEA

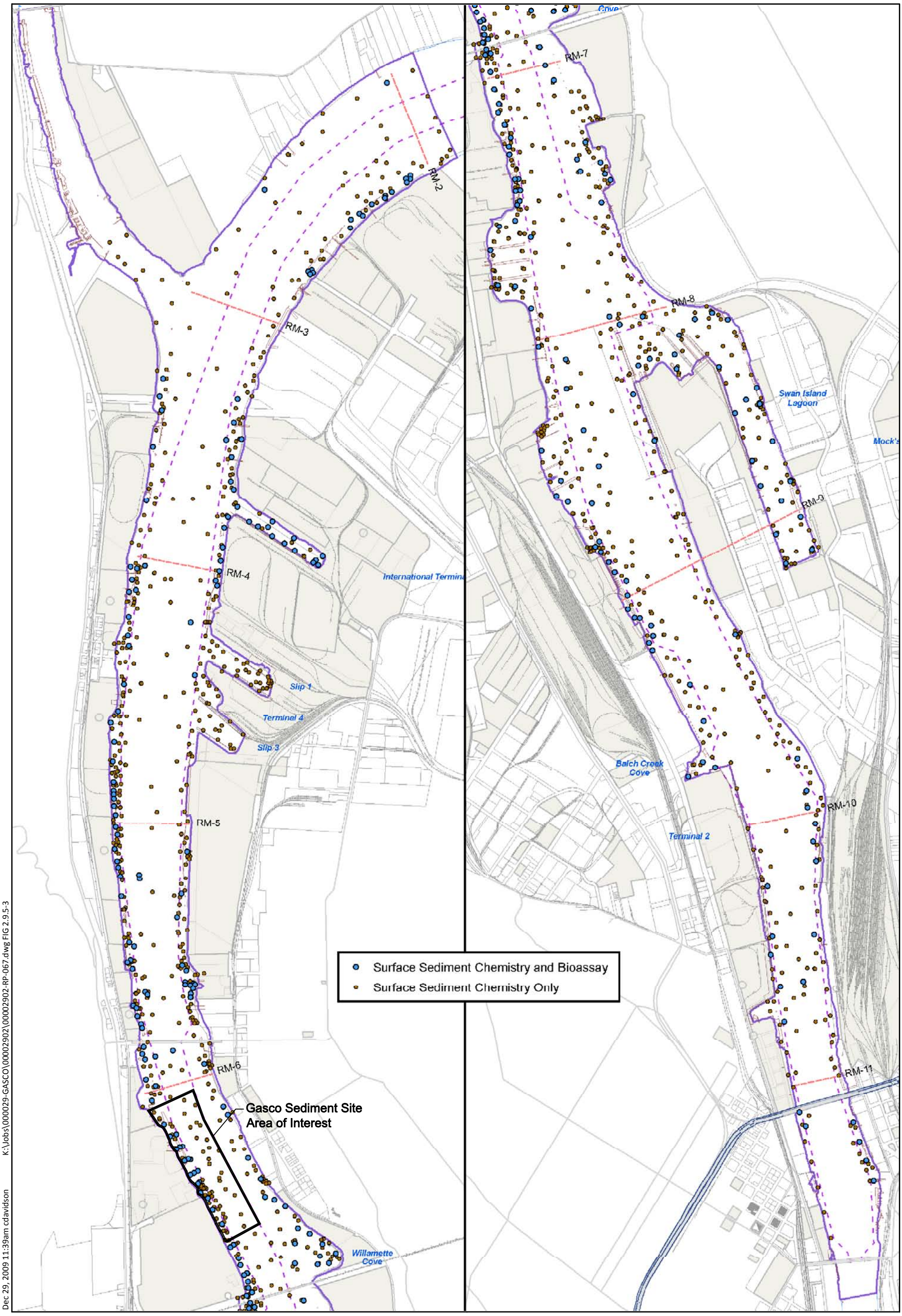
Figure 2.9.5-1
LWG Benthic Community Sediment Grab Locations
NW Natural "Gasco" Site
Gasco Sediment Cleanup Action



Dec 29, 2009 11:38am cdavidson K:\Jobs\000029-GASCO\00002902\00002902-RP-067.dwg FIG 2.9.5-2

Figure 2.9.5-2
LWG Muliplate and Mussel Tissue Sampling
NW Natural "Gasco" Site
Gasco Sediment Cleanup Action

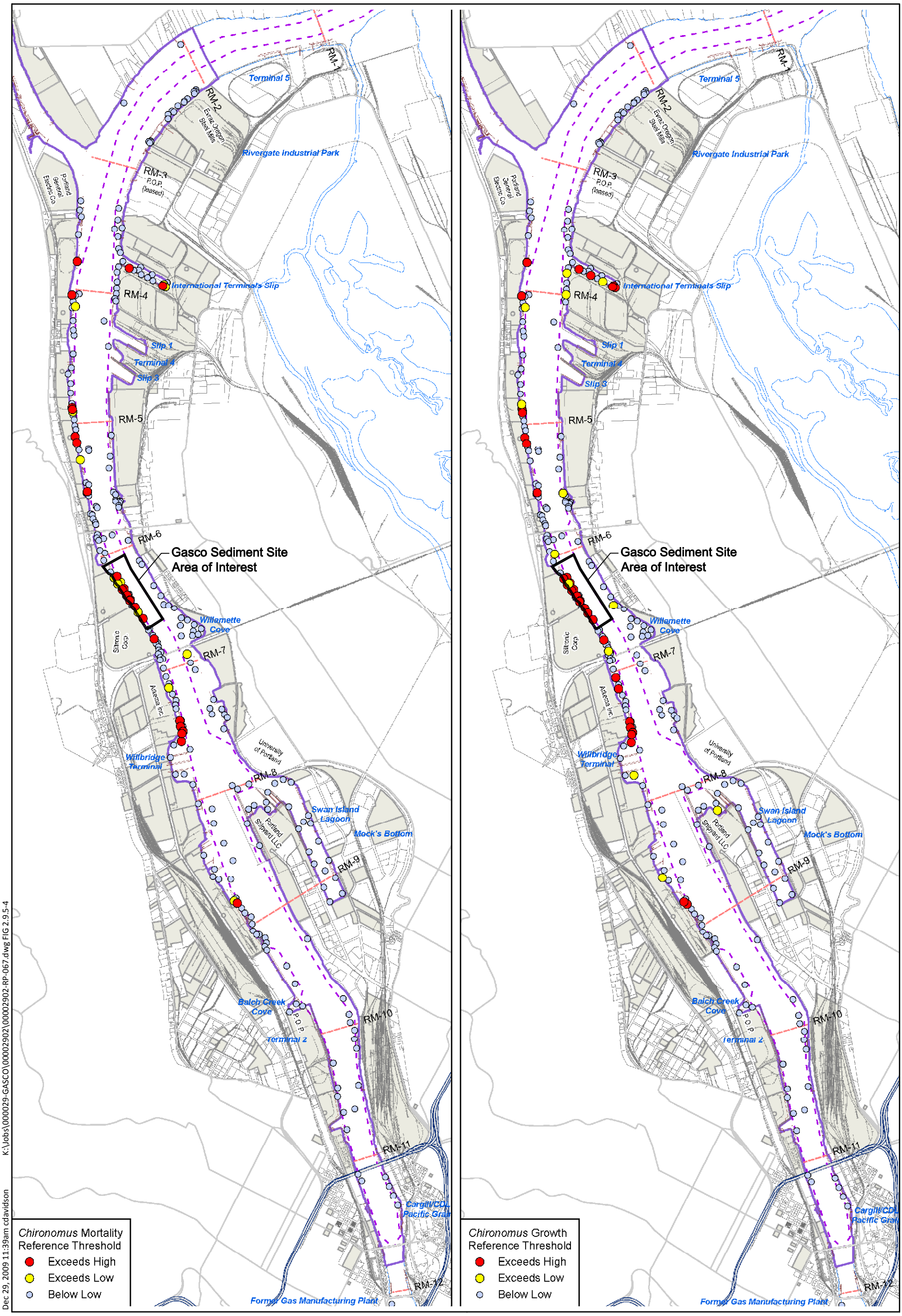
ANCHOR QEA



Dec 29, 2009 11:39am cdavidson K:\Jobs\000029-GASCO\00002902\00002902-RP-067.dwg FIG 2.9.5-3

Figure 2.9.5-3
LWG Bioassay Surface Sediment Grab Locations
NW Natural "Gasco" Site
Gasco Sediment Cleanup Action

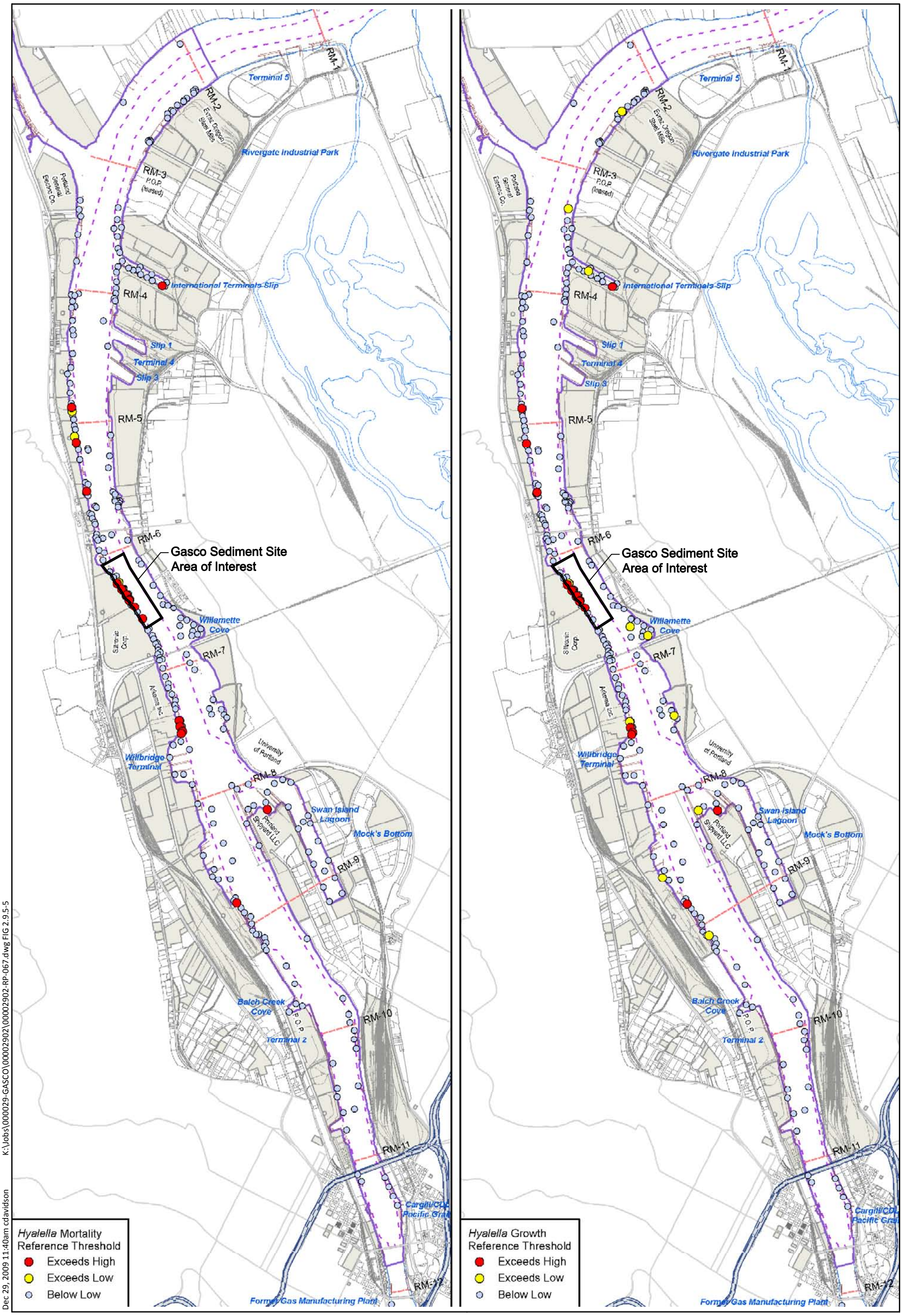
ANCHOR QEA



Dec 29, 2009 11:39am cdavidson K:\Jobs\000029-GASCO\00002902\00002902-RP-067.dwg FIG 2.9.5-4

Figure 2.9.5-4
LWG Chironomus dilutus Growth Exceedances of Threshold
NW Natural "Gasco" Site
Gasco Sediment Cleanup Action

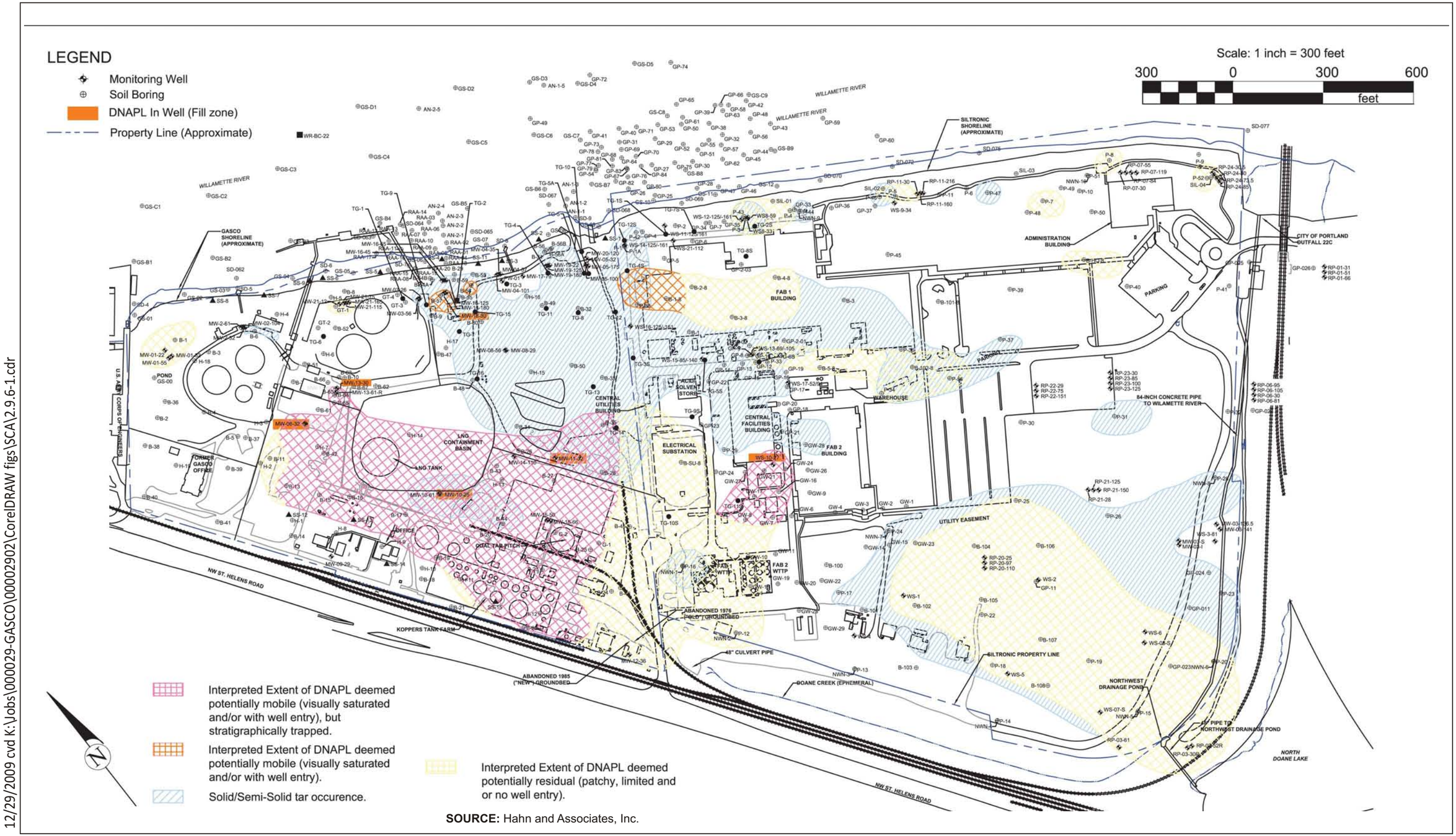
ANCHOR QEA



Dec 29, 2009 11:40am cdavidson K:\Jobs\000029-GASCO\00002902\00002902-RP-067.dwg FIG 2.9.5-5

Figure 2.9.5-5
LWG Hyalella azteca Growth Exceedances of Thresholds
NW Natural "Gasco" Site
Gasco Sediment Cleanup Action

ANCHOR QEA



SOURCE: Hahn and Associates, Inc.

12/29/2009 cvd K:\Jobs\000029-GASCO\0002902\CorelDRAW figs\SCA\2.9.6-1.cdr

Figure 2.9.6-1
Estimated Distribution of Tar and DNAPL in Fill Zone
NW Natural "Gasco" Site
Gasco Sediment Cleanup Action

ANCHOR QEA

Table: TarGOST DNAPL Presence
Screening Results - Gasco Property

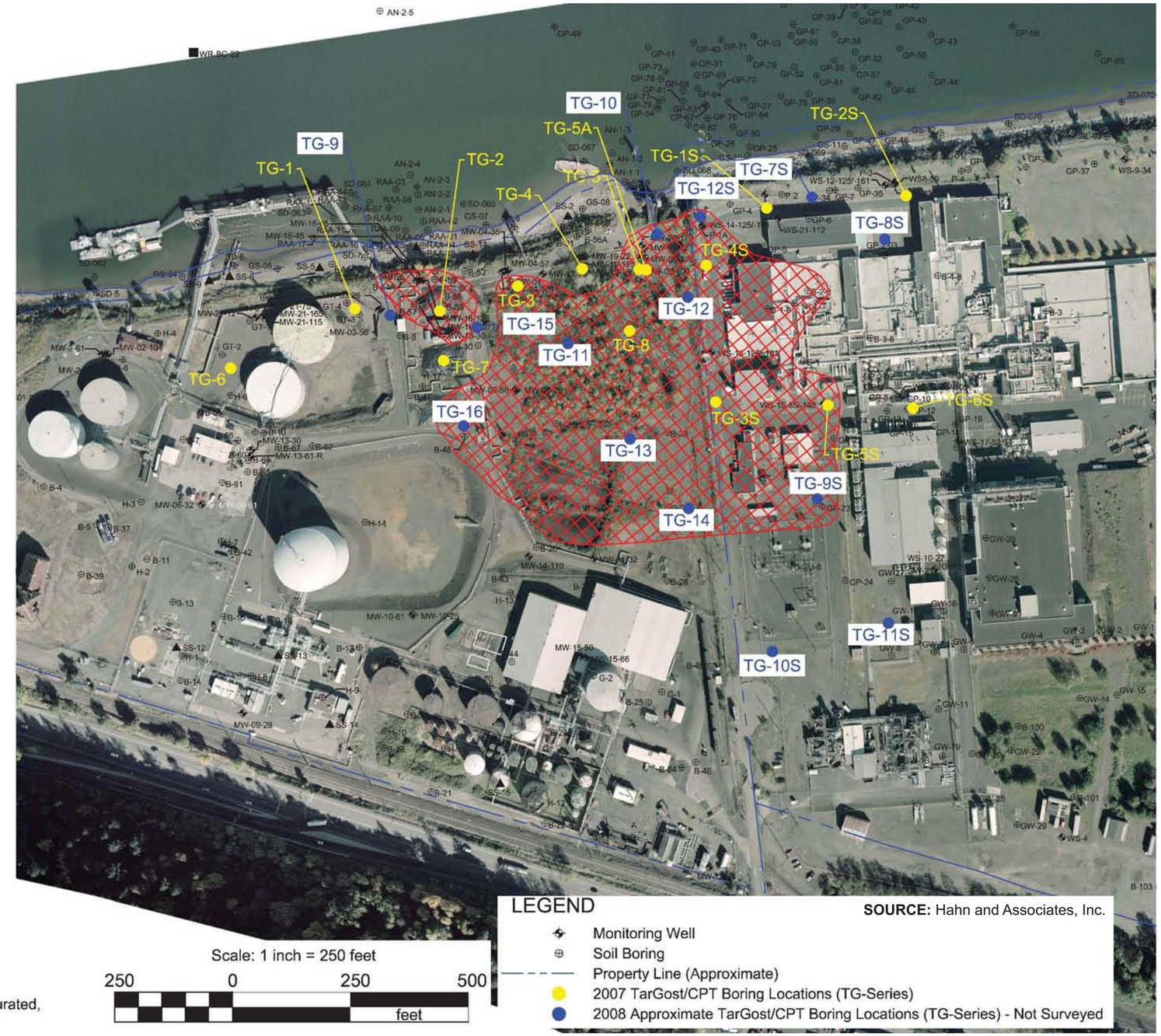
Boring ID	Boring Depth (ft bgs)	Depths of DNAPL Indication (Alluvial)
TG-1	150'	NONE
TG-2	150'	28.7'-30.6'
TG-3	150'	58.8'-60.6'
TG-4	150'	NONE
TG-5	100'	51.6'-53.3',57.8'-58.8',59.3'-63.2' 64.8'-65.1'
TG-5A	150'	51.3' ?
TG-6	125'	NONE
TG-7	150'	NONE
TG-8	150'	25'-39',41.4'-43.6',44.1'-45.3' 48.7'-48.9',51.5'-52.3',54.9'-61.1'
TG-9	148'	26',28' (MINOR)
TG-10	151'	75.5'-76.5',79.5'-86.5'
TG-11	150'	54'-56',112'?
TG-12	150'	26.5'-29.5',30'-32',32.5'-36.5', 40.5'-42.5',44.5'-48',50',52.5' ?
TG-13	102' (REFUSAL)	26.5'-36' (MINOR),36'-40',46'-50', 55'-68'
TG-14	100' (REFUSAL)	25'-34' (MINOR),36'-40',46'
TG-15	149'	144' (SHELL?) ?
TG-16	149'	42'-46',60'-61',78'-84'

Table: TarGOST DNAPL Presence
Screening Results - Siltronic Property

Boring ID	Boring Depth (ft bgs)	Depths of DNAPL Indication (Alluvial)
TG-1S	150'	116.2-118.6'
TG-2S	150'	NONE
TG-3S	150'	34'-78' in multiple intervals
TG-4S	150'	36.7'-36.9',62.8'-63.5',63.8'-65.6' 67.3'-68.6',79.0'-80.8',91.8'-93.2' 93.9'-94.5',98.6'-100'
TG-5S	150'	30'-38.6',40.2'-41.5',42.9'-44.2'
TG-6S	150'	NONE
TG-7S	150'	NONE
TG-8S	147'	NONE
TG-9S	148'	30'-42.5',44'-48',50',74'
TG-10S	91'	NONE
TG-11S	79'	NONE
TG-12S	156'	94'-96.5',110.5',113.5'-114', 115.5'-116',116.5'-120',126'-126.5',130'-131',133'-136'

NOTES:
Borings within outlined areas identified the presence of DNAPL at some depth or depth interval within the Alluvial water-bearing zone at depths shallower than 100' bgs. Tables 2 and 3 of *Summary Report - Former MGP Operations and DNAPL Occurrence* (HAI, November 2005) provide a description of the DNAPL presence at each boring.
TarGOST ™ = Tar-Specific Green Optical Screening Tool by Dakota Technologies.

Interpreted Extent of DNAPL (visually saturated, well entry, or TarGost ID).



SOURCE: Hahn and Associates, Inc.

12/29/2009 cvd K:\Jobs\000029-GASCO\00002902\CorelDRAW figs\SCA\2.9.6-2.cdr

ANCHOR QEA

Figure 2.9.6-2
Estimated DNAPL in Alluvial Above 100 ft bgs
NW Natural "Gasco" Site
Gasco Sediment Cleanup Action

Table: TarGOST DNAPL Presence
Screening Results - Gasco Property

Boring ID	Boring Depth (ft bgs)	Depths of DNAPL Indication (Alluvial)
TG-1	150'	NONE
TG-2	150'	28.7'-30.6'
TG-3	150'	58.8'-60.6'
TG-4	150'	NONE
TG-5	100'	51.6'-53.3',57.8'-58.8',59.3'-63.2' 64.8'-65.1'
TG-5A	150'	51.3' ?
TG-6	125'	NONE
TG-7	150'	NONE
TG-8	150'	25'-39',41.4'-43.6',44.1'-45.3' 48.7'-48.9',51.5'-52.3',54.9'-61.1'
TG-9	148'	26',28' (MINOR)
TG-10	151'	75.5'-76.5',79.5'-86.5'
TG-11	150'	54'-56',112'?
TG-12	150'	26.5'-29.5',30'-32',32.5'-36.5', 40.5'-42.5',44.5'-48',50',52.5' ?
TG-13	102' (REFUSAL)	26.5'-36' (MINOR),36'-40',46'-50', 55'-68'
TG-14	100' (REFUSAL)	25'-34' (MINOR),36'-40',46'
TG-15	149'	144' (SHELL?) ?
TG-16	149'	42'-46',60'-61',78'-84'

Table: TarGOST DNAPL Presence
Screening Results - Siltronic Property

Boring ID	Boring Depth (ft bgs)	Depths of DNAPL Indication (Alluvial)
TG-1S	150'	116.2-118.6'
TG-2S	150'	NONE
TG-3S	150'	34'-78' in multiple intervals
TG-4S	150'	36.7'-36.9',62.8'-63.5',63.8'-65.6' 67.3'-68.6',79.0'-80.8',91.8'-93.2' 93.9'-94.5',98.6'-100'
TG-5S	150'	30'-38.6',40.2'-41.5',42.9'-44.2'
TG-6S	150'	NONE
TG-7S	150'	NONE
TG-8S	147'	NONE
TG-9S	148'	30'-42.5',44'-48',50',74'
TG-10S	91'	NONE
TG-11S	79'	NONE
TG-12S	156'	94'-96.5',110.5',113.5'-114', 115.5'-116',116.5'-120',126'-126.5',130'-131',133'-136'

NOTES:
Borings within outlined areas identified the presence of DNAPL at some depth or depth interval within the Alluvial water-bearing zone at depths shallower than 100' bgs. Tables 2 and 3 of *Summary Report - Former MGP Operations and DNAPL Occurrence* (HAI, November 2005) provide a description of the DNAPL presence at each boring.
TarGOST ™ = Tar-Specific Green Optical Screening Tool by Dakota Technologies.

Interpreted Extent of DNAPL (visually saturated, well entry, or TarGost ID).

Scale: 1 inch = 250 feet
250 0 250 500
feet

LEGEND
- Monitoring Well
- Soil Boring
- Property Line (Approximate)
- 2007 TarGost/CPT Boring Locations (TG-Series)
- 2008 Approximate TarGost/CPT Boring Locations (TG-Series) - Not Surveyed

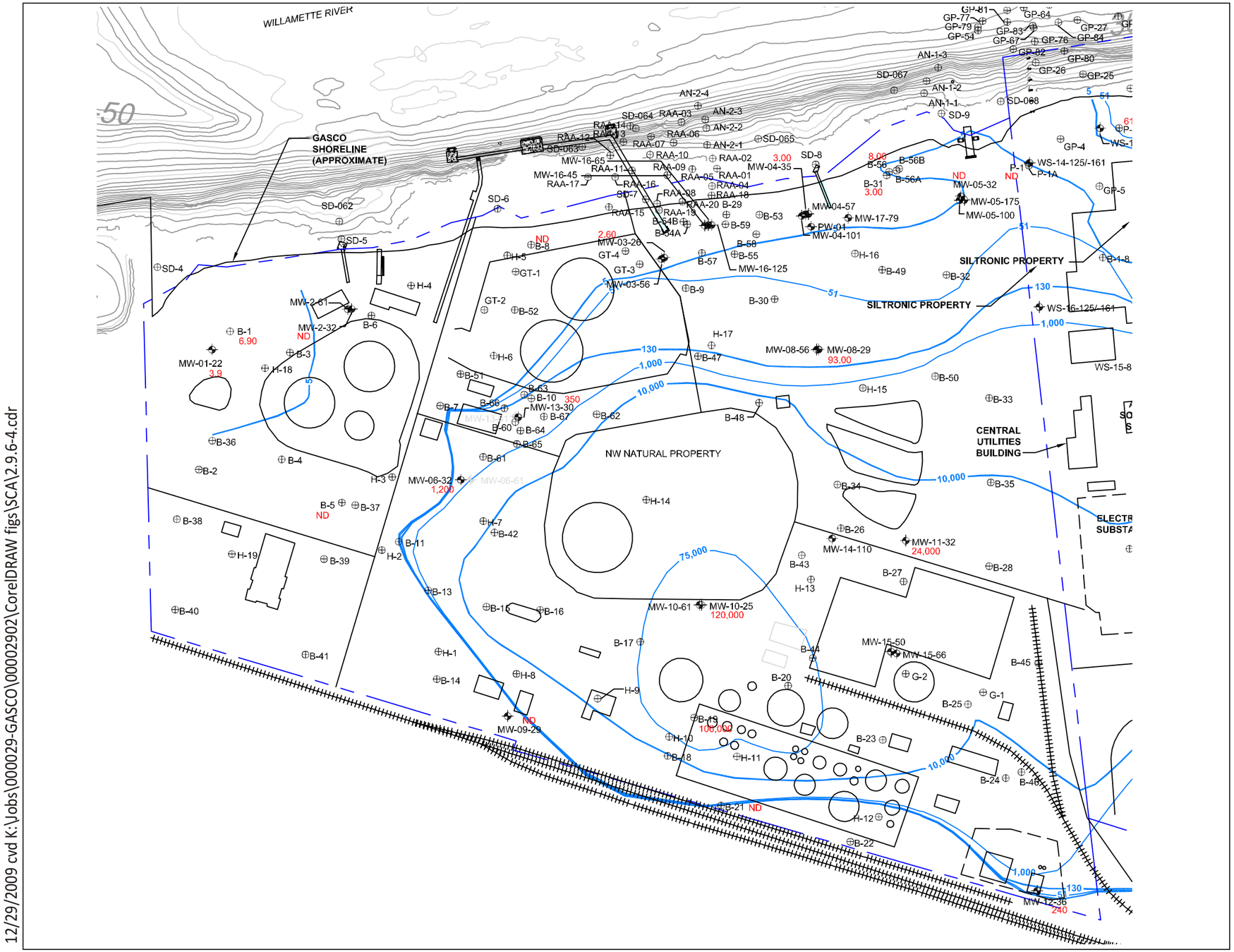
SOURCE: Hahn and Associates, Inc.

12/29/2009 cvd K:\Jobs\000029-GASCO\00002902\CorelDRAW figs\SCA\2.9.6-3.cdr

ANCHOR QEA

Figure 2.9.6-3
Estimated DNAPL in Alluvial Greater than 100 ft bgs
NW Natural "Gasco" Site
Gasco Sediment Cleanup Action

12/29/2009 cvd K:\Jobs\000029-GASCO\0000902\CorelDRAW figs\SCA\2.9.6-4.cdr



LEGEND

- Monitoring Well
- Soil Boring
- Property Line (Approximate)
- 0.2 — Estimated Isoconcentration of chemical in groundwater
- 0.02 — Chemical concentration in groundwater in parts per billion (µg/L)

0 200 400

Scale in feet

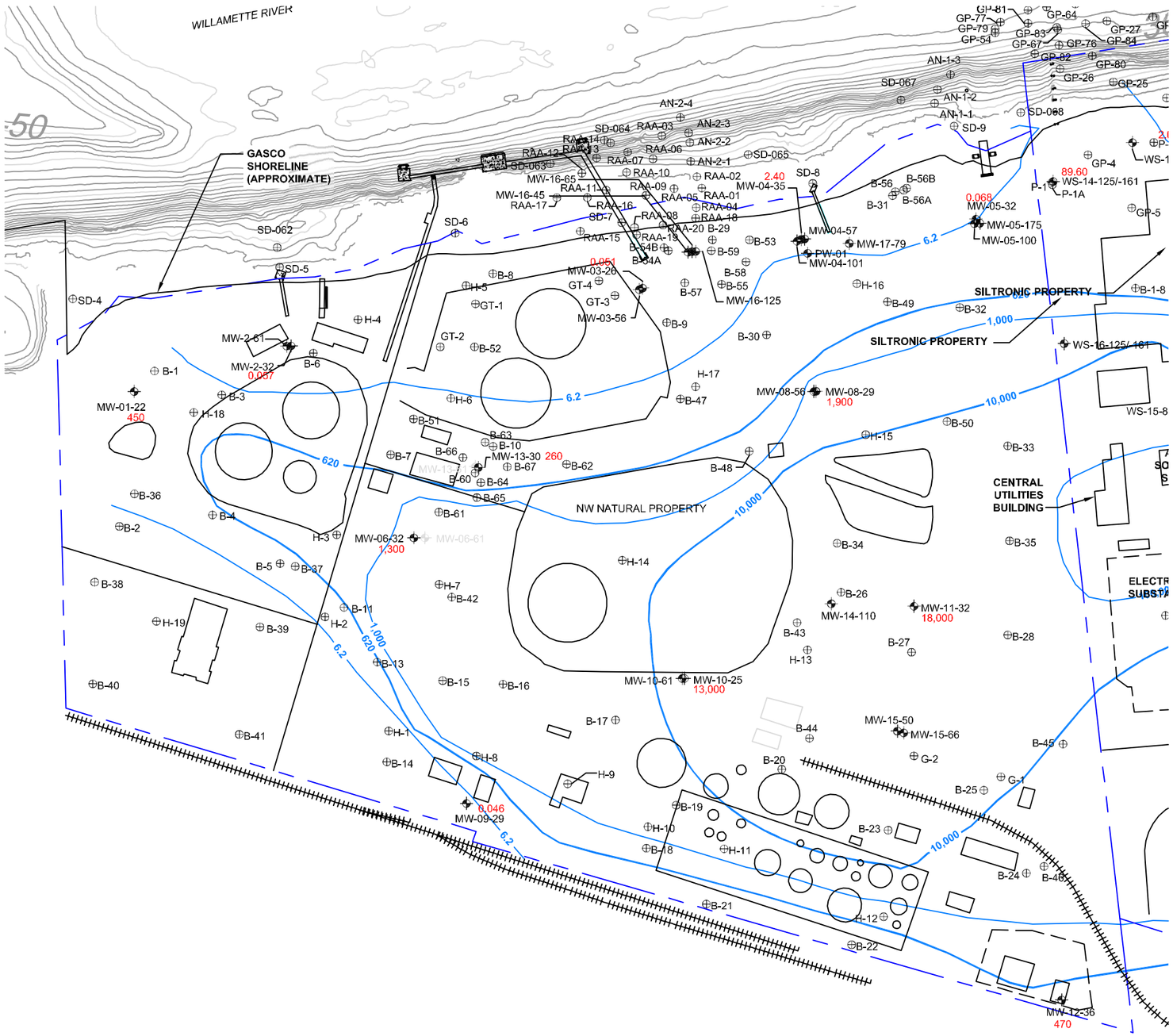
NOTES:
Willamette River bathymetry based on May 2003 survey provided by the Lower Willamette Group.

Groundwater Quality Data is derived from October 2006 Full Groundwater Monitoring Event.

Source: Hahn and Associates, Inc.

ANCHOR QEA

Figure 2.9.6-4
Benzene Concentrations in Gasco Groundwater:
Surficial Fill Water Bearing Zone
NW Natural "Gasco" Site
Gasco Sediment Cleanup Action



LEGEND

- Monitoring Well
- Soil Boring
- Property Line (Approximate)
- 0.2 — Estimated Isoconcentration of chemical in groundwater
- 0.02 — Chemical concentration in groundwater in parts per billion (µg/L)

N

0 200 400

Scale in feet

NOTES:
Willamette River bathymetry based on May 2003 survey provided by the Lower Willamette Group.

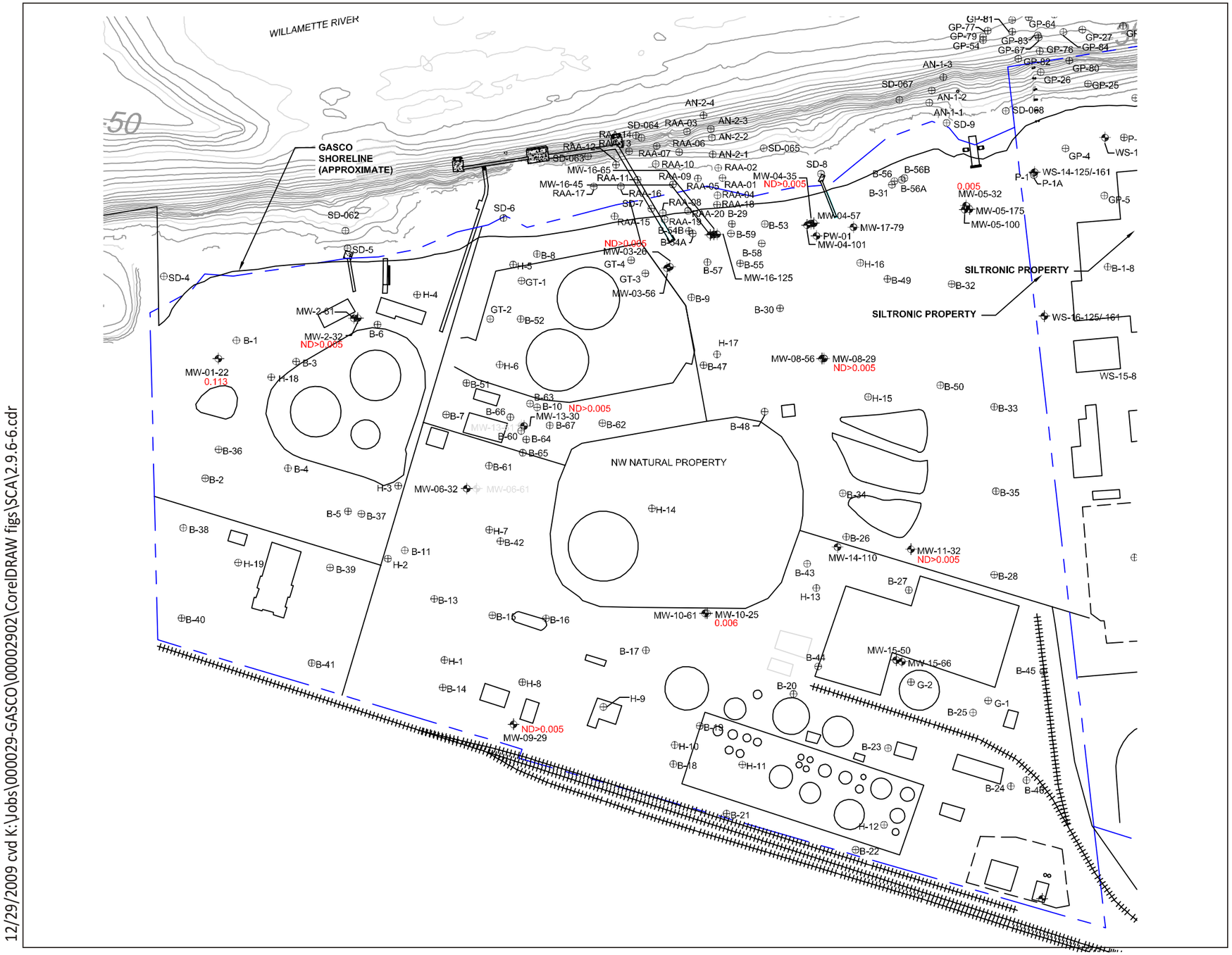
Groundwater Quality Data is derived from October 2006 Full Groundwater Monitoring Event.

Source: Hahn and Associates, Inc.

12/29/2009 cvd K:\Jobs\000029-GASCO\0000902\CorelDRAW figs\SCA\2.9.6-5.cdr

ANCHOR QEA

Figure 2.9.6-5
Naphthalene Concentrations in Gasco Groundwater:
Surficial Fill Water Bearing Zone
NW Natural "Gasco" Site
Gasco Sediment Cleanup Action



LEGEND

- Monitoring Well
- Soil Boring
- Property Line (Approximate)
- 0.2 — Estimated Isoconcentration of chemical in groundwater
- 0.02 — Chemical concentration in groundwater in parts per million (mg/L)

N

0 200 400

Scale in feet

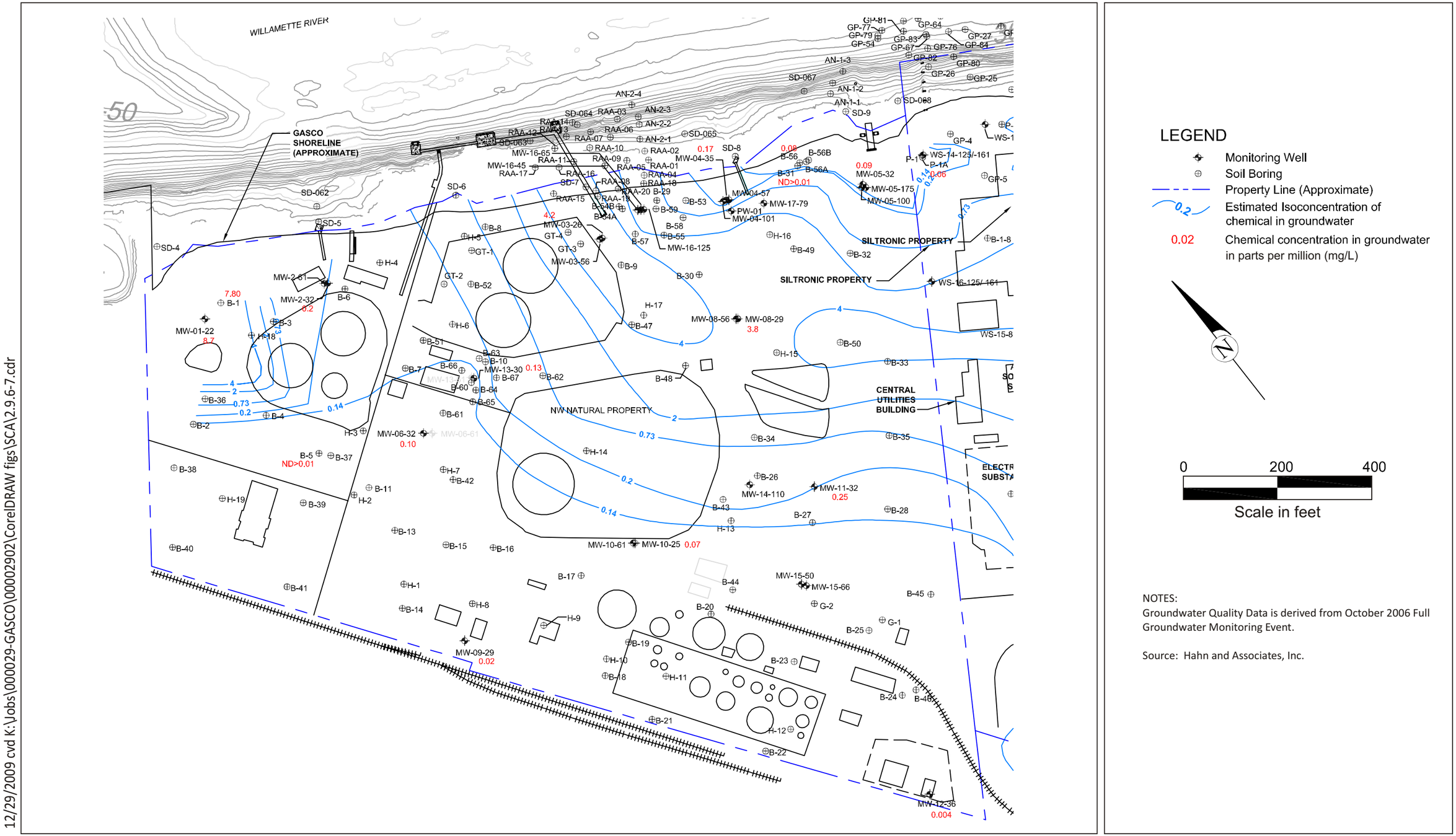
NOTES:
Groundwater Quality Data is derived from October 2006 Full Groundwater Monitoring Event.

Source: Hahn and Associates, Inc.

12/29/2009 cvd K:\Jobs\000029-GASCO\00002902\CorelDRAW figs\SCA\2.9.6-6.cdr

ANCHOR QEA

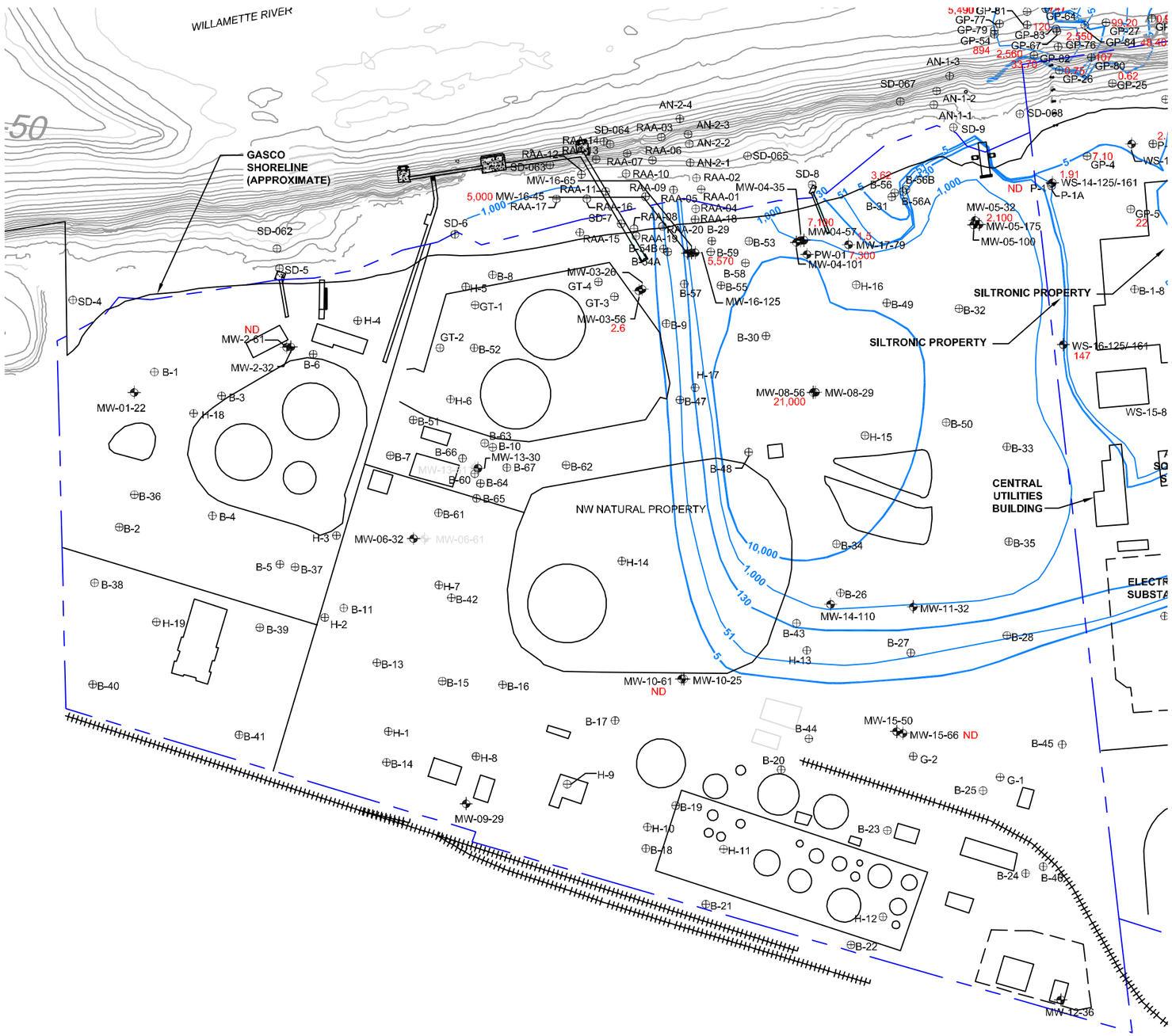
Figure 2.9.6-6
Free Cyanide Concentrations in Gasco Groundwater:
Surficial Fill Water Bearing Zone
NW Natural "Gasco" Site
Gasco Sediment Cleanup Action



12/29/2009 cvd K:\Jobs\000029-GASCO\0000902\CorelDRAW figs\SCA\2.9.6-7.cdr

ANCHOR QEA

Figure 2.9.6-7
Total Cyanide Concentrations in Gasco Groundwater:
Surficial Fill Water Bearing Zone
NW Natural "Gasco" Site
Gasco Sediment Cleanup Action



LEGEND

- Monitoring Well
- Soil Boring
- Property Line (Approximate)
- 0.2 — Estimated Isoconcentration of chemical in groundwater
- 0.02 — Chemical concentration in groundwater in parts per billion (µg/L)

NOTES:
Willamette River bathymetry based on May 2003 survey provided by the Lower Willamette Group.

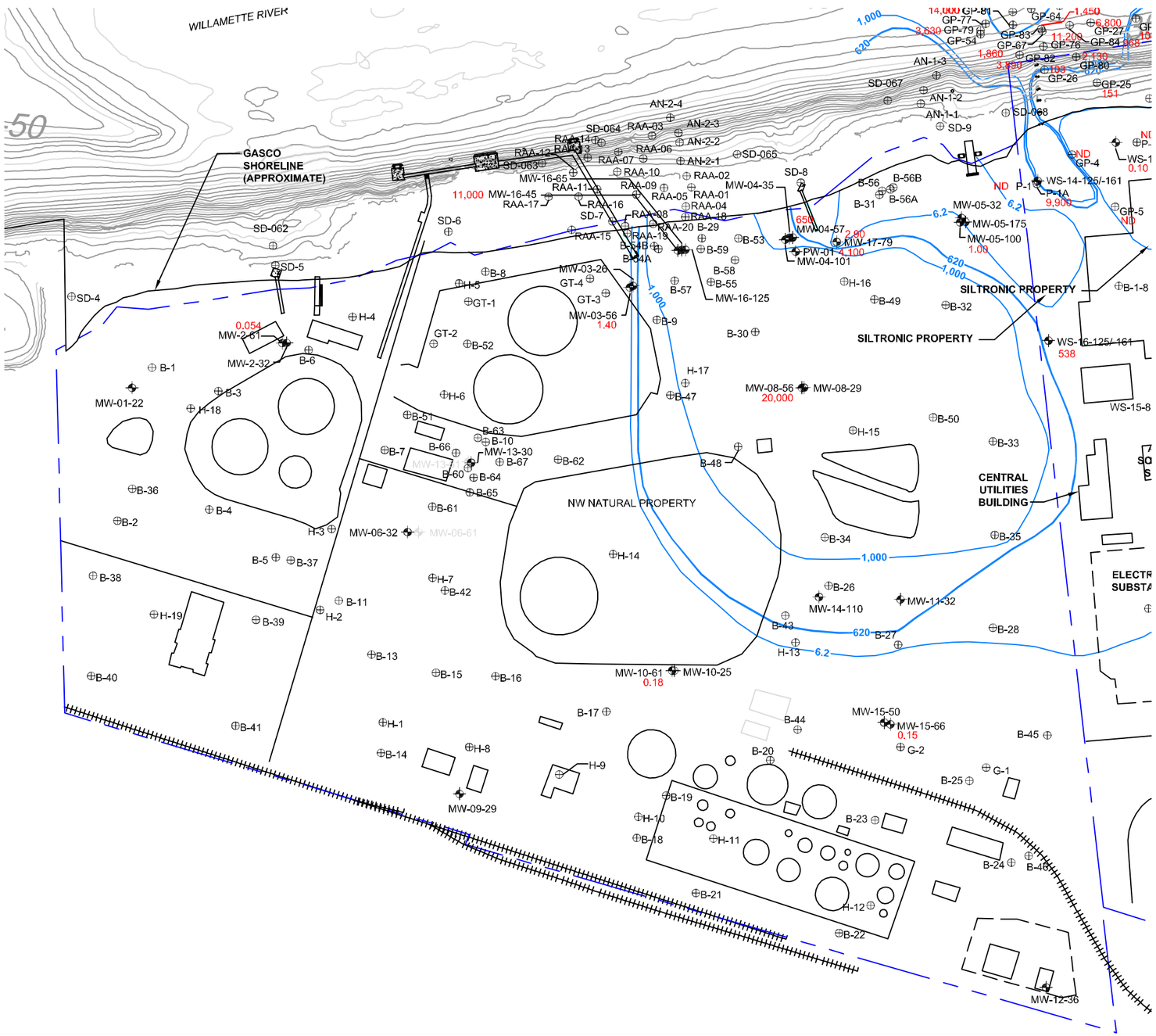
Groundwater Quality Data is derived from October 2006 Full Groundwater Monitoring Event.

Source: Hahn and Associates, Inc.

12/29/2009 cvd K:\Jobs\000029-GASCO\0002902\CorelDRAW figs\SCA\2.9.6-8.cdr

ANCHOR QEA

Figure 2.9.6-8
Benzene Concentrations in Gasco Groundwater:
Alluvial Water Bearing Zone
NW Natural "Gasco" Site
Gasco Sediment Cleanup Action



LEGEND

- Monitoring Well
- Soil Boring
- Property Line (Approximate)
- 0.2 — Estimated Isoconcentration of chemical in groundwater
- 0.02 — Chemical concentration in groundwater in parts per billion (µg/L)

N

0 200 400

Scale in feet

NOTES:
Willamette River bathymetry based on May 2003 survey provided by the Lower Willamette Group.

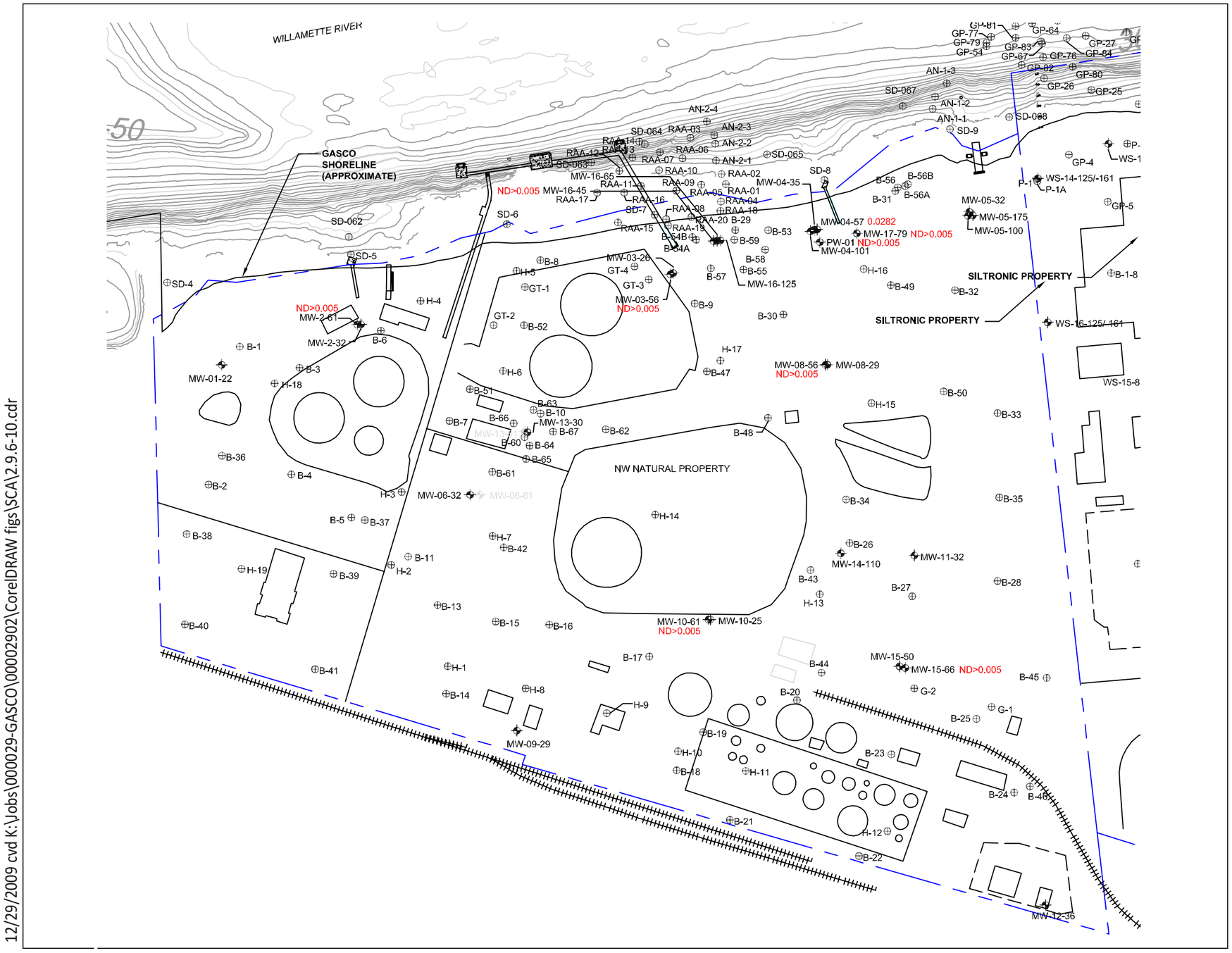
Groundwater Quality Data is derived from October 2006 Full Groundwater Monitoring Event.

Source: Hahn and Associates, Inc.

01/11/2010 cvd K:\Jobs\000029-GASCO\0000290 2\CorelDRAW figs\SCA\2.9.6-9.cdr

ANCHOR QEA

Figure 2.9.6-9
Naphthalene Concentrations in Gasco Groundwater:
Alluvial Water Bearing Zone
NW Natural "Gasco" Site
Gasco Sediment Cleanup Action



LEGEND

- Monitoring Well
- Soil Boring
- Property Line (Approximate)
- 0.2 — Estimated Isoconcentration of chemical in groundwater
- 0.02 — Chemical concentration in groundwater in parts per million (mg/L)

0 200 400

Scale in feet

NOTES:
Willamette River bathymetry based on May 2003 survey provided by the Lower Willamette Group.

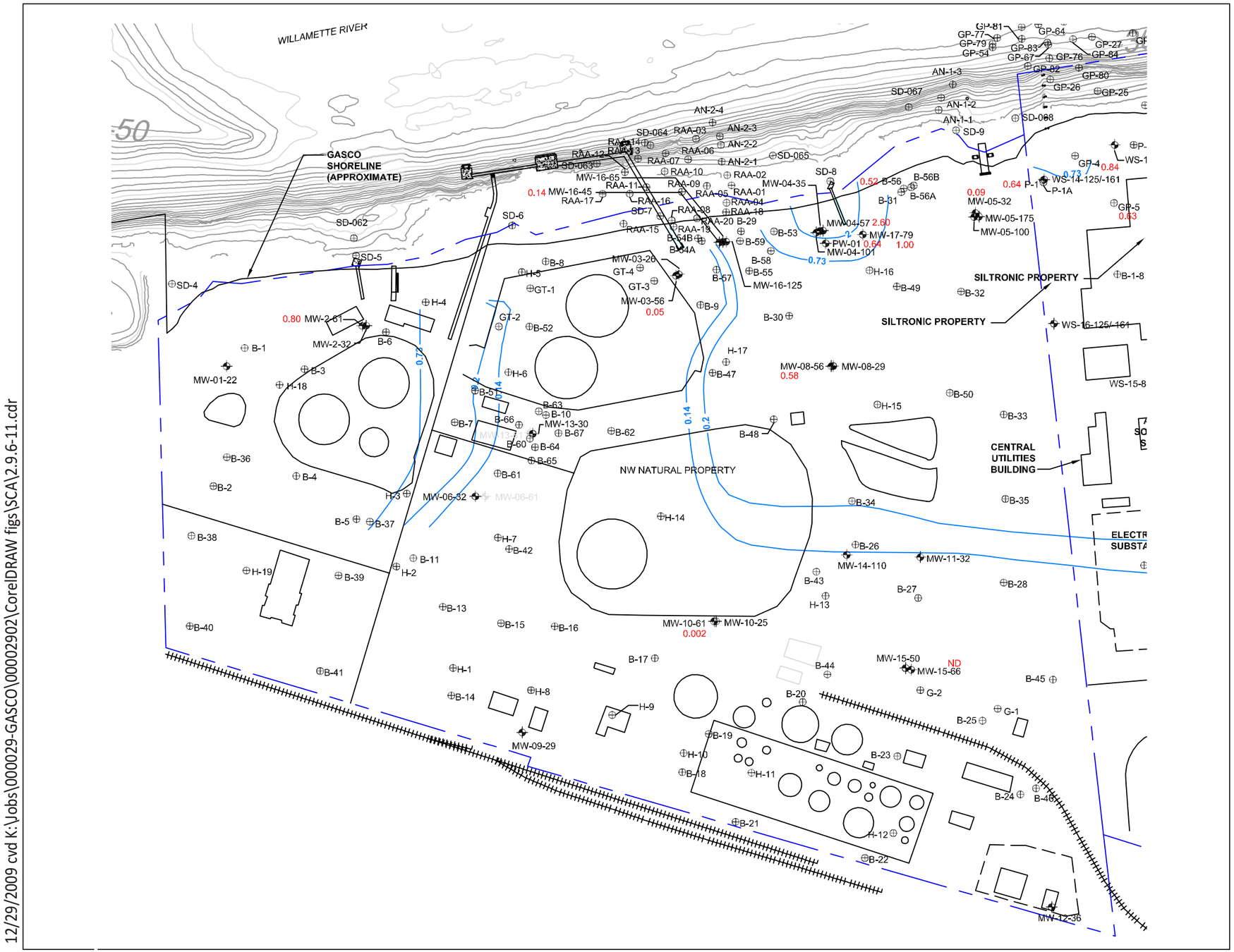
Groundwater Quality Data is derived from October 2006 Full Groundwater Monitoring Event.

Source: Hahn and Associates, Inc.

12/29/2009 cvd K:\Jobs\00029-GASCO\00002902\CorelDRAW figs\SCA\2.9.6-10.cdr

ANCHOR QEA

Figure 2.9.6-10
Free Cyanide Concentrations in Gasco Groundwater:
Alluvial Water Bearing Zone
NW Natural "Gasco" Site
Gasco Sediment Cleanup Action



LEGEND

- Monitoring Well
- Soil Boring
- Property Line (Approximate)
- 0.2 — Estimated Isoconcentration of chemical in groundwater
- 0.02 — Chemical concentration in groundwater in parts per million (mg/L)

0 200 400

Scale in feet

NOTES:
Willamette River bathymetry based on May 2003 survey provided by the Lower Willamette Group.

Groundwater Quality Data is derived from October 2006 Full Groundwater Monitoring Event.

Source: Hahn and Associates, Inc.

12/29/2009 cvd K:\Jobs\000029-GASCO\0002902\CorelDRAW figs\SCA\2.9.6-11.cdr

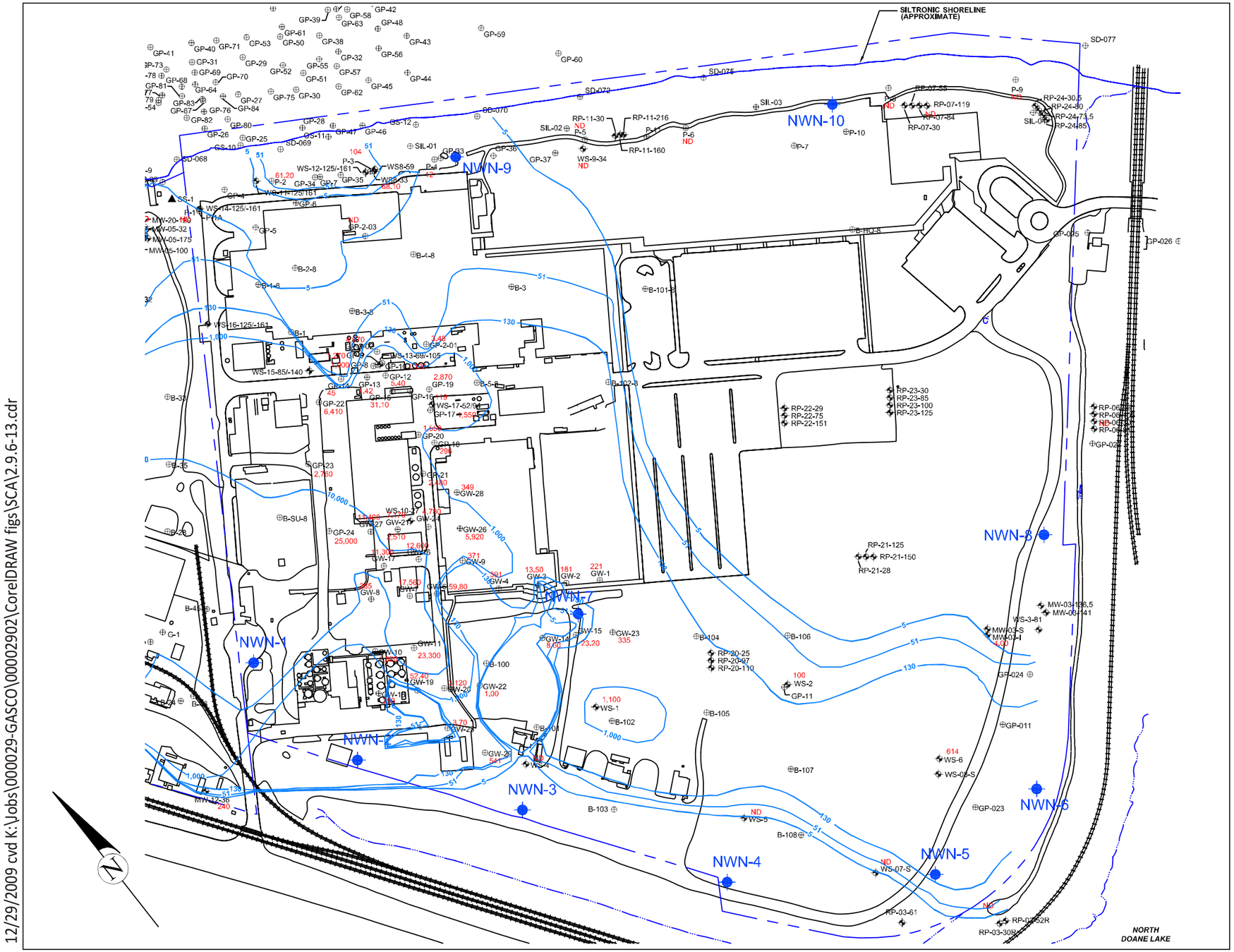
ANCHOR QEA

Figure 2.9.6-11
Total Cyanide Concentrations in Gasco Groundwater:
Alluvial Water Bearing Zone
NW Natural "Gasco" Site
Gasco Sediment Cleanup Action

12/29/2009 cvd K:\Jobs\000029-GASCO\00002902\CorelDRAW figs\SCA\2.9.6-12.cdr

Figure 2.9.6-12
Siltronic Offshore Groundwater Plumes - Area 1 and 2
NW Natural "Gasco" Site
Gasco Sediment Cleanup Action

ANCHOR QEA



LEGEND

- Monitoring Well
- Soil Boring
- Property Line (Approximate)
- 0.2 — Estimated Isoconcentration of chemical in groundwater
- 0.02 — Chemical concentration in groundwater in parts per billion (µg/L)
- Proposed Monitoring Well/Piezomenter Location - Surficial Fill WBZ

0 250 500

NOTES:
Willamette River bathymetry based on May 2003 survey provided by the Lower Willamette Group.

Groundwater Quality Data is derived from October 2006 Full Groundwater Monitoring Event.

Source: Hahn and Associates, Inc., June 2007.

Groundwater concentrations used for contouring are most recent available at time of map preperation, or as available from temporary well point data

-Siltronic Property Data
1) HAI boring (TWP) data from August 2001
2) LTI boring (TWP) data from March 2002
3) MFA boring (TWP) data: GP-4 through GP-7 data from Sep./Oct. 2002
4) MFA boring (TWP) data: GP-8 through GP-24 data from July 2004
5) MFA boring (TWP) data: GP-25 through GP-32 data from Sep./Oct. 2004
6) MFA boring (TWP) data: GP-33 through GP-84 data from May/June 2005
7) CH2M Hill boring (TWP) data from October 1990 (GW-Series)
8) Monitoring well data WS-1 through WS-7 from August 1985
9) Monitoring well data WS-8 and WS-9 from July 2002
10) Monitoring well data WS-10 through WS-13 (15 foot screen) from November 2004; exploratory data (2 foot screen) from Sept. 2003
11) Monitoring well data WS-14 through WS-17 (15 foot screen) from November 2004; exploratory data (2 foot screen) from June/July/Aug. 2004

Notes-Siltronic Property Borings and Wells:

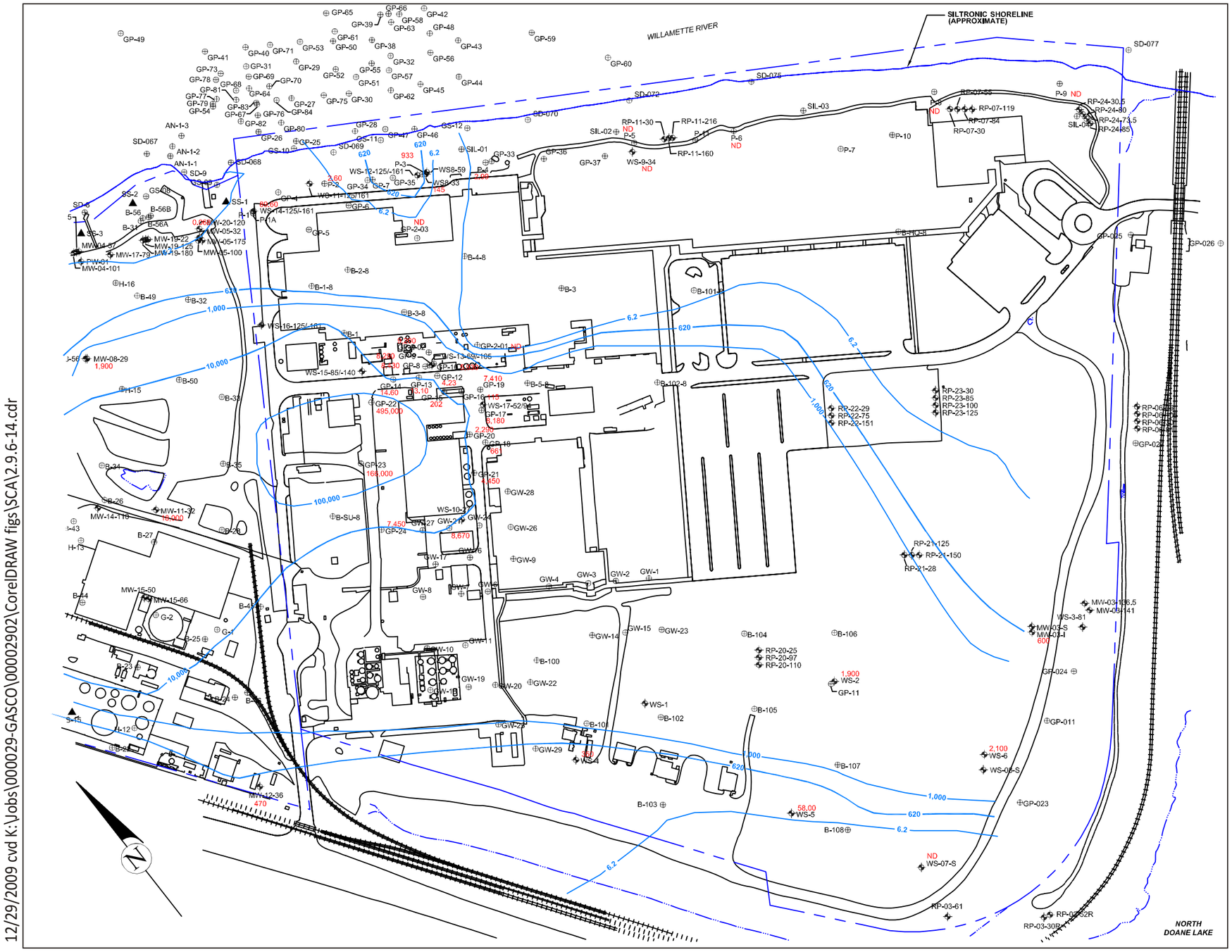
Boring or Well ID	Installer (year installed)
B-1 through B-8:	CH2M Hill (1977)
B-XX-8 Series:	CH2M Hill (1978)
B-101 through B-108:	CH2M Hill (1982)
WS-1 through WS-7	CH2M Hill (1985)
GW-1 through GW-29	CH2M Hill (1990)
WS-8 and WS-9	HAI (2001)
WS-10 through WS-13	MFA (2003)
WS-14 through WS-17	MFA (2004)
RP-7	AMEC (2002)
P-1 through P-11:	HAI (2001)
GP-2-01 through GP-2-03	LTI (2002)
GP-4 through GP-7	MFA (2002)
GP-8 through GP-11	MFA (2003)
GP-12 through GP-32	MFA (2004)
GP-33 through GP-84	MFA (2005)

HAI = Hahn and Associates, Inc.
MFA = Maul, Foster, Alongi, Inc.
LTI = Limno-Tech, Inc.
AMEC = AMEC Earth and Envoronment, Inc.

12/29/2009 cvd K:\Jobs\000029-GASCO\0002902\CorelDRAW figs\SCA\2.9.6-13.cdr

ANCHOR QEA

Figure 2.9.6-13
Benzene Concentrations in Siltronic Groundwater:
Surficial Fill Water Bearing Zone
NW Natural "Gasco" Site
Gasco Sediment Cleanup Action



LEGEND

- Monitoring Well
- Soil Boring
- Property Line (Approximate)
- 0.2 — Estimated Isoconcentration of chemical in groundwater
- 0.02 — Chemical concentration in groundwater in parts per billion (µg/L)

0 250 500

NOTES:
Willamette River bathymetry based on May 2003 survey provided by the Lower Willamette Group.

Groundwater Quality Data is derived from October 2006 Full Groundwater Monitoring Event.

Groundwater concentrations used for contouring are most recent available at time of map preperation, or as available from temporary well point data

-Siltronic Property Data
1) HAI boring (TWP) data from August 2001
2) LTI boring (TWP) data from March 2002
3) MFA boring (TWP) data: GP-4 through GP-7 data from Sep./Oct. 2002
4) MFA boring (TWP) data: GP-8 through GP-24 data from July 2004
5) MFA boring (TWP) data: GP-25 through GP-32 data from Sep./Oct. 2004
6) MFA boring (TWP) data: GP-33 through GP-84 data from May/June 2005
7) CH2M Hill boring (TWP) data from October 1990 (GW-Series)
8) Monitoring well data WS-1 through WS-7 from August 1985
9) Monitoring well data WS-8 and WS-9 from July 2002
10) Monitoring well data WS-10 through WS-13 (15 foot screen) from November 2004; exploratory data (2 foot screen) from Sept. 2003
11) Monitoring well data WS-14 through WS-17 (15 foot screen) from November 2004; exploratory data (2 foot screen) from June/July/Aug. 2004

Notes-Siltronic Property Borings and Wells:

Boring or Well ID	Installer (year installed)
B-1 through B-8:	CH2M Hill (1977)
B-XX-8 Series:	CH2M Hill (1978)
B-101 through B-108:	CH2M Hill (1982)
WS-1 through WS-7	CH2M Hill (1985)
GW-1 through GW-29	CH2M Hill (1990)
WS-8 and WS-9	HAI (2001)
WS-10 through WS-13	MFA (2003)
WS-14 through WS-17	MFA (2004)
RP-7	AMEC (2002)
P-1 through P-11:	HAI (2001)
GP-2-01 through GP-2-03	LTI (2002)
GP-4 through GP-7	MFA (2002)
GP-8 through GP-11	MFA (2003)
GP-12 through GP-32	MFA (2004)
GP-33 through GP-84	MFA (2005)

HAI = Hahn and Associates, Inc.
MFA = Maul, Foster, Alongi, Inc.
LTI = Limno-Tech, Inc.
AMEC = AMEC Earth and Envoronment, Inc.

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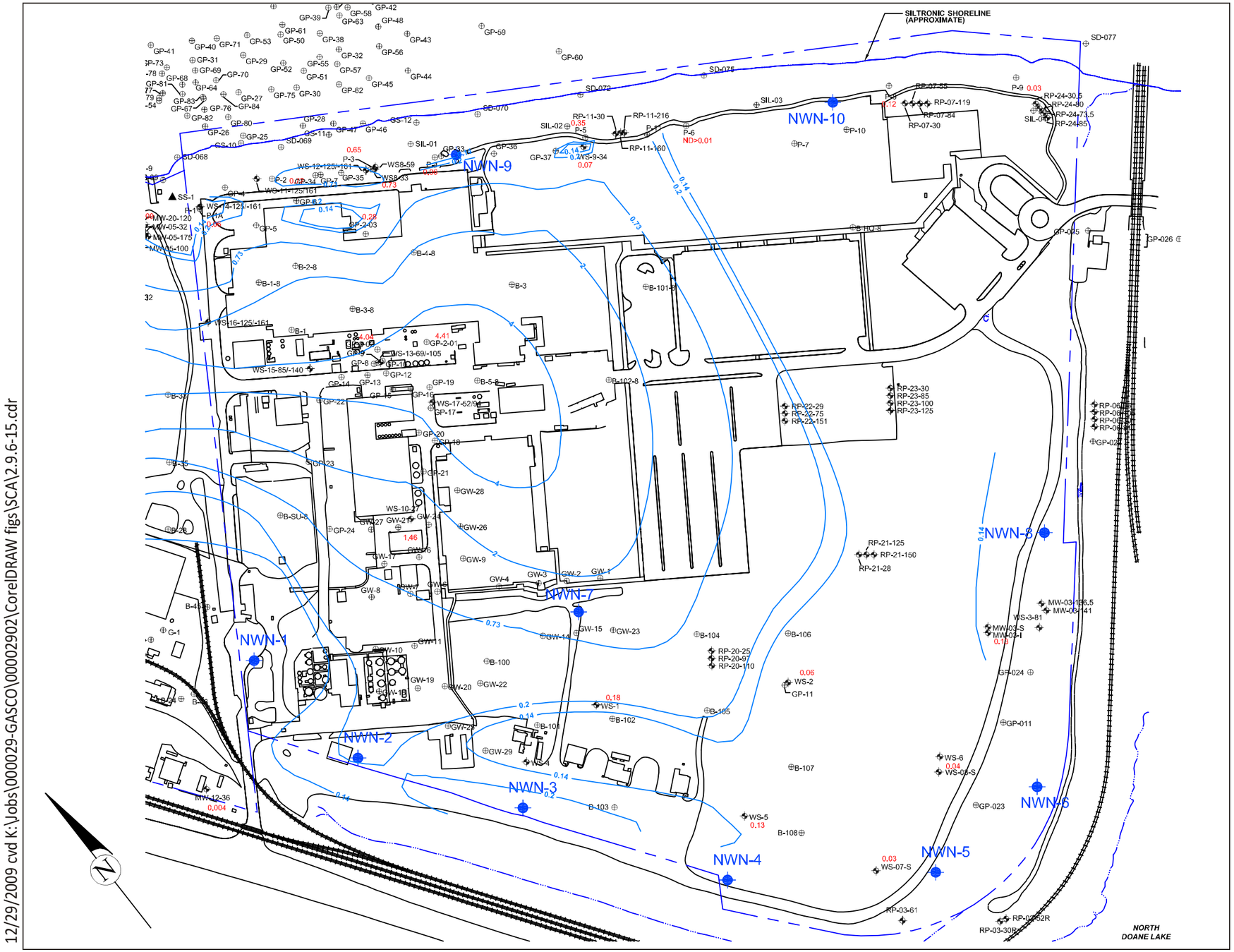
ANCHOR QEA

Figure 2.9.6-14
Naphthalene Concentrations in Siltronic Groundwater:
Surficial Fill Water Bearing Zone
NW Natural "Gasco" Site
Gasco Sediment Cleanup Action



LEGEND

- Monitoring Well
- Soil Boring
- Property Line (Approximate)
- 0.2 — Estimated Isoconcentration of chemical in groundwater
- 0.02 — Chemical concentration in groundwater in parts per million (mg/L)
- Proposed Monitoring Well/Piezomenter Location - Surficial Fill WBZ

0 250 500

NOTES:
Willamette River bathymetry based on May 2003 survey provided by the Lower Willamette Group.

