FINAL
MONITORING AND REPORTING PLAN – POST CONSTRUCTION

REMOVAL ACTION
NW NATURAL "GASCO" SITE

Prepared for Submittal to

U.S. Environmental Protection Agency, Region 10
1200 Sixth Avenue
Seattle, Washington 98101

Prepared by

Anchor Environmental, L.L.C.
6650 SW Redwood Lane Suite 110
Portland, Oregon 97224

On behalf of

NW Natural
220 NW Second Avenue
Portland, Oregon 97209

March 2006

FINAL
MONITORING AND REPORTING PLAN – POST CONSTRUCTION

REMOVAL ACTION
NW NATURAL "GASCO" SITE

Prepared for Submittal to

U.S. Environmental Protection Agency, Region 10

1200 Sixth Avenue

Seattle, Washington 98101

Prepared by

Anchor Environmental, L.L.C.

6650 SW Redwood Lane Suite 110

Portland, Oregon 97224

On behalf of

NW Natural

220 NW Second Avenue

Portland, Oregon 97209

March 2006

1 INTRODUCTION 1
1.1 Project and Data Collection Objectives 1
1.1.1 RAOs Identified in the SOW 1
1.1.2 Objectives for Engineered Pilot Cap Study 2
1.1.3 Data Collection Objectives to Meet RAOs and Pilot Study Objectives 2

2 MONITORING APPROACH 4
2.1 Monitoring Rationale 4
2.1.1 Visual Inspection/Diver Survey (RAO specific) 4
2.1.2 Bathymetric Survey (RAO specific) 4
2.1.3 Product Seepage Monitoring (RAO specific) 4
2.1.4 Porewater Migration Sampling (Pilot Study Specific) 5
2.1.5 Near-Bottom Surface Water Sampling (Pilot Study Specific) 6
2.2 Monitoring Area and Locations 6
2.2.1 Visual Monitoring 6
2.2.2 Diver and Bathymetry Surveys 7
2.2.3 Sediment Core and Porewater Monitoring 7
2.2.4 Near-Bottom Surface Water Monitoring 7
2.3 Monitoring Frequency 8
2.3.1 Visual Monitoring 8
2.3.2 Diver and Bathymetry Surveys 8
2.3.3 Sediment Core, Porewater, and Discrete and Time-Integrated Near-Bottom Surface Water Monitoring 9
2.4 Monitoring Methods 9

3 RESULTS REPORTING 10
3.1 Data Reduction, Analysis, Interpretation, and Reporting 10
3.1.1 Visual Inspections and Diver Surveys 10
3.1.2 Bathymetry Surveys 10
3.1.3 Sediment Core Characterization 11
3.1.4 Porewater Sampling 11
3.1.5 Near-Bottom Surface Water Monitoring 12
3.2 Report Contents 13
3.3 Reporting Schedule 14

4 POST-CONSTRUCTION PROJECT CONTROLS 15
4.1 Proposed Controls 15
4.2 Documentation Procedures 16
4.3 Notification Procedures 16

5 CONTINGENCY RESPONSE AND ADAPTIVE MANAGEMENT PROCESS 17
5.1 Contingency Response Approach 17
5.2 Tiered Adaptive Management Process 17

6 REFERENCES 19

List of Figures

Figure 1 Vicinity Map
Figure 2 Former Pre-Removal Lateral and Vertical Extents of Surface Tar Body
Figure 3 Post-Cap and Cover Bathymetry and Organo-Clay Mat Location
Figure 4 Proposed Long-Term Monitoring Sampling Stations

List of Appendices

Appendix A Field Sampling Plan
Appendix B Quality Assurance Project Plan

%R	Percent recovery
Anchor	Anchor Environmental, L.L.C.
AST	Aboveground storage tank
ASTM	American Society for Testing of Materials
BTEX	benzene, toluene, ethylbenzene, and xylene
CAS	Columbia Analytical Service, Inc.
CCB	Continuing Calibration Blank
CCV	Continuous Calibration Verification
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CHASP	Construction Health and Safety Plan
COC	chain-of-custody
CQAP	Construction Quality Assurance Plan
DEQ	Oregon Department of Environmental Quality
DGPS	Differential Global Positioning System
DNAPL	Dense non-aqueous phase liquid
DOC	Dissolved organic carbon
DQOs	Data Quality Objectives
ECL	Office of Environmental Cleanup
EPA	U.S. Environmental Protection Agency
EST	Environmental Sampling Technologies
FC	Field Coordinator
FSP	Field Sampling Plan
i.d.	inside diameter
ICV	Initial (or Independent) Calibration Verification
LDW	Lower Duwamish Waterway
LWG	Lower Willamette Group
MARP	Monitoring and Reporting Plan
MDL	Method Detection Limit
MRL	Method Reporting Limit
MS/MSD	Matrix Spikes and Matrix Spike Duplicate
NAVD	National Vertical Datum

Order	Administrative Order on Consent
OSC	On-Scene Coordinator
PAH	polycyclic aromatic hydrocarbons
PARCC	Precision, Accuracy, Representativeness, Comparability, and Completeness
ppb	parts per billion
PCB	polychlorinated biphenyl
PM	Project Manager
PRC	permeability/performance reference compound
PTFE	Polytetrafloroethylene
QA/QC	Quality Assurance/Quality Control
QAPP	Quality Assurance Project Plan
RAO	Removal Action Objectives
RAPP	Removal Action Progress Plan
RAWP	Removal Action Work Plan
RI/FS	Remedial Investigation/Feasibility Study
RPD	Relative Percent Difference
SAP	Sampling and Analysis Plan
SDG	Sample delivery group
SOPs	Standard Operating Procedures
SOW	Statement of Work
SPMD	semipermeable membrane device
SVOC	semivolatile organic compound
TOC	total organic carbon
TPM	Technical Project Manager
USACE	U.S. Army Corps of Engineers
VOC	volatile organic compound

1 INTRODUCTION

NW Natural entered into an Administrative Order on Consent (Order) with the U.S. Environmental Protection Agency (EPA) on April 28, 2004 to perform a time-critical removal action at the "Gasco site" (Site) (EPA 2004) (Figure 1). The Order requires that NW Natural perform a number of actions associated with removing a tar body (as defined in the Order) from the riverbank and nearshore sediment adjacent to the site. The extent of the tar body was defined during the design characterization sampling (Figure 2). In accordance with the EPA-approved Final Removal Action Project Plan (RAPP; Anchor 2005), removal of the tar body was initiated in August 2005 and was completed in late October 2005. This Monitoring and Reporting Plan (MARP) describes post-removal monitoring objectives and provides an overview of the monitoring approach, design of the monitoring program (e.g., sampling strategy, station locations and replication, field sampling methods, and laboratory methods), data analysis and interpretation, reporting requirements, post-removal site control, contingency response, and adaptive management. The field monitoring is required by the Order and will provide information necessary to evaluate the performance of the engineered pilot cap, as discussed below. The removal action was an interim action, and the information gathered pursuant to this MARP is not intended to monitor a permanent remedy. However, it is intended to provide information on whether this type of cap (or a similar cap) might be suitable for further evaluation as a permanent remedy here or elsewhere on the Site.

1.1 Project and Data Collection Objectives

1.1.1 RAOs Identified in the SOW

The Removal Action Objectives (RAOs) for the project are defined in Section II of the Statement of Work (SOW) and are reviewed in the RAPP. The objectives that are relevant to post-construction monitoring include evaluating the cap's ability to isolate any residual contamination, monitoring for seepage of product in the low spot created by the removal, and providing information that contributes to the efficient performance of any anticipated long-term remedial actions.

In addition to these RAOs, the capping was also designed to include an engineered pilot sediment remediation cap placed over a portion of the removal area following completion of the dredging (Figure 3). The objectives of the engineered pilot cap are discussed below.

1.1.2 Objectives for Engineered Pilot Cap Study

The purpose of the engineered pilot cap is to place a barrier over a portion of the removed tar body and monitor the performance of the cap until the Portland Harbor RI/FS is completed and EPA selects a final remedy for the Site. The monitoring information collected, as described in this MARP, will be used to help evaluate contaminant loading through the pilot cap due to residual contamination in sediments or any potential migration of contaminants from upland groundwater, and determine whether capping might be an effective remedy for future remediation at the Site. Information from the pilot study will be used in subsequent sediment remediation evaluations for shoreline sediments at the Site. The engineered pilot cap is designed to withstand erosive forces that might reasonably be expected over the next few years while the Site-wide remedial alternatives are evaluated. The engineered pilot cap is not intended as a long-term permanent remedy for this area, although it might be integrated into a wider capping approach should capping be determined to be an effective remedy for the Site.

1.1.3 Data Collection Objectives to Meet RAOs and Pilot Study Objectives

Post-removal action field monitoring is required by the Order and will provide information necessary to evaluate the performance of the engineered pilot cap. Field data collection activities will function to:

- Evaluate the nature and extent of potential seepage of non-aqueous phase liquid (e.g., tar oil and tar) in the bathymetric “low spot” created by the dredging activities
- Evaluate whether groundwater movement from upland sources or through residual sediments occurs that recontaminates the removal action area
- Monitor cap stability over the 3-year design life
- Determine the near-bottom surface water quality overlying the pilot cap for comparison with porewater concentrations within the cap

In addition, for the pilot study portion of the effort, as defined in the Army Corps of Engineers (USACE) Guidance for Subaqueous Dredged Material Capping (USACE 1998), an engineered cap should function to provide physical isolation of contaminated sediments from biota, stabilize contaminated sediments such that they do not re-

suspend into the water column, and reduce the flux of dissolved contaminants to the water column. Consistent with these functions, monitoring of the engineered pilot cap's effectiveness over time would target the following field data collection objectives:

- Document variations in cap thickness
- Evaluate cap stability
- Document changes in surface sediment quality
- Determine cap porewater quality

2 MONITORING APPROACH

2.1 Monitoring Rationale

To achieve the data collection objectives defined in Section 1.1.3, a variety of field monitoring methods will be employed, as discussed below. Note that the placement of several feet of quarry spalls on top of the organo-clay mat prevents the collection of cores, porewater and/or near-bottom surface water samples in the organoclay mat area. The effectiveness of the organo-clay mat isolation will be assessed through topside visual inspection (see Section 2.2.1) and documentation of potential seeps and/or sheen stemming from the area of the mat placement (visibility permitting).

2.1.1 Visual Inspection/Diver Survey (RAO specific)

Long-term visual monitoring will be conducted to identify any areas of sheen/product release and ensure buoys placed at the Site to demarcate the pilot cap area remain in place. In addition, diver surveys will be performed within the pilot cap area and surrounding perimeter of fringe cover (extending to at least 50 feet beyond the cap) to visibly evaluate the nature and extent of potential seepage of product in the bathymetric "low spot" created by the dredging activities and to visibly evaluate the integrity of the engineered pilot cap and surrounding fringe cover areas.

2.1.2 Bathymetric Survey (RAO specific)

Bathymetry surveys will be performed within the entire area previously bounded by the outer area containment system to monitor changes in mudline elevation and assess changes in cap and fringe cover thickness. Through cap cores will also be used to assess cap thickness directly. These cores will also fulfill other objectives as discussed below.

2.1.3 Product Seepage Monitoring (RAO specific)

Product seepage monitoring will be performed through the collection of sediment cores (the same cores as noted above), both within and just channelward of the pilot cap area. The sediment cores collected from the pilot cap area will be logged, observed for any signs of product, and subsampled for bulk chemical analyses to monitor temporal and spatial changes in sediment concentrations within the pilot cap. Logging is intended to determine the extent of mixing within the pilot cap (at both the sediment/cap and cap/mudline interfaces) and document whether seepage of non-aqueous phase liquid

(e.g., tar oil and tar) is observable. The core samples will be horizontally and vertically co-located with the porewater samples (discussed below) to facilitate direct comparison of the bulk sediment and porewater concentrations residing within the cap. Initially, each core sample will be analyzed for total solids, total organic carbon (TOC), grain size, cyanide, polycyclic aromatic hydrocarbons (PAHs), benzene, toluene, ethylbenzene, and xylene (BTEX), total metals (i.e., arsenic, chromium, copper, nickel, lead, and zinc), pesticides, and polychlorinated biphenyls (PCBs). This analyte list may be reduced based upon review of the post-dredge sediment characterization results in coordination with EPA. In addition, if a new depositional layer of surface sediment overlies the pilot cap armor layer, this material may be sampled (volume permitting) and analyzed to evaluate whether sediment transport and deposition on the pilot cap may be contributing chemicals to the cap. Samples of depositional sediment will be analyzed for the full list of Portland Harbor Superfund Site contaminants of interest (Integral et al. 2004).

Sediment cores will also be collected through the fringe cap just channelward of the pilot cap area to visibly monitor potential seepage of non-aqueous phase liquid (e.g., tar oil and tar) in the bathymetric “low spot” created by the dredging activities. No samples will be collected for chemical analyses from these channelward cores.

2.1.4 Porewater Migration Sampling (Pilot Study Specific)

Migration of chemicals via porewater advection and/or diffusion through the pilot cap will be monitored through the collection of porewater samples within the pilot cap. The porewater stations will be co-located with the pilot cap core stations (see above). A single porewater sample will be collected at each station from the midpoint of the cap layer (as determined during the co-located core logging) to minimize potential collection of porewater from the underlying sediment-pilot cap mixed layer and the overlying surface water. The porewater samples will be analyzed for TOC, dissolved organic carbon (DOC), cyanide, PAHs, and BTEX. The porewater analytical results will be evaluated to assess the following: temporal and spatial variations in porewater chemical concentrations within the cap, the relationship with bulk sediment chemistry results (obtained from co-located cores), and the relationship with discrete and time-integrated near-bottom surface water concentrations. This evaluation as well as visual observation

results will help determine whether the observed porewater concentrations are due to groundwater transport through the cap, product seepage, mixing of underlying sediments with cap sediments, mixing of recently deposited sediments with cap sediments and/or surface water recharge or exchange.

2.1.5 Near-Bottom Surface Water Sampling (Pilot Study Specific)

The surface water quality directly overlying the cap and at ambient stations upstream and downstream of the removal action area will be monitored through the collection of near-bottom surface water samples. Both discrete and time-integrated (approximately 1-month in duration) near-bottom surface water samples will be collected. The discrete samples will be analyzed for TOC, DOC, total suspended solids, cyanide, PAHs, and BTEX, whereas the time-integrated samples will be analyzed for PAHs (i.e., the sampling device is not capable of sampling for BTEX). The observed discrete and time-integrated near-bottom surface water analytical results will be evaluated to assess the following: temporal and spatial variations in surface water chemical concentrations, the relationship between the discrete and time-integrated concentrations, and the relationship with co-located porewater chemistry results. This evaluation will help identify whether porewater concentrations identified in the pilot cap are due to surface water recharge and/or exchange or other processes noted above.

2.2 Monitoring Area and Locations

The monitoring area and locations for the visual, diver and bathymetry surveys, coring (observations and sediment chemistry), porewater, and near-bottom surface water monitoring are described below.

2.2.1 Visual Monitoring

Visual monitoring will be conducted from the top of bank, beach, and/or the adjacent pipeline structure. These surveys will be conducted from a variety of vantage points to ensure visual coverage of the removal action area.

2.2.2 Diver and Bathymetry Surveys

The diver surveys will encompass the entire pilot cap area plus an approximately 50-foot perimeter outside the pilot cap. The bathymetry survey will extend throughout the entire area previously bounded by the outer containment area (Figure 3).

2.2.3 Sediment Core and Porewater Monitoring

Nine sediment core and porewater monitoring stations will be co-located within the pilot cap area (Figure 4). These stations were selected to provide adequate spatial coverage and targeted areas where the post-dredge surface sediment samples contained the highest chemical concentrations. The number of proposed sediment core and porewater stations may be decreased (in consultation with EPA) following the Year 2 monitoring if the chemical concentration variability observed in the Year 0, Year 1, and Year 2 sampling events is low across the various sampling stations.

In addition, two cores will be collected within the bathymetric "low spot" in the fringe cover area just channelward of the pilot cap (Figure 4) and observed for potential seepage of non-aqueous phase liquid (e.g., tar oil and tar). These cores were placed in the direct vicinity of post-dredge surface sampling station RAA-PD12, which showed relatively elevated chemical concentrations.

2.2.4 Near-Bottom Surface Water Monitoring

Nine near-bottom discrete and time-integrated surface water samples will be co-located with the sediment core and porewater sampling stations (see above) within the pilot cap area (Figure 4). These stations were co-located to facilitate comparison between the observed porewater and near-bottom surface water concentrations. Based upon the observed relationships between the co-located porewater and near-bottom surface water analytical results, as well as the spatial variability of surface water chemical concentrations, the number of proposed near-bottom surface water stations following the Year 2 monitoring may be decreased (in consultation with EPA). In addition to the nine samples within the pilot cap area, surface water samples will be also be collected and analyzed from two ambient stations. One of the ambient stations will be located approximately 600 feet upstream of the pilot cap area and the other will be located approximately 600 feet downstream of the pilot cap area. These stations will be set at a

similar elevation to the cap area and will be used to determine ambient surface water concentrations.

2.3 Monitoring Frequency

The following sections describe the proposed monitoring frequency for the various long-term monitoring activities. It is important to note that additional monitoring may be conducted if flow conditions exceed the design parameters or substantial evidence of other natural or anthropogenic activities indicates a potential for impacts to the engineered pilot cap. As requested by EPA, the proposed monitoring frequency is based on a tiered approach where the results of intensive initial monitoring will help guide the long-term sampling frequency.

2.3.1 Visual Monitoring

Initial visual monitoring will be conducted weekly for a period of 1 month (initiating following EPA-approval of this MARP). From April 2006 through July 2006, visual monitoring will be conducted on a monthly basis unless more frequent monitoring is warranted based on initial monitoring observations. As the river discharge decreases in August 2006, the monitoring frequency will be increased again to once per week to monitor for potential increased erosion due to wave action on the shoreline during low river elevations. Based on the observations gathered during the weekly monitoring, monitoring may be scaled back to monthly through November 2006 in consultation with EPA. The results of the first year of monitoring will be used to determine the appropriate visual monitoring frequency in subsequent years.

2.3.2 Diver and Bathymetry Surveys

Bathymetric changes are most likely to occur following periods of high and low river discharge and variations in river elevation. Mean annual discharges and elevations in the Willamette River in Portland are historically the highest from December through June. Therefore, bathymetry will be collected following the high discharge period and following the low discharge period. Diver surveys will also be conducted to confirm the bathymetric findings and provide visual observations. As requested by EPA, the initial survey frequency during these periods is proposed as follows:

- Year 0: March/April 2006 (diver survey and bathymetry), August 2006 (diver survey and bathymetry), and November 2006 (bathymetry)
- Year 1: August 2007 (diver survey and bathymetry) and November 2007 (bathymetry)
- Year 2: August 2008 (diver survey and bathymetry) and November 2008 (bathymetry).
- Year 3 through implementation of the site-wide remedy: the previous survey data will be reviewed in consultation with EPA to determine whether the current sampling frequency (i.e., semi-annual) can be reduced.

2.3.3 Sediment Core, Porewater, and Discrete and Time-Integrated Near-Bottom Surface Water Monitoring

As requested by EPA, the initial sediment core, porewater, and discrete and time-integrated near-bottom surface water monitoring frequency is proposed as follows during the appropriate hydrologic conditions (see above):

- Year 0: March/April 2006, August 2006, and November 2006
- Year 1: August 2007 and November 2007
- Year 2: August 2008 and November 2008
- Year 3 through implementation of the site-wide remedy: the previous monitoring data will be reviewed in consultation with EPA to determine whether the current sampling frequency (i.e., semi-annual) can be reduced.

Sediment core, porewater, and discrete surface water samples will all be collected at the same time during each sampling event. Integrated surface water sample equipment will be also deployed at these times. This equipment will be retrieved for analysis approximately 1 month later.

2.4 Monitoring Methods

The visual inspection/diver survey, bathymetry, sediment core, porewater, and near-bottom surface water monitoring activities will be conducted in accordance with the Sampling and Analysis Plan (SAP), which consists of the Field Sampling Plan (FSP; Appendix A) and Quality Assurance Project Plan (QAPP; Appendix B).

3 RESULTS REPORTING

3.1 Data Reduction, Analysis, Interpretation, and Reporting

3.1.1 Visual Inspections and Diver Surveys

The visual inspections will serve to identify any areas of sheen/product release from the removal action area and monitor the condition of the buoys used to demarcate the pilot cap area. Detailed notes of any areas with sheen/product release and their relationship to the removal action area will be identified on a map (based on visual observations) and photographed. In addition, notes will be taken to identify any issues associated with the buoys (e.g., missing buoys, movement of the buoys, etc.). During the diver surveys, the dive crew will document the condition of the engineered cap and immediately surrounding fringe cover areas using video recording equipment and will keep detailed notes of areas, if any, that indicate the presence of subsurface seeps as well as areas with visible accretion or erosion. The information gathered during these surveys will help determine if additional monitoring is necessary to assess general conditions of the cap, stability of the cap material, and any observable product seepage. The visual inspection and diver monitoring results will be summarized in the data summary and data evaluation monitoring reports. In addition, EPA will be provided a copy of the diver reconnaissance video in each data summary monitoring report.

3.1.2 Bathymetry Surveys

A figure showing the survey bathymetry results will be submitted to EPA in the data summary monitoring reports. The bathymetry results for each monitoring event will be compared to the final construction (post-cap) bathymetric survey (conducted to verify compliance with the capping design criteria) to evaluate changes in bathymetry over time. Changes in bathymetry (allowing for the accuracy of the surveys, which will show some level of change that represents “noise” of the measurement technique) will be evaluated to identify areas of erosion, deposition, or consolidation of the engineered pilot cap. To the extent and accuracy possible, elevation changes will be discussed in the annual data evaluation monitoring reports. General response actions based on bathymetry and other results are identified in Section 5.

3.1.3 Sediment Core Characterization

Sediment core sample chemistry concentrations will be tabulated and submitted to EPA following each monitoring event in the data summary monitoring reports. Annually, the tabulated chemistry concentrations will be compared to the first Year 0 sediment chemistry results (anticipated to be collected in March/April 2006) to determine if the pilot cap sediment chemical concentrations increase or otherwise change over time. The results of this evaluation will be submitted to EPA in the annual data evaluation monitoring reports. This and other monitoring information will be used to evaluate whether any changes in cap chemistry indicate groundwater transport through the cap, product seepage, mixing of underlying sediments with cap sediments, mixing of recently deposited sediments with cap sediments and/or surface water recharge or exchange.

In addition, if a layer of depositional surface sediment overlies the armor layer of the engineered pilot cap, this material will be sampled (volume permitting). If measured, the analytical results will be tabulated and submitted to EPA in the data summary monitoring reports. The surface sediment analytical results will be compared to the underlying subsurface sediment results to evaluate whether sediment transport and deposition on the engineered pilot cap may be contributing to contamination of the cap layer. The physical characteristics of the surface and subsurface sediments will also be compared over time to assess mixing into the cap layer either from above or below the cap layer. The results of these evaluations will be submitted to EPA in the annual data evaluation monitoring reports. Response actions based on any observations of product seepage results are discussed in Section 5.

3.1.4 Porewater Sampling

Pilot cap porewater chemistry analytical results will be tabulated and submitted to EPA following each monitoring event in the data summary monitoring reports. Annually, the tabulated chemistry concentrations will be compared to the concentrations detected in the first Year 0 co-located baseline porewater samples (anticipated to be collected in March/April 2006). This information will be evaluated along with other monitoring results to determine whether any changes in porewater concentrations may be due to groundwater transport through the cap, product seepage, mixing of underlying

sediments with cap sediments, mixing of recently deposited sediments with cap sediments and/or surface water recharge or exchange. This evaluation will specifically include comparison of the porewater chemical results to the co-located sediment chemical concentrations. Similarly, the porewater chemical results will be compared to the co-located discrete and time-integrated near-bottom surface water chemical concentrations to assess the loading of dissolved contaminants into the overlying water and/or potential recontamination of the cap layer from the overlying surface water. The porewater migration sampling results and evaluation will be summarized in the annual data evaluation monitoring reports.

It should be noted that representative porewater samples very close to a cap/underlying sediment interface can be very difficult to collect. Experience on past projects has shown that a number of potential sampling artifacts can occur. Porewater sampling results will always be evaluated in the context of the potential for such artifacts before conclusions are drawn about potential migration rates. Potential artifacts include: difficulty sampling a layer close to the underlying sediments' unobservable physical mixing with layers above or below the cap, inaccuracies in probe location due to small variations in cap thickness leading to collection of porewater from within the underlying sediments, pumping of porewater across the mixing layer (in cases where the probe tip is too close to the cap-sediment interface), pumping of overlying surface water, and disturbance of the cap caused by placement of the probe itself. The sampling protocols listed in the attached SAP (the FSP and QAPP, Appendices A and B, respectively) aim to reduce these sampling artifacts.

3.1.5 Near-Bottom Surface Water Monitoring

For each monitoring event, the discrete and time-integrated near-bottom surface water chemical concentrations will be submitted to EPA following each monitoring event in the data summary monitoring reports. Annually, the tabulated chemistry concentrations will be compared to the co-located porewater chemical concentrations as discussed above to determine if dissolved contaminants are entering the surface water through the cap or if surface water is contributing to chemicals in the cap. In addition, the discrete and time-integrated near bottom surface water concentrations at each station will be compared to evaluate potential temporal variations of the near-bottom

surface water chemical concentrations. The near-bottom surface water sampling results and evaluation will be summarized in the annual data evaluation monitoring reports.