Groundwater Quality Data is derived from October 2006 Full Groundwater Monitoring Event.

Source: Hahn and Associates, Inc., June 2007.

Groundwater concentrations used for contouring are most recent available at time of map preperation, or as available from temporary well point data

-Siltronic Property Data
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5) MFA boring (TWP) data: GP-25 through GP-32 data from Sep./Oct. 2004
6) MFA boring (TWP) data: GP-33 through GP-84 data from May/June 2005
7) CH2M Hill boring (TWP) data from October 1990 (GW-Series)
8) Monitoring well data WS-1 through WS-7 from August 1985
9) Monitoring well data WS-8 and WS-9 from July 2002
10) Monitoring well data WS-10 through WS-13 (15 foot screen) from November 2004; exploratory data (2 foot screen) from Sept. 2003
11) Monitoring well data WS-14 through WS-17 (15 foot screen) from November 2004; exploratory data (2 foot screen) from June/July/Aug. 2004

Notes-Siltronic Property Borings and Wells:

Boring or Well ID	Installer (year installed)
B-1 through B-8:	CH2M Hill (1977)
B-XX-8 Series:	CH2M Hill (1978)
B-101 through B-108:	CH2M Hill (1982)
WS-1 through WS-7	CH2M Hill (1985)
GW-1 through GW-29	CH2M Hill (1990)
WS-8 and WS-9	HAI (2001)
WS-10 through WS-13	MFA (2003)
WS-14 through WS-17	MFA (2004)
RP-7	AMEC (2002)
P-1 through P-11:	HAI (2001)
GP-2-01 through GP-2-03	LTI (2002)
GP-4 through GP-7	MFA (2002)
GP-8 through GP-11	MFA (2003)
GP-12 through GP-32	MFA (2004)
GP-33 through GP-84	MFA (2005)

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ANCHOR QEA

Figure 2.9.6-15
Total Cyanide Concentrations in Siltronic Groundwater:
Surficial Fill Water Bearing Zone
NW Natural "Gasco" Site
Gasco Sediment Cleanup Action

12/29/2009 cvd K:\Jobs\000029-GASCO\0000292\CorelDRAW figs\SCA\2.9.6-16.cdr

LEGEND

- Monitoring Well
- Soil Boring
- Property Line (Approximate)
- 0.2 — Estimated Isoconcentration of chemical in groundwater
- 0.02 — Chemical concentration in groundwater in parts per billion (µg/L)
- Proposed Roto-Sonic Boring through full Surficial Fill and Alluvial Unit Thickness

0 250 500

NOTES:
Willamette River bathymetry based on May 2003 survey provided by the Lower Willamette Group.

Groundwater Quality Data is derived from October 2006 Full Groundwater Monitoring Event.

Source: Hahn and Associates, Inc., June 2007.

Groundwater concentrations used for contouring are most recent available at time of map preperation, or as available from temporary well point data

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5) MFA boring (TWP) data: GP-25 through GP-32 data from Sep./Oct. 2004
6) MFA boring (TWP) data: GP-33 through GP-84 data from May/June 2005
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Notes-Siltronic Property Borings and Wells:

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B-101 through B-108:	CH2M Hill (1982)
WS-1 through WS-7	CH2M Hill (1985)
GW-1 through GW-29	CH2M Hill (1990)
WS-8 and WS-9	HAI (2001)
WS-10 through WS-13	MFA (2003)
WS-14 through WS-17	MFA (2004)
RP-7	AMEC (2002)
P-1 through P-11:	HAI (2001)
GP-2-01 through GP-2-03	LTI (2002)
GP-4 through GP-7	MFA (2002)
GP-8 through GP-11	MFA (2003)
GP-12 through GP-32	MFA (2004)
GP-33 through GP-84	MFA (2005)

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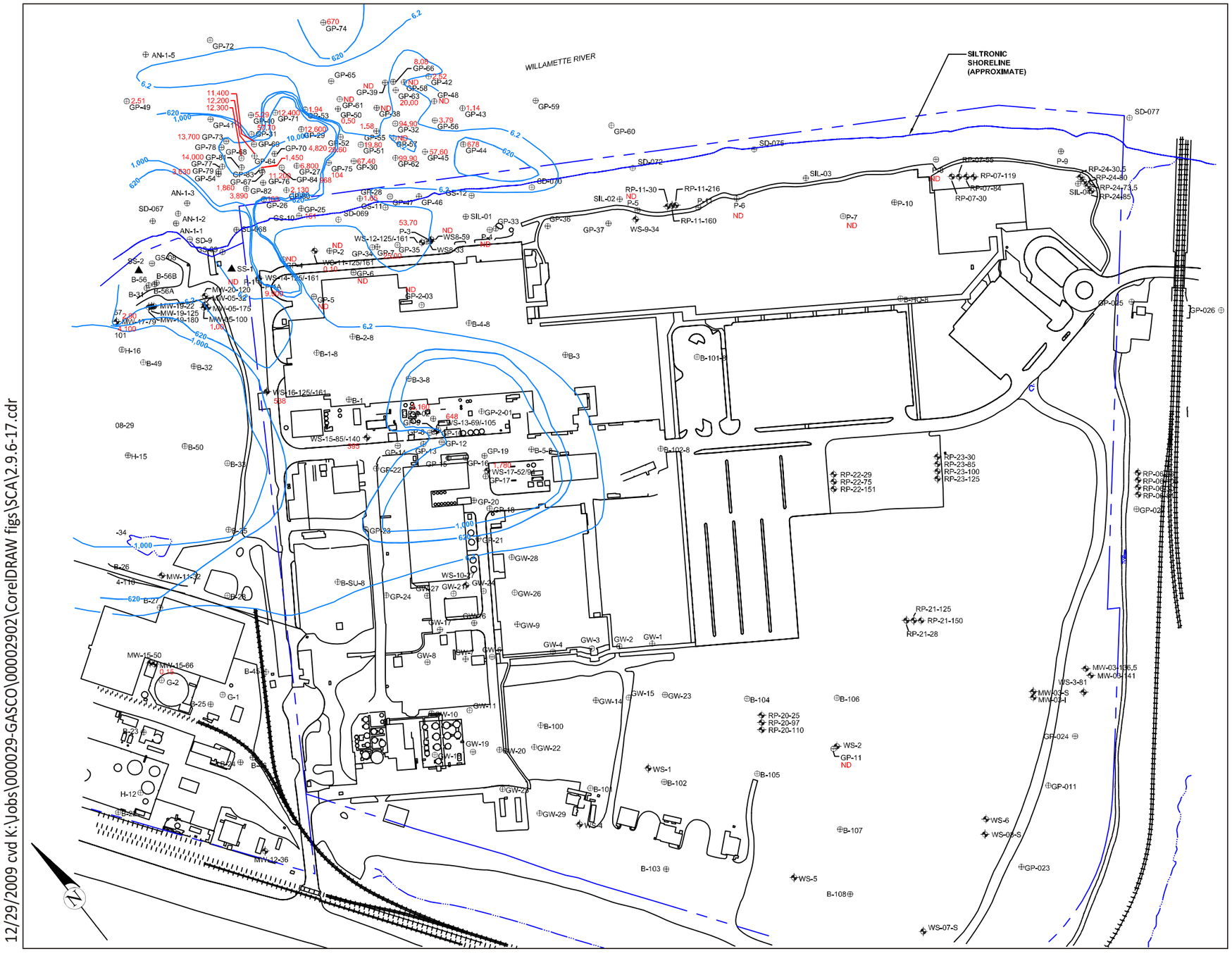
ANCHOR QEA

Figure 2.9.6-16
Benzene Concentrations in Siltronic Groundwater:
Alluvial Water Bearing Zone
NW Natural "Gasco" Site
Gasco Sediment Cleanup Action



LEGEND

- Monitoring Well
- Soil Boring
- Property Line (Approximate)
- 0.2 — Estimated Isoconcentration of chemical in groundwater
- 0.02 — Chemical concentration in groundwater in parts per billion (µg/L)

0 250 500

NOTES:
Willamette River bathymetry based on May 2003 survey provided by the Lower Willamette Group.

Groundwater Quality Data is derived from October 2006 Full Groundwater Monitoring Event.

Groundwater concentrations used for contouring are most recent available at time of map preperation, or as available from temporary well point data

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5) MFA boring (TWP) data: GP-25 through GP-32 data from Sep./Oct. 2004
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Notes-Siltronic Property Borings and Wells:

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WS-1 through WS-7	CH2M Hill (1985)
GW-1 through GW-29	CH2M Hill (1990)
WS-8 and WS-9	HAI (2001)
WS-10 through WS-13	MFA (2003)
WS-14 through WS-17	MFA (2004)
RP-7	AMEC (2002)
P-1 through P-11:	HAI (2001)
GP-2-01 through GP-2-03	LTI (2002)
GP-4 through GP-7	MFA (2002)
GP-8 through GP-11	MFA (2003)
GP-12 through GP-32	MFA (2004)
GP-33 through GP-84	MFA (2005)

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Figure 2.9.6-17
Naphthalene Concentrations in Siltronic Groundwater:
Alluvial Water Bearing Zone
NW Natural "Gasco" Site
Gasco Sediment Cleanup Action

LEGEND

- Monitoring Well
- Soil Boring
- Property Line (Approximate)
- 0.2 — Estimated Isoconcentration of chemical in groundwater
- 0.02 — Chemical concentration in groundwater in parts per million (mg/L)
- Proposed Roto-Sonic Boring through full Surficial Fill and Alluvial Unit Thickness

0 250 500

NOTES:
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Groundwater Quality Data is derived from October 2006 Full Groundwater Monitoring Event.

`roundwater concentrations used for contouring are most recent available at time of map reperation, or as available from temporary well point data

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Notes-Siltronic Property Borings and Wells:

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WS-1 through WS-7	CH2M Hill (1985)
GW-1 through GW-29	CH2M Hill (1990)
WS-8 and WS-9	HAI (2001)
WS-10 through WS-13	MFA (2003)
WS-14 through WS-17	MFA (2004)
RP-7	AMEC (2002)
P-1 through P-11:	HAI (2001)
GP-2-01 through GP-2-03	LTI (2002)
GP-4 through GP-7	MFA (2002)
GP-8 through GP-11	MFA (2003)
GP-12 through GP-32	MFA (2004)
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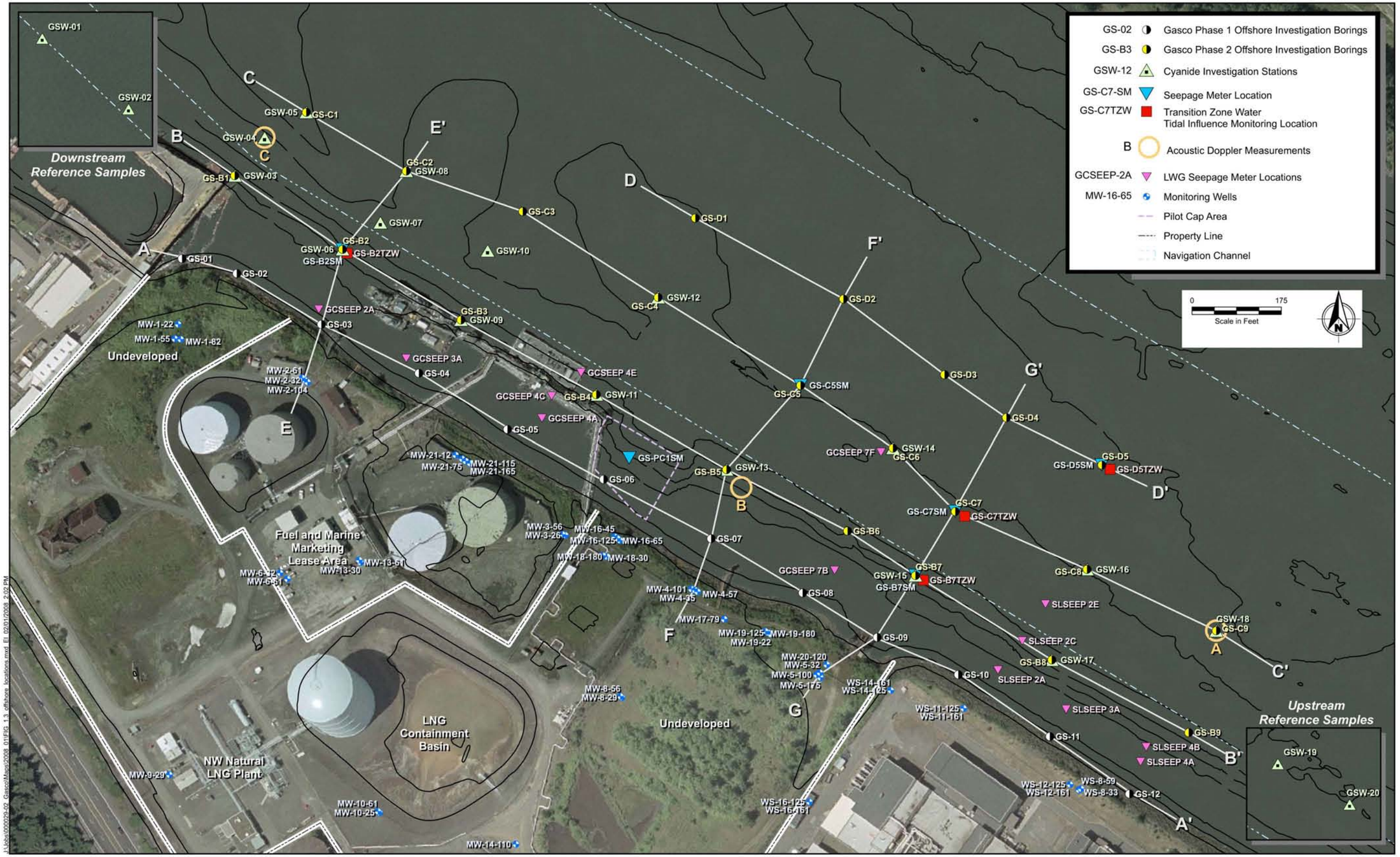
ANCHOR QEA

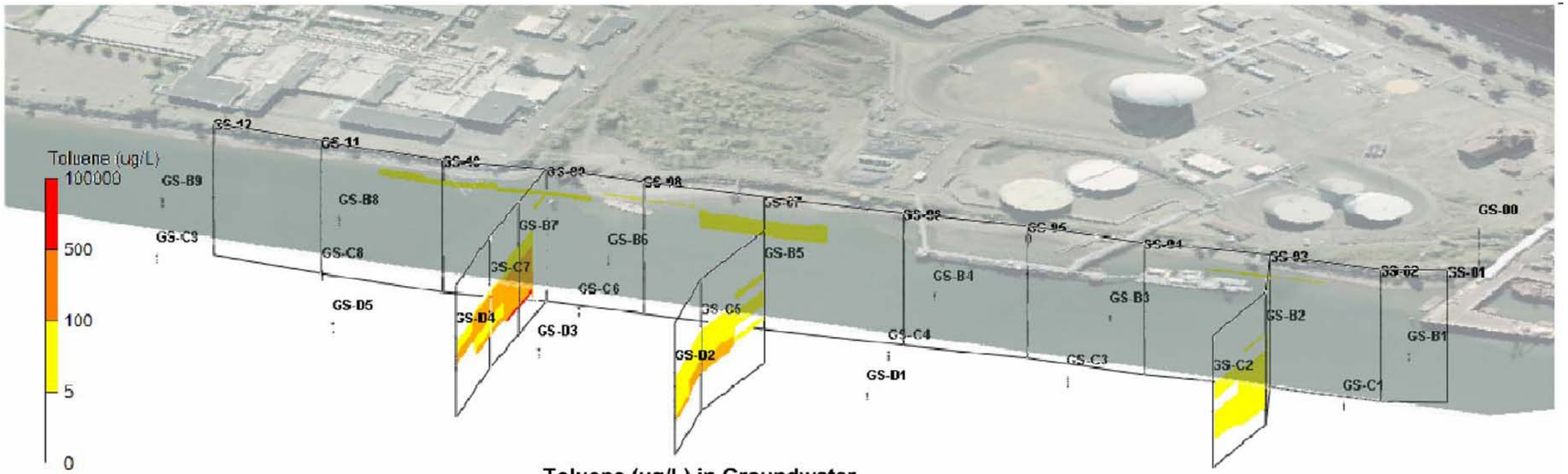
Figure 2.9.6-18
Total Cyanide Concentrations in Siltronic Groundwater:
Alluvial Water Bearing Zone
NW Natural "Gasco" Site
Gasco Sediment Cleanup Action



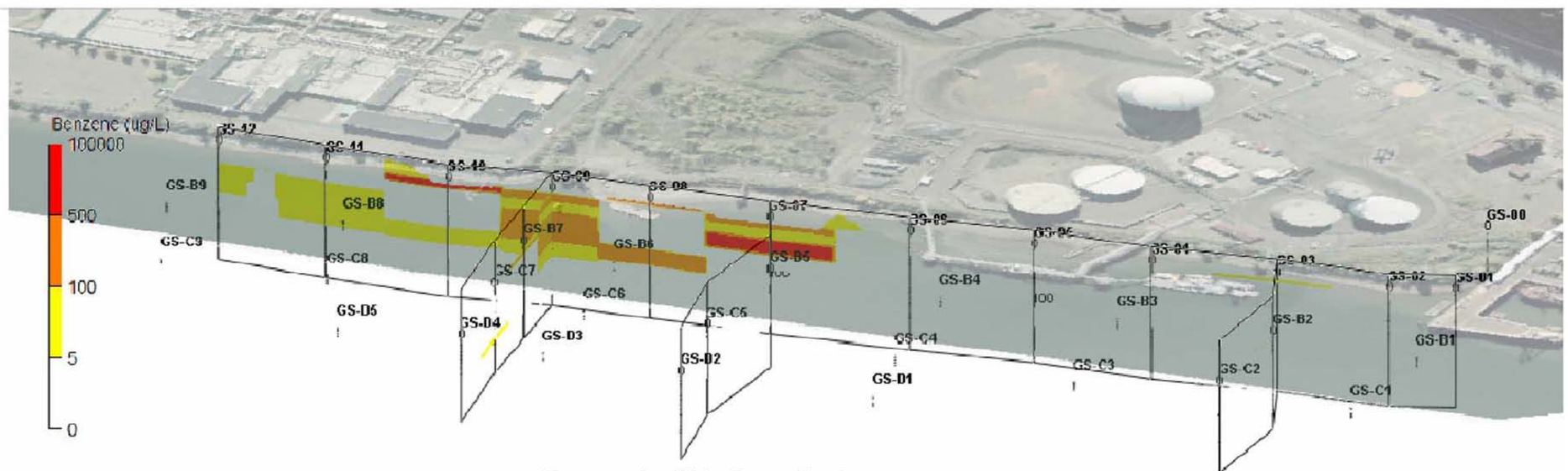
12/29/2009 cvd K:\Jobs\000029-GASCO\00002902\CorelDRAW figs\SCA\2.9.6-19.cdr

ANCHOR QEA

Figure 2.9.6-19
Offshore Sampling Locations - Gasco Property
NW Natural "Gasco" Site
Gasco Sediment Cleanup Action



Toluene (ug/L) in Groundwater



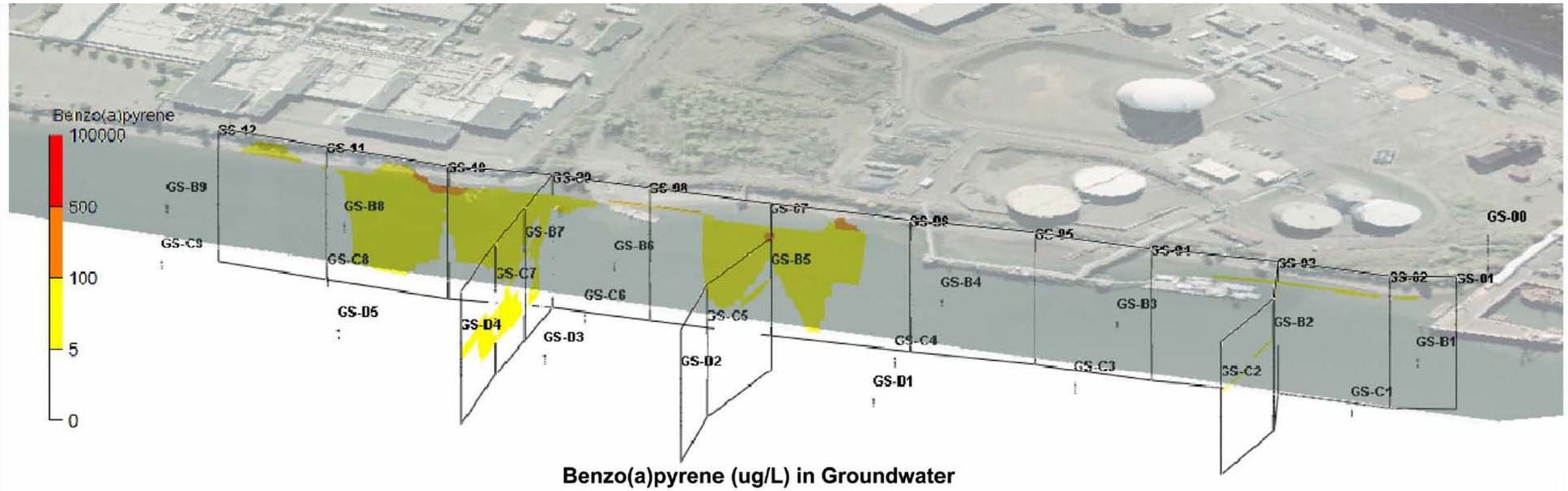
Benzene (ug/L) in Groundwater

NOTE: Locations are approximate and are for visualization purposes only.

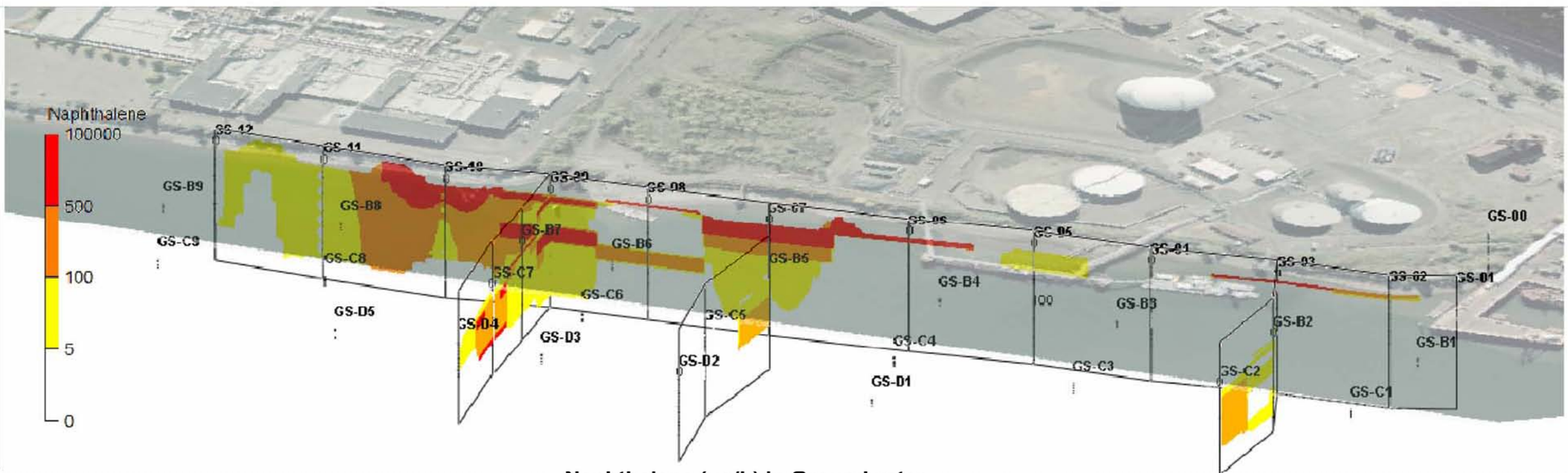
Jan 05, 2010 3:16pm cdavidson K:\Jobs\000029-GASCO\00002902\00002902-RP-033.dwg FIG 2.9.6-20

ANCHOR QEA

Figure 2.9.6-20
Offshore Groundwater Benzene and Toluene Concentrations: 3D Visualization Model
NW Natural "Gasco" Site
Gasco Sediment Cleanup Action



Benzo(a)pyrene (ug/L) in Groundwater



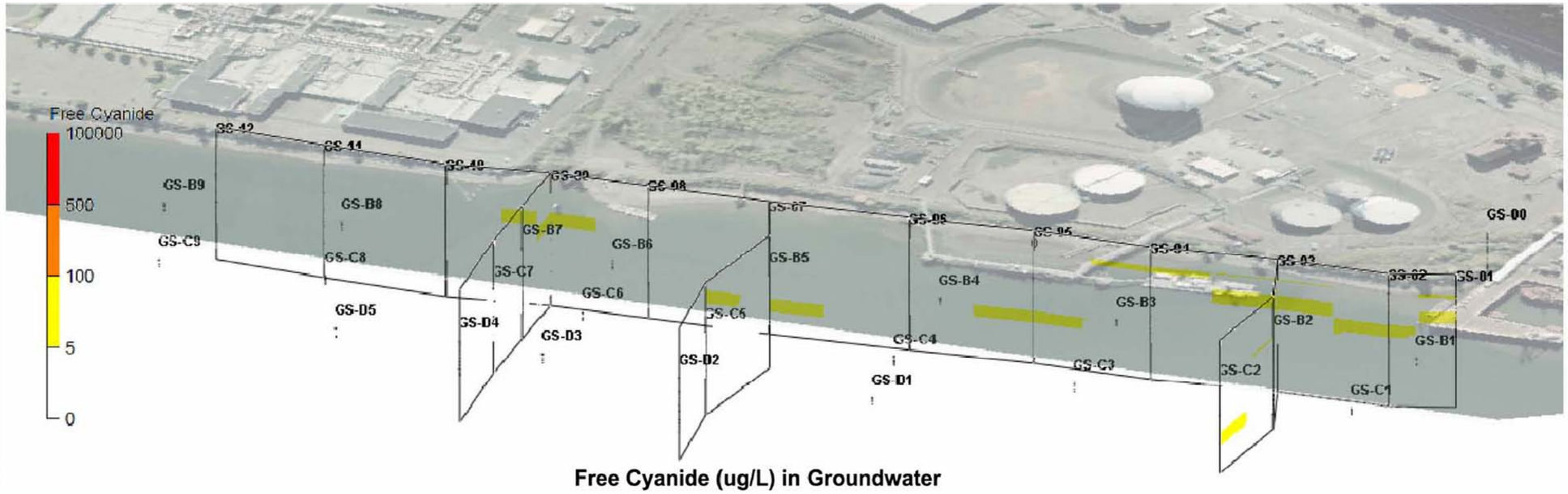
Naphthalene (ug/L) in Groundwater

NOTE: Locations are approximate and are for visualization purposes only.

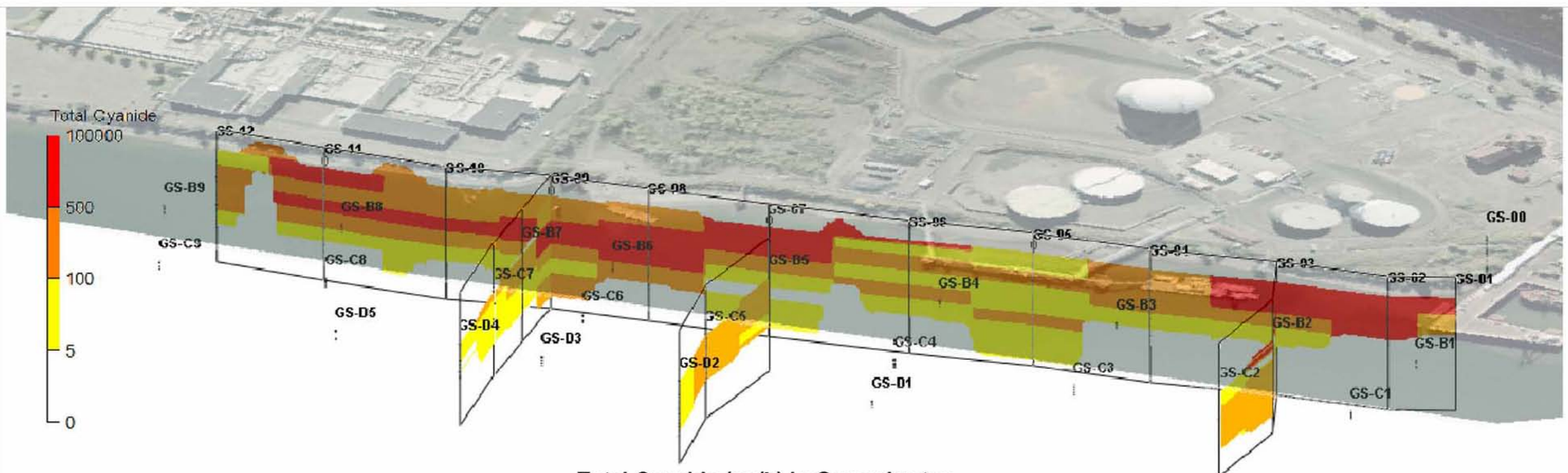
Dec 30, 2009 9:30am cdavidson K:\Jobs\000029-GASCO\00002902\00002902-RP-033.dwg FIG 2.9.6-21

ANCHOR QEA

Figure 2.9.6-21
Offshore Groundwater Naphthalene and Benzo(a)pyrene Concentrations: 3D Visualization Model
NW Natural "Gasco" Site
Gasco Sediment Cleanup Action



Free Cyanide (ug/L) in Groundwater



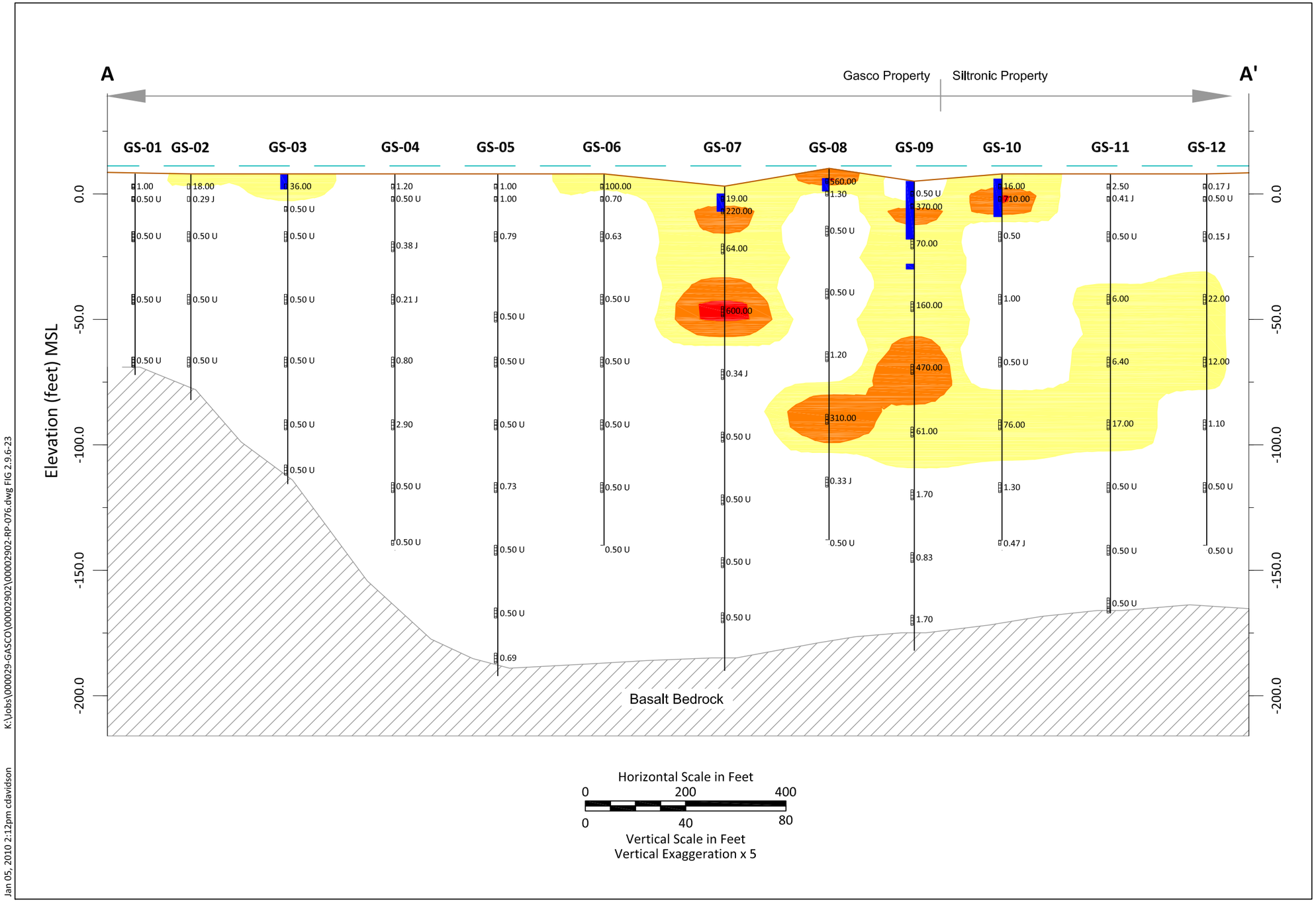
Total Cyanide (ug/L) in Groundwater

NOTE: Locations are approximate and are for visualization purposes only.

Dec 30, 2009 9:30am cdavidson K:\Jobs\000029-GASCO\00002902\00002902-RP-033.dwg FIG 2.9.6-22

ANCHOR QEA

Figure 2.9.6-22
Offshore Groundwater Free and Total Cyanide Concentrations: 3D Visualization Model
NW Natural "Gasco" Site
Gasco Sediment Cleanup Action



LEGEND:

Groundwater Benzene Concentrations (ug/L)

0.0 - 5.0

5.0 - 100.0

100.0 - 500.0

>500

GS-02 Boring ID

150.0 Benzene Concentration in Groundwater (ug/L)

NAPL and/or Tar Interval

Screen Interval

Approximate Willamette River Elevation

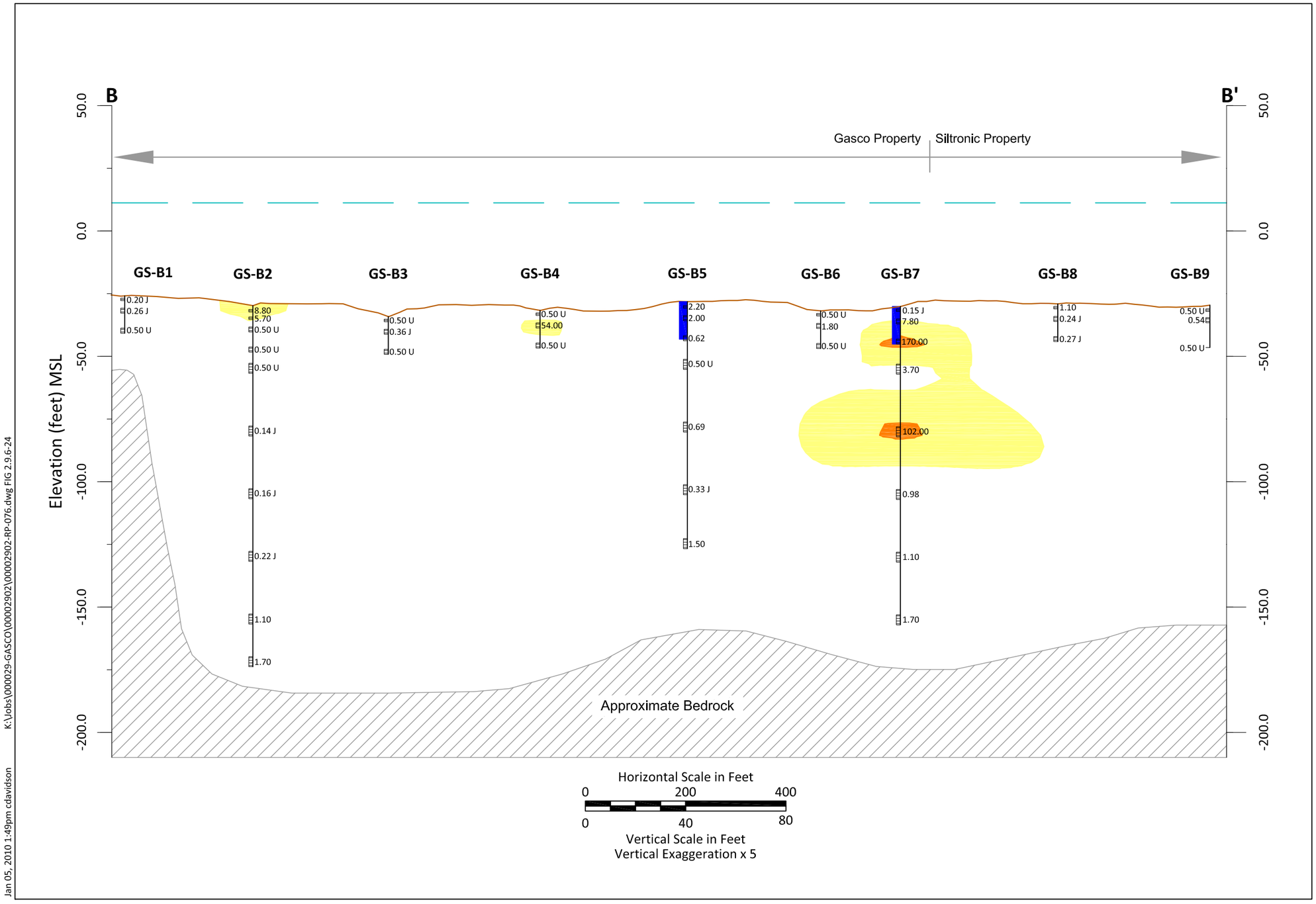
Existing Ground Surface

K:\Jobs\000029-GASCO\00002902\00002902-RP-076.dwg FIG 2.9.6-23

Jan 05, 2010 2:12pm cdavidson

ANCHOR QEA

Figure 2.9.6-23
Subsurface Profile A-A'
Benzene Concentrations in Groundwater - Gasco
NW Natural "Gasco" Site
Gasco Sediment Cleanup Action

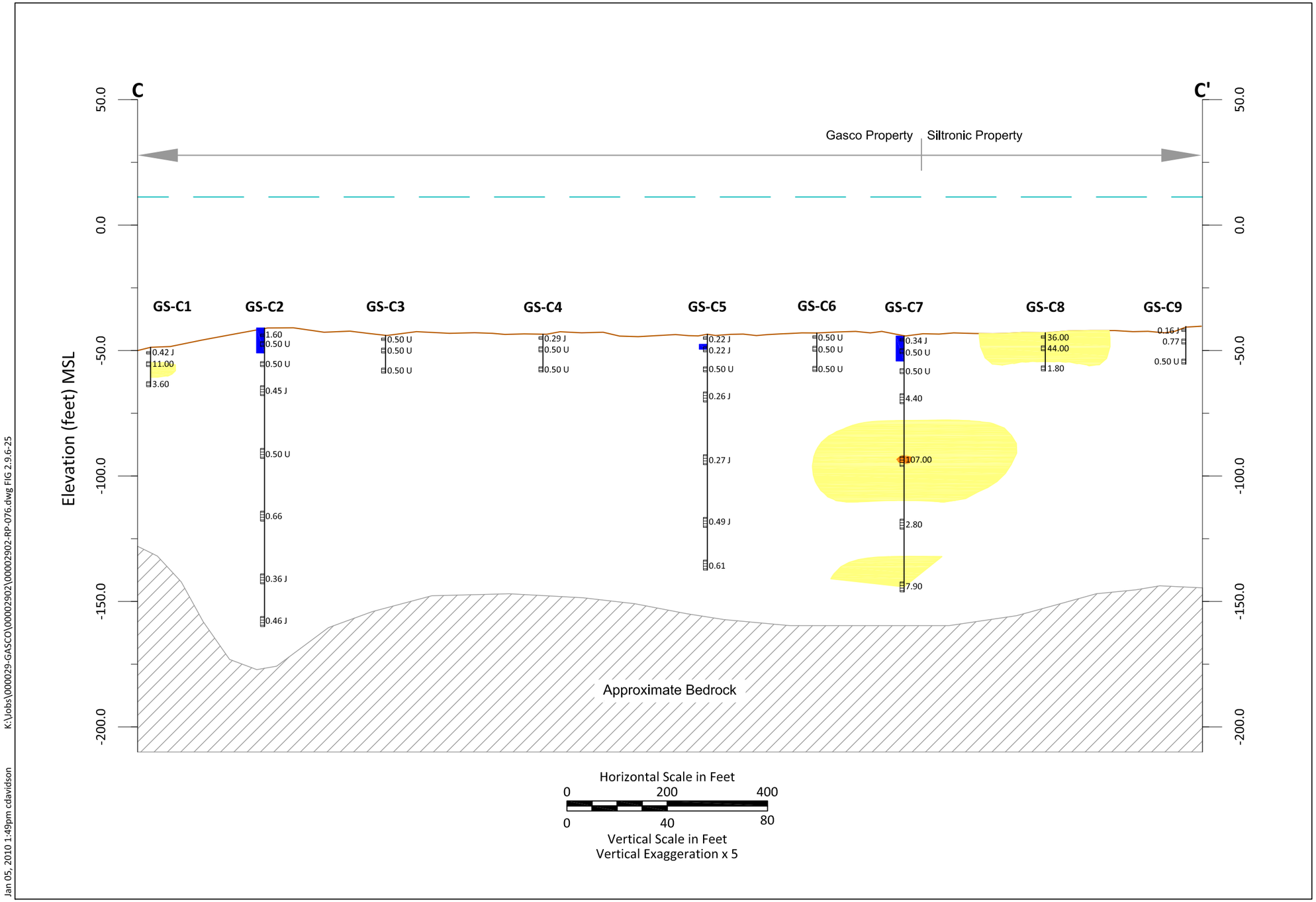


K:\Jobs\000029-GASCO\00002902\00002902-RP-076.dwg FIG 2.9.6-24

Jan 05, 2010 1:49pm cdavidson

ANCHOR QEA

Figure 2.9.6-24
Subsurface Profile B-B'
Benzene Concentrations in Groundwater - Gasco
NW Natural "Gasco" Site
Gasco Sediment Cleanup Action

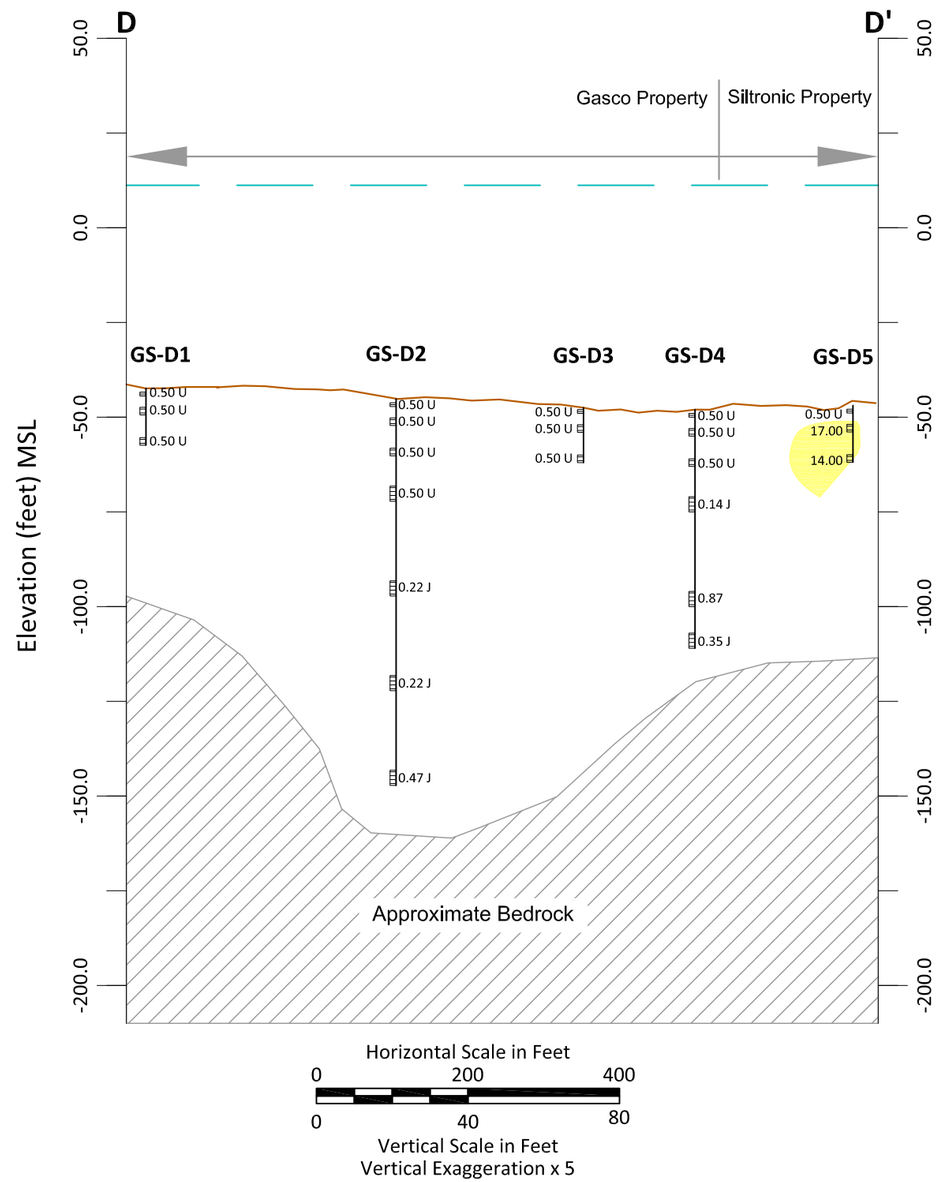


K:\Jobs\000029-GASCO\00002902\00002902-RP-076.dwg FIG 2.9.6-25

Jan 05, 2010 1:49pm cdavidson

ANCHOR QEA

Figure 2.9.6-25
Subsurface Profile C-C'
Benzene Concentrations in Groundwater - Gasco
NW Natural "Gasco" Site
Gasco Sediment Cleanup Action



LEGEND:

Groundwater Benzene Concentrations (ug/L)

0.0 - 5.0

5.0 - 100.0

100.0 - 500.0

>500

GS-02 Boring ID

150.0 Benzene Concentration in Groundwater (ug/L)

NAPL and/or Tar Interval

Screen Interval

Approximate Willamette River Elevation

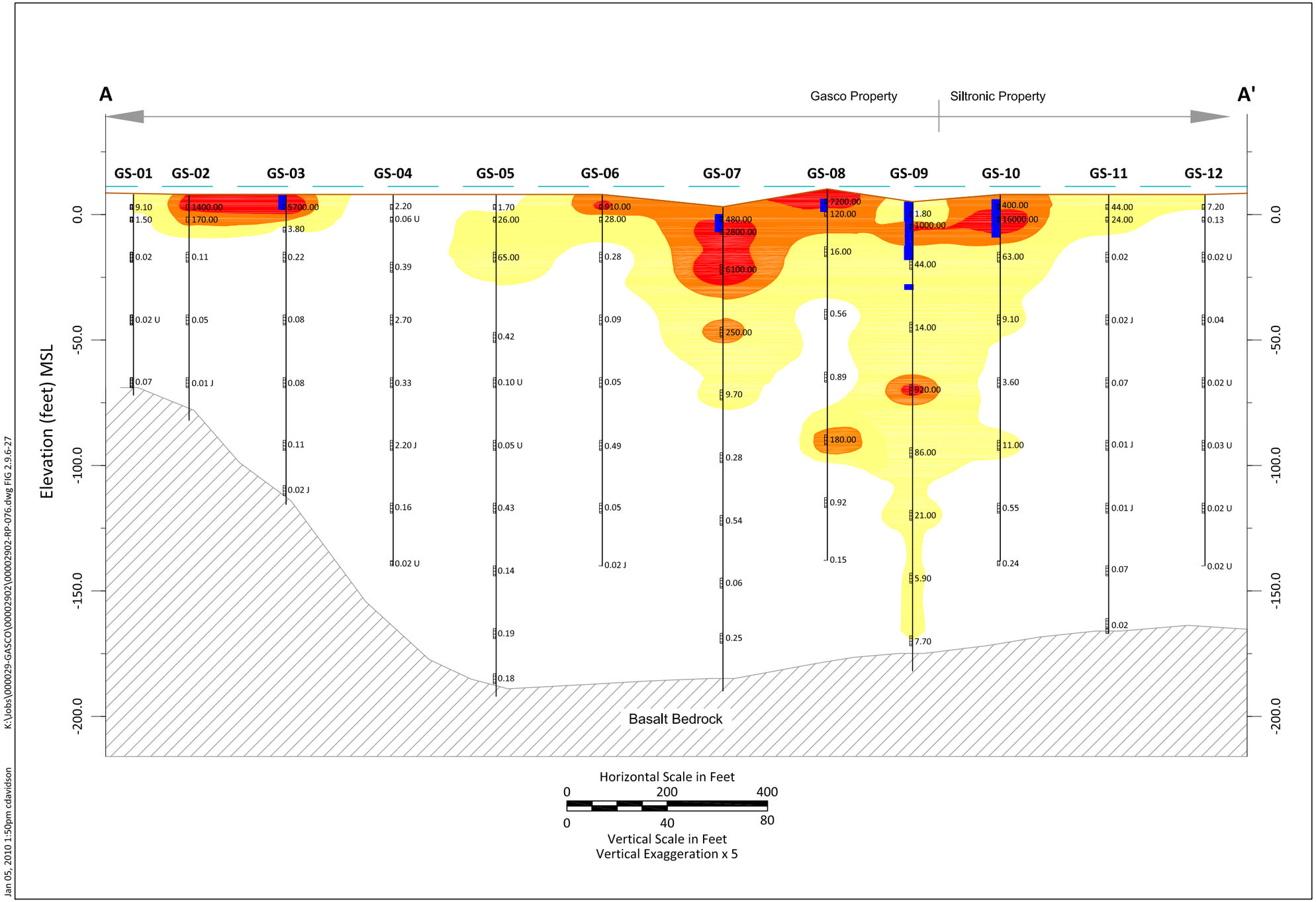
Existing Ground Surface

K:\Jobs\000029-GASCO\00002902\00002902-RP-076.dwg FIG 2.9.6-26

Jan 05, 2010 1:50pm cdavidson

ANCHOR QEA

Figure 2.9.6-26
Subsurface Profile D-D'
Benzene Concentrations in Groundwater - Gasco
NW Natural "Gasco" Site
Gasco Sediment Cleanup Action

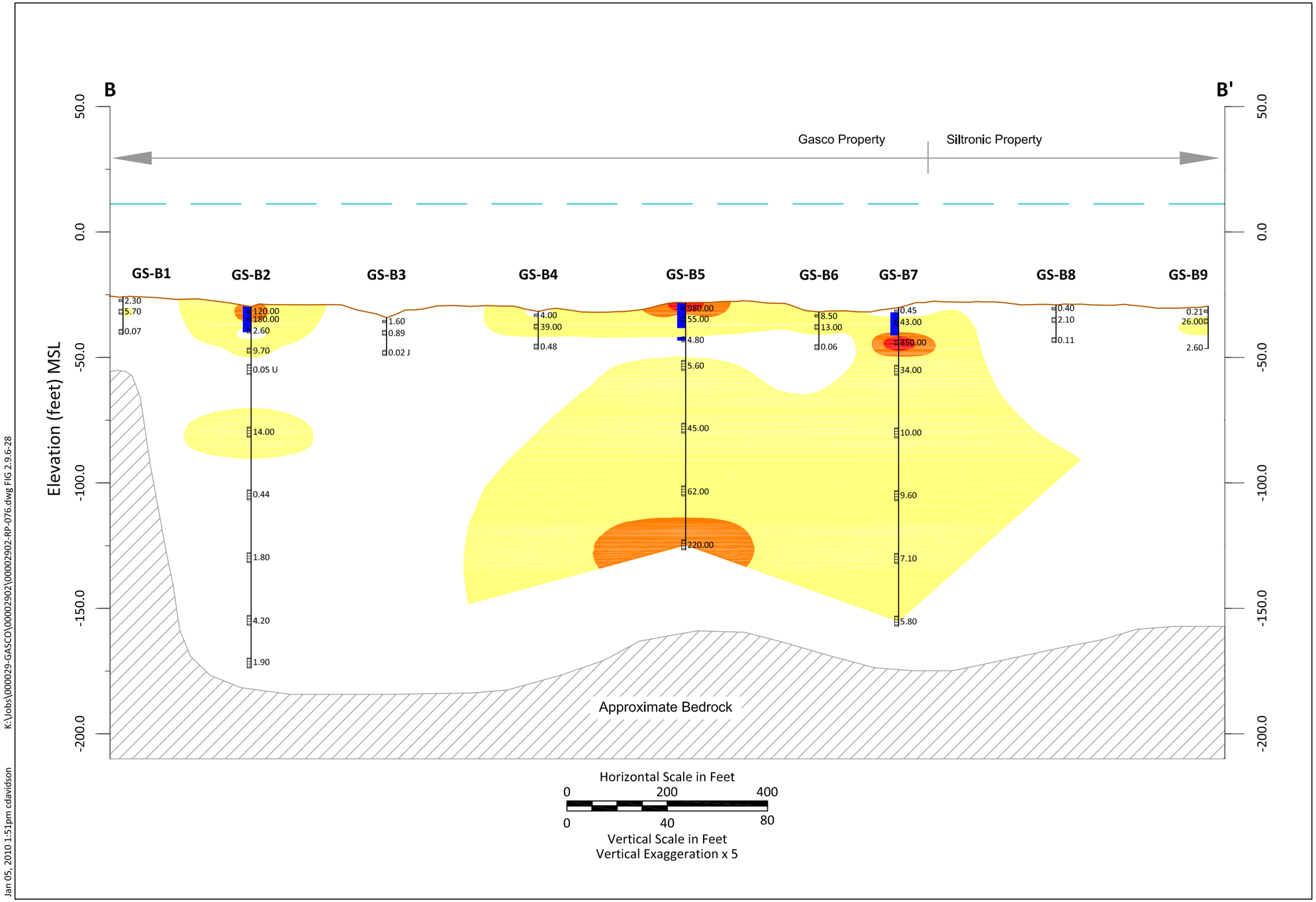


K:\Jobs\000029-GASCO\00002902\00002902-RP-076.dwg FIG 2.9.6-27

Jan 05, 2010 1:50pm cdavidson

ANCHOR QEA

Figure 2.9.6-27
Subsurface Profile A-A'
Naphthalene Concentrations in Groundwater - Gasco
NW Natural "Gasco" Site
Gasco Sediment Cleanup Action

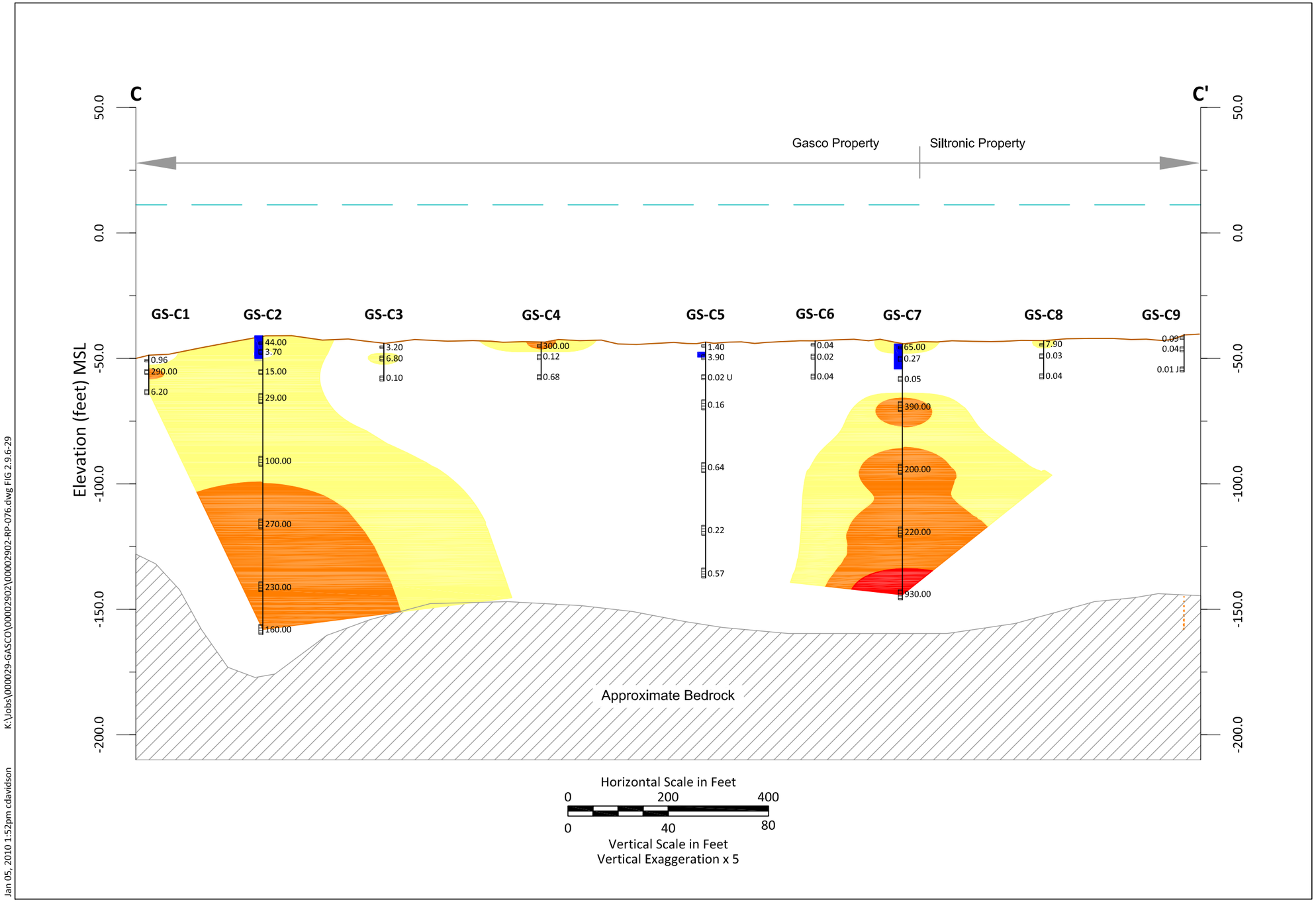


K:\Jobs\000029-GASCO\00002902\00002902-RP-076.dwg FIG 2.9.6-28

Jan 05, 2010 1:51pm cdavidson

ANCHOR QEA

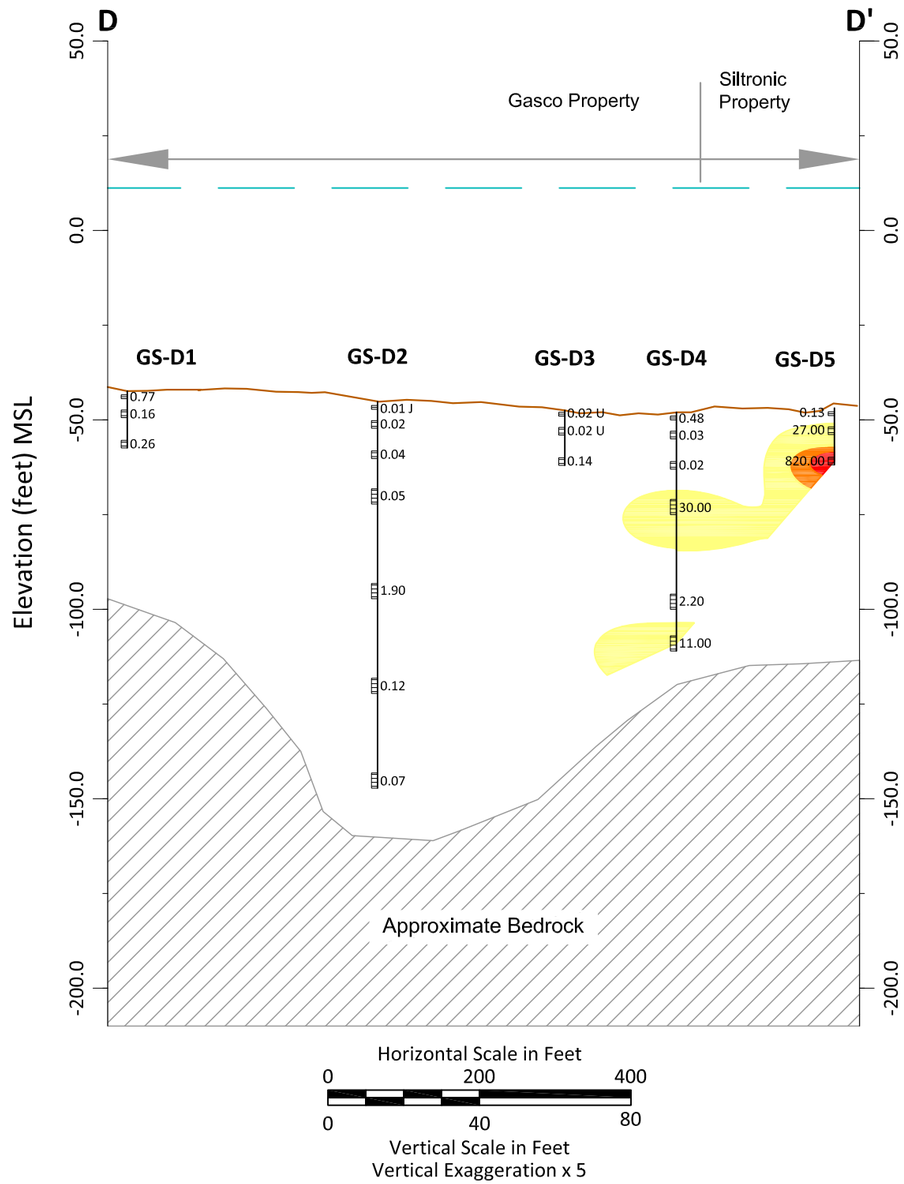
Figure 2.9.6-28
Subsurface Profile B-B'
Naphthalene Concentrations in Groundwater - Gasco
NW Natural "Gasco" Site
Gasco Sediment Cleanup Action



Jan 05, 2010 1:52pm cdavidson K:\Jobs\000029-GASCO\00002902\00002902-RP-076.dwg FIG 2.9.6-29

ANCHOR QEA

Figure 2.9.6-29
Subsurface Profile C-C'
Naphthalene Concentrations in Groundwater - Gasco
NW Natural "Gasco" Site
Gasco Sediment Cleanup Action



LEGEND:

Groundwater Naphthalene Concentrations (ug/L)

0.0 - 5.0

5.0 - 100.0

100.0 - 500.0

>500

GS-02 Boring ID

150.0 Naphthalene Concentration in Groundwater (ug/L)

NAPL and/or Tar Interval

Screen Interval

Approximate Willamette River Elevation

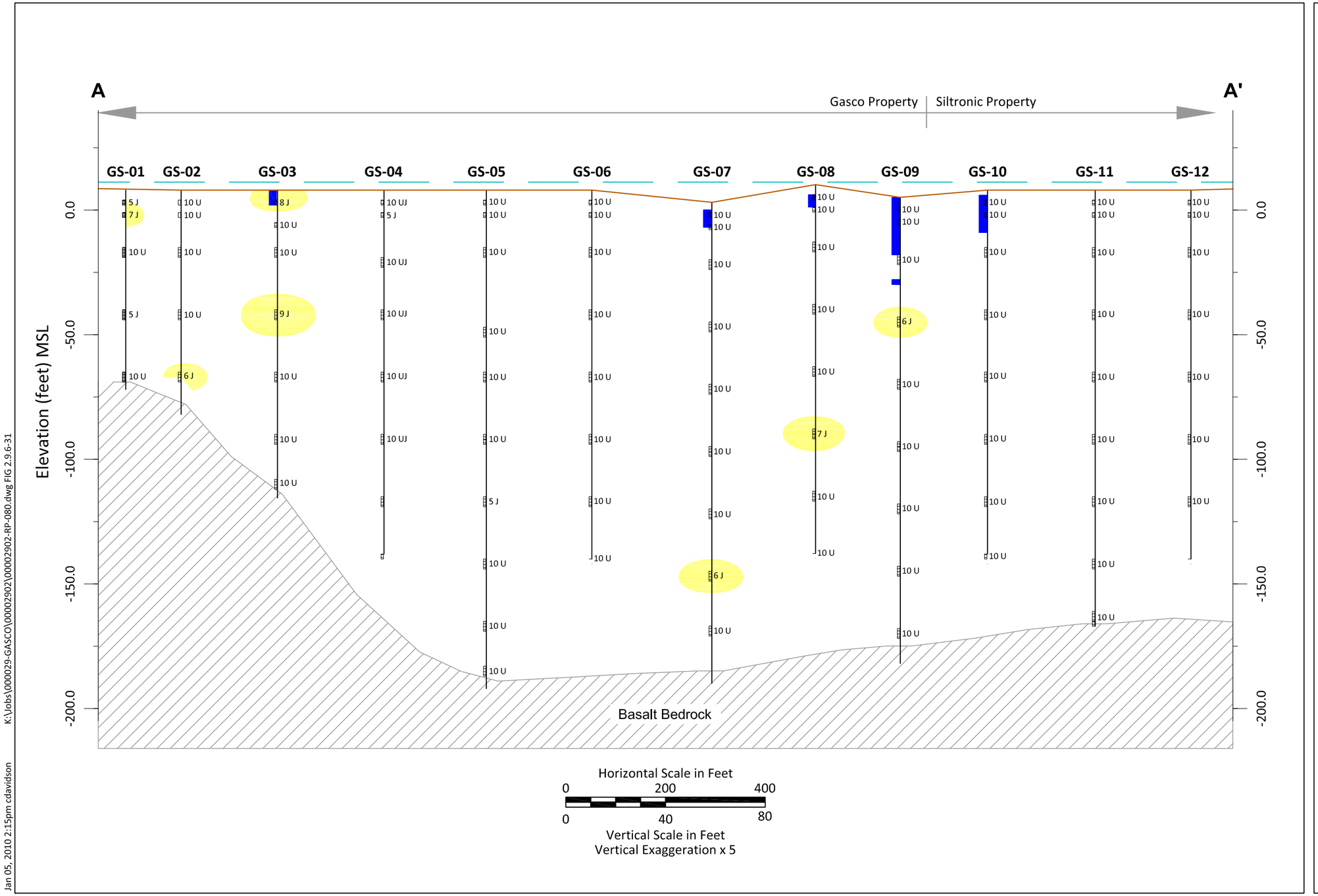
Existing Ground Surface

K:\Jobs\000029-GASCO\00002902\00002902-RP-076.dwg FIG 2.9.6-30

Jan 05, 2010 1:53pm cdavidson

ANCHOR QEA

Figure 2.9.6-30
Subsurface Profile D-D'
Naphthalene Concentrations in Groundwater - Gasco
NW Natural "Gasco" Site
Gasco Sediment Cleanup Action

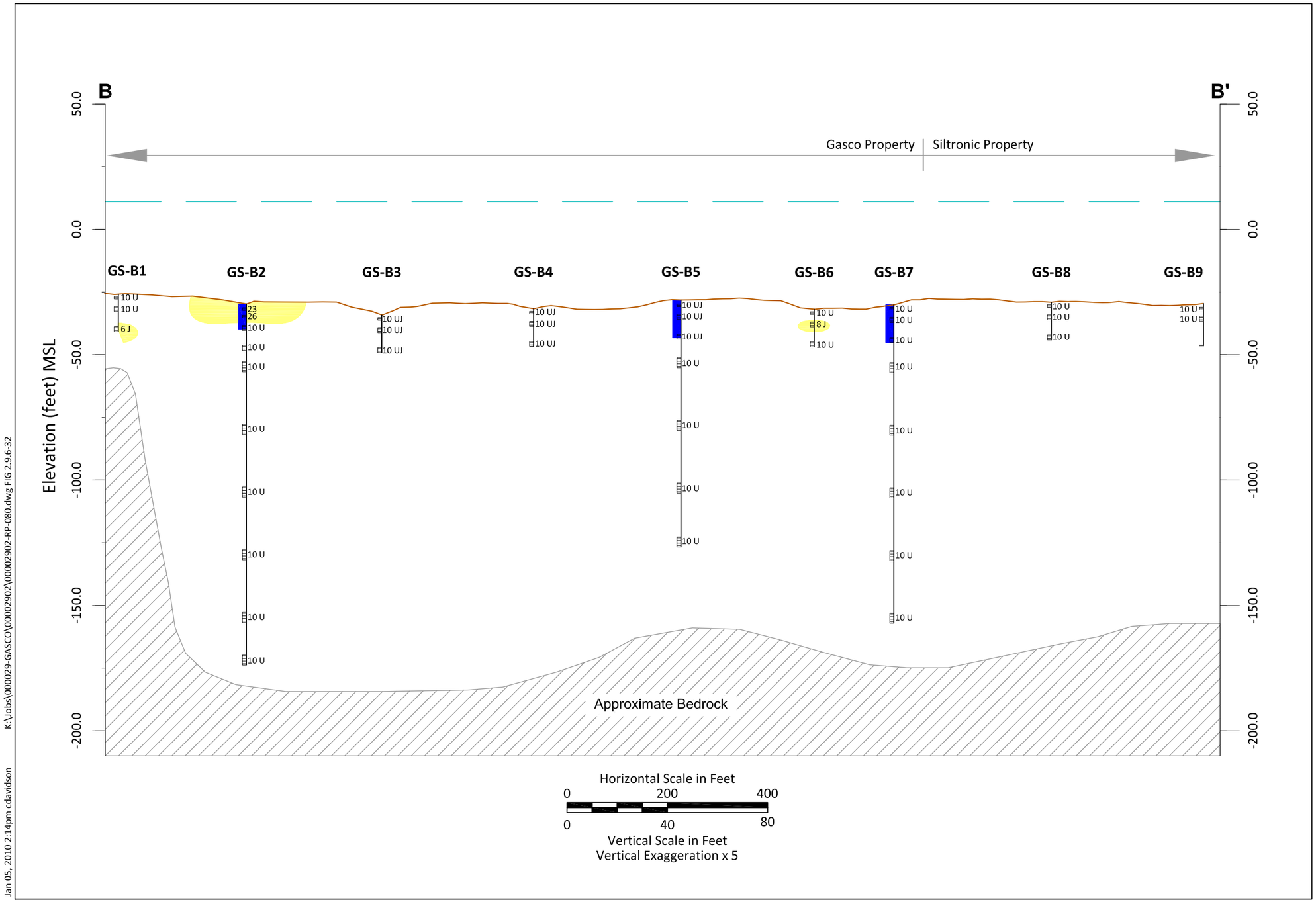


K:\Jobs\000029-GASCO\00002902\00002902-RP-080.dwg FIG 2.9.6-31

Jan 05, 2010 2:15pm cdavidson

ANCHOR QEA

Figure 2.9.6-31
Subsurface Profile A-A'
Free Cyanide Concentrations in Groundwater - Gasco
NW Natural "Gasco" Site
Gasco Sediment Cleanup Action



LEGEND:

Groundwater Free Cyanide Concentrations (ug/L)

- 0.0 - 5.0
- 5.0 - 100.0
- 100.0 - 500.0
- >500

GS-02 Boring ID

150.0 Free Cyanide Concentration in Groundwater (ug/L)

NAPL and/or Tar Interval

Screen Interval

Approximate Willamette River Elevation

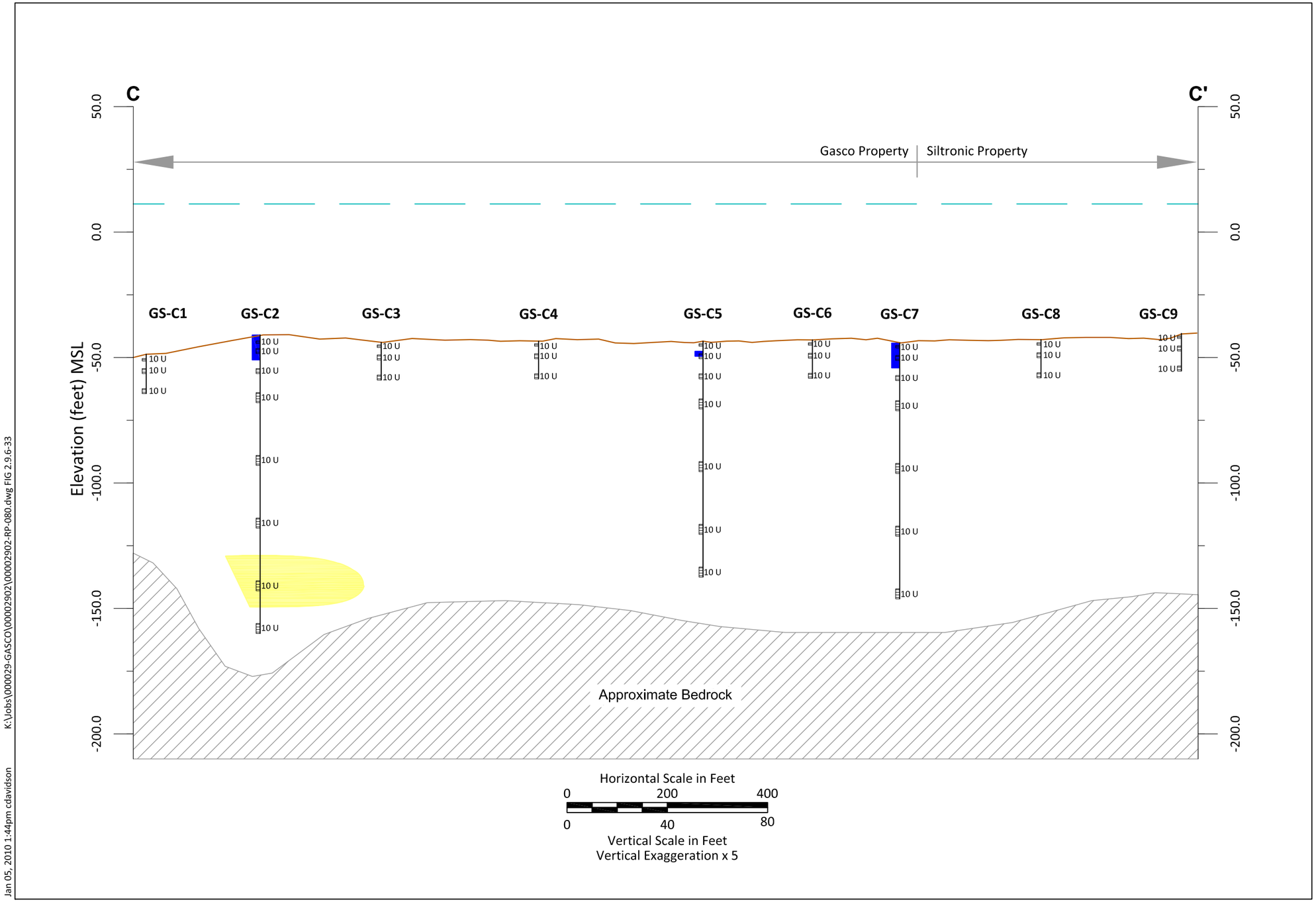
Existing Ground Surface

K:\Jobs\000029-GASCO\00002902\00002902-RP-080.dwg FIG 2.9.6-32

Jan 05, 2010 2:14pm cdavidson

ANCHOR QEA

Figure 2.9.6-32
Subsurface Profile B-B'
Free Cyanide Concentrations in Groundwater - Gasco
NW Natural "Gasco" Site
Gasco Sediment Cleanup Action



LEGEND:

Groundwater Free Cyanide Concentrations (ug/L)

0.0 - 5.0

5.0 - 100.0

100.0 - 500.0

>500

GS-02 Boring ID

150.0 Free Cyanide Concentration in Groundwater (ug/L)

NAPL and/or Tar Interval

Screen Interval

Approximate Willamette River Elevation

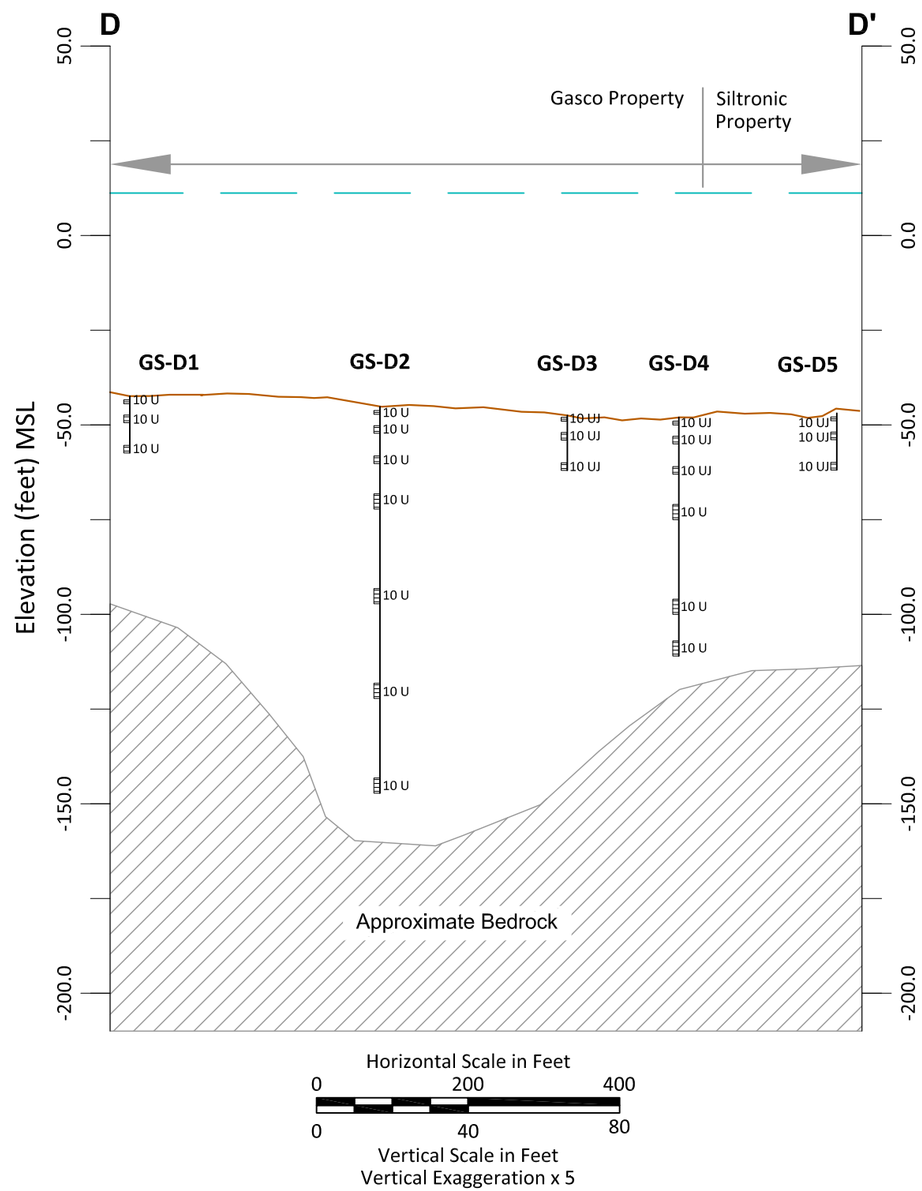
Existing Ground Surface

K:\Jobs\000029-GASCO\00002902\00002902-RP-080.dwg FIG 2.9.6-33

Jan 05, 2010 1:44pm cdavidson

ANCHOR QEA

Figure 2.9.6-33
Subsurface Profile C-C'
Free Cyanide Concentrations in Groundwater - Gasco
NW Natural "Gasco" Site
Gasco Sediment Cleanup Action



LEGEND:

Groundwater Free Cyanide Concentrations (ug/L)

0.0 - 5.0

5.0 - 100.0

100.0 - 500.0

>500

GS-02 Boring ID

150.0 Free Cyanide Concentration in Groundwater (ug/L)

NAPL and/or Tar Interval

Screen Interval

Approximate Willamette River Elevation

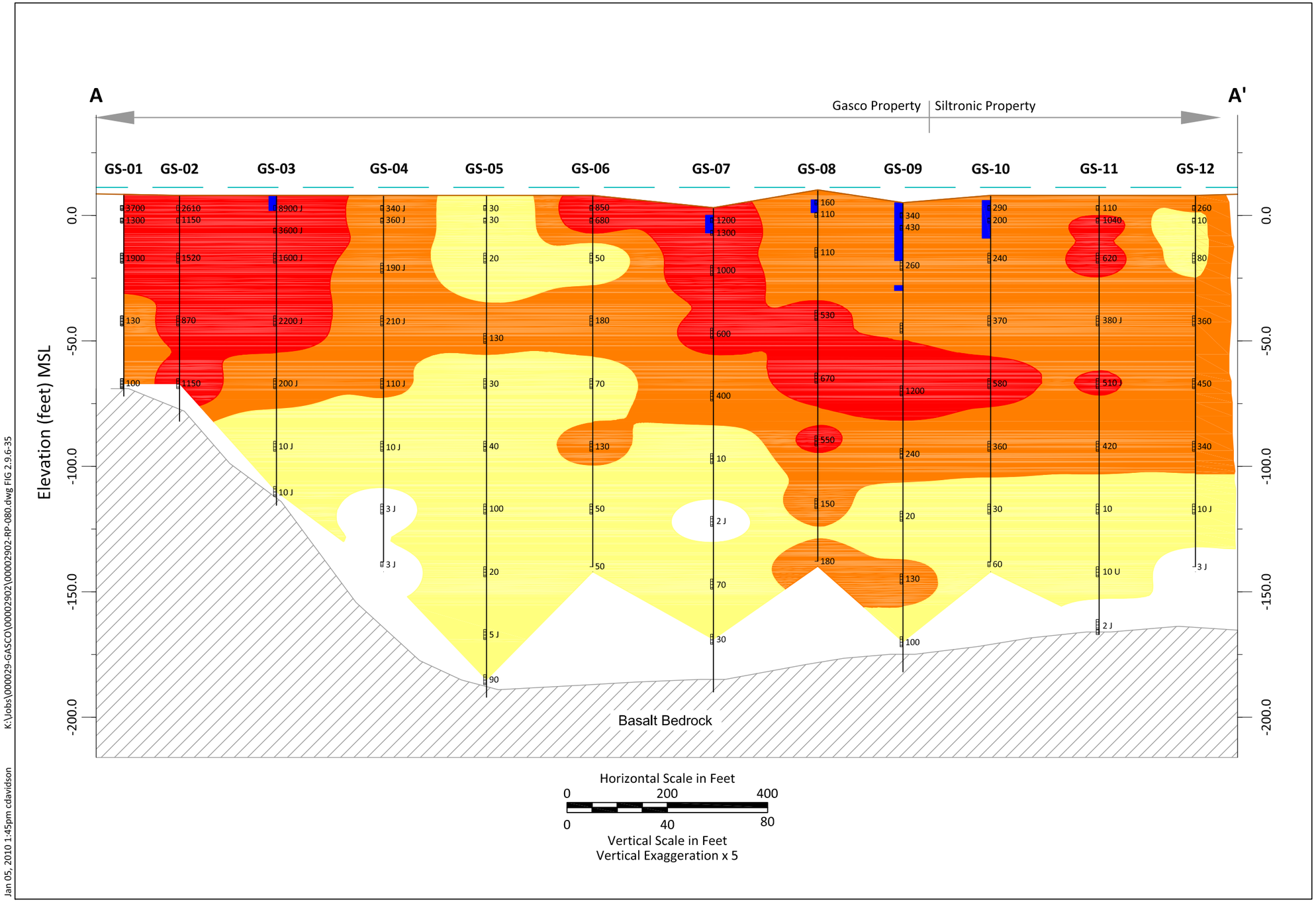
Existing Ground Surface

K:\Jobs\000029-GASCO\00002902\00002902-RP-080.dwg FIG 2.9.6-34

Jan 05, 2010 1:45pm cdavidson

ANCHOR QEA

Figure 2.9.6-34
Subsurface Profile D-D'
Free Cyanide Concentrations in Groundwater - Gasco
NW Natural "Gasco" Site
Gasco Sediment Cleanup Action

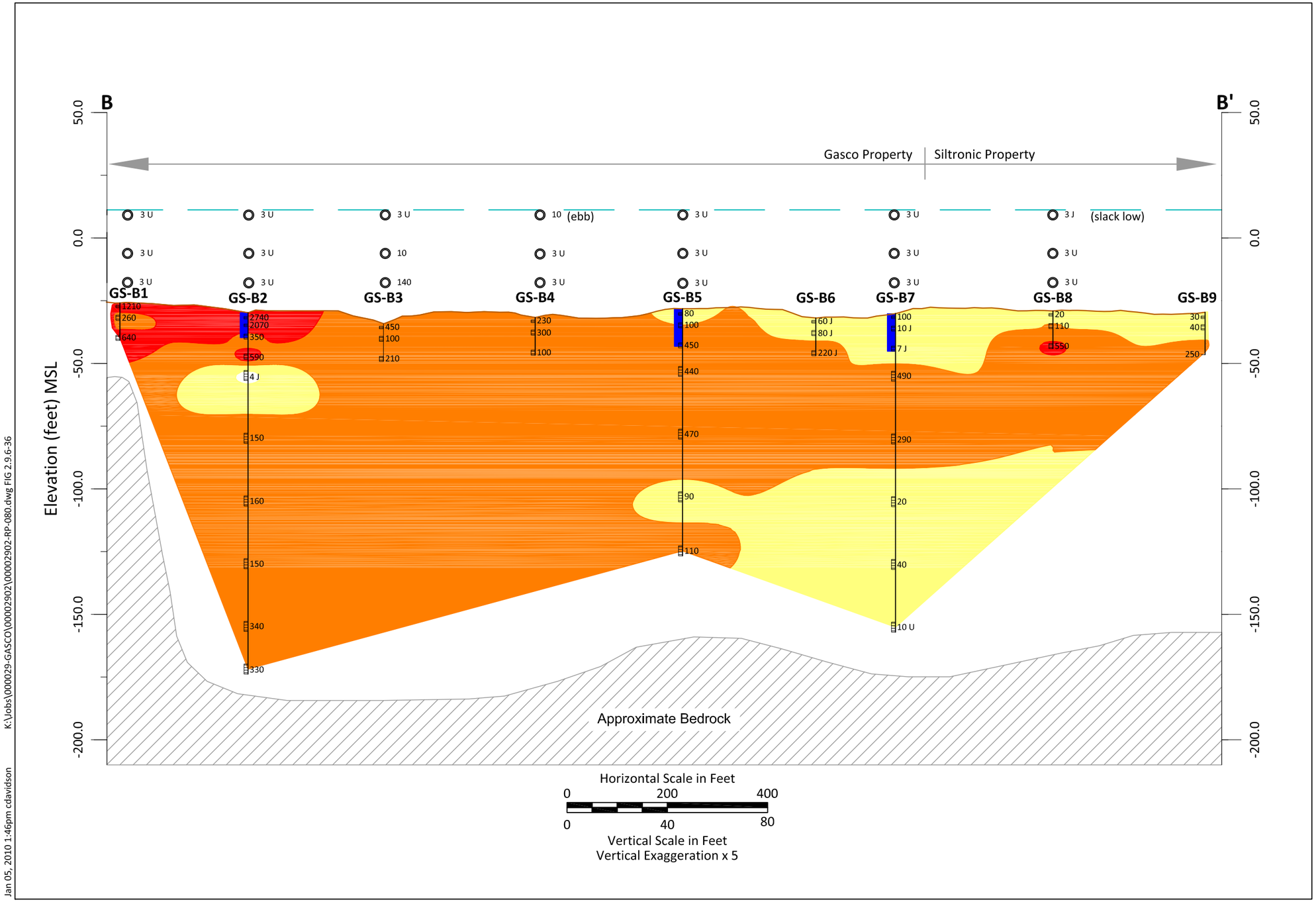


K:\Jobs\000029-GASCO\00002902\00002902-RP-080.dwg FIG 2.9.6-35

Jan 05, 2010 1:45pm cdavidson

ANCHOR QEA

Figure 2.9.6-35
Subsurface Profile B-B'
Total Cyanide Concentrations in Groundwater - Gasco
NW Natural "Gasco" Site
Gasco Sediment Cleanup Action



LEGEND:

Groundwater Total Cyanide Concentrations (ug/L)

- 0.0 - 5.0
- 5.0 - 100.0
- 100.0 - 500.0
- >500

GS-02 Boring ID

150.0 Total Cyanide Concentration in Groundwater (ug/L)

NAPL and/or Tar Interval

Screen Interval

Surface Water Sample (ug/L)

Approximate Willamette River Elevation

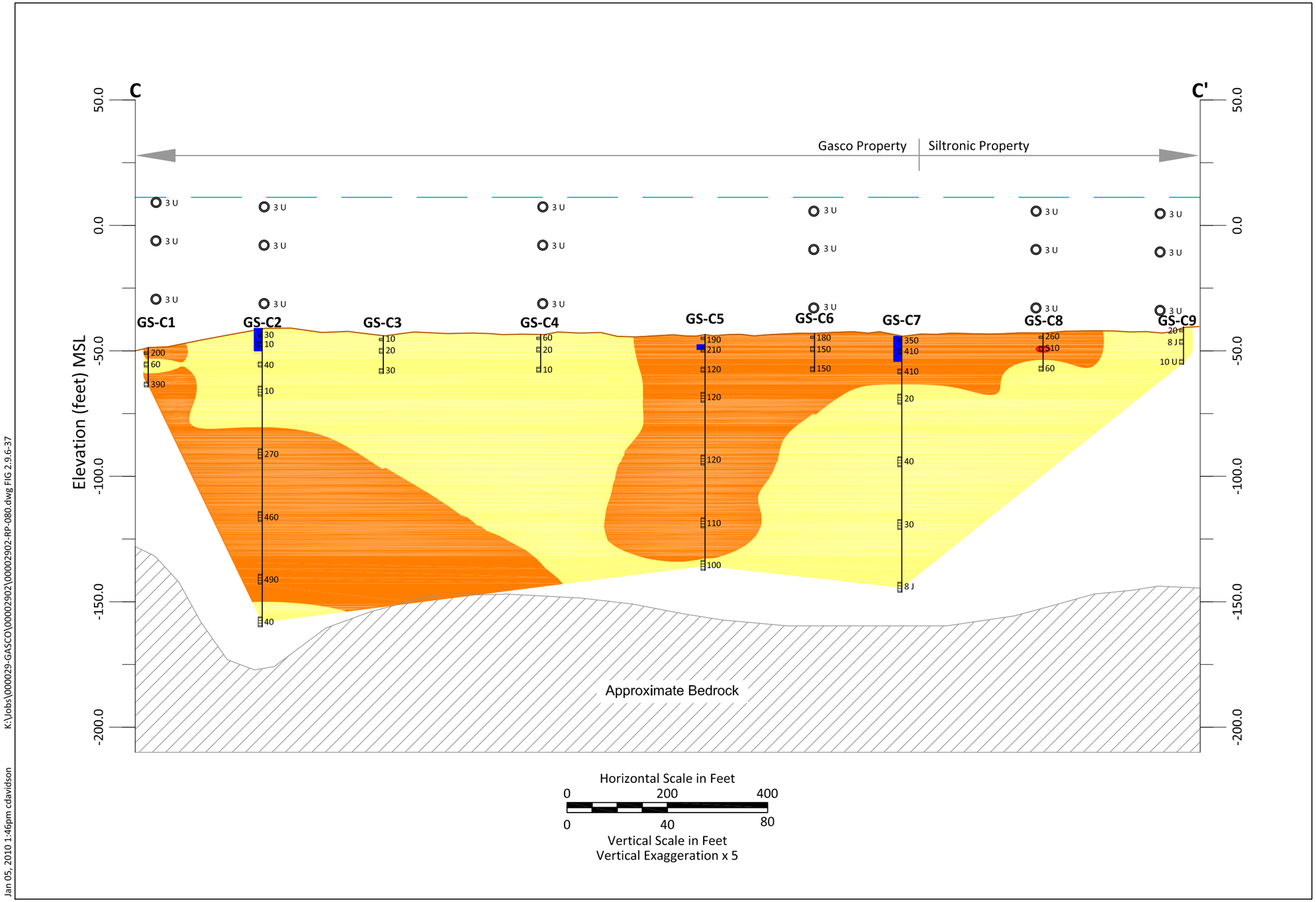
Existing Ground Surface

K:\Jobs\000029-GASCO\00002902\00002902-RP-080.dwg FIG 2.9.6-36

Jan 05, 2010 1:46pm cdavidson

ANCHOR QEA

Figure 2.9.6-36
Subsurface Profile B-B'
Total Cyanide Concentrations in Groundwater - Gasco
NW Natural "Gasco" Site
Gasco Sediment Cleanup Action



LEGEND:

Groundwater Total Cyanide Concentrations (ug/L)

0.0 - 5.0

5.0 - 100.0

100.0 - 500.0

>500

GS-02 Boring ID

150.0 Total Cyanide Concentration in Groundwater (ug/L)

NAPL and/or Tar Interval

Screen Interval

Surface Water Sample (ug/L)

Approximate Willamette River Elevation

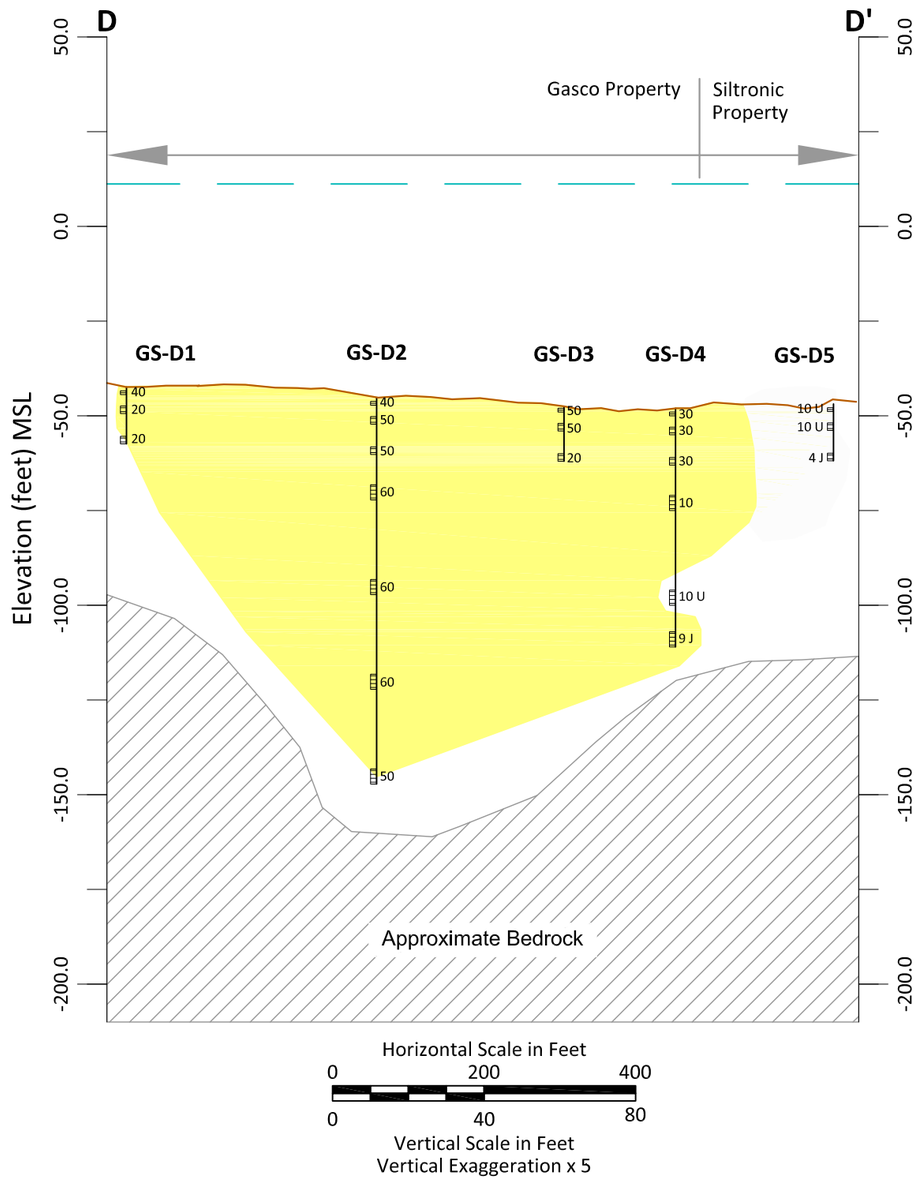
Existing Ground Surface

K:\Jobs\000029-GASCO\00002902\00002902-RP-080.dwg FIG 2.9.6-37

Jan 05, 2010 1:46pm cdavidson

ANCHOR QEA

Figure 2.9.6-37
Subsurface Profile C-C'
Total Cyanide Concentrations in Groundwater - Gasco
NW Natural "Gasco" Site
Gasco Sediment Cleanup Action



LEGEND:

Groundwater Total Cyanide Concentrations (ug/L)

0.0 - 5.0

5.0 - 100.0

100.0 - 500.0

>500

GS-02 Boring ID

150.0 Total Cyanide Concentration in Groundwater (ug/L)

NAPL and/or Tar Interval

Screen Interval

Approximate Willamette River Elevation

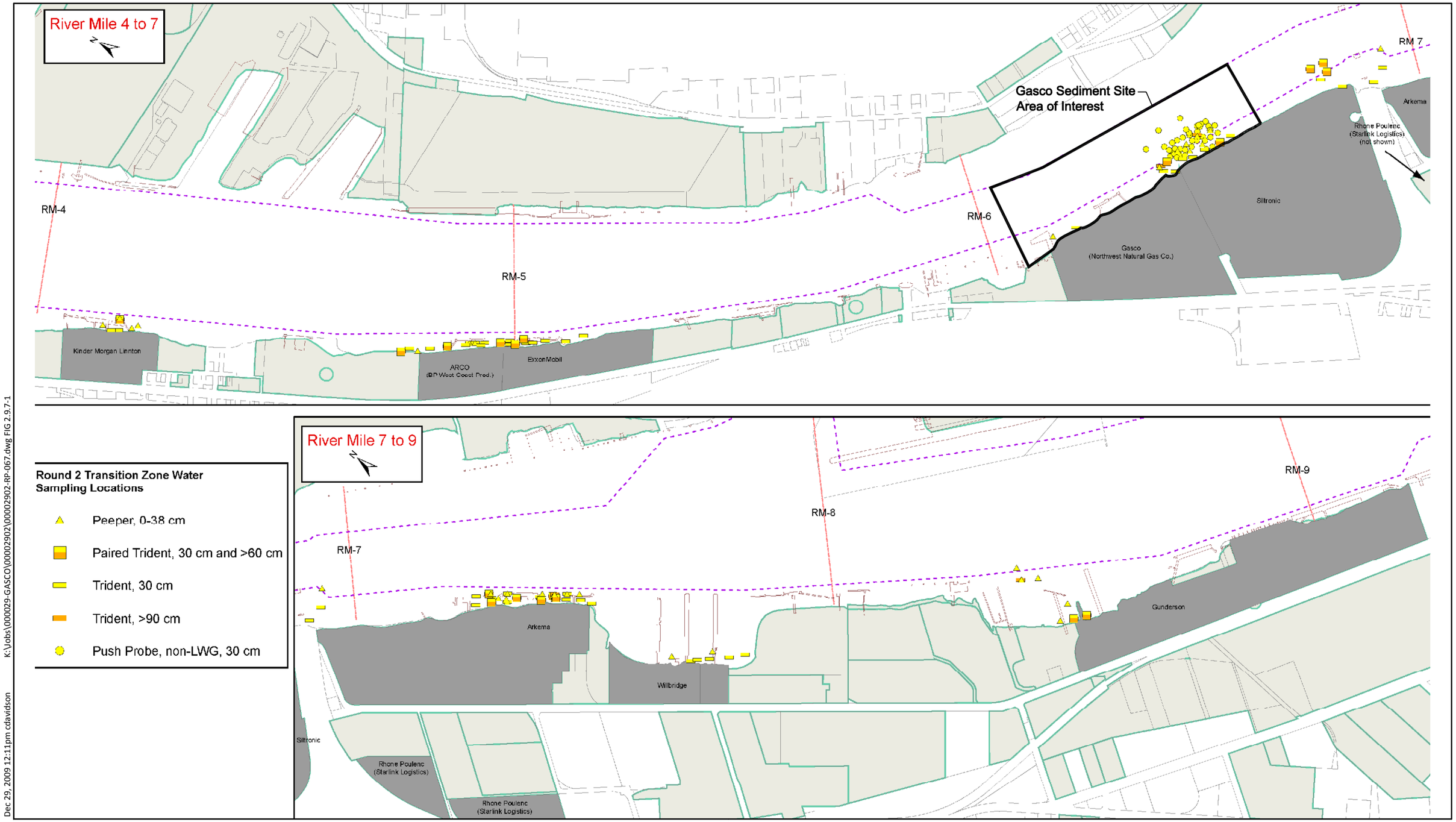
Existing Ground Surface

K:\Jobs\000029-GASCO\00002902\00002902-RP-080.dwg FIG 2.9.6-38

Jan 05, 2010 1:47pm cdavidson

ANCHOR QEA

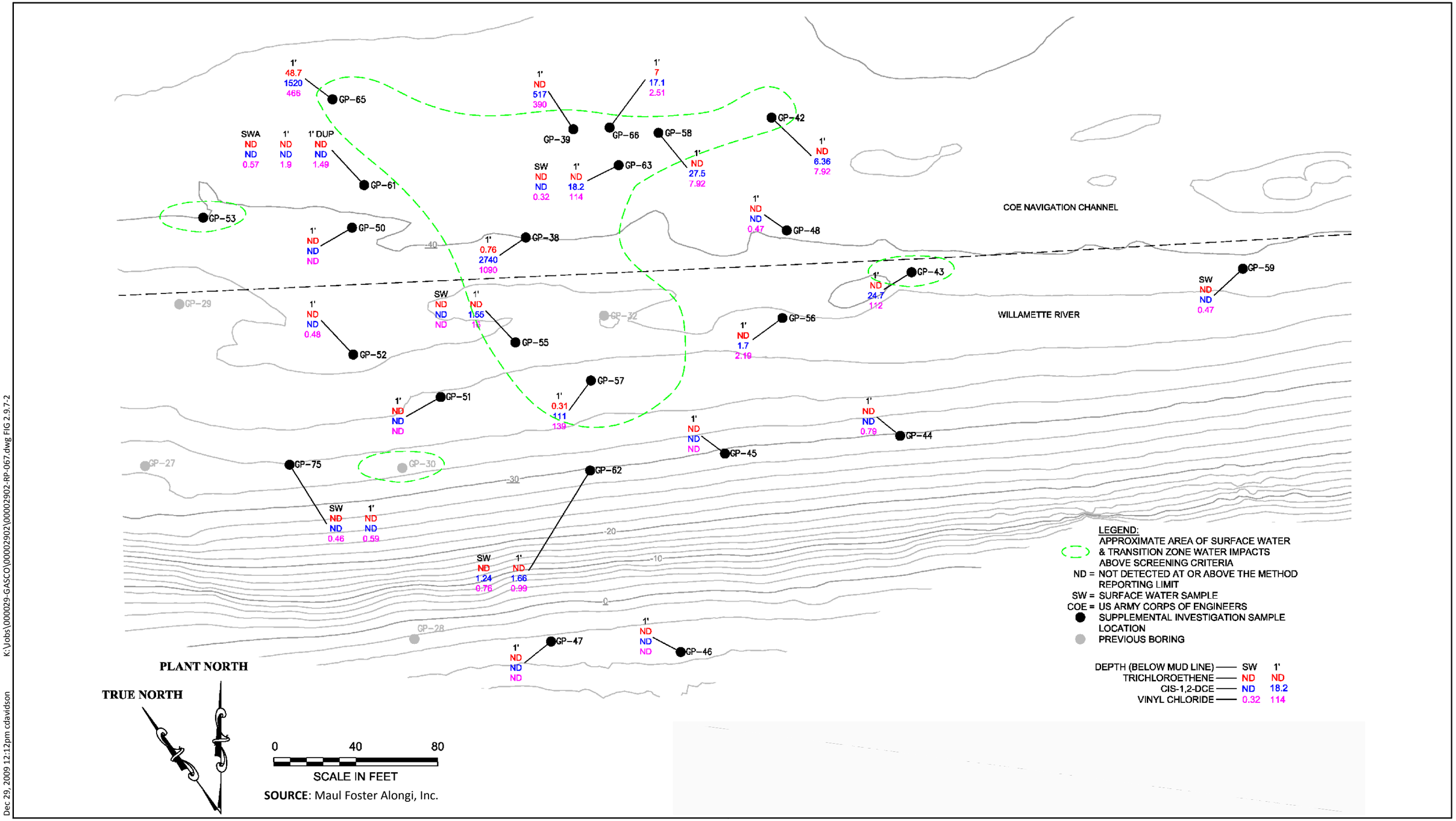
Figure 2.9.6-38
Subsurface Profile D-D'
Total Cyanide Concentrations in Groundwater - Gasco
NW Natural "Gasco" Site
Gasco Sediment Cleanup Action



Dec 29, 2009 12:11pm cdavidson K:\Jobs\000029-GASCO\00002902\00002902-RP-067.dwg FIG 2.9.7-1

ANCHOR QEA

Figure 2.9.7-1
LWG Round 2 Transition Zone Water Sampling Locations
NW Natural "Gasco" Site
Gasco Sediment Cleanup Action

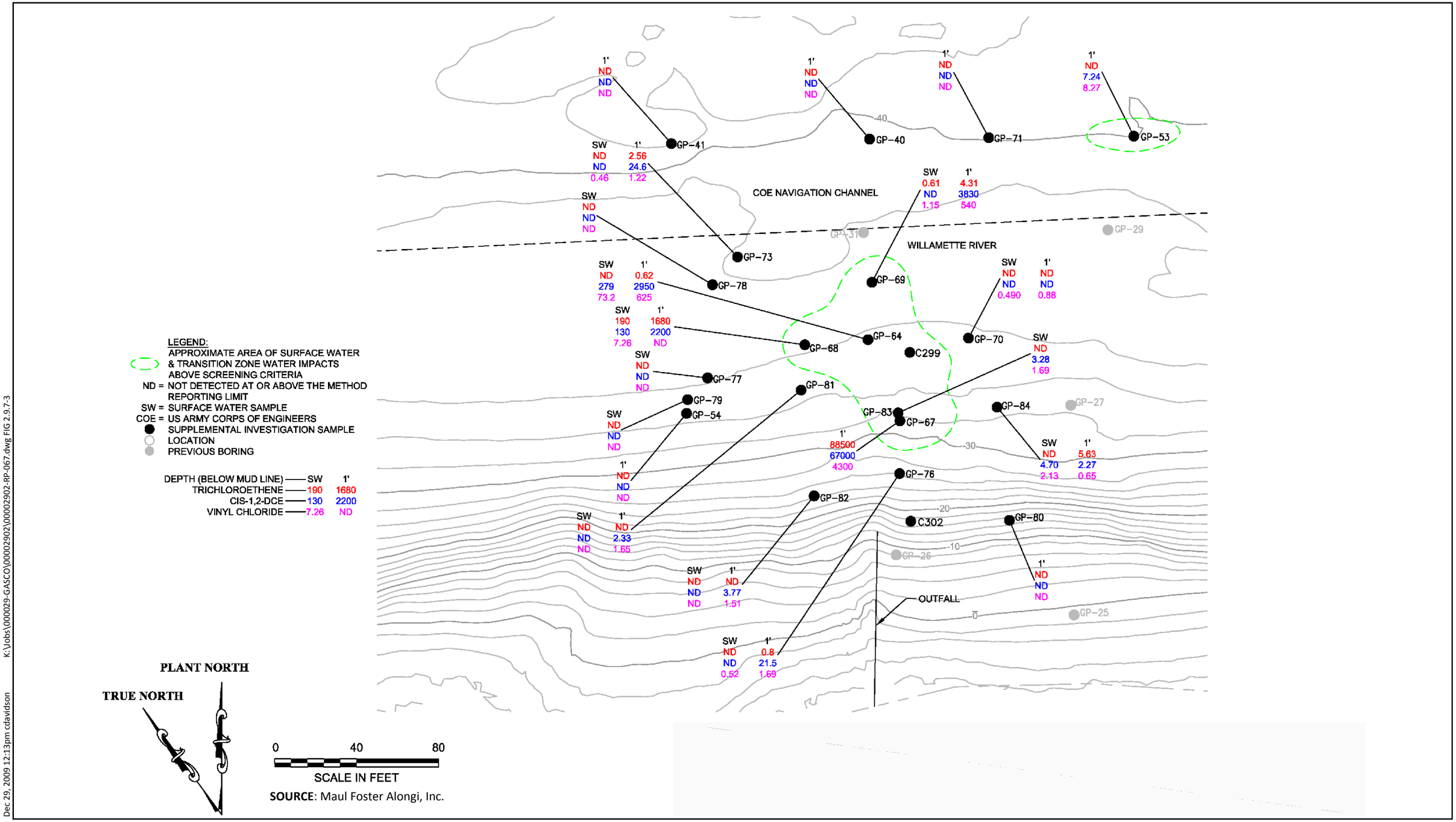


K:\Jobs\000029-GASCO\00002902\00002902-RP-067.dwg FIG 2.9.7-2

Dec 29, 2009 12:12pm cdavidson

ANCHOR QEA

Figure 2.9.7-2
Siltronic Transition Zone Water Sampling Locations - Area 1
NW Natural "Gasco" Site
Gasco Sediment Cleanup Action



SOURCE: Maul Foster Alongi, Inc.

K:\Jobs\000029-GASCO\00002902\00002902-RP-067.dwg FIG 2.9.7-3

Dec 29, 2009 12:13pm cdavidson

ANCHOR QEA

Figure 2.9.7-3
Siltronic Transition Zone Water Sampling Locations - Area 2
NW Natural "Gasco" Site
Gasco Sediment Cleanup Action

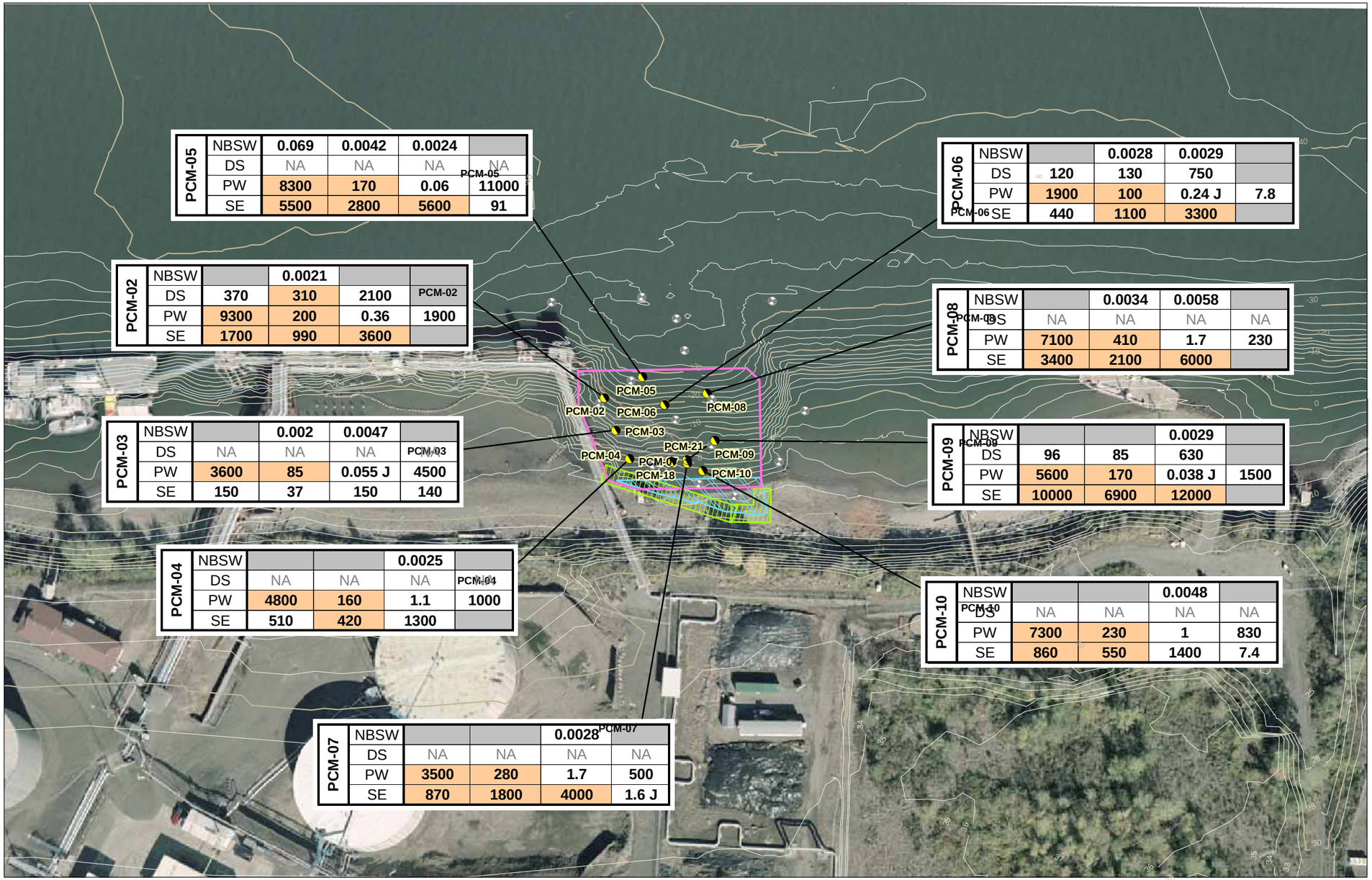
Legend

- Pilot Cap Monitoring Stations
- Post-Dredge Surface Sediment Samples
- Extent of 18-inch Thick Cap
- Reactive Organo-Clay Mat (RCM) Location
- Lateral Extents of Surf Zone Armoring

Location ID	Matrix	Naphthalene	Acenaphthene	Fluoranthene	Benzene
PCM-08	NBSW		0.0034	0.0058	
	DS	NA	NA	NA	NA
	PW	7100	410	1.7	230
	SE	3400	2100	6000	

- Non-Detect
- NA — Not Applicable
- Detection less than screening level, if available
- Detection greater than screening level, if available

NBSW - Discrete Near-Bottom Surface Water Sample (µg/L)
DS - Depositional Surface Sediment Sample (µg/kg)
PW - Pilot Cap Porewater Sample (µg/L)
SE - Pilot Cap Sediment Sample (µg/kg)



Location ID	Matrix	Naphthalene	Acenaphthene	Fluoranthene	Benzene
PCM-05	NBSW	0.069	0.0042	0.0024	
	DS	NA	NA	NA	NA
	PW	8300	170	0.06	11000
	SE	5500	2800	5600	91

Location ID	Matrix	Naphthalene	Acenaphthene	Fluoranthene	Benzene
PCM-06	NBSW		0.0028	0.0029	
	DS	120	130	750	
	PW	1900	100	0.24 J	7.8
	SE	440	1100	3300	

Location ID	Matrix	Naphthalene	Acenaphthene	Fluoranthene	Benzene
PCM-02	NBSW		0.0021		
	DS	370	310	2100	
	PW	9300	200	0.36	1900
	SE	1700	990	3600	

Location ID	Matrix	Naphthalene	Acenaphthene	Fluoranthene	Benzene
PCM-08	NBSW		0.0034	0.0058	
	DS	NA	NA	NA	NA
	PW	7100	410	1.7	230
	SE	3400	2100	6000	

Location ID	Matrix	Naphthalene	Acenaphthene	Fluoranthene	Benzene
PCM-03	NBSW		0.002	0.0047	
	DS	NA	NA	NA	NA
	PW	3600	85	0.055 J	4500
	SE	150	37	150	140

Location ID	Matrix	Naphthalene	Acenaphthene	Fluoranthene	Benzene
PCM-09	NBSW			0.0029	
	DS	96	85	630	
	PW	5600	170	0.038 J	1500
	SE	10000	6900	12000	

Location ID	Matrix	Naphthalene	Acenaphthene	Fluoranthene	Benzene
PCM-04	NBSW			0.0025	
	DS	NA	NA	NA	NA
	PW	4800	160	1.1	1000
	SE	510	420	1300	

Location ID	Matrix	Naphthalene	Acenaphthene	Fluoranthene	Benzene
PCM-10	NBSW			0.0048	
	DS	NA	NA	NA	NA
	PW	7300	230	1	830
	SE	860	550	1400	7.4

Location ID	Matrix	Naphthalene	Acenaphthene	Fluoranthene	Benzene
PCM-07	NBSW			0.0028	
	DS	NA	NA	NA	NA
	PW	3500	280	1.7	500
	SE	870	1800	4000	1.6 J

Notes:
1. Post-cap bathymetric contours produced from survey provided by Blue Water Engineering dated March 2006.
2. Upland topography directed by Anchor Environmental as part of upland investigation (2002).
3. Horizontal Datum: Oregon State Plane North NAD 83 (International feet).
4. Vertical Datum: NAVD88 (ft).
5. PCM-18 and PCM-21 were not sampled during this monitoring event.

0 100
Scale in Feet

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ANCHOR QEA

Figure 2.9.7-4
Gasco Pilot Cap Monitoring Transition Zone Water Concentrations
Year 0 Event 1
NW Natural "Gasco" Site
Gasco Sediment Cleanup Action

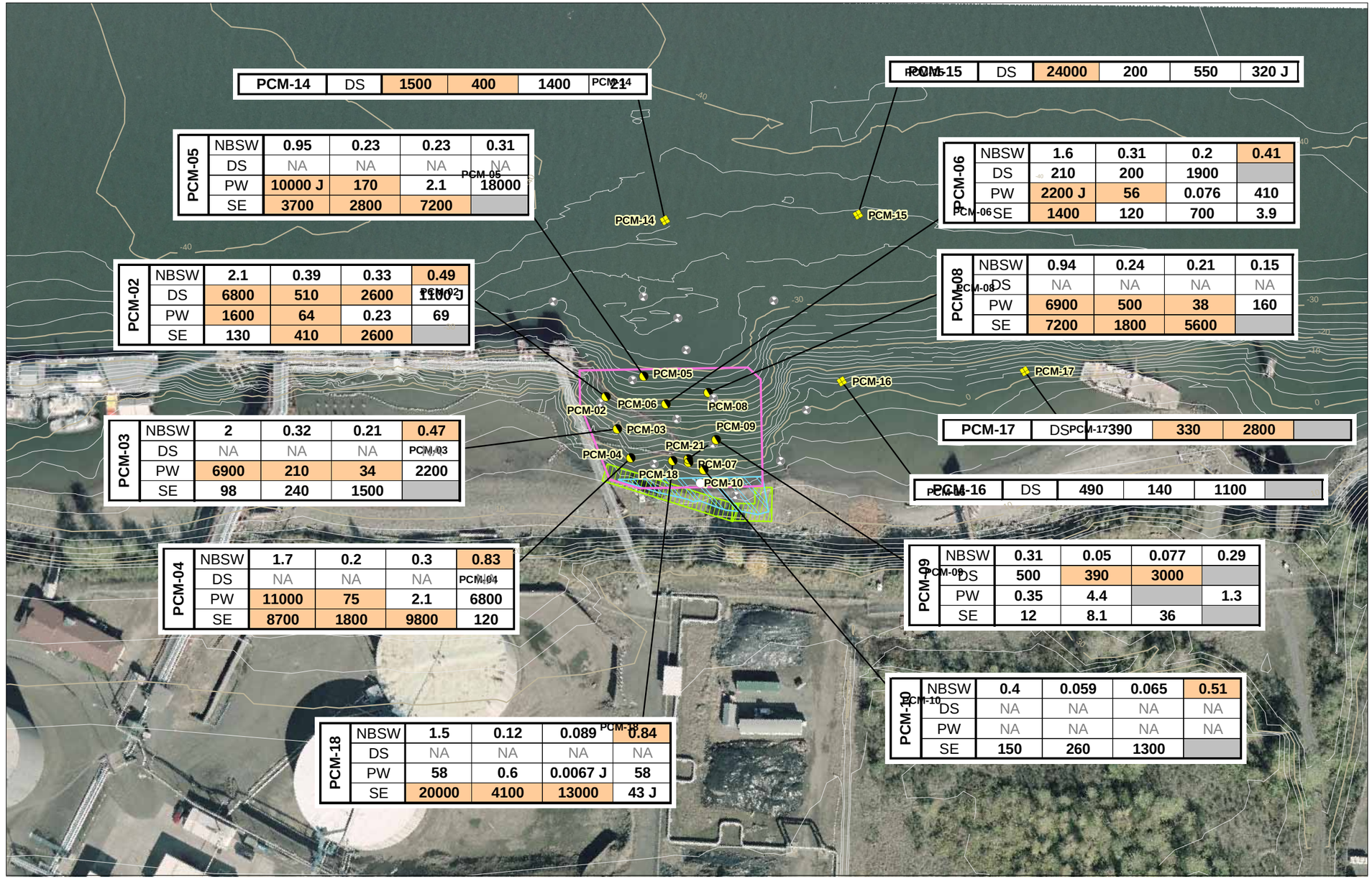
Legend

- Pilot Cap Monitoring Stations
- Fringe Cover Stations
- Post-Dredge Surface Sediment Samples
- Extent of 18-inch Thick Cap
- Reactive Organo-Clay Mat (RCM) Location
- Lateral Extents of Surf Zone Armoring

Location ID	Matrix	Naphthalene	Acenaphthene	Fluoranthene	Benzene
PCM-08	NBSW		0.0034	0.0058	
	DS	NA	NA	NA	NA
	PW	7100	410	1.7	230
	SE	3400	2100	6000	

- Non-Detect
- NA — Not Applicable
- Detection less than screening level, if available
- Detection greater than screening level, if available

NBSW - Discrete Near-Bottom Surface Water Sample (µg/L)
DS - Depositional Surface Sediment Sample (µg/kg)
PW - Pilot Cap Porewater Sample (µg/L)
SE - Pilot Cap Sediment Sample (µg/kg)



Notes:
1. Post-cap bathymetric contours produced from survey provided by Blue Water Engineering dated August 2006.
2. Upland topography directed by Anchor Environmental as part of upland investigation (2002).
3. Horizontal Datum: Oregon State Plane North NAD 83 International feet).
4. Vertical Datum: NAVD88 (ft).
5. PCM-07 and PCM-21 were not sampled during this monitoring event.

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ANCHOR QEA

Figure 2.9.7-5
Gasco Pilot Cap Monitoring Transition Zone Water Concentrations
Year 0 Event 2
NW Natural "Gasco" Site
Gasco Sediment Cleanup Action

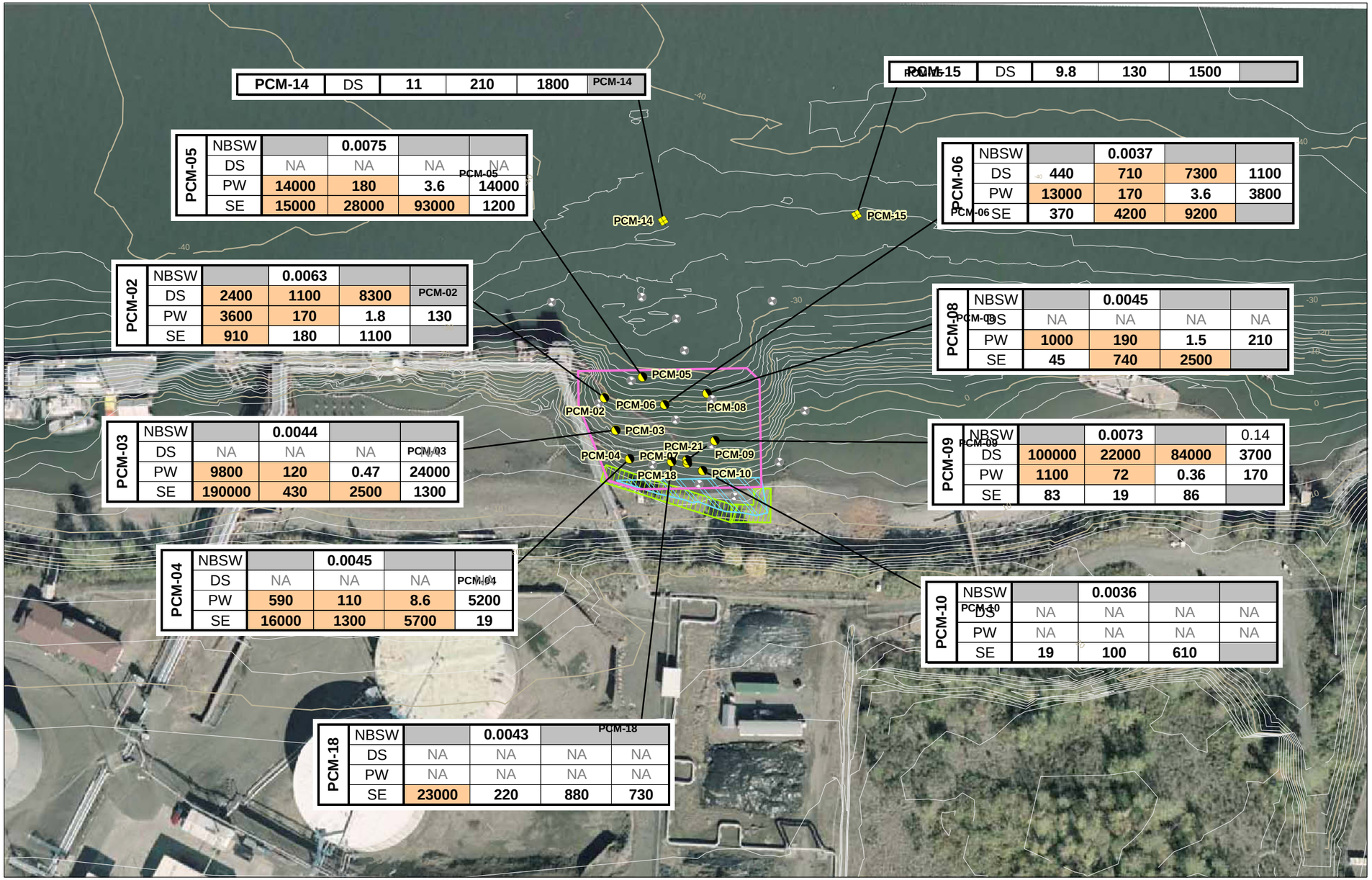
Legend

- Pilot Cap Monitoring Stations
- Fringe Cover Stations
- Post-Dredge Surface Sediment Samples
- Extent of 18-inch Thick Cap
- Reactive Organo-Clay Mat (RCM) Location
- Lateral Extents of Surf Zone Armoring

Location ID	Matrix	Naphthalene	Acenaphthene	Fluoranthene	Benzene
PCM-08	NBSW		0.0034	0.0058	
	DS	NA	NA	NA	NA
	PW	7100	410	1.7	230
	SE	3400	2100	6000	

- Non-Detect
- NA — Not Applicable
- Detection less than screening level, if available
- Detection greater than screening level, if available

NBSW - Discrete Near-Bottom Surface Water Sample (µg/L)
DS - Depositional Surface Sediment Sample (µg/kg)
PW - Pilot Cap Porewater Sample (µg/L)
SE - Pilot Cap Sediment Sample (µg/kg)



Location ID	Matrix	Naphthalene	Acenaphthene	Fluoranthene	Benzene
PCM-14	DS	11	210	1800	
PCM-15	DS	9.8	130	1500	
PCM-05	NBSW		0.0075		
	DS	NA	NA	NA	NA
	PW	14000	180	3.6	14000
	SE	15000	28000	93000	1200
PCM-06	NBSW		0.0037		
	DS	440	710	7300	1100
	PW	13000	170	3.6	3800
	SE	370	4200	9200	
PCM-02	NBSW		0.0063		
	DS	2400	1100	8300	
	PW	3600	170	1.8	130
	SE	910	180	1100	
PCM-08	NBSW		0.0045		
	DS	NA	NA	NA	NA
	PW	1000	190	1.5	210
	SE	45	740	2500	
PCM-03	NBSW		0.0044		
	DS	NA	NA	NA	
	PW	9800	120	0.47	24000
	SE	190000	430	2500	1300
PCM-09	NBSW		0.0073		0.14
	DS	100000	22000	84000	3700
	PW	1100	72	0.36	170
	SE	83	19	86	
PCM-04	NBSW		0.0045		
	DS	NA	NA	NA	
	PW	590	110	8.6	5200
	SE	16000	1300	5700	19
PCM-10	NBSW		0.0036		
	DS	NA	NA	NA	NA
	PW	NA	NA	NA	NA
	SE	19	100	610	
PCM-18	NBSW		0.0043		
	DS	NA	NA	NA	NA
	PW	NA	NA	NA	NA
	SE	23000	220	880	730

Notes:
1. Post-cap bathymetric contours produced from survey provided by Blue Water Engineering dated December 2006.
2. Upland topography directed by Anchor Environmental as part of upland investigation (2002).
3. Horizontal Datum: Oregon State Plane North NAD 83 (International feet).
4. Vertical Datum: NAVD88 (ft).
5. PCM-07 and PCM-21 were not sampled during this monitoring event.

0 100
Scale in Feet

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ANCHOR QEA

Figure 2.9.7-6
Gasco Pilot Cap Monitoring Transition Zone Water Concentrations
Year 0 Event 3
NW Natural "Gasco" Site
Gasco Sediment Cleanup Action

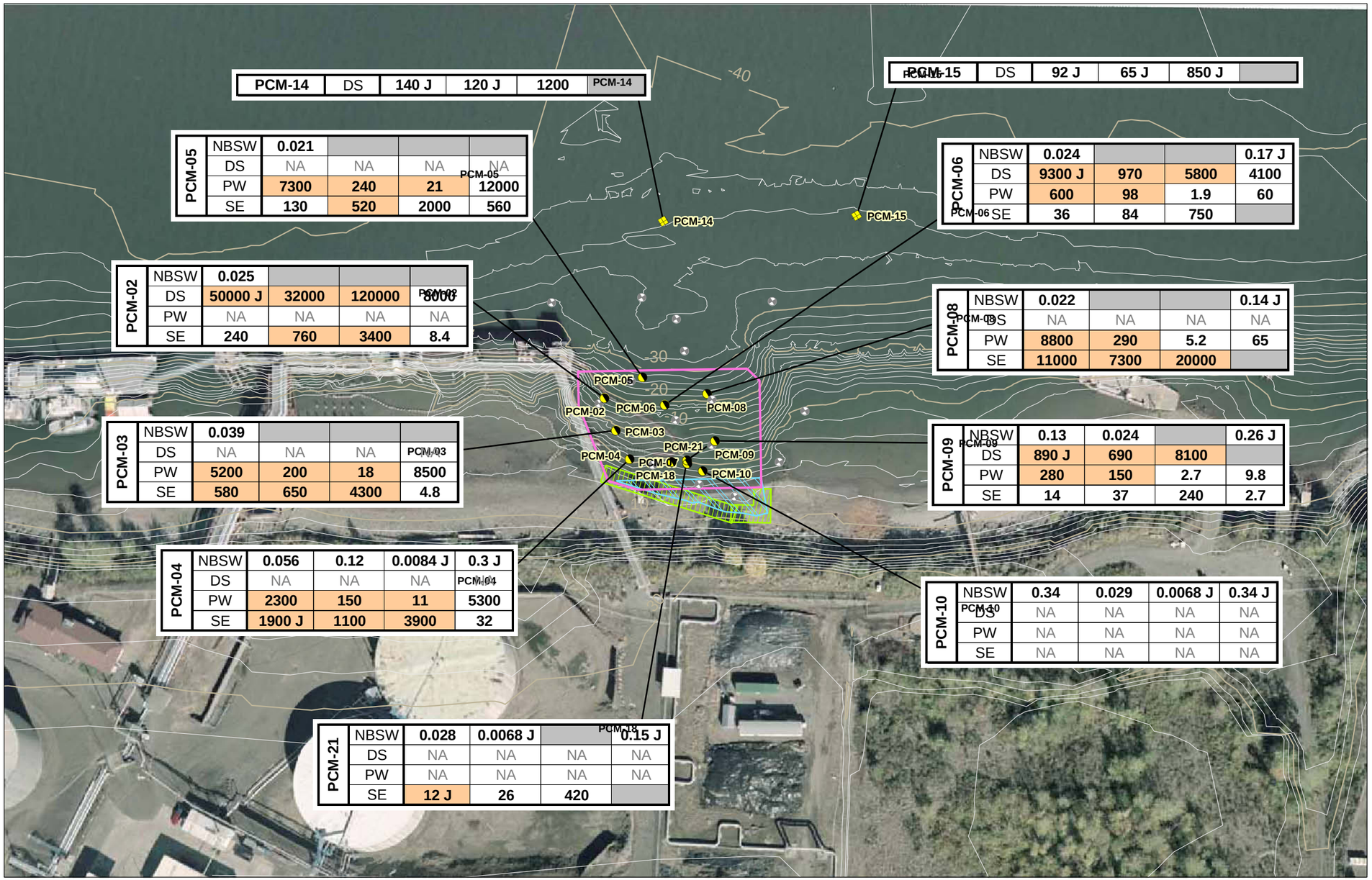
Legend

- Pilot Cap Monitoring Stations
- Fringe Cover Stations
- Post-Dredge Surface Sediment Samples
- Extent of 18-inch Thick Cap
- Reactive Organo-Clay Mat (RCM) Location
- Lateral Extents of Surf Zone Armoring

Location ID	Matrix	Naphthalene	Acenaphthene	Fluoranthene	Benzene
PCM-08	NBSW		0.0034	0.0058	
	DS	NA	NA	NA	NA
	PW	7100	410	1.7	230
	SE	3400	2100	6000	

- Non-Detect
- NA — Not Applicable
- Detection less than screening level, if available
- Detection greater than screening level, if available

NBSW - Discrete Near-Bottom Surface Water Sample (µg/L)
DS - Depositional Surface Sediment Sample (µg/kg)
PW - Pilot Cap Porewater Sample (µg/L)
SE - Pilot Cap Sediment Sample (µg/kg)



Location ID	Matrix	Naphthalene	Acenaphthene	Fluoranthene	Benzene
PCM-14	DS	140 J	120 J	1200	
PCM-15	DS	92 J	65 J	850 J	
PCM-05	NBSW	0.021			
	DS	NA	NA	NA	NA
	PW	7300	240	21	12000
	SE	130	520	2000	560
PCM-06	NBSW	0.024			0.17 J
	DS	9300 J	970	5800	4100
	PW	600	98	1.9	60
	SE	36	84	750	
PCM-02	NBSW	0.025			
	DS	50000 J	32000	120000	8000
	PW	NA	NA	NA	NA
	SE	240	760	3400	8.4
PCM-08	NBSW	0.022			0.14 J
	DS	NA	NA	NA	NA
	PW	8800	290	5.2	65
	SE	11000	7300	20000	
PCM-03	NBSW	0.039			
	DS	NA	NA	NA	
	PW	5200	200	18	8500
	SE	580	650	4300	4.8
PCM-09	NBSW	0.13	0.024		0.26 J
	DS	890 J	690	8100	
	PW	280	150	2.7	9.8
	SE	14	37	240	2.7
PCM-04	NBSW	0.056	0.12	0.0084 J	0.3 J
	DS	NA	NA	NA	
	PW	2300	150	11	5300
	SE	1900 J	1100	3900	32
PCM-10	NBSW	0.34	0.029	0.0068 J	0.34 J
	DS	NA	NA	NA	NA
	PW	NA	NA	NA	NA
	SE	NA	NA	NA	NA
PCM-21	NBSW	0.028	0.0068 J		0.15 J
	DS	NA	NA	NA	NA
	PW	NA	NA	NA	NA
	SE	12 J	26	420	

Notes:
1. Post-cap bathymetric contours produced from survey provided by Blue Water Engineering dated August 2007.
2. Upland topography directed by Anchor Environmental as part of upland investigation (2002).
3. Horizontal Datum: Oregon State Plane North NAD 83 (International feet).
4. Vertical Datum: NAVD88 (ft).
5. PCM-07 and PCM-18 were not sampled during this monitoring event.

0 100
Scale in Feet

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ANCHOR QEA

Figure 2.9.7-7
Gasco Pilot Cap Monitoring Transition Zone Water Concentrations
Year 1 Event 1
NW Natural "Gasco" Site
Gasco Sediment Cleanup Action

Legend

- Pilot Cap Monitoring Stations
- Fringe Cover Stations
- Post-Dredge Surface Sediment Samples
- Extent of 18-inch Thick Cap
- Reactive Organo-Clay Mat (RCM) Location
- Lateral Extents of Surf Zone Armoring

Location ID	Matrix	Naphthalene	Acenaphthene	Fluoranthene	Benzene
PCM-08	NBSW		0.0034	0.0058	
	DS	NA	NA	NA	NA
	PW	7100	410	1.7	230
	SE	3400	2100	6000	

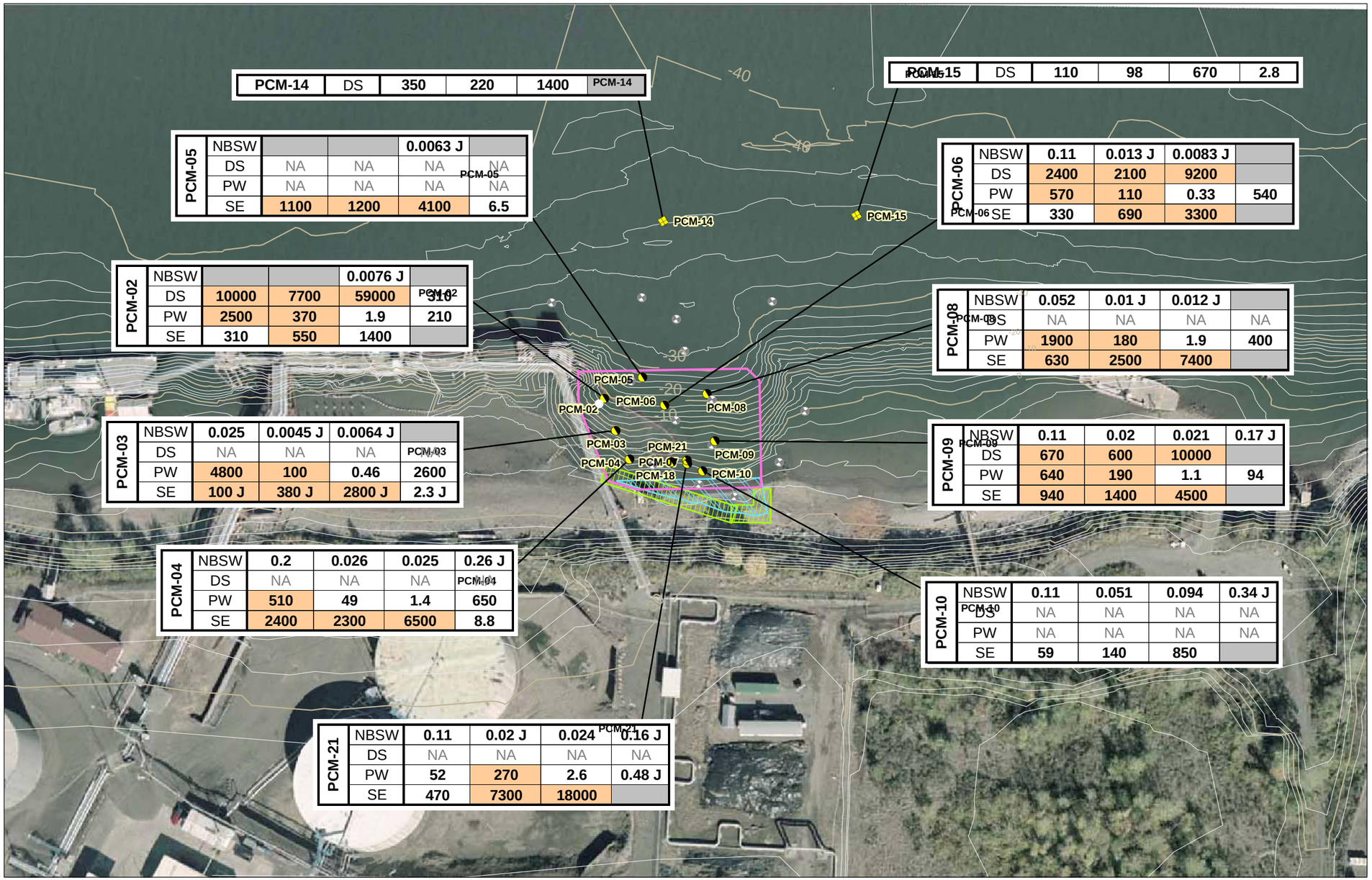
Non-Detect

NA Not Applicable

Detection less than screening level, if available

Detection greater than screening level, if available

NBSW - Discrete Near-Bottom Surface Water Sample (µg/L)
DS - Depositional Surface Sediment Sample (µg/kg)
PW - Pilot Cap Porewater Sample (µg/L)
SE - Pilot Cap Sediment Sample (µg/kg)



Location ID	Matrix	Naphthalene	Acenaphthene	Fluoranthene	Benzene
PCM-14	DS	350	220	1400	
PCM-15	DS	110	98	670	2.8
PCM-05	NBSW			0.0063 J	
	DS	NA	NA	NA	NA
	PW	NA	NA	NA	NA
	SE	1100	1200	4100	6.5
PCM-06	NBSW	0.11	0.013 J	0.0083 J	
	DS	2400	2100	9200	
	PW	570	110	0.33	540
	SE	330	690	3300	
PCM-02	NBSW			0.0076 J	
	DS	10000	7700	59000	310
	PW	2500	370	1.9	210
	SE	310	550	1400	
PCM-08	NBSW	0.052	0.01 J	0.012 J	
	DS	NA	NA	NA	NA
	PW	1900	180	1.9	400
	SE	630	2500	7400	
PCM-03	NBSW	0.025	0.0045 J	0.0064 J	
	DS	NA	NA	NA	NA
	PW	4800	100	0.46	2600
	SE	100 J	380 J	2800 J	2.3 J
PCM-09	NBSW	0.11	0.02	0.021	0.17 J
	DS	670	600	10000	
	PW	640	190	1.1	94
	SE	940	1400	4500	
PCM-04	NBSW	0.2	0.026	0.025	0.26 J
	DS	NA	NA	NA	NA
	PW	510	49	1.4	650
	SE	2400	2300	6500	8.8
PCM-10	NBSW	0.11	0.051	0.094	0.34 J
	DS	NA	NA	NA	NA
	PW	NA	NA	NA	NA
	SE	59	140	850	
PCM-21	NBSW	0.11	0.02 J	0.024	0.16 J
	DS	NA	NA	NA	NA
	PW	52	270	2.6	0.48 J
	SE	470	7300	18000	

Notes:
1. Post-cap bathymetric contours produced from survey provided by Blue Water Engineering dated October 2007.
2. Upland topography directed by Anchor Environmental as part of upland investigation (2002).
3. Horizontal Datum: Oregon State Plane North NAD 83 (feet).
4. Vertical Datum: NAVD88 (ft).
5. PCM-07 and PCM-18 were not sampled during this monitoring event.

0 100
Scale in Feet

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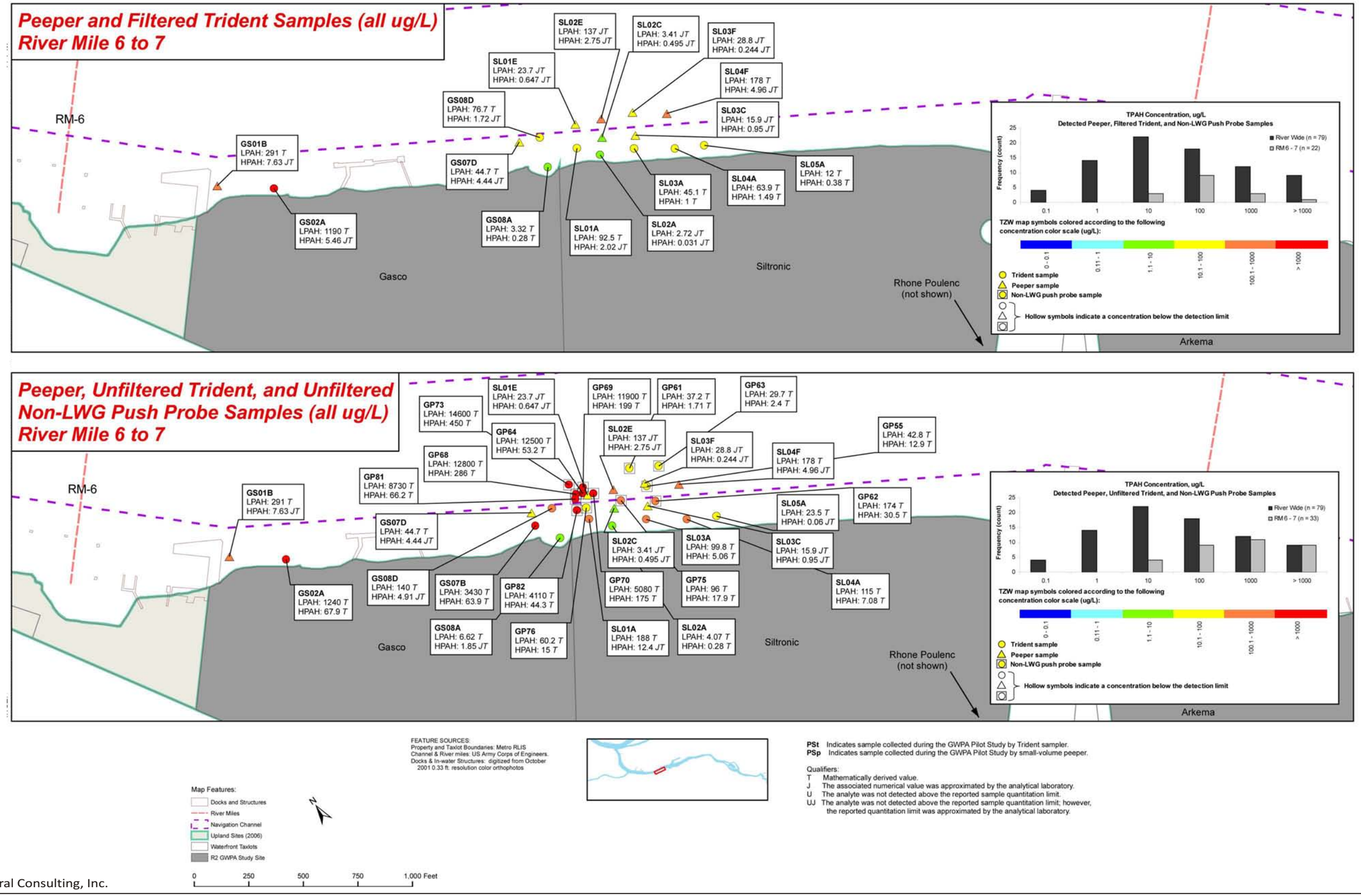
ANCHOR QEA

Figure 2.9.7-8
Gasco Pilot Cap Monitoring Transition Zone Water Concentrations
Year 1 Event 2
NW Natural "Gasco" Site
Gasco Sediment Cleanup Action

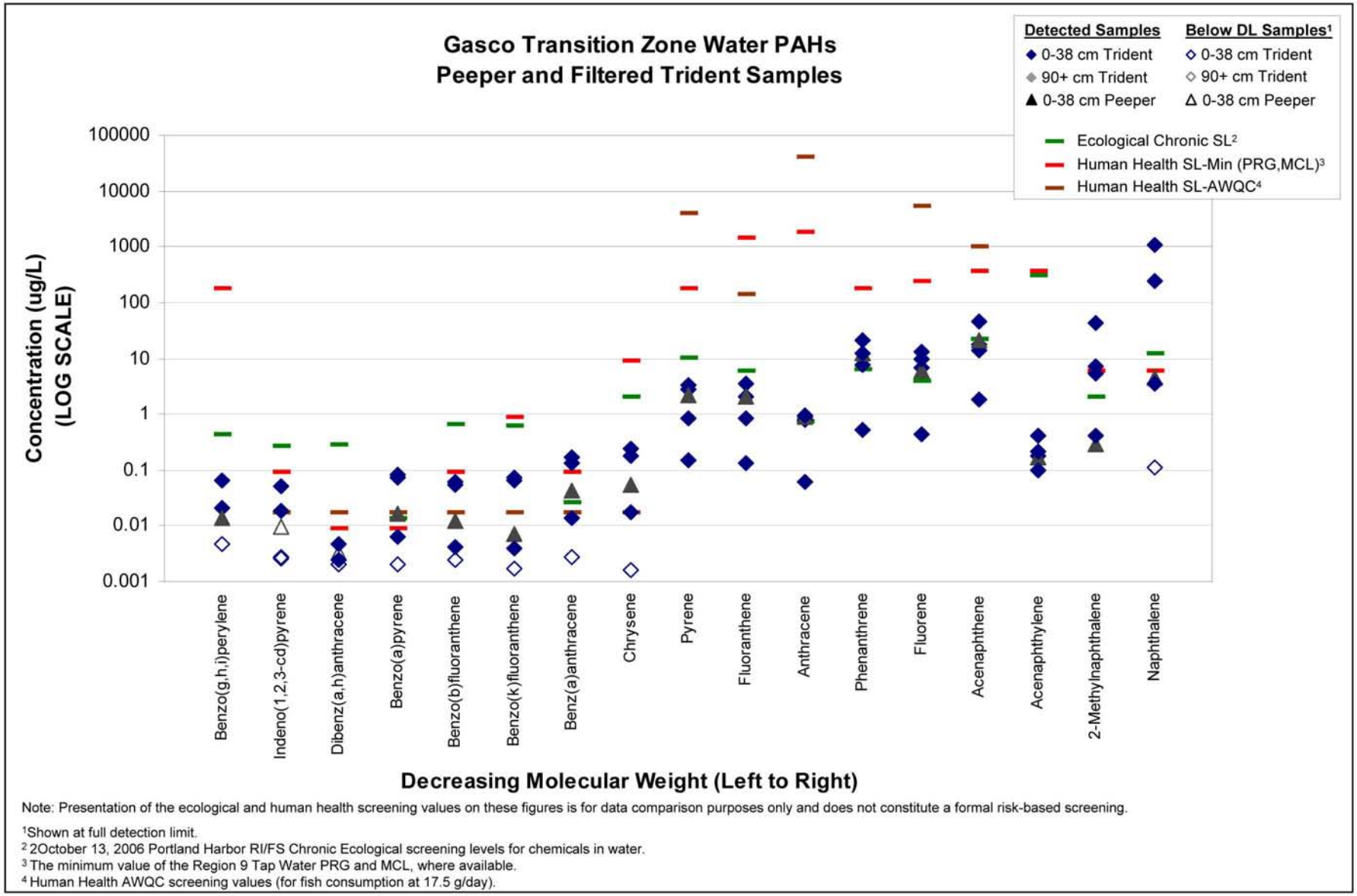


SOURCE: Integral Consulting, Inc.

12/29/2009 cvd K:\Jobs\000029-GASCO\00002902\CorelDRAW figs\SCA\2.9.7-9.cdr

Figure 2.9.7-9
LWG Concentrations of LPAHs and HPAHs in Transition Zone Water
NW Natural "Gasco" Site
Gasco Sediment Cleanup Action

ANCHOR QEA



Note: Presentation of the ecological and human health screening values on these figures is for data comparison purposes only and does not constitute a formal risk-based screening.

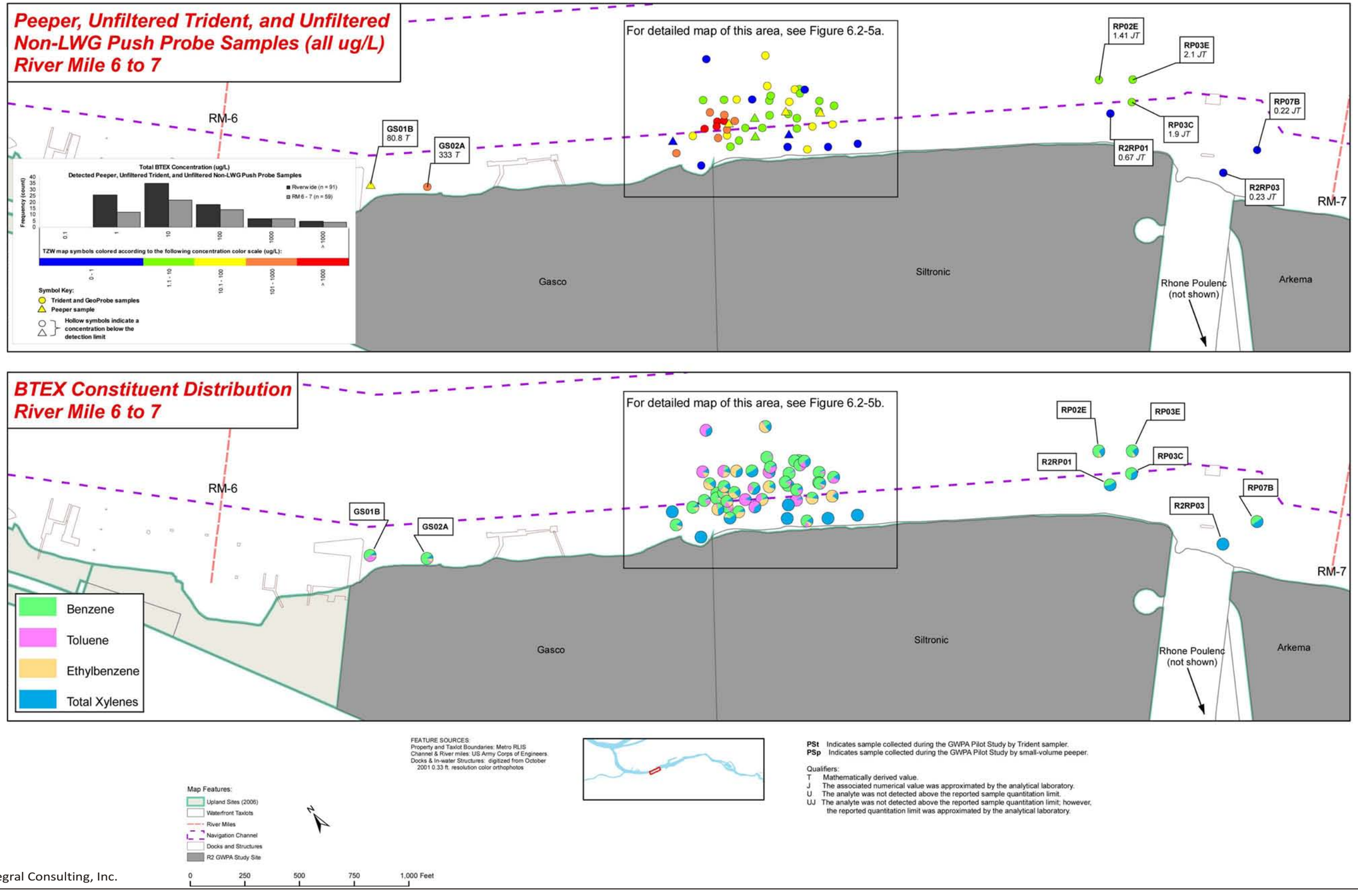
[1]Shown at full detection limit.
[2] 2October 13, 2006 Portland Harbor RI/FS Chronic Ecological screening levels for chemicals in water.
[3] The minimum value of the Region 9 Tap Water PRG and MCL, where available.
[4] Human Health AWQC screening values (for fish consumption at 17.5 g/day).

SOURCE: Integral Consulting, Inc.