3.2 Report Contents

The monitoring results will be summarized in the form of data summary reports and annual data evaluation reports. As requested by EPA, the data summary reports will include, at a minimum, a summary of the monitoring conducted and methods used, tabulated results, a data validation report, a copy of the diver reconnaissance video and sampling location maps. The annual data evaluation monitoring reports will present an evaluation of all data collected during each monitoring event during the year and compare this data to previous long-term monitoring data, where applicable. The data evaluation reports will provide an evaluation of data related to the RAOs and engineered pilot cap objectives as well as summarize comparisons of bulk sediment, porewater, and discrete and time-integrated near-bottom surface water chemical concentrations. At a minimum, the following will be included in each monitoring report:

- Summary of all field activities, including a description of any deviations from the EPA-approved SAP (FSP and QAPP) and/or MARP
- Locations of areas of erosion and/or accretion identified during the visual inspection/diver surveys
- Locations of any visible product or groundwater seeps
- Any issues associated with the buoys demarcating the pilot cap area
- Copies of dive survey video reconnaissance (as an appendix)
- Presentation of bathymetric data and comparison to baseline data
- Location of sediment core, porewater, and near-bottom sampling stations in latitude and longitude coordinates
- Project maps with actual sampling locations
- Final quality assurance/quality control (QA/QC) validation report
- Data results, including electronic copies of field logs, laboratory analysis results, and associated QA/QC data. All electronic data files will be stored in a data management system such as Equis®.
- Comparison of bulk sediment, porewater, and near-bottom surface chemical concentrations during each monitoring period and relative to the baseline conditions

- Recommendations of appropriate changes to the MARP, if necessary, to ensure the continued successful performance of the cap
- Any contingency actions implemented to better comply with the RAOs

3.3 Reporting Schedule

Following each monitoring event, a data summary monitoring report will be prepared and submitted to EPA within 30 days of receipt of validated data. In addition, an annual data evaluation monitoring report will be prepared and submitted to EPA within 60 days of receipt of the November validated data. If any results indicate failure of the cap to meet any of the RAO or engineered cap objectives, EPA will be immediately notified via email once the information is known to NW Natural. This will be followed up with results memos as necessary to fully inform EPA of the issue identified and the data relevant to the issue.

4 POST-CONSTRUCTION PROJECT CONTROLS

4.1 Proposed Controls

Given the industrial nature of the area, and the small aerial extent of the former tar body, future recreational use of the site is anticipated to be minimal. Thus, the proposed Site controls consist of the following for protection of the capped area:

- Written notification to NW Natural's tenants about the presence of the cap, which will include the following:
  - Instructions and maps that show areas where boat and ship traffic should be minimized and anchoring prohibited
  - Instructions for tugboat operators to direct propeller wash away from the capped area
  - Identification of a preferential tug use area on maps to show operators accessing the adjacent oil pipeline the location of tug work areas adjacent to the pipeline dock
  - Direction that all proposed work in the vicinity of the cap should be cleared with NW Natural prior to starting work
  - Direction that excavation and/or purposeful sediment disturbance shall not be conducted in the capped area
  - Direction that NW Natural shall be notified in the event of any possible damage to the engineered cap
- Posting signs on the beach and oil pipeline. The signs will delineate the general aerial extent of the engineered cap, and prohibit recreational use and boat anchorage in the capped area. The signs will also prescribe a no wake area around and over the cap.
- Placement of buoys with the "no wake" symbol and text surrounding the temporary cap
- As visual observations occur, NW Natural will assess the need for replacement of the buoys and/or placement of an oil-absorbent boom and skirt around the capping area. A specific proposal for the type, configuration, and maintenance of such a boom/skirt will be submitted to EPA should this condition occur. It should be noted that the tenant currently leasing the NW Natural oil pipeline facilities has a permanent boom installed at the Site. This boom would act as a second containment

barrier for sheens associated with the removal action area should they occur in the short term or over the longer term.

4.2 Documentation Procedures

NW Natural or its representatives will maintain a record of all correspondence with its tenants, if any, documenting any potential damage to the engineered cap. The condition of the engineered cap and ongoing monitoring results will be reported to EPA in the monitoring reports.

4.3 Notification Procedures

In the event of potential damage to the cap, NW Natural will notify EPA and provide EPA with a proposed response. EPA will also be involved in all levels of the tiered adaptive management process described in Section 5.2.

5 CONTINGENCY RESPONSE AND ADAPTIVE MANAGEMENT PROCESS

5.1 Contingency Response Approach

If a condition occurs that requires attention, a tiered adaptive management process will be implemented. The following conditions could occur in the capped area that would potentially lead to a contingency response:

- The physical integrity of the cap is compromised (such as identification of scour or other damage in the capped area).
- Identification of product seeps through the cap.
- Movement or loss of a buoy demarcating the location of the pilot cap area.

If any of these conditions is identified during the cap monitoring program, a tiered contingency response approach will be followed as described in this section. It should be noted that porewater and near-bottom surface water monitoring results will not be evaluated in the context of contingency response because these data are being collected solely for pilot cap evaluation purposes.

5.2 Tiered Adaptive Management Process

In the tiered adaptive management process, the contingency response would follow a sequence of actions once a trigger has been identified by the monitoring program. The adaptive management process is a hierarchy that describes the order in which each action would occur. The following levels of approach will be used when a trigger has been identified:

- Level 1: Once an issue has been identified (e.g., bathymetry survey or diver survey shows significant erosion of the cap), the data will be re-examined, and additional data analyses will be performed as necessary. EPA and NW Natural will evaluate the initial data and review any additional analyses performed. If the buoys demarcating the location of the cap are identified as missing or damaged, the Level 1 response will include replacement or maintenance as soon as possible.
- Level 2: If the issue is not resolved during the Level 1 response, additional data collection will be performed. For example, if a core sample through the cap indicates the cap has been eroded, another core sample would be collected to verify the condition identified, and to better delineate the area over which the condition is

occurring if necessary. NW Natural and EPA would evaluate the original and new data to determine if the issue requires additional response.

- Level 3: If the Level 1 and Level 2 response tiers indicate that further action is necessary, appropriate actions will be coordinated with EPA. While the Level 3 tier would typically follow the Level 1 and Level 2 actions, there could be times where it is appropriate to initiate a Level 3 action immediately without the additional analyses and data collection in Level 1 or Level 2.

Two scenarios that will require a contingency response following completion of the Level 1 and Level 2 response actions include: 1) the identification of non-aqueous phase liquid above the cap or in the bathymetric "low spot" created by the removal, and/or 2) significant erosion of the cap that compromises the cap's ability to provide an effective physical barrier to underlying contamination. If either of these scenarios are identified and documented through the Level 1 and Level 2 response actions, NW Natural will assess placement of additional cap material in the affected areas (in consultation with EPA). In addition, as part of the Level 1 response action the buoys demarcating the location of the cap will be maintained as necessary and replaced as soon as possible if they are identified as missing

6 REFERENCES

Anchor Environmental, L.L.C. (Anchor). 2005. Removal Action Project Plan – Final Design Submittal. Prepared on behalf of NW Natural. July 2005. Seattle, Washington.

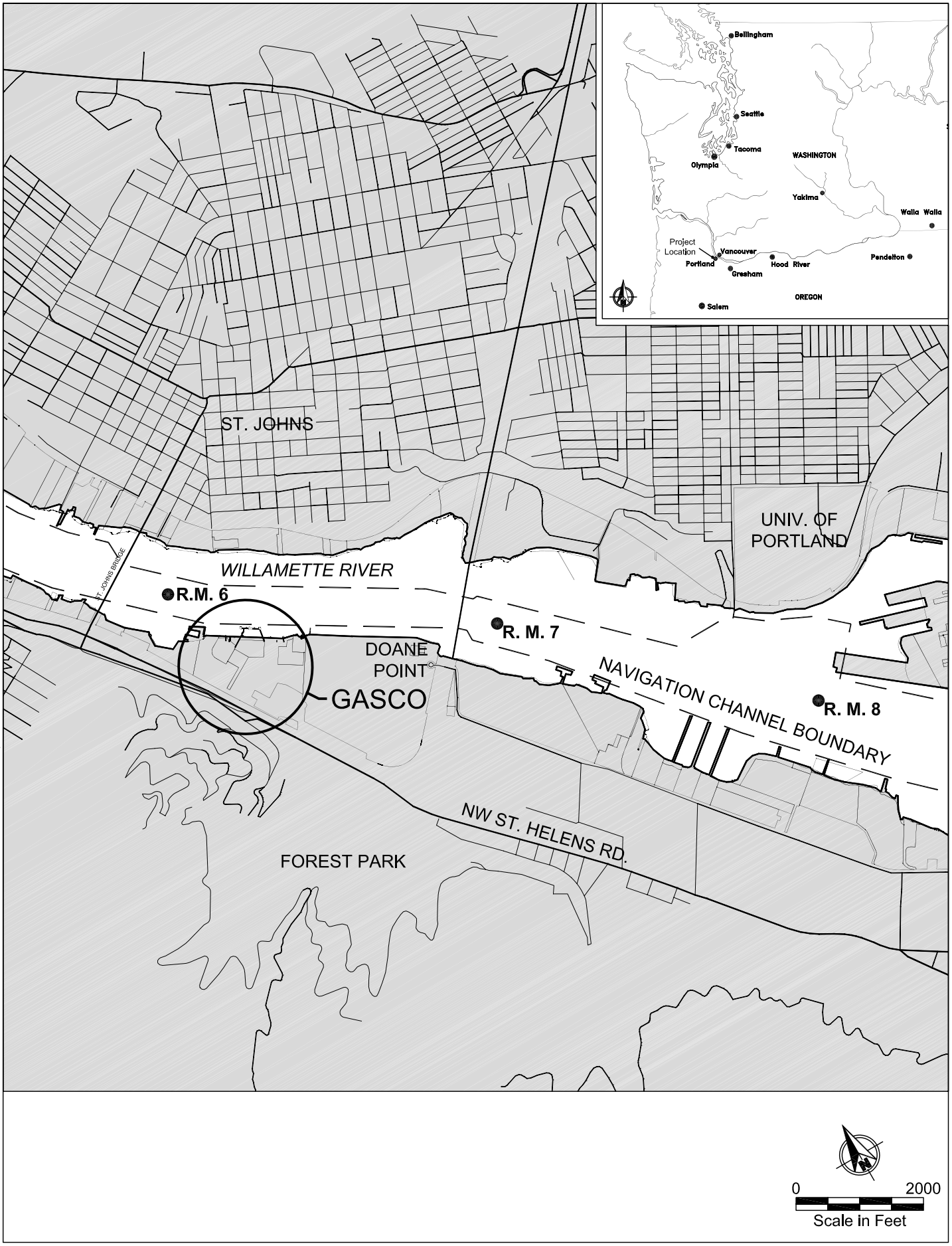
Environmental Protection Agency, U.S. (EPA). 2004. Administrative Order on Consent for Removal Action between NW Natural and the U.S. Environmental Protection Agency. April 28, 2004.

Integral Consulting Inc. (Integral), 2004. Portland Harbor RI/FS – Round 2 Quality Assurance Project Plan. Prepared for the Lower Willamette Group. July 24, 2004.

USACE. 1998. Guidance for Subaqueous Dredge Material Capping. Technical Report DOER-1. June 1998.

USACE, EPA Region 10, Ecology, Oregon DEQ, and Washington DNR. 1998. Dredged Material Evaluation Framework – Lower Columbia River Management Area. April 1998.

FIGURES



Oct 03, 2005 10:07am dholmer K:\Jobs\000029-GASCO\00002902\00002902-01.dwg FIG 1

ANCHOR ENVIRONMENTAL, L.L.C.

Figure 1
Vicinity Map
NW Natural "Gasco" Site

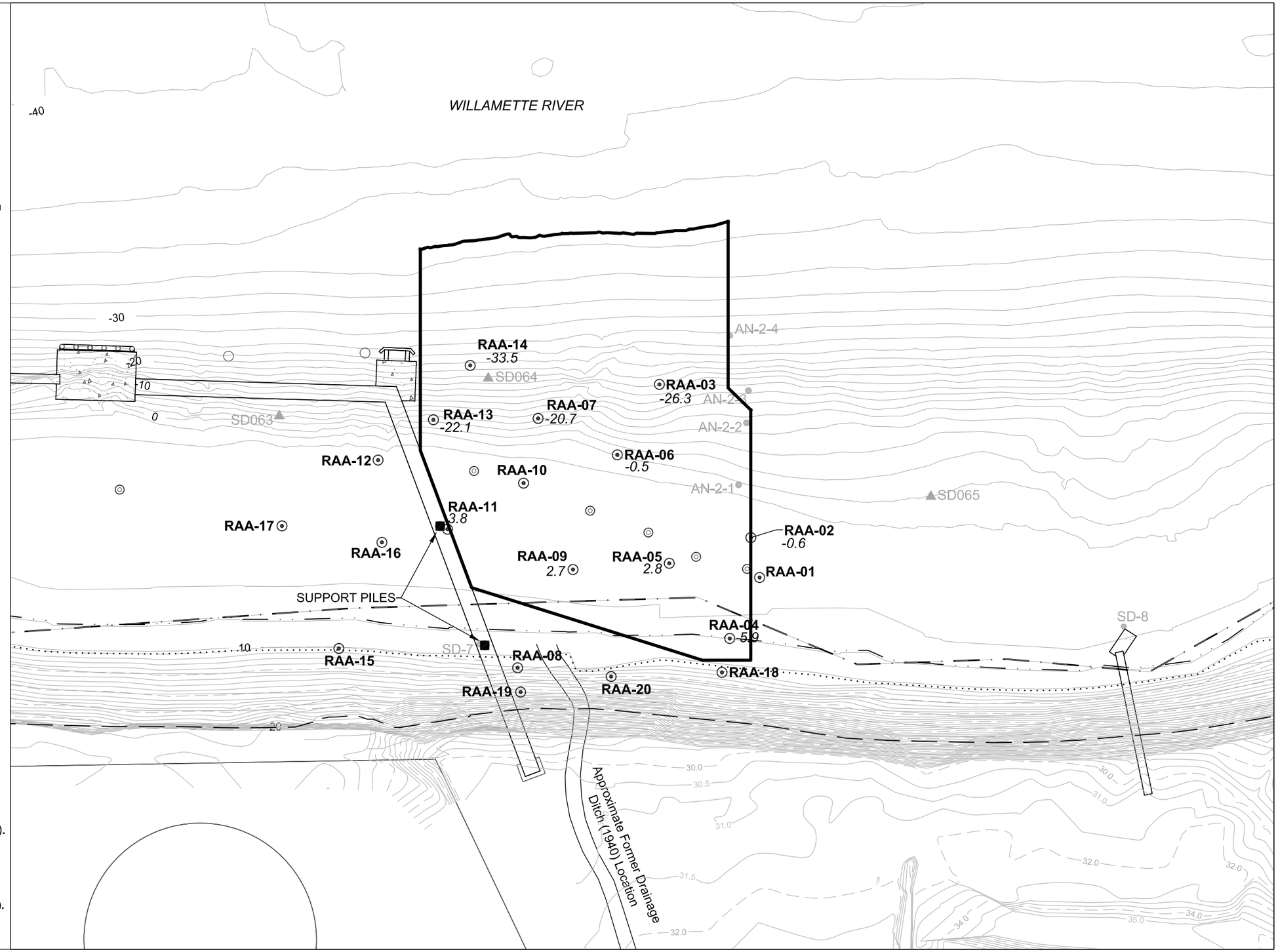
Legend:

- Lateral Extents of Suface Tar Body in Removal Action Area
- RAA-01 Design Characterization Sediment Core Location (Anchor 2004)
- -33.5 Bottom Elevation of Surface Tar Body in Removal Action Area (ft NAVD 88)
- Pile Location (surveyed August 2004)
- AN-2-1 Previous Sediment Core Location (Anchor 2002)
- SD063 Previous Sediment Core Location (Weston 1998)
- SD-7 Previous Sediment Core Location (HAI 1996)
- Support Pile Locations (to be protected during dredging)
- Property Line
- OHW = 20.41 ft NAVD 88
- OLW = 7.91 ft NAVD 88
- 50% River Stage Elevation = 10.23 ft NAVD 88

0 50
Scale in Feet

Notes:

1. Bathymetric contours provided by the Lower Willamette Group as part of the Portland Harbor Superfund Site study (2003).
2. Upland topography directed by Anchor Environmental as part of upland investigation (2002).
3. Horizontal Datum: Oregon State Plane North NAD 83 (ft).
4. Vertical Datum: NAVD 88 (ft).
5. Former Drainage Ditch location from Phase 1 Remedial Investigation Summary Report (HAI 1998).



K:\Jobs\000029-GASCO\0000290200029 02-62.dwg FIG 2

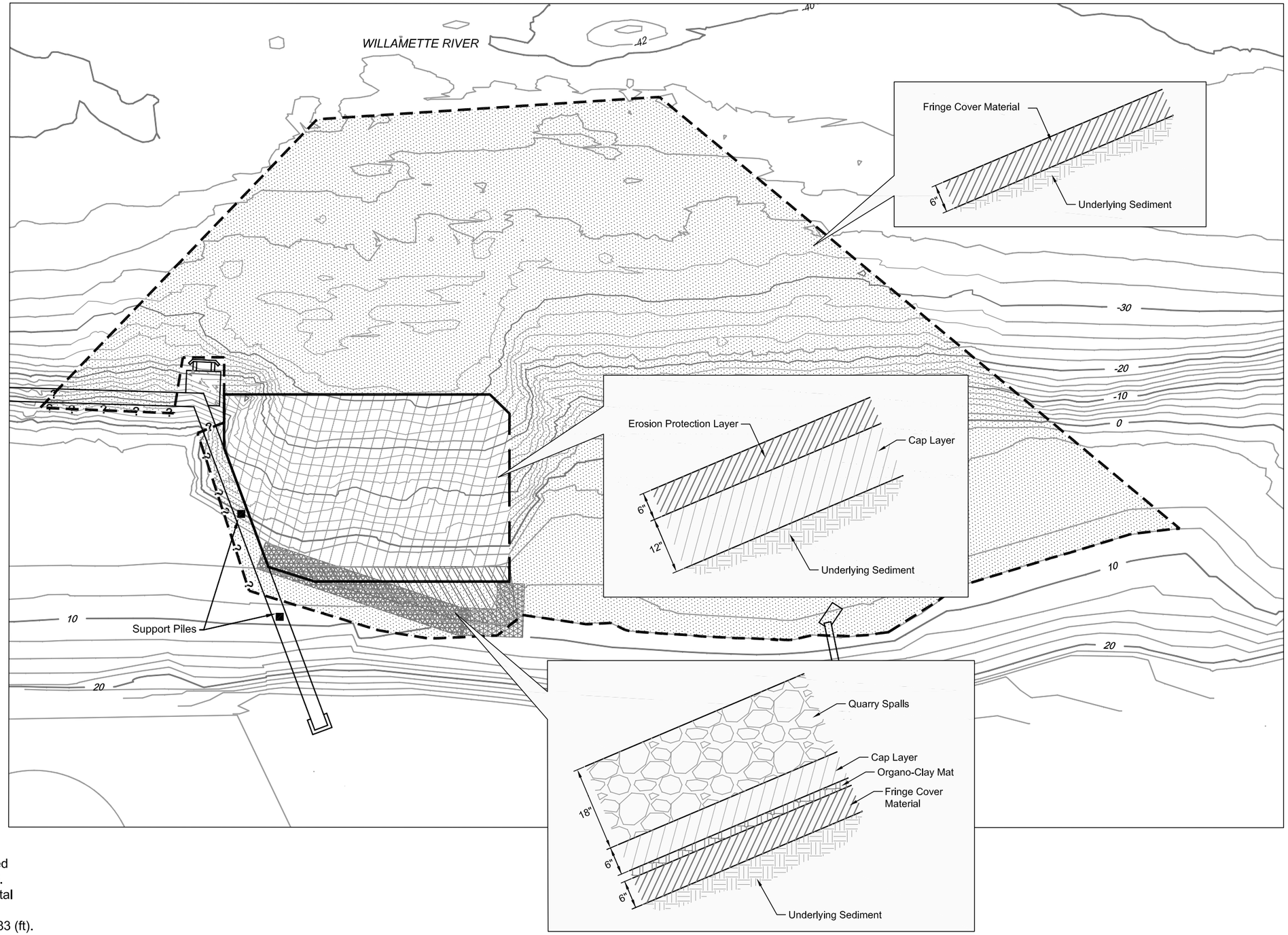
Feb 06, 2006 3:24pm dholmer

ANCHOR ENVIRONMENTAL, L.L.C.

Figure 2
Former Pre-Removal Lateral and Vertical Extents of Surface Tar Body
NW Natural "Gasco" Site

Legend:

- Support Pile Location
- Extent and Elevation of 18 in Thick Cap
- Extent and Elevation of 6 in Thick Cover
- Reactive Core Geotextile Mat (RCM) Location
- Lateral Extents of Surf Zone Armoring d50 = 3 inches



0 60
Scale in Feet

Notes:
1. Bathymetric contours produced from survey provided by Blue Water Engineering dated October 31, 2005.
2. Upland topography directed by Anchor Environmental as part of upland investigation (2002).
3. Horizontal Datum: Oregon State Plane North NAD 83 (ft).
4. Vertical Datum: NAVD 88 (ft).

Dec 19, 2005 8:31am dholmer K:\Jobs\000029-GASCO\00002902\00002902-130.dwg FIG 3

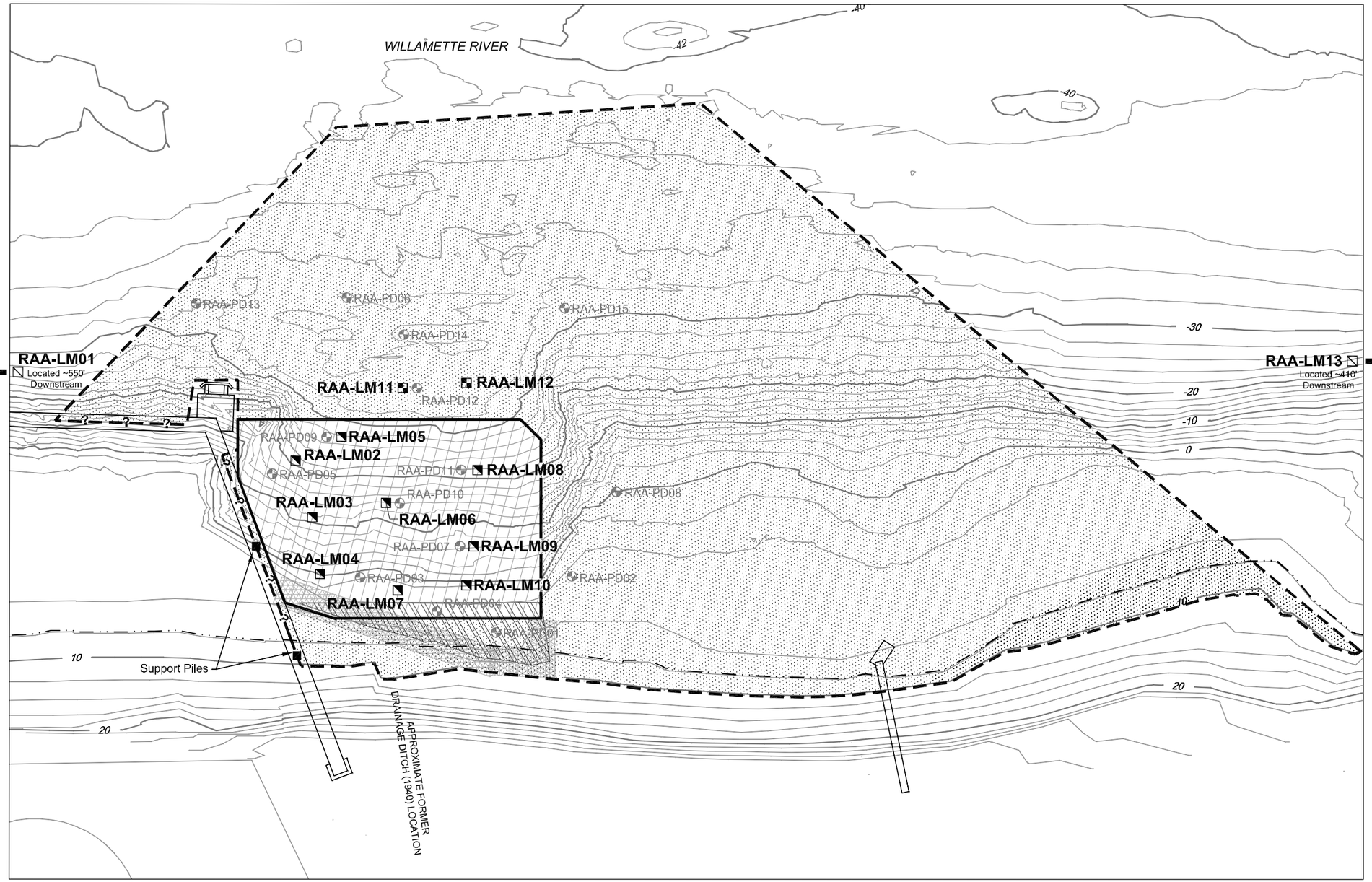
ANCHOR ENVIRONMENTAL, L.L.C.

Figure 3
Post-Cap and Cover Bathymetry and Organo-Clay Mat Location
NW Natural "Gasco" Site

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
- **RAA-LM02** Proposed Co-Located Core, Porewater & Near-Bottom Surface Water Samples
- **RAA-LM01** Proposed Background Near-Bottom Surface Water Sample
- **RAA-LM11** Proposed Seepage Monitoring Core
- RAA-PD13 Post-Dredge Surface Sediment Sample (October 2005)

0 60
Scale in Feet



Notes:
1. Post-cap bathymetric contours produced from survey provided by Blue Water Engineering dated October 31, 2005.
2. Upland topography directed by Anchor Environmental as part of upland investigation (2002).
3. Horizontal Datum: Oregon State Plane North NAD 83 (ft).
4. Vertical Datum: NAVD 88 (ft).
5. Former Drainage Ditch location from Phase 1 Remedial Investigation Summary Report (HAI 1998).

Jan 23, 2006 8:38am dholmer K:\Jobs\000029-GASCO\00002902\00002902-130.dwg LONG TERM SAMPLE

ANCHOR ENVIRONMENTAL, L.L.C.

Figure 4
Proposed Long-Term Monitoring Sampling Stations
NW Natural "Gasco" Site

APPENDIX A

FIELD SAMPLING PLAN

FINAL

APPENDIX A
FIELD SAMPLING PLAN
NORTHWEST NATURAL "GASCO" SITE
MONITORING AND REPORTING PLAN

Prepared for

U.S. Environmental Protection Agency, Region 10
1200 Sixth Avenue
Seattle, Washington 98101

Prepared by

Anchor Environmental, L.L.C.
6650 SW Redwood Lane, Suite 110
Portland, Oregon 97224

On behalf of

NW Natural
220 NW Second Avenue
Portland, Oregon 97209

March 2006

Table of Contents

1 INTRODUCTION 1
1.1 Purpose and Objectives 1
1.2 Document Organization 1

2 PROJECT MANAGEMENT AND RESPONSIBILITIES 2

3 MONITORING, SAMPLING, AND HANDLING 3
3.1 Field Sampling Schedule 3
3.1.1 Visual Inspections 3
3.1.2 Diver and Bathymetry Surveys 3
3.1.3 Sediment Core, Porewater, and Discrete and Time-Integrated Near-Bottom Surface Water Monitoring 4
3.2 Sampling Platform 4
3.3 Visual Inspections 5
3.4 Diver Surveys 5
3.4.1 Survey Methods 5
3.4.2 Horizontal Positioning and Vertical Control 6
3.4.3 Reporting 6
3.5 Bathymetry Surveys 6
3.5.1 Survey Tack Lines 7
3.5.2 Navigation 7
3.5.3 Survey Procedure 7
3.5.4 Survey Data Processing and Reporting 7
3.6 Sediment Cores 8
3.6.1 Horizontal Positioning and Vertical Control 8
3.6.2 Sediment Core Collection 9
3.6.3 Sediment Core Processing 10
3.7 Porewater Monitoring 13
3.7.1 Horizontal Positioning and Vertical Control 13
3.7.2 Porewater Collection and Processing 13
3.8 Discrete Near-Bottom Surface Water Monitoring 17
3.8.1 Horizontal Positioning and Vertical Control 18
3.8.2 Discrete Near-Bottom Surface Water Collection and Processing 18
3.9 Time-Integrated Near-Bottom Surface Water Monitoring 19
3.9.1 Horizontal Positioning and Vertical Control 21
3.9.2 Time-Integrated Near-Bottom Surface Water Collection and Processing 21
3.9.3 Time-Integrated Near-Bottom Surface Water Calculation Procedures 22
3.10 Station and Sample Identification 23
3.11 Field QA/QC Samples 24
3.12 Field Documentation 25
3.13 Sample Handling 26
3.13.1 Sample Containers for Analysis 26
3.13.2 General Sample Handling and Storage 26

3.13.3 Sample Transport and Chain-of-Custody Procedures 27
3.14 Field Equipment Decontamination 28
3.15 Disposal of Excess Sediment and Other Materials 28

4 CHEMICAL AND PHYSICAL TESTING 30
4.1 Sediment Cores 30
4.2 Porewater and Discrete Near-Bottom Surface Water Monitoring 31
4.3 Time-Integrated Near-Bottom Surface Water Monitoring 31

5 REFERENCES 32

List of Tables

Table 1 Proposed Core, Porewater, and Near-Bottom Surface Water Sampling Station Coordinates

Table 2 Guideline for Sampling Handling and Storage

Table 3a Analytes, Analysis Methods, and Targeted Reporting Limits – Bulk Sediment

Table 3b Analytes, Analysis Methods, and Targeted Reporting Limits – Depositional Sediment

Table 3c Analytes, Analysis Methods, and Targeted Reporting Limits – Porewater, Discrete Near-Bottom Surface Water, and Field QA/QC samples

List of Figures

Figure 1 Vicinity Map

Figure 2 Proposed Long-Term Monitoring Sampling Stations

Attachment A – Spreadsheet Calculator Template for SPMD Water Concentrations

1 INTRODUCTION

1.1 Purpose and Objectives

This Field Sampling Plan (FSP) identifies specific sampling and analysis protocols for the field monitoring activities identified in the Monitoring and Reporting Plan (MARP). The FSP provides detailed information regarding the field monitoring objectives; sample location and frequency; equipment and procedures to be used during the monitoring; and sample handling and analysis. The FSP also provides the basis for planning field activities and describes specific quality assurance protocols, which are presented in the Quality Assurance Project Plan (QAPP) (Appendix B of the MARP).

1.2 Document Organization

This FSP is organized into the following sections:

- Section 2 – Project Management and Responsibilities
- Section 3 – Monitoring, Sampling, and Handling
- Section 4 – Chemical and Physical Testing
- Section 5 – References

2 PROJECT MANAGEMENT AND RESPONSIBILITIES

This section describes the overall project management strategy for implementing and reporting for the FSP. Personnel responsible for project management and other roles are identified in the QAPP (Appendix B).

The Technical Project Manager (TPM) for Anchor Environmental L.L.C. (Anchor), Carl Stivers, will be responsible for overall project coordination, including production of all project deliverables and administrative coordination to ensure timely and successful completion of the project.

Field personnel from Anchor will provide overall direction for the field sampling effort in terms of logistics, personnel assignments, and field operations. The Field Coordinator (FC) will supervise field collection of all samples. The FC will also be responsible for positioning samples accurately; recording sample locations, depths, and identification; ensuring conformance to sampling and handling requirements, including field decontamination procedures; physical evaluation and logging of samples; and completing chain-of-custody (COC) forms.

The sampling and analysis will be completed with equipment owned or rented by Anchor. All subconsultants will follow the protocols established in this FSP. Anchor will be responsible for the submittal of environmental samples to Columbia Analytical Services (CAS), Environmental Sampling Technologies (EST), and Pacific Agricultural Laboratories, the designated laboratories for chemical and physical analyses. The Laboratory Project Manager at each laboratory will provide analytical support and will be responsible for providing certified, pre-cleaned sample containers, sample preservatives (as appropriate), ensuring that all chemical analyses meet the project Data Quality Objectives (DQOs) and other quality specifications of the QAPP (Appendix B).

3 MONITORING, SAMPLING, AND HANDLING

3.1 Field Sampling Schedule

The following sections describe the proposed monitoring schedule for the various long-term monitoring activities. It is important to note that additional monitoring may be conducted if flow conditions exceed the design parameters or substantial evidence of other natural or anthropogenic activities indicates a real potential for impacts to the engineered pilot cap. In addition, in accordance with U.S. Environmental Protection Agency (EPA) comments on the sampling timeline, the monitoring schedule is only prescriptive for the Year 0, 1, and 2 sampling events. The monitoring schedule beyond the Year 2 sampling will be coordinated with EPA.

3.1.1 Visual Inspections

Visual monitoring will be conducted using a tiered approach rather than a prescriptive timeline. Initial visual monitoring will be conducted weekly for a period of 1 month (initiating following EPA-approval of this MARP). From March/April 2006 through July 2006, visual monitoring will be conducted on a monthly basis unless more frequent monitoring is warranted based on initial monitoring observations. As the river discharge decreases in August 2006, the monitoring frequency will be increased again to once per week to monitor for potential increased erosion due to wave action on the shoreline during low river elevations. Based on the observations gathered during the weekly monitoring, monitoring may be scaled back to monthly through November 2006 in consultation with EPA. The results of the first year of monitoring will be used to determine the appropriate visual monitoring frequency in subsequent years.

3.1.2 Diver and Bathymetry Surveys

Bathymetric changes are most likely to occur following periods of high and low river discharge and variations in river elevation. Mean annual discharges and elevations in the Willamette River in Portland are historically the highest from December through June. Therefore, bathymetry will be collected following the high discharge period and following the low discharge period. Diver surveys will also be conducted to confirm the bathymetric findings and provide visual observations. As requested by EPA, the initial survey frequency during these periods is proposed as follows:

- Year 0: March/April 2006 (diver survey and bathymetry), August 2006 (diver survey and bathymetry), and November 2006 (bathymetry)
- Year 1: August 2007 (diver survey and bathymetry) and November 2007 (bathymetry)
- Year 2: August 2008 (diver survey and bathymetry) and November 2008 (bathymetry).
- Year 3 through implementation of the site-wide remedy: the previous survey data will be reviewed in consultation with EPA to determine whether the current sampling frequency (i.e., semi-annual) can be reduced.

3.1.3 Sediment Core, Porewater, and Discrete and Time-Integrated Near-Bottom Surface Water Monitoring

As requested by EPA, the initial sediment core, porewater, and discrete and time-integrated near-bottom surface water monitoring frequency is proposed as follows during the appropriate hydrologic conditions (see above):

- Year 0: March/April 2006, August 2006, and November 2006
- Year 1: August 2007 and November 2007
- Year 2: August 2008 and November 2008
- Year 3 through implementation of the site-wide remedy: the previous monitoring data will be reviewed in consultation with EPA to determine whether the current sampling frequency (i.e., semi-annual) can be reduced.

Sediment core, porewater, and discrete surface water samples will all be collected at the same time during each sampling event. Integrated surface water sample equipment will be also deployed at these times. This equipment will be retrieved for analysis approximately 1 month later.

3.2 Sampling Platform

Visual surveys will be conducted from the land-side from a variety of vantage points. Pending sufficient water depths, the diver surveys, seepage, porewater, and near-bottom surface water monitoring will be performed from the waterside using a shallow draft skiff. If the river elevations at the time of sampling are too shallow to allow sampling from the waterside, coring and porewater sampling will be conducted from the land side.

The bathymetry survey will be performed using a vessel provided by the selected surveyor. This vessel will be equipped with the appropriate location control and data acquisition equipment to provide data that is comparable to the constructed post-cap final survey. If water depths prevent surveying from the waterside, the bathymetry will be conducted from the landside using terrestrial surveying equipment.

3.3 Visual Inspections

Long-term visual monitoring will be conducted to identify any areas of sheen/product release and monitor the condition of the buoys used to demarcate the pilot cap area. Monitoring will be conducted from the beach and the adjacent oil pipeline, target low tide and/or windy conditions, occur for a period of at least several hours to document the effects of wave action and changing tidal conditions, and document the effectiveness of the organo-clay mat isolation. Detailed notes of any areas related to the removal action with sheen/product release will be identified on a map and photographed. In addition, notes will be taken to identify any issues associated with the buoys (e.g., missing buoys, movement of the buoys, etc.). The visual inspection results will be summarized in the data summary and data evaluation monitoring reports. In addition, EPA will be provided a copy of the diver reconnaissance video in each data summary monitoring report.

3.4 Diver Surveys

Diver surveys will be performed within the removal action area to visibly evaluate the nature and extent of any potential seepage of non-aqueous phase liquid (e.g., tar oil and tar) in the bathymetric “low spot” created by the dredging activities, and the integrity of the engineered pilot cap and immediately surrounding fringe cover areas. For each monitoring event, the survey is anticipated to take less than 1 day.

3.4.1 Survey Methods

Based on field conditions encountered, the divers will determine the most efficient method of visually surveying the extent of the cap and 50 feet beyond the perimeter of the pilot cap. The divers will document the condition of the pilot cap using video recording equipment. The divers will note any areas where erosion or accretion has occurred. This information will be transposed to a map by placing a surface marker

(e.g., buoy) and taking the GPS coordinates of the marker to show areas of potential concern for cap integrity. The divers will also similarly document the presence of any seeps or visible contaminants (i.e., sheen, tar, oil, etc.) in the removal action area. All diving activities will be conducted in accordance with the diver health and safety plan presented in the Construction Health and Safety Plan (CHASP; Appendix B of the Removal Action Project Plan [RAPP] Anchor 2005).

3.4.2 Horizontal Positioning and Vertical Control

Horizontal positioning during the visual inspections/diver surveys will be determined based on field conditions. Options for horizontal control include establishing known transect points in the removal action area with the divers navigating to these known points using compass bearings and/or depending on the water surface elevations and tidal conditions, the divers may opt to have topside support provide real-time directions through wireless communications. The chosen method will allow for visual observations of the entire removal action area including a minimum of 50 feet beyond the perimeter of the engineered pilot cap.

3.4.3 Reporting

Video documentation of the surveys as well as photographs (visibility permitting) of the approximate locations of identified visible non-aqueous phase liquid (e.g., tar oil and tar), product seeps, or cap erosional/depositional areas will be provided and summarized to EPA in the data summary and annual data evaluation monitoring reports. Notes will also include any other visible changes to the removal action area (e.g., debris, aquatic species, evidence for recolonization of the cap, etc.).

3.5 Bathymetry Surveys

Bathymetry surveys will be conducted to assess changes in cap thickness and stability over time. Data acquisition is anticipated to take less than 1 day. The bathymetry surveys will be conducted in accordance with the protocols described in the Construction Quality Assurance Plan (CQAP; Appendix C to the RAPP, Anchor 2005) and as summarized below.

3.5.1 Survey Tack Lines

To maintain consistency with the post-cap bathymetry survey (completed by Blue Water Engineering in October 2005) and facilitate complete survey coverage throughout the entire area previously bounded by the outer containment area, the bathymetry surveys will be conducted at 15-foot line spacing intervals.

3.5.2 Navigation

The survey boat will be outfitted with a differential global positioning system (DGPS) for navigation. The navigation system consists of a DGPS receiver and receiving computer, and operates under hydrographic software. The DGPS will be used to determine the vessel's location in real-time, and to plot the vessel's position along pre-selected survey lines. The pre-plotted survey lines and the actual survey lines traversed will be displayed in real time on a video monitor. The navigation computer will transmit event marks to the geophysical recording instruments in order to correlate the geophysical data with the survey vessel position during data analysis and mapping.

3.5.3 Survey Procedure

The survey procedure will consist of establishing the reference tidal datum and then acquiring bathymetric data along pre-selected tracklines to provide coverage and resolution comparable to the post-cap bathymetry survey (Blue Water Engineering, October 2005). At the surveyor's discretion, additional tracklines may be added if necessary to "tie in" the specified tracklines.

3.5.4 Survey Data Processing and Reporting

The surveyor will process the navigation and bathymetric sounding data. The output will consist of points that describe the bathymetry in terms of east-west position (X), north-south position (Y), and depth (Z) of the bottom surface. These data will be used to produce a post-capping bathymetric surface. The bathymetric surface will be submitted to EPA in the data summary monitoring reports. The bathymetry data collected during each monitoring event will be compared relative to the post-cap bathymetry survey (Blue Water Engineering, October 2005) to produce an isopach map of cap thickness and variation over time. In addition, several cross sections through the cap area will be created to show variations in cap thickness over time. To the extent and accuracy

possible, elevation changes will be discussed in the annual data evaluation monitoring reports.

3.6 Sediment Cores

Subsurface sediment cores will be collected through the engineered pilot cap and just channelward of the engineered pilot cap in the bathymetric "low spot" created by the removal. The core stations within the engineered pilot cap will be horizontally and vertically co-located with the porewater stations (Section 3.7) to facilitate direct comparison of the bulk sediment and porewater concentrations within the pilot cap. The cores collected through the fringe cover just channelward of the pilot cap will be collected solely to visually monitor potential seepage of non-aqueous phase liquid (e.g., tar oil and tar) in the bathymetric "low spot" created by the dredging activities. No samples will be collected from this area for chemical analyses. In addition, if a depositional layer of surface sediment overlies the engineered pilot cap, this material will be sampled (volume permitting) prior to coring and analyzed to evaluate whether sediment transport and deposition on the pilot cap may be contributing to recontamination of the cap layer.

The following subsections provide details of the sediment coring field procedures. These procedures are in accordance with the guidance set forth in the *Methods for Collection, Storage and Manipulation of Sediments for Chemical and Toxicological Analyses: Technical Manual* (EPA 2001).

3.6.1 Horizontal Positioning and Vertical Control

Horizontal positioning at each sediment sampling location will be determined using a DGPS with a handheld GPS unit as backup if necessary. Station positions will be recorded in latitude and longitude (decimal degrees format) in the North American Datum (NAD) 1983. The accuracy of the horizontal coordinates will be within 3 meters. During each of the monitoring events, the sampling locations will be marked with a stake extending a short distance above the mudline. These stakes will serve to allow the divers to identify the exact sampling location for each monitoring event. For each monitoring event, the samples will be slightly offset from the previous monitoring year's sampling locations to facilitate collection of an undisturbed sample.

Mudline elevation of each sampling station will be determined relative to National Vertical Datum 1988 (NAVD 88) elevation by measuring the water depth with a calibrated fathometer or lead line and subtracting the river elevation. River elevations will be determined using either the Morrison Street elevation gauge located approximately 6.5 miles upstream from the sampling area or the site-specific tide gage installed at the Site during the construction activities.

3.6.2 Sediment Core Collection

Nine subsurface sediment cores will be collected through the engineered pilot cap, and two subsurface cores will be collected just channelward of the engineered pilot cap in the bathymetric "low spot" created by the removal. The core locations are provided in Table 1 and depicted on Figure 2, respectively. These station locations are proposed and may change based on the field conditions (e.g., presence of riprap, accessibility, etc.) encountered during field sampling. Sediment cores will be collected using a diver-assisted core device constructed for penetration into sandy substrates. The cores will be collected following the near-bottom discrete surface water sampling (see Section 3.8) to minimize the potential for the collection of disturbed near-bottom surface water. The corer has a robust stainless-steel head which is mated to polycarbonate tubing (3.5-inch inside diameter [i.d.]). A stainless-steel plate is welded to the core head to create an impact surface for driving of the core. The diver will drive the core using a fence post driver or similar type device. The bottom of the core tube will be outfitted with a core catcher device to maximize core recovery following penetration. If the sampling station resides above the water line or in very shallow water (i.e., potentially only applicable for stations RAA-LM04, RAA-LM07, and RAA-LM10), the piston cores will be collected from the landside by field personnel (if outside the aerial extents of the armor layer overlying the organo-clay mat).

At each of the nine pilot cap coring stations the diver will initially make a visual estimate of the depth of recently deposited sediment overlying the pilot cap material. If sufficient depositional sediment (as determined by the diver based on his ability to isolate and collect this material) is present to facilitate sample collection, a sample of this material will be taken using a shallow core tube (or similar device) and capped in place to prevent loss of material during transport to the vessel. The sealed core tube will be

brought to the surface, the overlying water gently decanted, and the sediments will be placed (using a decontaminated, stainless-steel spoon) into a certified, pre-labeled, and pre-cleaned sample containers for analysis of the full list of Portland Harbor Superfund Site contaminants of interest (Integral 2004, Table 3b). Following this visual estimate and potential collection, the diver will gently remove the armor layer (design thickness of 6 inches) overlying the pilot cap to facilitate coring through the engineered pilot cap material (the armor material is too large to sample). The target penetration depth for each core is 1 foot below the sediment-pilot cap interface (for a total penetration of 2 feet where the cap material is at the nominal expected 1-foot thickness). Core penetration and recovery will be assessed via discoloration of Velcro® placed on the outside of the core tube. The core tube will be sealed on the top to create suction and then removed from the sediment slowly and steadily to avoid agitating the sample. The diver will insert a cap over the bottom of the core immediately upon its appearance above the mudline to prevent sediment from slipping out of the bottom of the core tube. The diver will then transfer the core to the topside crew for processing. Care will be taken to minimize disturbance during this transfer. Once on the vessel, each core will be inspected and a physical description of the material at the mouth of the core will be entered into the core log. Following inspection, core processing will be conducted as described in Section 3.6.3.

The sample handling and equipment decontamination procedures are specified in Section 3.13 and 3.14, respectively. Care will be taken during sampling to avoid contact of the sample tube with potentially contaminated surfaces. Extra sample tubes will be available during sample operations for uninterrupted sampling in the event of a potential core tube breakage or contamination. Core tubes suspected to have been accidentally contaminated will not be used.

3.6.3 Sediment Core Processing

All collected sediment cores will be processed on the sampling vessel following diver transfer and topside inspection. If field conditions preclude immediate processing, the cores will be carefully transferred to large containers full of ice on the vessel pending processing. The entire core length at each sampling station will be wiped clean of all sediments and visually inspected to document the core penetration and recovery. If

adequate core recovery is achieved (approximately 75 percent or greater), the entire length of the core will be slowly laid on a horizontal table and cut vertically using electric sheers or a similar type device. All cores will be processed in a stepwise fashion, as described below. The cores collected from the fringe cover area just channelward of the pilot cap will only undergo visual assessment and therefore will be processed following step 1 below. The remainder of the cores collected within the pilot cap area will undergo both visual and chemical characterization and therefore will be processed following steps 1 through 9.

1. **Core Logging** – Record the description of the full length of the core sample on the core log form, including, but not limited to, the following observations as appropriate:
   - Approximated sample percent recovery based on diver estimation of penetration depth and examination of the Velcro® on the outside of the core tube
   - Physical soil description
   - Odor (e.g., hydrogen sulfide, petroleum, etc.)
   - Vegetation
   - Man-made debris
   - Biological activity (e.g., shells, tubes, bioturbation, organisms, etc.)
   - Presence and depth of the redox layer, if observed
   - Presence of tar and/or oil related contamination
   - Locations, depths and distinctness of interfaces between mixing zones
   - Any other distinguishing characteristics or features
2. **Identify Sampling Zones –** Based on the physical characteristics identified above, identify the upper limits of the sediment-pilot cap mixed layer (where visibly distinguishable). If significant mixing within the cap has occurred making it difficult to ascertain the mixed layer interface, note this isssue in the field log book and make a conservative estimate of the interface. Note any other layering that is evident.
3. **Volatiles Analysis (not composited)** – Directly following extrusion and identification of the mixed layer, collect a representative sample from the pilot cap (i.e., mid-way between the start of the cap material layer and the top of the mixed layer zone) using a clean, stainless steel spoon and place into a certified,

pre-cleaned, and pre-labeled container for analysis of benzene, toluene, ethylbenzene and xylene (BTEX) compounds. The sample will be collected prior to homogenization and the 2-ounce jar will be filled completely (i.e., with no headspace) to minimize volatilization. Ensure the jar lid is closed tightly and excess sediment is not inhibiting a tight seal.

4. **Photograph Core –** Take digital photographs of the entire penetration depth of the core with labels in the areas showing the subsampling locations and a measuring tape corresponding to the depth below mudline.
5. **Collect Sample –** At a minimum, collect one subsample from the engineered pilot cap mid-way between the start of the cap material and the top of the mixed layer zone. Using a decontaminated spoon, remove the sediments from the identified layer(s) and place into a separate cleaned stainless-steel bowl or pot and homogenize until uniform color and texture is achieved. In some cases where a distinct strata is identified (i.e., new depositional surface layer above the cap, layer of discolored material, etc.), a discrete sample from this strata may be collected for potential future analysis (volume permitting).
6. **Fill Sample Jars –** Using a decontaminated stainless steel spoon, fill certified, pre-cleaned, and pre-labeled sample containers for the following analyses: total solids, total organic carbon (TOC), cyanide, polycyclic aromatic hydrocarbons (PAHs), total metals (i.e., arsenic, chromium, copper, nickel, lead, and zinc), pesticides, and polychlorinated biphenyls (PCBs). If volume permits, grain size analysis will also be performed. Each container will be clearly labeled with the name of the project, sample number, type of analysis, date, time, and initials of the person preparing the sample. This information will be recorded in the log book and on the chain-of-custody (COC) forms.
7. **Double Check –** Double check all sample containers to ensure proper sample identification, analytical parameters, and lid tightness.
8. **Pack on Ice –** Pack each jar carefully using bubble wrap or similar material to prevent breakage and place inside of a cooler on ice for storage at approximately 4°C during transport to the analytical laboratory courier. Completed COC forms will be enclosed in a plastic bag and taped to the inside lid of the cooler. The shipping containers will be clearly labeled and addressed, and affixed with signed and dated custody seals.

9. **Deliver the Samples –** Each cooler containing iced samples will be delivered to the analytical laboratory. The custody seal will be broken upon receipt of samples at the analytical laboratory. The receiver will record the temperature and condition of the samples, and cross-check the sample inventory with the chain-of-custody form.