12/29/2009 djh K:\Jobs\000029-GASCO\0000902\CorelDRAW figs\SCA\2.9.7-10.cdr

ANCHOR QEA

Figure 2.9.7-10
LWG Gasco Transition Zone Water PAH Concentrations
NW Natural "Gasco" Site
Gasco Sediment Cleanup Action

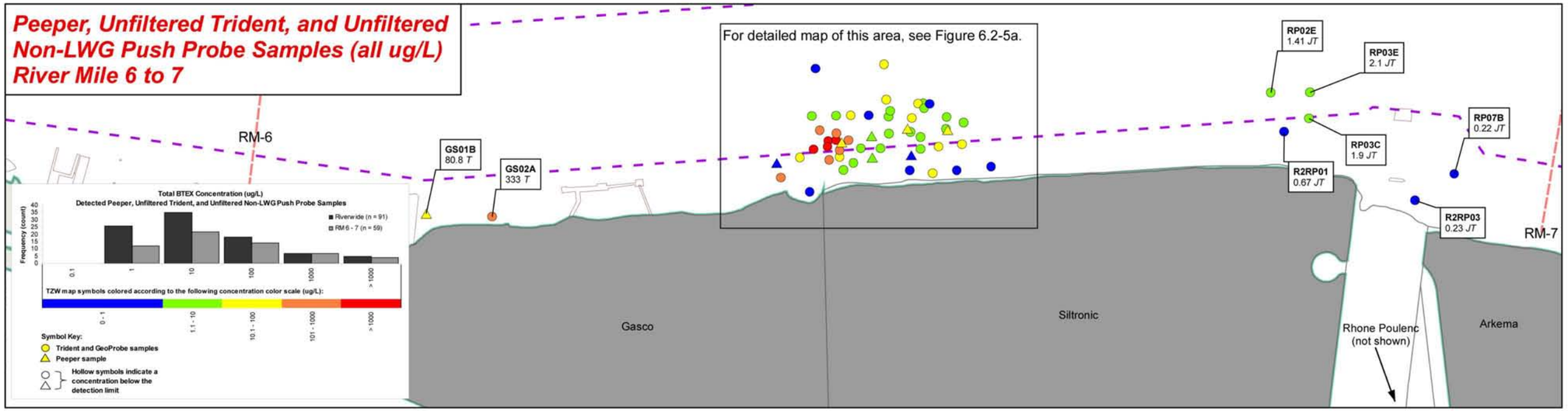


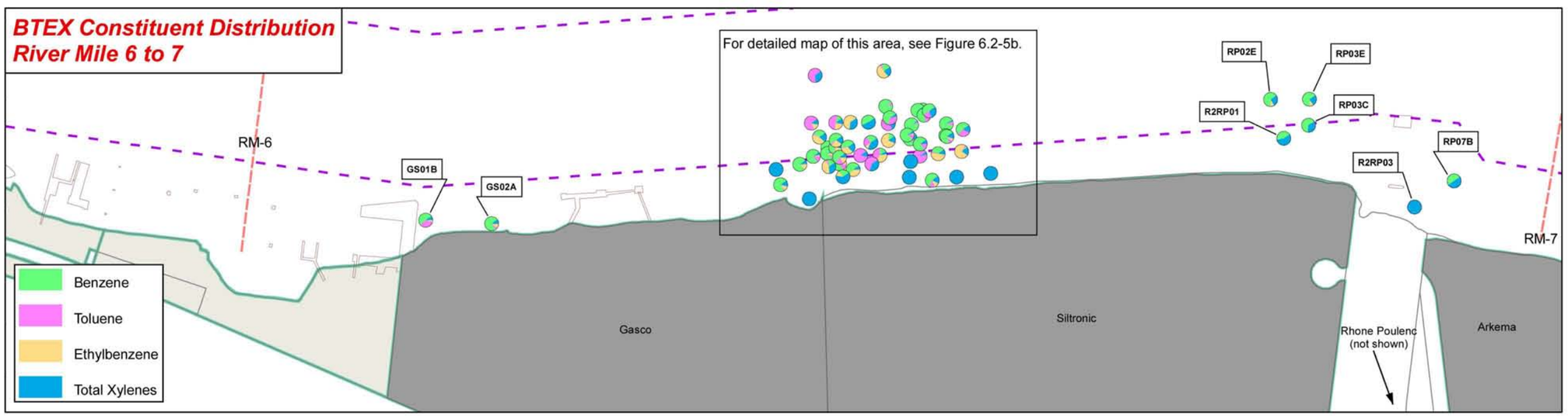
SOURCE: Integral Consulting, Inc.

12/29/2009 cvd K:\Jobs\000029-GASCO\00002902\CorelDRAW figs\SCA\2.9.7-11.cdr

Figure 2.9.7-11
LWG Concentrations of Total BTEX in Transition Zone Water
NW Natural "Gasco" Site
Gasco Sediment Cleanup Action

ANCHOR QEA





FEATURE SOURCES:
Property and Taxlot Boundaries: Metro RLIS
Channel & River miles: US Army Corps of Engineers.
Docks & In-water Structures: digitized from October 2001 0.33 ft. resolution color orthophotos

Map Features:
Upland Sites (2006)
Waterfront Taxlots
River Miles
Navigation Channel
Docks and Structures
R2 GWPA Study Site

0 250 500 750 1,000 Feet

PSt Indicates sample collected during the GWPA Pilot Study by Trident sampler.
PSp Indicates sample collected during the GWPA Pilot Study by small-volume peeper.

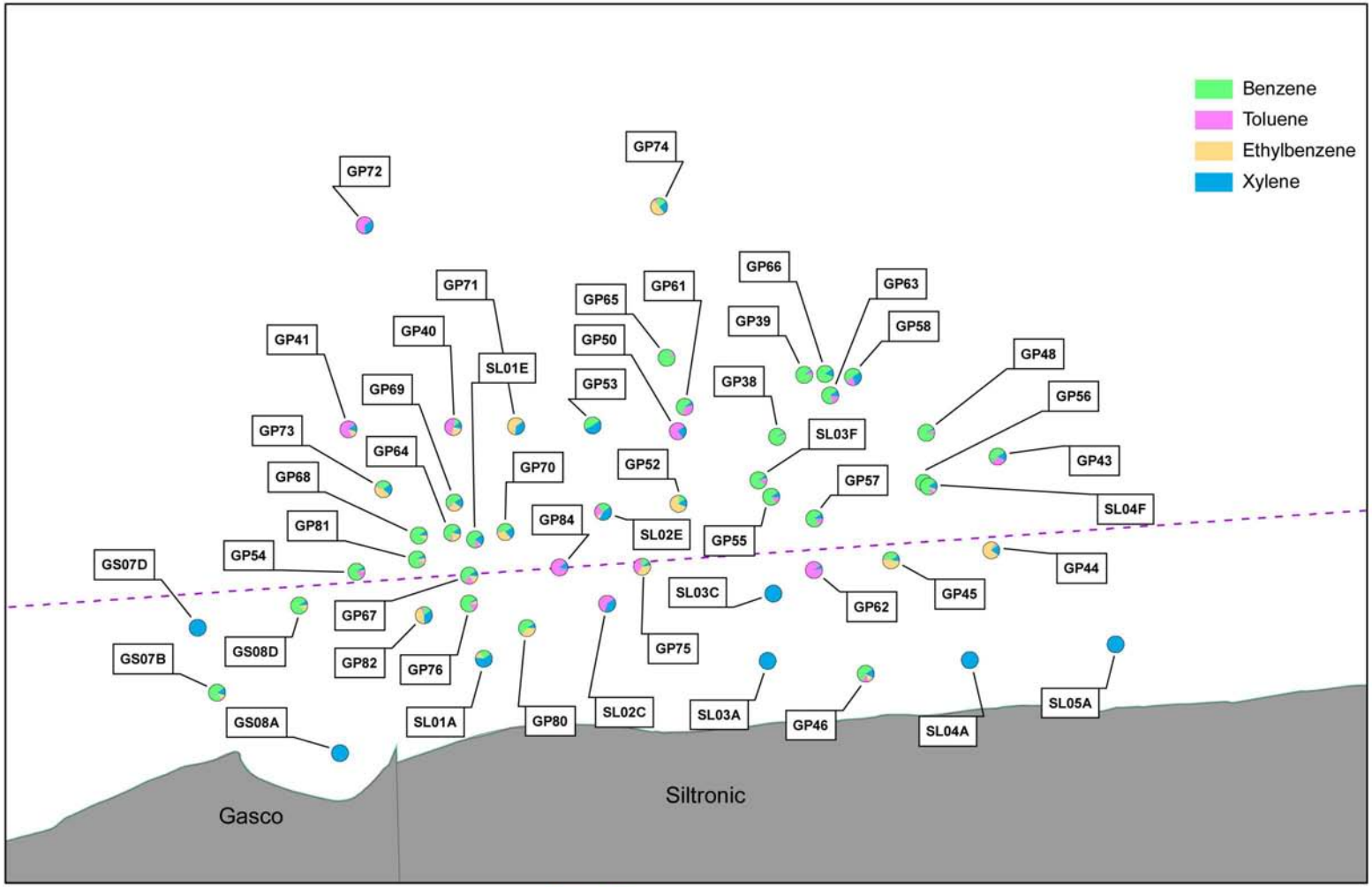
Qualifiers:
T Mathematically derived value.
J The associated numerical value was approximated by the analytical laboratory.
U The analyte was not detected above the reported sample quantitation limit.
UJ The analyte was not detected above the reported sample quantitation limit; however, the reported quantitation limit was approximated by the analytical laboratory.

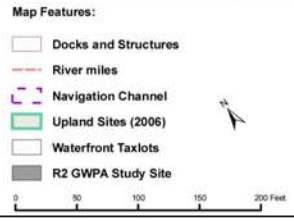
SOURCE: Integral Consulting, Inc.

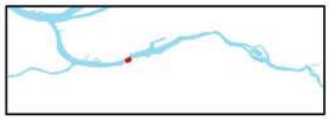
12/29/2009 cvd K:\Jobs\000029-GASCO\0000902\CorelDRAW figs\SCA\2.9.7-12.cdr

Figure 2.9.7-12
LWG Concentrations of Total BTEX in Transition Zone Water - Concentration Detail
NW Natural "Gasco" Site
Gasco Sediment Cleanup Action

ANCHOR QEA







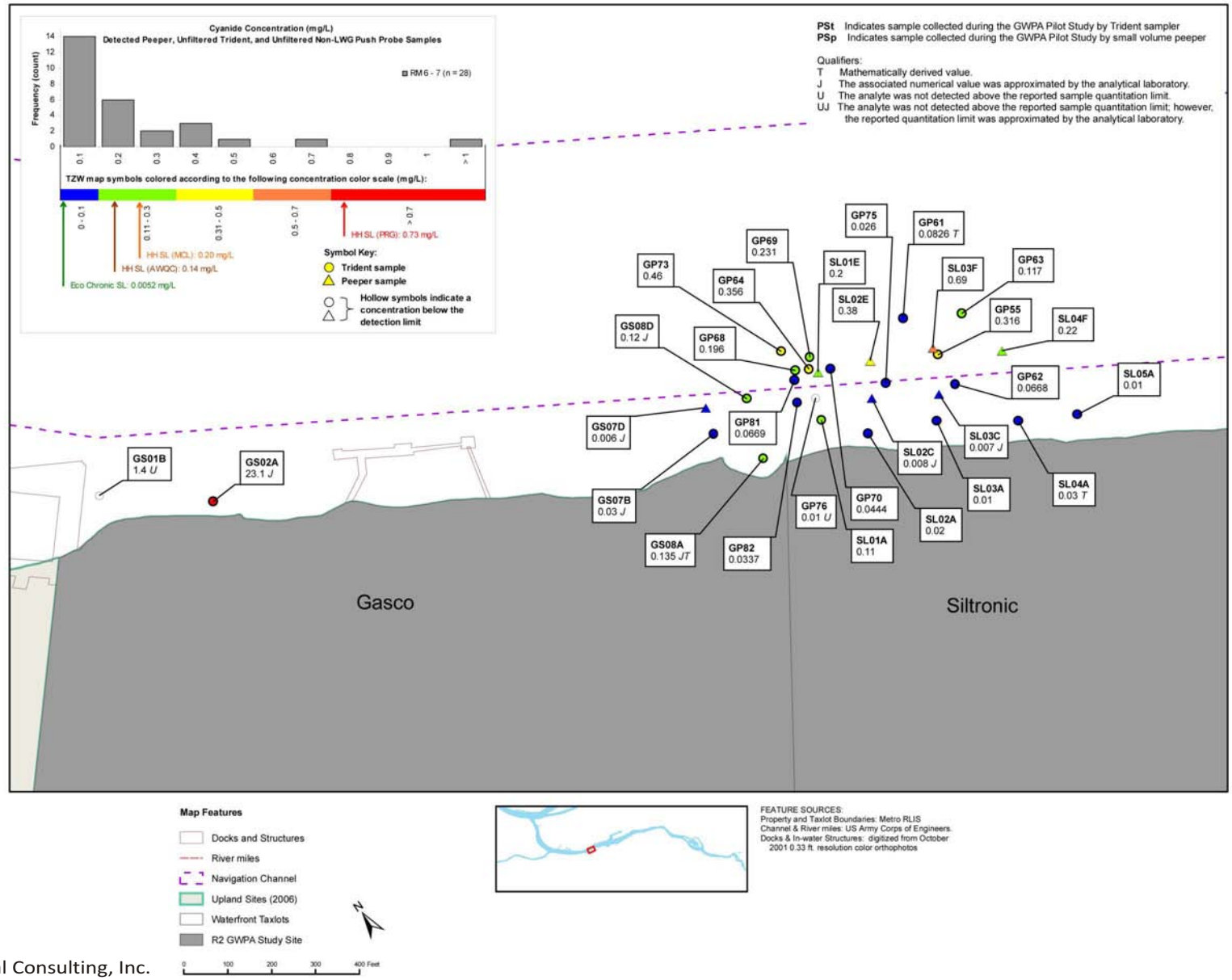
FEATURE SOURCES:
Property and Taxlot Boundaries: Metro RLIS
Channel & River miles: US Army Corps of Engineers.
Docks & In-water Structures: digitized from October 2001 0.33 ft. resolution color orthophotos

SOURCE: Integral Consulting, Inc.

12/29/2009 cvd K:\Jobs\000029-GASCO\00002902\CorelDRAW figs\SCA\2.9.7-13.cdr

ANCHOR QEA

Figure 2.9.7-13
LWG Concentrations of Total BTEX in Transition Zone Water - Pie Chart Detail
NW Natural "Gasco" Site
Gasco Sediment Cleanup Action

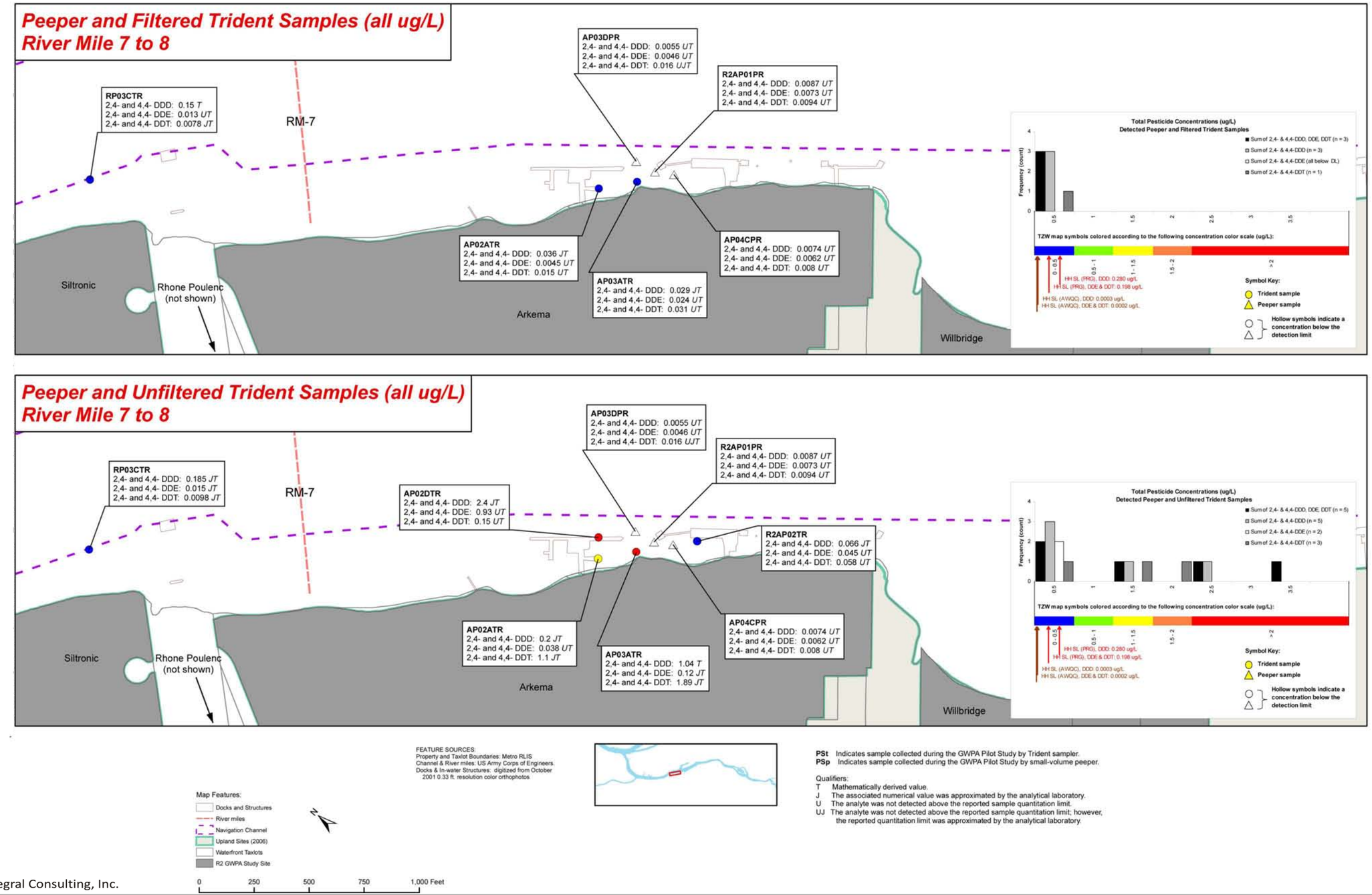


SOURCE: Integral Consulting, Inc.

12/29/2009 cvd K:\Jobs\000029-GASCO\00002902\CorelDRAW figs\SCA\2.9.7-14.cdr

ANCHOR QEA

Figure 2.9.7-14
LWG Concentrations of Cyanide in Transition Zone Water
NW Natural "Gasco" Site
Gasco Sediment Cleanup Action

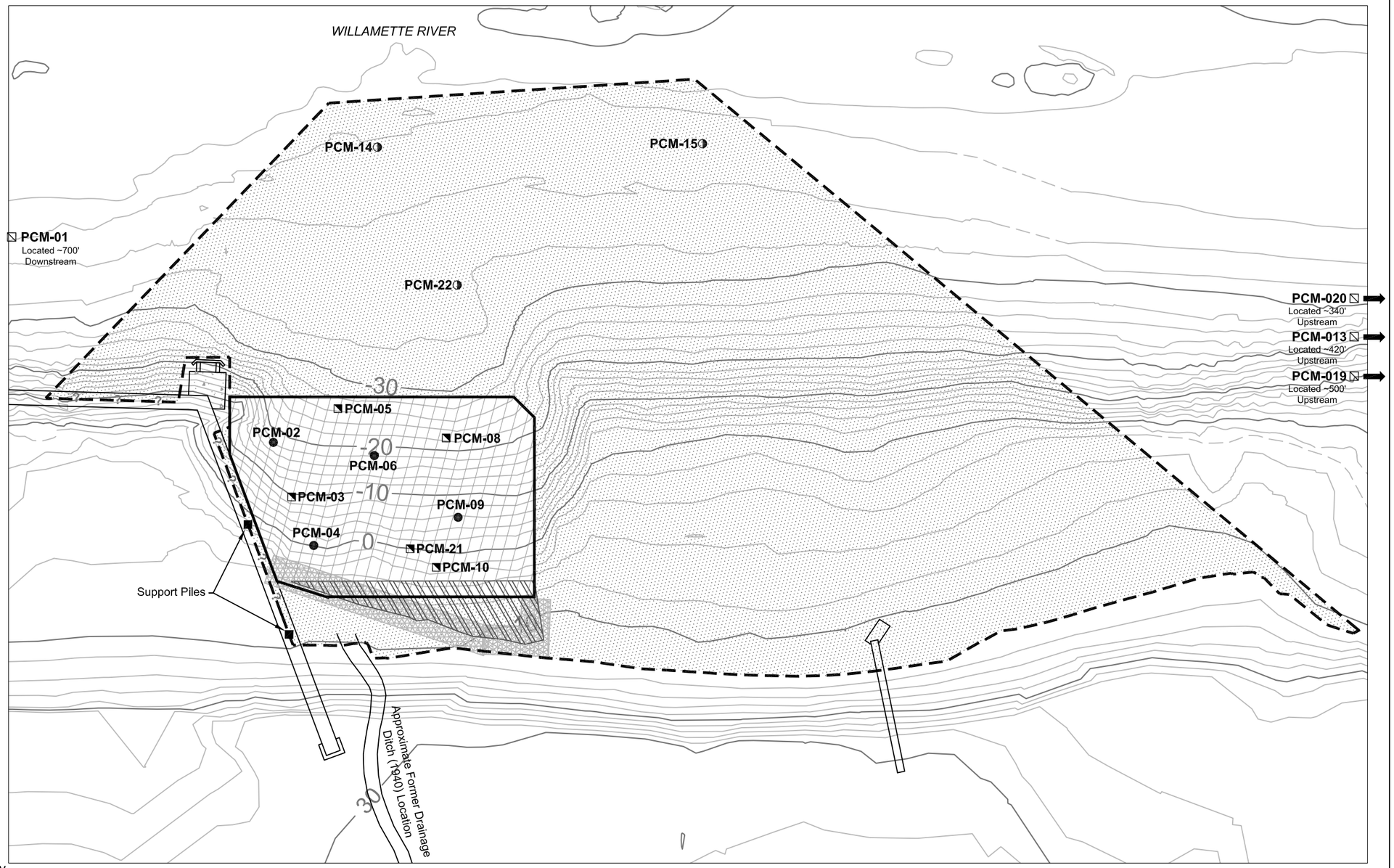


SOURCE: Integral Consulting, Inc.

12/29/2009 cvd K:\Jobs\000029-GASCO\0000902\CorelDRAW figs\SCA\2.9.7-15.cdr

Figure 2.9.7-15
LWG Concentrations of Pesticides in Transition Zone Water
NW Natural "Gasco" Site
Gasco Sediment Cleanup Action

ANCHOR QEA



Legend:

- Support Pile Location
- Extent and Elevation of 18 in Thick Cap
- Extent and Elevation of 6 in Thick Cover
- Reactive Organo-Clay Mat (RCM) Location
- Lateral Extents of Surf Zone Armoring d50 = 3 inches
- PCM-01 Background Near-Bottom Surface Water Sample
- PCM-14 Fringe Cover Depositional Surface Sediment Sample
- PCM-03 Near-Bottom Surface Water Sample
- PCM-02 Co-Located Depositional Surface Sediment & Near-Bottom Surface Water Sample
- Topographic and Bathymetric Contours (2 ft. Interval)

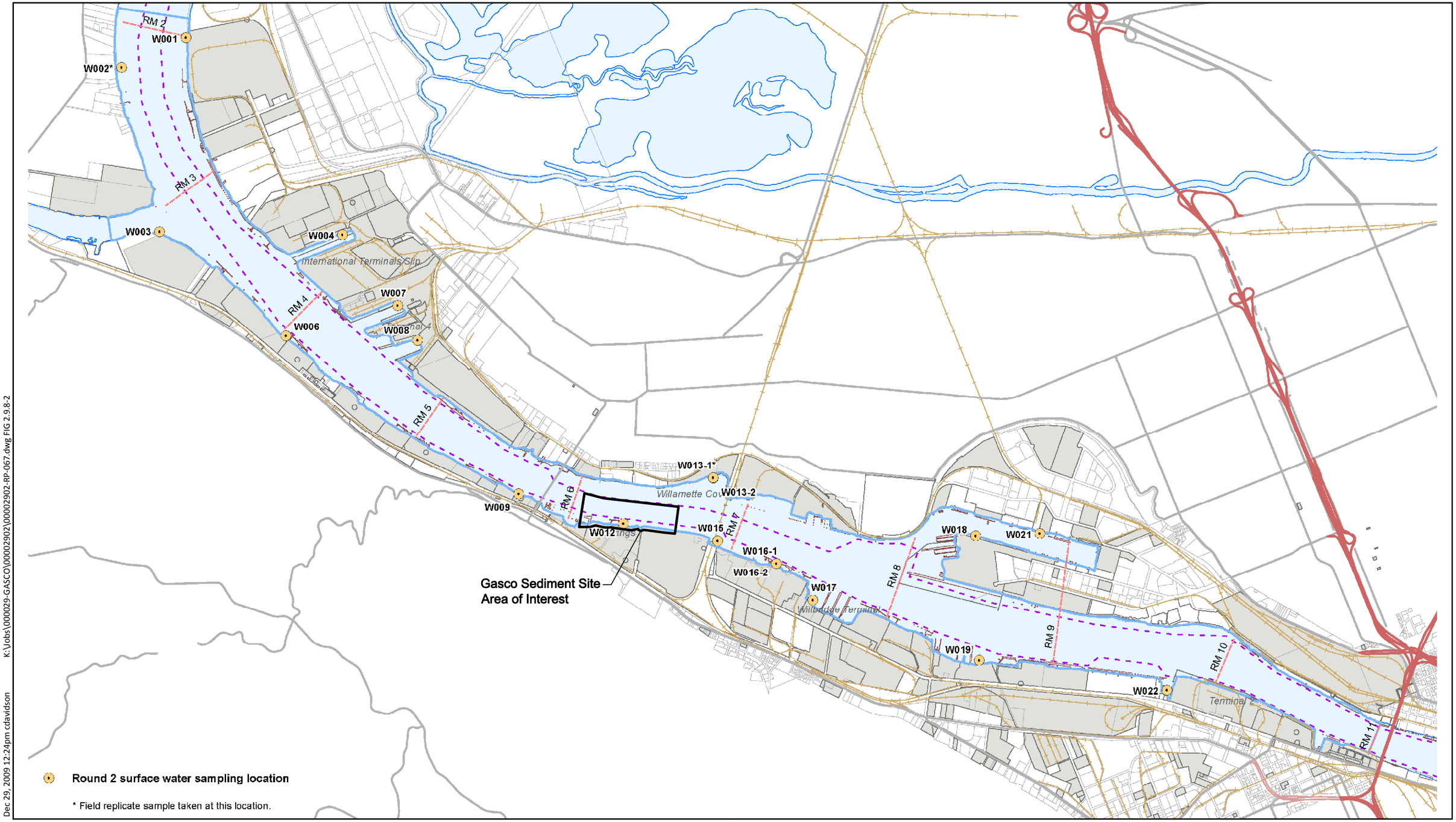
0 60
Scale in Feet

Notes:
1. Post-cap bathymetric contours produced from survey provided by Blue Water Engineering dated January 2009.
2. Horizontal Datum: Oregon State Plane North NAD 83 (International Feet).
3. Vertical Datum: NAVD 88 (ft).
4. Former Drainage Ditch location from Phase 1 Remedial Investigation Summary Report (HAI 1998).

Dec 29, 2009 12:21pm cdavidson K:\Jobs\000029-GASCO\00002902\00002902-RP-023.dwg FIG 2.9.8-1

ANCHOR QEA

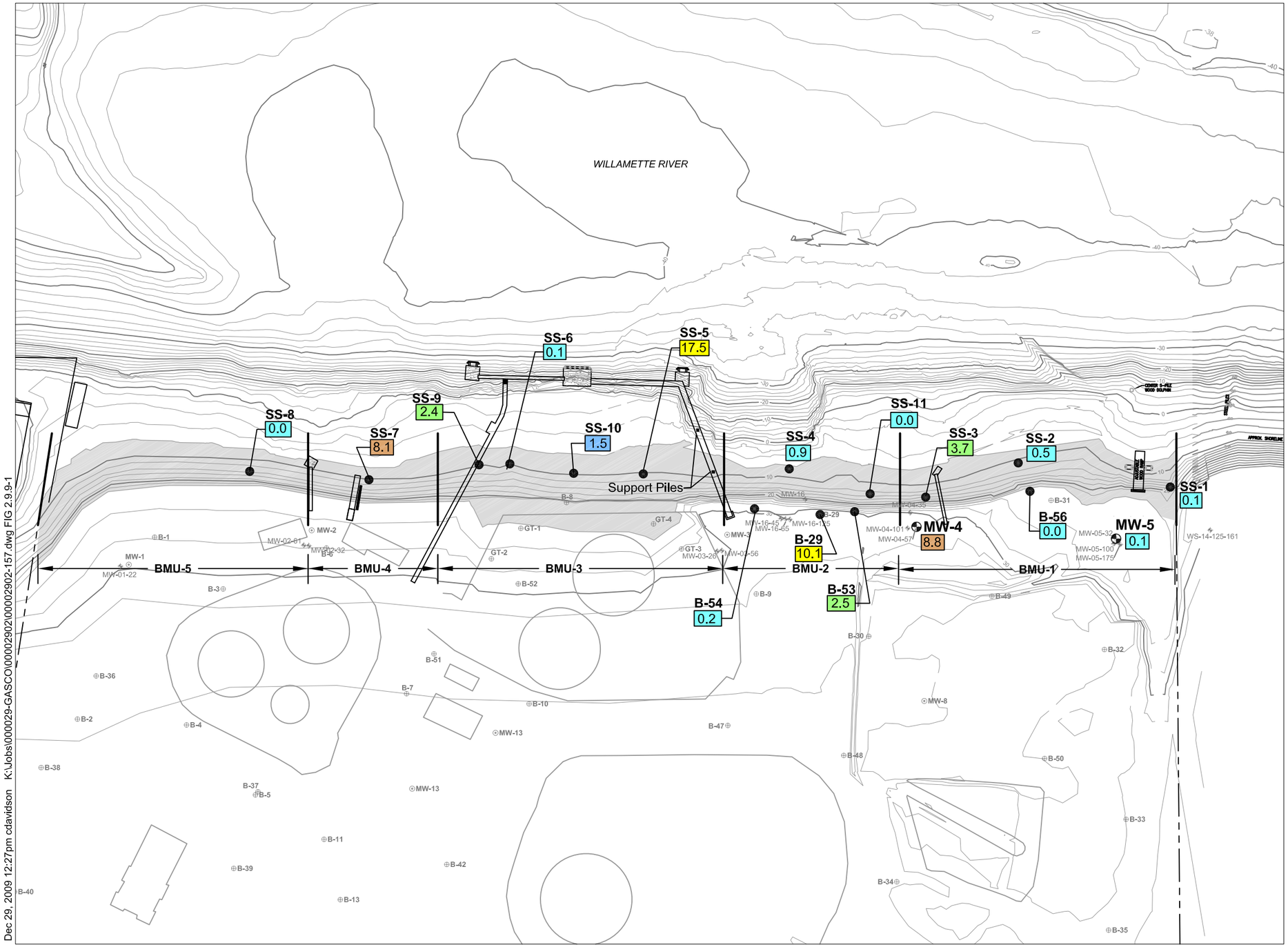
Figure 2.9.8-1
Gasco Pilot Cap Long Term Monitoring - Near-Bottom Surface Water Sampling Locations
NW Natural "Gasco" Site
Gasco Sediment Cleanup Action



Dec 29, 2009 12:24pm cdavidson K:\Jobs\000029-GASCO\00002902\00002902-RP-067.dwg FIG 2.9.8-2

ANCHOR QEA

Figure 2.9.8-2
LWG Near-Bottom Surface Water Sampling Locations
NW Natural "Gasco" Site
Gasco Sediment Cleanup Action



Legend

- Proposed Bank Stabilization Area between Approximately +8 to 24 Feet Elevation
- SS-1 Surface Soil Sample Location and Number
- 0.1 Maximum Screening Quotient for Soil Sample
- Intermediate Monitoring Well (50 - 66 Feet bgs)
- 2004 Boring
- Monitoring Well
- Topographic and Bathymetric Contours (2' Interval)

Maximum Screening Quotient

- <1
- 1 - 2
- 2 - 5
- 5 - 10
- >10

0 150
Scale in Feet

Notes:

1. Bathymetric contours updated with survey provided by Blue Water Engineering dated March 17, 2005.

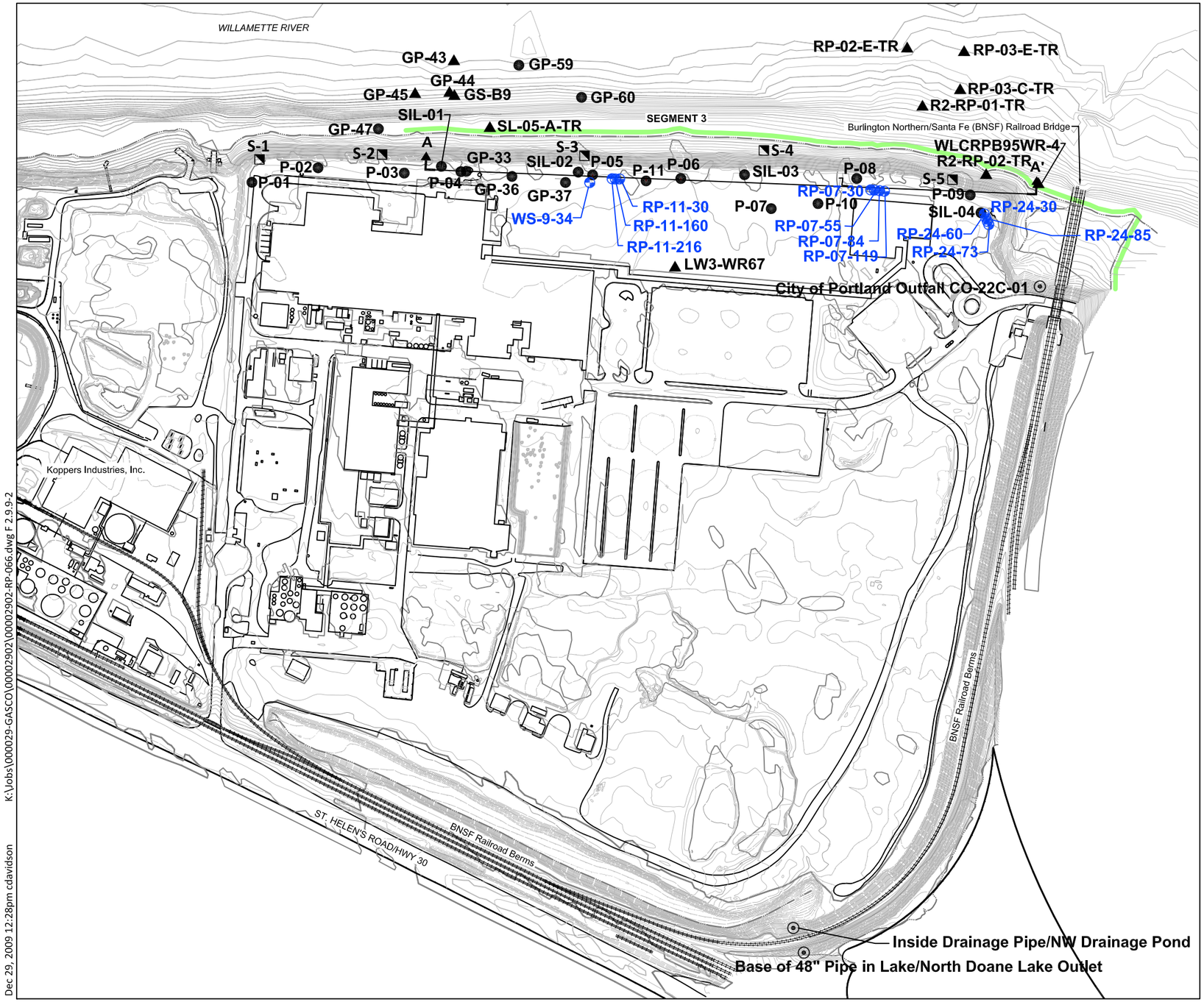
2. Horizontal Datum: NAVD-88.

3. Screening Quotient values based on the MacDonald PEC criteria for TPAH.

Dec 29, 2009 12:27pm cdavidson K:\Jobs\000029-GASCO\00002902\00002902-157.dwg FIG 2.9.9-1

ANCHOR QEA

Figure 2.9.9-1
Gasco Shoreline Bank and Near Shore Upland Surface - Soil Sample Locations
NW Natural "Gasco" Site
Gasco Sediment Cleanup Action



K:\Jobs\000029-GASCO\00002902\00002902-RP-066.dwg F 2.9.9-2

Dec 29, 2009 12:28pm cdavidson

LEGEND:

- Cross Section Location and Designation
- Soil Boring Location
- Sediment Sample Location
- Monitoring Well Location
- Surface Water Sample Location
- Surface Soil Sample Locations
- Segment 3

0 300
Scale in Feet

NOTE: Surface soil sampling locations not geo-referenced. Locations should be considered approximate.

SOURCE: Base map provided by Spencer B. Gross, Inc. dated 12/22/2006.

Horizontal Datum: Oregon State Plane North NAD 83 (International Feet).

Vertical Datum: City of Portland.

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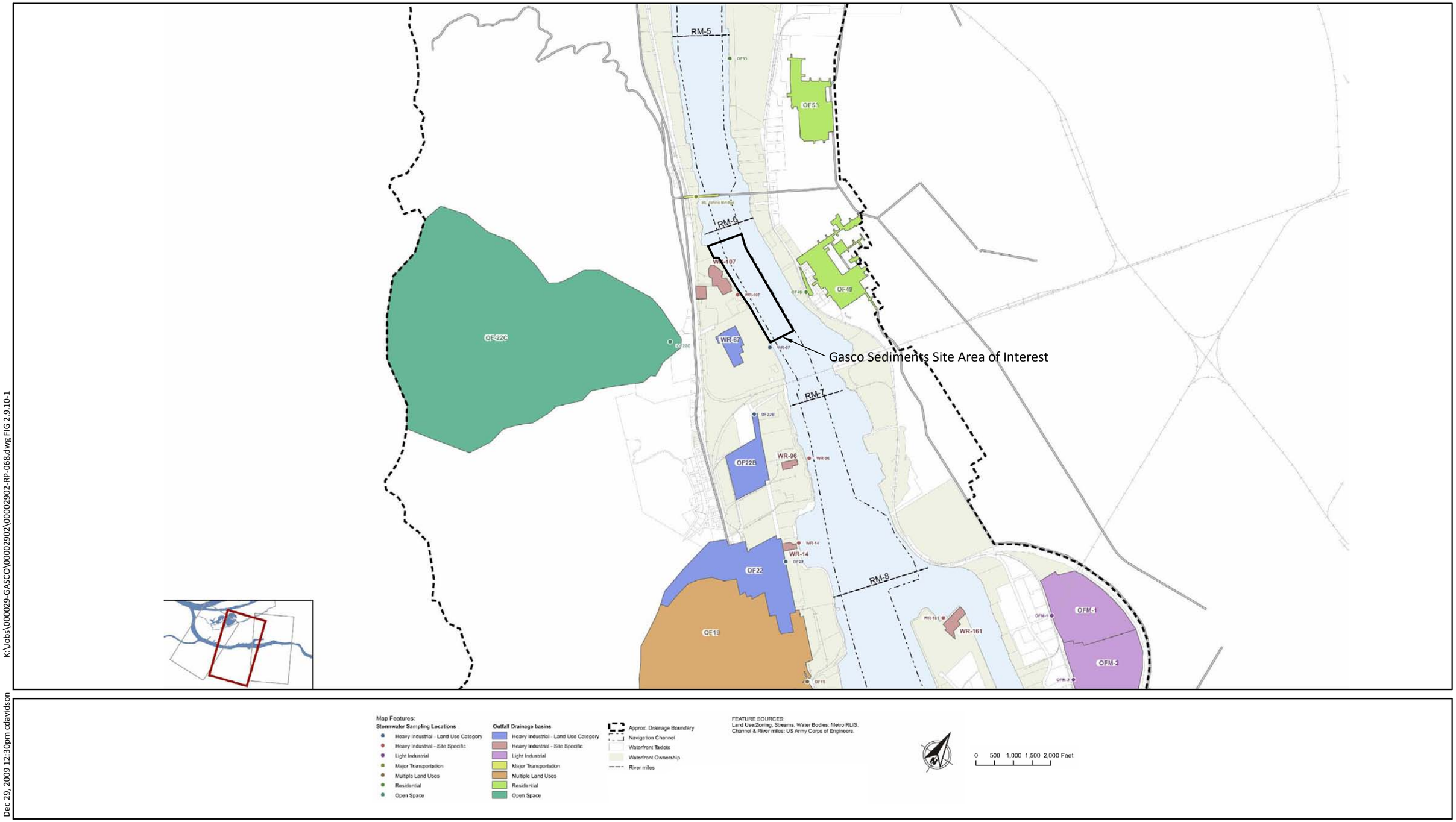
Figure 2.9.9-2

Siltronic Shoreline Bank and Near Shore Upland Surface soil Sample Locations

NW Natural "Gasco" Site

Gasco Sediment Cleanup Action



K:\Jobs\000029-GASCO\00002902\00002902-RP-068.dwg FIG 2.9.10-1

Dec 29, 2009 12:30pm cdavidson

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Figure 2.9.10-1
LWG Round 3A Stormwater Sampling Locations
NW Natural "Gasco" Site
Gasco Sediment Cleanup Action

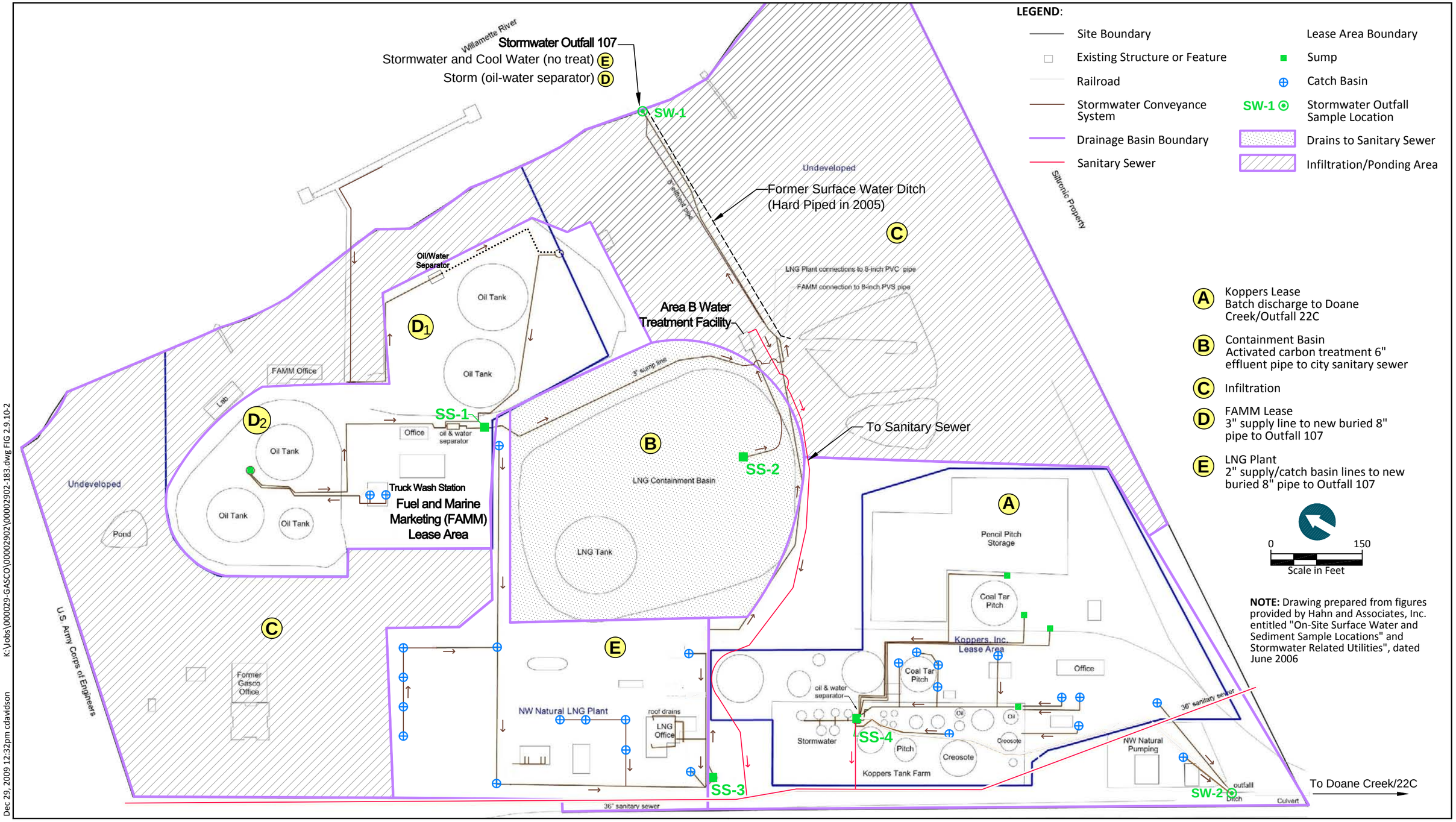

Figure 2.9.10-2
Stormwater Conveyance Schematic and Proposed Stormwater Sample Locations
NW Natural "Gasco" Site
Gasco Sediment Cleanup Action

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LEGEND:

Surface Water Sample Location

City of Portland Outfall 22C — Station ID

Benzene	2	HH

- HH — Human Health Criteria
- ECO — Ecological Base Exceedance Type Criteria
- 2 — Maximum Screening Quotient
- Benzene — Parameter Exceedance

Maximum Screening Quotient

- 1 - 10
- 11 - 100
- 101 - 1,000
- 1,001 - 10,000
- >10,001

SOURCE: Base map provided by Spencer B. Gross, Inc. dated 12/22/2006.
Horizontal Datum: Oregon State Plane North NAD 83 (International Feet).
Vertical Datum: City of Portland.

0 200
Scale in Feet

K:\Jobs\000029-GASCO\00002902\00002902-RP-011.dwg FIG 2.9.10-3
Dec 29, 2009 12:35pm cdavidson

ANCHOR QEA

Figure 2.9.10-3
Surface Water and Stormwater Maximum Screening Quotients - Segment 3
NW Natural "Gasco" Site
Gasco Sediment Cleanup Action

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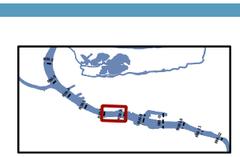
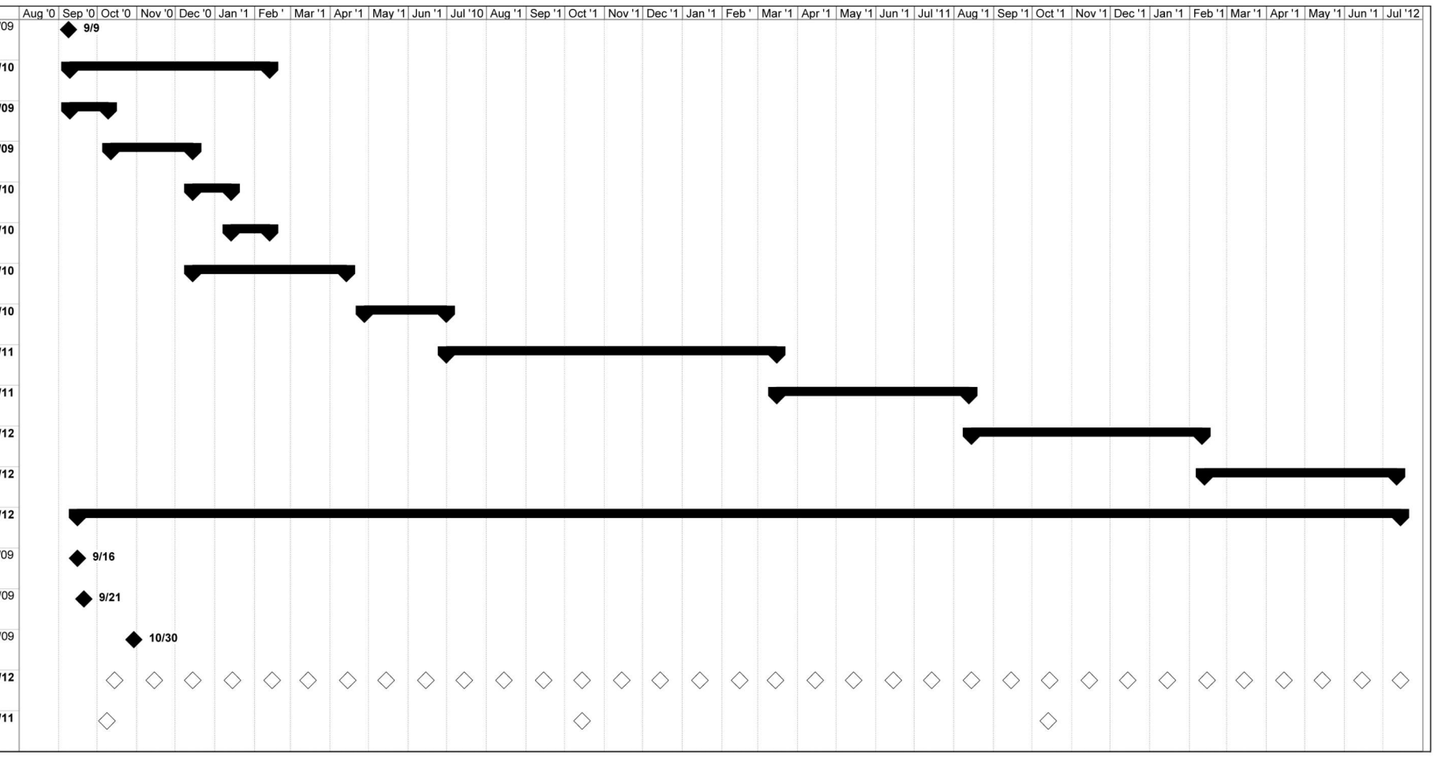


Feet
0 125 250 375 500

Figure 2.9.11-1
Sediment Trap Sampling Locations in the Vicinity of the Project Area
NW Natural "Gasco" Site
Gasco Sediment Cleanup Action

ID	Task Name	Duration	Start	Finish
1	**Administrative Settlement Agreement and Order on Consent Signed**	0 days	Wed 9/9/09	Wed 9/9/09
2	**Draft and Final Work Plan (Calendar Days)**	**156 days?**	**Thu 9/10/09**	**Fri 2/12/10**
3	**Develop Draft Work Plan (Calendar Days)**	**30 days**	**Thu 9/10/09**	**Fri 10/9/09**
11	**EPA Review and Comment on Draft Work Plan (Calendar Days)**	**64 days**	**Mon 10/12/09**	**Mon 12/14/09**
14	**Develop Final Work Plan (Calendar Days)**	**30 days**	**Tue 12/15/09**	**Wed 1/13/10**
22	**EPA Review and Approval of Final Work Plan (Calendar Days)**	**30 days?**	**Thu 1/14/10**	**Fri 2/12/10**
25	**Project AIR and Data Gaps QAPP (Calendar Days)**	**120 days?**	**Tue 12/15/09**	**Tue 4/13/10**
37	**Data Gaps Sampling (Calendar Days)**	**64 days?**	**Wed 4/28/10**	**Wed 6/30/10**
42	**Draft and Final EE/CA and Data Report (Calendar Days)**	**258 days?**	**Thu 7/1/10**	**Tue 3/15/11**
65	**Preliminary Design Report (Calendar Days)**	**150 days?**	**Wed 3/16/11**	**Fri 8/12/11**
77	**Interim Design Report (Calendar Days)**	**180 days?**	**Mon 8/15/11**	**Fri 2/10/12**
89	**Final Design Report (Calendar Days)**	**150 days?**	**Mon 2/13/12**	**Wed 7/11/12**
101	**Coordination**	**738 days**	**Wed 9/16/09**	**Sun 7/15/12**
102	Project Coordinator Designated	0 days	Wed 9/16/09	Wed 9/16/09
103	Notify EPA of Contractor Name and Qualification	0 days	Mon 9/21/09	Mon 9/21/09
104	Obtain Access Agreements from the Oregon Department of State Lands	0 days	Fri 10/30/09	Fri 10/30/09
105	**Submit Progress Reports to EPA**	**717 days**	**Thu 10/15/09**	**Sun 7/15/12**
140	**Annual Coordination Meetings with Tribes**	**525 days**	**Fri 10/9/09**	**Fri 10/14/11**



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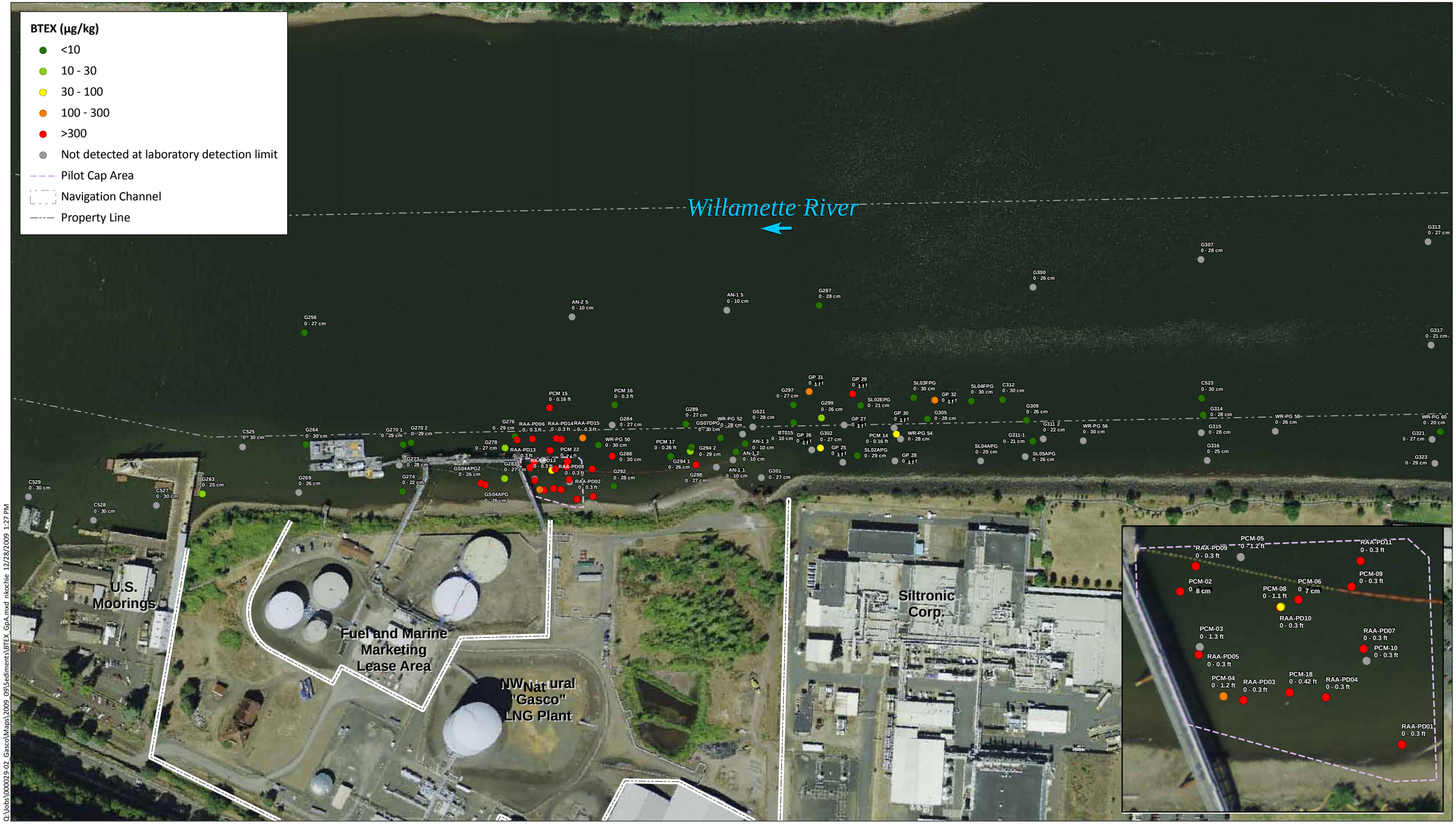
ANCHOR QEA

Figure 5-1
Gasco Sediments Cleanup Action - Detailed Schedule for Completion of Statement of Work
NW Natural "Gasco" Site
Gasco Sediment Cleanup Action

APPENDIX A
SURFACE SEDIMENT QUALITY FIGURES



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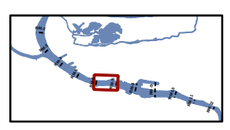
ANCHOR QEA

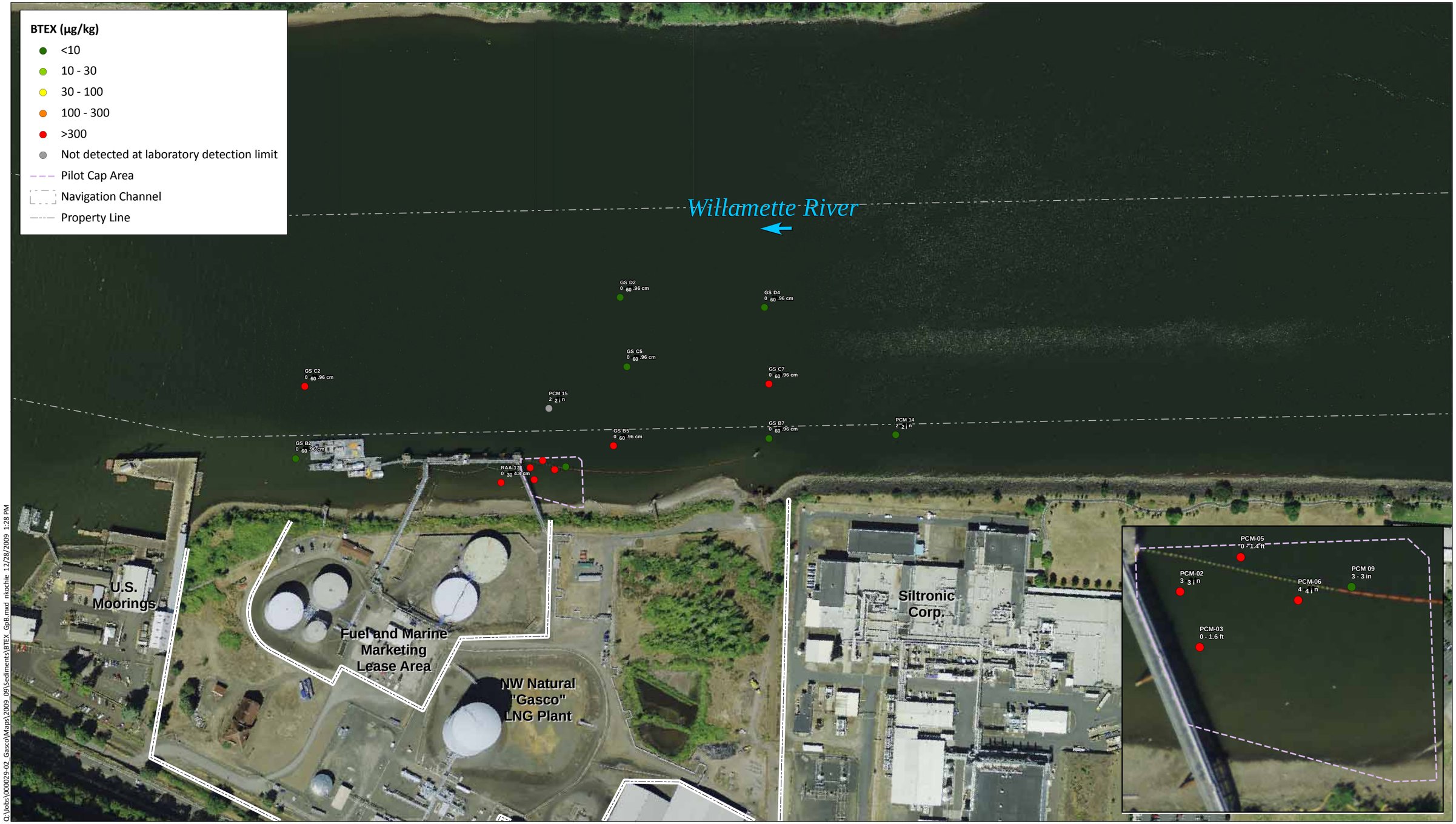


Feet

0 125 250 375 500

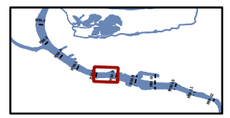
NOTES:
1. Inset shows Pilot Cap Monitoring Area.
2. Consistent with the Portland Harbor Superfund Site process, surface sediment is considered 0-40 cm below mudline.

Figure A1.1
Maximum BTEX Sediment Concentration - 0-40 cm
NW Natural "Gasco" Site
Gasco Sediment Cleanup Action



Q:\Jobs\000029-02_Gasco\Maps\2009_09\Sediments\BTEX_GpB.mxd nkochie 12/28/2009 1:28 PM

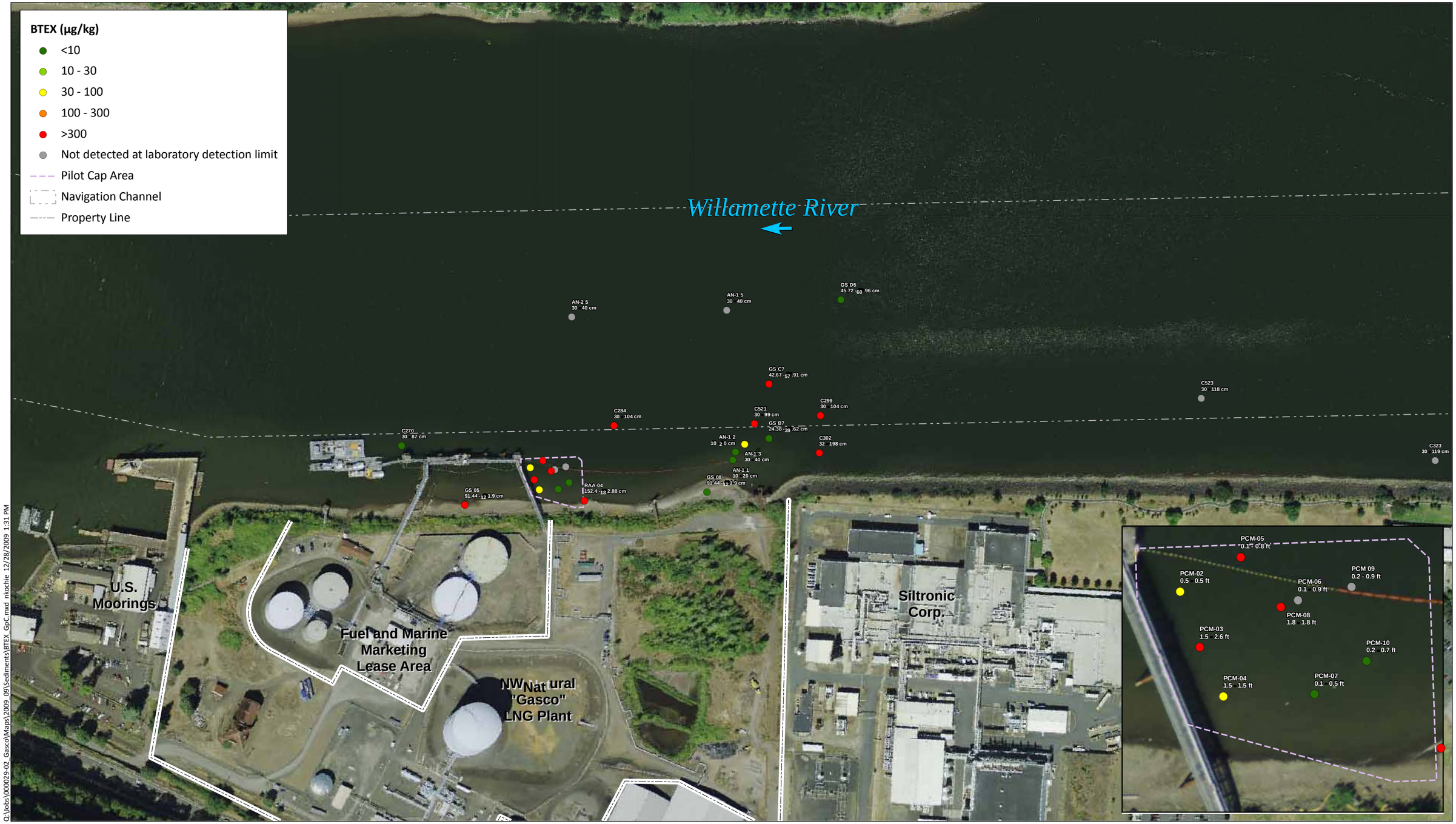
ANCHOR QEA



Feet
0 125 250 375 500

NOTES:
1. Inset shows Pilot Cap Monitoring Area.
2. The 0-40+ cm depth designation indicates samples originating at the mudline and extending below 40 cm.

Figure A1.2
Maximum BTEX Sediment Concentration - 0-40+ cm
NW Natural "Gasco" Site
Gasco Sediment Cleanup Action



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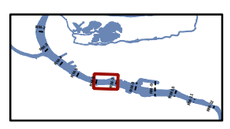
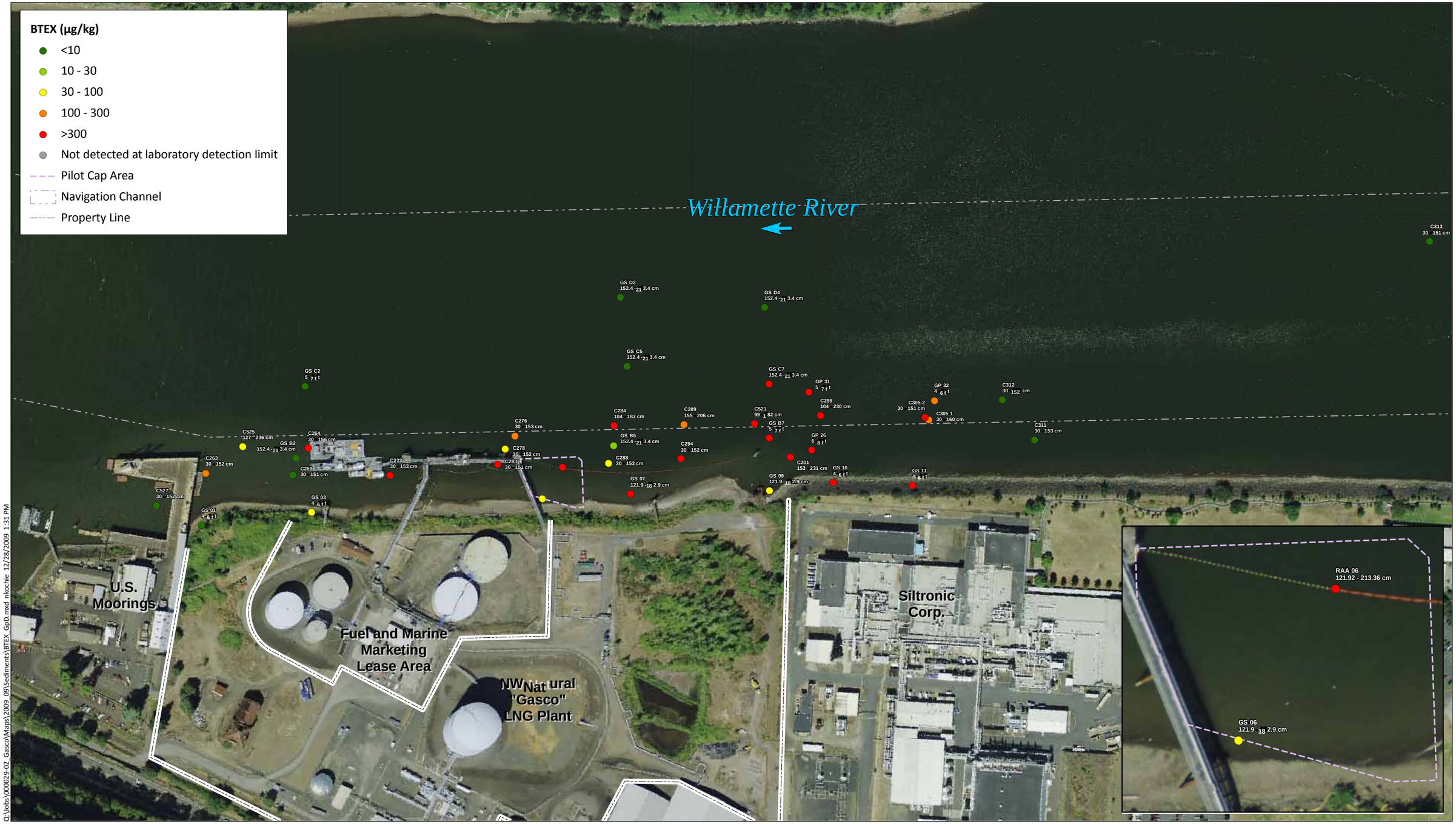


Feet

0 125 250 375 500

NOTES:
1. Inset shows Pilot Cap Monitoring Area.
2. The <> 0-4 ft depth designation indicates samples that were collected originating some depth below the mudline and extending to 4 ft or less.

Figure A1.3
Maximum BTEX Sediment Concentration - <> 0-4 ft
NW Natural "Gasco" Site
Gasco Sediment Cleanup Action



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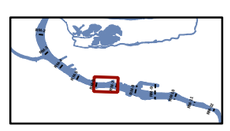
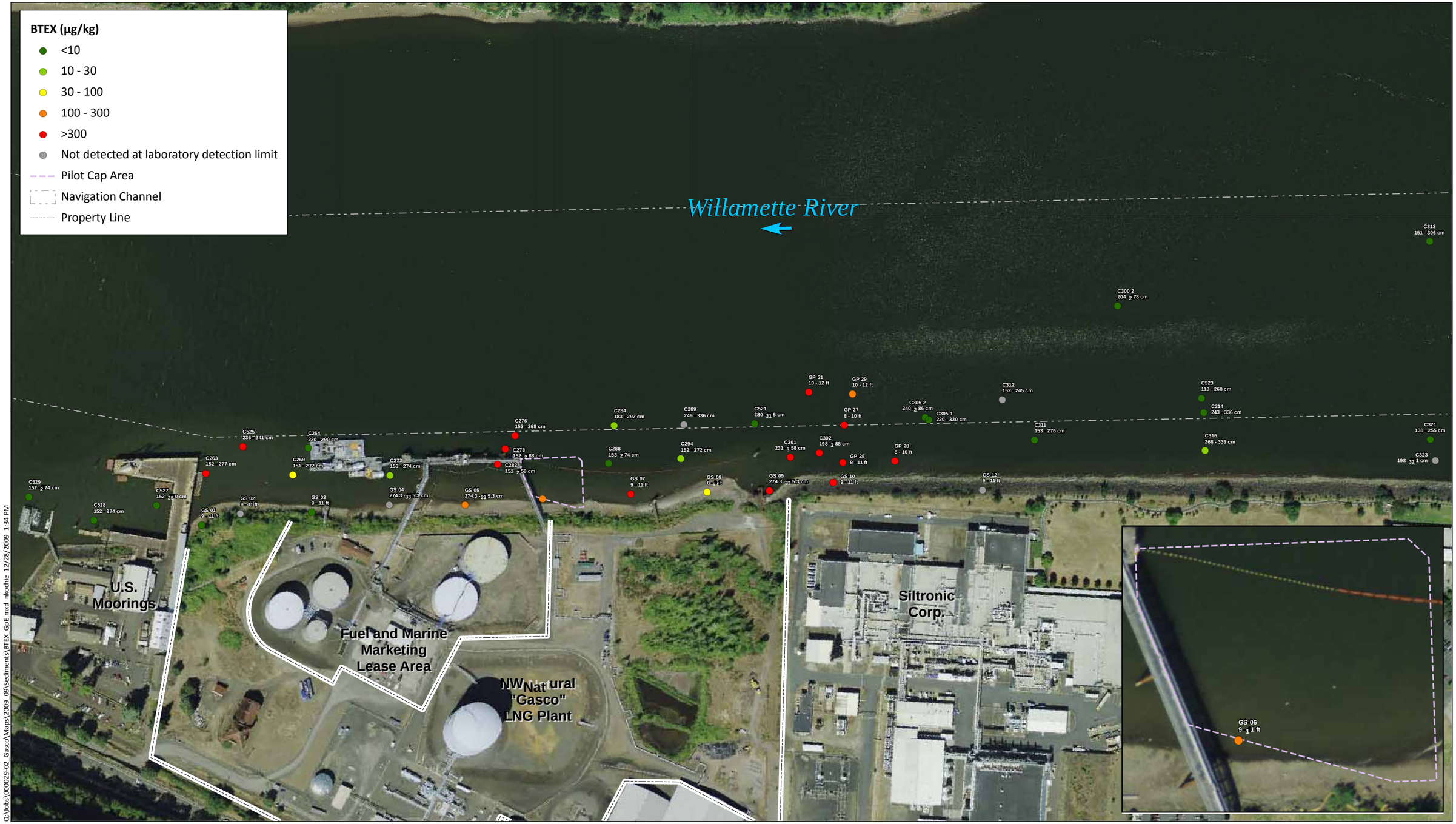
ANCHOR QEA



Feet
0 125 250 375 500

NOTES:
1. Inset shows Pilot Cap Monitoring Area.

Figure A1.4
Maximum BTEX Sediment Concentration - 4-8 Feet
NW Natural "Gasco" Site
Gasco Sediment Cleanup Action



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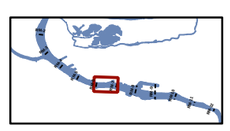
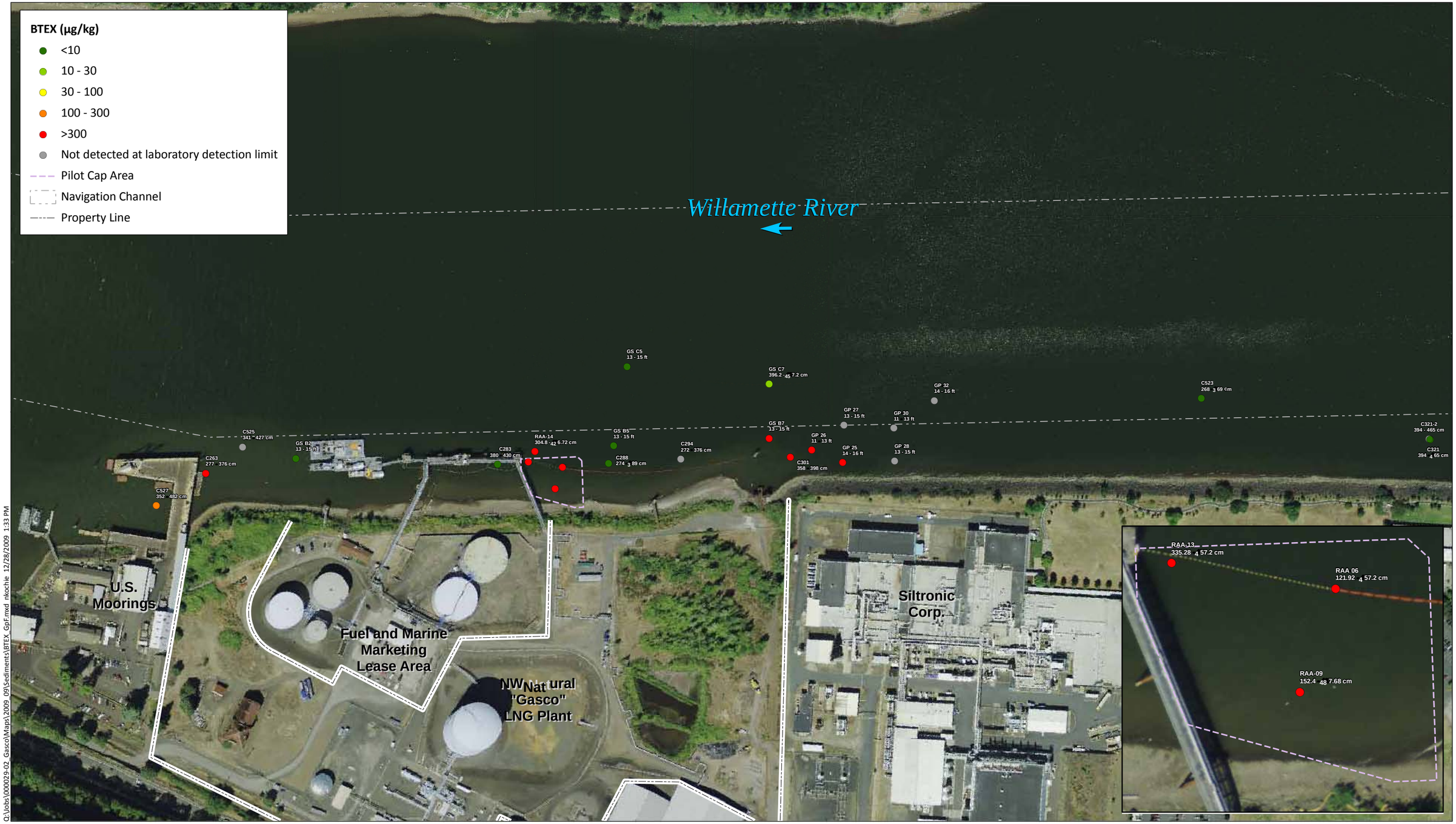


Feet
0 125 250 375 500

NOTES:
1. Inset shows Pilot Cap Monitoring Area.

Figure A1.5
Maximum BTEX Sediment Concentration - 8-12 ft
NW Natural "Gasco" Site
Gasco Sediment Cleanup Action



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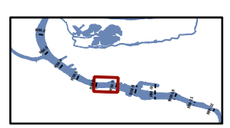
ANCHOR QEA

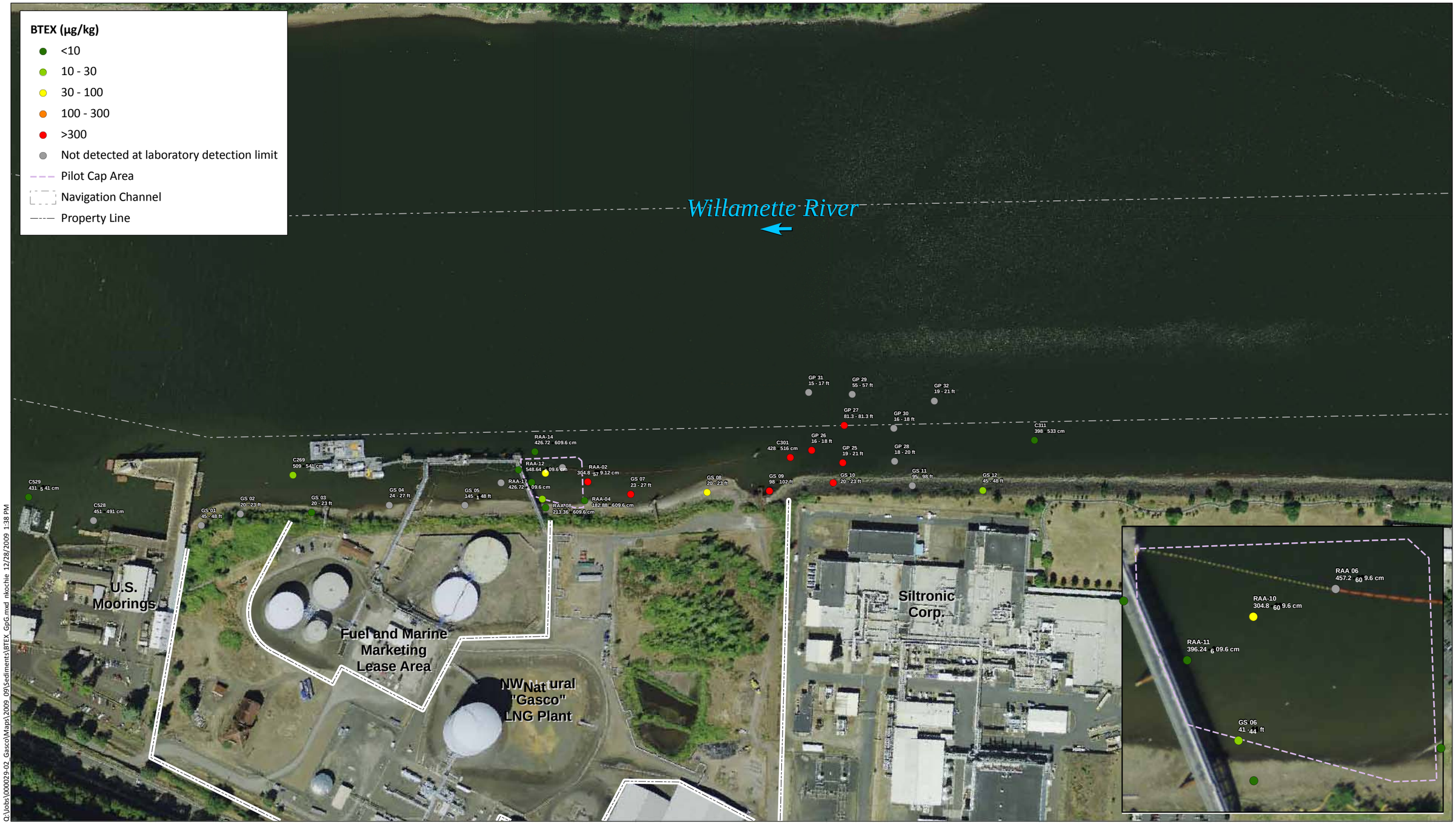


Feet

0 125 250 375 500

NOTES:
1. Inset shows Pilot Cap Monitoring Area.