Table 2 lists the holding times, preservation, and maximum holding times for the categories of analytes, as described in the *Methods for Collection, Storage, and Manipulation of Sediments for Chemical and Toxicological Analyses: Technical Manual* (EPA 2001). The sample handling and equipment decontamination procedures are specified in Section 3.13 and 3.14, respectively.

3.7 Porewater Monitoring

Porewater migration through the engineered pilot cap will be monitored through the collection of porewater samples just above the sediment- pilot cap interface. The following subsections provide details of the porewater collection field procedures. These procedures are in accordance with the guidance set forth in the *Methods for Collection, Storage and Manipulation of Sediments for Chemical and Toxicological Analyses: Technical Manual* (EPA 2001) and are similar to the EPA-approved methods used for porewater collection at the Rhone-Poulenc Superfund site located in Seattle, Washington in the Lower Duwamish Waterway (LDW) (EPA 2005a). These techniques are being proposed in lieu of those used by the Lower Willamette Group (LWG) in Portland Harbor, because the LWG technique (i.e., Trident Probe) does not allow for the vertical positioning and sampling accuracy facilitated by the approaches discussed below.

3.7.1 Horizontal Positioning and Vertical Control

The horizontal and vertical positioning methods will be identical to those discussed in Section 3.6.1.

3.7.2 Porewater Collection and Processing

Porewater collection is proposed at the nine station locations provided in Table 1 and depicted on Figure 2, respectively. These station locations are co-located with the through pilot cap core (Section 3.6) and the near-bottom surface water (Section 3.8)

stations and may change based on the field conditions (e.g., presence of riprap, accessibility, etc.) encountered during field sampling. Porewater will be collected using push-point minipiezometers fabricated using a design similar to the EPA-constructed minipiezometers used for porewater collection in the LDW as part of the LDW Superfund site investigation activities. Based on discussions with EPA Region 10 personnel (i.e., Bruce Duncan and Doc Thompson), the minipiezometers were a very effective tool for collection of shallow subsurface in-situ porewater from the LDW. The minipiezometers are essentially a mini well point constructed of a stainless-steel rod with a screened end at the tip. The EPA design was revised slightly to include a larger diameter probe with a heavier weight stainless-steel construction, approximately two inch screened interval with a smaller aperture size near the tip of the probe, and a base plate attachment that will sit at the mudline elevation to minimize short-circuiting from the overlying water column. The percent fines in the pilot cap will likely be low (design specified less than 2 percent passing the #200 sieve), which will significantly minimize fouling of the screened interval during porewater collection. Clean polyethylene tubing will be connected to the end (opposite end of screened portion) of the minipiezometer and extended through the water column to the deck of the sampling vessel and into a peristaltic pump or similar type pumping device. The samples will be poured directly into the sampling jars from the tubing.

A stepwise procedure for the collection of the porewater samples is discussed below.

1. **Purging Volume Determination and Field Blank Collection** – Prior to the diver entering the water, insert the polyethylene tubing through the water-tight stopper in the end of the decontaminated minipiezometer and push the tubing through the probe to the non-screened end of the minipiezometer. Calculate the approximate volume contained within the minipiezometer and full length of polyethylene tubing necessary to reach the sampling depth from the peristaltic pump. Fill the minipiezometer and full length of polyethylene tubing with deionized water. Pump one tube volume (calculated above) of deionized water through the full length of the tube. Collect the deionized water directly into certified, pre-cleaned and pre-labeled sample jars for TOC, dissolved organic carbon (DOC), PAHs, cyanide and BTEX analysis. Prior to the diver entering the

water with the piezometer, refill the minipiezometer and full length of tubing with deionized water.

2. **Determine Sampling Depth** – Determine the pilot cap mid-depth based on the physical characteristics identified within the co-located core. The mid-depth is calculated as the depth of sediment between the surface of the underlying sediment-pilot cap mixed layer and the pilot cap-armor layer interface. Affix a decontaminated stainless-steel clamp to the appropriate location on the minipiezometer so that the clamp comes into contact with the baseplate when the screened interval of the probe reaches the calculated sampling depth. This will allow the diver to easily and accurately drive the minipiezometer to the correct depth below the mudline.
3. **Porewater Volume Determination** – Calculate a conservative volume of pilot cap porewater that can be collected at each sampling location that minimizes the potential for collection of overlying river water or porewater from the underlying sediments. The input parameters for this calculation are described below. Note, to minimize the potential for collection of river water a square stainless-steel baseplate will placed over the sampling station to minimize short-circuiting of overlying surface water. Given that the permeability of the pilot cap material is orders of magnitude greater than the underlying sediments, it can be assumed that porewater will preferentially be collected from the pore space within the pilot cap material. The porosity of sandy materials with similar physical characteristics as the engineered pilot cap ranges from approximately 0.33 to 0.45. Therefore, the available porewater can be conservatively estimated by the following equation:

   PV = Surface area of baseplate (ft^2) * Step 2 height (ft) * 0.33

4. **Sampling Location** – The diver will locate the sediment stake that indicates the through cap core sampling station. Install the stainless-steel baseplate approximately 1 foot from the edge of the area of disturbance caused by the core collection to minimize potential sampling disturbances caused by the core collection. Diver drive the minipiezometer until the stainless-steel clamp comes into contact with the baseplate.

5. **Initial Purging** – Connect the tubing to a peristaltic pump or similar type pumping device and purge the minipiezometer using a low-flow pumping rate. During the transition zone water sampling conducted as part of the Portland Harbor Superfund investigation, the low-flow pumping rate was maintained between approximately 80 to 100 milliliter (ml) per minute so this range of pumping rates will be used for the Site porewater monitoring. Purge until the calculated purge volume (Step 1) is reached. Discard this waste volume (i.e., deionized water).
6. **Collect the Porewater Sample** – Maintaining a low-flow pumping rate (i.e., approximately 80 to 100 ml per minute), collect the sample volume for BTEX directly into laboratory supplied certified, pre-cleaned, and pre-labeled sampling containers. The sampling container should be free of all headspace and capped immediately to minimize the potential for volatilization loss. Immediately following collection of the BTEX samples, collect the sample volume for TOC, DOC, cyanide and PAH analysis maintaining a low pumping rate (i.e., approximately 80 to 100 ml per minute) directly into laboratory certified, pre-cleaned, and pre-labeled containers until the calculated porewater volume is reached (Step 3) or the laboratory volume requirements are satisfied, whichever occurs first. If additional porewater volume is necessary to reach the laboratory volume requirements, place a clip across the tubing to completely close the tubing and proceed to Step 7.
7. **Slightly Move Minipiezometer to Adjacent Location** – Communicate with diver to reinstall the minipiezometer at an adjacent location. As with the first station, the new location should be approximately 1 foot from the edge of the area of disturbance caused by the through cap core collection. An ideal location would be on the opposite site of the core location from the previously collected porewater volume. Maintaining a low-flow pumping rate (i.e., approximately 80 to 100 ml per minute), purge the sampling tube until the calculated purge volume is reached (Step 1). Discard this waste volume. Collect porewater into the remaining laboratory certified, pre-cleaned, and pre-labeled containers until the calculated porewater volume is reached or the laboratory volume requirements are satisfied, whichever occurs first. If additional porewater

volume is necessary to reach the laboratory volume requirements, repeat this step until the laboratory volume requirements are satisfied.

8. **Double Check –** Double check all sample containers to ensure proper sample identification, analytical parameters, and lid tightness.
9. **Pack on Ice –** Pack each jar carefully using bubble wrap or similar material to prevent breakage and place inside of a cooler on ice for storage at approximately 4° C during transport to the analytical laboratory courier. Completed COC forms will be enclosed in a plastic bag and taped to the inside lid of the cooler. The shipping containers will be clearly labeled and addressed, and affixed with signed and dated custody seals.
10. **Deliver the Samples –** Each cooler containing iced samples will be delivered to the analytical laboratory. The custody seal will be broken upon receipt of samples at the analytical laboratory. The receiver will record the temperature and condition of the samples, and cross-check the sample inventory with the COC form.

Detailed notes will be maintained during both the diver installation, core processing, and porewater collection activities to attempt to minimize and document any potential sampling artifacts.

Table 2 lists the sample containers, preservation, and maximum holding times for the categories of analytes, as described in the *Methods for Collection, Storage, and Manipulation of Sediments for Chemical and Toxicological Analyses: Technical Manual* (EPA 2001). The sample handling and equipment decontamination procedures are specified in Section 3.13 and 3.14, respectively. It is important to note that the TOC, DOC, cyanide and PAH samples will be filtered by the laboratory (during the first day following receipt) through a 0.45µm glass fiber filter. The BTEX samples will not be filtered to minimize potential volatilization.

3.8 Discrete Near-Bottom Surface Water Monitoring

The discrete (i.e., single point in time) near-bottom surface water quality directly overlying the cap and at the two ambient stations in the vicinity of the removal action area will be monitored through the collection of near-bottom surface water samples. Water quality will

be measured at a single point in time to evaluate and document short-term temporal changes in near-bottom surface water concentrations in the vicinity of the pilot cap and at ambient stations. The following subsections provide details of the surface water field collection procedures. These procedures are in accordance with the guidance set forth in the *Methods for Collection, Storage and Manipulation of Sediments for Chemical and Toxicological Analyses: Technical Manual* (EPA 2001).

3.8.1 Horizontal Positioning and Vertical Control

The horizontal and vertical positioning methods will be identical to those discussed in Section 3.6.1.

3.8.2 Discrete Near-Bottom Surface Water Collection and Processing

Discrete near-bottom surface water collection is proposed at the eleven station locations provided in Table 1 and depicted on Figure 2, respectively. Nine of these station locations are within the pilot cap area and are co-located with the through cap core (Section 3.6) and porewater (Section 3.7) monitoring stations. The remaining two samples will be collected at a single station approximately 600 feet upstream and 600 feet downstream of the removal action area to monitor ambient near-bottom surface water chemical concentrations (Figure 2). These stations may change based on the field conditions (e.g., presence of riprap, accessibility, etc.) encountered during field sampling. Discrete near-bottom surface water samples will be collected at each station through point grab samples. The grab samples will be collected using the following procedures:

1. **Depth Measurement –** Measure the depth of the water column using a leadline or fathometer.
2. **Sample Collection –** Prior to initiating the cores within the pilot cap area, deploy a decontaminated van Dorn sampler or similar type surface water sampler to approximately 1 foot above the mudline (a diver may be used to ensure placement at this depth) at each station and collect a near-bottom water sample.
3. **Sample Processing for BTEX –** Immediately following retrieval to the surface, pour the collected surface water directly into laboratory provided certified, pre-cleaned and pre-labeled sampling containers for analysis of BTEX. The sampling

container should be free of all headspace and capped immediately to minimize the potential for volatilization loss.

4. **Sample Processing for DOC, total suspended solids, cyanide and PAHs –** Following collection of the BTEX samples, pour the collected surface water directly into laboratory provided certified, pre-cleaned and pre-labeled sampling containers for analysis of DOC, total suspended solids, cyanide, and PAHs.
5. **Double Check –** Double check all sample containers to ensure proper sample identification, analytical parameters, and lid tightness.
6. **Pack on Ice –** Pack each jar carefully using bubble wrap or similar material to prevent breakage and place inside of a cooler on ice for storage at approximately 4°C during transport to the analytical laboratory courier. Completed COC forms will be enclosed in a plastic bag and taped to the inside lid of the cooler. The shipping containers will be clearly labeled and addressed, and affixed with signed and dated custody seals.
7. **Deliver the Samples –** Each cooler containing iced samples will be delivered to the analytical laboratory. Each cooler containing BTEX samples should also include laboratory provided trip blank samples. The custody seal will be broken upon receipt of samples at the analytical laboratory. The receiver will record the temperature and condition of the samples, and cross-check the sample inventory with the COCform.

Table 2 lists the sample containers, preservation, and maximum holding times for the categories of analytes, as described in the *Methods for Collection, Storage, and Manipulation of Sediments for Chemical and Toxicological Analyses: Technical Manual* (EPA 2001). The sample handling and equipment decontamination procedures are specified in Section 3.13 and 3.14, respectively.

3.9 Time-Integrated Near-Bottom Surface Water Monitoring

The time-integrated (i.e., collection of in situ near-bottom surface water for a specified continuous duration) near-bottom surface water quality directly overlying the cap and at ambient stations in the vicinity of the removal action area will be monitored through the collection of near-bottom surface water samples. Water quality will be measured over a specified duration to evaluate and document time-integrated temporal changes in near-

bottom surface water concentrations in the vicinity of the pilot cap and at ambient stations. The following subsections provide details of the surface water field collection procedures.

The time-integrated near-bottom surface water samples will be collected at each station using passive in-situ semipermeable membrane devices (SPMDs). SPMD technology is based on rate-controlled chemical partitioning from the water column to enclosed neutral lipid materials, and can be used to mathematically extrapolate steady-state water concentrations of dissolved organic chemicals such as PAHs (Huckins et al. 1993 and 2002).

A standard "commercial" SPMD configuration will be used, consisting of a thin film of triolein (approximately 95 percent pure) sealed in a low-density polyethylene layflat tube (70 to 90 μm wall thickness) manufactured without additives. The standard SPMD contains 1 milliliter of triolein, has dimensions of 2.5 centimeters (cm) wide by 91 cm long, with a membrane surface area of approximately 450 cm^2. The SPMDs are heat sealed at each end, and are protected within a galvanized steel cage during deployment and shipping.

As discussed in Huckins et al. (2002), a number of different environmental factors control uptake within a SPMD, including the analyte-specific SPMD sampling rate (liters of water extracted per day), the SPMD capacity for the specific analyte, the average water concentration during deployment, exposure conditions (primarily temperature, flow velocity, turbulence, and biofouling), and deployment duration. Of the environmental conditions affecting sampling rates, flow velocity and turbulence appear to have the greatest impact. To minimize these impacts, Huckins et al. (2002) recommend that the flow regime of deployment stations be as similar as possible to facilitate inter-station comparisons. Due to small aerial extent of the removal action area these impacts are anticipated to be minor. Permeability/performance reference compounds (PRCs) will also be evaluated within each SPMD to ensure comparability between stations.

For most analytes, extended exposure periods (greater than 30 days) will typically result in a greater mass of analyte sequestered, but increased biofouling may gradually reduce the daily amount of residues sequestered. As discussed in Huckins et al. (2002), fouling impedance is generally insignificant for the first 2 weeks of an exposure but becomes

increasingly important during extended deployments. For these reasons the SPMDs will be deployed for a duration of 30 days for each monitoring event.

The SPMDs will be provided by EST (St. Joseph, Missouri). The triolein will include three PAH PRCs that will be used to correct sampling rates affected by turbulence and/or biofouling. A PRC is an analytically non-interfering compound added to the SPMD lipid before field deployment. Measured values of PRC loss rates will be used to account for differences in sampling rates between different locations and to improve the accuracy of SPMD-based estimates. This approach to in-situ SPMD calibration is based on the principle that the rate of residue loss is proportional to the rate of uptake. Thus, PRC loss rate data will be used to adjust SPMD-derived estimates of ambient concentrations to reflect site-specific environmental conditions of an exposure. As discussed in Huckins et al. (2002), using the PRC method, SPMD-based estimates of ambient water concentrations can obtain an accuracy within approximately twofold.

3.9.1 Horizontal Positioning and Vertical Control

The horizontal and vertical positioning methods will be identical to those discussed in Section 3.6.1.

3.9.2 Time-Integrated Near-Bottom Surface Water Collection and Processing

Time-integrated near-bottom surface water collection is proposed at the eleven station locations provided in Table 1 and depicted on Figure 2, respectively. Nine of these station locations are within the pilot cap area and are co-located with the through cap cores (Section 3.6), porewater (Section 3.7), and discrete near-bottom surface water monitoring stations (Section 3.8.2). The remaining two samples will be co-located with the discrete near-bottom surface water ambient stations approximately 600 feet upstream and 600 feet downstream of the removal action area (Figure 2). These proposed stations may change based on the field conditions (e.g., presence of riprap, accessibility, etc.) encountered during field sampling.

At each station, a diver will install the SPMDs no more than 3 feet (measured from the bottom of the bag) above the mudline. Care will be taken to minimize the time between removal of the SPMDs from the EST provided pre-cleaned containers and deployment at

the Site. In addition, the SPMDs will be maintained on ice prior to installation to maintain appropriate holding conditions for the PAH PRC's within the SPMDs. At each station, a SPMD spiked with the PAH PRCs will be deployed in duplicate. The SPMDs will be left in place for a period of approximately 30 days followed by diver retrieval. Immediately following diver retrieval, the SPMDs will be placed in pre-cleaned containers provided by EST, and transported on ice in a cooler to the EST laboratory. Care will be taken to minimize the potential for contamination during transfer of the SPMDs from the river to the pre-cleaned containers. The SPMDs will be held frozen (-20°C) until extraction by EST.

Table 2 lists the sample containers, preservation, and maximum holding times for the categories of analytes, as described in the *Methods for Collection, Storage, and Manipulation of Sediments for Chemical and Toxicological Analyses: Technical Manual* (EPA 2001). The sample handling and equipment decontamination procedures are specified in Section 3.13 and 3.14, respectively.

3.9.3 Time-Integrated Near-Bottom Surface Water Calculation Procedures

The PAH concentrations in water will be computed using SPMD technology from the following relationship and using the U.S. Geological Service SPMD spreadsheet calculator shown in Attachment A:

$$C_W = C_{SPMD} / K_{SPMD} * (1 - \exp[-k_u * t / K_{SPMD}])$$

where:

C_W is the calculated dissolved analyte concentration in water

C_{SPMD} is the measured analyte concentration in the SPMD

K_{SPMD} is the literature-based equilibrium SPMD-water partition coefficient

k_u is the literature-based first-order linear uptake rate constant, calibrated with site-specific measurements as practicable

t is the duration of the SPMD deployment

For each monitoring event, the time-integrated near-bottom surface water chemical concentrations will be compared to the co-located porewater chemical concentrations to

determine if dissolved contaminants are entering the surface water through the cap or if surface water is contributing to chemicals in the cap. In addition, the discrete and time-integrate near bottom surface water concentrations at each station will be compared to evaluate potential temporal variations of the near-bottom surface water chemical concentrations.

3.10 Station and Sample Identification

Each discrete subsurface sediment and porewater sample will be assigned a unique alphanumeric identifier according to the method described below. The identifiers facilitate sample tracking by incorporating identifying information. The alphanumeric identifiers will be assigned as follows:

- The first three characters identify the sample location by the project descriptor: PCM = Post Construction Monitoring
- The next two characters identify the sample station: -01 = Station 01
- The next two characters identify the sampling matrix: SC = sediment core, DS = depositional sediment, PW = porewater, DSW = discrete near-bottom surface water, or TSW = time-integrated near-bottom surface water
- The next character identifies the core sampling interval, if applicable: -A = First Interval, -B = Second Interval, etc., with increasing depth. This will only be applicable if layering is identified within the core that warrants sampling of various layers within a single core.
- The last characters identify the sampling date in year, month, day format: YYMMDD

For example, sample number PCM-02SC-A-060215 indicates a subsurface sediment sample obtained from Station 02 within the first sampling interval and PCM-01PW-060215 indicates a porewater sample obtained from Station 01 within the first sampling interval, respectively, both of which were collected on February 15, 2006. The representative depths for each sampling interval will be defined in the field logs and provided in the chemical analytical results tables.

The field quality assurance/quality control (QA/QC) sample will be assigned a unique alphanumeric identifier according to the method described below:

- The first three characters identify the sample location by using the first letter of each word in the location name: PCM = Post Construction Monitoring
- The field replicate for the discrete near-bottom surface water sample will be followed by -XXDSW where XX is the station number plus 50 followed by the date in YYMMDD format
- The field replicate for the SPMD sample will be followed by -XXTSW where XX is the station number plus 50 followed by the date in YYMMDD format
- The sediment core rinsate blank samples will be followed with -SCRB followed by the date in YYMMDD format
- The porewater rinsate blank will be followed with -PWRB followed by the date in YYMMDD format
- The discrete near-bottom surface water rinsate blank will be followed with -DRB followed by the date in YYMMDD format
- The field blank for the deionized water used for the sediment core, porewater and discrete near-bottom surface water sampling activities will be followed with -WFB followed by the date in YYMMDD format
- The field blank for the SPMDs will be followed by -BFB followed by the date in YYMMDD format
- The trip blank shipped to CAS with samples submitted for volatiles analysis will be followed with -TB followed by the date in the YYMMDD format

For example, sample numbers PCM-SCRB-060215 and PCM-54DSW-060215 represent a rinsate blank conducted on the sediment coring equipment and a duplicate discrete near-bottom surface water sample collected at station 04, respectively, each of which was collected on February 15, 2006.

The proposed sampling station coordinates and locations are provided in Table 1 and Figure 2, respectively.

3.11 Field QA/QC Samples

Field QA/QC samples will be collected and used to evaluate the efficiency of field decontamination procedures (Section 3.9) for the sediment coring, porewater, and discrete near-bottom surface water sampling collection activities. In addition, field QA/QC samples

will be collected and used to evaluate the spatial variability of the discrete and time-integrated near-bottom surface water sampling chemical concentrations. Due to sampling volume limitations, no field QA/QC samples will be collected to monitor the spatial variability of the identified bulk chemical or porewater concentrations. All field QC samples will be documented in the field log book(s).

During each monitoring event, one rinsate blank will be collected for the sediment coring, porewater and discrete near-bottom surface water sampling equipment (three samples total) and a single water field blank will be collected. The rinsate blank will consist of rinsing down the aforementioned sampling equipment following sample collection and decontamination with deionized water, and collecting the rinsate into certified, pre-cleaned and pre-labeled sampling containers. The water field blank will be collected by pouring deionized water directly into certified, pre-cleaned and pre-labeled sampling containers in the same physical location that other field samples are collected. These water rinsate and field blank samples will be analyzed for the identical chemical analyte list as the media from which they were collected. A field blank will also be collected for the SPMDs. EST will provide an SPMD, identical to those used for the field collection activities, that will remain unused. This SPMD will be returned to EST with the SPMDs deployed at the Site and analyzed for the identical analyte list. In addition, a trip blank will be included in each container shipped to CAS containing samples to be analyzed for volatiles compounds (i.e., BTEX). The trip blank samples will be analyzed for BTEX. The sample numbers for the rinsate and field blanks are identified in Section 3.10.

3.12 Field Documentation

A complete record of all field activities will be maintained including the following:

- Documentation of all field activities in a field log book
- Documentation of all samples collected for analysis

The FC or a designee will maintain the field log book, which will consist of bound, numbered pages. All on-site activities, including health and safety entries, and field observations will be documented in a site log book. All entries will be made in indelible ink. The field log book is intended to provide sufficient data and observations to enable readers to reconstruct events that occurred during the sampling period. The field log book will

include clear information concerning any modifications to the details and procedures identified in this FSP. Subsurface sediment and porewater collection log sheets will be completed for each sampling station.

3.13 Sample Handling

This section describes the sample containers, sample handling and storage, COC forms, and sample shipping for all sediment sampling activities.

3.13.1 Sample Containers for Analysis

All sample containers received from the analytical lab will be pre-cleaned, certified, and EPA-approved. Prior to shipping, the analytical laboratory will add preservative, where required. Sample container types are listed in Table 2.

3.13.2 General Sample Handling and Storage

The guidelines for sample handling and storage for collected sediment, porewater, discrete and time-integrated near- bottom surface water and field QA samples are provided in Table 2. Sample containers, instruments, working surfaces, technician protective gear, and other items that may come into contact with sample material must meet high standards of cleanliness. All equipment and instruments used to remove sediment from the sampler and/or sample porewater and surface water will be made of glass, stainless steel, or polytetrafluoroethylene (PTFE), and will be decontaminated prior to each day's use and between sampling events.

All working surfaces and instruments will be thoroughly cleaned, decontaminated, air dried and covered with aluminum foil to minimize outside contamination between sampling events. Disposable gloves will be discarded after processing each station and replaced prior to handling decontaminated instruments or work surfaces. Sample containers will be kept in packaging as received from the analytical lab until use. A sample container will be withdrawn only when a sample is to be collected and returned to a cooler containing completed samples. In addition, the SPMDs will be maintained in the packaging sent from EST (with ice as necessary) until the time of deployment and returned to the packaging immediately following removal from the river (with ice as necessary).

3.13.3 Sample Transport and Chain-of-Custody Procedures

All containerized samples will be transported to the analytical laboratory after preparation is completed. Specific sample shipping procedures will be as follows:

1. The shipping containers will be clearly labeled with appropriate information (i.e., name of project, time and date container was sealed, consultant's office name, required analyses, and initials of the individual processing the sample) to enable positive identification.
2. Individual sediment, porewater, and discrete surface water sample containers will be placed in a shipping container (likely a cooler that will maintain low temperatures) and packed to prevent breakage during transport to CAS. The SPMDs will be returned to the shipping container and packaging provided by EST and packed to minimize disturbance during transport.
3. Glass jars will be separated in the shipping container by shock absorbent material (e.g., bubble wrap) to prevent breakage.
4. Ice will be placed in separate plastic bags, sealed and placed into each shipping container, as appropriate.
5. A sealed envelope containing COC forms will be enclosed in a plastic bag and taped to the inside lid of the shipping container.
6. The shipping container lids will be secured by wrapping the containers in strapping tape.
7. Each shipping container with samples for analysis at CAS will either be shipped or picked up at a pre-determined meeting location by a CAS courier. All SPMDs will be shipped directly to EST.
8. EST will extract the distillate from each of the SPMDs and ship the distillate directly to Pacific Agricultural Lab following the 8 steps listed above.

Upon transfer of sample possession to the analytical laboratory, the persons transferring custody of the sample container will sign the COC form. Upon receipt of samples at the laboratory, the shipping container seal will be broken and the condition of the samples recorded by the recipient. COC forms will be used internally in the lab to track sample handling and final disposition.

3.14 Field Equipment Decontamination

To prevent sample cross contamination, sampling and processing equipment that comes in contact with the sediment and water samples will undergo the following decontamination procedures prior to and between collection activities in accordance with EPA protocols (EPA 2001). Between samples, the core equipment, minipiezometer equipment, and discrete near-bottom surface water sampler will be decontaminated prior to use by the following procedure:

1. Rinse with potable water and wash with scrub brush until free of visible contamination.
2. Wash with phosphate-free detergent (e.g., Alconox®).
3. Visually inspect the sampler and repeat the scrub and rinse step, if necessary. If scrubbing and rinsing with Alconox® is insufficient to remove visually observable contamination on the core, porewater or surface water equipment , the equipment will be scrubbed and rinsed using hexane (or similar type solution) until all visual signs of contamination are absent.
4. Rinse with potable water.
5. Rinse with deionized water three times.

All sediment sample homogenizing equipment will be decontaminated prior to and between processing cores at each station using the following procedure:

1. Rinse with potable water and wash with scrub brush until free of sediment.
2. Wash with Alconox®.
3. Visually inspect the equipment and repeat the scrub and rinse step, if necessary. If scrubbing and rinsing with Alconox® is insufficient to remove visually observable contamination on the core tubes and extension, the equipment will be scrubbed and rinsed using hexane (or similar type solution) until all visual signs of contamination are absent.
4. Rinse with potable water.
5. Rinse three times with distilled water.

3.15 Disposal of Excess Sediment and Other Materials

All remaining sediment, fluids used for decontamination of sampling equipment, and core collection disposable wastes (e.g., gloves, paper towels, foil, etc.) will be placed into

appropriate containers, labeled, and staged on-site for disposal. Sediments remaining following collection and processing will be placed into sealable containers and disposed offsite. The decontamination fluids will be stored in sealable containers and will be disposed based on the amount of visibly apparent oil. If the fluid contains only a small amount of visibly apparent oil it will be transferred into an on-site 250-gallon aboveground storage tank (AST) for treatment via the Gasco facility carbon treatment unit. Alternatively, fluids containing a visibly appreciable amount of oil will be transferred into a 500-gallon AST located at the MW-6 dense non-aqueous phase liquid (DNAPL) extraction system. When the containers are not being used, they will be sealed to prevent spills. All disposable wastes will be placed into two heavy duty plastic bags (i.e., double-bagged) and disposed at a permitted solid waste disposal facility.

4 CHEMICAL AND PHYSICAL TESTING

This section summarizes the target physical and chemical analyses for the characterization of subsurface sediments, porewater, and discrete and time-integrated near-bottom surface water collected during the monitoring activities. All sample analyses will be conducted in accordance with EPA-approved methods and the QAPP (Appendix B). Prior to analysis, all samples will be maintained according to the appropriate holding times and temperatures for each analysis (Table 2). Table 3 presents the proposed analytes, the analytical methods to be used, and the targeted detection limits for the evaluation of sampling media and field QA/QC samples. In addition, if a subsample of surface sediment overlying the engineered pilot cap is collected, this material will be analyzed for the full list of Portland Harbor Superfund Site contaminants of interest (Integral et al. 2004).

CAS, EST and Pacific Agricultural Labs (will analyze the SPMD distillates prepared by EST) will prepare a detailed report in accordance with the QAPP (Appendix B) to be included as an appendix in the annual monitoring reports.

4.1 Sediment Cores

In accordance with the EPA comments on the Draft MARP dated November 16, 2005 (EPA, 2005b), the core sediment samples will be analyzed for the identical list of compounds analyzed for the post removal (pre-capping) surface sediment characterization samples including semivolatile organic compounds (SVOCs) and VOCs. The post removal samples were analyzed for TOC, total solids, grain size, PAHs, BTEX, TPH, cyanide, total metals (i.e., arsenic, chromium, copper, lead, nickel, and zinc) PCBs, and pesticides. Note that the RAPP (Anchor 2005) specified analysis of SVOCs and VOCs as defined by the Removal Action Work Plan (RAWP; Anchor 2004). Table 3A of the RAWP lists PAHs for SVOCs and BTEX compounds for VOCs.

In addition, the following methods will be used for physical testing of sediments:

1. Soil classification – ASTM D 2487
2. Total solids (EPA 160.M)
3. Grain size – ASTM D 422 (volume permitting)

4.2 Porewater and Discrete Near-Bottom Surface Water Monitoring

The porewater and discrete near-bottom surface water samples will be submitted for TOC, PAHs, cyanide and BTEX analysis. In addition, the discrete near-bottom surface water samples will be submitted for DOC and total suspended solids. The PAH and cyanide samples will be laboratory filtered (glass fiber filter with 0.45 μm pore size) and as such the data will be in terms of dissolved concentrations. The BTEX samples will not be filtered because of the potential for loss of volatiles during the filtering process.

4.3 Time-Integrated Near-Bottom Surface Water Monitoring

The time-integrated near-bottom surface water samples (i.e., SPMDs) will be submitted for PAHs. Volatile compounds such as BTEX cannot be measured using the SPMD technology so these analytes will not be measured. EST will extract the distillate and send the distillate to CAS for PAH analysis. The PAH concentrations will be in terms of dissolved concentrations.

5 REFERENCES

Anchor Environmental, L.L.C. (Anchor). 2005. Removal Action Project Plan – Final Design Submittal. Prepared on behalf of NW Natural. July 2005. Portland, Oregon.

Anchor Environmental, L.L.C. (Anchor). 2004. NW Natural "Gasco" Site Removal Action Work Plan. Prepared on behalf of NW Natural. August 2004. Portland, Oregon.

Huckins, J.N., J.D. Petty, J.A. Lebo, C.E. Orazio, R.C. Clark, and V.L. Gibson, 2002. Guide for the Use of Semipermeable Membrane Devices as Samplers for Waterborne Hydrophobic Organic Contaminants. American Petroleum Institute Publication No. 4690. (see also http://wwwaux.cerc.cr.usgs.gov/SPMD/SPMD-Tech_Tutorial.htm).

Huckins, J.N., G.K. Manuweera, J.D. Petty, D. Mackay, and J.A. Lebo, 1993. Lipid-Containing Semipermeable Membrane Devices for Monitoring Organic Contaminants in Water. *Environ. Sci. Technol.* 27(12):2489-2496.

Integral Consulting Inc. (Integral), 2005. Portland Harbor RI/FS – DRAFT Field Sampling Plan: Attachment 2 Transition Zone Water Sampling Addendum 1 – Sampling Plans for ExxonMobil, Siltronic, Gasco, and Arkema.

Integral Consulting Inc. (Integral), 2004. Portland Harbor RI/FS – Round 2 Quality Assurance Project Plan. Prepared for the Lower Willamette Group. July 24, 2004.

U.S. Environmental Protection Agency (EPA), 2005a. Rhone-Poulenc (Rhodia) Sediment and Porewater Investigation Aug/Sept 2004 – Data Report: Volatile Organic Compounds, Metals and Pesticides/PCBs Detected in Sediment and Porewater – DRAFT. Site ID No. WAD 009282302. September 13, 2005.

U.S. Environmental Protection Agency (EPA), 2005b. Letter to NW Natural, Subject: "GASCO Removal Action; October 2005 MARP Comments", dated November 16, 2005.

U.S. Environmental Protection Agency (EPA), 2001. Methods for Collection, Storage, and Manipulation of Sediments for Chemical and Toxicological Analyses: Technical Manual. EPA/823/B-01-022. October 2001.

TABLES

Table 1
Proposed Core, Porewater, and Near-Bottom Surface Water Sampling Station Coordinates

RAA-LM01	45.58116405	122.7606154
RAA-LM02	45.58013084	122.758293
RAA-LM03	45.580044	122.7583189
RAA-LM04	45.57996343	122.7583619
RAA-LM05	45.58012966	122.758182
RAA-LM06	45.58001002	122.7581655
RAA-LM07	45.57988608	122.7582322
RAA-LM08	45.57998796	122.7579595
RAA-LM09	45.57989004	122.7580445
RAA-LM10	45.5798435	122.7580979
RAA-LM11	45.58015041	122.7580166
RAA-LM12	45.5801113	122.7578917
RAA-LM13	45.57897146	122.7547911

Notes: Sampling stations are proposed and may be revised based on conditions encountered in the field.

Table 2
Guidelines for Sample Handling and Storage

Sediments			
BTEX compounds	2-oz Glass	14 days	Cool/4°C
Cyanide	From PAH container	14 Days	Cool/4°C
Total petroleum hydrocarbons (TPH)	2x2-oz Glass	14 days	Cool/4° C
Metals (except mercury)	8-oz Glass	6 Months	Cool/4°C
		2 Years	Freeze/-18 C
Polychlorinated biphenyls (PCBs)	8-oz Glass	14 days until extraction	Cool/4°C
		40 days after extraction	Freeze/–18 C
Pesticides	From PCB container	14 days until extraction	Cool/4°C
		40 days after extraction	Freeze/–18 C
Polycyclic Aromatic Hydrocarbons (PAHs)	16-oz Glass	14 days until extraction	Cool/4°C
		1 year until extraction	Freeze/ -18°C
		40 days after extraction	
Total solids (TS)	From PAH container	6 months	Freeze/-18°C
		14 days	Cool/4°C
Total organic carbon (TOC)	From PAH container	6 months	Freeze/-18°C
		14 days	Cool/4°C
Grain size	8-oz Glass	NA	Cool/4°C
Porewater, Near-Bottom Surface Water and Field QA/QC			
Total/Dissolved Organic Carbon	500-mL Plastic	28 days	Cool/4°C with H2SO4
Total Suspended Solids	1-Liter Plastic	7 days	Cool/4°C
BTEX compounds	3x40-mL VOA Vials	14 days	Cool/4°C
Cyanide	250-mL Plastic	14 days	Cool/4°C with NaOH to pH 12
Polycyclic Aromatic Hydrocarbons (PAHs)	1-L Amber Glass	7 days until extraction	Cool/4°C
		40 days after extraction	

Table 3a
Analytes, Analysis Methods, and Targeted Reporting Limits – Bulk Sediments

Conventionals				
Total solids (%)	NA	NA	EPA 160.M	0.1
Total organic carbon (%)	NA	NA	PSEP	0.1
Grain size (%)	NA	NA	ASTM D 422	0.1
Cyanide (mg/kg)	57-12-5	NA	EPA 335.2	0.1
Semivolatile Organic Compounds (µg/kg dry weight) (Partial List)				
LPAHs				
Naphthalene	91203	US EPA Method 3550	US EPA Method 8270C-SIM	5
Acenaphthylene	208968	US EPA Method 3550	US EPA Method 8270C-SIM	5
Acenaphthene	83329	US EPA Method 3550	US EPA Method 8270C-SIM	5
Fluorene	86737	US EPA Method 3550	US EPA Method 8270C-SIM	5
Phenanthrene	85018	US EPA Method 3550	US EPA Method 8270C-SIM	5
Anthracene	1201727	US EPA Method 3550	US EPA Method 8270C-SIM	5
2-Methylnaphthalene	91576	US EPA Method 3550	US EPA Method 8270C-SIM	5
HPAHs				
Fluoranthene	206440	US EPA Method 3550	US EPA Method 8270C-SIM	5
Pyrene	129000	US EPA Method 3550	US EPA Method 8270C-SIM	5
Benz(a)anthracene	56553	US EPA Method 3550	US EPA Method 8270C-SIM	5
Chrysene	218019	US EPA Method 3550	US EPA Method 8270C-SIM	5
Benzofluoranthene	205992	US EPA Method 3550	US EPA Method 8270C-SIM	5
Benzo(a)pyrene	50328	US EPA Method 3550	US EPA Method 8270C-SIM	5
Indeno(1,2,3-cd)pyrene	193395	US EPA Method 3550	US EPA Method 8270C-SIM	5
Dibenz(a,h)anthracene	53703	US EPA Method 3550	US EPA Method 8270C-SIM	5
Benzo(g,h,i)perylene	191242	US EPA Method 3550	US EPA Method 8270C-SIM	5
Volatile Organic Compounds (µg/kg dry weight) (Partial List)				
Benzene	71-43-2	US EPA Method 5030	US EPA Method 8260	1[a]
Toluene	108-88-3	US EPA Method 5030	US EPA Method 8260	5
Ethylbenzene	100414	US EPA Method 5030	US EPA Method 8260	5
Total Xylenes	1330207	US EPA Method 5030	US EPA Method 8260	5
Metals (mg/kg dry weight) (Partial List)				
Arsenic	1888-71-7	US EPA Method 6020	US EPA Method 6020	0.5
Chromium	32774-16-6	US EPA Method 6020	US EPA Method 6020	0.2
Copper	33820-53-0	US EPA Method 6020	US EPA Method 6020	0.1
Lead	56-53-1	US EPA Method 6020	US EPA Method 6020	0.05
Nickel	624-92-0	US EPA Method 6020	US EPA Method 6020	0.2
Zinc	7440-66-6	US EPA Method 6020	US EPA Method 6020	0.5
Total Petroleum Hydrocarbons (TPH) (mg/kg dry weight)				

Table 3a
Analytes, Analysis Methods, and Targeted Reporting Limits – Bulk Sediments

Parameter	CAS Number	Preparation Method	Analytical Method	Targeted Reporting Limit
NW Total Petroleum Hydrocarbons	NA	Northwest TPH	Northwest TPH-Dx	10
Polychlorinated Biphenyls (PCBs) (µg/kg dry weight)				
Aroclor 1016	12674	US EPA Method SW 3540	US EPA Method 8082	10
Aroclor 1221	11104	US EPA Method SW 3540	US EPA Method 8082	20
Aroclor 1232	11141	US EPA Method SW 3540	US EPA Method 8082	10
Aroclor 1242	53469	US EPA Method SW 3540	US EPA Method 8082	10
Aroclor 1248	12672	US EPA Method SW 3540	US EPA Method 8082	10
Aroclor 1254	11097	US EPA Method SW 3540	US EPA Method 8082	10
Aroclor 1260	11096	US EPA Method SW 3540	US EPA Method 8082	10
Aroclor 1262	37324	US EPA Method SW 3540	US EPA Method 8082	10
Aroclor 1268	11100	US EPA Method SW 3540	US EPA Method 8082	10
Pesticides (µg/kg dry weight)				
4,4'-DDD	53-19-0	US EPA Method SW 3540	US EPA Method 8081	1
4,4'-DDE	3424-82-6	US EPA Method SW 3540	US EPA Method 8081	1
4,4'-DDT	789-02-6	US EPA Method SW 3540	US EPA Method 8081	1
Aldrin	309-00-2	US EPA Method SW 3540	US EPA Method 8081	1
alpha-BHC	319-84-6	US EPA Method SW 3540	US EPA Method 8081	1
alpha-Chlordane	319-85-7	US EPA Method SW 3540	US EPA Method 8081	1
beta-BHC	319-85-7	US EPA Method SW 3540	US EPA Method 8081	1
delta-BHC	319-86-8	US EPA Method SW 3540	US EPA Method 8081	1
Dieldrin	60-57-1	US EPA Method SW 3540	US EPA Method 8081	1
Endosulfan I	959-98-8	US EPA Method SW 3540	US EPA Method 8081	1
Endosulfan II	33213-65-9	US EPA Method SW 3540	US EPA Method 8081	1
Endosulfan Sulfate	1031-07-8	US EPA Method SW 3540	US EPA Method 8081	1
Endrin	72-20-8	US EPA Method SW 3540	US EPA Method 8081	1
Endrin aldehyde	7421-93-4	US EPA Method SW 3540	US EPA Method 8081	1
Endrin ketone	53494-70-5	US EPA Method SW 3540	US EPA Method 8081	1
gamma-BHC (Lindane)	58-89-9	US EPA Method SW 3540	US EPA Method 8081	1
gamma-Chlordane	5103-71-9	US EPA Method SW 3540	US EPA Method 8081	1
Heptachlor	5103-74-2	US EPA Method SW 3540	US EPA Method 8081	1
Heptachlor Epoxide	27304-13-8	US EPA Method SW 3540	US EPA Method 8081	1
Methoxychlor	72-43-5	US EPA Method SW 3540	US EPA Method 8081	1
Toxaphene	2385-85-5	US EPA Method SW 3540	US EPA Method 8081	50

Notes:
a – The value presented lies between the method reporting limit and the method detection limit.
b – The list of pesticides will be identical to the pesticide compounds analyzed for the post-removal surface sediment samples.

Table 3b
Analytes, Analysis Methods, and Targeted Reporting Limits - Depositional Sediment (If Applicable)

Analyte	CAS number	MDL[b]	MRL[c]
2,2',4,4',5-PeCB	PCB-99	tbd	tbd
2,2',3',4,6-PeCB	PCB-98	tbd	tbd
2,2',3',4,5-PeCB	PCB-97	tbd	tbd
2,2',3,6,6'-PeCB	PCB-96	tbd	tbd
2,2',3,5',6-PeCB	PCB-95	tbd	tbd
2,2',3,5,6'-PeCB	PCB-94	tbd	tbd
2,2',3,5,6-PeCB	PCB-93	tbd	tbd
2,2',3,5,5'-PeCB	PCB-92	tbd	tbd
2,2',3,4',6-PeCB	PCB-91	tbd	tbd
2,2',3,4',5-PeCB	PCB-90	tbd	tbd
2,5-DiCB	PCB-9	tbd	tbd
2,2',3,4,6'-PeCB	PCB-89	tbd	tbd
2,2',3,4,6-PeCB	PCB-88	tbd	tbd
2,2',3,4,5'-PeCB	PCB-87	tbd	tbd
2,2',3,4,5-PeCB	PCB-86	tbd	tbd
2,2',3,4,4'-PeCB	PCB-85	tbd	tbd
2,2',3,3',6-PeCB	PCB-84	tbd	tbd
2,2',3,3',5-PeCB	PCB-83	tbd	tbd
2,2',3,3',4-PeCB	PCB-82	tbd	tbd
3,4,4',5-TeCB	PCB-81	tbd	tbd
3,3',5,5'-TeCB	PCB-80	tbd	tbd
2,4'-DiCB	PCB-8	tbd	tbd
3,3',4,5'-TeCB	PCB-79	tbd	tbd
3,3',4,5-TeCB	PCB-78	tbd	tbd
3,3',4,4'-TeCB	PCB-77	tbd	tbd
2',3,4',5-TeCB	PCB-76	tbd	tbd
2,4,4',6-TeCB	PCB-75	tbd	tbd
2,4,4',5-TeCB	PCB-74	tbd	tbd
2,3',5',6-TeCB	PCB-73	tbd	tbd
2,3',5,5'-TeCB	PCB-72	tbd	tbd
2,3',4',6-TeCB	PCB-71	tbd	tbd
2,3',4',5-TeCB	PCB-70	tbd	tbd
2,4-DiCB	PCB-7	tbd	tbd
2,3',4,6-TeCB	PCB-69	tbd	tbd
2,3',4,5'-TeCB	PCB-68	tbd	tbd
2,3',4,5-TeCB	PCB-67	tbd	tbd
2,3',4,4'-TeCB	PCB-66	tbd	tbd
2,3,5,6-TeCB	PCB-65	tbd	tbd
2,3,4',6-TeCB	PCB-64	tbd	tbd
2,3,4',5-TeCB	PCB-63	tbd	tbd
2,3,4,6-TeCB	PCB-62	tbd	tbd
2,3,4,5-TeCB	PCB-61	tbd	tbd
2,3,4,4'-TeCB	PCB-60	tbd	tbd
2,3'-DiCB	PCB-6	tbd	tbd
2,3,3',6-TeCB	PCB-59	tbd	tbd
2,3,3',5'-TeCB	PCB-58	tbd	tbd
2,3,3',5-TeCB	PCB-57	tbd	tbd
2,3,3',4'-TeCB	PCB-56	tbd	tbd
2,3,3',4'-TeCB	PCB-55	tbd	tbd
2,2',6,6'-TeCB	PCB-54	tbd	tbd
2,2',5,6'-TeCB	PCB-53	tbd	tbd
2,2',5,5'-TeCB	PCB-52	tbd	tbd
2,2',4,6'-TeCB	PCB-51	tbd	tbd
2,2',4,6-TeCB	PCB-50	tbd	tbd
2,3-DiCB	PCB-5	tbd	tbd

Table 3b
Analytes, Analysis Methods, and Targeted Reporting Limits - Depositional Sediment (If Applicable)

Analyte	CAS number	MDL[b]	MRL[c]
2,2',4,5'-TeCB	PCB-49	tbd	tbd
2,2',4,5-TeCB	PCB-48	tbd	tbd
2,2',3,4'-TeCB	PCB-47	tbd	tbd
2,2',3,6'-TeCB	PCB-46	tbd	tbd
2,2',3,6-TeCB	PCB-45	tbd	tbd
2,2',3,5'-TeCB	PCB-44	tbd	tbd
2,2',3,5-TeCB	PCB-43	tbd	tbd
2,2',3,4'-TeCB	PCB-42	tbd	tbd
2,2',3,4-TeCB	PCB-41	tbd	tbd
2,2',3,3'-TeCB	PCB-40	tbd	tbd
2,2'-DiCB	PCB-4	tbd	tbd
3,4',5-TrCB	PCB-39	tbd	tbd
3,4,5-TrCB	PCB-38	tbd	tbd
3,4,4'-TrCB	PCB-37	tbd	tbd
3,3',5-TrCB	PCB-36	tbd	tbd
3,3',4-TrCB	PCB-35	tbd	tbd
2',3,5-TrCB	PCB-34	tbd	tbd
2',3,4-TrCB	PCB-33	tbd	tbd
2,4',6-TrCB	PCB-32	tbd	tbd
2,4',5-TrCB	PCB-31	tbd	tbd
2,4,6-TrCB	PCB-30	tbd	tbd
4-MoCB	PCB-3	tbd	tbd
2,4,5-TrCB	PCB-29	tbd	tbd
2,4,4'-TrCB	PCB-28	tbd	tbd
2,3',6-TrCB	PCB-27	tbd	tbd
2,3',5-TrCB	PCB-26	tbd	tbd
2,3',4-TrCB	PCB-25	tbd	tbd
2,3,6-TrCB	PCB-24	tbd	tbd
2,3,5-TrCB	PCB-23	tbd	tbd
2,3,4'-TrCB	PCB-22	tbd	tbd
2,3,4-TrCB	PCB-21	tbd	tbd
DeCB	PCB-209	tbd	tbd
2,2',3,3',4,5,5',6,6'-NoCB	PCB-208	tbd	tbd
2,2',3,3',4,4',5,6,6'-NoCB	PCB-207	tbd	tbd
2,2',3,3',4,4',5,5',6-NoCB	PCB-206	tbd	tbd
2,3,3',4,4',5,5',6-OcCB	PCB-205	tbd	tbd
2,2',3,4,4',5,6,6'-OcCB	PCB-204	tbd	tbd
2,2',3,4,4',5,5',6-OcCB	PCB-203	tbd	tbd
2,2',3,3',5,5',6,6'-OcCB	PCB-202	tbd	tbd
2,2',3,3',4,5',6,6'-OcCB	PCB-201	tbd	tbd
2,2',3,3',4,5,6,6'-OcCB	PCB-200	tbd	tbd
2,3,3'-TrCB	PCB-20	tbd	tbd
3-MoCB	PCB-2	tbd	tbd
2,2',3,3',4,5,5',6'-OcCB	PCB-199	tbd	tbd
2,2',3,3',4,5,5',6-OcCB	PCB-198	tbd	tbd
2,2',3,3',4,4',6,6'-OcCB	PCB-197	tbd	tbd
2,2',3,3',4,4',5,6'-OcCB	PCB-196	tbd	tbd
2,2',3,3',4,4',5,6-OcCB	PCB-195	tbd	tbd
2,2',3,3',4,4',5,5'-OcCB	PCB-194	tbd	tbd
2,3,3',4',5,5',6-HpCB	PCB-193	tbd	tbd
2,3,3',4,5,5',6-HpCB	PCB-192	tbd	tbd
2,3,3',4,4',5',6-HpCB	PCB-191	tbd	tbd
2,3,3',4,4',5,6-HpCB	PCB-190	tbd	tbd
2,2',6-TrCB	PCB-19	tbd	tbd
2,3,3',4,4',5,5'-HpCB	PCB-189	tbd	tbd

Table 3b
Analytes, Analysis Methods, and Targeted Reporting Limits - Depositional Sediment (If Applicable)