Figure A1.6
Maximum BTEX Sediment Concentration - 12-16 ft
NW Natural "Gasco" Site
Gasco Sediment Cleanup Action



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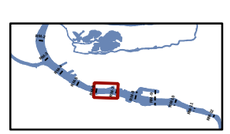
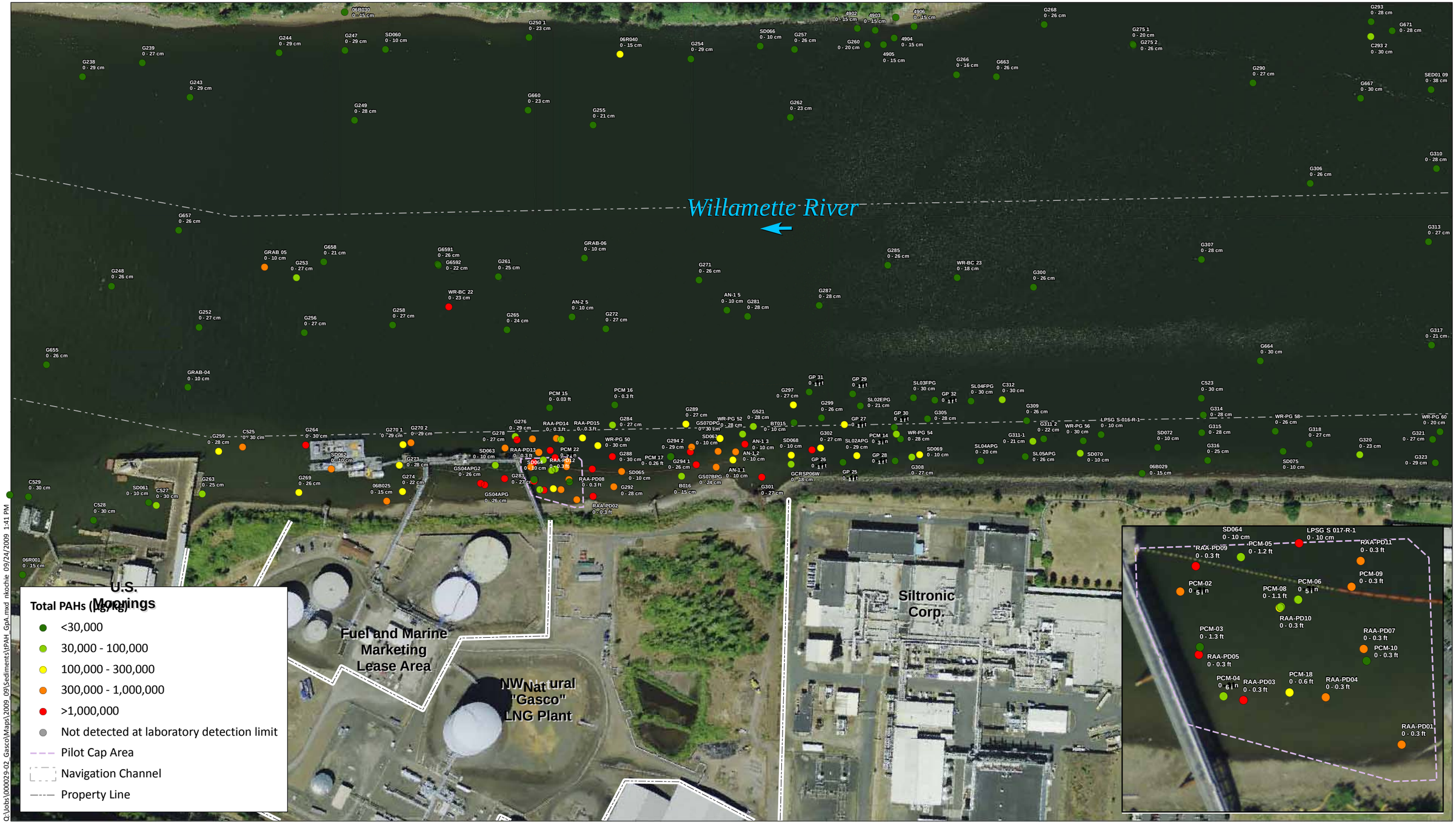


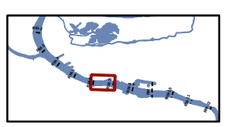
Feet
0 125 250 375 500

NOTES:
1. Inset shows Pilot Cap Monitoring Area.

Figure A1.7
Maximum BTEX Sediment Concentration - 16+ ft
NW Natural "Gasco" Site
Gasco Sediment Cleanup Action



ANCHOR QEA

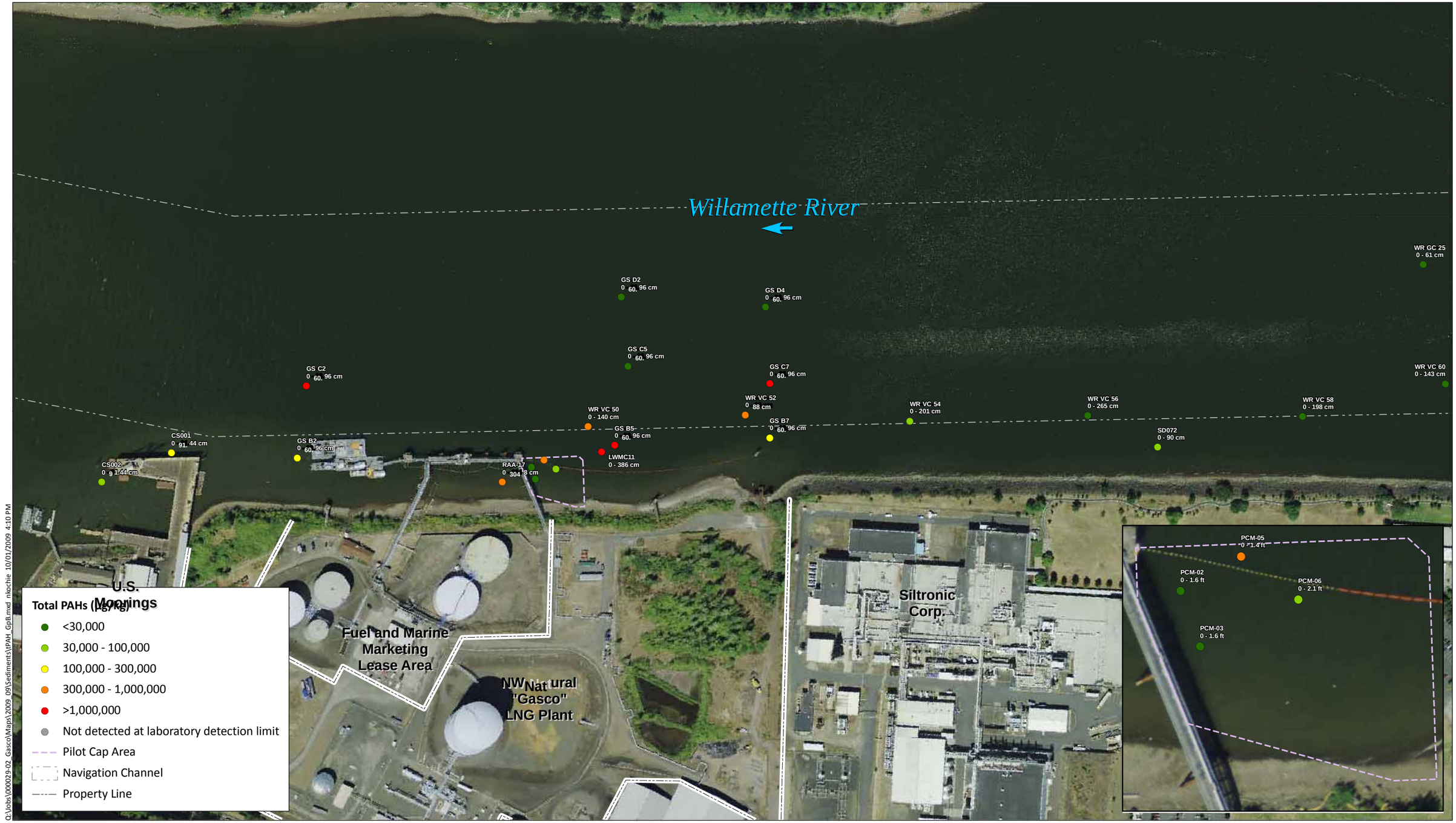


Feet

0 125 250 375 500

NOTES:
1. Inset shows Pilot Cap Monitoring Area.
2. Consistent with the Portland Harbor Superfund Site process, surface sediment is considered 0-40 cm below mudline.

Figure A2.1
Maximum Total PAHs Sediment Concentration - 0-40 cm
NW Natural "Gasco" Site
Gasco Sediment Cleanup Action



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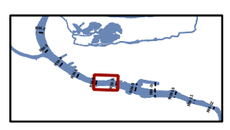
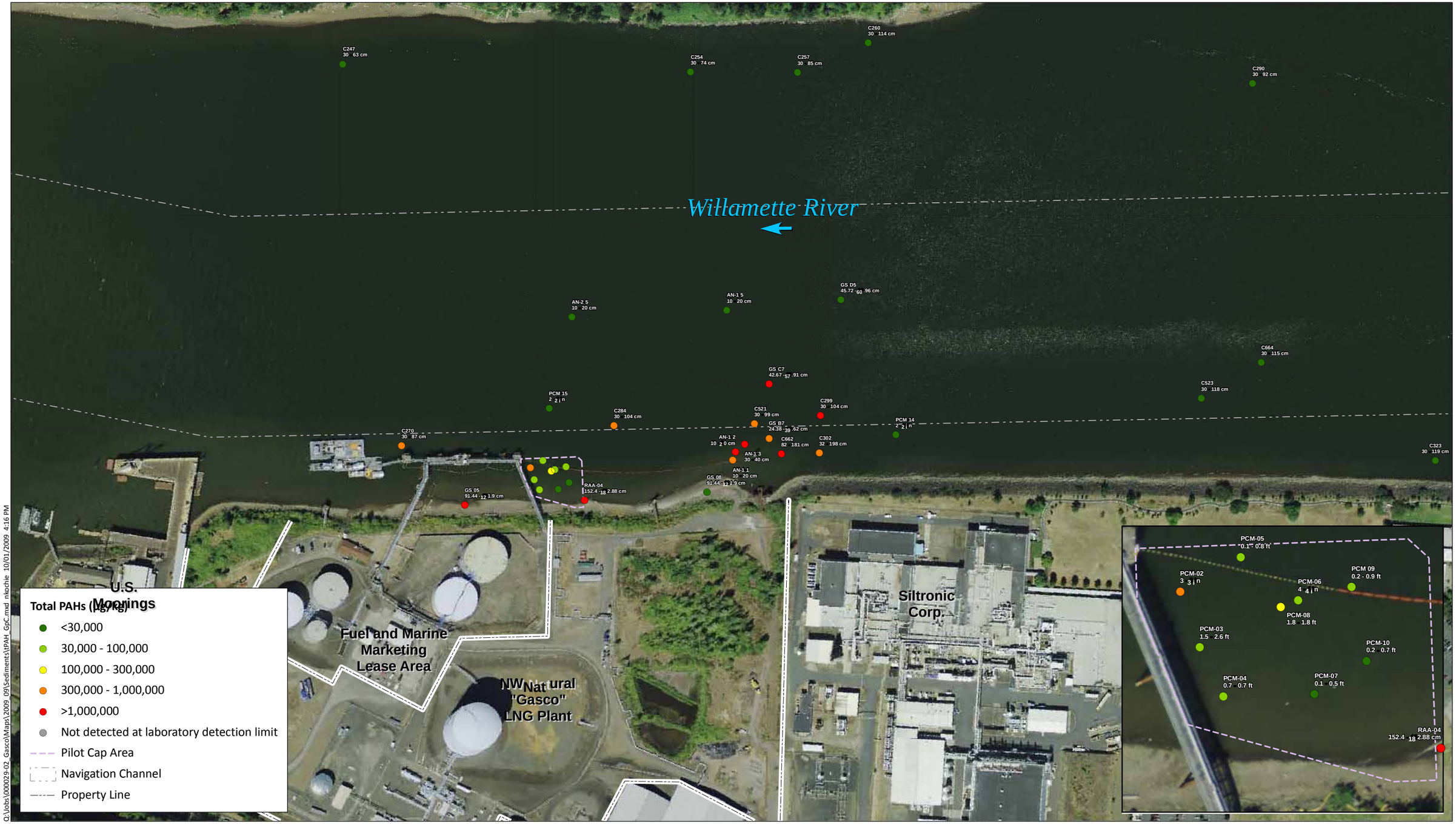


Feet
0 125 250 375 500

NOTES:
1. Inset shows Pilot Cap Monitoring Area.
2. The 0-40+ cm depth designation indicates samples originating at the mudline and extending below 40 cm.

Figure A2.2
Maximum Total PAHs Sediment Concentration - 0-40+ cm
NW Natural "Gasco" Site
Gasco Sediment Cleanup Action



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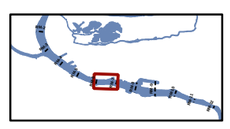
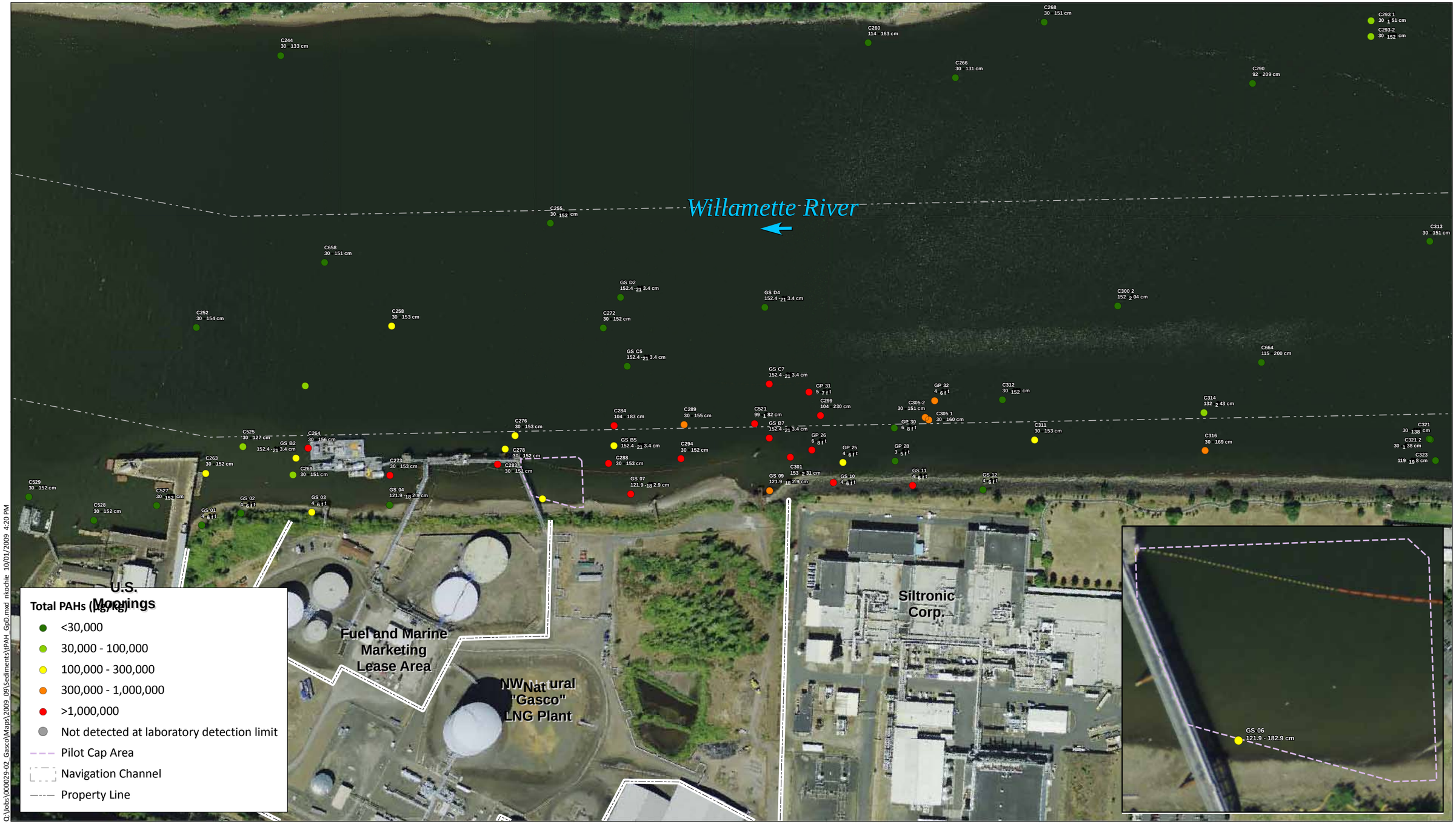


Feet

0 125 250 375 500

NOTES:
1. Inset shows Pilot Cap Monitoring Area.
2. The <>0-4 ft depth designation indicates samples that were collected originating some depth below the mudline and extending to 4 ft or less.

Figure A2.3
Maximum Total PAHs Sediment Concentration - <> 0-4 ft
NW Natural "Gasco" Site
Gasco Sediment Cleanup Action



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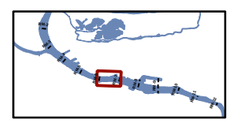
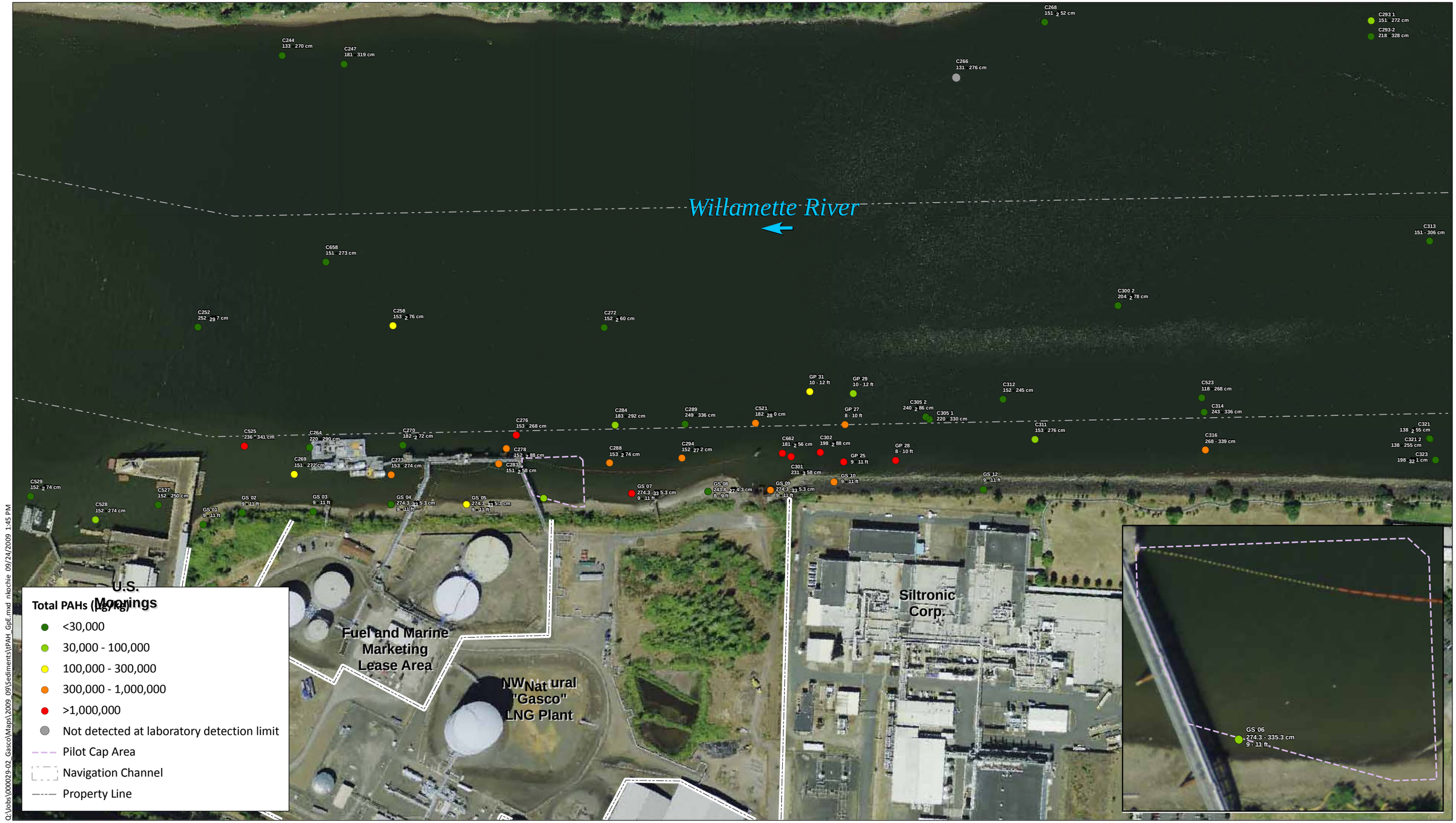


Feet
0 125 250 375 500

NOTES:
1. Inset shows Pilot Cap Monitoring Area.

Figure A2.4
Maximum Total PAHs Sediment Concentration - 4-8 ft
NW Natural "Gasco" Site
Gasco Sediment Cleanup Action



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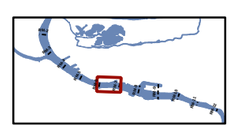
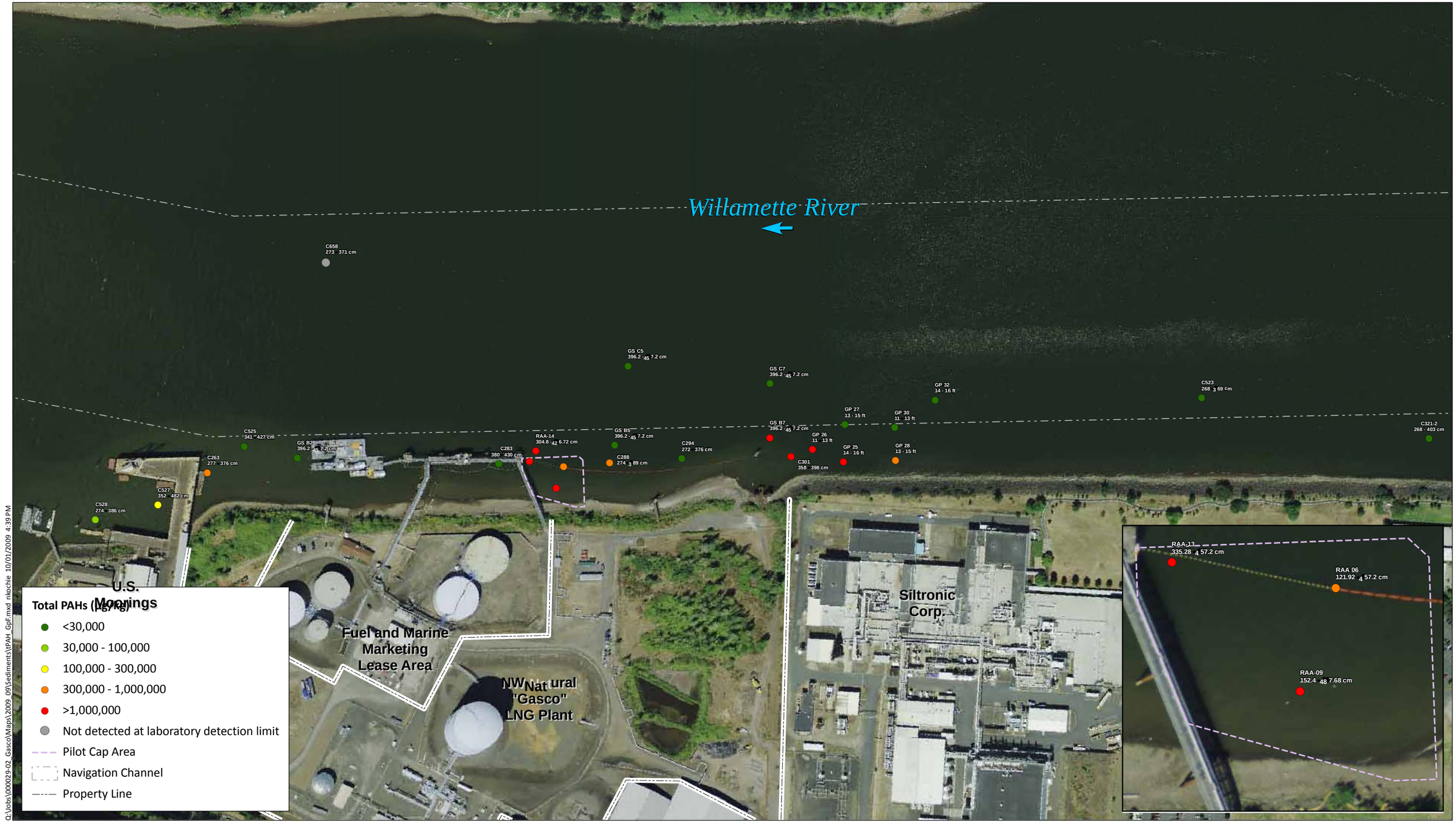
ANCHOR QEA



Feet
0 125 250 375 500

NOTES:
1. Inset shows Pilot Cap Monitoring Area.

Figure A2.5
Maximum Total PAHs Sediment Concentration - 8-12 ft
NW Natural "Gasco" Site
Gasco Sediment Cleanup Action



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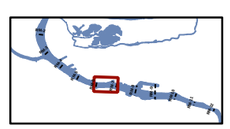
ANCHOR QEA

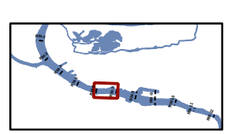


Feet
0 125 250 375 500

NOTES:
1. Inset shows Pilot Cap Monitoring Area.

Figure A2.6
Maximum Total PAHs Sediment Concentration - 12-16 ft
NW Natural "Gasco" Site
Gasco Sediment Cleanup Action

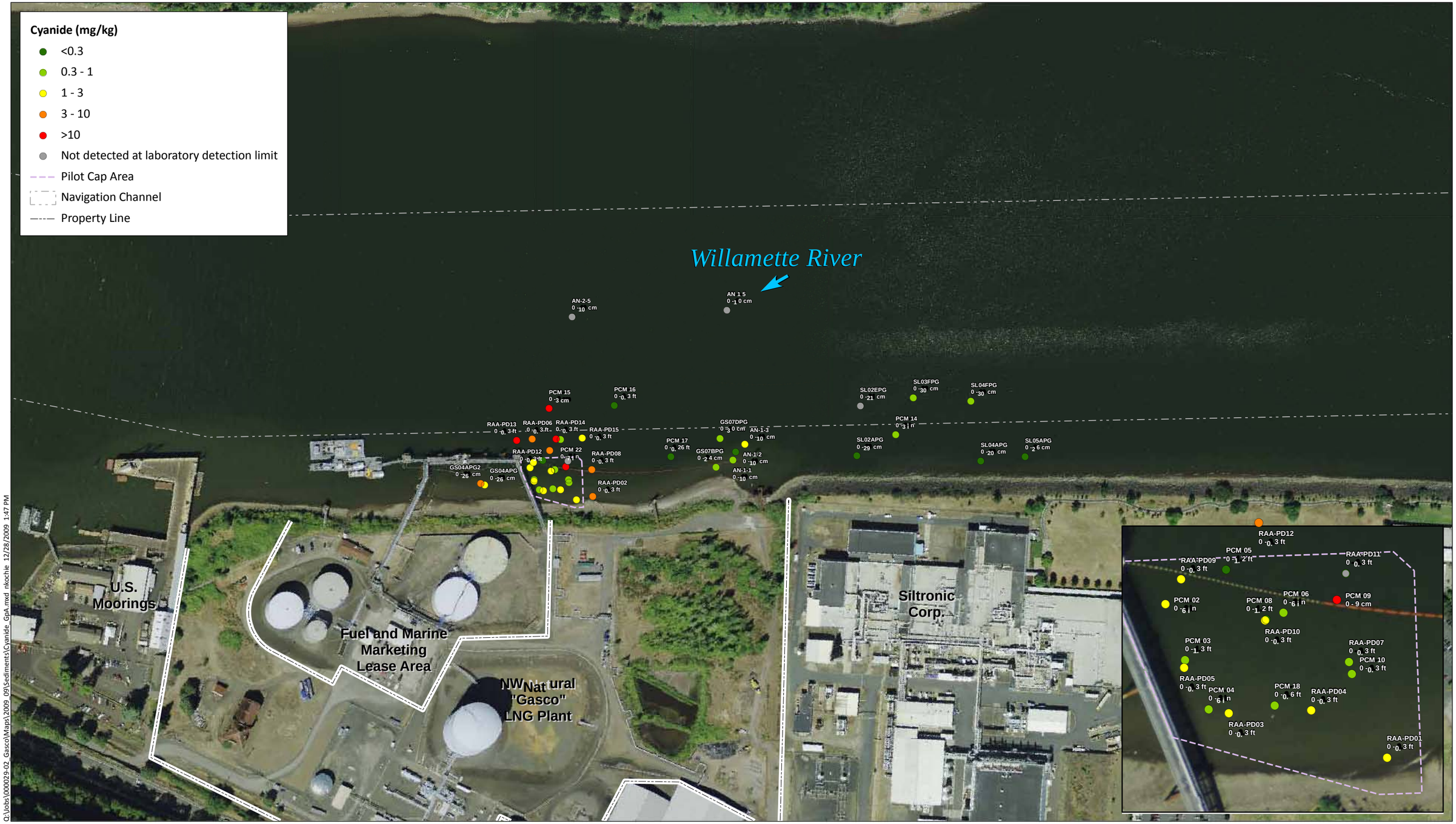
ANCHOR QEA



Feet
0 125 250 375 500

NOTES:
1. Inset shows Pilot Cap Monitoring Area.

Figure A2.7
Maximum Total PAHs Sediment Concentration - 16+ ft
NW Natural "Gasco" Site
Gasco Sediment Cleanup Action



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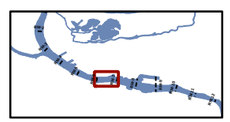
ANCHOR QEA



Feet

0 125 250 375 500

NOTES:
1. Inset shows Pilot Cap Monitoring Area.
2. Consistent with the Portland Harbor Superfund Site process, surface sediment is considered 0-40 cm below mudline.

Figure A3.1
Maximum Cyanide Sediment Concentration - 0-40 cm
NW Natural "Gasco" Site
Gasco Sediment Cleanup Action

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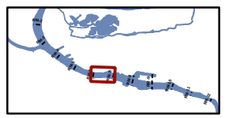
ANCHOR QEA



Feet

0 125 250 375 500

NOTES:
1. Inset shows Pilot Cap Monitoring Area.
2. The 0-40+ cm depth designation indicates samples originating at the mudline and extending below 40 cm.

Figure A3.2
Maximum Cyanide Sediment Concentration - 0-40+ cm
NW Natural "Gasco" Site
Gasco Sediment Cleanup Action

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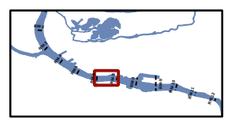
ANCHOR QEA



Feet

0 125 250 375 500

NOTES:
1. Inset shows Pilot Cap Monitoring Area.
2. The <>0-4 ft depth designation indicates samples that were collected originating some depth below the mudline and extending to 4 ft or less.

Figure A3.3
Maximum Cyanide Sediment Concentration - <> 0-4 ft
NW Natural "Gasco" Site
Gasco Sediment Cleanup Action

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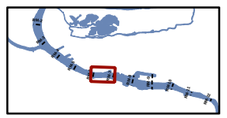
ANCHOR QEA



Feet
0 125 250 375 500

NOTES:
1. Inset shows Pilot Cap Monitoring Area.

Figure A3.4
Maximum Cyanide Sediment Concentration - 4-8 ft
NW Natural "Gasco" Site
Gasco Sediment Cleanup Action

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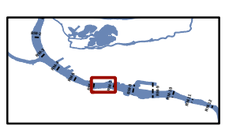
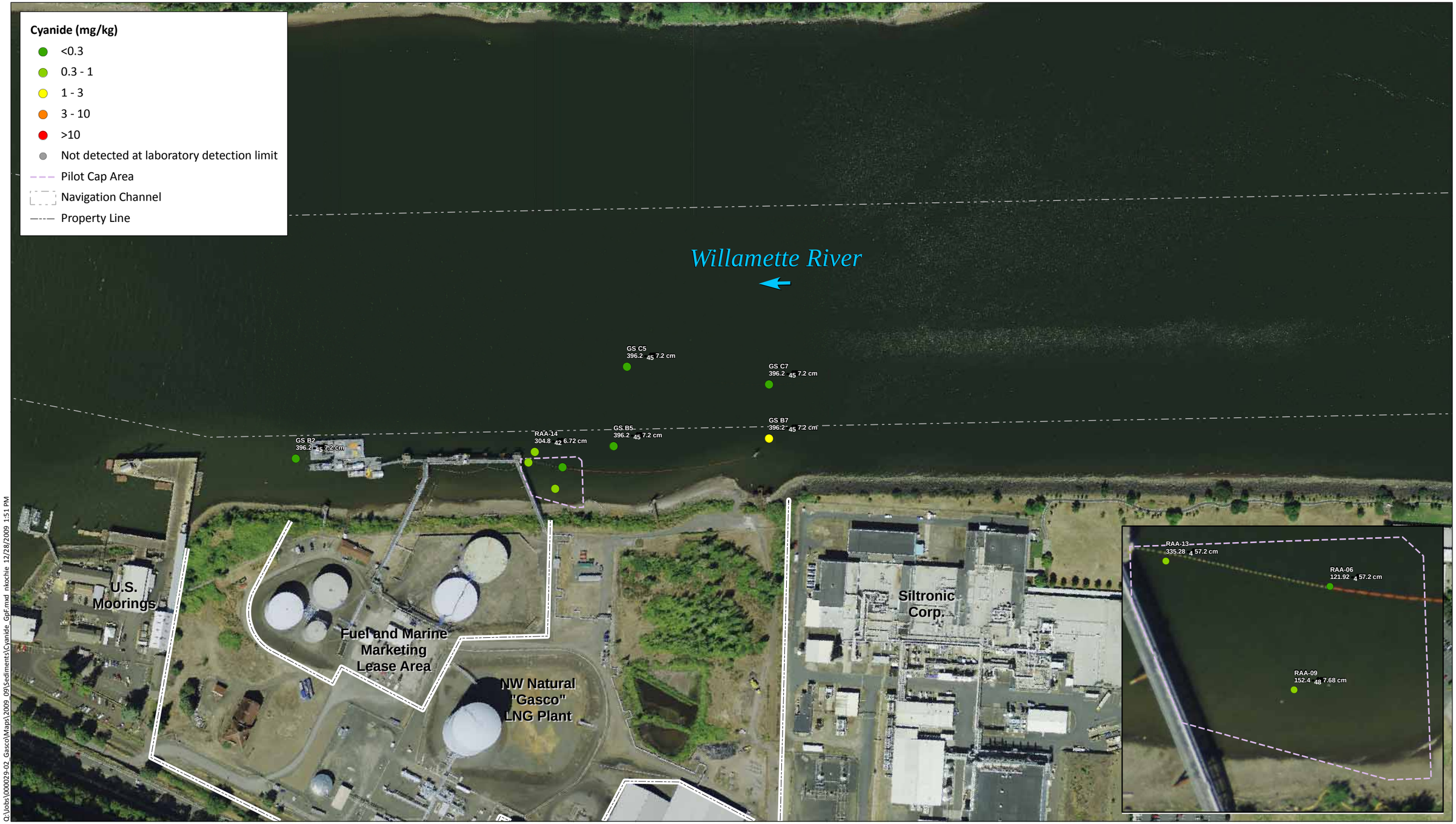
ANCHOR QEA



Feet
0 125 250 375 500

NOTES:
1. Inset shows Pilot Cap Monitoring Area.

Figure A3.5
Maximum Cyanide Sediment Concentration - 8-12 ft
NW Natural "Gasco" Site
Gasco Sediment Cleanup Action



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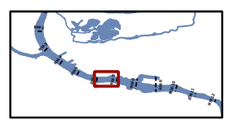
ANCHOR QEA



Feet
0 125 250 375 500

NOTES:
1. Inset shows Pilot Cap Monitoring Area.

Figure A3.6
Maximum Cyanide Sediment Concentration - 12-16 ft
NW Natural "Gasco" Site
Gasco Sediment Cleanup Action

Q:\Jobs\000029-02_Gasco\Maps\2009_09\Sediments\Cyanide_GpG.mxd nkochie 12/28/2009 1:51 PM

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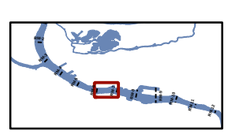
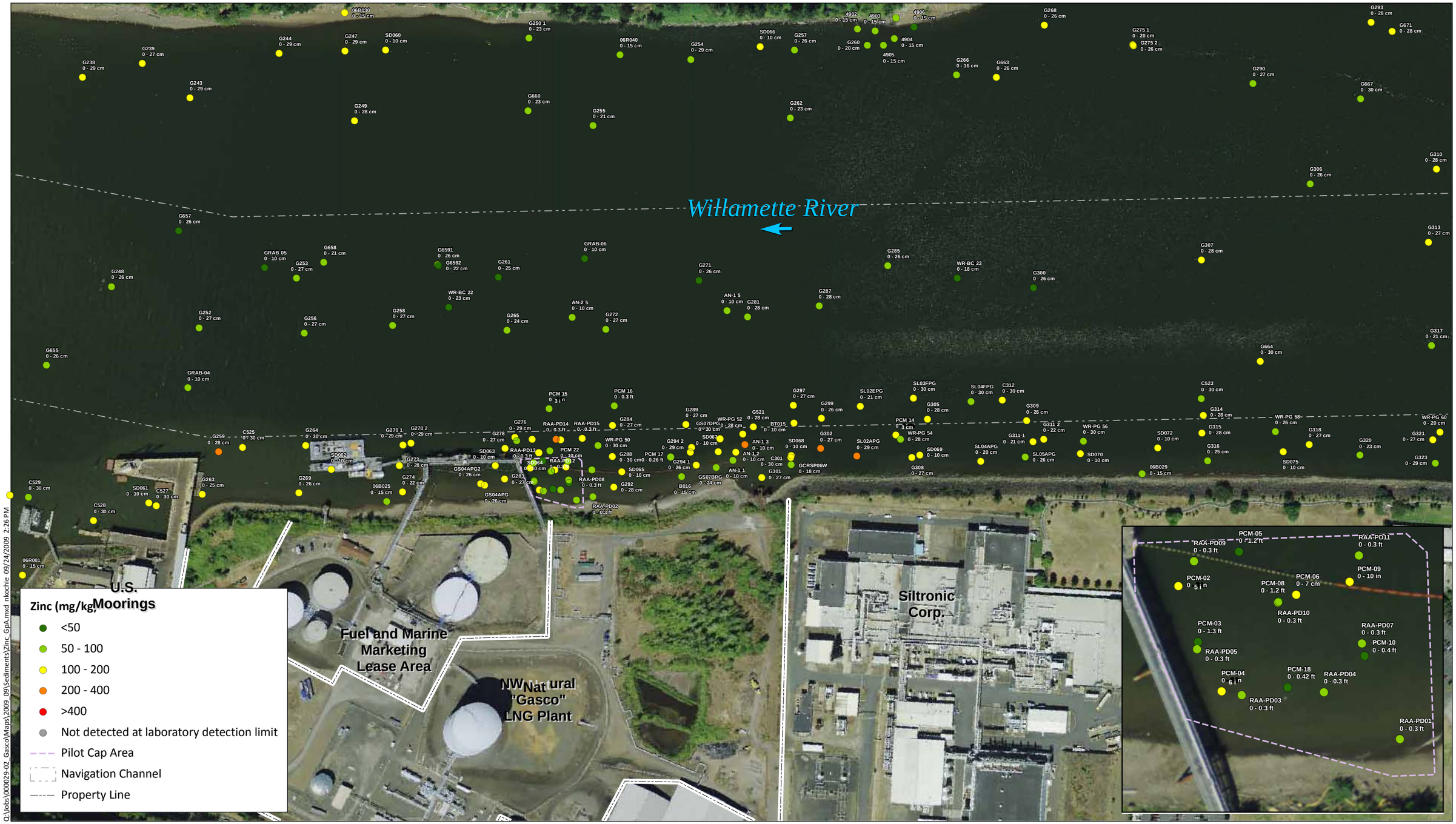


Feet
0 125 250 375 500

NOTES:
1. Inset shows Pilot Cap Monitoring Area.

Figure A3.7
Maximum Cyanide Sediment Concentration - 16+ ft
NW Natural "Gasco" Site
Gasco Sediment Cleanup Action



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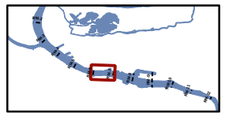
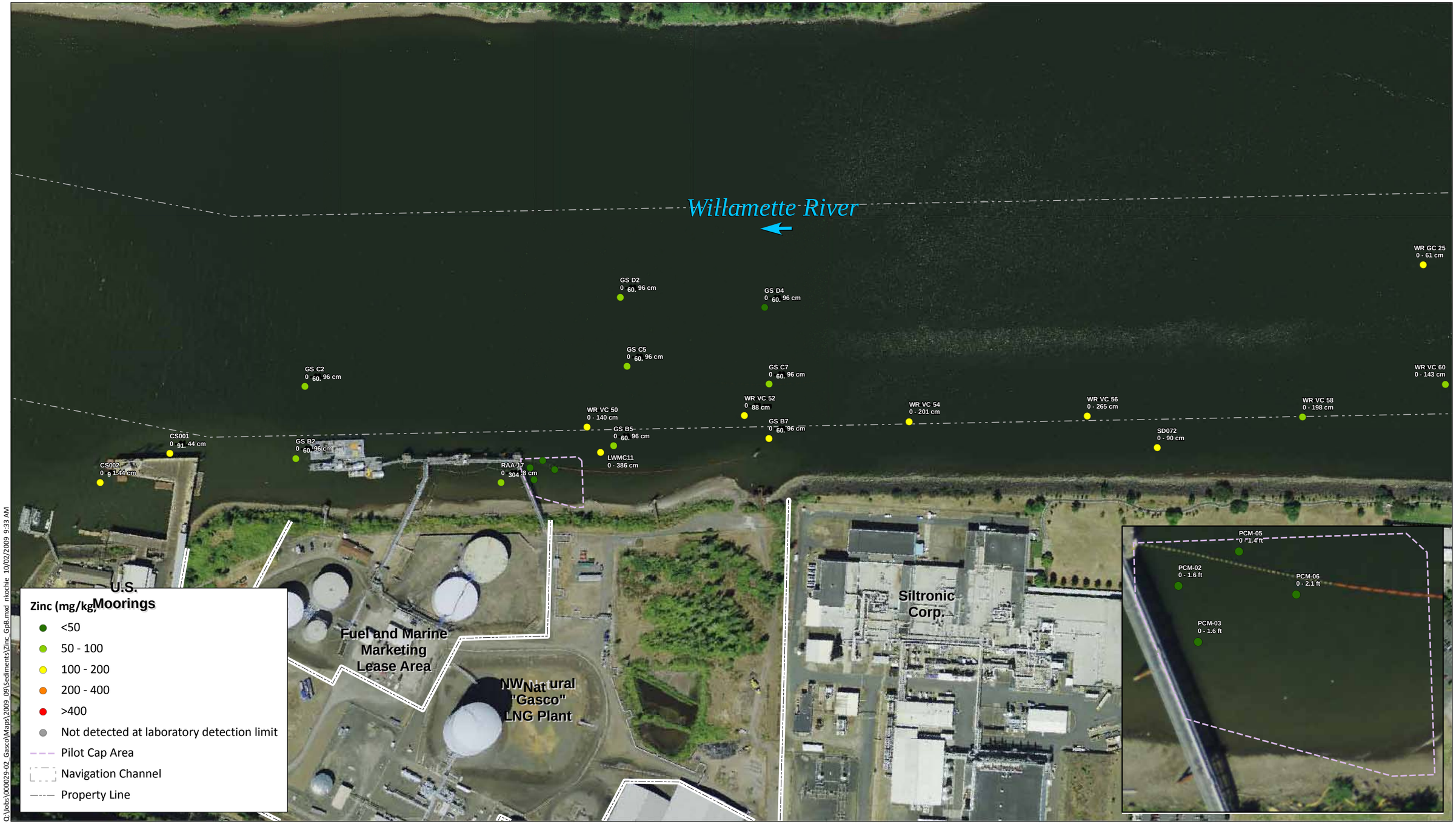


Feet
0 125 250 375 500

NOTES:
1. Inset shows Pilot Cap Monitoring Area.
2. Consistent with the Portland Harbor Superfund Site process, surface sediment is considered 0-40 cm below mudline.

Figure A4.1
Maximum Zinc Sediment Concentration - 0-40 cm
NW Natural "Gasco" Site
Gasco Sediment Cleanup Action



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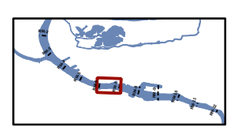
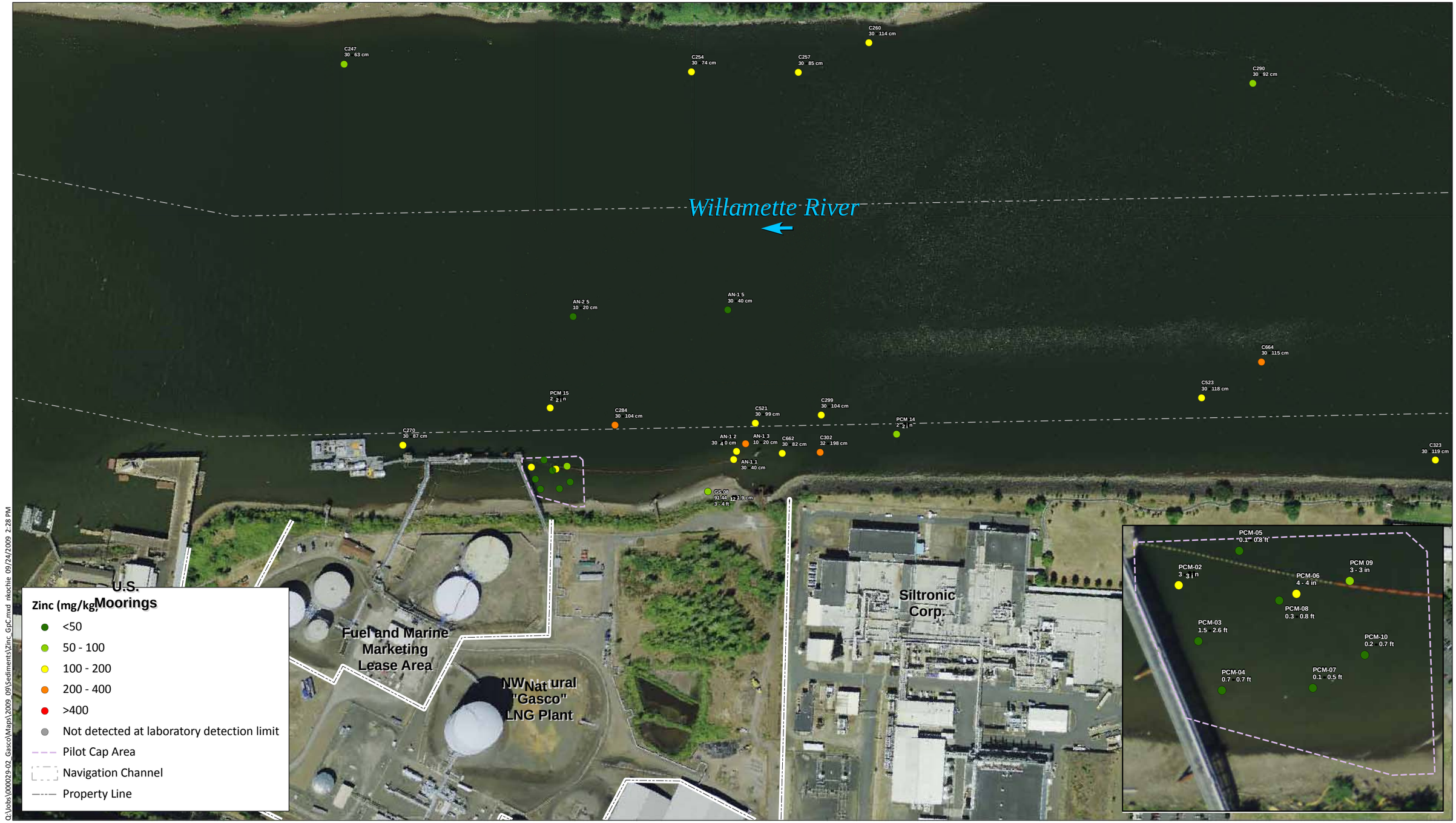
ANCHOR QEA



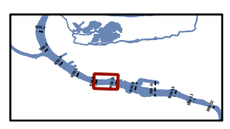
Feet
0 125 250 375 500

NOTES:
1. Inset shows Pilot Cap Monitoring Area.
2. The 0-40+ cm depth designation indicates samples originating at the mudline and extending below 40 cm.

Figure A4.2
Maximum Zinc Sediment Concentration - 0-40+ cm
NW Natural "Gasco" Site
Gasco Sediment Cleanup Action



ANCHOR QEA

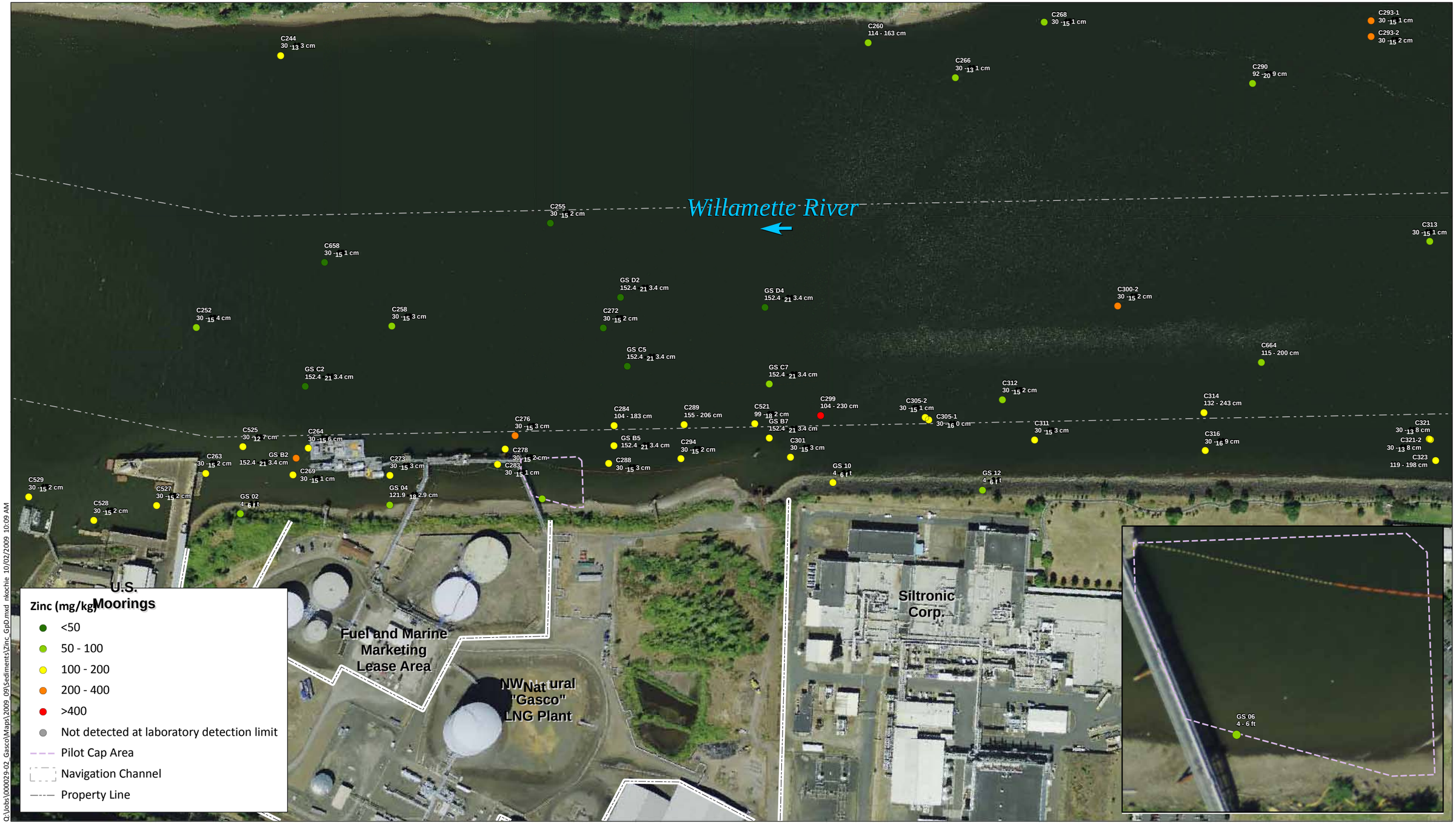


Feet

0 125 250 375 500

NOTES:
1. Inset shows Pilot Cap Monitoring Area.
2. The <>0-4 ft depth designation indicates samples that were collected originating some depth below the mudline and extending to 4 ft or less.

Figure A4.3
Maximum Zinc Sediment Concentration - <> 0-4 ft
NW Natural "Gasco" Site
Gasco Sediment Cleanup Action



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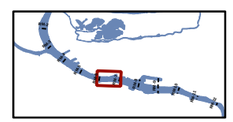
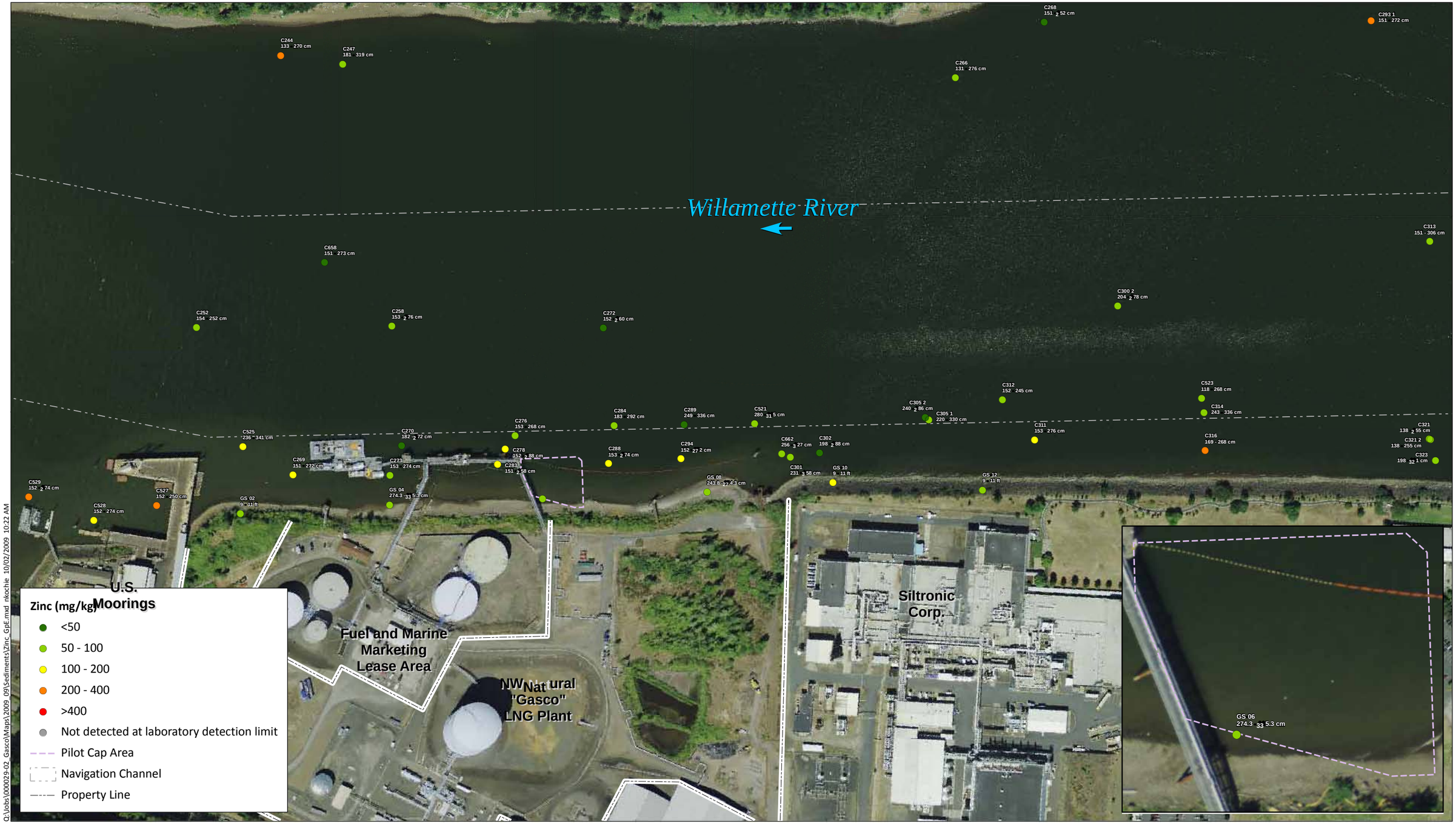


Feet
0 125 250 375 500

NOTES:
1. Inset shows Pilot Cap Monitoring Area.

Figure A4.4
Maximum Zinc Sediment Concentration - 4-8 ft
NW Natural "Gasco" Site
Gasco Sediment Cleanup Action



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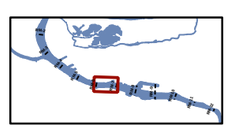
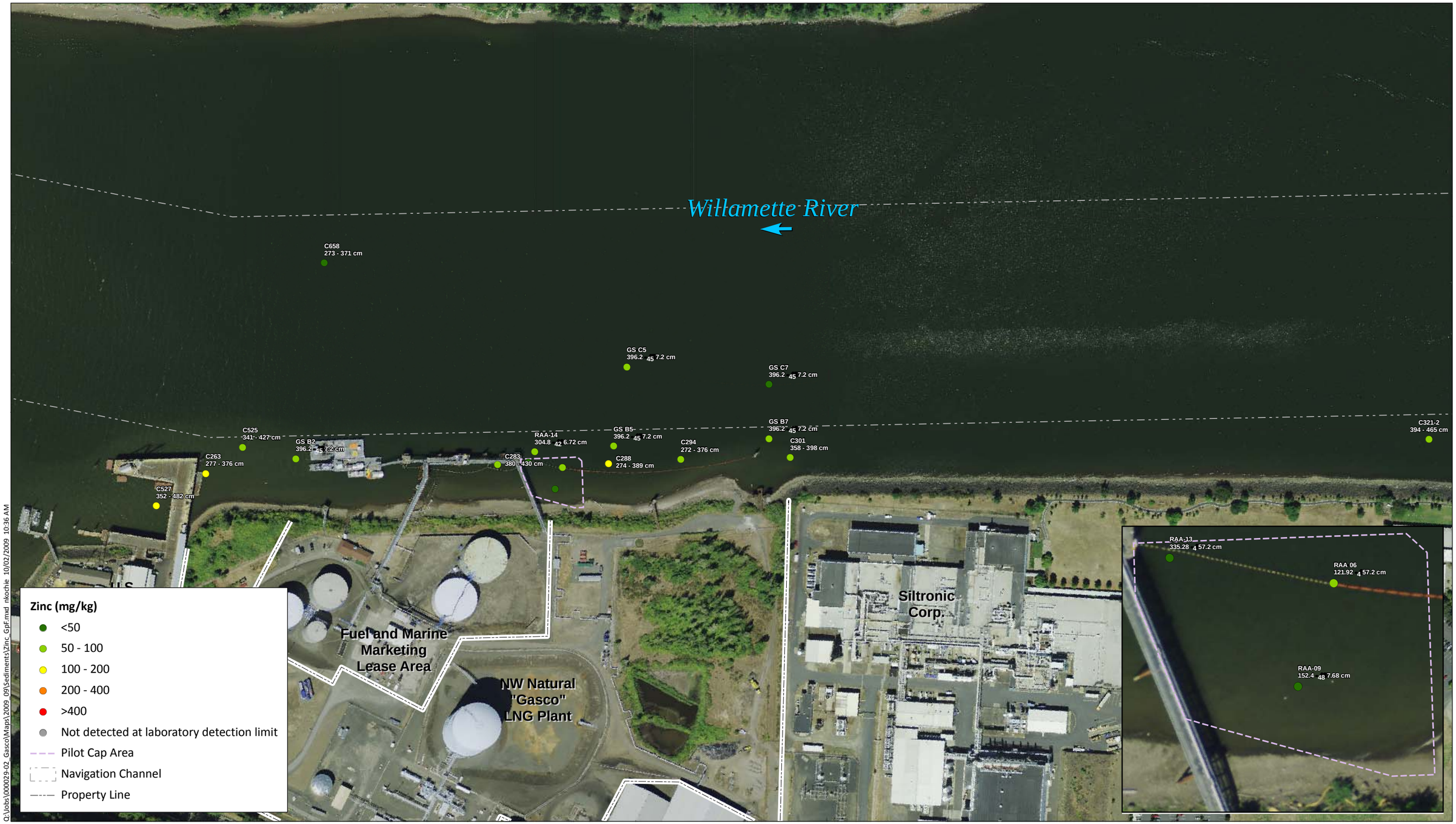
ANCHOR QEA



Feet
0 125 250 375 500

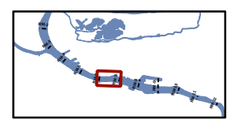
NOTES:
1. Inset shows Pilot Cap Monitoring Area.

Figure A4.5
Maximum Zinc Sediment Concentration - 8-12 ft
NW Natural "Gasco" Site
Gasco Sediment Cleanup Action



Q:\Jobs\000029-02_Gasco\Maps\2009_09\Sediments\Zinc_GpF.mxd nkochie 10/02/2009 10:36 AM

ANCHOR QEA



Feet
0 125 250 375 500

NOTES:
1. Inset shows Pilot Cap Monitoring Area.

Figure A4.6
Maximum Zinc Sediment Concentration - 12-16 ft
NW Natural "Gasco" Site
Gasco Sediment Cleanup Action

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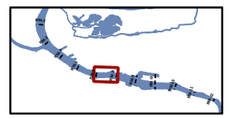
ANCHOR QEA



Feet
0 125 250 375 500

NOTES:
1. Inset shows Pilot Cap Monitoring Area.

Figure A4.7
Maximum Zinc Sediment Concentration - 16+ ft
NW Natural "Gasco" Site
Gasco Sediment Cleanup Action

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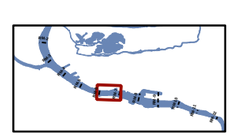
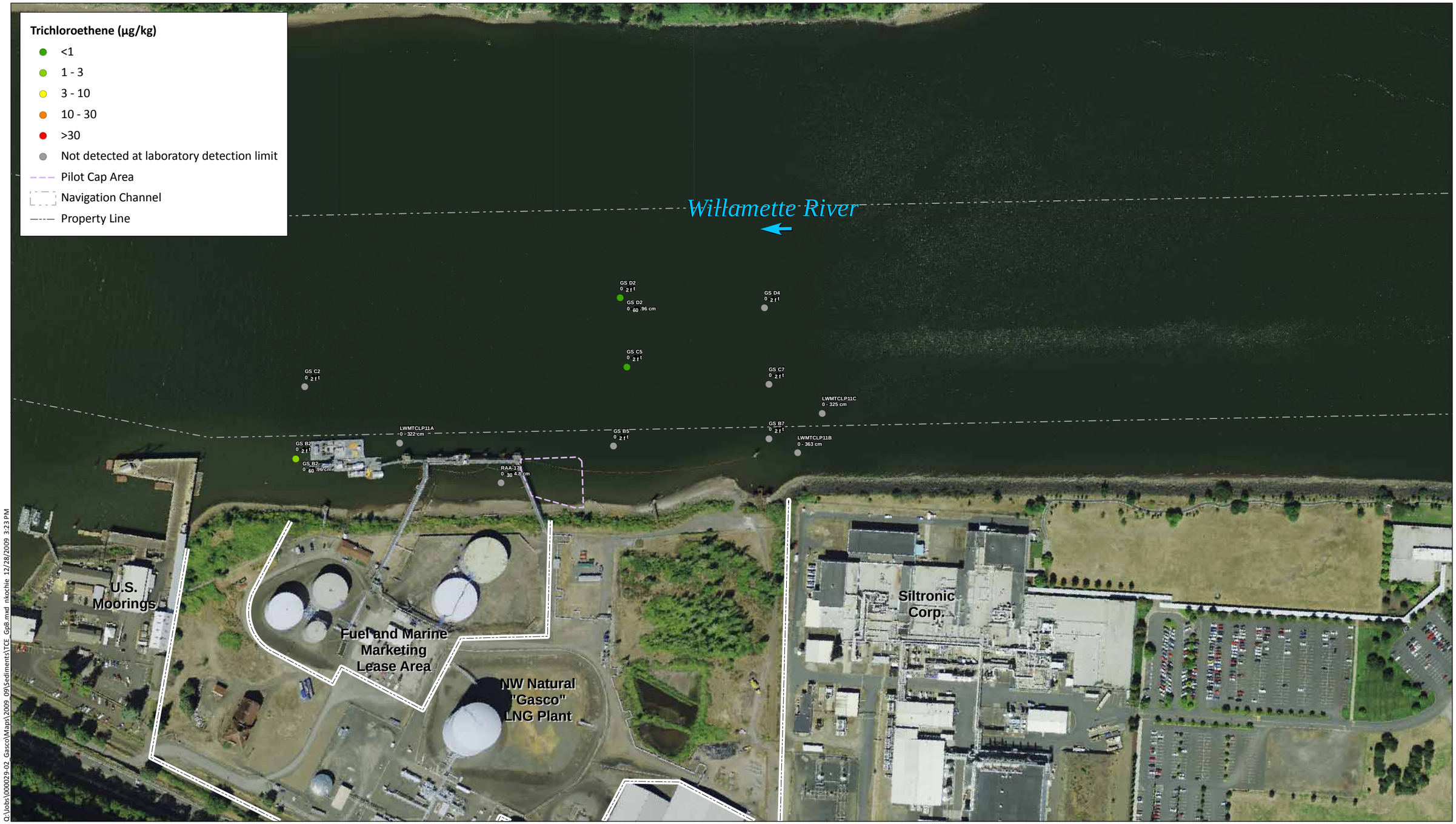


Feet

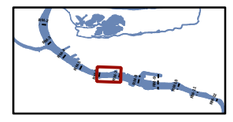
0 125 250 375 500

NOTES:
1. Inset shows Pilot Cap Monitoring Area.
2. Consistent with the Portland Harbor Superfund Site process, surface sediment is considered 0-40 cm below mudline.

Figure A5.1
Maximum Trichloroethene Sediment Concentration - 0-40 cm
NW Natural "Gasco" Site
Gasco Sediment Cleanup Action



ANCHOR QEA

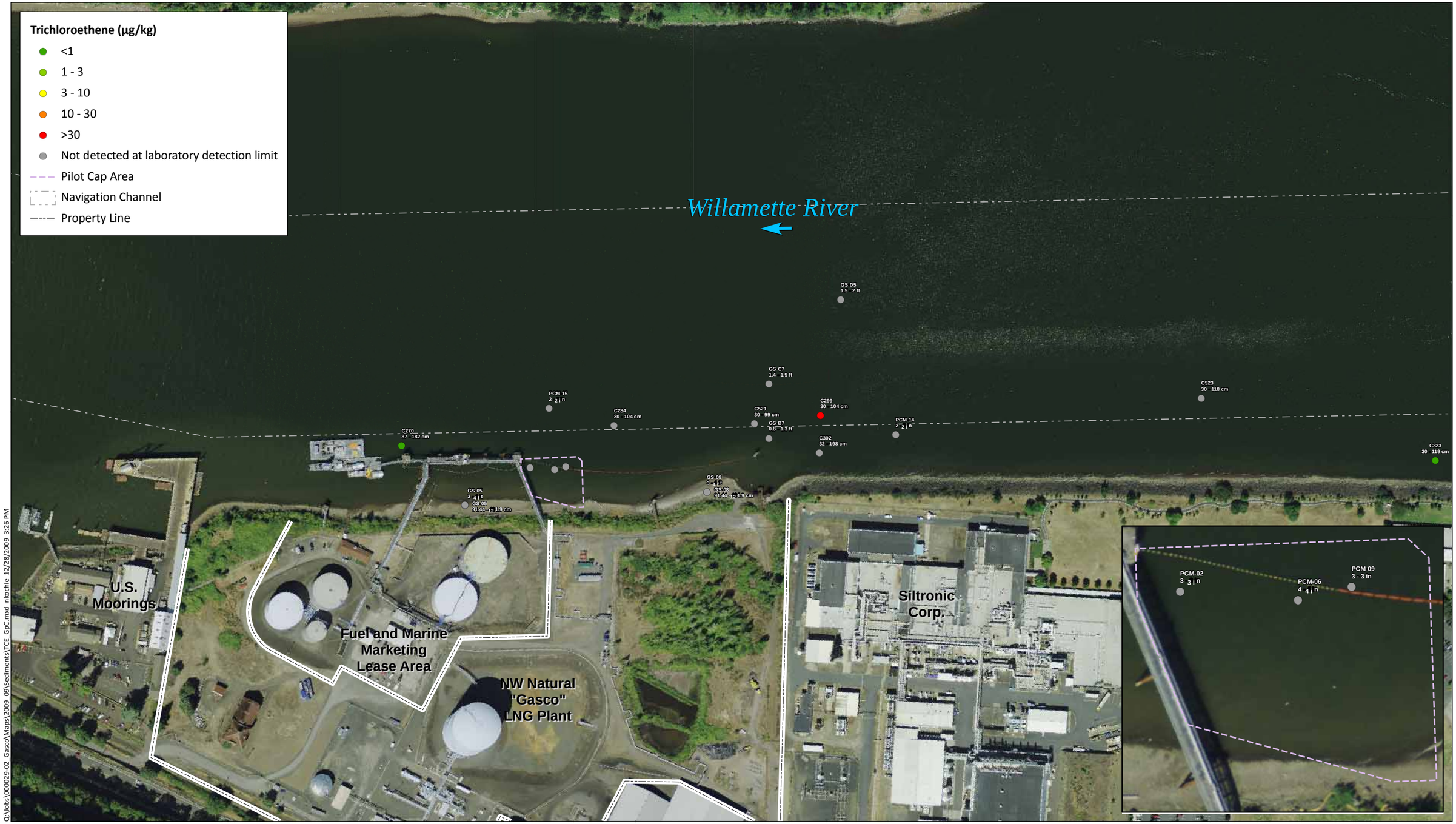


Feet

0 125 250 375 500

NOTES:
1. The 0-40+ cm depth designation indicates samples originating at the mudline and extending below 40 cm.

Figure A5.2
Maximum Trichloroethene Sediment Concentration - 0-40+ cm
NW Natural "Gasco" Site
Gasco Sediment Cleanup Action



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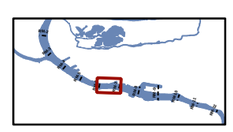
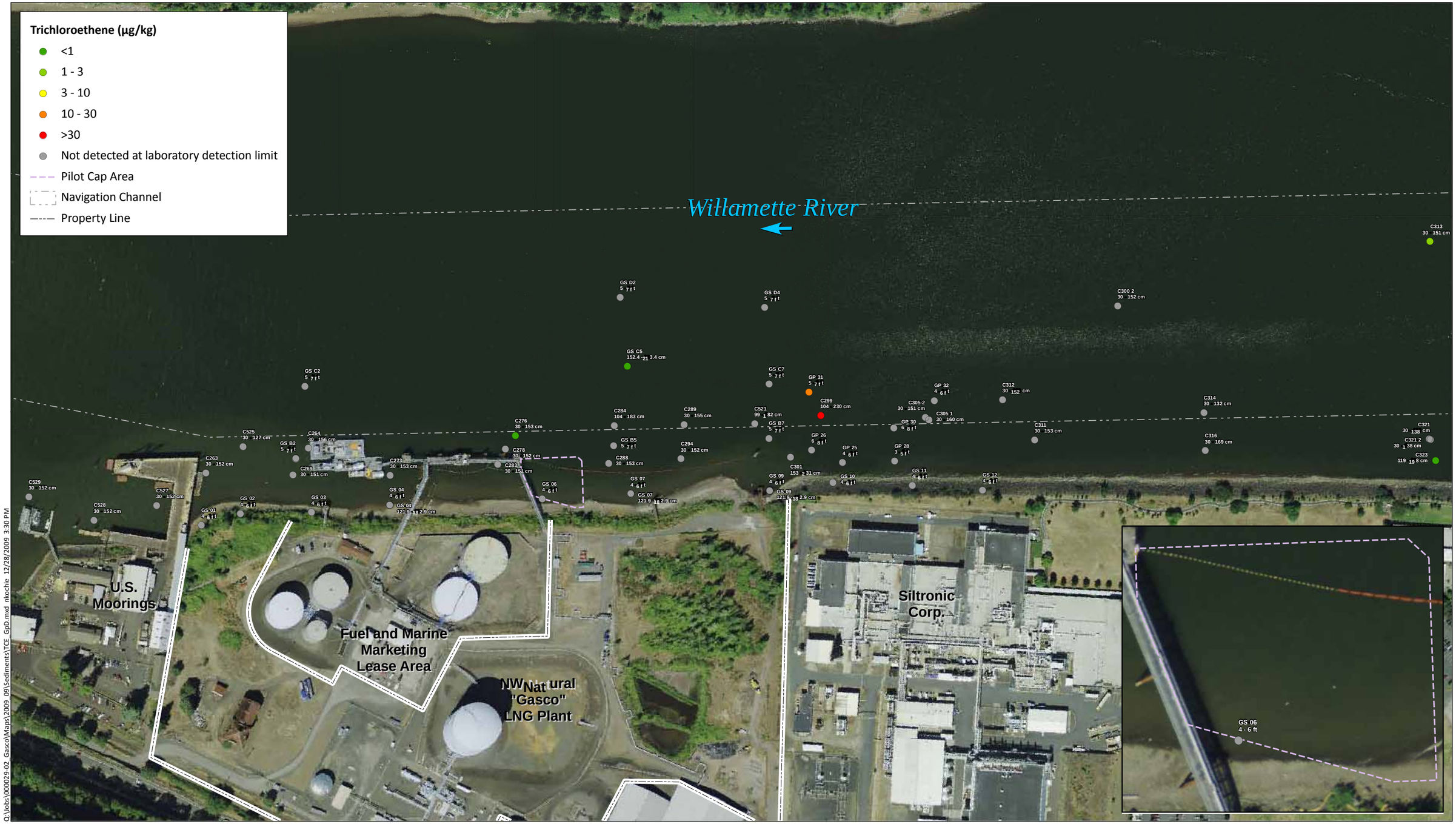
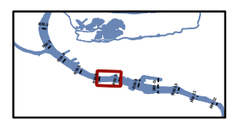


Feet
0 125 250 375 500

NOTES:
1. Inset shows Pilot Cap Monitoring Area.
2. The <>0-4 ft depth designation indicates samples that were collected originating some depth below the mudline and extending to 4 ft or less.

Figure A5.3
Maximum Trichloroethene Sediment Concentration - <> 0-4 ft
NW Natural "Gasco" Site
Gasco Sediment Cleanup Action

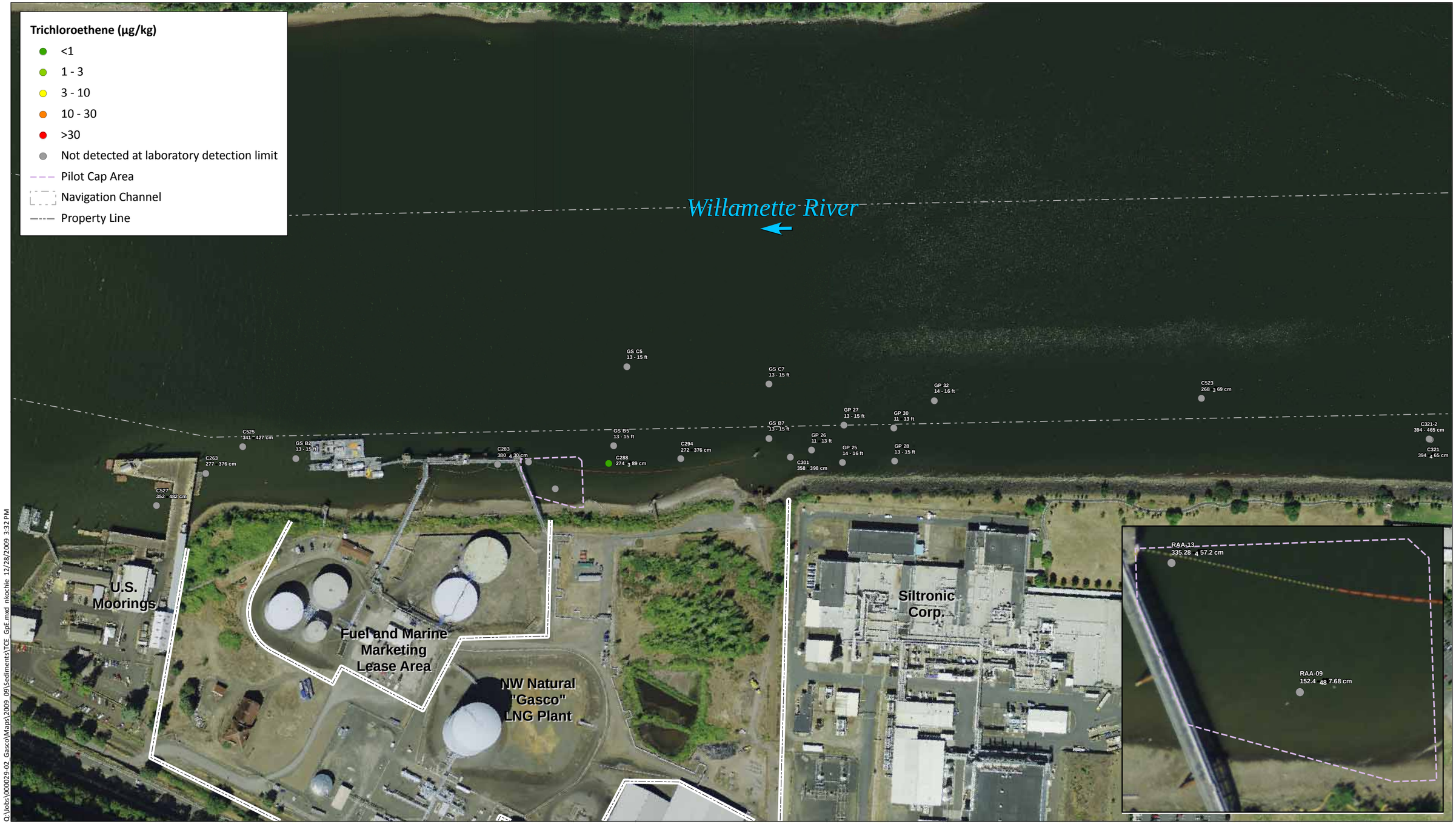




Feet
0 125 250 375 500

NOTES:
1. Inset shows Pilot Cap Monitoring Area.

Figure A5.4
Maximum Trichloroethene Sediment Concentration - 4-8 ft
NW Natural "Gasco" Site
Gasco Sediment Cleanup Action



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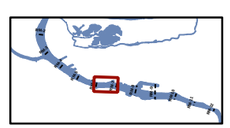
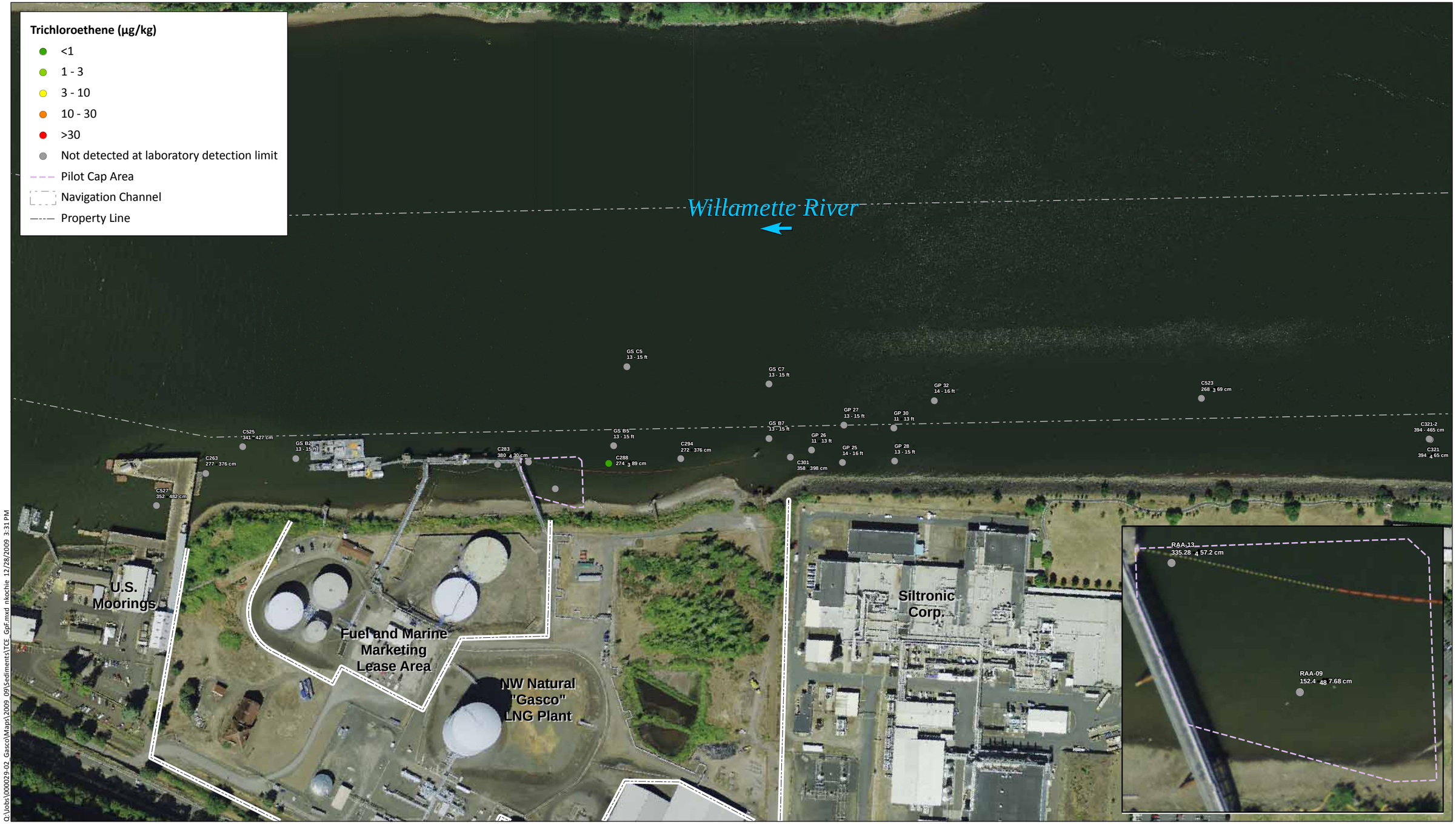


Feet

0 125 250 375 500

NOTES:
1. Inset shows Pilot Cap Monitoring Area.

Figure A5.5
Maximum Trichloroethene Sediment Concentration - 8-12 ft
NW Natural "Gasco" Site
Gasco Sediment Cleanup Action



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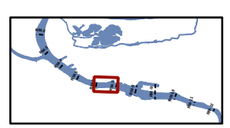

Feet

0 125 250 375 500

NOTES:
1. Inset shows Pilot Cap Monitoring Area.

Figure A5.6
Maximum Trichloroethene Sediment Concentration - 12-16 ft
NW Natural "Gasco" Site
Gasco Sediment Cleanup Action

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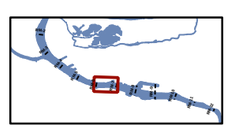
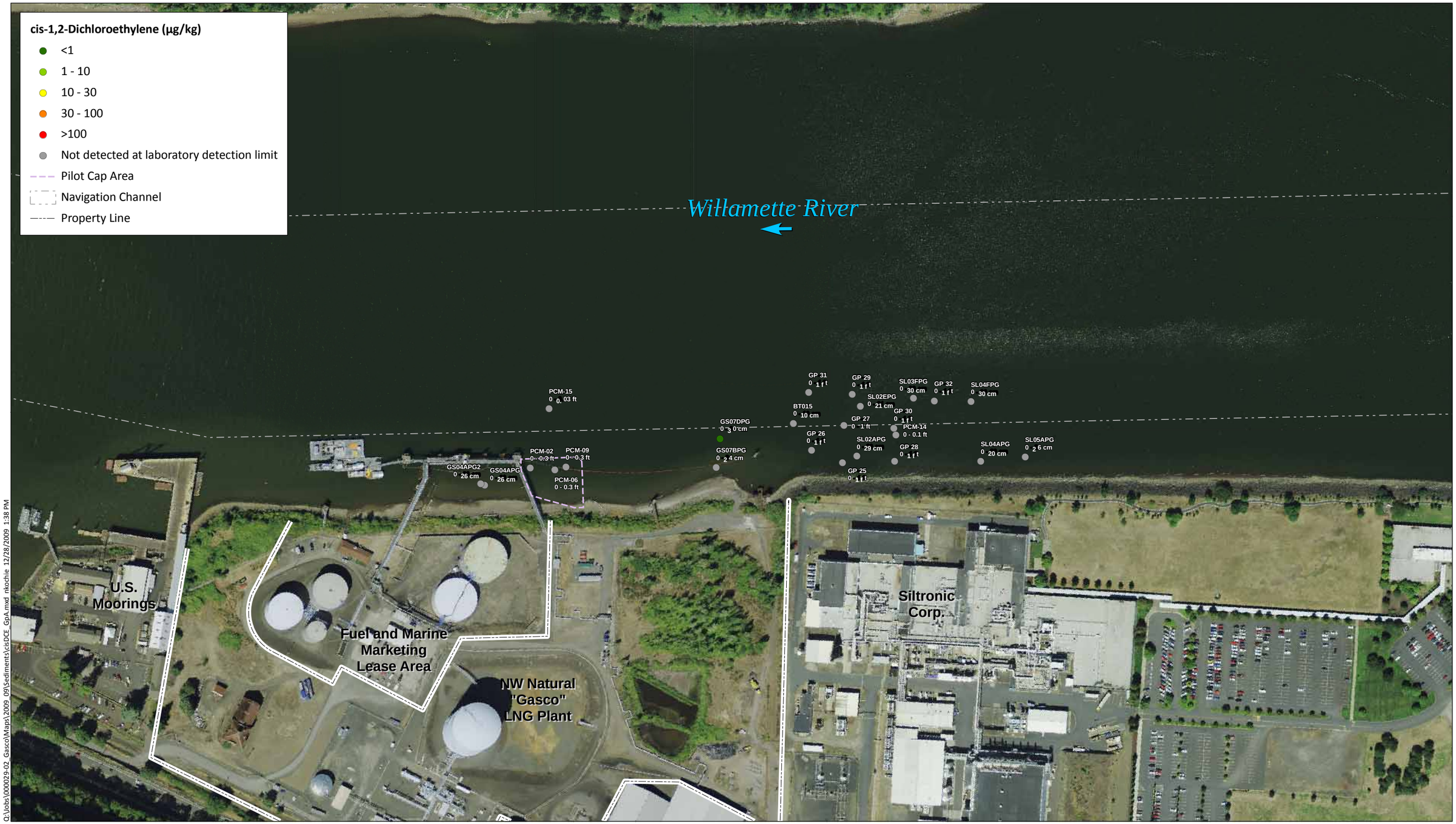


Feet
0 125 250 375 500

NOTES:
1. Inset shows Pilot Cap Monitoring Area.

Figure A5.7
Maximum Trichloroethene Sediment Concentration - 16+ ft
NW Natural "Gasco" Site
Gasco Sediment Cleanup Action



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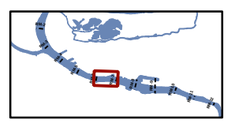

Feet
0 125 250 375 500

NOTES:
1. Consistent with the Portland Harbor Superfund Site process, surface sediment is considered 0-40 cm below mudline.

Figure A6.1
Maximum cis-1,2-Dichloroethylene Sediment Concentration - 0-40 cm
NW Natural "Gasco" Site
Gasco Sediment Cleanup Action

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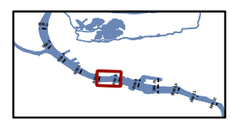

Feet
0 125 250 375 500

NOTES:
1. The 0-40+ cm depth designation indicates samples originating at the mudline and extending below 40 cm.

Figure A6.2
Maximum cis-1,2-Dichloroethylene Sediment Concentration - 0-40+ cm
NW Natural "Gasco" Site
Gasco Sediment Cleanup Action

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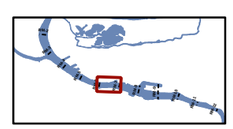
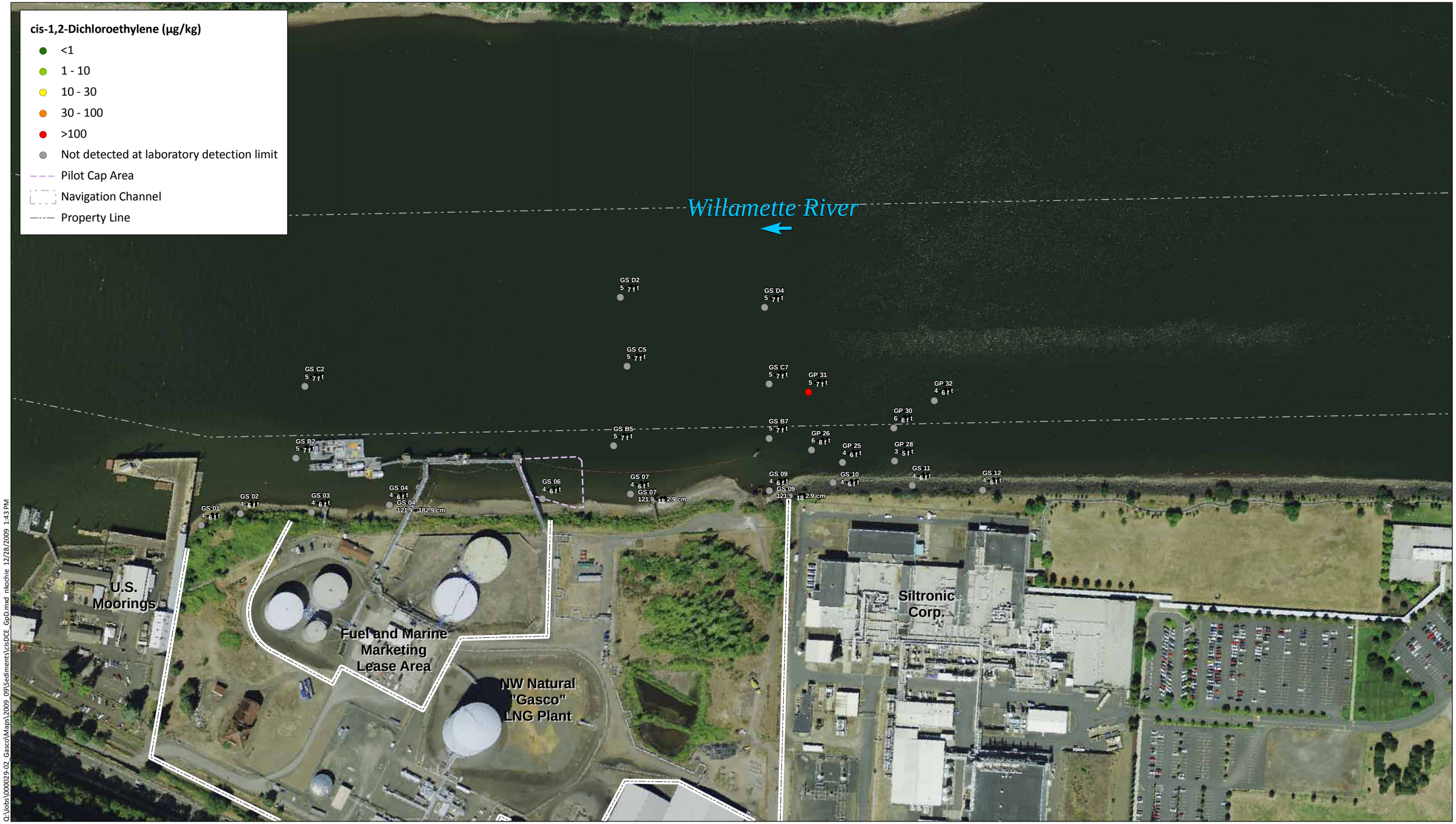


Feet
0 125 250 375 500

NOTES:
1. Inset shows Pilot Cap Monitoring Area.
2. The <>0-4 ft depth designation indicates samples that were collected originating some depth below the mudline and extending to 4 ft or less.

Figure A6.3
Maximum cis-1,2-Dichloroethylene Sediment Concentration - <> 0-4 ft
NW Natural "Gasco" Site
Gasco Sediment Cleanup Action



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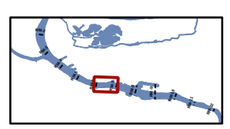

Feet
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Figure A6.4
Maximum cis-1,2-Dichloroethylene Sediment Concentration - 4-8 ft
NW Natural "Gasco" Site
Gasco Sediment Cleanup Action

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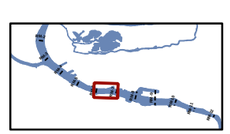

Feet
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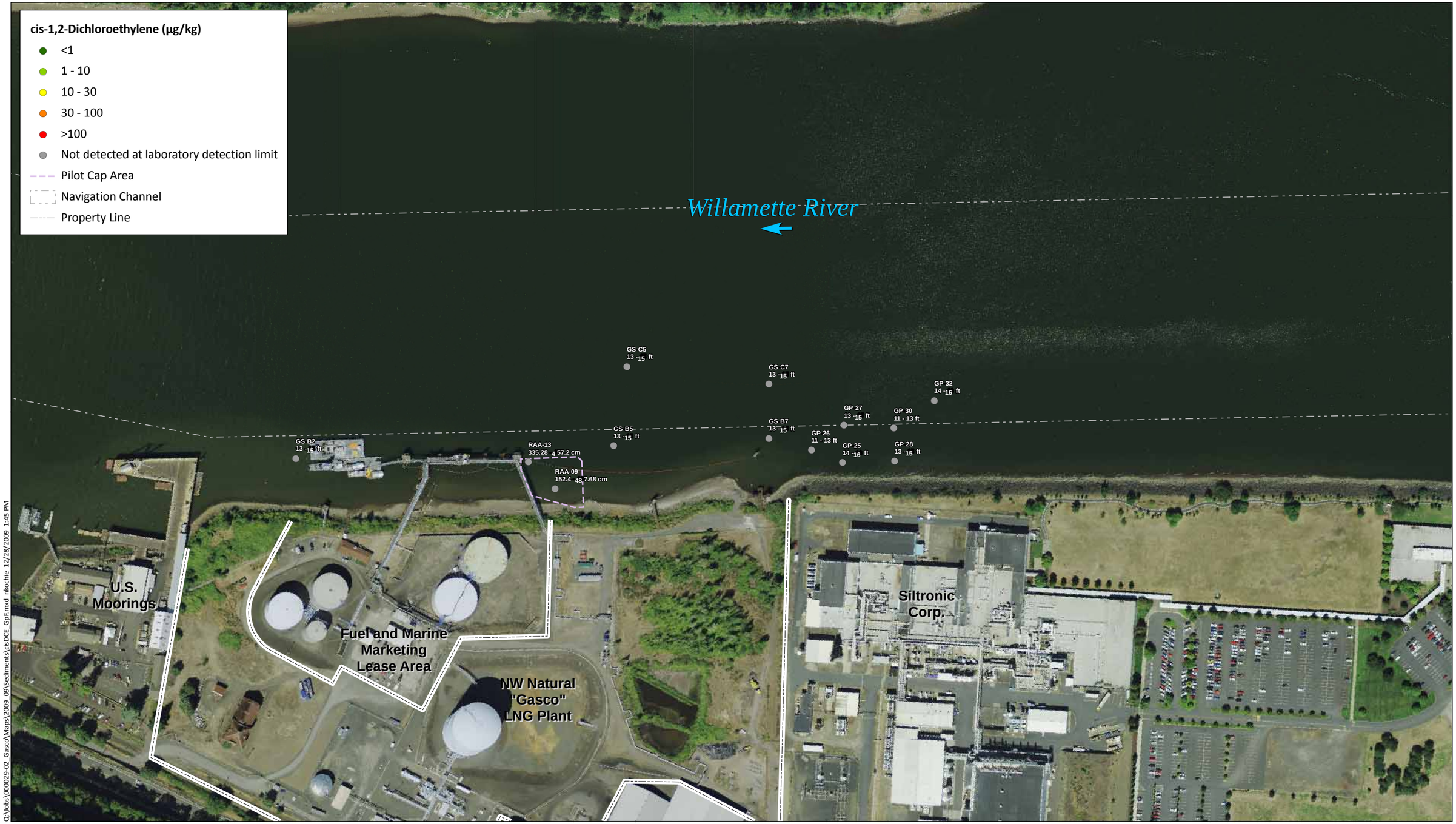
Figure A6.5
Maximum cis-1,2-Dichloroethylene Sediment Concentration - 8-12 ft
NW Natural "Gasco" Site
Gasco Sediment Cleanup Action



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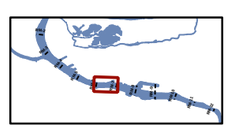
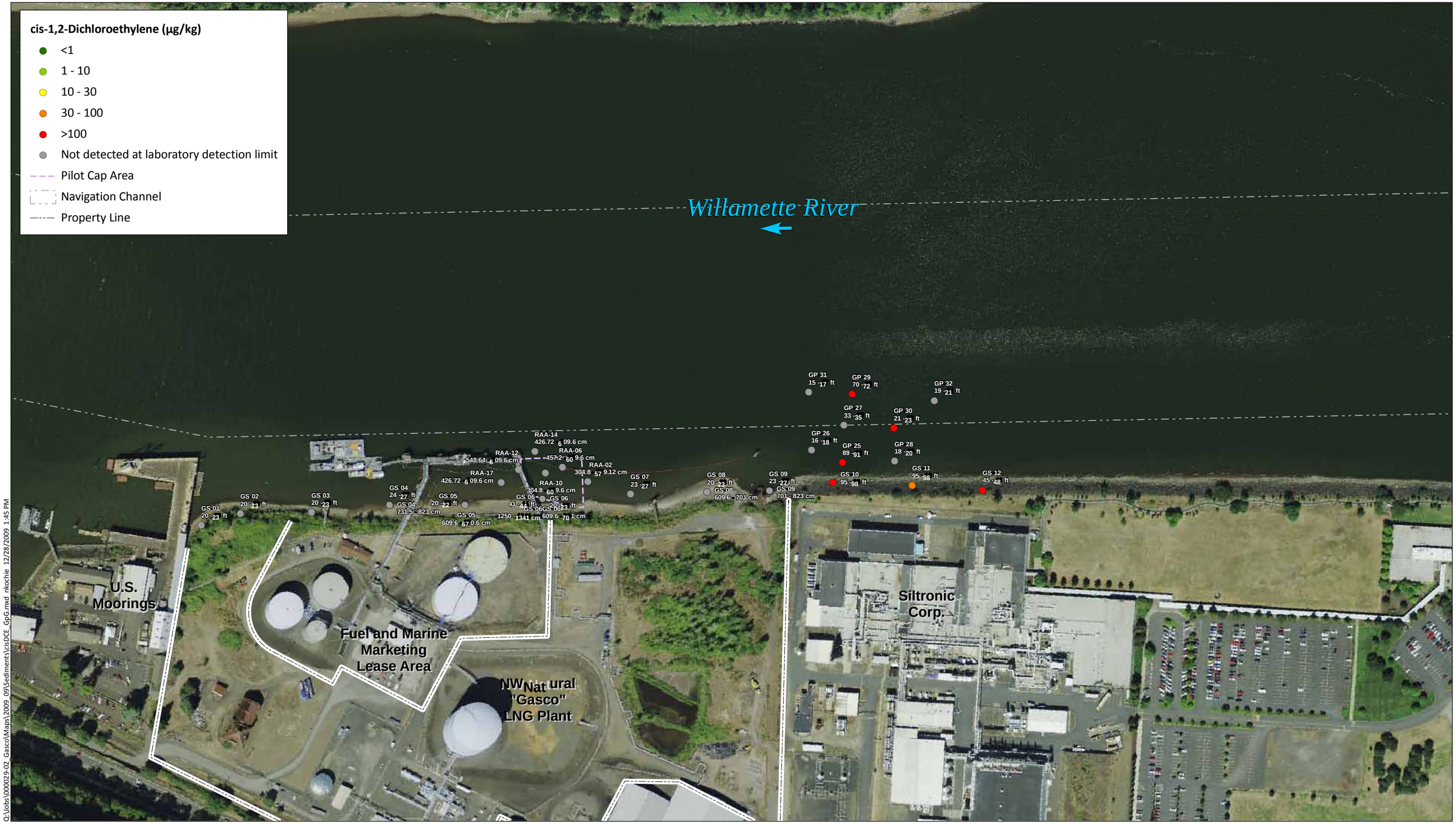


Feet
0 125 250 375 500

Figure A6.6
Maximum cis-1,2-Dichloroethylene Sediment Concentration - 12-16 ft
NW Natural "Gasco" Site
Gasco Sediment Cleanup Action



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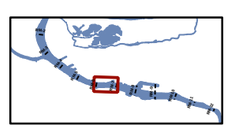
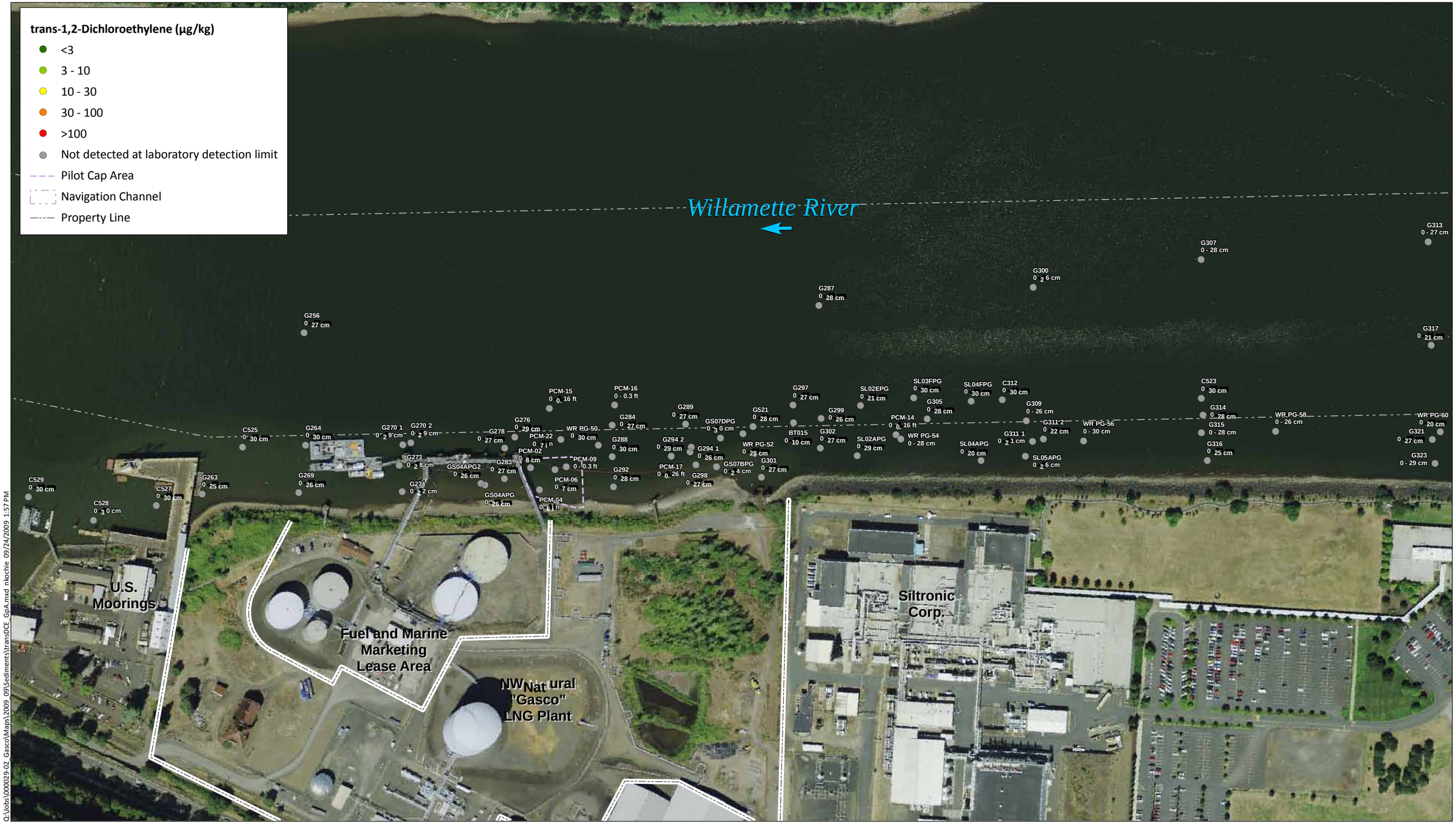


Feet
0 125 250 375 500

Figure A6.7
Maximum cis-1,2-Dichloroethylene Sediment Concentration - 16+ ft
NW Natural "Gasco" Site
Gasco Sediment Cleanup Action



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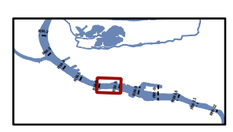

Feet
0 125 250 375 500

NOTES:
1. Consistent with the Portland Harbor Superfund Site process, surface sediment is considered 0-40 cm below mudline.

Figure A7.1
Maximum trans-1,2-Dichloroethylene Sediment Concentration - 0-40 cm
NW Natural "Gasco" Site
Gasco Sediment Cleanup Action

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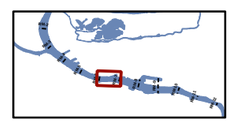
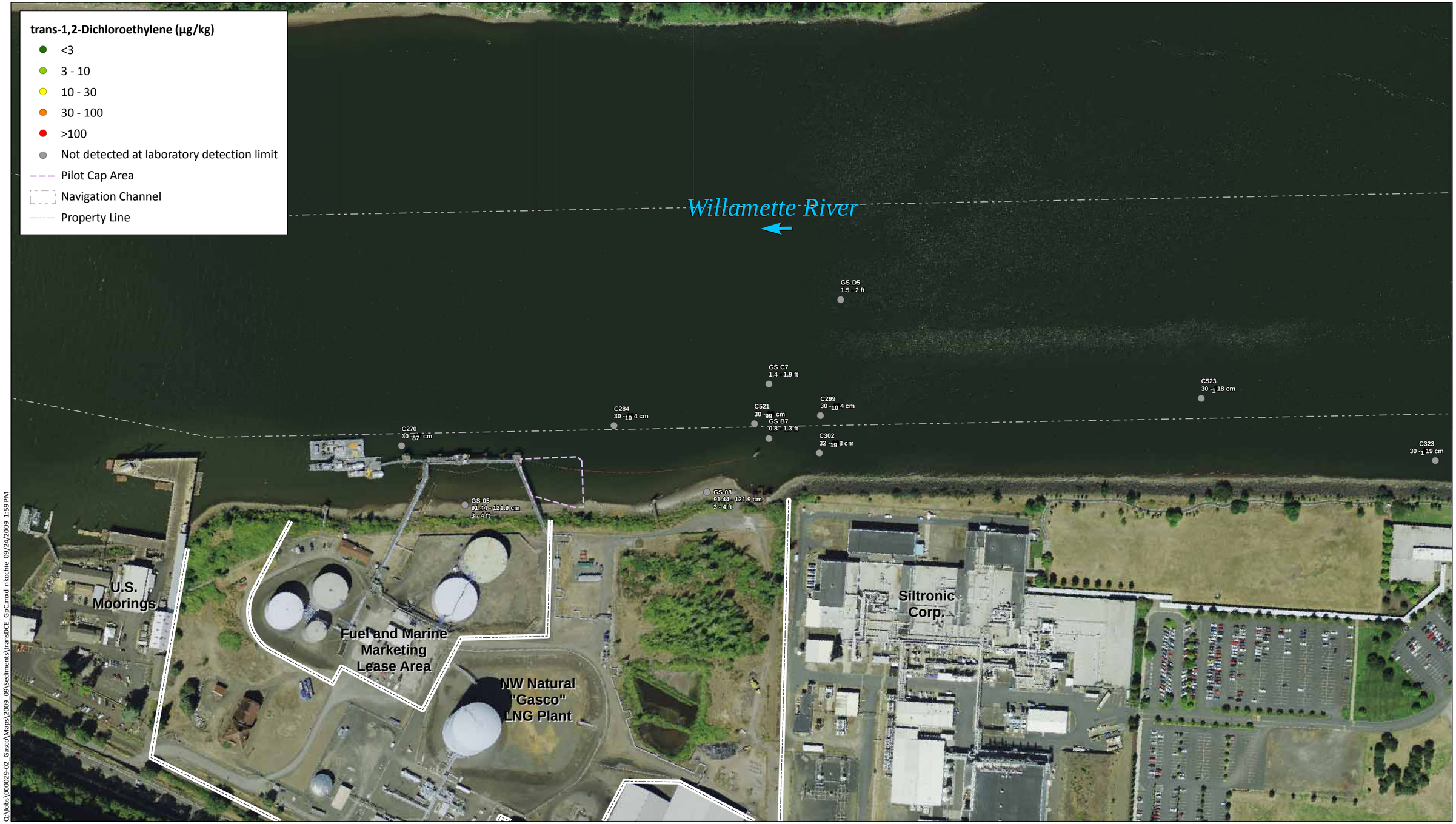


Feet
0 125 250 375 500

NOTES:
1. The 0-40+ cm depth designation indicates samples originating at the mudline and extending below 40 cm.

Figure A7.2
Maximum trans-1,2-Dichloroethylene Sediment Concentration - 0-40+ cm
NW Natural "Gasco" Site
Gasco Sediment Cleanup Action



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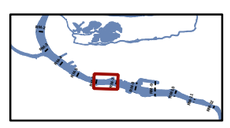
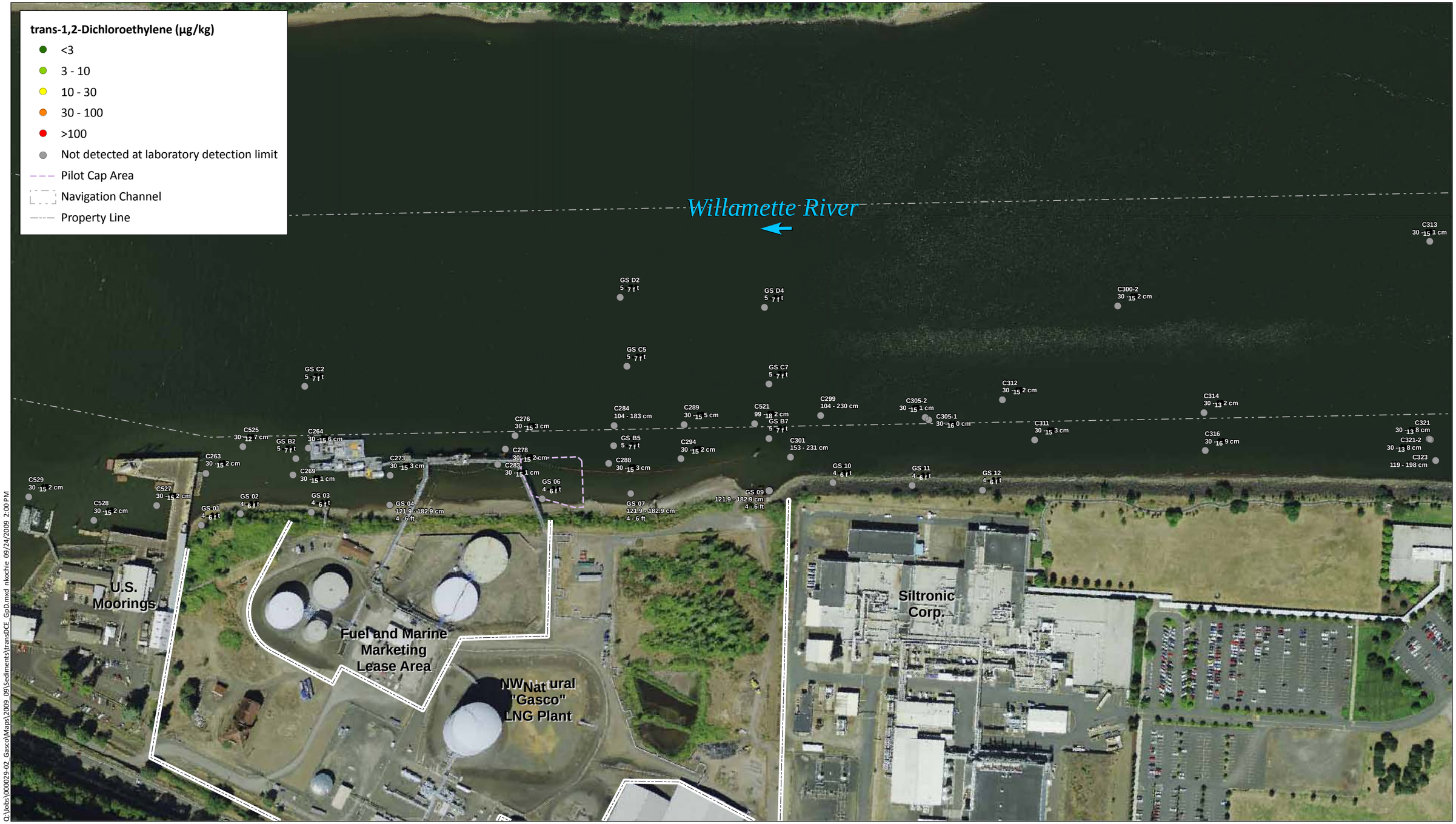


Feet
0 125 250 375 500

NOTES:
1. The <>0-4 ft depth designation indicates samples that were collected originating some depth below the mudline and extending to 4 ft or less.

Figure A7.3
Maximum trans-1,2-Dichloroethylene Sediment Concentration - <> 0-4 ft
NW Natural "Gasco" Site
Gasco Sediment Cleanup Action



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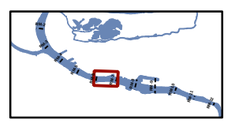
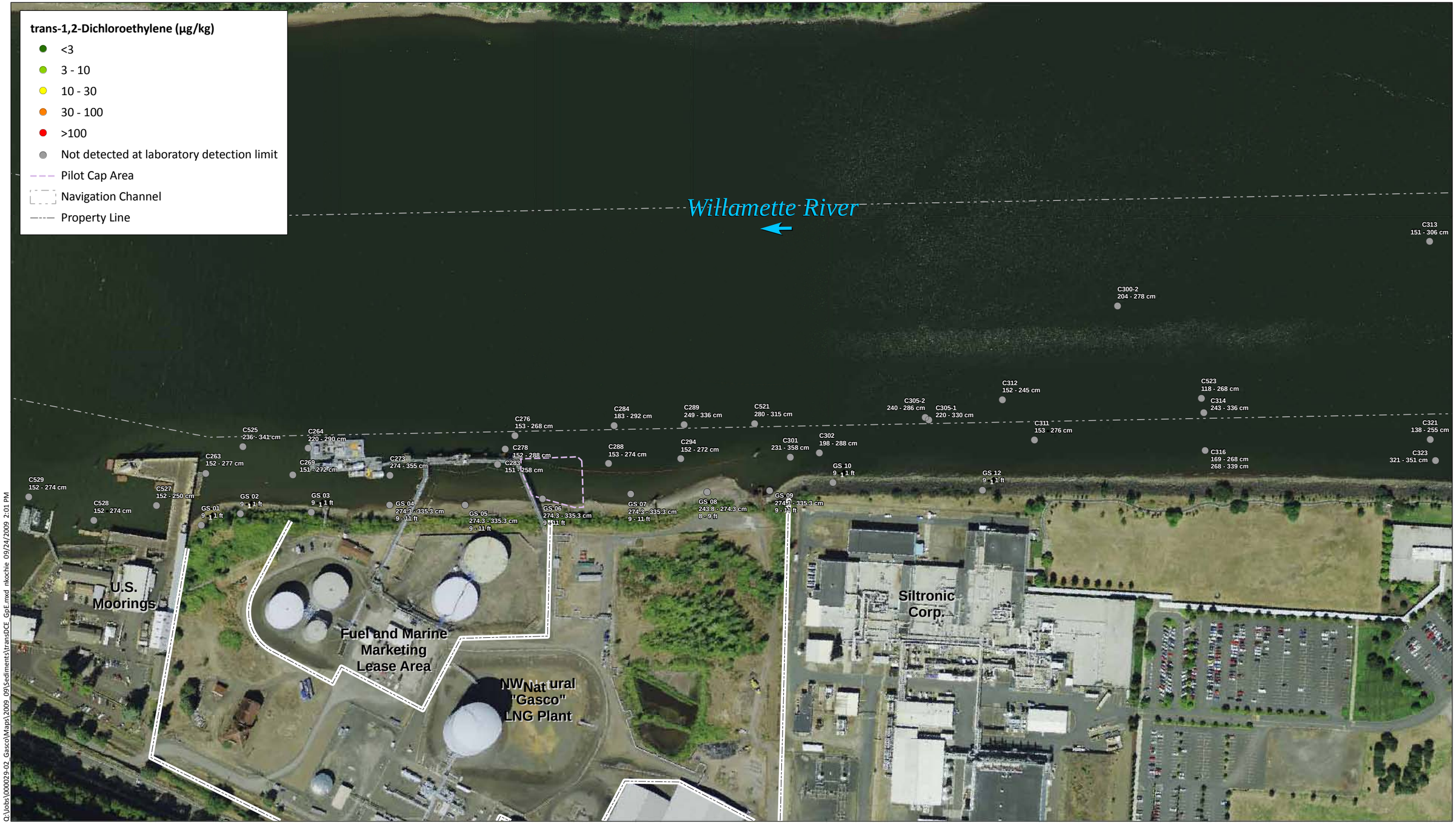


Feet
0 125 250 375 500

Figure A7.4
Maximum trans-1,2-Dichloroethylene Sediment Concentration - 4-8 ft
NW Natural "Gasco" Site
Gasco Sediment Cleanup Action



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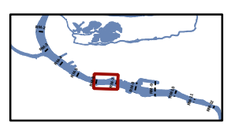

Feet
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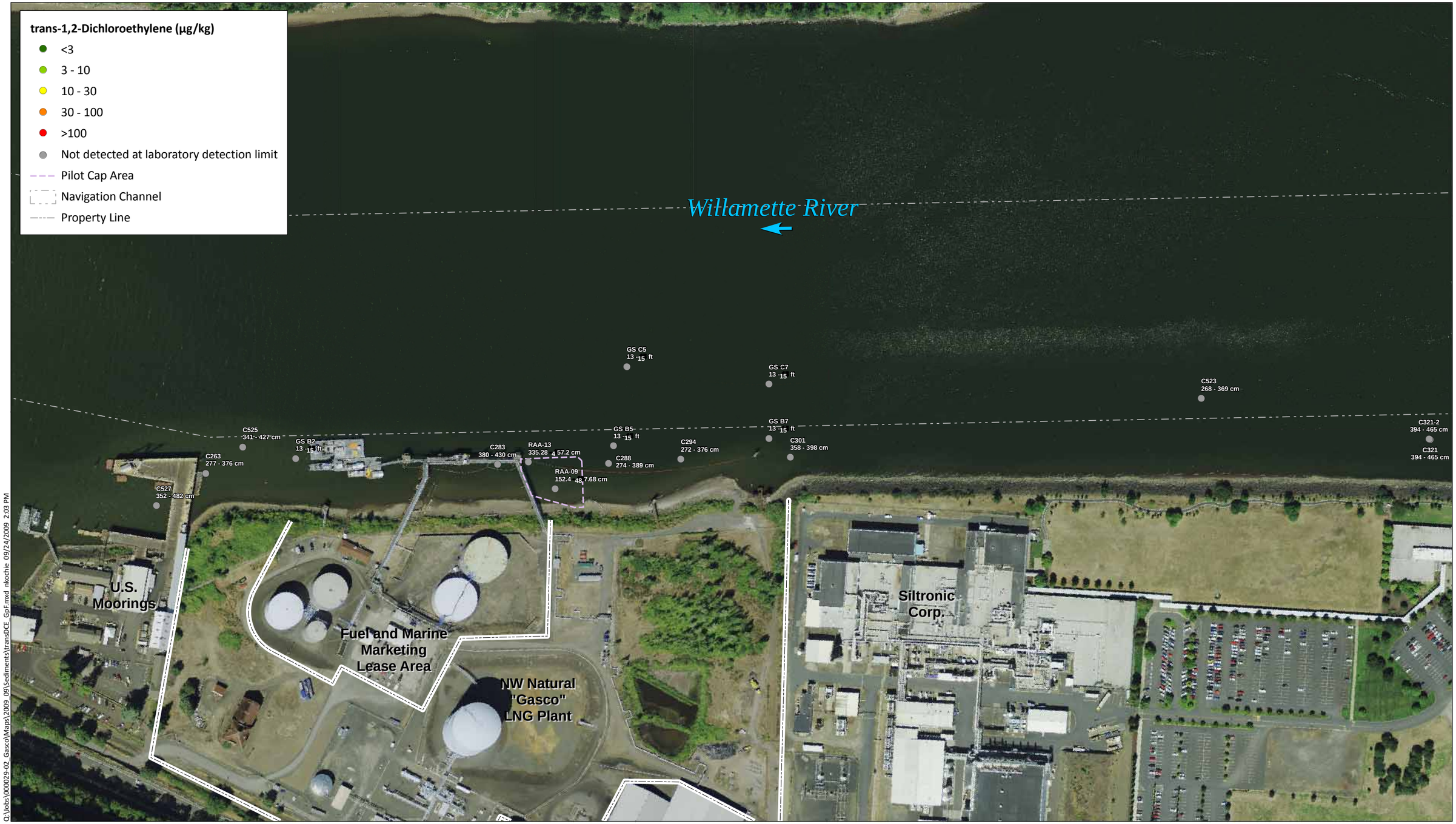
Figure A7.5
Maximum trans-1,2-Dichloroethylene Sediment Concentration - 8-12 ft
NW Natural "Gasco" Site
Gasco Sediment Cleanup Action



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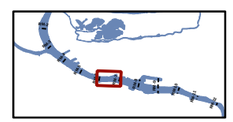

Feet
0 125 250 375 500

Figure A7.6
Maximum trans-1,2-Dichloroethylene Sediment Concentration - 12-16 ft
NW Natural "Gasco" Site
Gasco Sediment Cleanup Action

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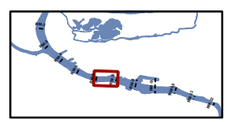
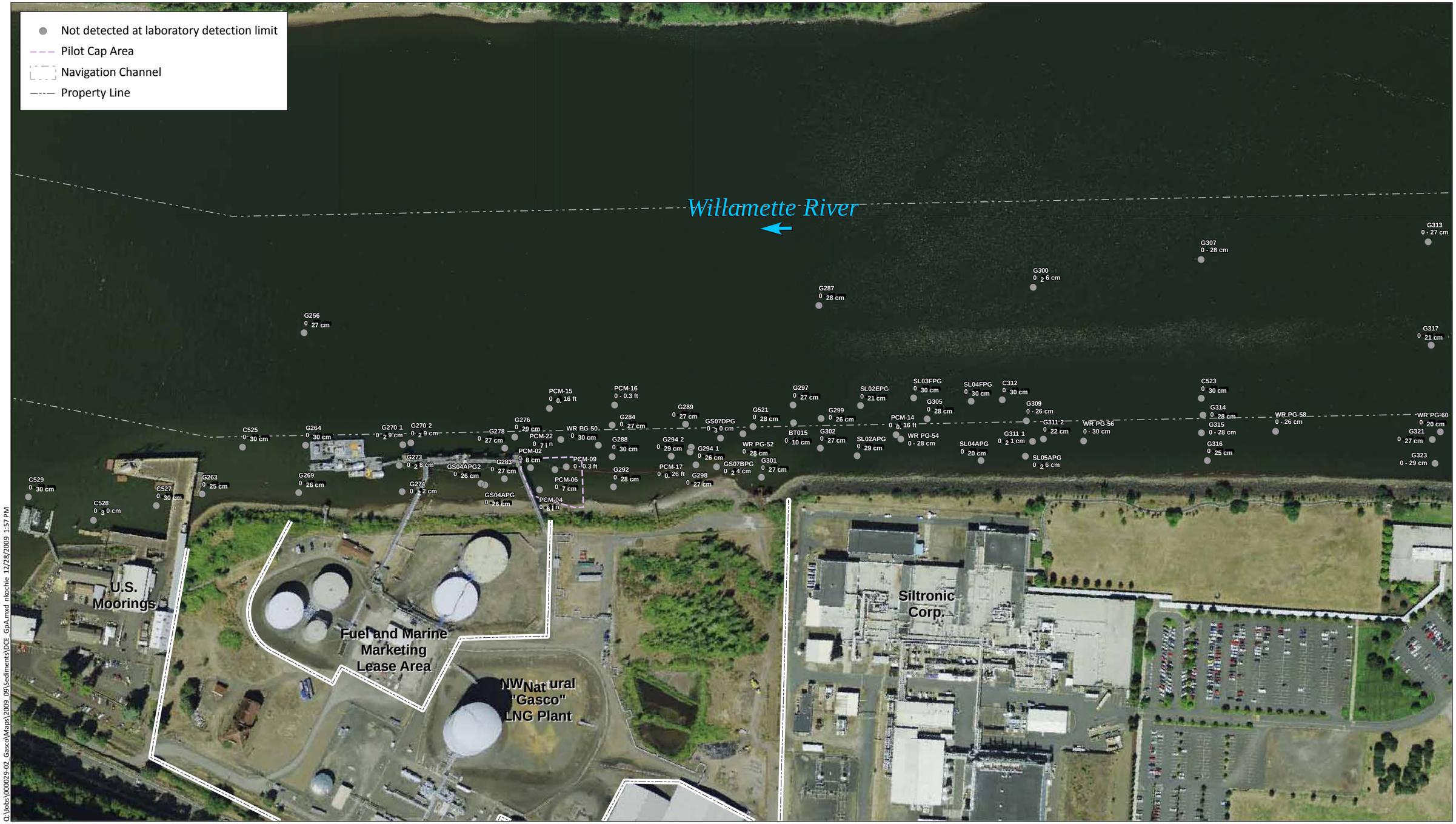


Feet
0 125 250 375 500

Figure A7.7
Maximum trans-1,2-Dichloroethylene Sediment Concentration - 16+ ft
NW Natural "Gasco" Site
Gasco Sediment Cleanup Action



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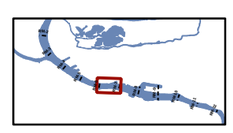

Feet

0 125 250 375 500

NOTES:
1. Consistent with the Portland Harbor Superfund Site process, surface sediment is considered 0-40 cm below mudline.

Figure A8.1
Maximum 1,1-Dichloroethylene Sediment Concentration - 0-40 cm
NW Natural "Gasco" Site
Gasco Sediment Cleanup Action

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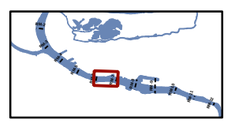
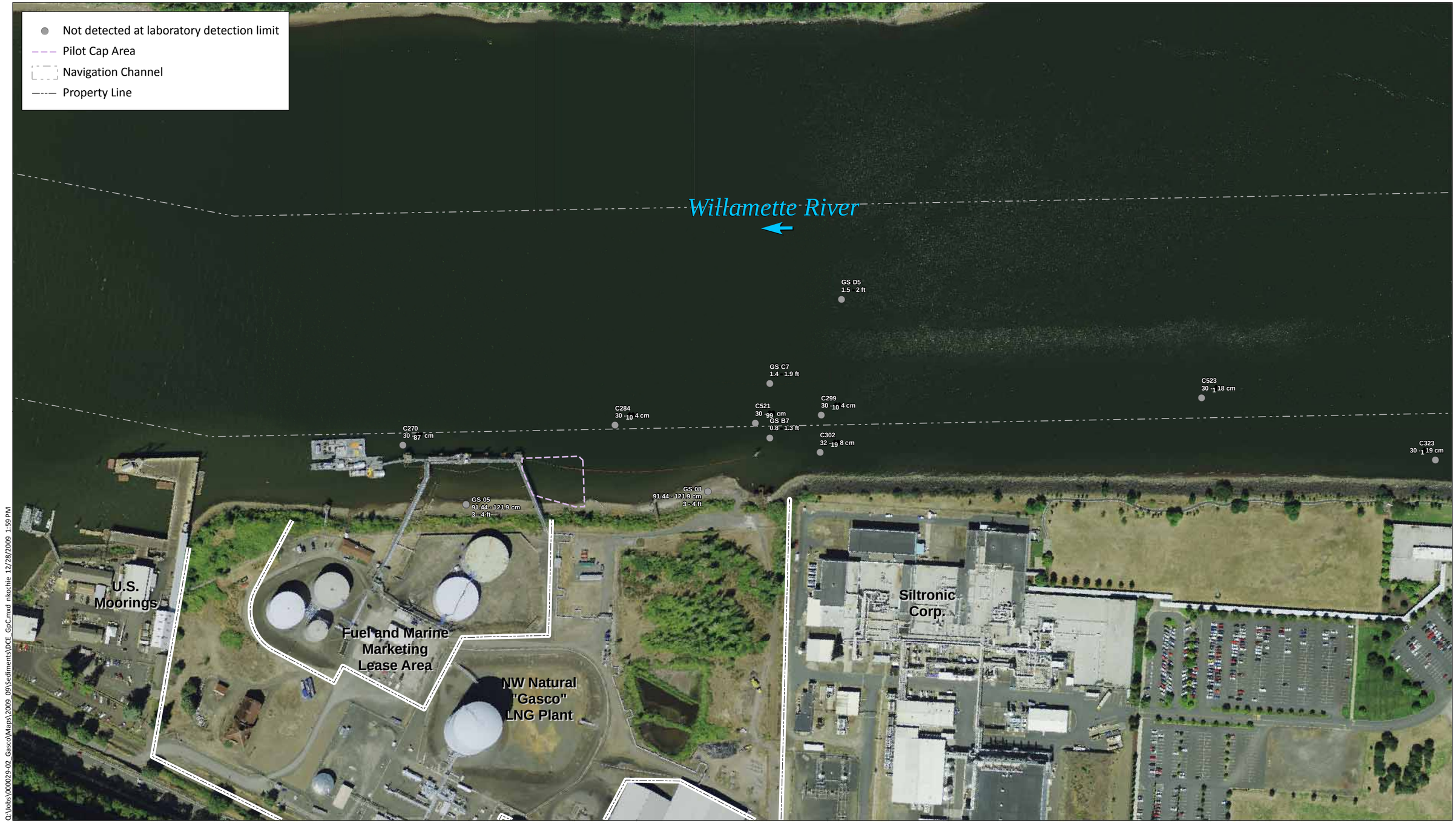


Feet
0 125 250 375 500

NOTES:
1. The 0-40+ cm depth designation indicates samples originating at the mudline and extending below 40 cm.

Figure A8.2
Maximum 1,1-Dichloroethylene Sediment Concentration - 0-40+ cm
NW Natural "Gasco" Site
Gasco Sediment Cleanup Action



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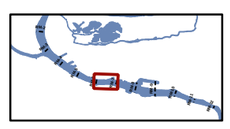
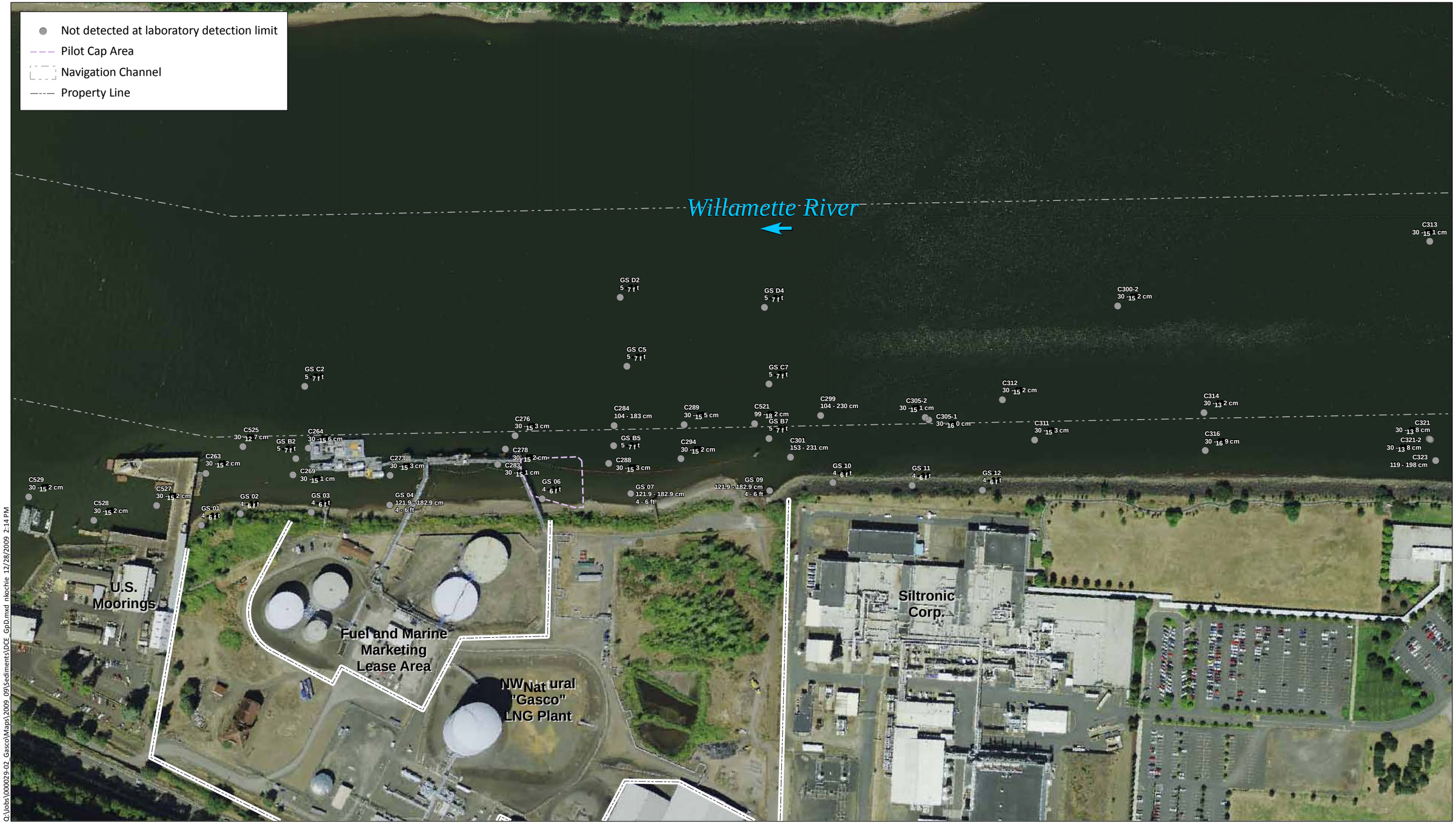


Feet
0 125 250 375 500

NOTES:
1. The <>0-4 ft depth designation indicates samples that were collected originating some depth below the mudline and extending to 4 ft or less.

Figure A8.3
Maximum 1,1-Dichloroethylene Sediment Concentration - <> 0-4 ft
NW Natural "Gasco" Site
Gasco Sediment Cleanup Action



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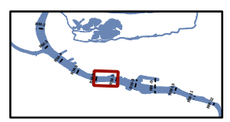
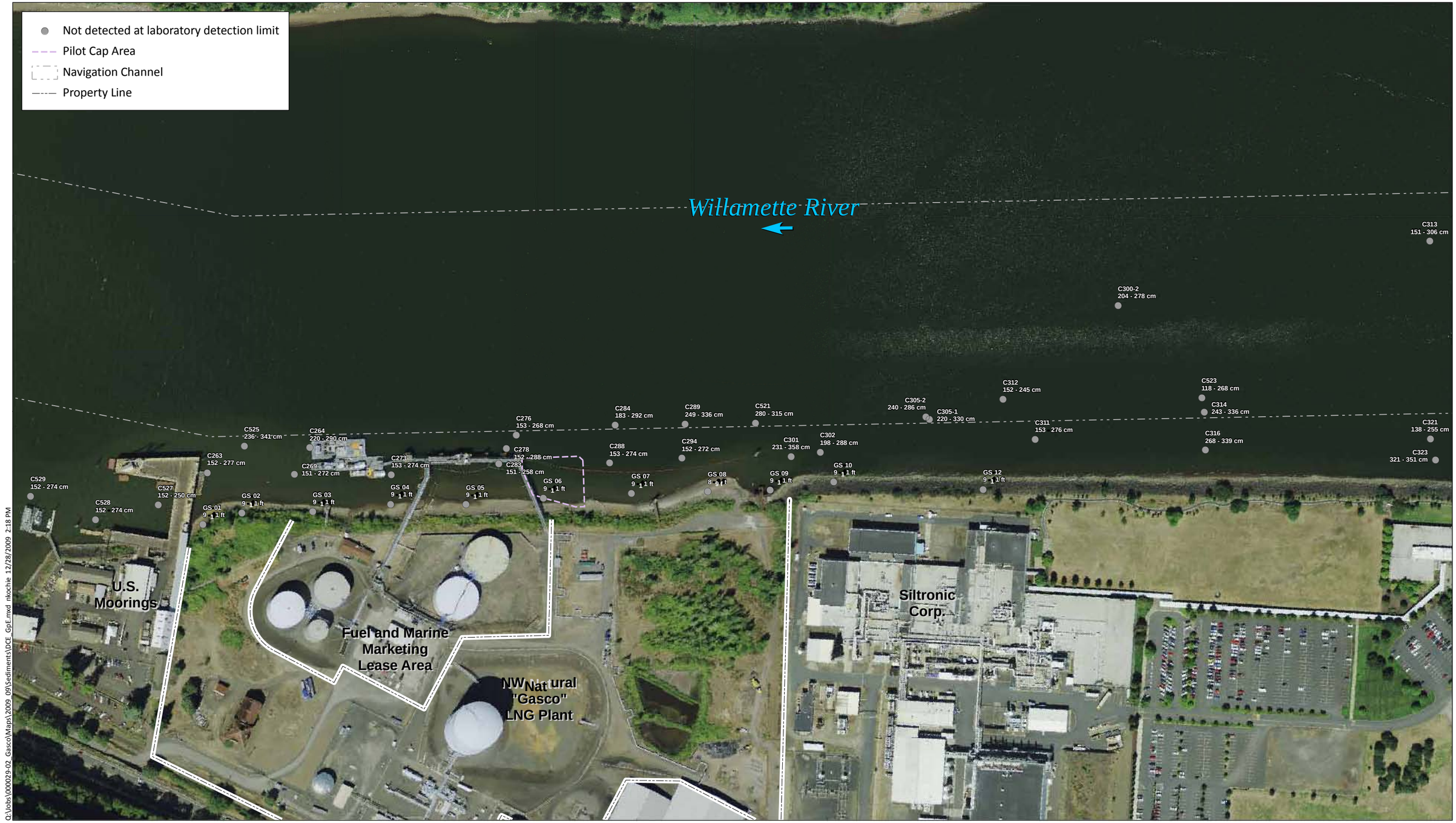


Feet
0 125 250 375 500

Figure A8.4
Maximum 1,1-Dichloroethylene Sediment Concentration - 4-8 ft
NW Natural "Gasco" Site
Gasco Sediment Cleanup Action



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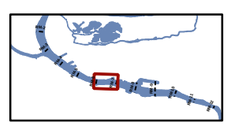
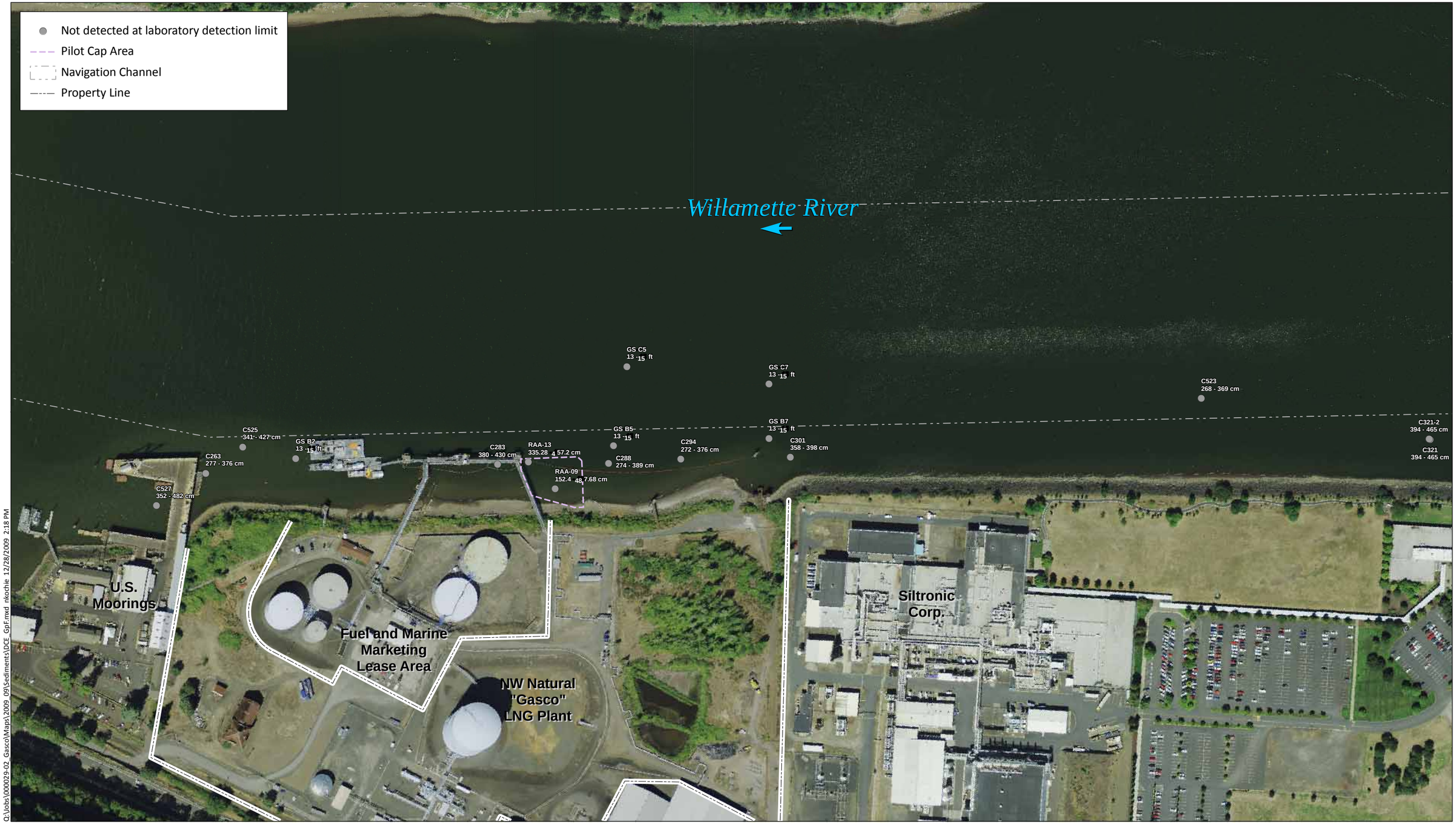


Feet
0 125 250 375 500

Figure A8.5
Maximum 1,1-Dichloroethylene Sediment Concentration - 8-12 ft
NW Natural "Gasco" Site
Gasco Sediment Cleanup Action



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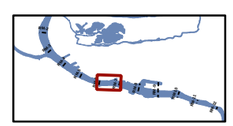
ANCHOR QEA



Feet
0 125 250 375 500

Figure A8.6
Maximum 1,1-Dichloroethylene Sediment Concentration - 12-16 ft
NW Natural "Gasco" Site
Gasco Sediment Cleanup Action

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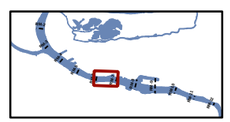
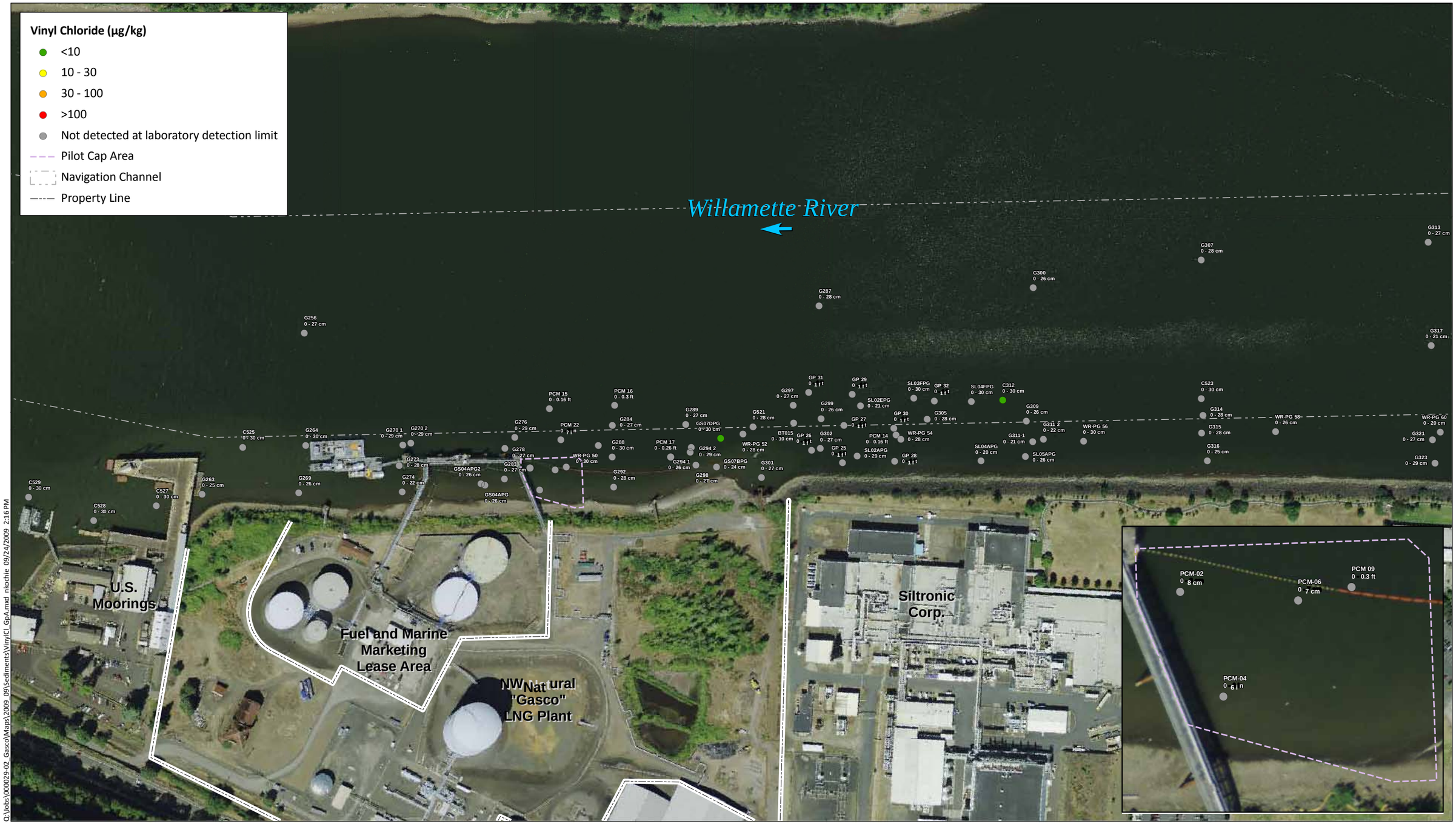


Feet
0 125 250 375 500

Figure A8.7
Maximum 1,1-Dichloroethylene Sediment Concentration - 16+ ft
NW Natural "Gasco" Site
Gasco Sediment Cleanup Action



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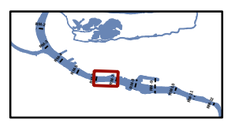
Feet
0 125 250 375 500

NOTES:
1. Inset shows Pilot Cap Monitoring Area.
2. Consistent with the Portland Harbor Superfund Site process, surface sediment is considered 0-40 cm below mudline.

Figure A9.1
Maximum Vinyl Chloride Sediment Concentration - 0-40 cm
NW Natural "Gasco" Site
Gasco Sediment Cleanup Action

Q:\Jobs\000029-02_Gasco\Maps\2009_09\Sediments\VinylCl_GpB.mxd nkochie 09/24/2009 2:16 PM

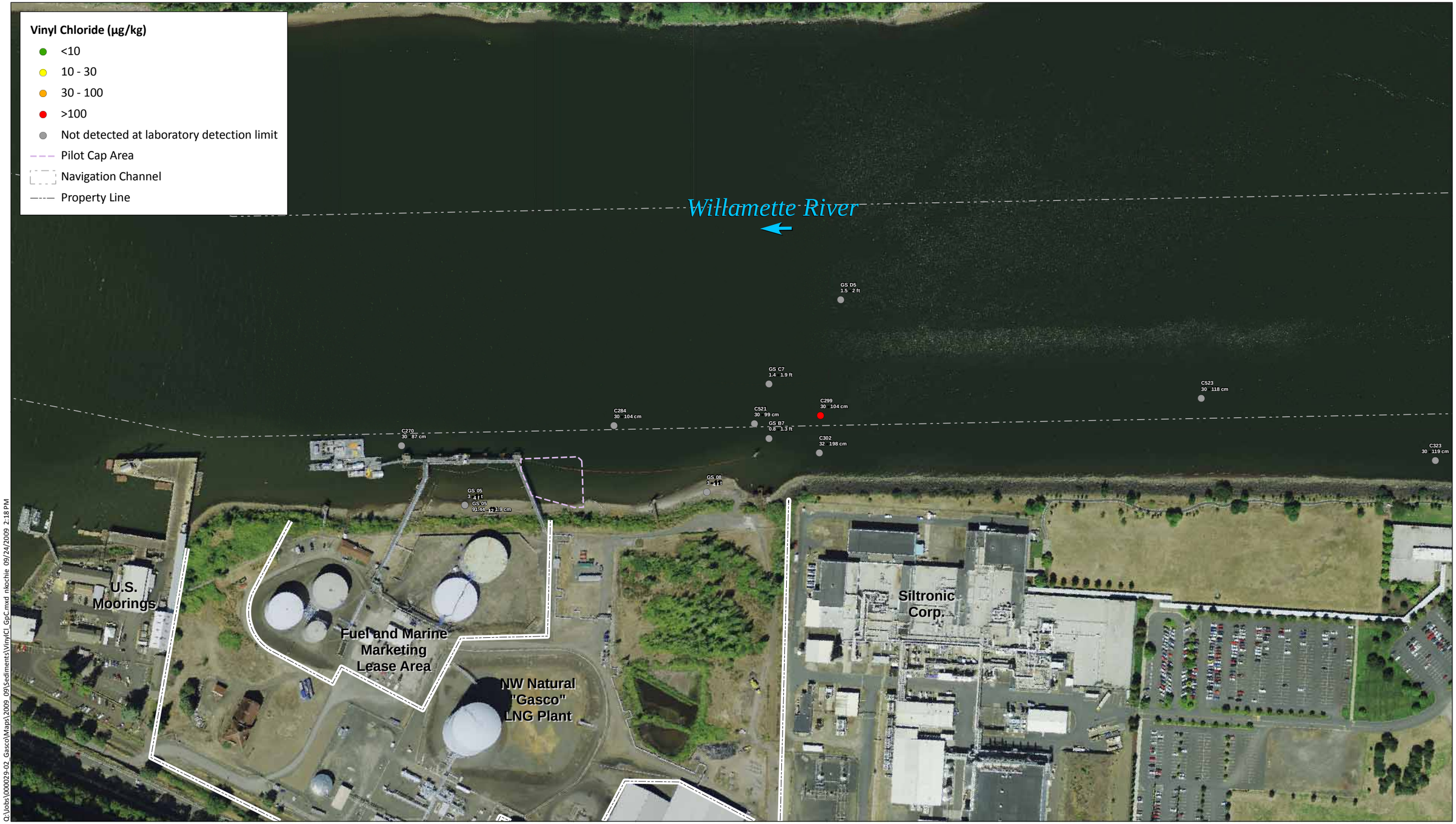
ANCHOR QEA



Feet
0 125 250 375 500

NOTES:
1. Inset shows Pilot Cap Monitoring Area.
2. The 0-40+ cm depth designation indicates samples originating at the mudline and extending below 40 cm.

Figure A9.2
Maximum Vinyl Chloride Sediment Concentration - 0-40+ cm
NW Natural "Gasco" Site
Gasco Sediment Cleanup Action



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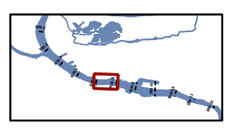
ANCHOR QEA



Feet
0 125 250 375 500

NOTES:
1. The <>0-4 ft depth designation indicates samples that were collected originating some depth below the mudline and extending to 4 ft or less.

Figure A9.3
Maximum Vinyl Chloride Sediment Concentration - <> 0-4 ft
NW Natural "Gasco" Site
Gasco Sediment Cleanup Action

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ANCHOR QEA

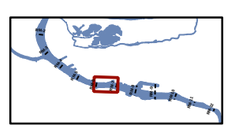
Feet
0 125 250 375 500

NOTES:
1. Inset shows Pilot Cap Monitoring Area.

Figure A9.4
Maximum Vinyl Chloride Sediment Concentration - 4-8 ft
NW Natural "Gasco" Site
Gasco Sediment Cleanup Action

Q:\Jobs\000029-02_Gasco\Maps\2009_09\Sediments\VinylCl_GpE.mxd nkochie 09/24/2009 2:19 PM

ANCHOR QEA

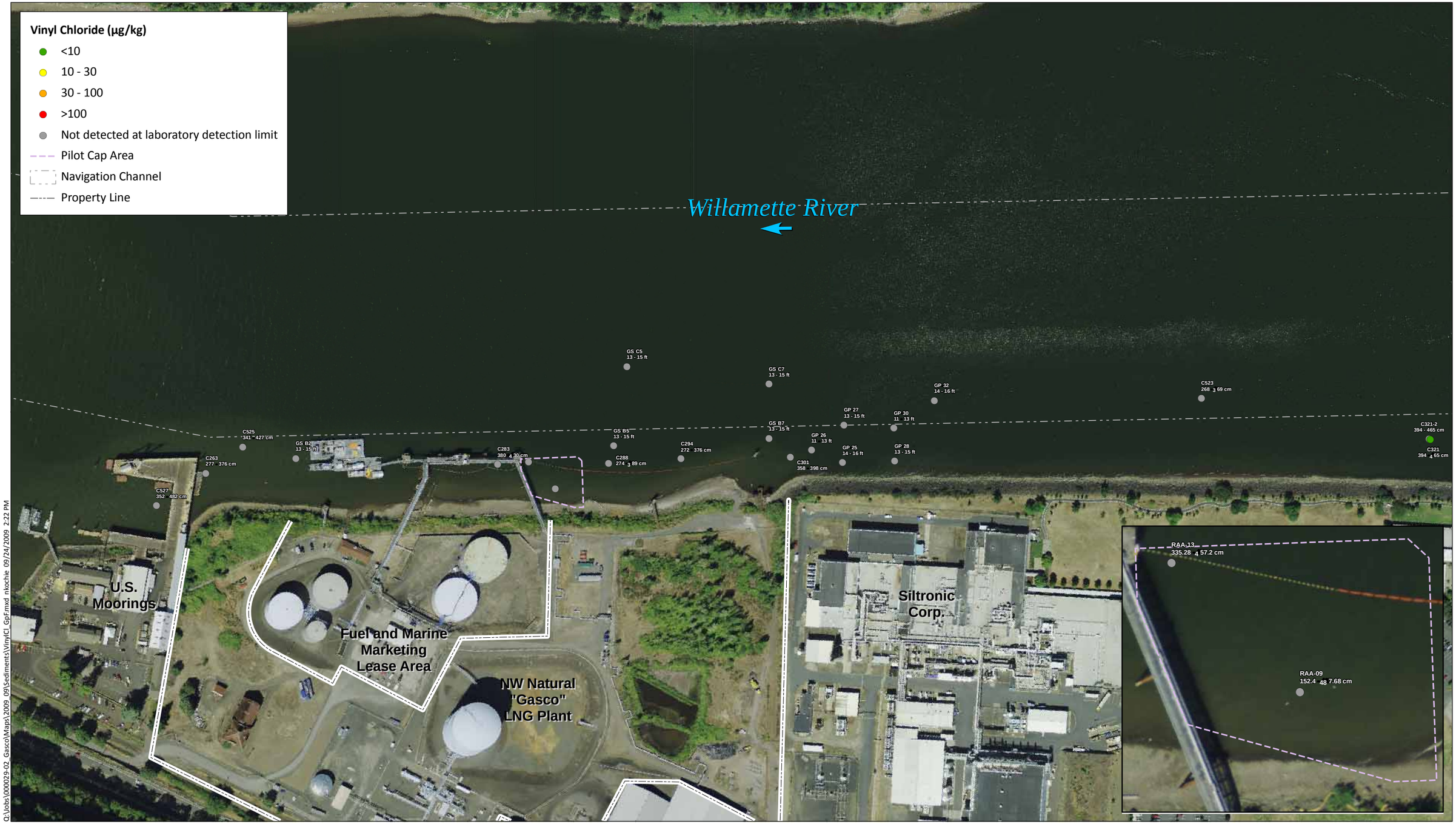


Feet

0 125 250 375 500

NOTES:
1. Inset shows Pilot Cap Monitoring Area.