Analyte	CAS number	MDL[b]	MRL[c]
2,2',3,4',5,6,6'-HpCB	PCB-188	tbd	tbd
2,2',3,4,5,5',6-HpCB	PCB-187	tbd	tbd
2,2',3,4,5,6,6'-HpCB	PCB-186	tbd	tbd
2,2',3,4,5,5',6-HpCB	PCB-185	tbd	tbd
2,2',3,4,4',6,6'-HpCB	PCB-184	tbd	tbd
2,2',3,4,4',5',6-HpCB	PCB-183	tbd	tbd
2,2',3,4,4',5,6'-HpCB	PCB-182	tbd	tbd
2,2',3,4,4',5,6-HpCB	PCB-181	tbd	tbd
2,2',3,4,4',5,5'-HpCB	PCB-180	tbd	tbd
2,2',5-TrCB	PCB-18	tbd	tbd
2,2',3,3',5,6,6'-HpCB	PCB-179	tbd	tbd
2,2',3,3',5,5',6-HpCB	PCB-178	tbd	tbd
2,2',3,3',4',5,6-HpCB	PCB-177	tbd	tbd
2,2',3,3',4,6,6'-HpCB	PCB-176	tbd	tbd
2,2',3,3',4,5',6-HpCB	PCB-175	tbd	tbd
2,2',3,3',4,5,6'-HpCB	PCB-174	tbd	tbd
2,2',3,3',4,5,6-HpCB	PCB-173	tbd	tbd
2,2',3,3',4,5,5'-HpCB	PCB-172	tbd	tbd
2,2',3,3',4,4',6-HpCB	PCB-171	tbd	tbd
2,2',3,3',4,4',5-HpCB	PCB-170	tbd	tbd
2,2',4-TrCB	PCB-17	tbd	tbd
3,3',4,4',5,5'-HxCB	PCB-169	tbd	tbd
2,3',4,4',5',6-HxCB	PCB-168	tbd	tbd
2,3,4,4',5,5'-HxCB	PCB-167	tbd	tbd
2,3,4,4',5,6-HxCB	PCB-166	tbd	tbd
2,3,3',5,5',6-HxCB	PCB-165	tbd	tbd
2,3,3',4',5',6-HxCB	PCB-164	tbd	tbd
2,3,3',4',5,6-HxCB	PCB-163	tbd	tbd
2,3,3',4',5,5'-HxCB	PCB-162	tbd	tbd
2,3,3',4,5',6-HxCB	PCB-161	tbd	tbd
2,3,3',4,5,6-HxCB	PCB-160	tbd	tbd
2,2',3-TrCB	PCB-16	tbd	tbd
2,3,3',4,5,5'-HxCB	PCB-159	tbd	tbd
2,3,3',4,4',6-HxCB	PCB-158	tbd	tbd
2,3,3',4,4',5'-HxCB	PCB-157	tbd	tbd
2,3,3',4,4',5-HxCB	PCB-156	tbd	tbd
2,2',4,4',6,6'-HxCB	PCB-155	tbd	tbd
2,2',4,4',5',6-HxCB	PCB-154	tbd	tbd
2,2',4,4',5,5'-HxCB	PCB-153	tbd	tbd
2,2',3,5,6,6'-HxCB	PCB-152	tbd	tbd
2,2',3,5,5',6-HxCB	PCB-151	tbd	tbd
2,2',3,4',6,6'-HxCB	PCB-150	tbd	tbd
4,4'-DiCB	PCB-15	tbd	tbd
2,2',3,4',5',6-HxCB	PCB-149	tbd	tbd
2,2',3,4',5,6'-HxCB	PCB-148	tbd	tbd
2,2',3,4',5,6-HxCB	PCB-147	tbd	tbd
2,2',3,4',5,5'-HxCB	PCB-146	tbd	tbd
2,2',3,4,6,6'-HxCB	PCB-145	tbd	tbd
2,2',3,4,5',6-HxCB	PCB-144	tbd	tbd
2,2',3,4,5,6'-HxCB	PCB-143	tbd	tbd
2,2',3,4,5,6-HxCB	PCB-142	tbd	tbd
2,2',3,4,5,5'-HxCB	PCB-141	tbd	tbd
2,2',3,4,4',6'-HxCB	PCB-140	tbd	tbd
3,5-DiCB	PCB-14	tbd	tbd
2,2',3,4,4',6-HxCB	PCB-139	tbd	tbd

Table 3b
Analytes, Analysis Methods, and Targeted Reporting Limits - Depositional Sediment (If Applicable)

Analyte	CAS number	MDL[b]	MRL[c]
2,2',3,4,4',5'-HxCB	PCB-138	tbd	tbd
2,2',3,4,4',5-HxCB	PCB-137	tbd	tbd
2,2',3,3',6,6'-HxCB	PCB-136	tbd	tbd
2,2',3,3',5,6'-HxCB	PCB-135	tbd	tbd
2,2',3,3',5,6-HxCB	PCB-134	tbd	tbd
2,2',3,3',5,5'-HxCB	PCB-133	tbd	tbd
2,2',3,3',4,6'-HxCB	PCB-132	tbd	tbd
2,2',3,3',4,6-HxCB	PCB-131	tbd	tbd
2,2',3,3',4,5'-HxCB	PCB-130	tbd	tbd
3,4'-DiCB	PCB-13	tbd	tbd
2,2',3,3',4,5-HxCB	PCB-129	tbd	tbd
2,2',3,3',4,4'-HxCB	PCB-128	tbd	tbd
3,3',4,5,5'-PeCB	PCB-127	tbd	tbd
3,3',4,4',5-PeCB	PCB-126	tbd	tbd
2',3,4,5,6'-PeCB	PCB-125	tbd	tbd
2',3,4,5,5'-PeCB	PCB-124	tbd	tbd
2',3,4,4',5-PeCB	PCB-123	tbd	tbd
2',3,3',4,5-PeCB	PCB-122	tbd	tbd
2,3',4,5,6-PeCB	PCB-121	tbd	tbd
2,3',4,5,5'-PeCB	PCB-120	tbd	tbd
3,4-DiCB	PCB-12	tbd	tbd
2,3',4,4',6-PeCB	PCB-119	tbd	tbd
2,3',4,4',5-PeCB	PCB-118	tbd	tbd
2,3,4',5,6-PeCB	PCB-117	tbd	tbd
2,3,4,5,6-PeCB	PCB-116	tbd	tbd
2,3,4,4',6-PeCB	PCB-115	tbd	tbd
2,3,4,4',5-PeCB	PCB-114	tbd	tbd
2,3,3',5',6-PeCB	PCB-113	tbd	tbd
2,3,3',5,6-PeCB	PCB-112	tbd	tbd
2,3,3',5,5'-PeCB	PCB-111	tbd	tbd
2,3,3',4',6-PeCB	PCB-110	tbd	tbd
3,3'-DiCB	PCB-11	tbd	tbd
2,3,3',4,6-PeCB	PCB-109	tbd	tbd
2,3,3',4,5'-PeCB	PCB-108	tbd	tbd
2,3,3',4',5-PeCB	PCB-107	tbd	tbd
2,3,3',4,5-PeCB	PCB-106	tbd	tbd
2,3,3'4,4'-PeCB	PCB-105	tbd	tbd
2,2',4,6,6'-PeCB	PCB-104	tbd	tbd
2,2',4,5,6'-PeCB	PCB-103	tbd	tbd
2,2',4,5,6'-PeCB	PCB-102	tbd	tbd
2,2',4,5,5'-PeCB	PCB-101	tbd	tbd
2,2',4,4',6-PeCB	PCB-100	tbd	tbd
2,6-DiCB	PCB-10	tbd	tbd
2-MoCB	PCB-1	tbd	tbd
3-Nitroaniline	99-09-2	tbd	120
Nitrobenzene	98-95-3	tbd	20
Isopropyl benzene	98-82-8	tbd	4
1,2,3-Trichloropropane	96-18-4	tbd	1
Endosulfan I	959-98-8	tbd	0.2
2,4,5-Trichlorophenol	95-95-4	tbd	100
2-Chlorophenol	95-57-8	tbd	20
1,2-Dichlorobenzene	95-50-1	tbd	20
2-Methylphenol	95-48-7	tbd	20
o-Xylene	95-47-6	tbd	1
2,4-DB	94-82-6	tbd[e]	5

Table 3b
Analytes, Analysis Methods, and Targeted Reporting Limits - Depositional Sediment (If Applicable)

Analyte	CAS number	MDL[b]	MRL[c]
2,4-D	94-75-7	tbd[e]	5
MCPA	94-74-6	tbd	5
2,4,5-T	93-76-5	tbd[e]	8
2,4,5-TP (Silvex)	93-72-1	tbd[e]	8
MCPP	93-65-2	tbd	5
3,3'-Dichlorbenzidine	91-94-1	tbd	100
2-Chloronaphthalene	91-58-7	tbd	20
2-Methylnaphthalene	91-57-6	tbd	20
Naphthalene	91-20-3	tbd	4
Naphthalene	91-20-3	tbd	20
Dinoseb	88-85-7	tbd	8
2-Nitrophenol	88-75-5	tbd	100
2-Nitroaniline	88-74-4	tbd	20
2,4,6-Trichlorophenol	88-06-2	tbd	100
Pentachlorophenol	87-86-5	tbd[e]	5
Pentachlorophenol[i]	87-86-5	tbd	34
Hexachlorobutadiene	87-68-3	tbd	tbd
Hexachlorobutadiene[h]	87-68-3	tbd	100
Carbazole	86-74-8	tbd	5
Fluorene	86-73-7	tbd	20
n-Nitrosodiphenylamine	86-30-6	tbd	20
Butylbenzylphthalate	85-68-7	tbd	20
Phenanthrene	85-01-8	tbd	20
Di-n-butylphthalate	84-74-2	tbd	20
Diethylphthlalate	84-66-2	tbd	20
Acenaphthene	83-32-9	tbd	20
Toxaphene	8001-35-2	tbd	20
1,1,2,2-Tetrachloroethane	79-34-5	tbd	1
Trichloroethene	79-01-6	tbd	1
1,1,2-Trichloroethane	79-00-5	tbd	1
2-Butanone	78-93-3	tbd	4
2,4'-DDT	789-02-6	tbd	0.2
1,2-Dichloropropane	78-87-5	tbd	1
Monobutyltin	78763-54-9	0.071	1
Isophorone	78-59-1	tbd	20
Selenium	7782-49-2	0.05	0.1
Hexachlorocyclopentadiene	77-47-4	tbd	100
Ammonia (mg/kg)	7664-41-7	0.05	0.1
Heptachlor	76-44-8	tbd	0.2
Dalapon	75-99-0	tbd	5
Dichlorodifluoromethane	75-71-8	tbd	1
Trichlorofluoromethane	75-69-4	tbd	1
1,1-Dichloroethene	75-35-4	tbd	1
1,1-Dichloroethane	75-34-3	tbd	1
Bromodichloromethane	75-27-4	tbd	1
Bromoform	75-25-2	tbd	1
Carbon Disulfide	75-15-0	tbd	1
Methylene chloride	75-09-2	tbd	2
Vinyl Chloride	75-01-4	tbd	1
Chloroethane	75-00-3	tbd	1
Bromochloromethane	74-97-5	tbd	1
Bromoethane	74-96-4	tbd	NE
Dibromomethane	74-95-3	tbd	1
Iodomethane	74-88-4	tbd	4

Table 3b
Analytes, Analysis Methods, and Targeted Reporting Limits - Depositional Sediment (If Applicable)

Analyte	CAS number	MDL[b]	MRL[c]
Chloromethane	74-87-3	tbd	1
Bromomethane	74-83-9	tbd	1
Zinc	7440-66-6	0.1	0.5
Copper	7440-50-8	0.07	0.1
Chromium	7440-47-3	0.04	0.2
Cadmium	7440-43-9	0.006	0.02
Arsenic	7440-38-2	0.05	0.1
Antimony	7440-36-0	0.02	0.05
Silver	7440-22-4	0.02	0.02
Nickel	7440-02-0	0.03	0.2
Mercury	7439-97-6	0.01	0.02
Lead	7439-92-1	0.02	0.05
Aluminum	7429-90-5	2.0	2.0
Endrin aldehyde	7421-93-4	tbd	0.2
1,2,3,7,8,9-HxCDF	72918-21-9	0.017	0.5
4,4'-DDE	72-55-9	tbd	0.2
4,4'-DDD	72-54-8	tbd	0.2
Methoxychlor	72-43-5	tbd	0.2
Endrin	72-20-8	tbd	0.2
1,1,1-Trichloroethane	71-55-6	tbd	1
Benzene	71-43-2	tbd	1
1,2,3,4,7,8-HxCDF	70648-26-9	0.013	0.5
4-Chlorophenyl-phenyl ether	7005-72-3	tbd	20
Hexachloroethane	67-72-1	tbd	tbd
Hexachloroethane[h]	67-72-1	tbd	5
Chloroform	67-66-3	tbd	1
Acetone	67-64-1	tbd	4
1,2,3,4,6,7,8-HpCDF	67562-39-4	0.033	0.5
Benzoic Acid	65-85-0	tbd	200
1,1,1,2-Tetrachloroethane	630-20-6	tbd	1
n-Nitrosodimethylamine	62-75-9	tbd	100
Aniline	62-53-3	tbd	20
n-Nitroso-di-n-propylamine	621-64-7	tbd	20
2,3,4,6,7,8-HxCDF	60851-34-5	0.013	0.5
2,6-Dinitrotoluene	606-20-2	tbd	100
Dieldrin	60-57-1	tbd	0.2
4-Chloro-3-methylphenol	59-50-7	tbd	40
2-Hexanone	591-78-6	tbd	4
2,3,4,6-Tetrachlorophenol	58-90-2	tbd	100
g - BHC (Lindane)	58-89-9	tbd	0.2
1,2,3,6,7,8-HxCDD	57653-85-7	0.034	0.5
1,2,3,6,7,8-HxCDF	57117-44-9	0.013	0.5
1,2,3,7,8-PeCDF	57117-41-6	0.017	0.5
2,3,4,7,8-PeCDF	57117-31-4	0.017	0.5
Benzo(a)anthracene	56-55-3	tbd	5
Carbon Tetrachloride	56-23-5	tbd	1
Total hexachlorinated furans	55684-94-1	--	--
1,2,3,4,7,8,9-HpCDF	55673-89-7	0.052	0.5
1,3-Dichlorobenzene	541-73-1	tbd	20
Dibenz(a,h)anthracene	53-70-3	tbd	5
Endrin ketone	53494-70-5	tbd	0.2
Aroclor 1242	53469-21-9	tbd	4
4,6-Dinitro-2-methylphenol	534-52-1	tbd	200
2,4'-DDD	53-19-0	tbd	0.2
2,4-Dinitrophenol	51-28-5	tbd	200

Table 3b
Analytes, Analysis Methods, and Targeted Reporting Limits - Depositional Sediment (If Applicable)

Analyte	CAS number	MDL[b]	MRL[c]
2,3,7,8-TCDF	51207-31-9	0.020	0.2
g - Chlordane	5103-74-2	tbd	0.2
cis - Nonachlor	5103-73-1	tbd	0.2
a - Chlordane	5103-71-9	tbd	0.2
Benzo(a)pyrene	50-32-8	tbd	5
4,4'-DDT	50-29-3	tbd	0.2
2,3,4,5- and 2,3,5,6-Tetrachlorophenol	4901-51-3; 935-95-5	tbd	100
Total tetrachlorinated dioxins	41903-57-5	--	--
1,2,3,7,8-PeCDD	40321-76-4	0.029	0.5
trans - Nonachlor	39765-80-5	tbd	0.2
1,2,3,4,7,8-HxCDD	39227-28-6	0.030	0.5
OCDF	39001-02-0	0.065	1.0
Total heptachlorinated furans	38998-75-3	--	--
Total heptachlorinated dioxins	37871-00-4	--	--
Aroclor 1262	37324-23-5	tbd	4
Tributyltin	36643-28-4	0.16	1
Total pentachlorinated dioxins	36088-22-9	--	--
1,2,3,4,6,7,8-HpCDD	35822-46-9	0.035	0.5
Total hexachlorinated dioxins	34465-46-8	--	--
2,4'-DDE	3424-82-6	tbd	0.2
Endosulfan II	33213-65-9	tbd	0.2
OCDD	3268-87-9	0.061	1.0
d - BHC	319-86-8	tbd	0.2
b - BHC	319-85-7	tbd	0.2
a - BHC	319-84-6	tbd	0.2
Aldrin	309-00-2	tbd	0.2
Total pentachlorinated furans	30402-15-4	--	--
Total tetrachlorinated furans	30402-14-3	--	--
Oxychlordane	27304-13-8	tbd	0.2
Mirex	2385-85-5	tbd	0.2
Chrysene	218-01-9	tbd	5
Acenaphthylene	208-96-8	tbd	20
Benzo(k)fluoranthene	207-08-9	tbd	5
Fluoranthene	206-44-0	tbd	20
Benzo(b)fluoranthene	205-99-2	tbd	5
1,2,3,7,8,9-HxCDD	19408-74-3	0.032	0.5
Indeno(1,2,3-cd)pyrene	193-39-5	tbd	5
Dicamba	1918-00-9	tbd	5
Benzo(g,h,i)perylene	191-24-2	tbd	5
Hexavalent chromium	18540-29-9	0.2	0.5
m,p -Xylene	179601-23-1	tbd	1
2,3,7,8-TCDD	1746-01-6	0.026	0.2
Methyl-*t* -butyl ether (MTBE)	1634-04-4	tbd	1
trans -1,2-Dichloroethene	156-60-5	tbd	1
Tetrabutyltin	1461-25-2	0.12	1
Dibutyltin	14488-53-0	0.041	1
Dibenzofuran	132-64-9	tbd	5
Dimethylphthalate	131-11-3	tbd	20
Pyrene	129-00-0	tbd	20
Tetrachloroethene	127-18-4	tbd	1
Aroclor 1016	12674-11-2	tbd	4
Aroclor 1248	12672-29-6	tbd	4
Chlorodibromomethane	124-48-1	tbd	1
1,2-Diphenylhydrazine	122-66-7	tbd	tbd
2,4-Dinitrotoluene	121-14-2	tbd	100

Table 3b
Analytes, Analysis Methods, and Targeted Reporting Limits - Depositional Sediment (If Applicable)

Analyte	CAS number	MDL[b]	MRL[c]
2,4-Dichlorophenol	120-83-2	tbd	60
1,2,4-Trichlorobenzene	120-82-1	tbd	20
Dichlorprop	120-36-5	tbd	5
Anthracene	120-12-7	tbd	20
Hexachlorobenzene	118-74-1	tbd	tbd
Hexachlorobenzene[h]	118-74-1	tbd	100
Di-n-octylphthalate	117-84-0	tbd	20
bis(2-Ethylhexyl)phthalate	117-81-7	tbd	20
Bis-(2-chloroethoxy) methane	111-91-1	tbd	20
Bis-(2-chloroethyl) ether	111-44-4	tbd	40
Aroclor 1232	11141-16-5	tbd	4
Aroclor 1221	11104-28-2	tbd	4
Aroclor 1268	11100-14-4	tbd	4
Aroclor 1254	11097-69-1	tbd	4
Aroclor 1260	11096-82-5	tbd	4
2-Chloroethyl Vinyl Ether	110-75-8	tbd	2
trans -1,4-Dichloro-2-butene	110-57-6	tbd	4
Phenol	108-95-2	tbd	20
Chlorobenzene	108-90-7	tbd	1
Toluene	108-88-3	tbd	1
2,2'-oxybis(1-chloropropane)	108-60-1	tbd	20
4-Methyl-2-Pentanone	108-10-1	tbd	4
Vinyl Acetate	108-05-4	tbd	4
Acrylonitrile	107-13-1	tbd	4
1,2-Dichloroethane	107-06-2	tbd	1
Acrolein	107-02-8	tbd	20
4-Chloroaniline	106-47-8	tbd	tbd
1,4-Dichlorobenzene	106-46-7	tbd	1
1,4-Dichlorobenzene[g]	106-46-7	tbd	20
4-Methylphenol	106-44-5	tbd	20
2,4-Dimethylphenol	105-67-9	tbd	20
Endosulfan sulfate	1031-07-8	tbd	0.2
Heptachlor epoxide	1024-57-3	tbd	0.2
4-bromophenyl-phenyl ether	101-55-3	tbd	20
trans -1,3-Dichloropropene	10061-02-6	tbd	1
cis - 1,3-Dichloropropene	10061-01-5	tbd	1
Benzyl Alcohol	100-51-6	tbd	20
Styrene	100-42-5	tbd	1
Ethyl Benzene	100-41-4	tbd	1
4-Nitrophenol	100-02-7	tbd	100
4-Nitroaniline	100-01-6	tbd	60
Total solids (percent of whole weight)	--	0.01	0.01
Grain size (percent)[d]	--	0.1	0.1
Total sulfides (mg/kg)	--	0.1	0.2
Total organic carbon (percent)	--	0.02	0.05
Gasoline-range petroleum hydrocarbons	--	3.2	10
Diesel-range petroleum hydrocarbons	--	7.1	25
Motor oil-range petroleum hydrocarbons	--	4.6	100
Conventional Analyses			
Metals			
Petroleum hydrocarbons			
Butyltins			
Chlorinated Herbicides and Pentachlorophenol			
Organochlorine Pesticides and Selected SVOCs			

Table 3b
Analytes, Analysis Methods, and Targeted Reporting Limits - Depositional Sediment (If Applicable)

Analyte	CAS number	MDL[b]	MRL[c]
Total DDT		tbd	
Total chlordane[f]		tbd	
PCB Aroclors			
Volatile Organic Compounds			
Semivolatile Organic Compounds			
Halogenated Compounds			
Organonitrogen Compounds			
Oxygen-Containing Compounds			
Phenols and Substituted Phenols			
Phthalate Esters			
Polycyclic Aromatic Hydrocarbons			
PCB congeners			
Chlorinated Dioxins and Furans[j]			

Notes:

[a] Values are provided in bold font when the MRL is not expected to meet the ACG. ACGs for PCB congeners to be determined.

[b] The laboratory's current MDL is provided when an MDL study has been completed for the proposed method.
When no MDL is provided, the laboratory will complete an MDL study prior to analysis of samples for this project.

[c] The MRL is provided on a dry-weight basis and assumes 50% moisture in the samples.
The MRL for project samples will vary with moisture content in the samples.
The MRL represents the level of lowest calibration standard (i.e., the practical quantitation limit).

[d] Grain-size intervals will include the following:

Gravel	Very fine sand	Clay, phi size 8-9
Very coarse sand	Coarse silt	Clay, phi size 9-10
Coarse sand	Medium silt	Clay, phi size >10
Medium sand	Fine silt	
Fine sand	Very fine silt	

[e] The MDLs for the herbicides and pentachlorophenol are expected to be lower than the ACGs.

[f] Total chlordane will be calculated as the sum of the 5 components listed above this entry.

[g] 1,4-Dichlorobenzene will also be analyzed by purge-and-trap GC/MS with the VOCs to improve MRLs.

[h] Hexachlorobenzene, hexachloroethane, and hexachlorobutadiene will also be analyzed by GC/ECD with the pesticides to improve MRLs.

[i] Pentachlorophenol will also be analyzed with the herbicides to improve the MRL.

[j] Expected MDLs are shown. MDLs for PCB congeners and dioxins and furans are sample-dependent and will vary from the indicated values.

[k] MDLs and MRLs are shown for a sample weight of 10 g. MDLs and MRLs will be lower for a larger sample size.