Figure A9.5
Maximum Vinyl Chloride Sediment Concentration - 8-12 ft
NW Natural "Gasco" Site
Gasco Sediment Cleanup Action



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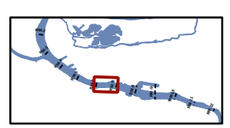
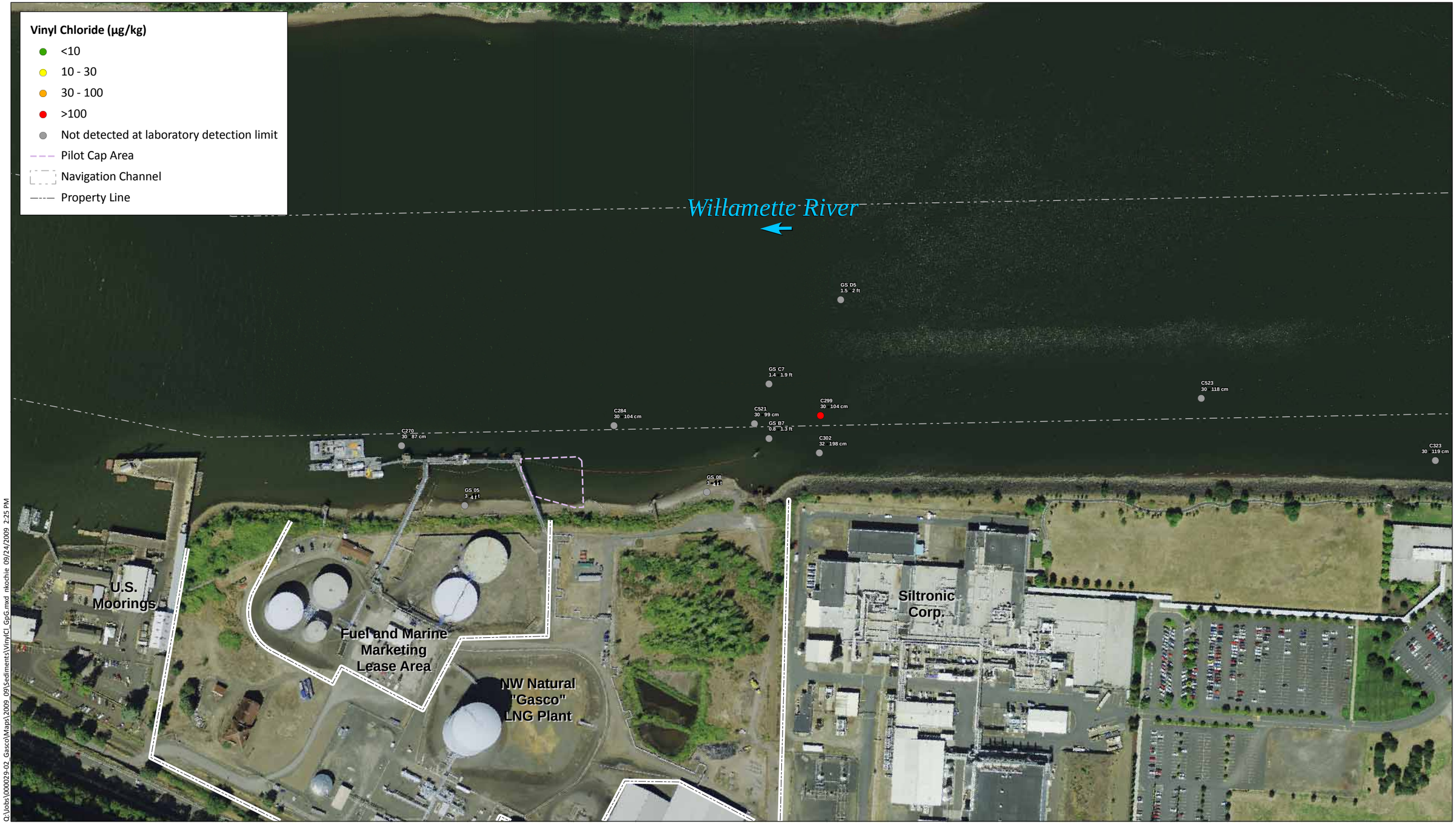


Feet
0 125 250 375 500

NOTES:
1. Inset shows Pilot Cap Monitoring Area.

Figure A9.6
Maximum Vinyl Chloride Sediment Concentration - 12-16ft
NW Natural "Gasco" Site
Gasco Sediment Cleanup Action



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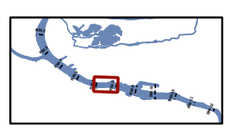
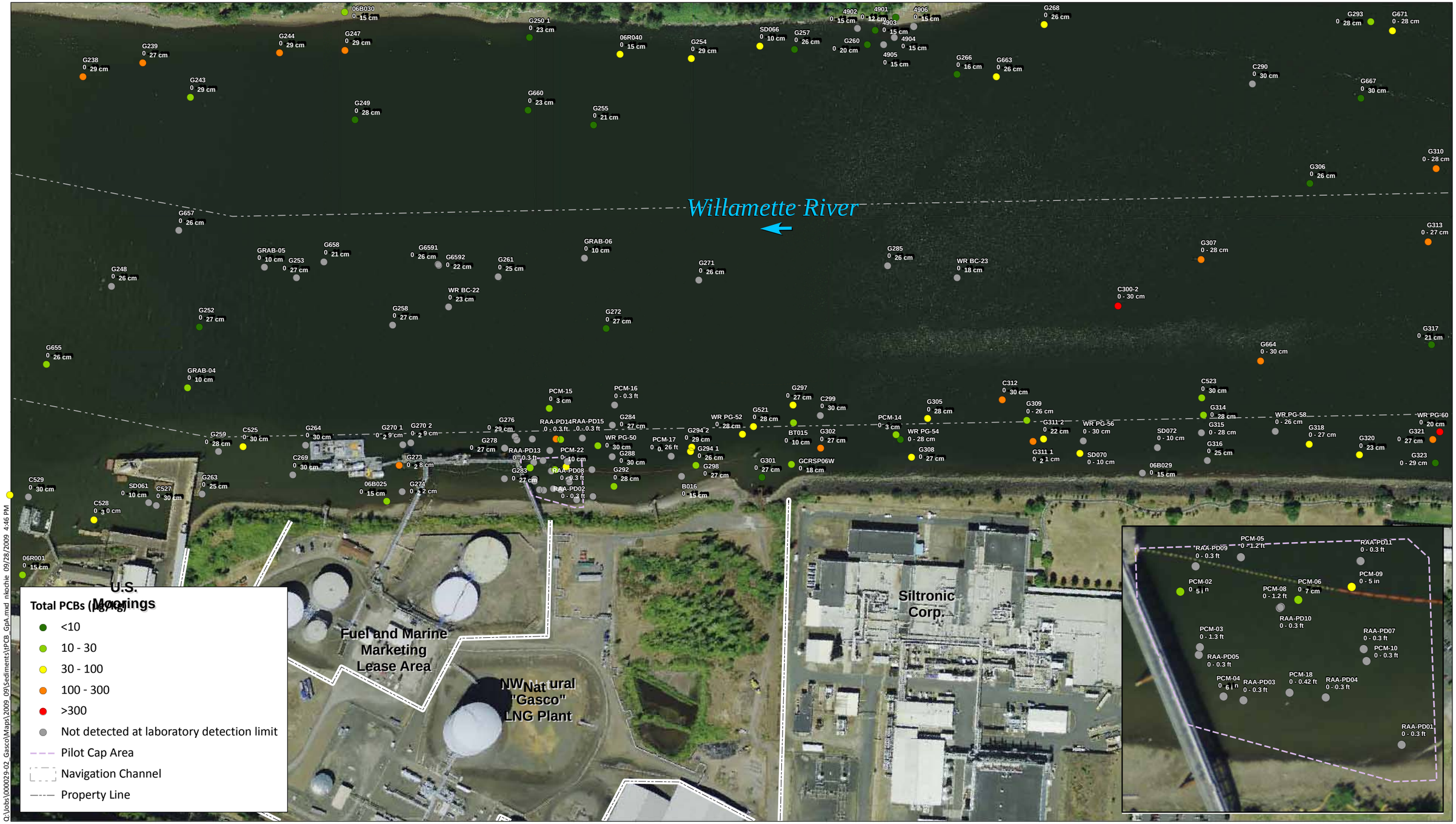
ANCHOR QEA



Feet
0 125 250 375 500

Figure A9.7
Maximum Vinyl Chloride Sediment Concentration - 16+ ft
NW Natural "Gasco" Site
Gasco Sediment Cleanup Action

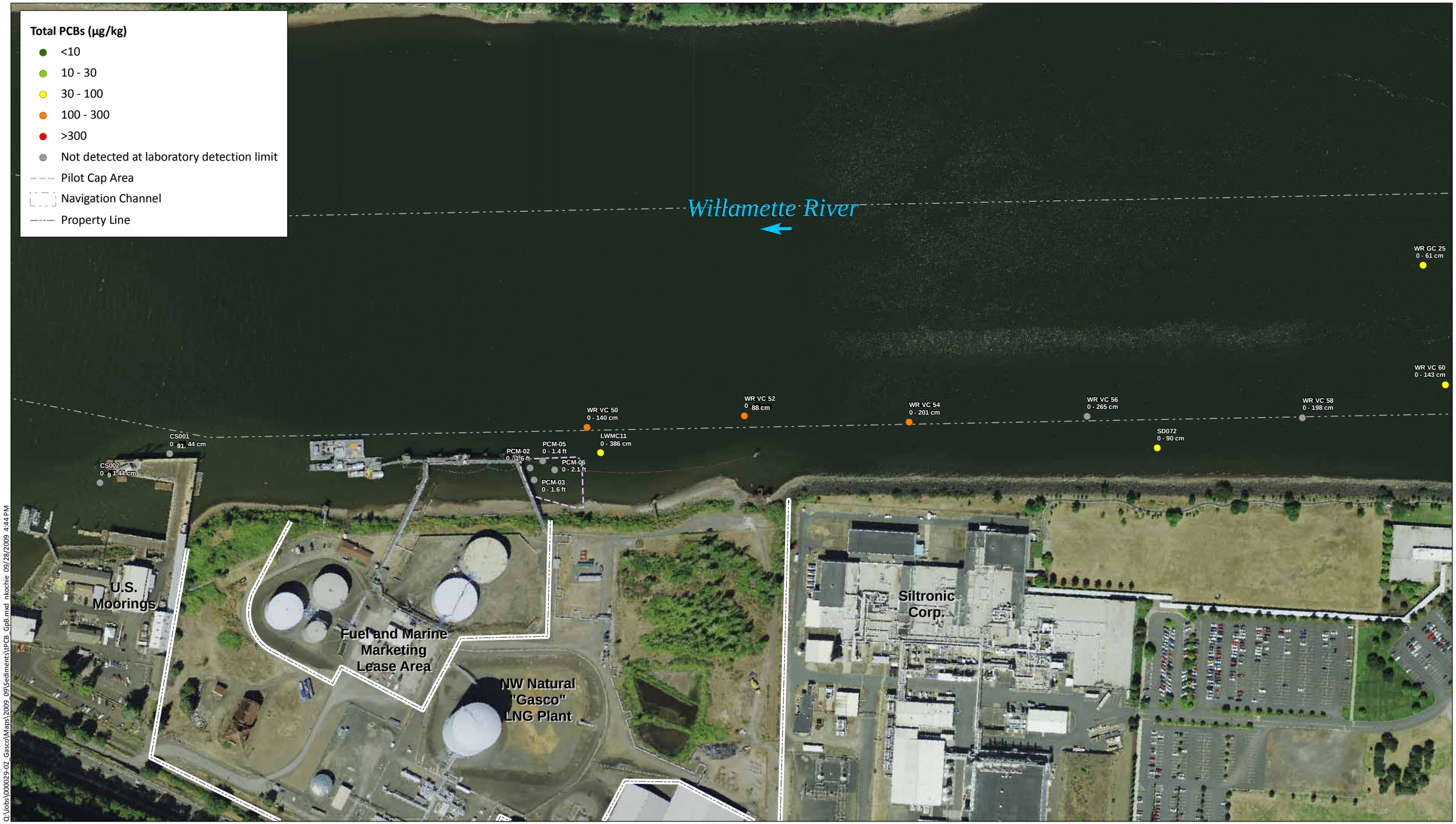


ANCHOR QEA

Feet
0 125 250 375 500

NOTES:
1. Inset shows Pilot Cap Monitoring Area.
2. Consistent with the Portland Harbor Superfund Site process, surface sediment is considered 0-40 cm below mudline.

Figure A10.1
Maximum Total PCBs Sediment Concentration - 0-40 cm
NW Natural "Gasco" Site
Gasco Sediment Cleanup Action



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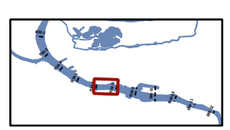

Feet
0 125 250 375 500

NOTES:
1. The 0-40+ cm depth designation indicates samples originating at the mudline and extending below 40 cm.

Figure A10.2
Maximum Total PCBs Sediment Concentration - 0-40+ cm
NW Natural "Gasco" Site
Gasco Sediment Cleanup Action

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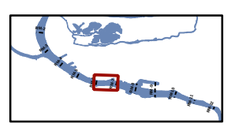
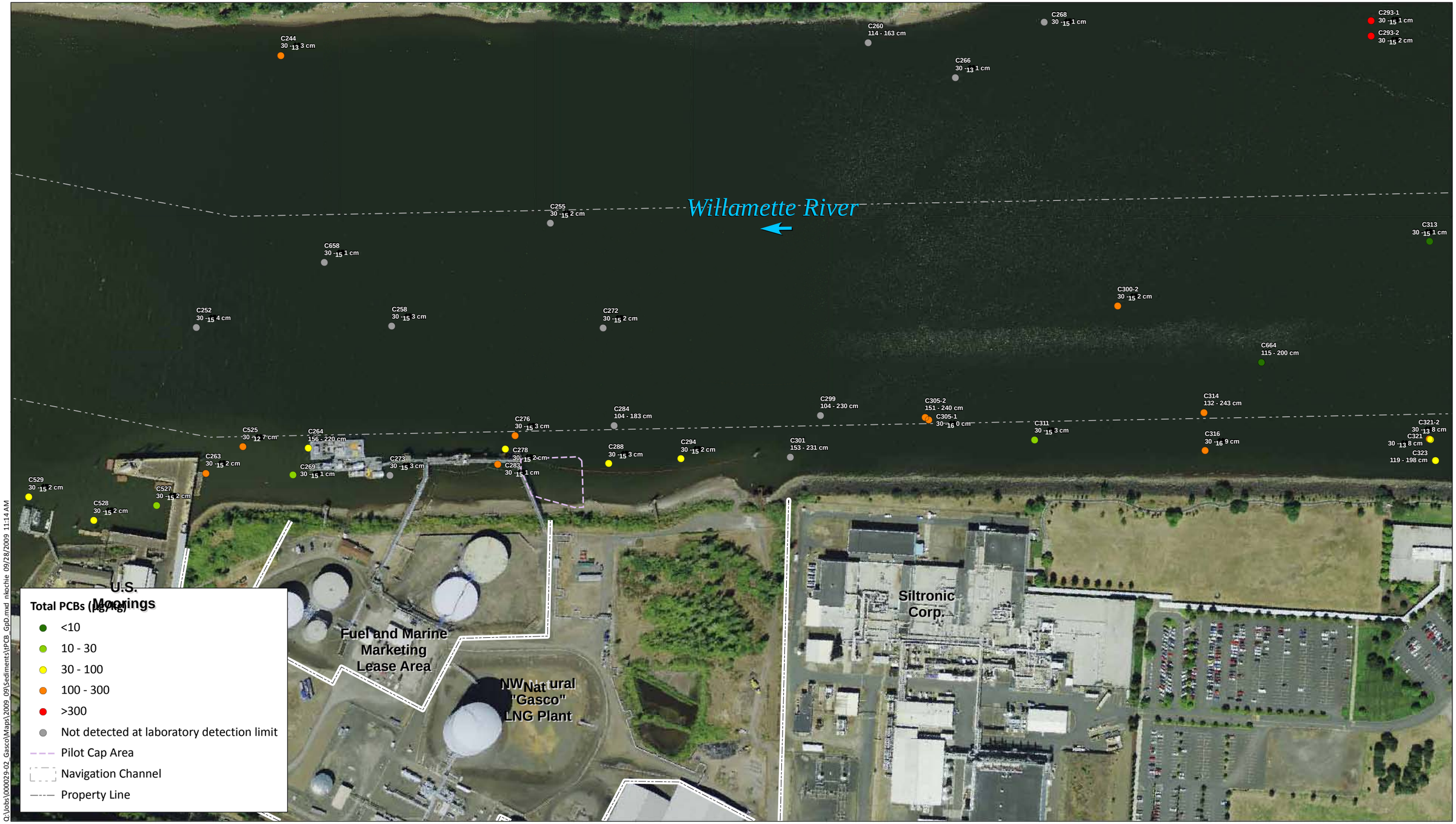
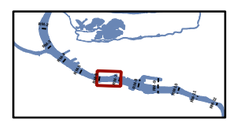


Feet
0 125 250 375 500

NOTES:
1. The <>0-4 ft depth designation indicates samples that were collected originating some depth below the mudline and extending to 4 ft or less.

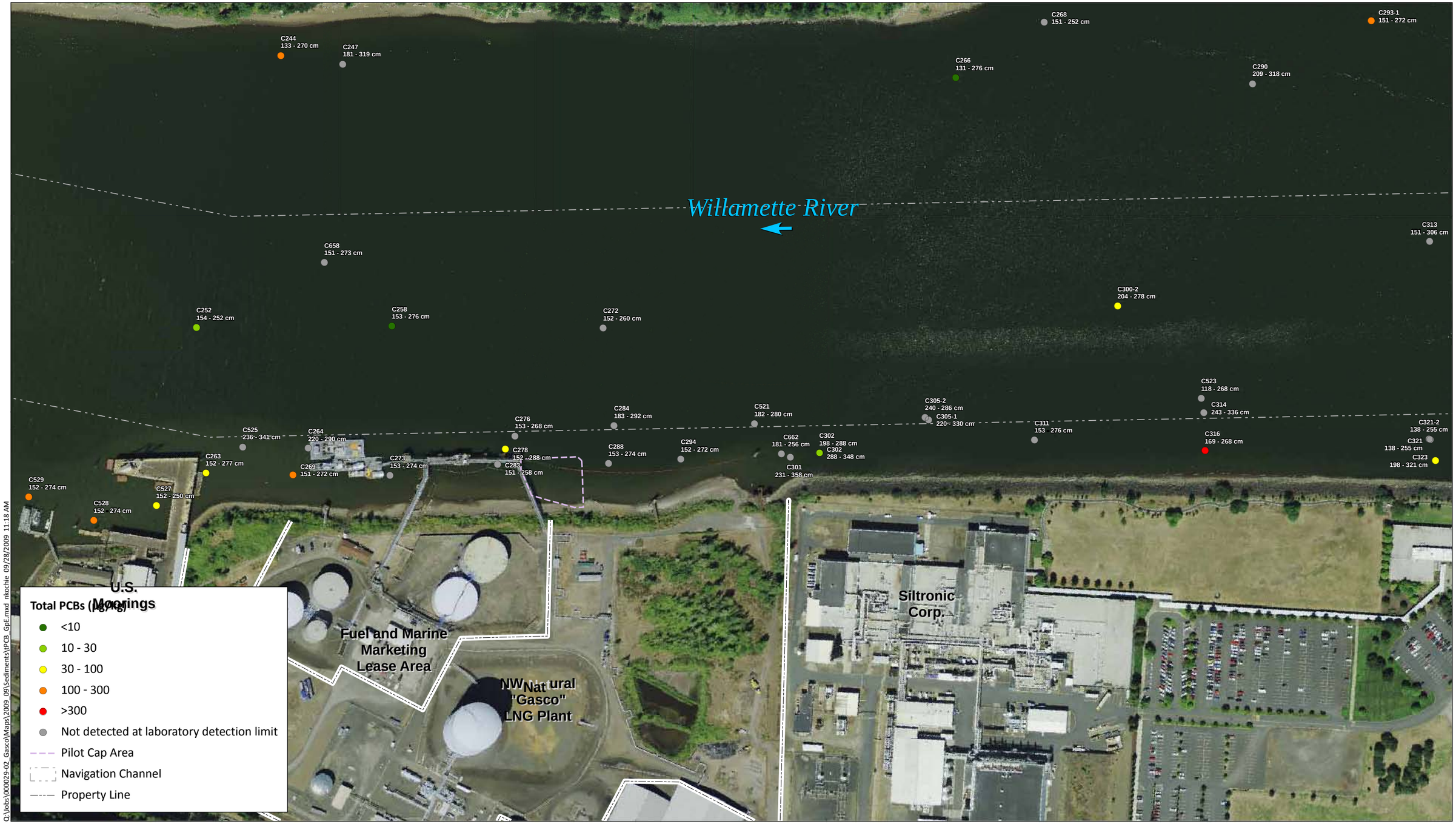
Figure A10.3
Maximum Total PCBs Sediment Concentration - <> 0-4 ft
NW Natural "Gasco" Site
Gasco Sediment Cleanup Action

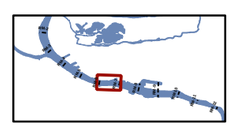




Feet
0 125 250 375 500

Figure A10.4
Maximum Total PCBs Sediment Concentration - 4-8 ft
NW Natural "Gasco" Site
Gasco Sediment Cleanup Action





Feet
0 125 250 375 500

Figure A10.5
Maximum Total PCBs Sediment Concentration - 8-12 ft
NW Natural "Gasco" Site
Gasco Sediment Cleanup Action

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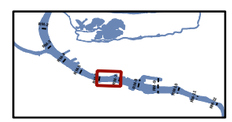
ANCHOR QEA



Feet
0 125 250 375 500

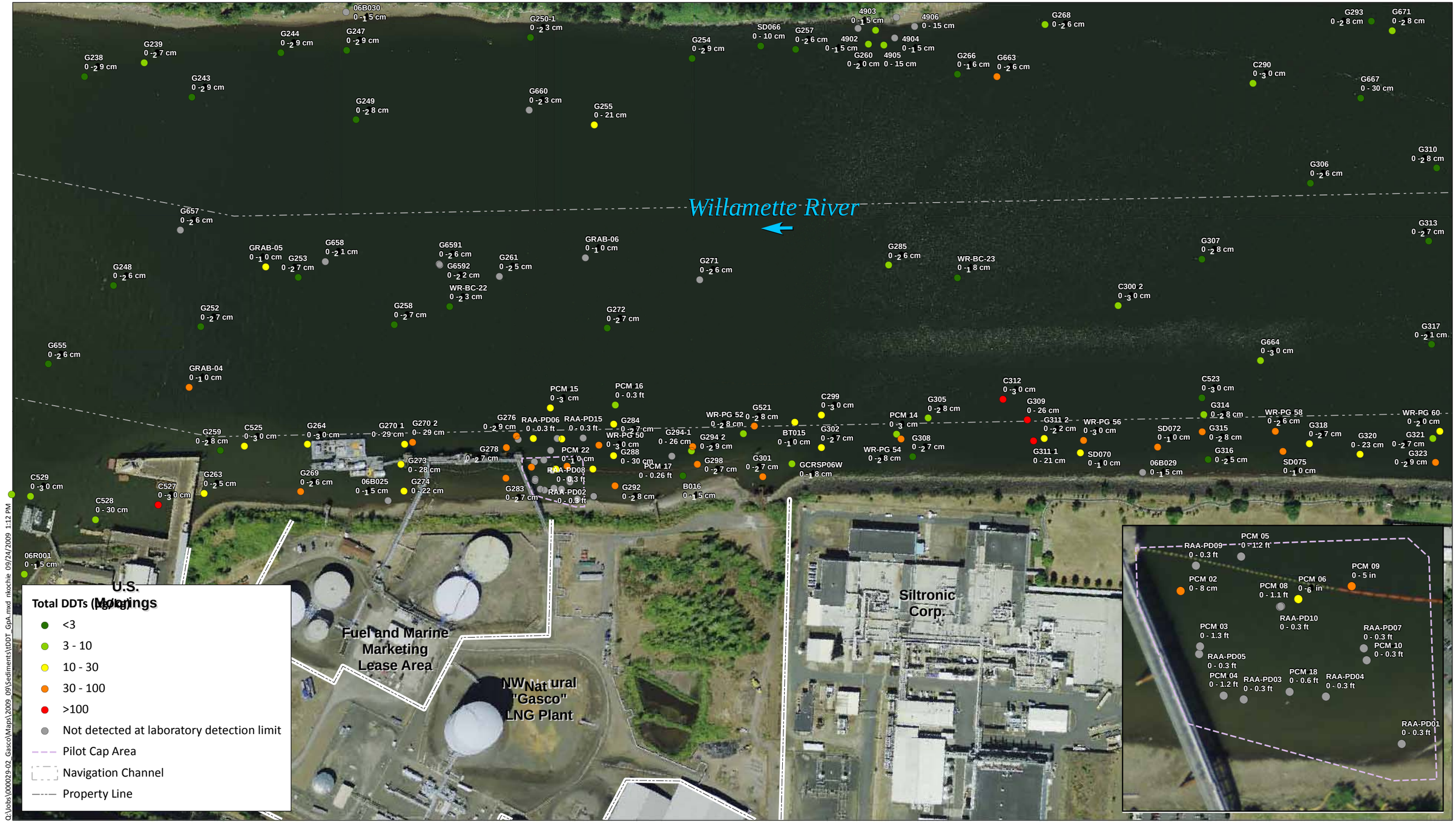
Figure A10.6
Maximum Total PCBs Sediment Concentration - 12-16 ft
NW Natural "Gasco" Site
Gasco Sediment Cleanup Action

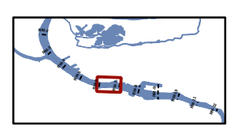
Q:\Jobs\000029-02_Gasco\Maps\2009_09\Sediments\tPCB_GpG.mxd nkochie 09/28/2009 10:47 AM

ANCHOR QEA

Feet
0 125 250 375 500

Figure A10.7
Maximum Total PCBs Sediment Concentration - 16+ ft
NW Natural "Gasco" Site
Gasco Sediment Cleanup Action

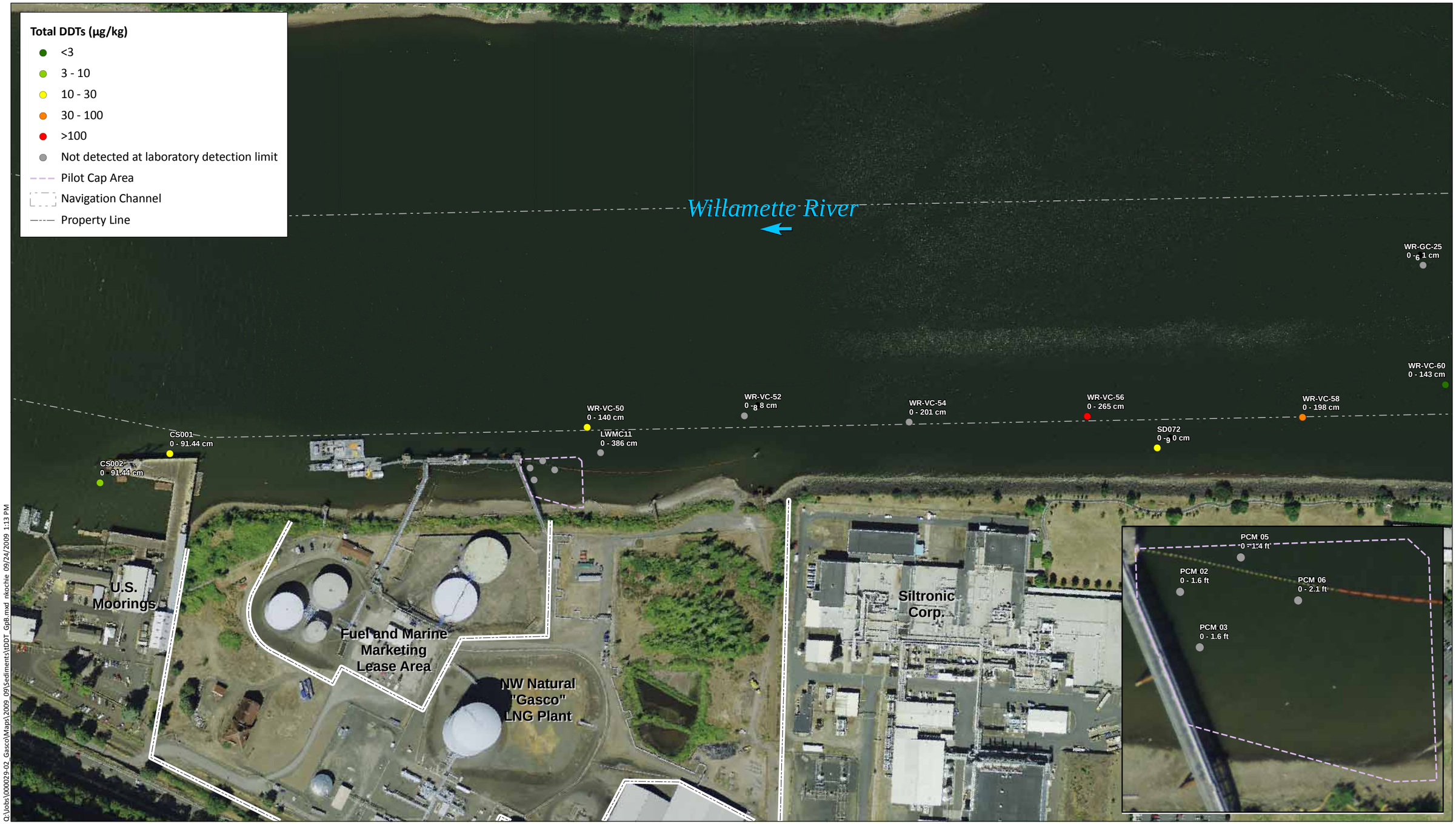




Feet
0 125 250 375 500

NOTES:
1. Inset shows Pilot Cap Monitoring Area.
2. Consistent with the Portland Harbor Superfund Site process, surface sediment is considered 0-40 cm below mudline.

Figure A11.1
Maximum Total DDTs Sediment Concentration - 0-40 cm
NW Natural "Gasco" Site
Gasco Sediment Cleanup Action



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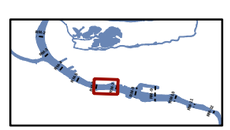
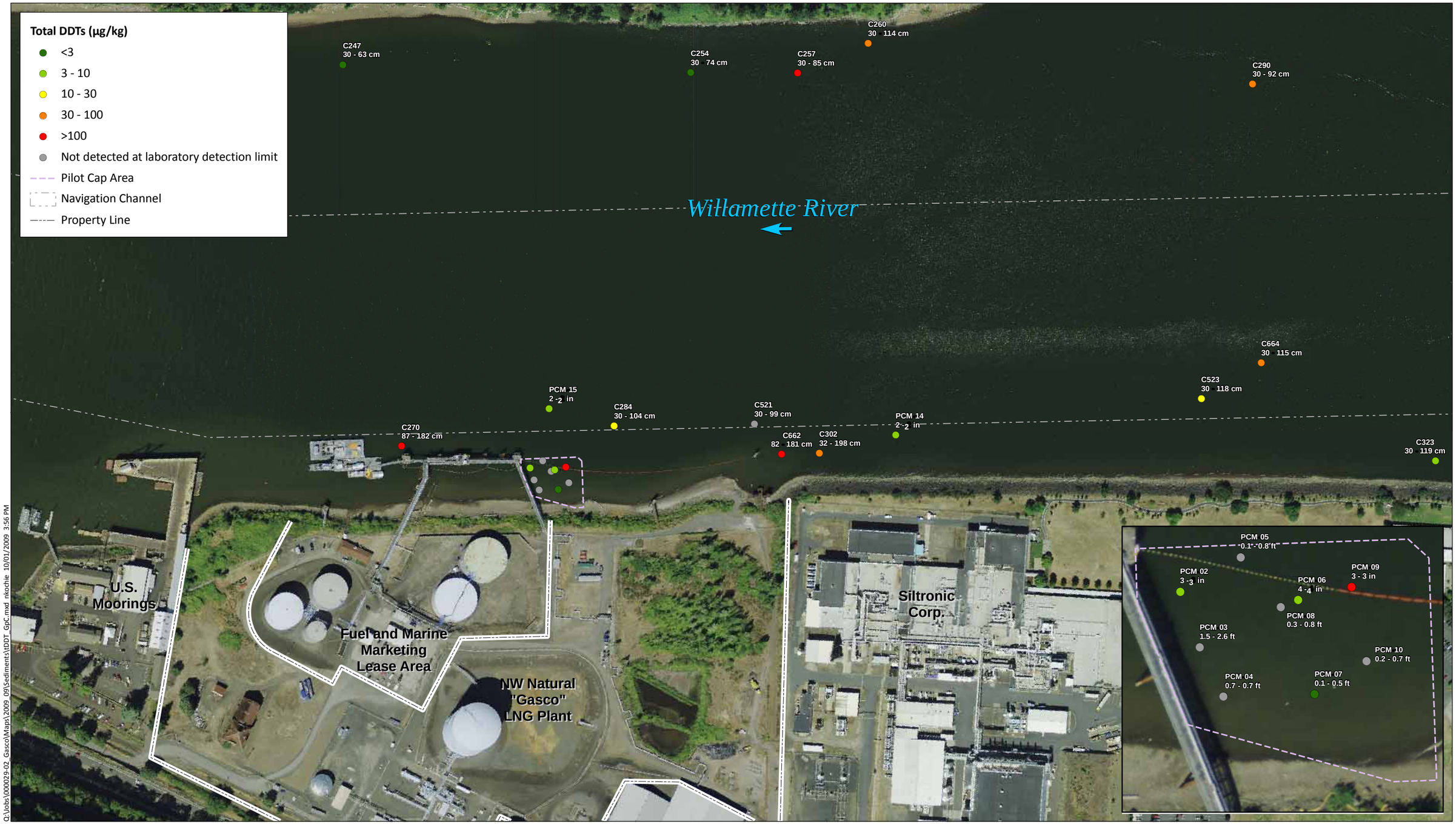


Feet
0 125 250 375 500

NOTES:
1. Inset shows Pilot Cap Monitoring Area.
2. The 0-40+ cm depth designation indicates samples originating at the mudline and extending below 40 cm.

Figure A11.2
Maximum Total DDTs Sediment Concentration - 0-40+ cm
NW Natural "Gasco" Site
Gasco Sediment Cleanup Action



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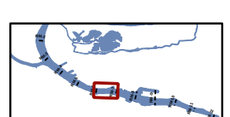
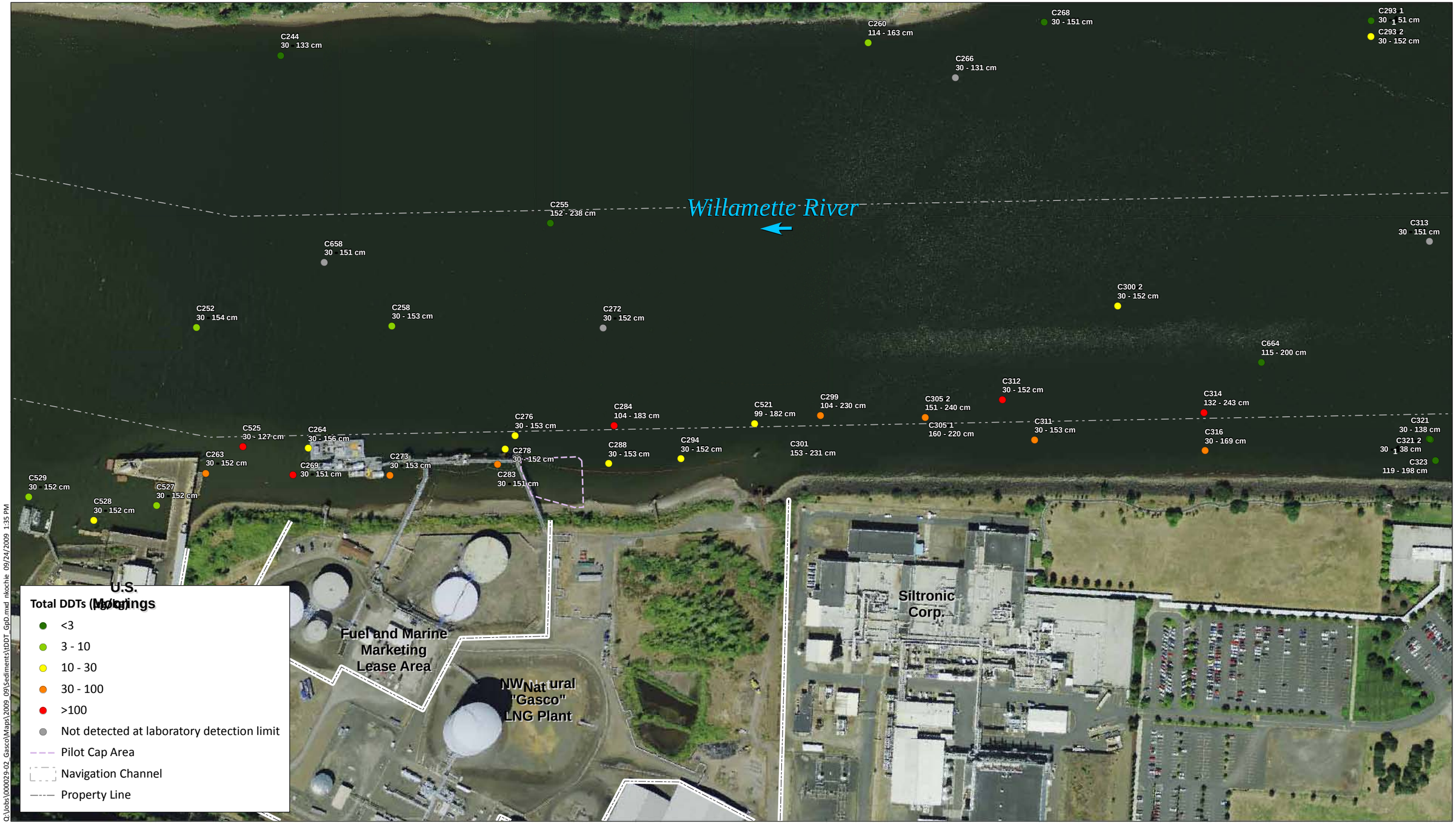
ANCHOR QEA

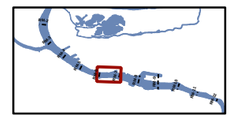


Feet
0 125 250 375 500

NOTES:
1. Inset shows Pilot Cap Monitoring Area.
2. The <>0-4 ft depth designation indicates samples that were collected originating some depth below the mudline and extending to 4 ft or less.

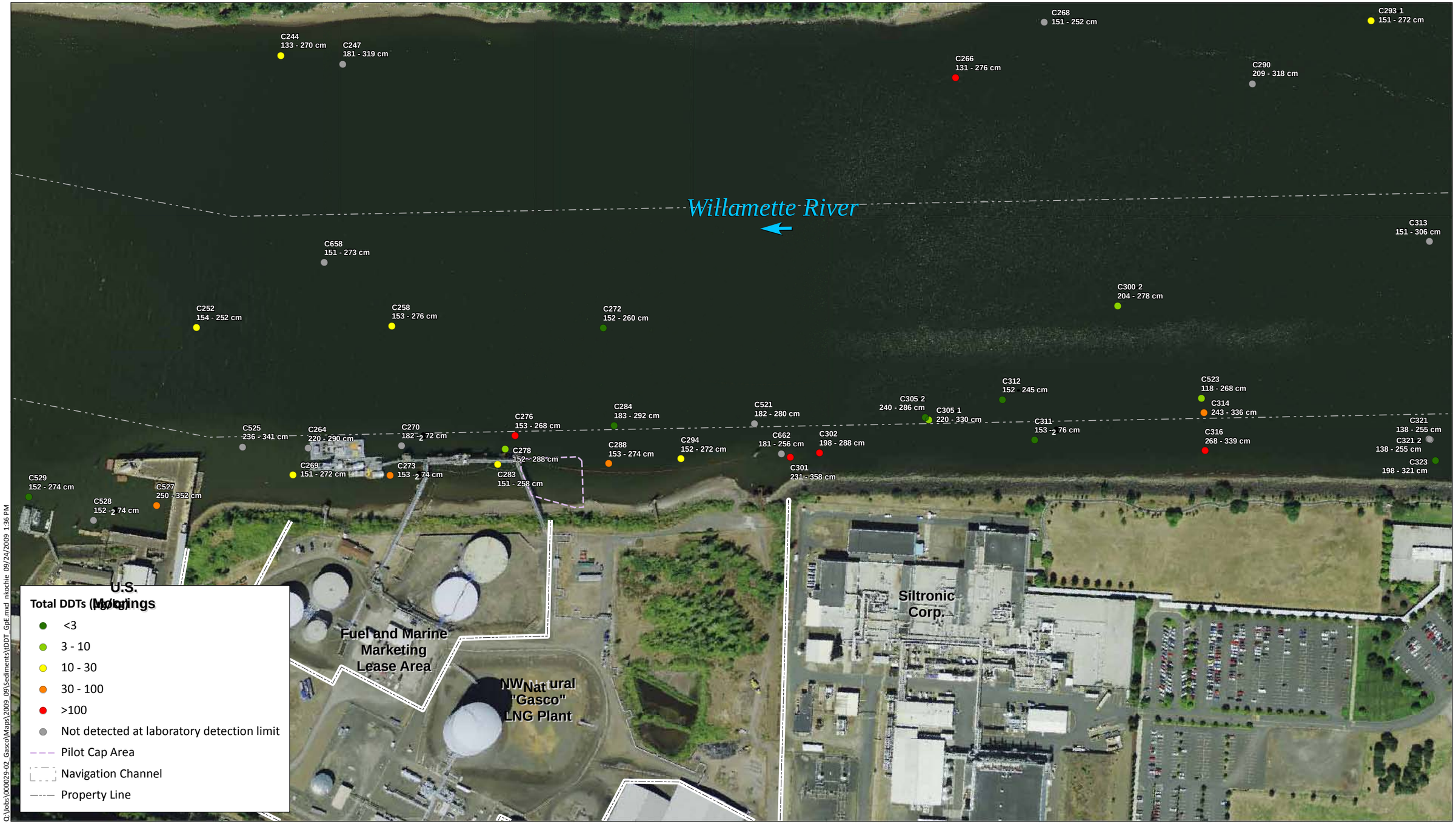
Figure A11.3
Maximum Total DDTs Sediment Concentration - <> 0-4 ft
NW Natural "Gasco" Site
Gasco Sediment Cleanup Action





Feet
0 125 250 375 500

Figure A11.4
Maximum Total DDTs Sediment Concentration - 4-8 ft
NW Natural "Gasco" Site
Gasco Sediment Cleanup Action



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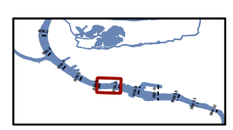

Feet
0 125 250 375 500

Figure A11.5
Maximum Total DDTs Sediment Concentration - 8-12 ft
NW Natural "Gasco" Site
Gasco Sediment Cleanup Action

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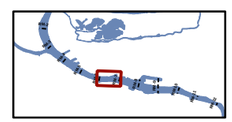
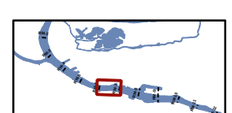


Feet
0 125 250 375 500

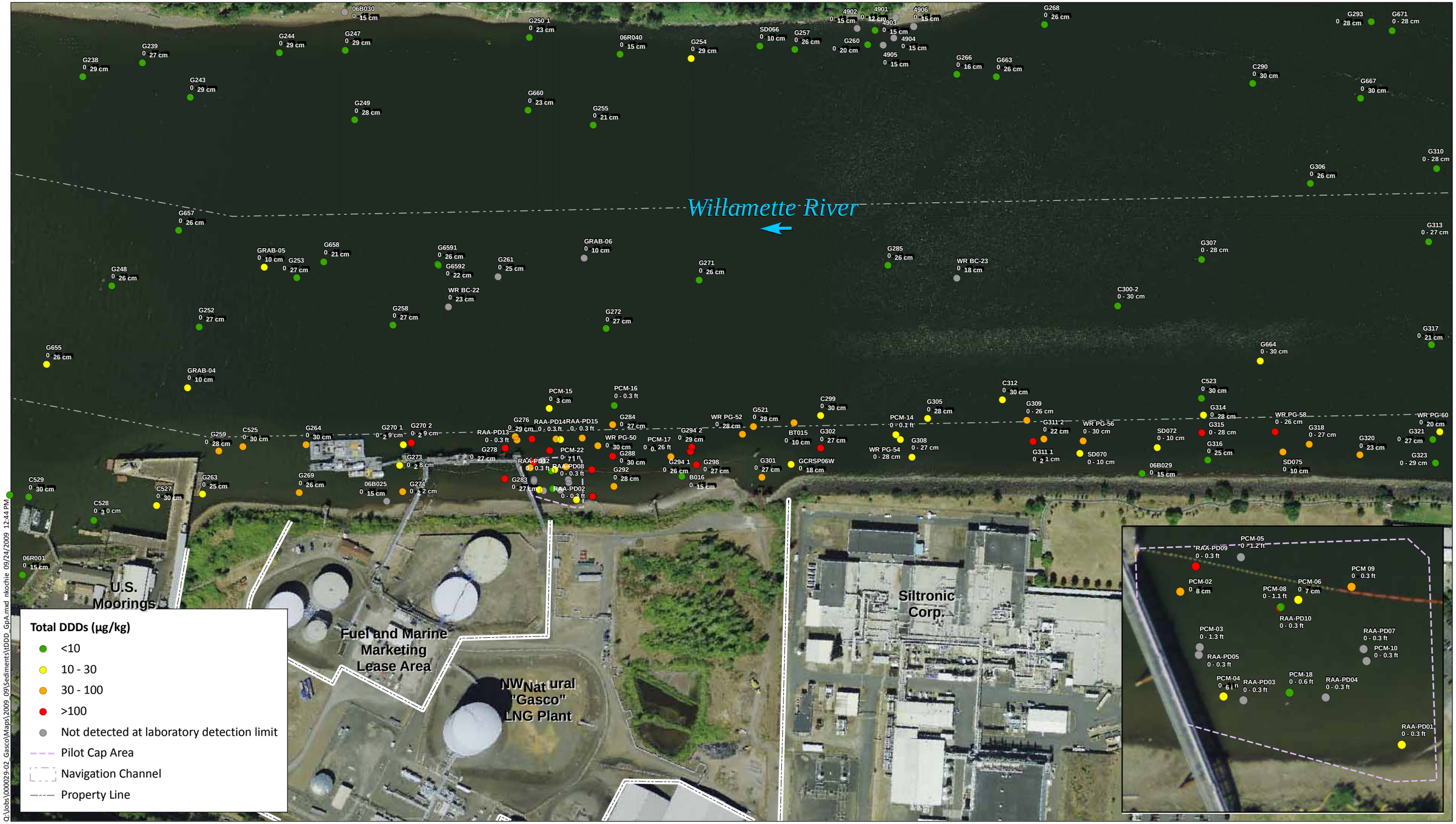
Figure A11.6
Maximum Total DDTs Sediment Concentration - 12-16 ft
NW Natural "Gasco" Site
Gasco Sediment Cleanup Action

Q:\Jobs\000029-02_Gasco\Maps\2009_09\Sediments\DDT_GpG.mxd nkochie 09/24/2009 1:39 PM



Feet
0 125 250 375 500

Figure A11.7
Maximum Total DDTs Sediment Concentration - 16+ ft
NW Natural "Gasco" Site
Gasco Sediment Cleanup Action



Q:\Jobs\000029-02_Gasco\Maps\2009_09\Sediments\DDD_GpA.mxd nkochie 09/24/2009 12:44 PM

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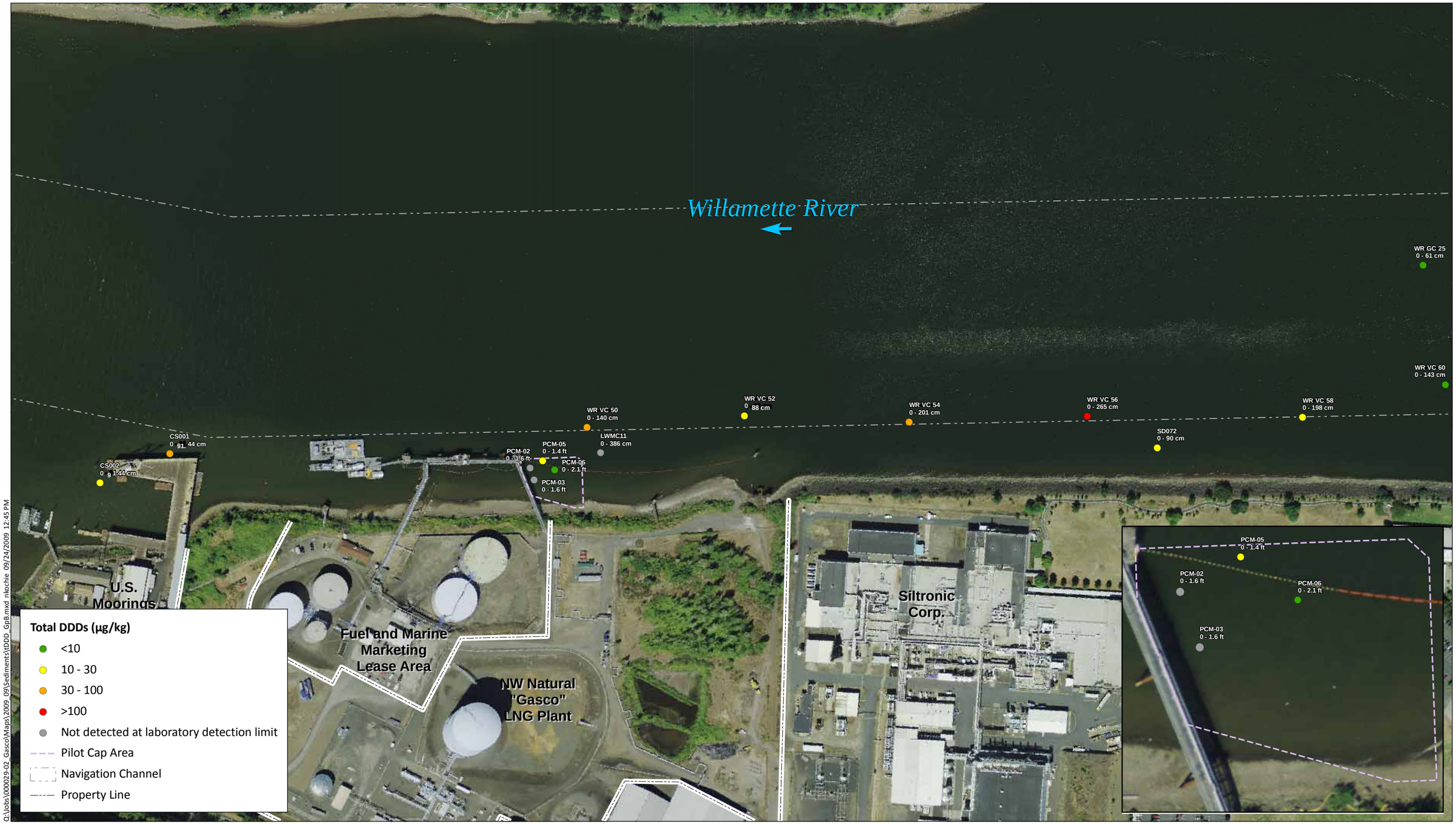
Feet
0 125 250 375 500

NOTES:
1. Inset shows Pilot Cap Monitoring Area.
2. Consistent with the Portland Harbor Superfund Site process, surface sediment is considered 0-40 cm below mudline.

Figure A12.1
Maximum Total DDDs Sediment Concentration - 0-40 cm
NW Natural "Gasco" Site
Gasco Sediment Cleanup Action



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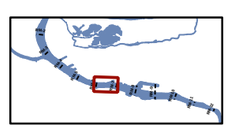
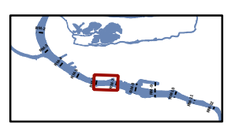


Feet
0 125 250 375 500

NOTES:
1. Inset shows Pilot Cap Monitoring Area.
2. The 0-40+ cm depth designation indicates samples originating at the mudline and extending below 40 cm.

Figure A12.2
Maximum Total DDDs Sediment Concentration - 0-40+ cm
NW Natural "Gasco" Site
Gasco Sediment Cleanup Action

ANCHOR QEA

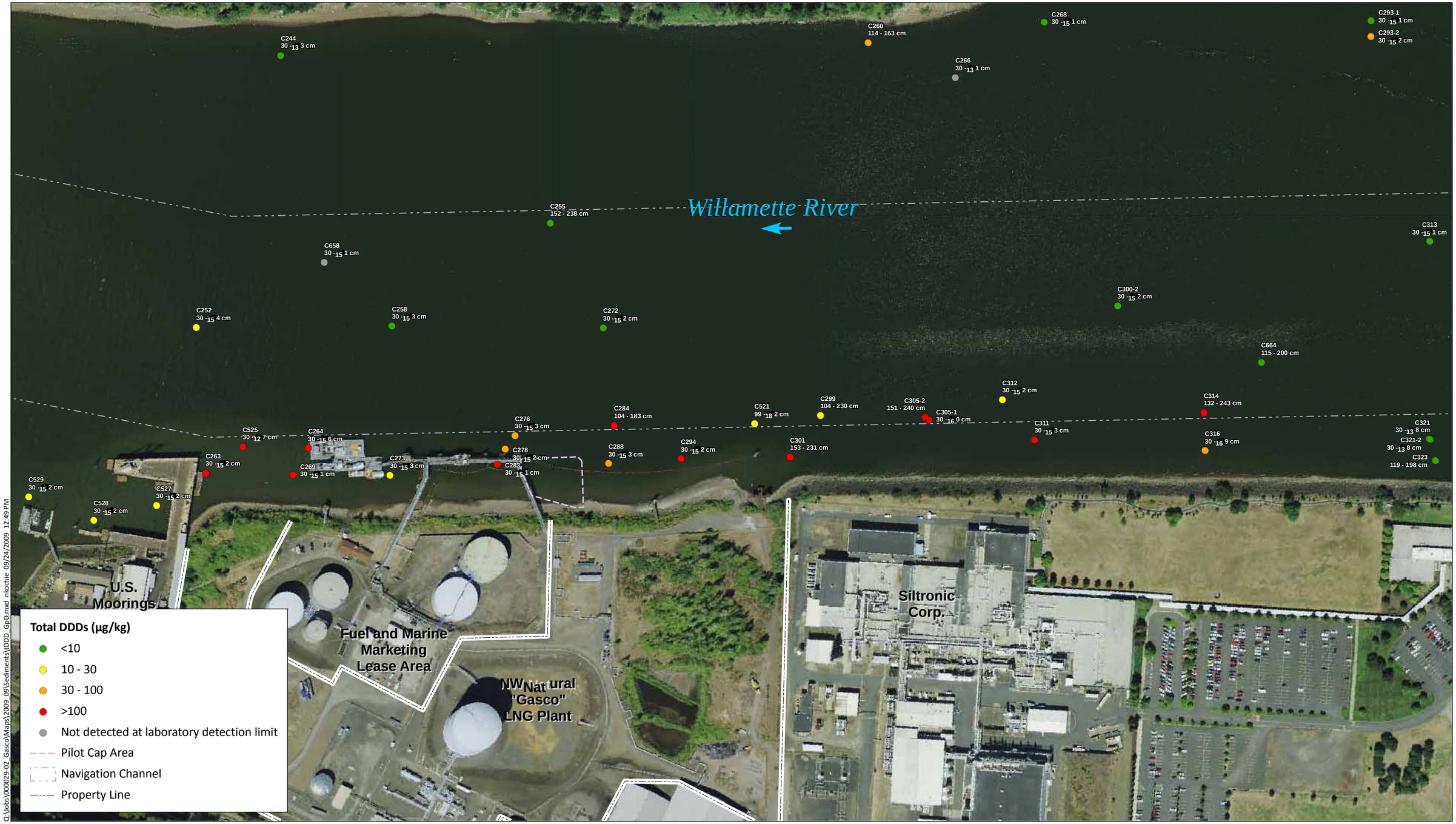


Feet

0 125 250 375 500

NOTES:
1. Inset shows Pilot Cap Monitoring Area.
2. The <>0-4 ft depth designation indicates samples that were collected originating some depth below the mudline and extending to 4 ft or less.

Figure A12.3
Maximum Total DDDs Sediment Concentration - <> 0-4 ft
NW Natural "Gasco" Site
Gasco Sediment Cleanup Action



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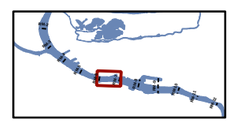
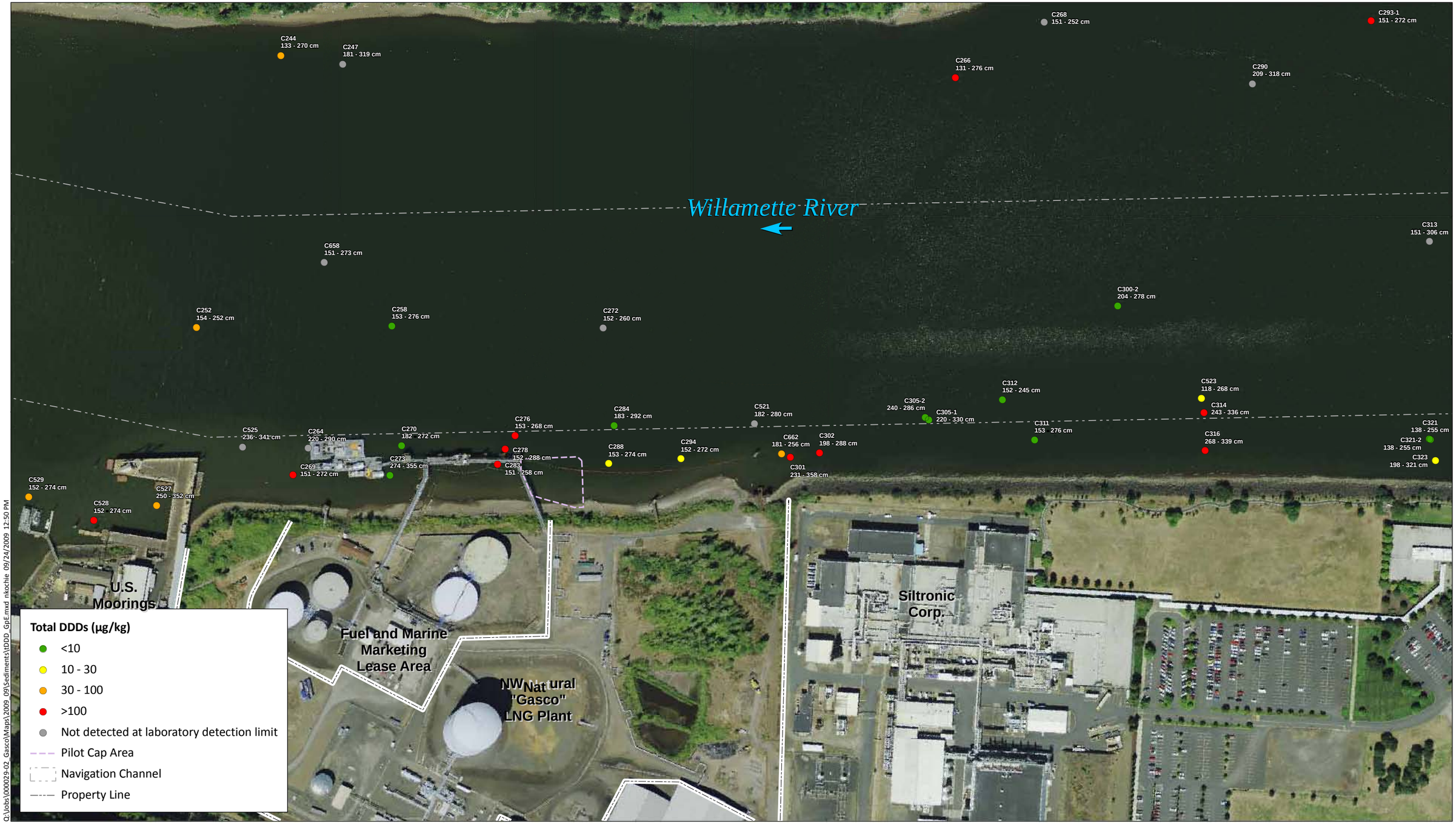
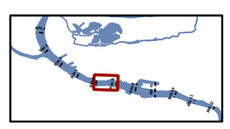


Feet
0 125 250 375 500

Figure A12.4
Maximum Total DDDs Sediment Concentration - 4-8 ft
NW Natural "Gasco" Site
Gasco Sediment Cleanup Action



ANCHOR QEA

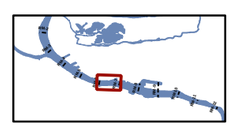


Feet
0 125 250 375 500

Figure A12.5
Maximum Total DDDs Sediment Concentration - 8-12 ft
NW Natural "Gasco" Site
Gasco Sediment Cleanup Action

Q:\Jobs\000029-02_Gasco\Maps\2009_09\Sediments\DDD_GpF.mxd nkochie 09/24/2009 12:51 PM

ANCHOR QEA



Feet
0 125 250 375 500

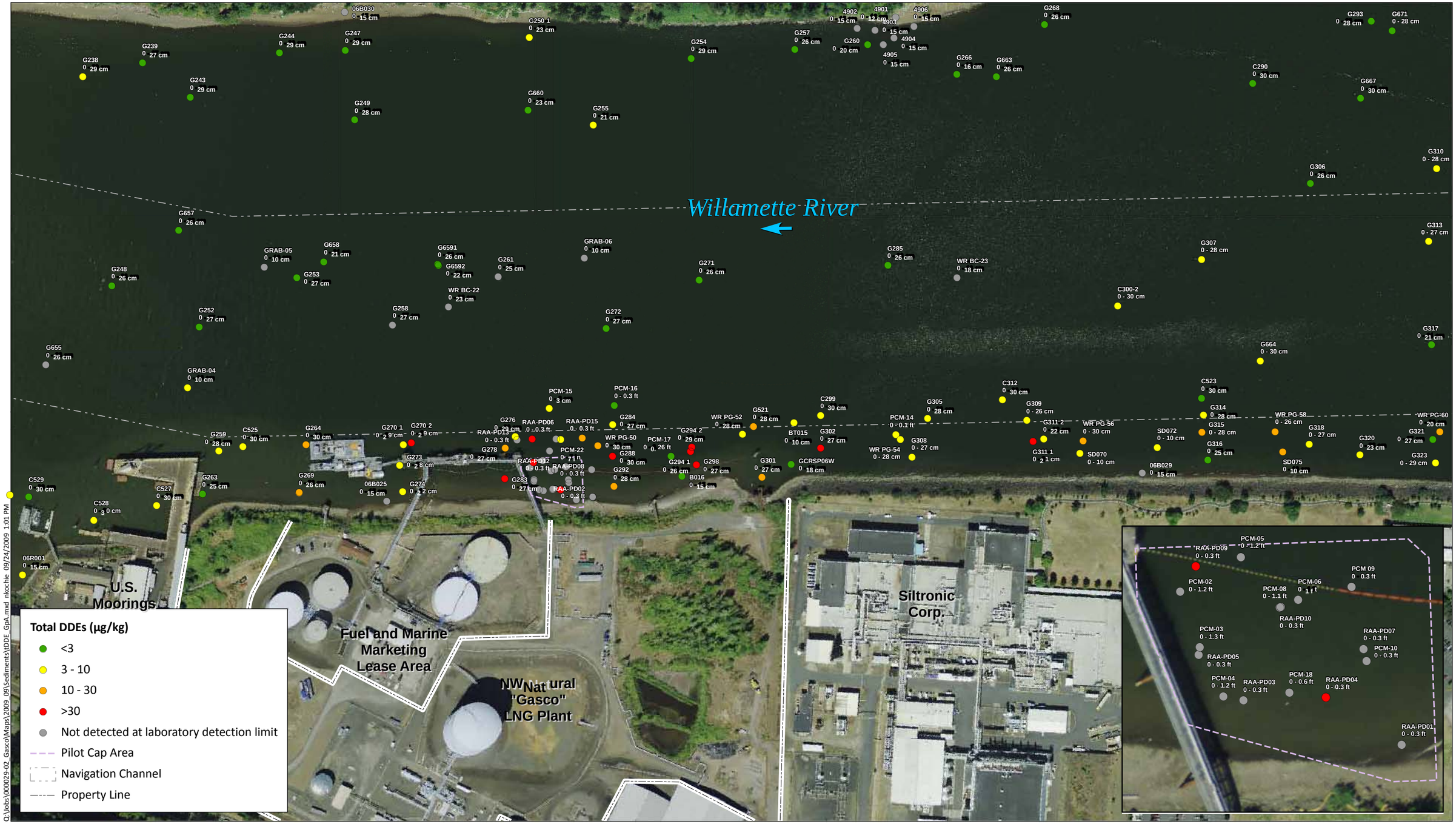
Figure A12.6
Maximum Total DDDs Sediment Concentration - 12-16 ft
NW Natural "Gasco" Site
Gasco Sediment Cleanup Action

Q:\Jobs\000029-02_Gasco\Maps\2009_09\Sediments\DDD_GpG.mxd nkochie 09/24/2009 12:53 PM

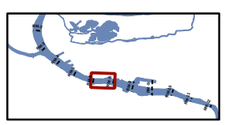
ANCHOR QEA

Feet
0 125 250 375 500

Figure A12.7
Maximum Total DDDs Sediment Concentration - 16+ ft
NW Natural "Gasco" Site
Gasco Sediment Cleanup Action



ANCHOR QEA

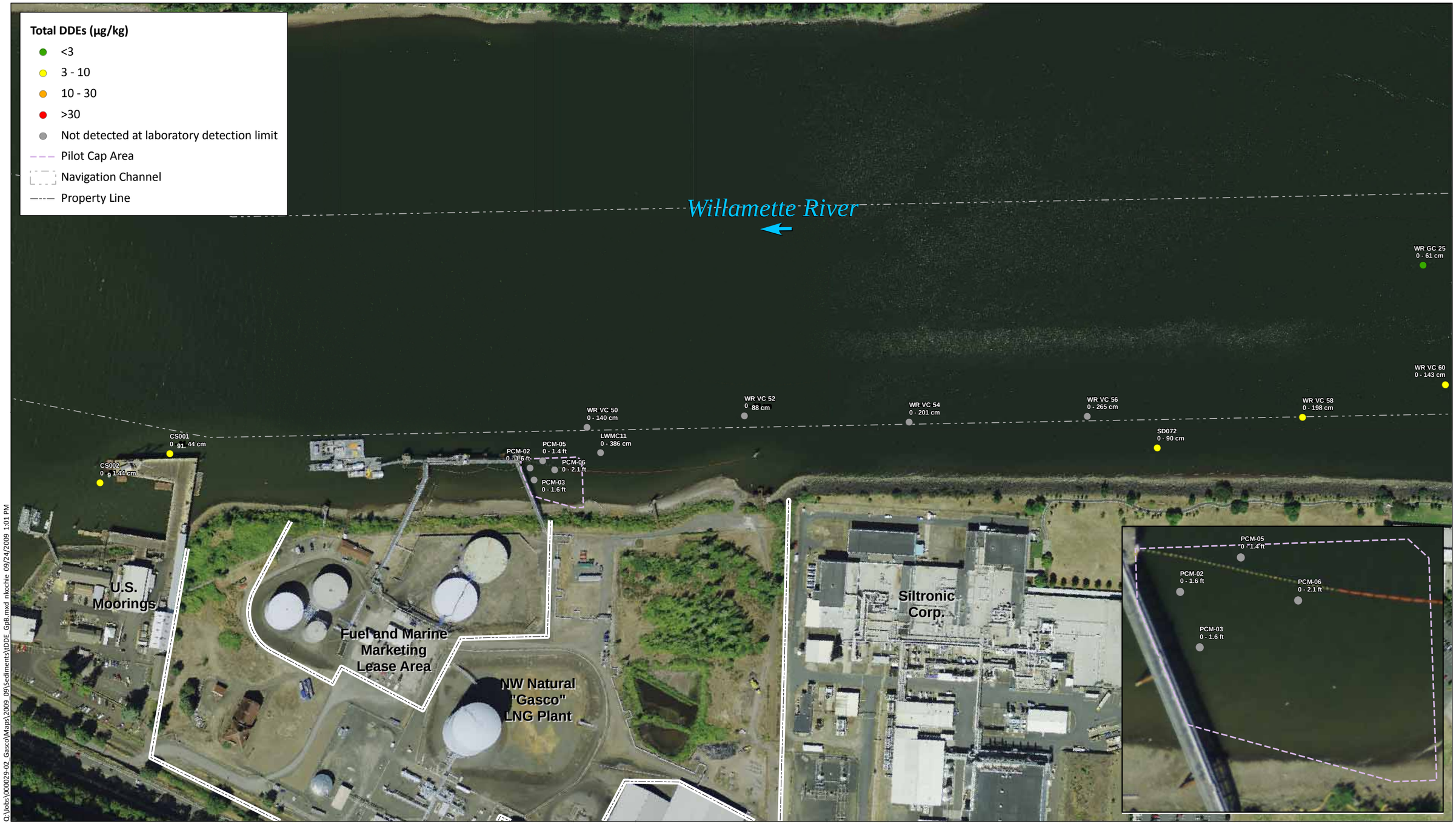


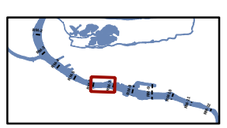
Feet

0 125 250 375 500

NOTES:
1. Inset shows Pilot Cap Monitoring Area.
2. Consistent with the Portland Harbor Superfund Site process, surface sediment is considered 0-40 cm below mudline.

Figure A13.1
Maximum Total DDEs Sediment Concentration- 0-40 cm
NW Natural "Gasco" Site
Gasco Sediment Cleanup Action





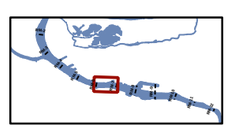
Feet
0 125 250 375 500

NOTES:
1. Inset shows Pilot Cap Monitoring Area.
2. The 0-40+ cm depth designation indicates samples originating at the mudline and extending below 40 cm.

Figure A13.2
Maximum Total DDEs Sediment Concentration - 0-40+ cm
NW Natural "Gasco" Site
Gasco Sediment Cleanup Action

Q:\Jobs\000029-02_Gasco\Maps\2009_09\Sediments\DDE_GpC.mxd nkochie 10/01/2009 3:50 PM

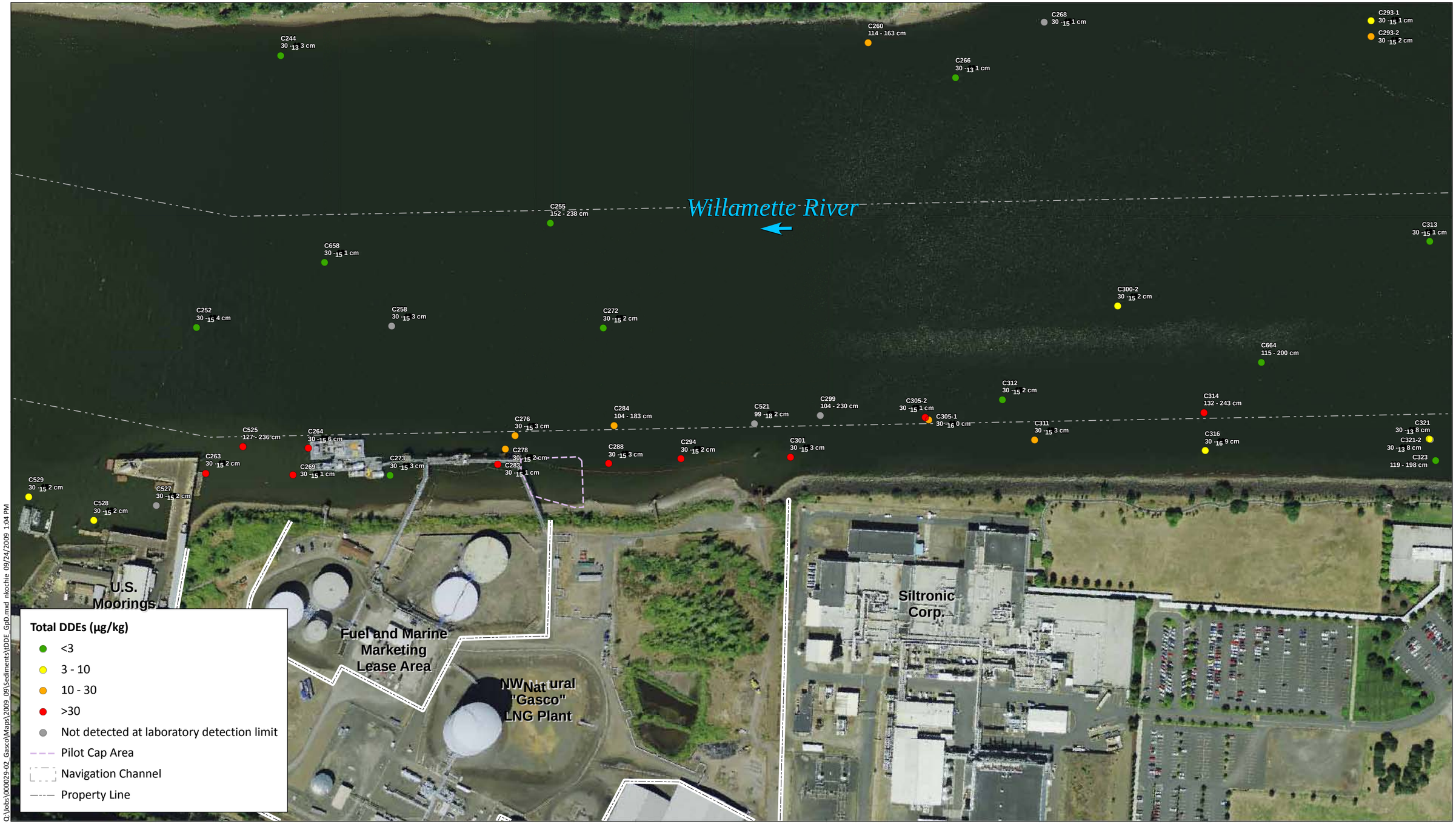
ANCHOR QEA

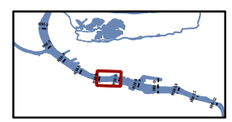


Feet
0 125 250 375 500

NOTES:
1. Inset shows Pilot Cap Monitoring Area.
2. The <>0-4 ft depth designation indicates samples that were collected originating some depth below the mudline and extending to 4 ft or less.

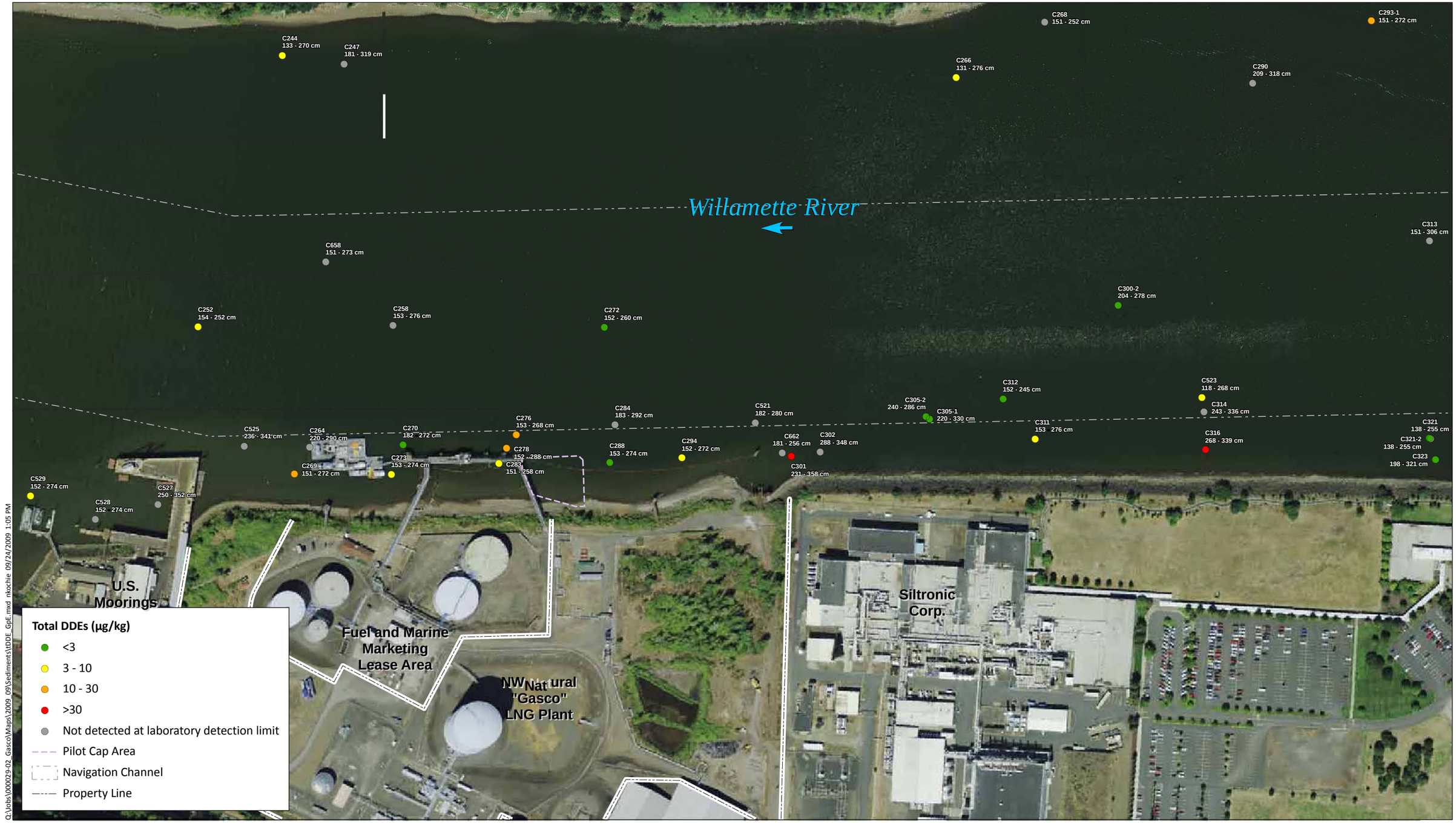
Figure A13.3
Maximum Total DDEs Sediment Concentration - <> 0-4 ft
NW Natural "Gasco" Site
Gasco Sediment Cleanup Action

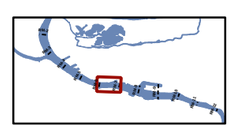




Feet
0 125 250 375 500

Figure A13.4
Maximum Total DDEs Sediment Concentration - 4-8 ft
NW Natural "Gasco" Site
Gasco Sediment Cleanup Action





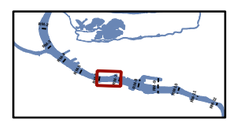
Feet
0 125 250 375 500

ANCHOR QEA

Figure A13.5
Maximum Total DDEs Sediment Concentration - 8-12 ft
NW Natural "Gasco" Site
Gasco Sediment Cleanup Action

Q:\Jobs\000029-02_Gasco\Maps\2009_09\Sediments\DDE_GpF.mxd nkochie 09/24/2009 1:07 PM

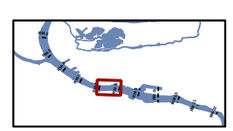
ANCHOR QEA



Feet
0 125 250 375 500

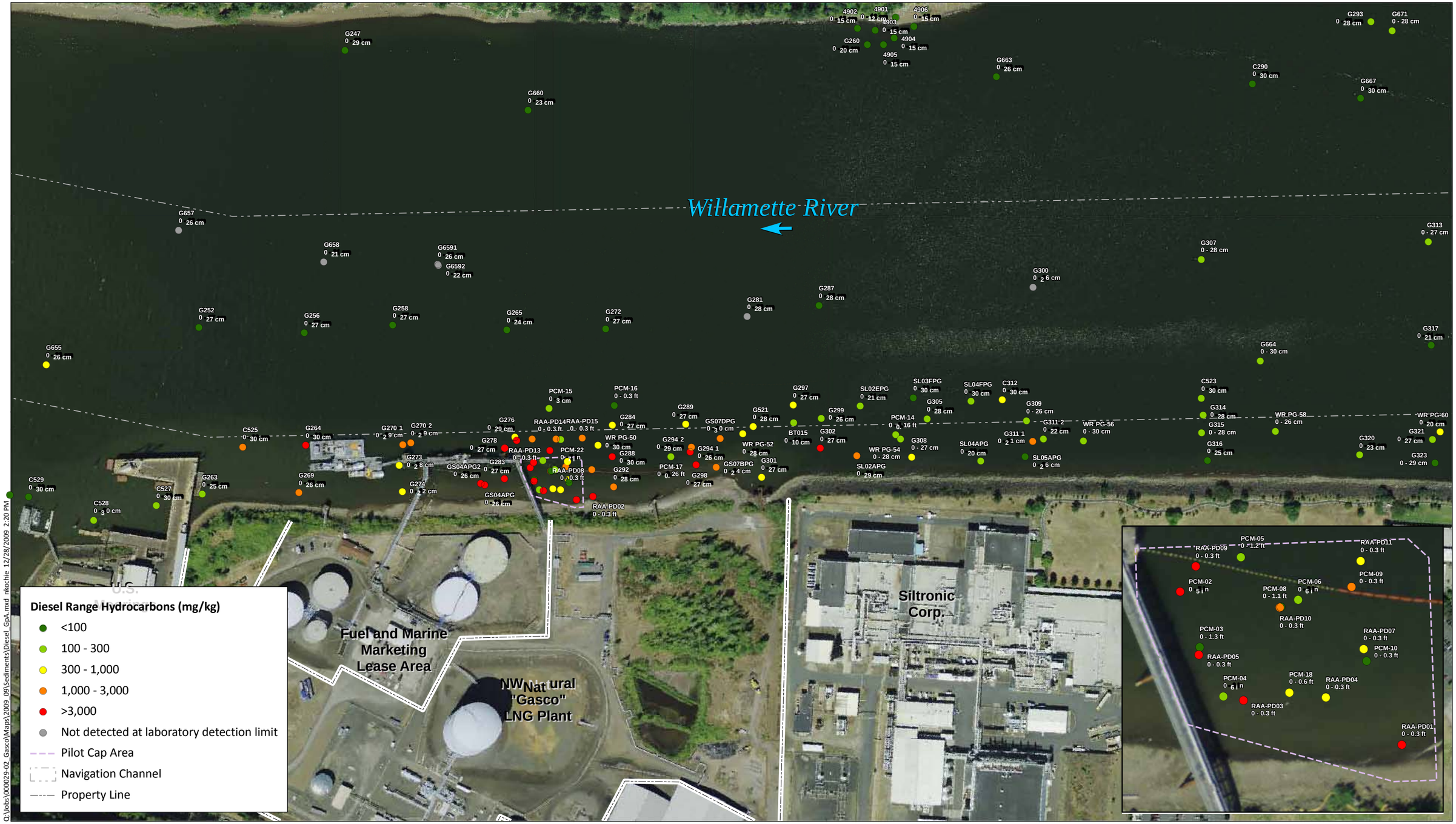
Figure A13.6
Maximum Total DDEs Sediment Concentration - 12-16 ft
NW Natural "Gasco" Site
Gasco Sediment Cleanup Action

ANCHOR QEA



Feet
0 125 250 375 500

Figure A13.7
Maximum Total DDEs Sediment Concentration - 16+ ft
NW Natural "Gasco" Site
Gasco Sediment Cleanup Action



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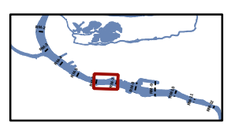
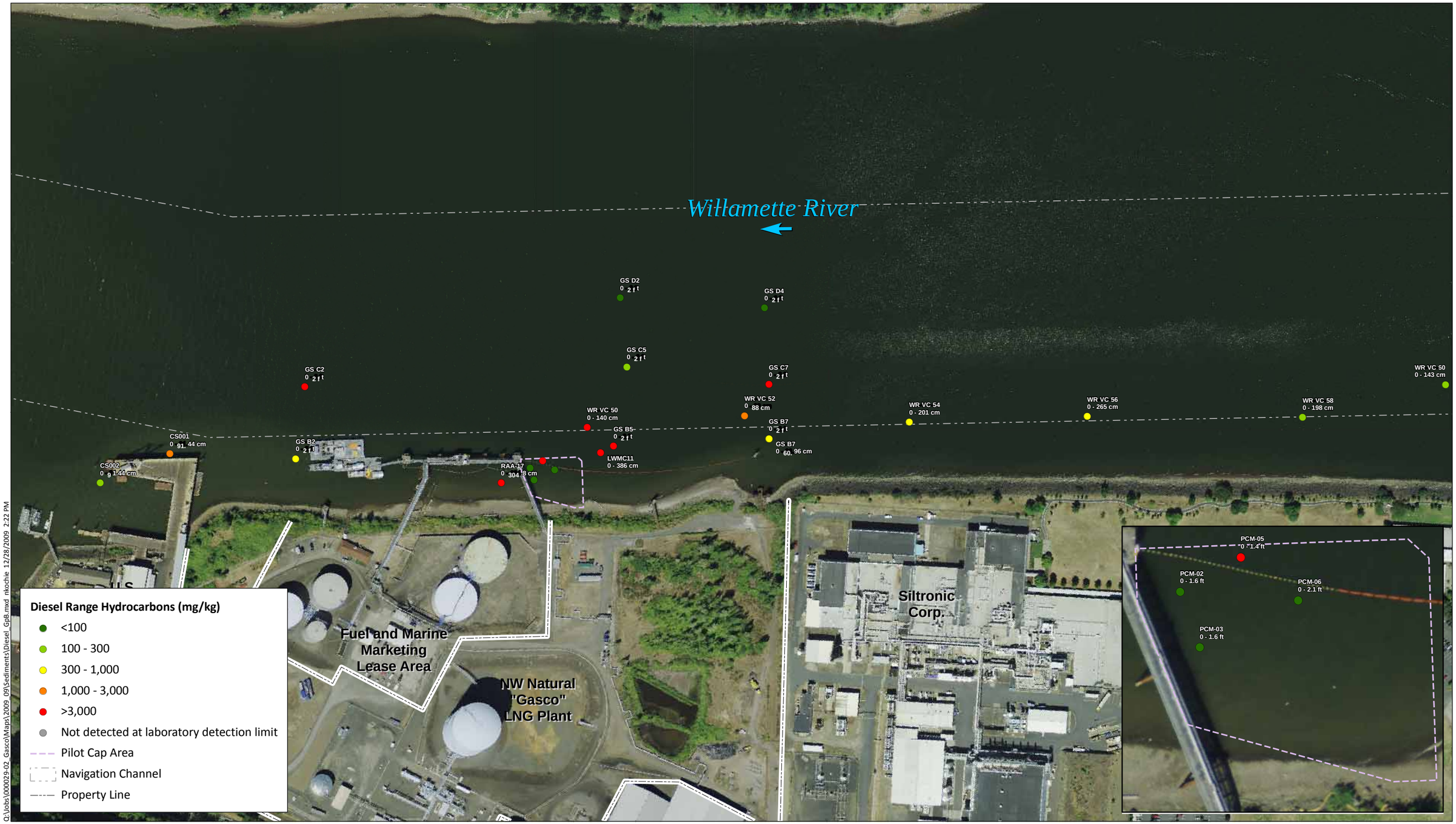
ANCHOR QEA



Feet
0 125 250 375 500

NOTES:
1. Inset shows Pilot Cap Monitoring Area.
2. Consistent with the Portland Harbor Superfund Site process, surface sediment is considered 0-40 cm below mudline.

Figure A14.1
Maximum Diesel Range Hydrocarbons Sediment Concentration - 0-40 cm
NW Natural "Gasco" Site
Gasco Sediment Cleanup Action



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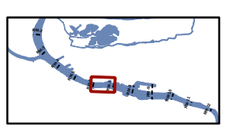
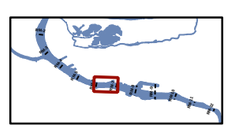
ANCHOR QEA



Feet
0 125 250 375 500

NOTES:
1. Inset shows Pilot Cap Monitoring Area.
2. The 0-40+ cm depth designation indicates samples originating at the mudline and extending below 40 cm.

Figure A14.2
Maximum Diesel Range Hydrocarbons Sediment Concentration - 0-40+ cm
NW Natural "Gasco" Site
Gasco Sediment Cleanup Action

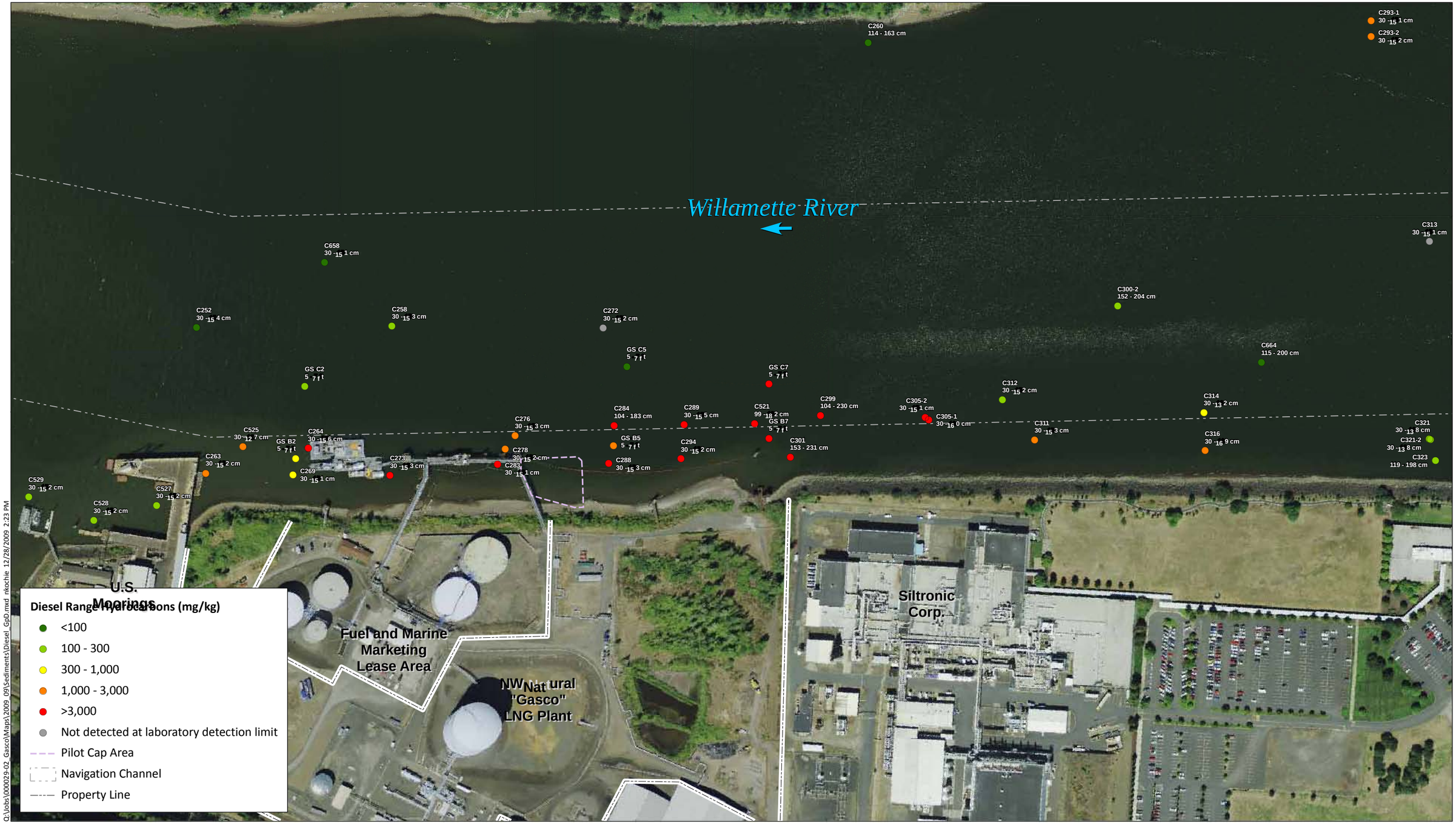


Feet

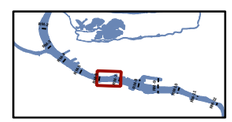
0 125 250 375 500

NOTES:
1. Inset shows Pilot Cap Monitoring Area.
2. The <>0-4 ft depth designation indicates samples that were collected originating some depth below the mudline and extending to 4 ft or less.

Figure A14.3
Maximum Diesel Range Hydrocarbons Sediment Concentration - <> 0-4 ft
NW Natural "Gasco" Site
Gasco Sediment Cleanup Action

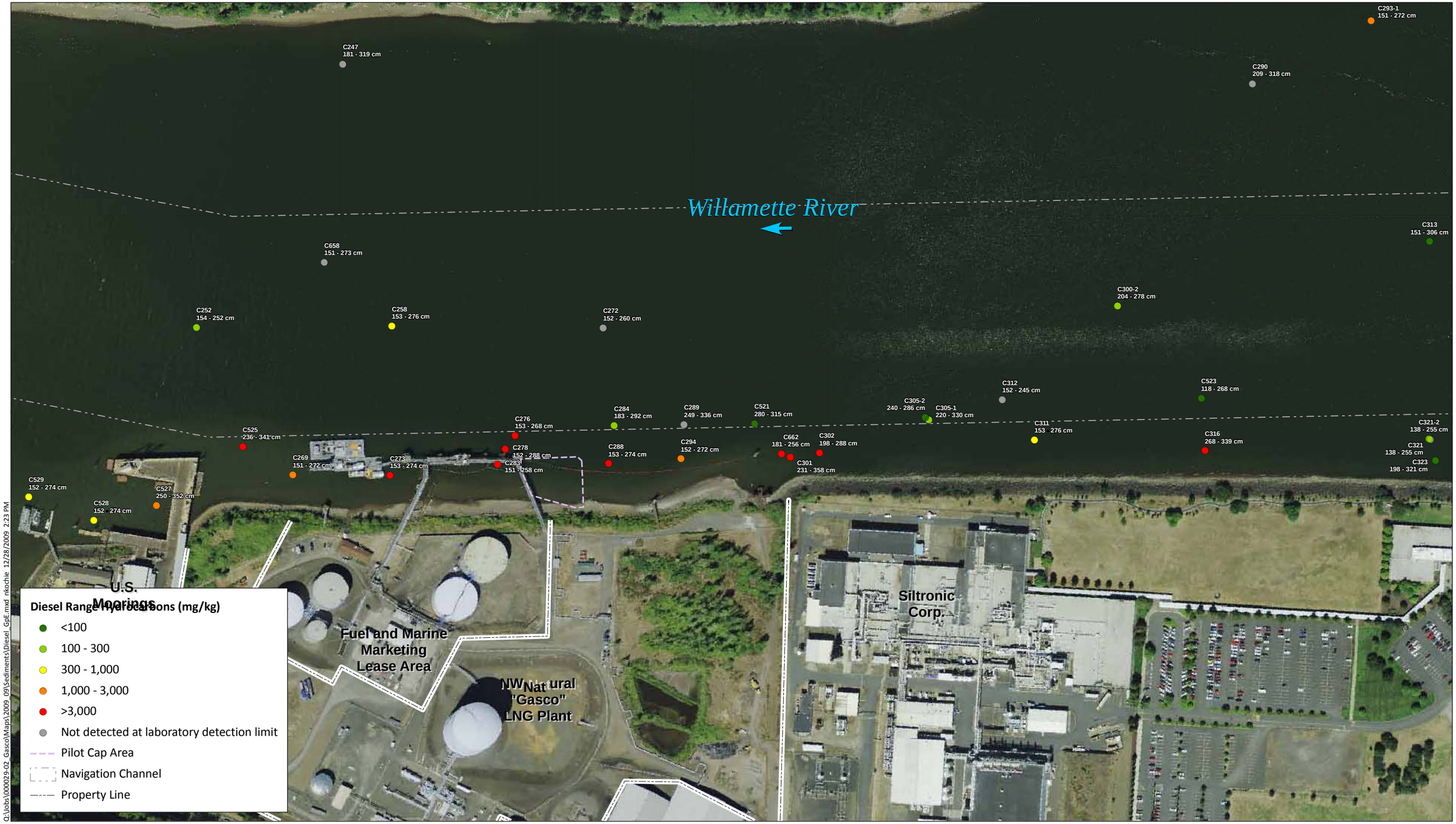


ANCHOR QEA



Feet
0 125 250 375 500

Figure A14.4
Maximum Diesel Range Hydrocarbons Sediment Concentration - 4-8 ft
NW Natural "Gasco" Site
Gasco Sediment Cleanup Action



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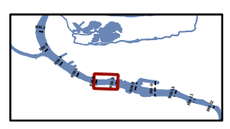
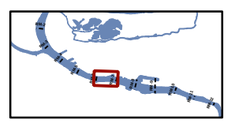


Feet
0 125 250 375 500

Figure A14.5
Maximum Diesel Range Hydrocarbons Sediment Concentration - 8-12 ft
NW Natural "Gasco" Site
Gasco Sediment Cleanup Action

Q:\Jobs\000029-02_Gasco\Maps\2009_09\Sediments\Diesel_GpF.mxd nkochie 12/28/2009 2:24 PM

ANCHOR QEA

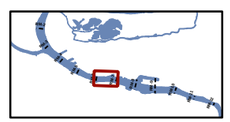


Feet
0 125 250 375 500

NOTES:
1. Inset shows Pilot Cap Monitoring Area.

Figure A14.6
Maximum Diesel Range Hydrocarbons Sediment Concentration - 12-16 ft
NW Natural "Gasco" Site
Gasco Sediment Cleanup Action

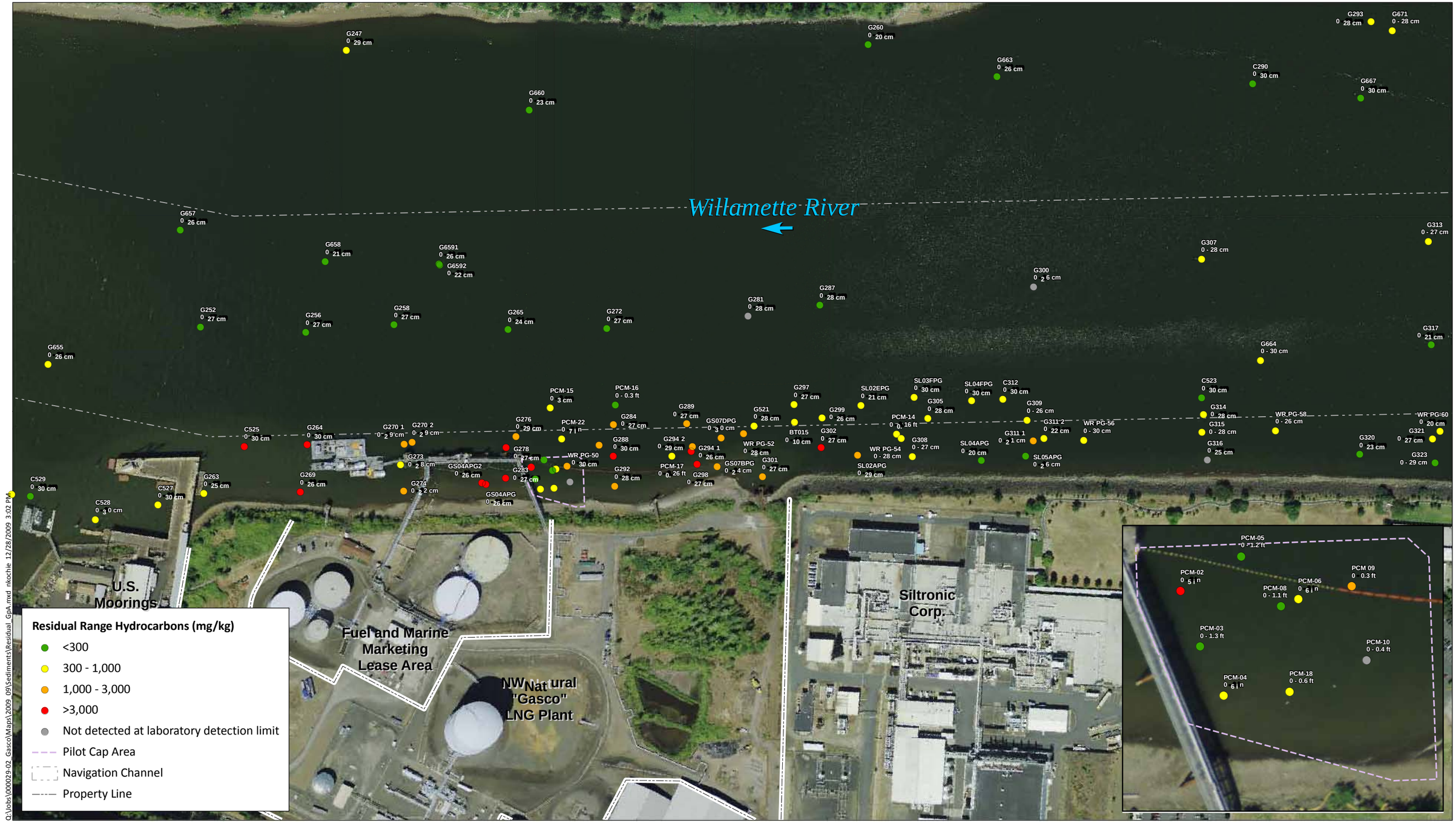
ANCHOR QEA



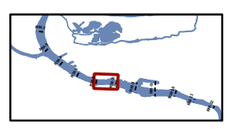
Feet
0 125 250 375 500

NOTES:
1. Inset shows Pilot Cap Monitoring Area.

Figure A14.7
Maximum Diesel Range Hydrocarbons Sediment Concentration - 16+ ft
NW Natural "Gasco" Site
Gasco Sediment Cleanup Action



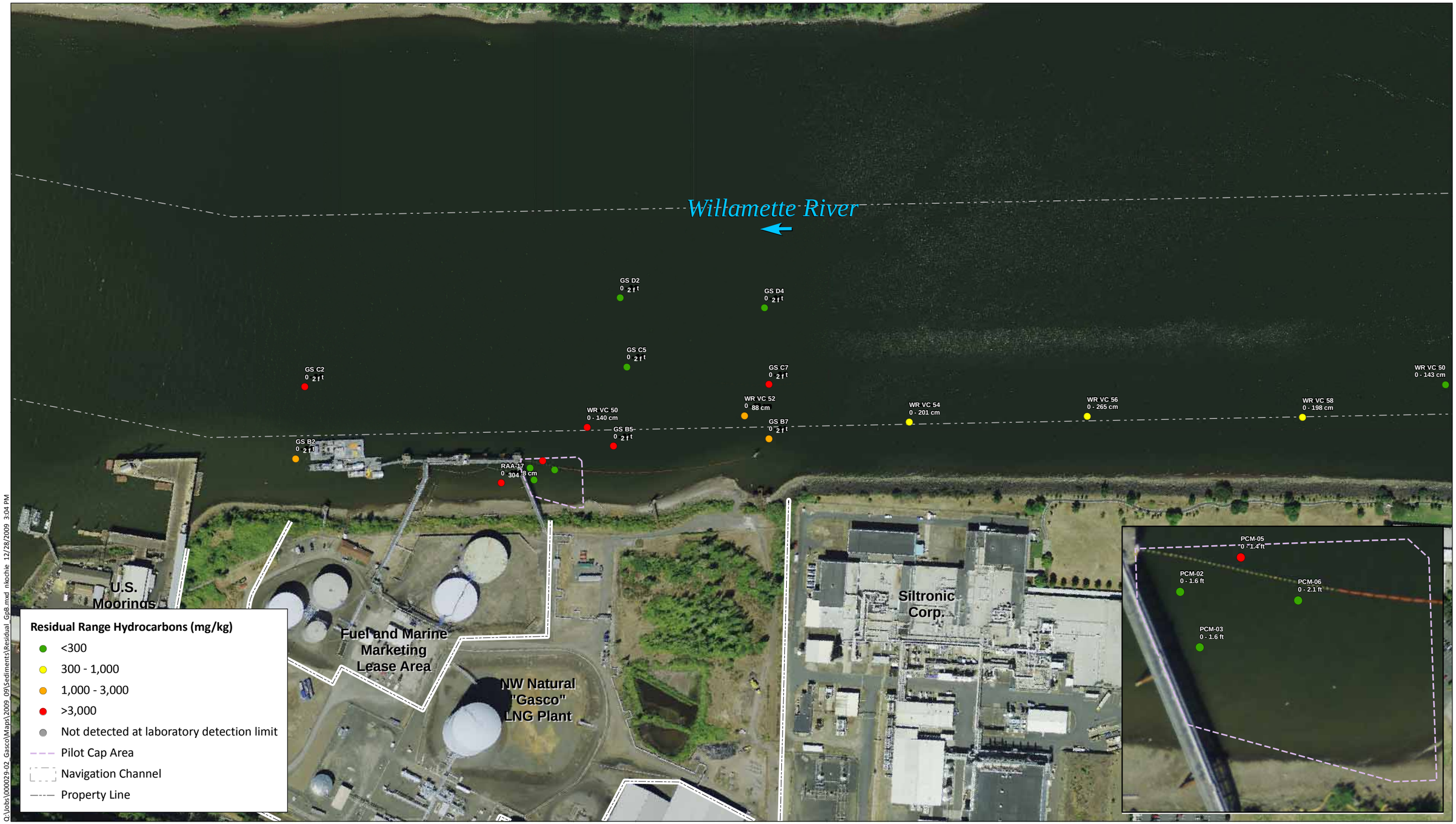
ANCHOR QEA



Feet
0 125 250 375 500

NOTES:
1. Inset shows Pilot Cap Monitoring Area.
2. Consistent with the Portland Harbor Superfund Site process, surface sediment is considered 0-40 cm below mudline.

Figure A15.1
Maximum Residual Range Hydrocarbons Sediment Concentration - 0-40 cm
NW Natural "Gasco" Site
Gasco Sediment Cleanup Action



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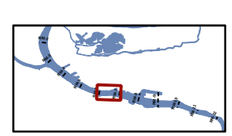
ANCHOR QEA

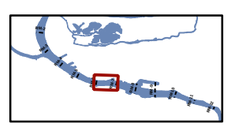


Feet
0 125 250 375 500

NOTES:
1. Inset shows Pilot Cap Monitoring Area.
2. The 0-40+ cm depth designation indicates samples originating at the mudline and extending below 40 cm.

Figure A15.2
Maximum Residual Range Hydrocarbons Sediment Concentration - 0-40+ cm
NW Natural "Gasco" Site
Gasco Sediment Cleanup Action

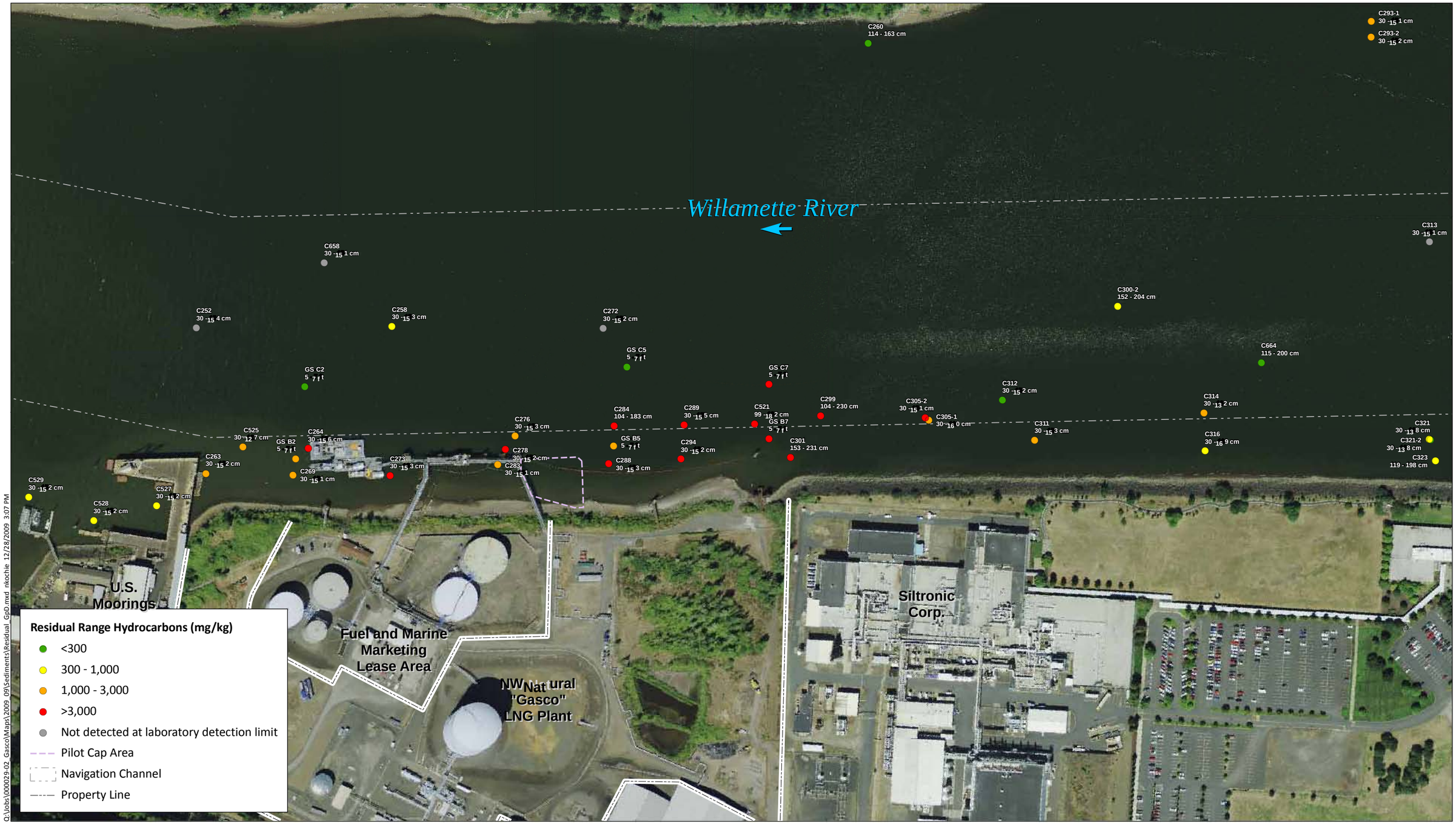
ANCHOR QEA



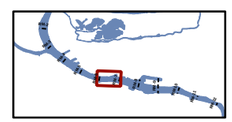
Feet
0 125 250 375 500

NOTES:
1. Inset shows Pilot Cap Monitoring Area.
2. The <>0-4 ft depth designation indicates samples that were collected originating some depth below the mudline and extending to 4 ft or less.

Figure A15.3
Maximum Residual Range Hydrocarbons Sediment Concentration - <> 0-4 ft
NW Natural "Gasco" Site
Gasco Sediment Cleanup Action

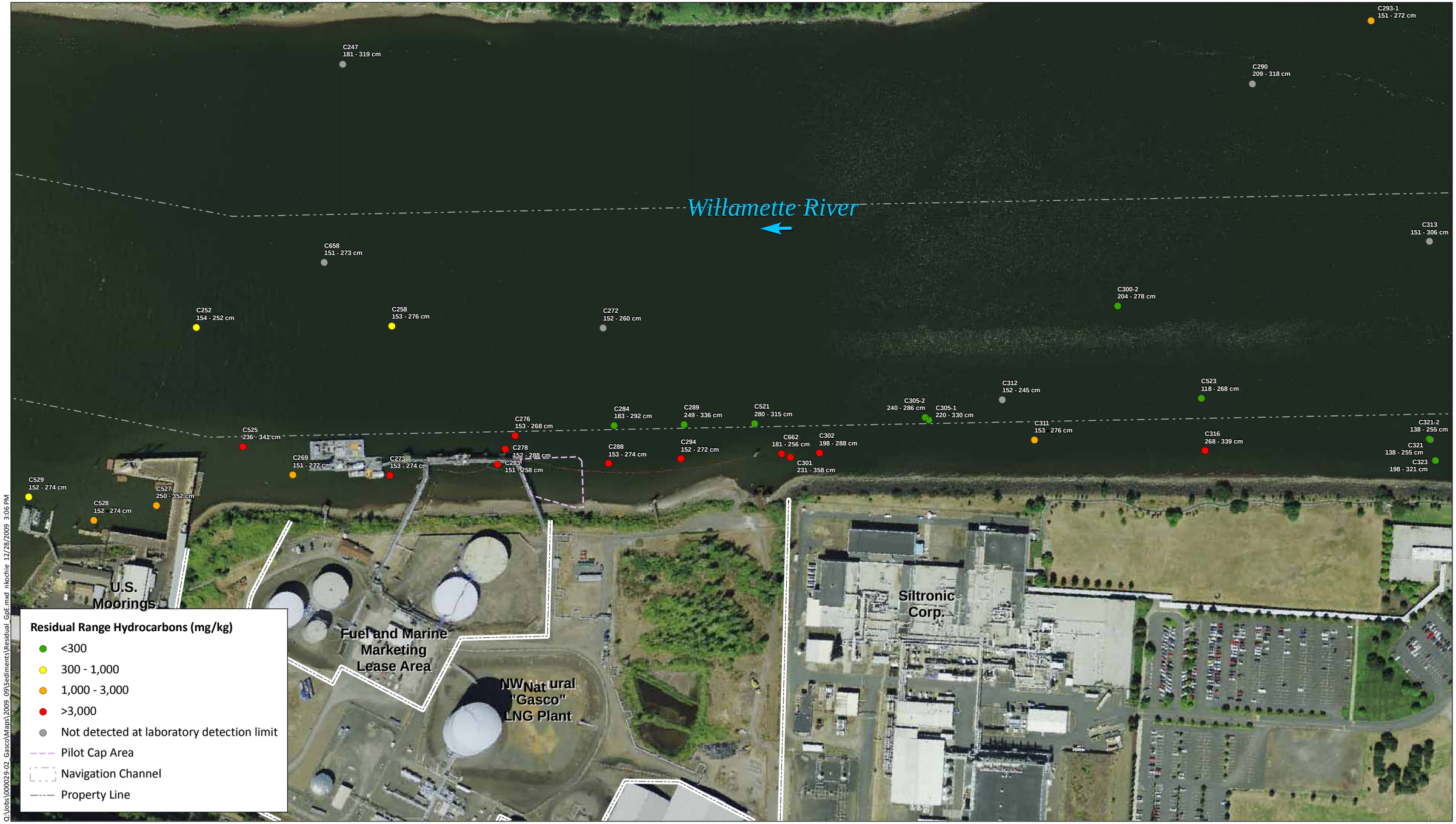


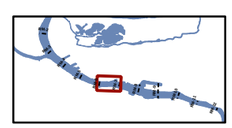
ANCHOR QEA



Feet
0 125 250 375 500

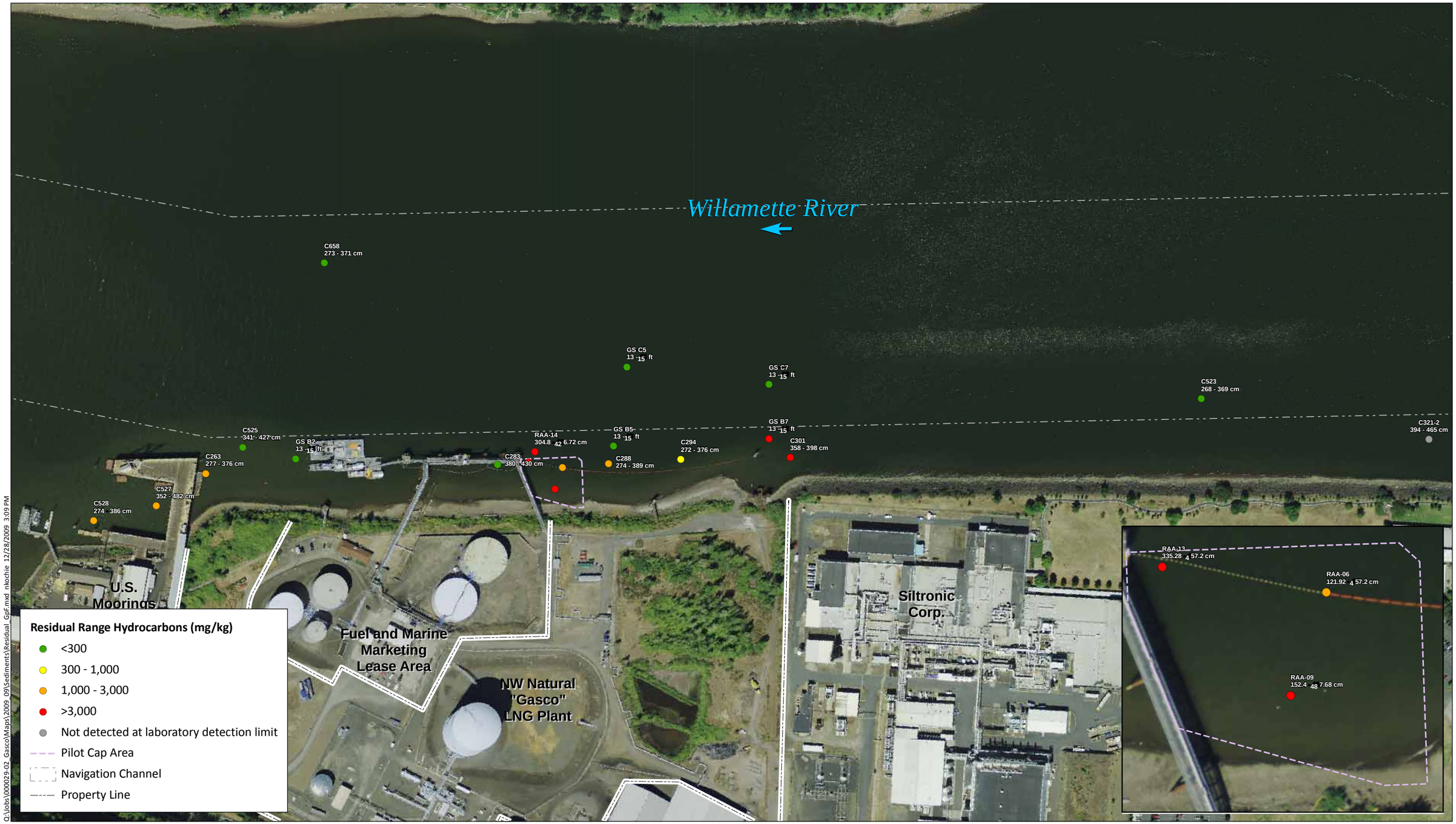
Figure A15.4
Maximum Residual Range Hydrocarbons Sediment Concentration - 4-8 ft
NW Natural "Gasco" Site
Gasco Sediment Cleanup Action





Feet
0 125 250 375 500

Figure A15.5
Maximum Residual Range Hydrocarbons Sediment Concentration - 8-12 ft
NW Natural "Gasco" Site
Gasco Sediment Cleanup Action



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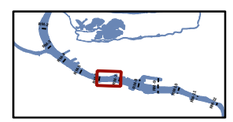
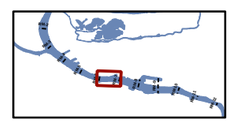


Feet
0 125 250 375 500

Figure A15.6
Maximum Residual Range Hydrocarbons Sediment Concentration - 12-16 ft
NW Natural "Gasco" Site
Gasco Sediment Cleanup Action

NOTES:
1. Inset shows Pilot Cap Monitoring Area.

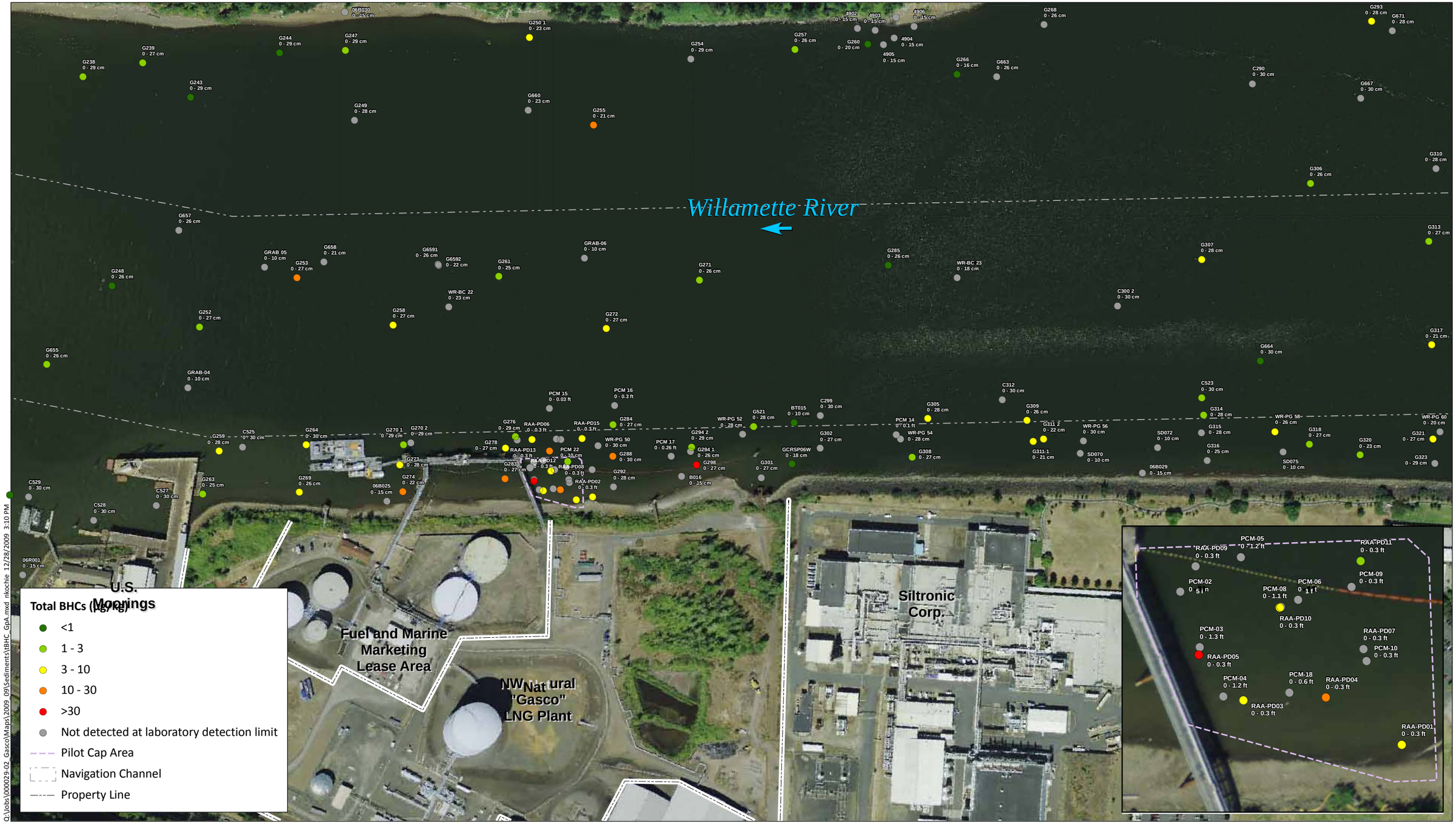
ANCHOR QEA



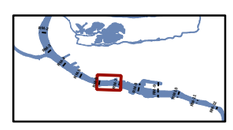
Feet
0 125 250 375 500

Figure A15.7
Maximum Residual Range Hydrocarbons Sediment Concentration - 16+ ft
NW Natural "Gasco" Site
Gasco Sediment Cleanup Action

NOTES:
1. Inset shows Pilot Cap Monitoring Area.



ANCHOR QEA

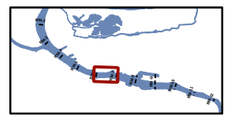


Feet
0 125 250 375 500

NOTES:
1. Inset shows Pilot Cap Monitoring Area.
2. Consistent with the Portland Harbor Superfund Site process, surface sediment is considered 0-40 cm below mudline.

Figure A16.1
Maximum Total BHCs Sediment Concentration - 0-40 cm
NW Natural "Gasco" Site
Gasco Sediment Cleanup Action

ANCHOR QEA



Feet

0 125 250 375 500

NOTES:
1. Inset shows Pilot Cap Monitoring Area.
2. The 0-40+ cm depth designation indicates samples originating at the mudline and extending below 40 cm.

Figure A16.2
Maximum Total BHCs Sediment Concentration - 0-40+ cm
NW Natural "Gasco" Site
Gasco Sediment Cleanup Action

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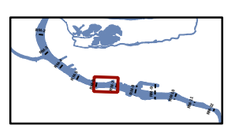
ANCHOR QEA

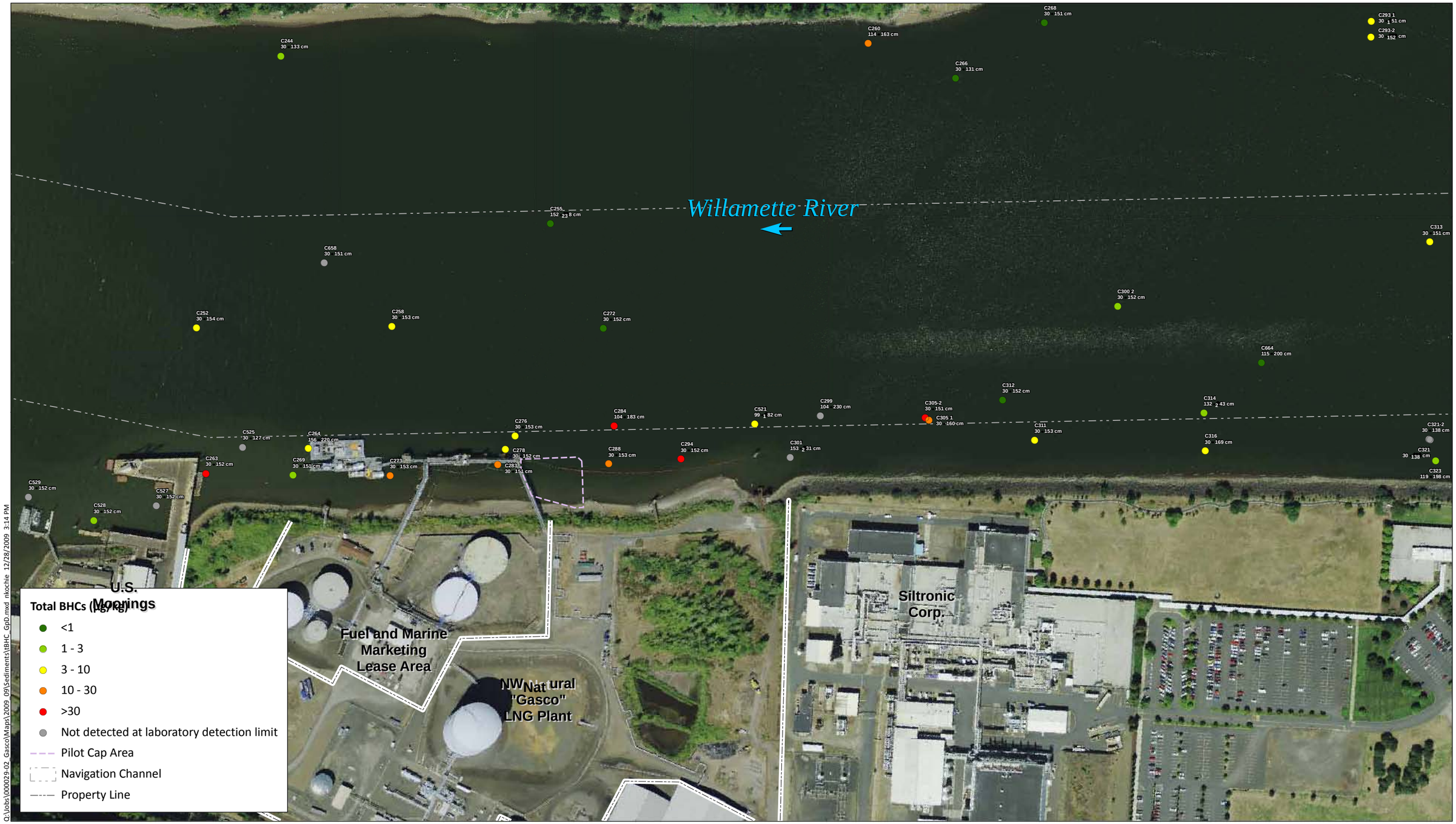


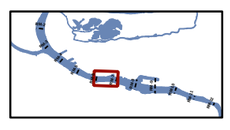
Feet

0 125 250 375 500

NOTES:
1. Inset shows Pilot Cap Monitoring Area.
2. The <>0-4 ft depth designation indicates samples that were collected originating some depth below the mudline and extending to 4 ft or less.

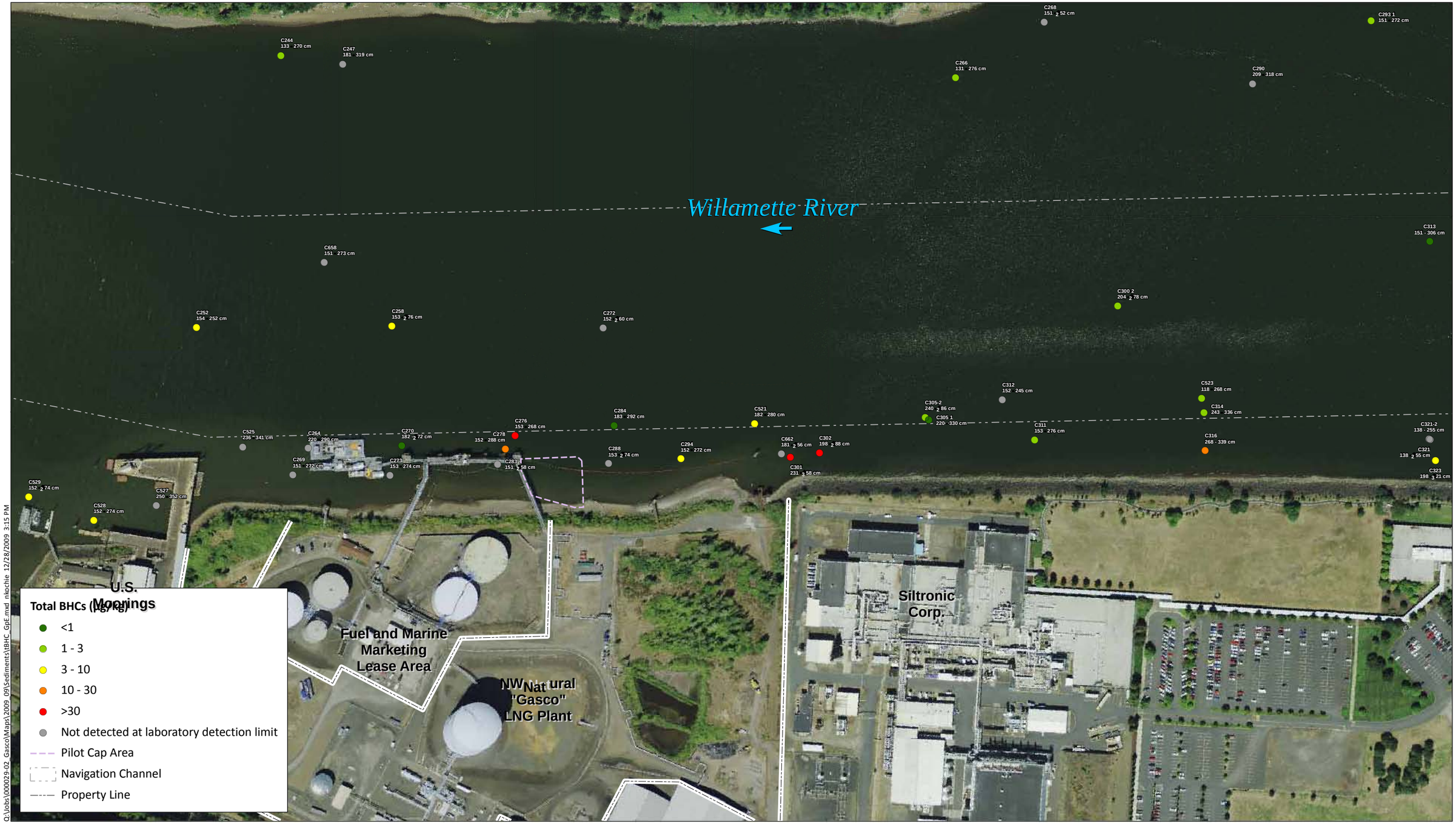
Figure A16.3
Maximum Total BHCs Sediment Concentration - <> 0-4 ft
NW Natural "Gasco" Site
Gasco Sediment Cleanup Action





Feet
0 125 250 375 500

Figure A16.4
Maximum Total BHCs Sediment Concentration - 4-8 ft
NW Natural "Gasco" Site
Gasco Sediment Cleanup Action



Feet
0 125 250 375 500

Figure A16.5
Maximum Total BHCs Sediment Concentration - 8-12 ft
NW Natural "Gasco" Site
Gasco Sediment Cleanup Action

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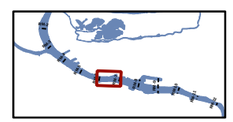
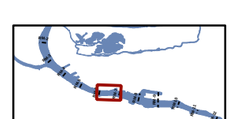


Feet
0 125 250 375 500

Figure A16.6
Maximum Total BHCs Sediment Concentration - 12-16 ft
NW Natural "Gasco" Site
Gasco Sediment Cleanup Action

ANCHOR QEA



Feet
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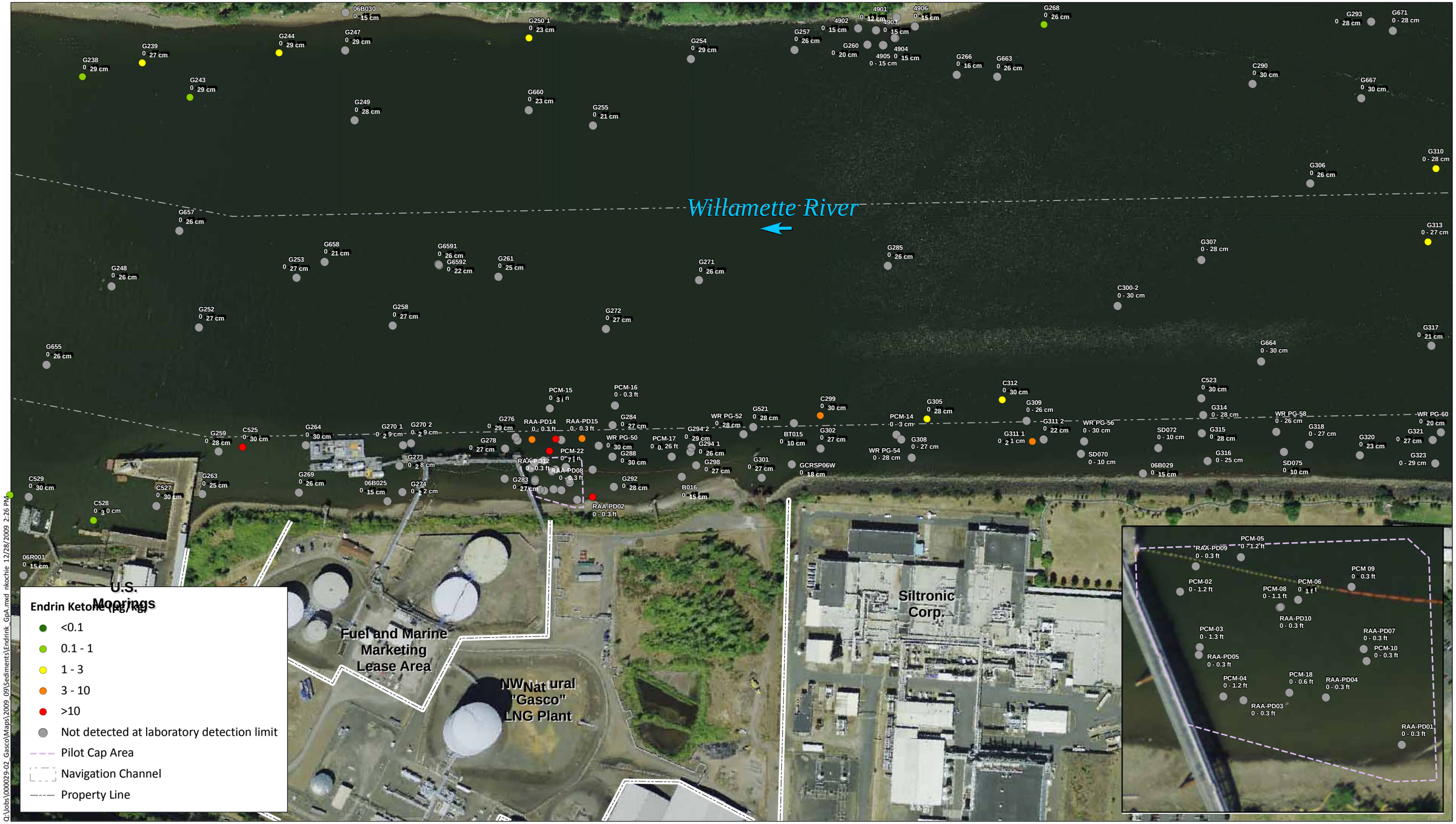
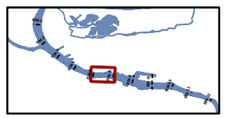
Figure A16.7
Maximum Total BHCs Sediment Concentration - 16+ ft
NW Natural "Gasco" Site
Gasco Sediment Cleanup Action



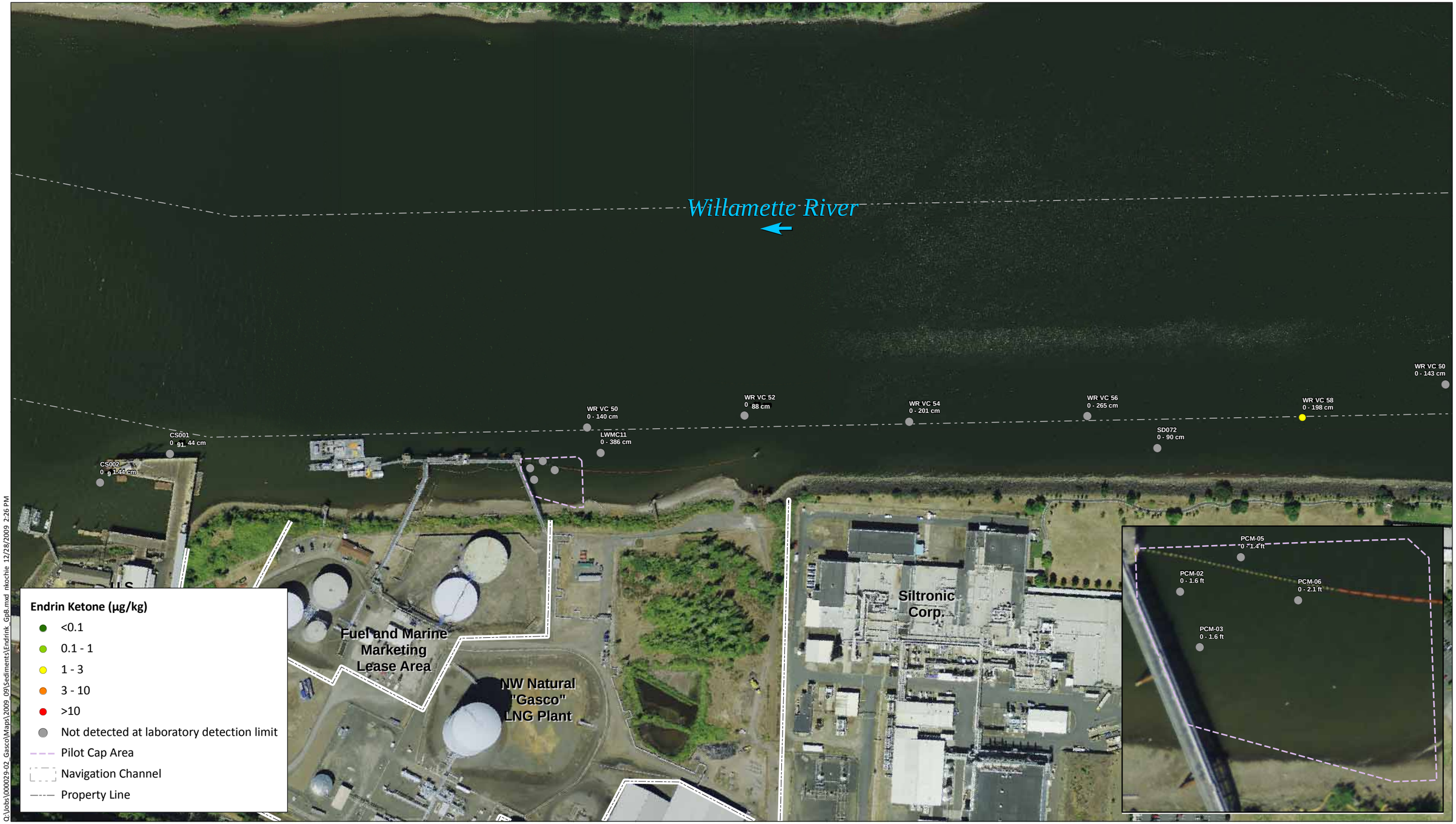


Feet

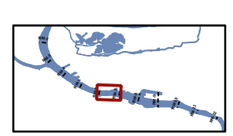
0 125 250 375 500

NOTES:
1. Inset shows Pilot Cap Monitoring Area.
2. Consistent with the Portland Harbor Superfund Site process, surface sediment is considered 0-40 cm below mudline.

Figure A17.1
Maximum Endrin Ketone Sediment Concentration - 0-40 cm
NW Natural "Gasco" Site
Gasco Sediment Cleanup Action



ANCHOR QEA



Feet
0 125 250 375 500

NOTES:
1. Inset shows Pilot Cap Monitoring Area.
2. The 0-40+ cm depth designation indicates samples originating at the mudline and extending below 40 cm.

Figure A17.2
Maximum Endrin Ketone Sediment Concentration - 0-40+ cm
NW Natural "Gasco" Site
Gasco Sediment Cleanup Action

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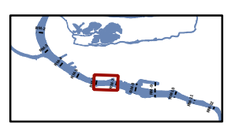
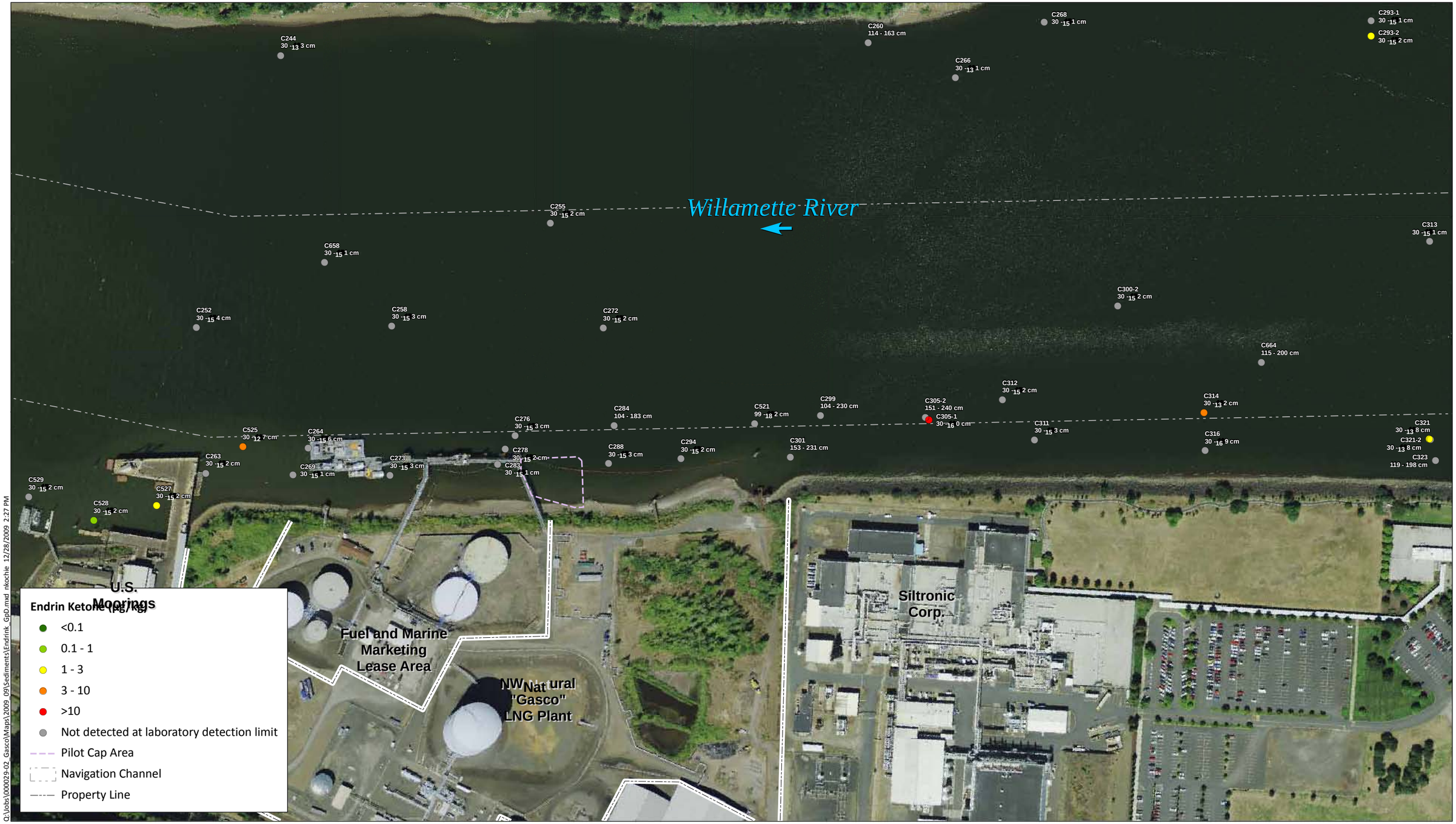


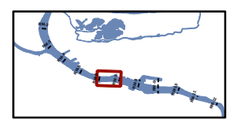
Feet

0 125 250 375 500

NOTES:
1. Inset shows Pilot Cap Monitoring Area.
2. The <>0-4 ft depth designation indicates samples that were collected originating some depth below the mudline and extending to 4 ft or less.

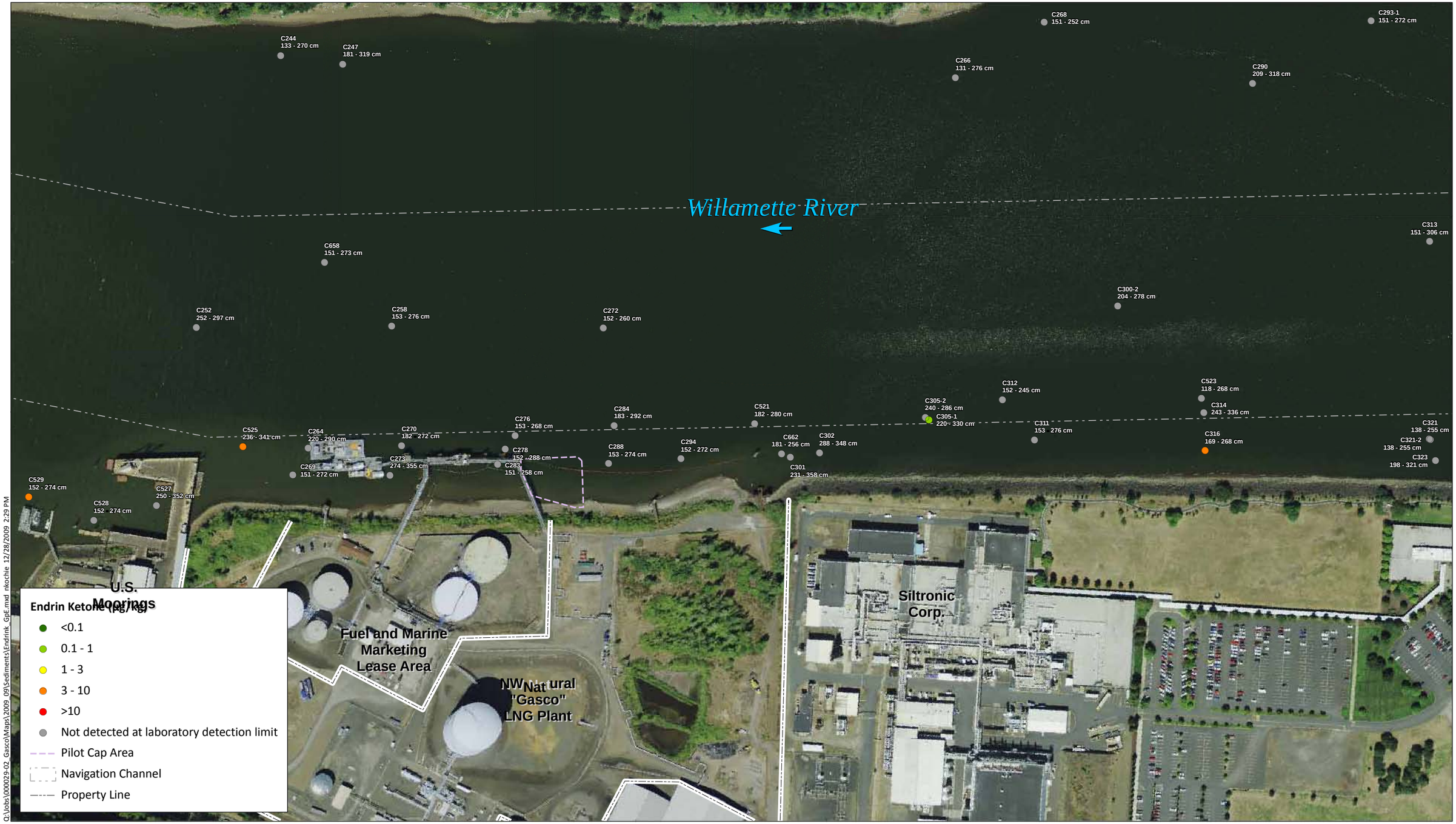
Figure A17.3
Maximum Endrin Ketone Sediment Concentration - <> 0-4 ft
NW Natural "Gasco" Site
Gasco Sediment Cleanup Action





Feet
0 125 250 375 500

Figure A17.4
Maximum Endrin Ketone Sediment Concentration - 4-8 ft
NW Natural "Gasco" Site
Gasco Sediment Cleanup Action



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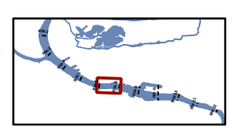

Feet
0 125 250 375 500

Figure A17.5
Maximum Endrin Ketone Sediment Concentration - 8-12 ft
NW Natural "Gasco" Site
Gasco Sediment Cleanup Action

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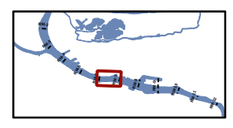
ANCHOR QEA

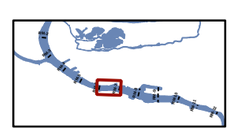


Feet
0 125 250 375 500

Figure A17.6
Maximum Endrin Ketone Sediment Concentration - 12-16 ft
NW Natural "Gasco" Site
Gasco Sediment Cleanup Action

Q:\Jobs\000029-02_Gasco\Maps\2009_09\Sediments\Endrink_GpG.mxd nkochie 12/28/2009 2:32 PM

ANCHOR QEA



Feet
0 125 250 375 500

Figure A17.7
Maximum Endrin Ketone Sediment Concentration - 16+ ft
NW Natural "Gasco" Site
Gasco Sediment Cleanup Action

APPENDIX B
CULTURAL RESOURCES WORK PLAN

PORTLAND HARBOR SUPERFUND SITE
Cultural Resources Work Plan

Regulatory Setting

NW Natural and Siltronic Corporation (Siltronic) entered into the Administrative Settlement Agreement and Order on Consent (Settlement Agreement; Docket No. CERCLA 10-2009-0255) with the EPA on September 9, 2009, to implement a final sediment remedy investigation, Engineering Evaluation/Cost Analysis (EE/CA), and design for the Gasco Sediments Site within the Portland Harbor Site. The area that will be subject to remedial actions at the Gasco Sediments Site is referred to as the Project Area in the Work Plan. As stated in the Statement of Work (SOW) attached to the Settlement Agreement, the Project Areas will be determined in a series of iterative evaluation steps that are intended to make the Project Area consistent with the Portland Harbor Site remediation. The current general Project Area for the Gasco Sediments Site is located at about river mile (RM) 6.7 on the Willamette River in Portland, Oregon, as described in Section 1.2.1 and shown in Figure 1-1 of the Work Plan. As part of the Settlement Agreement, EPA must comply with Section 106 of the National Historic Preservation Act and its implementing regulations at 36 CFR 800. This Cultural Resources Work Plan describes how the Section 106 compliance process will be completed.

Consultation

EPA and NW Natural will consult with the six Tribes that serve as Natural Resource Trustees for the Portland Harbor Superfund Site:

- The Confederated Tribes of the Grand Ronde Community of Oregon
- The Nez Perce Tribe
- The Confederated Tribes of Siletz Indians
- The Confederated Tribes of the Umatilla Indian Reservation
- The Confederated Tribes of the Warm Springs Reservation
- The Confederated Tribes and Bands of the Yakama Nation

EPA and NW Natural will consult as necessary prior to and during development of the EE/CA and subsequent design documents with the Tribal Historic Preservation Officers (THPO) of the Confederated Tribes of the Warm Springs Reservation and Confederated Tribes of the Umatilla Indian Reservation and the cultural resource program managers for the Nez Perce Tribe, Confederated Tribes of the Grand Ronde community of Oregon, Confederated Tribes and Bands of the Yakama Nation, and the Confederated Tribes of the Siletz Indians of Oregon.

Consultation will include providing information on the proposed action and the scope of the cultural resource studies, providing the rationale for the potential need or lack thereof for completing archeological monitoring during cleanup activities and the proposed scope of work if deemed necessary, an opportunity for a field visit, and meetings with Tribal representatives as requested by individual Tribes or all of the Tribes. The consultation will be directed toward obtaining information that Tribes may be able to share regarding cultural resources at or in the vicinity of the research area, receiving comments on the identified Area of Potential Effects (APE), presenting evidence regarding the need or lack thereof for monitoring cultural resources during the cleanup activities, and identifying any more general Tribal cultural resource issues or concerns at the Project Area. Similar coordination and consultation will be undertaken with the Oregon State Historic Preservation Office (SHPO). The outcome of the consultations will be documented and submitted to the Tribes and SHPO.

Any disagreements with the Tribes and SHPO will be resolved through the processes described in the Settlement Agreement and SOW; these issues will be resolved similar to any other technical issues on the project.

Area of Potential Effects

Under 36 CFR 800, EPA must define an APE for the undertaking. The APE for the Cultural Resources Work Plan will consist of the entire area of ground disturbance for the project, which is entirely within the boundaries of the Project Area.

Previous Research

A cultural resources study of the entire Gasco property was conducted in 2004 (Ellis and Baker 2004). The study included:

- Records searches and background research at the Oregon State Historic Preservation Office, local libraries, the Bureau of Land Management, the U.S. Army Corps of Engineers Portland District, the Oregon Historical Society, and NW Natural's internal records
- An assessment of archaeological potential based on historical maps, surveyor's records, photographs, geological and geomorphological information, and other relevant sources
- A field visit to examine the site, particularly beach exposures
- Monitoring of ten sediment borings

The report concluded that the archaeological potential of the area was low, and that the planned work would exclude the possibility of archaeological monitoring:

> *It is our professional opinion that the proposed removal area has a low potential for archaeological resources. The maximum depth of the planned excavations is unlikely to encounter sediments that are more than a few hundred years ago, a period during which the area is very likely to have a nearshore and offshore area, as it is currently. We cannot exclude entirely the possibility of the presence of individual artifacts in this area, deposited through discard or loss or redeposited through erosion from other locations. From an archaeological perspective, such items are highly unlikely to be significant. Some individual artifacts, however, may be sacred objects or objects of cultural patrimony as defined in both state and federal law. These items are culturally important to Tribes. Recognizing or identifying such artifacts in the removal process would be extremely difficult, if not impossible, given that the tar and visibly contaminated sediments will be removed with a clamshell dredge and placed in a barge for transport. We therefore believe monitoring by an archaeologist during the removal action would not be productive given both the low probability that archaeological deposits or materials would be encountered and the low probability that any deposits or artifacts that might be present would be observed by the monitor.* (Ellis and Baker 2004:25)

Nevertheless, an archaeologist monitored removal of nearshore portions of the "tar body," an area of approximately 2,000 square meters along the northwestern boundary of the Gasco property (Ogle and Ellis 2005). No archaeological deposits were observed during the monitoring, though opportunities for examining sediments were limited. Archaeologists concluded that no archaeological resources had been affected by the project.

Planned Work

Extensive historical research has been conducted for the Gasco property. The area has low potential for archaeological resources, and no such resources have been observed on site by archaeologists. No further field testing is recommended.

Because the 2004 report covers the entire current APE, that report may be submitted by the EPA in support of its determinations. No additional documentation is recommended.

If consulting parties raise concerns about archaeological resources, monitoring of the cleanup work may be appropriate in areas where the monitor will be able to observe the removal of deposits.

References

Ellis, David V. and R. Todd Baker. 2004. An Assessment of the Potential for Archaeological and Historical Resources at the GASCO Removal Action Location, Portland, Oregon. Archaeological Investigations Northwest, Inc. Report No. 1373. On file at Anchor QEA, LLC, Seattle, WA.

Ogle, Todd and David V. Ellis. 2005. Letter Report RE: Archaeological Monitoring, Gasco Removal Action. Archaeological Investigations Northwest, Inc. Report No. 1588. December 16, 2005. On file at Anchor QEA, LLC, Seattle, WA.