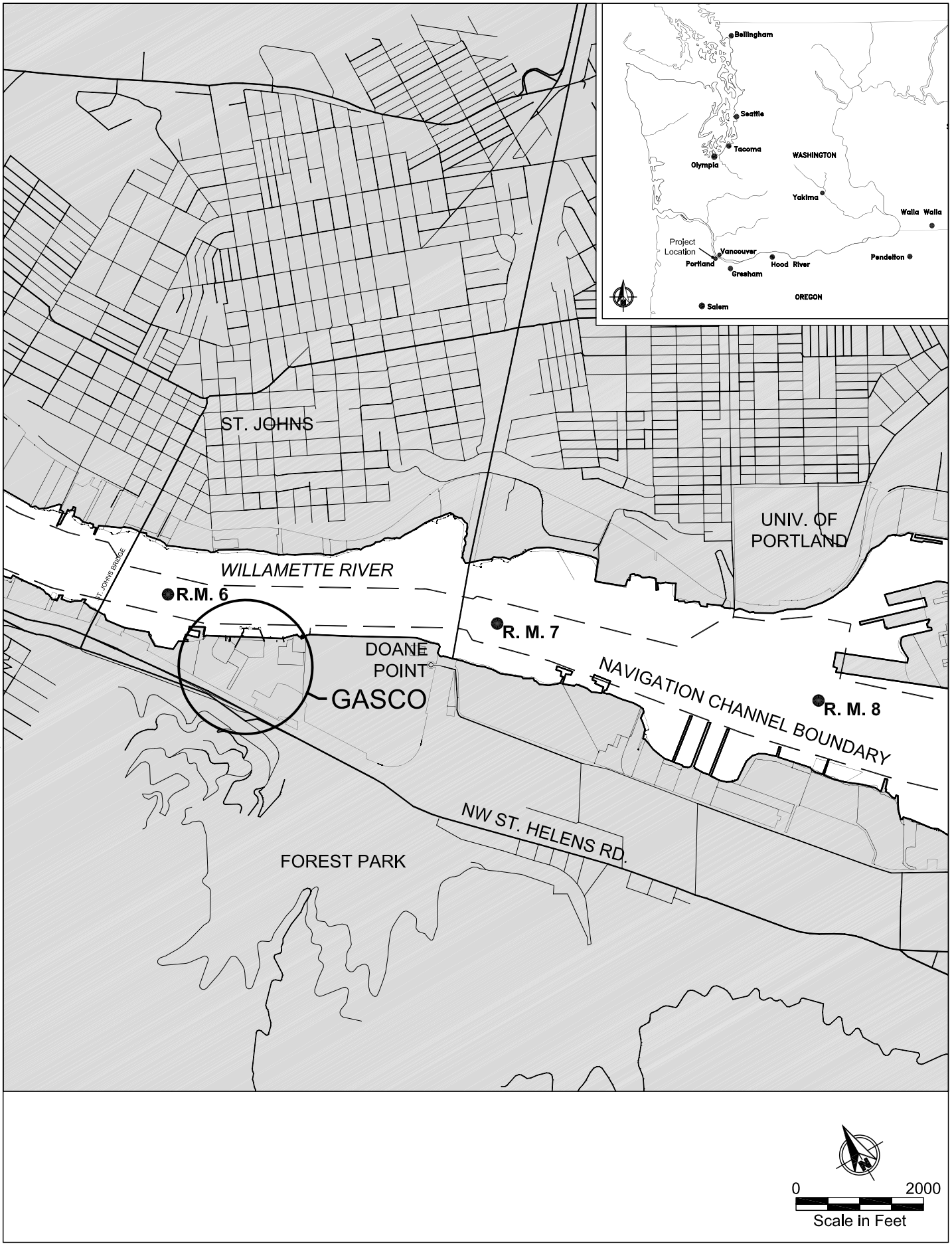
ACG = Analytical concentration goals; established by EPA during *ad hoc* meeting with LWG May 10, 2002
MDL = Method detection limit
MRL = Method reporting limit
NA = Not applicable
tbd = To be determined
* = A risk-based ACG has not been established

Table 3c
Analytes, Analysis Methods, and Targeted Reporting Limits – Porewater, Discrete Near-Bottom Surface Water, and Field QA/QC Samples

Conventionals				
Cyanide (ug/L)	57-12-5	NA	EPA Method 335.2	10
Total Suspended Solids (mg/L)	TSS	NA	EPA Method 160.2	1
Total Organic Carbon (%)	TOC	NA	EPA Method 415.1	0.1
Semivolatile Organic Compounds (µg/L) (Partial List)				
LPAHs				
Naphthalene	91203	NA	US EPA Method 8270C-SIM	0.02
Acenaphthylene	208968	NA	US EPA Method 8270C-SIM	0.02
Acenaphthene	83329	NA	US EPA Method 8270C-SIM	0.02
Fluorene	86737	NA	US EPA Method 8270C-SIM	0.02
Phenanthrene	85018	NA	US EPA Method 8270C-SIM	0.02
Anthracene	1201727	NA	US EPA Method 8270C-SIM	0.02
2-Methylnaphthalene	91576	NA	US EPA Method 8270C-SIM	0.02
HPAHs				
Fluoranthene	206440	NA	US EPA Method 8270C-SIM	0.02
Pyrene	129000	NA	US EPA Method 8270C-SIM	0.02
Benz(a)anthracene	56553	NA	US EPA Method 8270C-SIM	0.02
Chrysene	218019	NA	US EPA Method 8270C-SIM	0.02
Benzofluoranthene	205992	NA	US EPA Method 8270C-SIM	0.02
Benzo(a)pyrene	50328	NA	US EPA Method 8270C-SIM	0.02[a]
Indeno(1,2,3-cd)pyrene	193395	NA	US EPA Method 8270C-SIM	0.02
Dibenz(a,h)anthracene	53703	NA	US EPA Method 8270C-SIM	0.02
Benzo(g,h,i)perylene	191242	NA	US EPA Method 8270C-SIM	0.02
BTEX Compounds (µg/L) (Partial List)				
Benzene	71-43-2	NA	US EPA Method 8260	0.5
Toluene	108-88-3	NA	US EPA Method 8260b	0.5
Ethylbenzene	100414	NA	US EPA Method 8260	0.5
Total Xylenes	1330207	NA	US EPA Method 8260	0.5

Notes:
a – The laboratory will attempt to report down to a level between the MDL and MRL to meet the 0.014 ppb criteria.
NA – not applicable

FIGURES



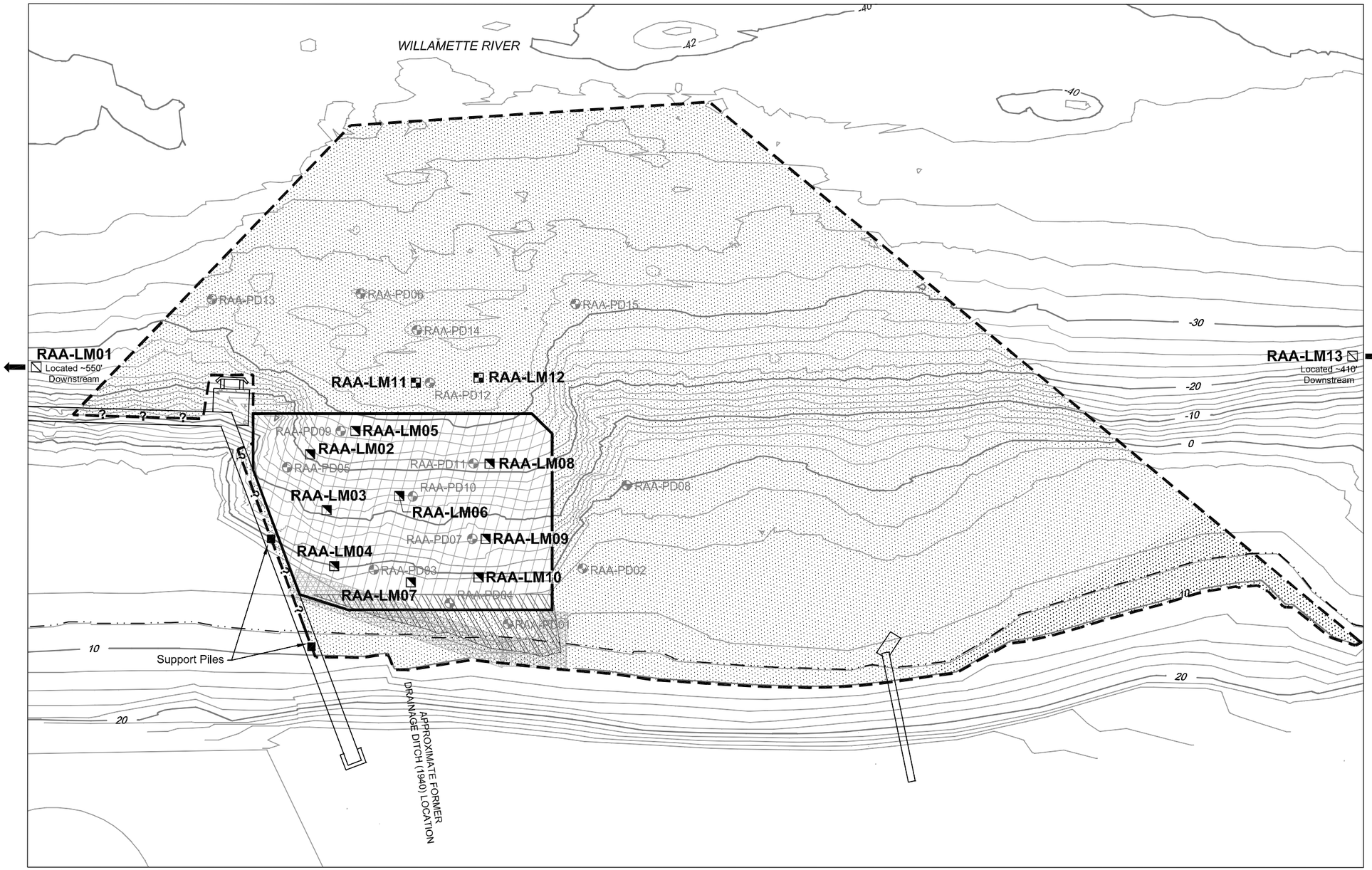
Oct 03, 2005 10:07am dholmer K:\Jobs\000029-GASCO\00002902\00002902-01.dwg FIG 1

ANCHOR ENVIRONMENTAL, L.L.C.

Figure 1
Vicinity Map
NW Natural "Gasco" Site

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
- **RAA-LM02** Proposed Co-Located Core, Porewater & Near-Bottom Surface Water Samples
- **RAA-LM01** Proposed Background Near-Bottom Surface Water Sample
- **RAA-LM11** Proposed Seepage Monitoring Core
- RAA-PD13 Post-Dredge Surface Sediment Sample (October 2005)



0 60
Scale in Feet

Notes:
1. Post-cap bathymetric contours produced from survey provided by Blue Water Engineering dated October 31, 2005.
2. Upland topography directed by Anchor Environmental as part of upland investigation (2002).
3. Horizontal Datum: Oregon State Plane North NAD 83 (ft).
4. Vertical Datum: NAVD 88 (ft).
5. Former Drainage Ditch location from Phase 1 Remedial Investigation Summary Report (HAI 1998).

Jan 23, 2006 2:35pm dholmer K:\Jobs\000029-GASCO\00002902\00002902-130.dwg FIG 2

ANCHOR ENVIRONMENTAL, L.L.C.

Figure 2
Proposed Long-Term Monitoring Sampling Stations
NW Natural "Gasco" Site

ATTACHMENT A
SPREADSHEET CALCULATOR TEMPLATE FOR SPMD WATER CONCENTRATIONS

Estimated Water Concentration Calculator From SPMD Data

To calculate the estimated water concentrations (C_W) from SPMD data, enter the appropriate information into the highlighted yellow cells.

Enter a temperature value (10, 18, or 26) in °C which most closely approximates the actual exposure water temperature.

Temperature (°C) = [ ] **Exposure Time (d) =** [ ]

mass of SPMD (g) = [ ] (NOTE: a standard 81 cm SPMD has a mass of 4.5 g)

Volume of Lipid (L) = [ ] **Volume of Membrane (L) =** [ ] **Volume of SPMD (L) =** [ ]

(NOTE: a standard 81 cm SPMD has lipid volume of 0.001L, membrane volume of 0.0037L, and a total volume of 0.0047L.)

If a PRC was used, the $k_{e\text{-}PRC}$ can be calculated by $k_{e\text{-}PRC} = [\ln(C_{SPMDo}/C_{SPMD})]/t$. If a PRC was not used, enter the same number for the $k_{e\text{-}PRC}$ as for the $k_{e\text{-}cal}$.

$k_{e\text{-}PRC}$ (d^{-1})= [ ]

The $k_{e\text{-}cal}$ value is the laboratory calibration value for the native PRC analog.

$k_{e\text{-}cal}$ (d^{-1})= [ ] (NOTE: the $k_{e\text{-}cal}$ for D_{10}-Phenanthrene is 0.021 d^{-1})

Estimated water concentrations can not be calculated for all compounds.

For compounds in which laboratory R_s values do not exist, the term N/A will appear in place of a numerical value, indicating the inability to estimate the water concentration.

The final Estimated Water Concentration values appear in the light blue highlighted cells.

Project Name: [ ]

PAHs and Related Heterocyclic Compounds	Log K_{ow}	K_{SPMD}	Laboratory R_s (L/d)	PRC corrected R_s (L/d)	Theoretical $t_{1/2}$	Total Analyte (ng/SPMD)	Water Conc. (pg/L)	Model Used
Naphthalene	3.45 [f]	1.90E+03	N/A	N/A	N/A		N/A	linear
Biphenyl	3.90 [l]	5.54E+03	N/A	N/A	N/A		N/A	linear
Dibenzofuran	4.12 [l]	9.01E+03	N/A	N/A	N/A		N/A	linear
C1-naphthalenes	3.86 [l]	5.06E+03	N/A	N/A	N/A		N/A	linear
C2-naphthalenes	4.37 [l]	1.52E+04	N/A	N/A	N/A		N/A	linear
C3-naphthalenes	4.90 [l]	4.13E+04	N/A	N/A	N/A		N/A	linear
C4-naphthalenes	5.30 [l]	8.00E+04	N/A	N/A	N/A		N/A	linear
1-methylnaphthalene	3.86 [l]	5.06E+03	N/A	N/A	N/A		N/A	linear
2-methylnaphthalene	3.86 [l]	5.06E+03	N/A	N/A	N/A		N/A	linear
2,6-dimethylnaphthalene	4.37 [l]	1.52E+04	N/A	N/A	N/A		N/A	linear
2,3,5-trimethylnaphthalene	4.90 [l]	4.13E+04	N/A	N/A	N/A		N/A	linear
Acenaphthylene	4.08 [f]	8.26E+03	2.3	1.7	15.7		0.0	curvilinear
Acenaphthene	4.22 [f]	1.11E+04	2.7	2.0	18.0		0.0	curvilinear
Fluorene	4.38 [f]	1.55E+04	3.0	2.2	22.6		0.0	curvilinear
C1-fluorenes	4.97 [l]	4.66E+04	N/A	N/A	N/A		N/A	linear
C2-fluorenes	5.20 [l]	6.83E+04	N/A	N/A	N/A		N/A	linear
C3-fluorenes	5.50 [l]	1.08E+05	N/A	N/A	N/A		N/A	linear
1-methylfluorene	4.97 [l]	4.66E+04	N/A	N/A	N/A		N/A	linear
dibenzothiophene	4.38 [l]	1.55E+04	N/A	N/A	N/A		N/A	linear
C1-dibenzothiophenes	4.80 [l]	3.45E+04	N/A	N/A	N/A		N/A	linear
C2-dibenzothiophenes	5.50 [l]	1.08E+05	N/A	N/A	N/A		N/A	linear
C3-dibenzothiophenes	5.70 [l]	1.43E+05	N/A	N/A	N/A		N/A	linear
Phenanthrene	4.46 [f]	1.82E+04	3.9	2.9	20.4		0.0	curvilinear
Anthracene	4.54 [f]	2.12E+04	3.0	2.2	31.0		0.0	linear
C1-phenanthrenes/anthracenes	5.14 [l]	6.20E+04	N/A	N/A	N/A		N/A	linear
C2-phenanthrenes/anthracenes	5.60 [l]	1.25E+05	N/A	N/A	N/A		N/A	linear
C3-phenanthrenes/anthracenes	5.85 [l]	1.75E+05	N/A	N/A	N/A		N/A	linear
C4-phenanthrenes/anthracenes	6.50 [l]	3.69E+05	N/A	N/A	N/A		N/A	linear
1-methylphenanthrene	5.14 [l]	6.20E+04	N/A	N/A	N/A		N/A	linear
Fluoranthene	5.20 [f]	6.83E+04	4.3	3.2	69.4		0.0	linear
Pyrene	5.30 [f]	8.00E+04	5.1	3.8	68.6		0.0	linear
C1-fluoranthenes/pyrenes	5.70 [l]	1.43E+05	N/A	N/A	N/A		N/A	linear
Benz[a]anthracene	5.91 [f]	1.89E+05	3.6	2.7	229.7		0.0	linear
Chrysene	5.61 [f]	1.27E+05	4.0	3.0	138.4		0.0	linear
C1-chrysenes	6.20 [l]	2.68E+05	N/A	N/A	N/A		N/A	linear
C2-chrysenes	6.50 [l]	3.69E+05	N/A	N/A	N/A		N/A	linear
C3-chrysenes	6.80 [l]	4.89E+05	N/A	N/A	N/A		N/A	linear
C4-chrysenes	8.00 [l]	1.04E+06	N/A	N/A	N/A		N/A	linear
Benzo[b]fluoranthene	5.78 [f]	1.60E+05	3.2	2.4	218.3		0.0	linear
Benzo[k]fluoranthene	6.20 [f]	2.68E+05	3.4	2.5	344.6		0.0	linear
Benzo[e]pyrene	6.40 [l]	3.33E+05	N/A	N/A	N/A		N/A	linear
Benzo[a]pyrene	6.35 [f]	3.16E+05	3.5	2.6	394.9		0.0	linear
Indeno[1,2,3-cd]pyrene	6.75 [f]	4.68E+05	3.3	2.5	620.1		0.0	linear
Dibenzo[a,h]anthracene	6.51 [f]	3.73E+05	2.3	1.7	709.0		0.0	linear
Benzo[g,h,I]perylene	6.90 [f]	5.33E+05	1.9	1.4	1225.7		0.0	linear
Coronene	7.64 [l]	8.81E+05	N/A	N/A	N/A		N/A	linear

Compounds are listed in general order of their chromatographic elution on a DB-35MS and a DB-5 GC-column for the organochlorine pesticides and PAHs respectively.

The linear model of estimation was used in cases where a compound's log K_{ow}>6.

This calculator applies only to SPMDs which conform to the surface area-to-volume ratio of a standard SPMD.

If multiple log K_{ow} values were found in the literature, a mean value was selected using the t test at 95% Confidence for rejection of outliers.

[a] Mackay, D.; Shiu, W-Y; Ma, K-C Illustrated Handbook of Physical-Chemical Properties and Environmental Fate for Organic Chemicals. Volume V, Lewis Publishers, Boca Raton, 1997.
[b] Oliver, B.G.; Niimi, A.J. Environ. Sci. Technol., 1985, 19:9, 842-849.
[c] Simpson, C.D.; Wilcock, R.J.; Smith, T.J.; Wilkins, A.L.; Langdon, A.G. Bull. Environ. Contam. Toxicol., 1995, 55:1, 149-153.
[d] Veith, G.D.; DeFoe, D.L.; Bergstedt, B.V. J. Fish Res. Board Can., 1979, 36, 1040-1048.
[e] Syracuse Research Corporation, On-Line Log K_{ow} Estimator (KowWin), http://esc.syrres.com/interkow/logkow.htm.
[f] Huckins, J.N.; Petty, J.D.; Orazio, C.E.; Lebo, J.A.; Clark, R.C.; Gibson, V.L.; Gala, W.R.; Echols, K.R. Environ. Sci. Technol., 1999, 33, 3918-3923.
[g] Meadows, J.C.; Echols, K.R.; Huckins, J.N.; Borsuk, F.A.; Carline, R.F.; Tillit, D.E. Environ. Sci. Technol., 1998, 32, 1847-1852.
[h] Rantalainen, A.L.; Cretney, W.; Ikonomou, M.G. Chemosphere, 2000, 40, 147-158.
[i] Sabaliunas, D.; Lazutka, J.; Sabaliuniene, I.; Sodergren, A. Environ. Tox. Chem., 1998, 17, 1815-1824.
[j] Chlorpyrifos and Diazinon values estimated from Endrin and Lindane, respectively, due to their proxitimy in Log K_{ow} values.
[k] Log K_{ow} values estimated from similar congeners.
[l] Luellen, D.R.; Shea, D. Environ. Sci. Technol., 2002, 36, 1791-1797.

Property of the U.S. Geological Survey, Columbia Environmental Research Center
4200 New Haven Road, Columbia, MO 65202
Contact: David Alvarez, Ph.D. (573) 441-2970, david_alvarez@usgs.gov

Last Updated: 2/20/2003

APPENDIX B

QUALITY ASSURANCE PROJECT PLAN

FINAL

APPENDIX B
QUALITY ASSURANCE PROJECT PLAN
NORTHWEST NATURAL "GASCO" SITE
MONITORING AND REPORTING PLAN

Prepared for

U.S. Environmental Protection Agency, Region 10

1200 Sixth Avenue

Seattle, Washington 98101

Prepared by

Anchor Environmental, L.L.C.

6650 SW Redwood Lane, Suite 110

Portland, Oregon 97224

On behalf of

NW Natural

220 NW Second Avenue

Portland, Oregon 97209

March 2006

QUALITY ASSURANCE PROJECT PLAN FOR NW NATURAL "GASCO" SITE MONITORING AND REPORTING PLAN

Prepared by

Anchor Environmental, L.L.C.
6650 SW Redwood Lane, Suite 110
Portland, Oregon 97224

Approvals:

Project Manager (Signature) _____

Name/Date _____

Project QA Officer (Signature) _____

Name/Date _____

USEPA Project Manager (Signature) _____

Name/Date _____

USEPA QA Officer (Signature) _____

Name/Date _____

Table of Contents

1 DISTRIBUTION LIST 1

2 PROJECT/TASK ORGANIZATION 2
2.1 Management 2
2.2 Field Monitors and Team Captains 2
2.3 Data Manager 3
2.4 Quality Assurance Personnel 3

3 PROBLEM DEFINITION/BACKGROUND 4

4 PROJECT/TASK DESCRIPTION AND SCHEDULE 5
4.1 Objectives 5
4.2 Description of Work and Measurements to be Performed 5
4.3 Bathymetry Survey Reporting Objectives 5
4.4 Sediment Reporting Limit Objectives 5
4.5 Porewater and Field QA/QC Water Samples Reporting Limit Objectives 6
4.6 Monitoring and Reporting Plan Implementation Schedule 6

5 DATA QUALITY OBJECTIVES AND CRITERIA 7
5.1 Precision 7
5.2 Accuracy 8
5.3 Representativeness 9
5.4 Comparability 9
5.5 Completeness 9

6 SPECIAL TRAINING/CERTIFICATION 11

7 DOCUMENTATION AND RECORDS 12

8 SAMPLING PROCESS DESIGN 15
8.1 Sampling Number and Locations 15
8.2 Selection of Indicator Chemicals 15

9 SAMPLING METHODS 16

10 SAMPLE HANDLING AND CUSTODY 17

11 ANALYTICAL METHODS 18

12 QUALITY CONTROL 19
12.1 Field QC Procedure 19
12.2 Laboratory QC Procedures 19
12.2.1 Laboratory QC Criteria 19
12.2.2 Initial and Continuing Calibration 20

12.2.3 Laboratory Duplicates 20
12.2.4 Matrix Spikes and Matrix Spike Duplicates (MS/MSD) 21
12.2.5 Method Blanks 21

13 INSTRUMENT/EQUIPMENT TESTING, INSPECTION, AND MAINTENANCE 22

14 INSTRUMENT/EQUIPMENT CALIBRATION AND FREQUENCY 23

15 INSPECTION/ACCEPTANCE OF SUPPLIES AND CONSUMABLES 24

16 NON-DIRECT MEASUREMENTS 25

17 DATA MANAGEMENT 26
17.1 Required Hardware 26

18 LABORATORY ASSESSMENTS AND RESPONSE ACTIONS 27
18.1 Laboratory and Field Performance Assessment 27

19 REPORTS TO EPA 29

20 DATA REVIEW, VALIDATION, AND VERIFICATION 30

21 VERIFICATION AND VALIDATION METHODS 31

22 RECONCILIATION WITH USER REQUIREMENTS 33

23 REFERENCES 34

List of Tables

Table 1a Analytes, Analysis Methods, and Targeted Reporting Limits – Sediment Cores
Table 1b Analytes, Analysis Methods, and Targeted Reporting Limits – Depositional Sediment
Table 1c Analytes, Analysis Methods, and Targeted Reporting Limits – Porewater, Discrete Near-Bottom Surface Water, and Field QA/QC Samples
Table 2 Project Schedule – Monitoring and Reporting Plan Activities
Table 3a Laboratory QA/QC Guidelines – Bulk Sediments
Table 3b Laboratory QA/QC Guidelines – Porewater, Near-Bottom Surface Water and Field QA/QC Samples
Table 4 Guidelines for Sample Handling and Storage

List of Figures

Figure 1 Vicinity Map

Figure 2 Proposed Long-Term Monitoring Sampling Stations

1 DISTRIBUTION LIST

All group leaders and technical advisors will receive copies of this Quality Assurance Project Plan (QAPP), and any approved revisions of this plan. Once approved, this QAPP will be available to any authorized party by requesting a copy from the Project Manager (PM), Robert J. Wyatt, of NW Natural.

2 PROJECT/TASK ORGANIZATION

NW Natural is providing the U.S. Environmental Protection Agency (EPA) Region 10 with a Monitoring and Reporting Plan (MARP) in response to Administrative Order on Consent (Order) for removal action at the "Gasco site" (Site) located along the Willamette River, Portland, Oregon (Figure 1).

NW Natural has selected Anchor Environmental L.L.C. (Anchor) to develop the MARP and manage associated technical activities.

2.1 Management

The project key staff and their responsibilities are as described below.

As identified in the Order, project manager (PM) Robert J. Wyatt, of NW Natural will manage compliance with the Order and communications with the On-Scene Coordinator (OSC)/Project Coordinator, Sean Sheldrake, at the EPA Region 10, Office of Environmental Cleanup (ECL).

Technical Project Manager (TPM) (Carl Stivers, Anchor) will:

- Develop and manage all technical activities associated with this project.
- Prepare monthly project reports.
- Coordinate with NW Natural's PM to ensure communication and information transfer within and among project proponents as required to conduct project.
- Direct activities of Anchor staff, subcontractors, and laboratories.

2.2 Field Monitors and Team Captains

Field Supervisor (Ryan Barth, Anchor) will:

- Assist in sampling design and development of the work plan.
- Train all field technicians who will participate in sample collection and data observations.
- Oversee field operations on site.
- Review data sheets from field personnel.
- Provide input on recommended actions.

Laboratory Managers (Abbie Spielman, Columbia Analytical Services [CAS], Terri Spencer, Environmental Sampling Technologies [EST], and Steve Thun, Pacific Agricultural Lab) will:

- Oversee the receipt and laboratory handling of sediment, porewater, discrete and time-integrated near-bottom surface water, and field quality assurance/quality control (QA/QC) samples from field team.
- Supervise collection of distillate from semipermeable membrane devices (SPMDs).
- Supervise chemical analyses in laboratory.
- Review laboratory reports and prepare case narrative describing any anomalies and exceptions that occurred during analysis.

2.3 Data Manager

Data Manager (Michelle McClelland, Anchor) will:

- Develop database of observations and data from sampling event.
- Review data for completeness and consistency.
- Provide summaries and analysis of data to the TPM.

2.4 Quality Assurance Personnel

QA Officer (Susan Snyder, Anchor) will:

- Prepare and implement this QAPP.
- Review data for compliance with EPA Comprehensive Environmental Response, Compensation and Liability Act (CERCLA) requirements.
- Recommend corrective actions, as necessary.

3 PROBLEM DEFINITION/BACKGROUND

NW Natural entered into an Order with EPA on April 28, 2004 to perform a removal action at the Site (EPA 2004b). The Order requires that NW Natural perform a number of actions associated with removing the tar body from the riverbank and nearshore sediment adjacent to the Site.

The project background is provided in the project MARP associated with this QAPP. In summary, the Site is a former oil gasification plant located at 7900 NW St. Helens Road, Portland, Oregon, 97210 and is bounded on the northeast by the Willamette River at River Mile 6 and on the southwest by State Highway 30 (St. Helens Road). The Site is within the initial study area of the Portland Harbor Superfund Site. The upland area of the Site is approximately 35 acres. The approximate former surface location of the tar body offshore of the Site was identified through previous visual investigations and is shown in the Removal Action Project Plan (RAPP; Anchor 2005). As required by the Order, the tar body and adjacent sediments were removed in the fall of 2005 (Anchor 2006). An engineered pilot cap and additional fringe cap were placed over the removal action area.

The purpose of this QAPP is to provide the specific objectives, organization, and functional activities associated with the field monitoring activities to evaluate the performance of the constructed removal action over time. This QAPP covers analyses of subsurface sediment, porewater, and discrete and time-integrated near-bottom surface water samples. The specific sampling and analysis objectives are described in the MARP.

In accordance with the Order, this QAPP is prepared following the EPA QA/R-5 (EPA 2001) and QA/G-5 (EPA 1998) protocols, and follows the guidance set forth in the OSWER Directive No. 9360.4-01 (EPA 1990). In addition, a number of other EPA documents were used as aids in preparing this document (EPA 1996 and 1998). The laboratory chosen for physical and chemical analyses (CAS and Pacific Agricultural Lab) is qualified to conduct the proposed analyses.

4 PROJECT/TASK DESCRIPTION AND SCHEDULE

4.1 Objectives

The performance monitoring includes the visual inspections, diver surveys, bathymetry surveys, and the collection of sediment cores, porewater, and near-bottom surface water samples to achieve the objectives described in the MARP.

4.2 Description of Work and Measurements to be Performed

The FSP (Appendix A) describes in detail the sampling station locations, equipment to be used, location control, sample nomenclature, sampling intervals and analyses, and sampling protocols which will be followed to achieve the removal action objectives (RAOs) and the pilot cap objectives.

4.3 Bathymetry Survey Reporting Objectives

The bathymetry survey will be conducted such that the measurement tolerances are generally within 6 inches.

4.4 Sediment Reporting Limit Objectives

There are no currently accepted measures of sediment risks specifically for use within the Portland Harbor Superfund Site, or the Site. Therefore, the sediment laboratory method reporting limits (MRLs) for the MARP-related sediment core samples will be identical to the EPA-approved sediment characterization MRLs summarized in the Removal Action Work Plan (RAWP; Anchor 2004). For benzene, toulene, ethylbenzene, and xylene (BTEX), where values from these documents are greater than 1 parts per billion (ppb) (μg/kg), detection limits of 1 ppb or less will be obtained. The Source Control Evaluation (Anchor 2001) determined that values of less than 1 ppb in sediments (particularly for benzene) are unlikely to be associated with porewater concentrations impacted by upland groundwater contaminant migration, and serve as a screening level for the detection of such potential impacts. Since there are no widely accepted sediment screening values for cyanide, the reporting limits for these analytes are set at the laboratory (i.e., CAS) method reporting limits (MRL; 0.1 mg/kg). The sediment MRLs are summarized in Table 1a.

Samples potentially collected from the recently deposited sediments overlying the pilot cap armor layer will be analyzed for the full list of Portland Harbor Superfund Site contaminants of interest (Integral et al. 2004). For these samples, the laboratory MRLs will be at or below the MRLs defined in the *Portland Harbor RI/FS – Round 2 QAPP* (Integral et al. 2004), as summarized in Table 1b.

4.5 Porewater, Near-Bottom Surface Water, and Field QA/QC Water Samples Reporting Limit Objectives

Water analyses will be conducted on pilot cap porewater, near-bottom surface water and field QA/QC samples. The reporting limits for these media shall be at or below the lowest values provided by DEQ (2001) for surface water ecological exposures and EPA chronic Criteria Continuous Concentrations (CCC) National Recommended Water Quality Criteria (EPA 2004a). For PAHs and BTEX compounds with reporting limits less than 1 ppb (i.e., 1 μg/L), a detection limit of 1 ppb will be obtained. The laboratory MRLs for water analysis are summarized in Table 1c.

4.6 Monitoring and Reporting Plan Implementation Schedule

Table 2 identifies the schedule of major activities associated with the MARP implementation and reporting.

5 DATA QUALITY OBJECTIVES AND CRITERIA

The QA objective for this project is to ensure that the data collected are of known and acceptable quality so that the project objectives described in Section 1.1 of the Field Sampling Plan (FSP; Appendix A to the MARP) can be achieved. The quality of the laboratory data is assessed by precision, accuracy, representativeness, comparability, and completeness (the "PARCC" parameters). Definitions of these parameters and the applicable QC procedures are given below. Applicable quantitative goals for these data quality parameters are listed or referenced in Table 3.

5.1 Precision

Precision is the ability of an analytical method or instrument to reproduce its own measurement. It is a measure of the variability, or random error, in sampling, sample handling, and in laboratory analysis. The American Society of Testing and Materials (ASTM) recognizes two levels of precision: repeatability—the random error associated with measurements made by a single test operator on identical aliquots of test material in a given laboratory, with the same apparatus, under constant operating conditions; and reproducibility—the random error associated with measurements made by different test operators, in different laboratories, using the same method but different equipment to analyze identical samples of test material.

In the laboratory, "within-batch" precision is measured using replicate sample or QC analyses and is expressed as the relative percent difference (RPD) between the measurements. The "batch-to-batch" precision is determined from the variance observed in the analysis of standard solutions or laboratory control samples from multiple analytical batches.

Field precision will be evaluated by the collection of blind field homogenization duplicate for chemistry samples at a frequency of 10 percent. Per the FSP (Appendix A), two field homogenization duplicates will be collected from the 16 sediment chemistry samples collected from beneath the tar body. Field chemistry duplicate precision will be screened against a RPD of 50 percent for sediment samples. However, no data will be qualified based solely on field homogenization duplicate precision.

Precision measurements can be affected by the nearness of a chemical concentration to the MDL, where the percent error (expressed as RPD) increases. The equations used to express precision are as follows:

$$RPD = \frac{(C_1 - C_2) \times 100\%}{(C_1 + C_2)/2}$$

Where:

RPD = relative percent difference

C_1 = larger of the two observed values

C_2 = smaller of the two observed values

5.2 Accuracy

Accuracy is a measure of the closeness of an individual measurement (or an average of multiple measurements) to the true or expected value. Accuracy is determined by calculating the mean value of results from ongoing analyses of laboratory-fortified blanks, standard reference materials, and standard solutions. In addition, laboratory-fortified (i.e. matrix-spiked) samples are also measured; this indicates the accuracy or bias in the actual sample matrix. Accuracy is expressed as percent recovery (%R) of the measured value, relative to the true or expected value. If a measurement process produces results whose mean is not the true or expected value, the process is said to be biased. Bias is the systematic error either inherent in a method of analysis (e.g., extraction efficiencies) or caused by an artifact of the measurement system (e.g., contamination). CAS utilizes several QC measures to eliminate analytical bias, including systematic analysis of method blanks, laboratory control samples, and independent calibration verification standards. Because bias can be positive or negative, and because several types of bias can occur simultaneously, only the net, or total, bias can be evaluated in a measurement.

Laboratory accuracy will be evaluated against quantitative matrix spike and surrogate spike recovery performance criteria provided by the laboratory. Accuracy can be expressed as a percentage of the true or reference value, or as a %R in those analyses where reference materials are not available and spiked samples are analyzed. The equation used to express accuracy is as follows:

$$\%R = 100\% \times (S-U)/C_{sa}$$

Where:

%R = percent recovery

S = measured concentration in the spiked aliquot

U = measured concentration in the unspiked aliquot

C_{sa} = actual concentration of spike added

Field accuracy will be controlled by adherence to sample collection procedures outlined in the FSP (Appendix A).

5.3 Representativeness

Representativeness expresses the degree to which data accurately and precisely represents an environmental condition. For the removal action characterization sampling program (FSP [Appendix A]), the list of analytes has been identified to provide a comprehensive assessment of the tar-related contamination at the Site.

5.4 Comparability

Comparability expresses the confidence with which one data set can be evaluated in relation to another data set. For this program, comparability of data will be established through the use of standard analytical methodologies and reporting formats, and of common traceable calibration and reference materials.

5.5 Completeness

Completeness is a measure of the amount of data that is determined to be valid in proportion to the amount of data collected. Completeness will be calculated as follows:

$$C = \frac{\text{(Number of acceptable data points)} \times 100}{\text{(Total number of data points)}}$$

The data quality objective (DQO) for completeness for all components of this project is 90 percent. Data that have been qualified as estimated because the QC criteria were not met

will be considered valid for the purpose of assessing completeness. Data that have been qualified as rejected will not be considered valid for the purpose of assessing completeness.

6 SPECIAL TRAINING/CERTIFICATION

For the visual inspections, diver surveys, bathymetry surveys, and sediment, porewater, and near-bottom surface water sample preparation tasks, it is important that field crews are trained in health and safety and data collection requirements. All field crew that conduct coring, porewater, and near-bottom surface water monitoring activities are required to be 40-hour Hazardous Waste Operations and Emergency Response (HAZWOPER) certified. In addition, the dive subconsultant will be trained in accordance with the dive protocols defined in the EPA-reviewed dive plan for Research Support Services, Inc., submitted as part of the Construction Health and Safety Plan (CHASP) (Appendix B of the RAPP, Anchor 2005). The survey consultant will be fully trained in use of the vessel location control and data acquisition software and equipment. The field crew used to collect the various samples will be fully trained in the collection and compositing of sediment cores, collection of porewater and near-bottom surface water samples, decontamination protocols, visual inspections, and chain-of-custody (COC) procedures. All effort will be made to keep the same personnel for logging all cores collected under the FSP (Appendix A) to maintain logging consistency.

7 DOCUMENTATION AND RECORDS

Sample documentation is a critical aspect of environmental investigations. For the visual inspections, diver surveys, bathmetry surveys, and collection of sediment cores, porewater, and near-bottom surface water samples, the field activities will be maintained in field log books, as discussed in the FSP (Appendix A). The field notes for the visual inspections, diver surveys and bathymetry surveys will undergo QA through the field personnel to ensure that all records are accurate and thorough. Documentation and recording of the sediment, porewater, and near-bottom surface water samples are discussed below.

For the sediment, porewater, and near-bottom surface water field activities, sample possession and handling must be traceable from the time of sample collection, through laboratory and data analysis, to the time sample results are potentially introduced as evidence. A sample log form and field log book entries will be completed for each location occupied and each sample collected.

Sample labeling and custody documentation will be performed as described in the FSP (Appendix A). Custody procedures will be used for all samples at all stages in the analytical or transfer process and for all data and data documentation whether in hard copy or electronic format.

For the sediment, porewater, and near-bottom surface water samples, the analytical laboratory will be required, where applicable, to report the following:

- Project Narrative. This summary, in the form of a cover letter, will discuss problems, if any, encountered during any aspect of analysis. This summary should discuss, but not be limited to, QC, sample shipment, sample storage, and analytical difficulties. Any problems encountered, actual or perceived, and their resolutions will be documented in as much detail as appropriate.
- **Chain of Custody Records.** Legible copies of the COC forms will be provided as part of the data package. This documentation will include the time of receipt and condition of each sample received by the laboratory. Additional internal tracking of sample custody by the laboratory will also be documented.
- **Sample Results.** The data package will summarize the results for each sample analyzed. The summary will include the following information when applicable:

- Field sample identification code and the corresponding laboratory identification code
- Sample matrix
- Date of sample extraction
- Date and time of analysis
- Weight and/or volume used for analysis
- Final dilution volumes or concentration factor for the sample
- Identification of the instrument used for analysis
- Method reporting and detection limits
- Analytical results with reporting units identified
- Data qualifiers and their definitions
- A computer disk with the data in a format specified in advance by the NW Natural or their designee (Anchor)

- **QA/QC Summaries.** This section will contain the results of the laboratory QA/QC procedures. Each QA/QC sample analysis will be documented with the same information required for the sample results (see above). No recovery or blank corrections will be made by the laboratory. The required summaries are listed below; additional information may be requested.
- **Calibration Data Summary.** The concentrations of the initial calibration and daily calibration standards, and the date and time of analysis will be reported. This will include the response factor, percent relative standard deviation, percent difference, and retention time for each analyte as appropriate. Report results for standards to indicate instrument sensitivity.
- **Internal Standard Area Summary.** The stability of internal standard areas will be reported.
- **Method Blank Analysis.** This includes the method blank analyses associated with each sample and the concentration of all compounds of interest identified in these blanks.
- **Surrogate Spike Recovery.** This includes all surrogate spike recovery data for organic compounds, with the name and concentration of all compounds added, percent recoveries, and range of recoveries listed.
- **Matrix Spike Recovery.** This includes all matrix spike recovery data for organic and metal compounds with the name and concentration of all compounds added, percent

recoveries, and range of recoveries listed. The RPD for all duplicate analyses will be included.

- **Matrix Duplicate.** This includes the RPD for all matrix duplicate analyses.
- **Relative Retention Time.** The relative retention time of each analyte detected in the samples for both primary and conformational analyses will be reported.
- **Original Data.** Legible copies of the original data generated by the laboratory will include:
  - Sample extraction, preparation, and cleanup logs.
  - Instrument specifications and analysis logs for all instruments used on days of calibration and analysis.
  - Reconstructed ion chromatograms for all samples, standards, blanks, calibrations, spikes, replicates, and reference materials.
  - Enhanced spectra of detected compounds with associated best-match spectra for each sample.
  - Printouts and quantitation reports for each instrument used, including reports for all samples, standards, blanks, calibrations, spikes, replicates, and reference materials.
  - Original data quantification reports for each sample.
  - Original data for blanks and samples not reported.

All data collected during the monitoring activities will be maintained at Anchor for 10 years after NW Natural's receipt of EPA's Notice of Completion of Work (see Order ¶30).

8 SAMPLING PROCESS DESIGN

8.1 Sampling Number and Locations

The sampling numbers and locations for each of the various monitoring activities are described in the FSP (Appendix A) and shown in Figure 2.

8.2 Selection of Indicator Chemicals

Previous sampling of soils and sediments with tar-related materials within and in the vicinity of the tar body indicate the primary chemicals likely to be encountered during monitoring include benzene, polycyclic aromatic hydrocarbons (PAHs), and cyanide (Anchor, 2001 and 2005). However, this analyte list was revised in accordance with the EPA comments on the Draft MARP (EPA 2005). The sediment core samples will be analyzed for the following as detailed in the RAWP (Anchor 2004): total solids, total organic carbon (TOC), grain size, cyanide, PAHs, BTEX, total metals (i.e., arsenic, chromium, copper, nickel, lead, and zinc), pesticides, and polychlorinated biphenyls (PCBs). In addition, if a layer of surface sediment becomes deposited over the engineered pilot cap this material will be sampled (volume permitting) and analyzed for the full list of Portland Harbor Superfund Site contaminants of interest (Integral et al. 2004). The porewater, discrete near-bottom surface water, and field QA/QC samples will be analyzed for PAHs, cyanide and BTEX. The time-integrated near-bottom surface water samples will be analyzed for PAHs. The analytical methods for each of these compounds are summarized in Table 1a, 1b, and 1c.

9 SAMPLING METHODS

Visual inspections, diver surveys, bathymetry, and sediment core, porewater, and near-bottom surface water sampling methods and procedures for the MARP are described in detail in the FSP (Appendix A).

10 SAMPLE HANDLING AND CUSTODY

Sample collection and handling procedures are detailed in the FSP (Appendix A). To control the integrity of the sediment, porewater and near-bottom surface water samples during transit to the laboratory and during holding prior to analysis, established preservation and storage measures will be taken. Table 4 presents container type, preservation, and maximum holding times for various chemical analyses of sediment. Laboratory prepared sample containers will be labeled with the name of the project, time and date container was sealed, consultant's office name, required analyses, and initials of the individual processing the sample. The Field QA Manager or designee will check all container labels, custody form entries, and log book entries for completeness and accuracy at the end of each sampling day.

Sample labeling and COC documentation will be performed as described in the FSP (Appendix A). Custody procedures will be used for all samples at all stages in the analytical or transfer process and for all data and data documentation whether in hard copy or electronic format.

11 ANALYTICAL METHODS

In completing chemical analyses for the sediment and porewater samples, the contract laboratory is expected to meet the following minimum requirements:

1. Adhere to the methods outlined in this QAPP, including methods referenced for each analytical procedure.
2. Deliver fax, hard copy, and electronic data as specified.
3. Meet reporting requirements for deliverables.
4. Meet turnaround times for deliverables.
5. Implement QA/QC procedures, including the QAPP data quality requirements, laboratory QA requirements, and performance evaluation testing requirements.
6. Allow laboratory and data audits to be performed, if deemed necessary.

The laboratory chosen for physical and chemical analyses (CAS) is qualified to conduct the proposed analyses and complies with ANSI/ASQC E-4 1994 and QA/R-2 or equivalent documentation per the removal action Order.

Table 4 presents the analysis methods and the target reporting limits for the sediment core, porewater, and near-bottom surface water samples and field QA/QC samples (i.e., field replicates, rinsate blanks and field blanks) to be collected during the MARP activities. These reporting limits were chosen based on the evaluation described in Section 4.4 and 4.5 above. To achieve the appropriate laboratory MRL for sediment BTEX concentrations (1 ppb), the laboratory will need to report down to a level between the MRL (5 ppb) and the method detection limit (MDL; 0.02 ppb).

12 QUALITY CONTROL

12.1 Field QC Procedure

Field sampling and documentation procedures are detailed in the FSP (Appendix A). Field blank samples will be collected to evaluate the efficiency of field decontamination procedures. During each monitoring event, one rinsate blank will be collected for the sediment coring, porewater, and discrete near-bottom surface water sampling equipment (three rinsate blank samples total) and a single field blank will be collected for each monitoring event. A separate field blank will also be collected for the SPMDs. In addition, a trip blank will be included in each container shipped to CAS containing samples to be analyzed for volatiles compounds (i.e., BTEX). Although validation guidelines have not been established for field QC samples, their analysis is useful in identifying possible problems resulting from sample collection or sample processing in the field. All field QC samples will be documented in the field log book and verified by the QA Manager, or their designee.

12.2 Laboratory QC Procedures

12.2.1 Laboratory QC Criteria

Results of the QC samples from each sample group will be reviewed by the analyst immediately after a sample group has been analyzed. The QC sample results will then be evaluated to determine if control limits have been exceeded. If control limits are exceeded in the sample group, the Project QA Manager will be contacted immediately, and corrective action (e.g., method modifications followed by reprocessing the affected samples) will be initiated prior to processing a subsequent group of samples.

All primary chemical standards and standard solutions used in this project will be traceable to documented, reliable, commercial sources. Standards will be validated to determine their accuracy by comparison with an independent standard. Any impurities found in the standard will be documented.

The following sections summarize the procedures that will be used to assess data quality throughout sample analysis.

12.2.2 Initial and Continuing Calibration

Calibration standards are solutions of known concentration prepared from primary standard solutions that are, in turn, prepared from stock standard materials. Calibration standards are used to calibrate the instrument response with respect to analyte concentration. Standards are analyzed in accordance with the requirements stated in the particular method being used.

Initial (or independent) calibration verification (ICV) standards are standards that are analyzed *after* calibration with newly prepared standard(s), but *prior to* sample analysis in order to verify the validity of the standards used in the calibration. Once it is determined that there is no systematic error in preparation of the calibration standard(s), they are considered valid standards and may be used for subsequent calibrations (as expiration dates and methods allow). The ICV standards are prepared from materials obtained from a source independent of that used for preparing the calibration standards. ICVs are also analyzed in accordance with method-specific requirements.

Continuing calibration verification (CCV) standards are midrange standards that are analyzed in order to verify that the calibration of the analytical system is still acceptable. The frequency of CCV analysis is either once every 10 samples, or as indicated in the method.

All project samples analyzed while instrument calibration was out of control will be reanalyzed, if sufficient sample volume is available.

12.2.3 Laboratory Duplicates

Analytical duplicates provide information on the precision of the analysis and are useful in assessing potential sample heterogeneity and matrix effects. Analytical duplicates are subsamples of the original sample and are prepared and analyzed as a separate sample. A minimum of one duplicate will be analyzed per sample group per sampling matrix (i.e., sediment, porewater and/or surface water) or for every 20 samples, whichever is more frequent.

12.2.4 Matrix Spikes and Matrix Spike Duplicates (MS/MSD)

Matrix spiked samples are aliquots of samples to which a known amount of the target analyte(s) has been added. The samples are then prepared and analyzed in the same analytical batch, and in exactly the same manner, as are routine samples. The stock solutions used for spiking the sample(s) are purchased and prepared independently of calibration standards. The spike recovery measures the effects of interferences caused by the sample matrix and reflects the accuracy of the method for the particular matrix in question. Surrogate recoveries will be reported by the laboratory; however, no sample result will be corrected for recovery using these values.

12.2.5 Method Blanks

The method blank is either analyte-free water or analyte-free soil (when available), subjected to the entire analytical process. When analyte-free soil is not available, anhydrous sodium sulfate, organic-free sand, or an acceptable substitute may be used instead. The method blank is analyzed to demonstrate that the analytical system itself is not contaminated with the analyte(s) being measured. The method blank results should be below the MRL for the analyte(s) being tested. Otherwise, corrective action must be taken. A method blank is included with the analysis of every sample preparation batch, every 20 samples, or as stated in the method, whichever is more frequent.

13 INSTRUMENT/EQUIPMENT TESTING, INSPECTION, AND MAINTENANCE

Instruments and equipment will be calibrated and inspected before each sampling event and laboratory analyses in accordance with the manufacturer specifications. Any field equipment that is faulty or not functioning properly will not be used for sampling.

14 INSTRUMENT/EQUIPMENT CALIBRATION AND FREQUENCY

Multipoint initial calibration will be performed on each instrument at the start of each year of monitoring, after each major interruption to the analytical instrument, and when any ongoing calibration does not meet control criteria.

Instrument blanks or continuing calibration blanks (CCBs) provide information on the stability of the baseline established. CCBs are solutions of either analyte-free water, reagent, or solvent that are analyzed in order to verify the system is contamination-free when CCV standards are analyzed. The frequency of CCB analysis is either once every 10 samples or as indicated in the method, whichever is greater.

All project samples analyzed while instrument calibration was out of control will be reanalyzed.

15 INSPECTION/ACCEPTANCE OF SUPPLIES AND CONSUMABLES

Inspection and acceptance of field supplies including laboratory prepared sampling bottles will be performed by the Field Supervisor. All primary chemical standards and standard solutions used in this project, either in the field or laboratory, will be traceable to documented, reliable, commercial sources. Standards will be validated to determine their accuracy by comparison with an independent standard. Any impurities found in the standard will be documented.

16 NON-DIRECT MEASUREMENTS

Additional information may be obtained from NW Natural or EPA. If such information is needed, NW Natural or EPA will be asked to provide any information on data limitations. This information will be maintained with the data files.

17 DATA MANAGEMENT

Field data sheets for the sediment, porewater, and near-bottom surface water sampling will be checked for completeness and accuracy by the Field Supervisor. Samples and sample information will be examined by the laboratory manager upon receipt to be sure samples are within holding times, sample identification information is correct, and samples have been held and handled appropriately. Any samples that are not acceptable will be marked and not entered into the database or given an appropriate qualifier.

All data generated in the field will be documented on hard copy and provided to the office data manager for review and to whoever is responsible for the data's entry into an EQuIS (or similar program) database. All manually entered data will be checked by a second party. Field documentation will be filed in the main project file, after data entry and backchecking is complete.

Laboratory data will be provided to the Data Manager in the EQuIS electronic format. Laboratory data, which is electronically provided and loaded into the database, will undergo a 10 percent check against the laboratory hardcopy data. Data will be validated or reviewed manually, and qualifiers, if assigned, will be entered manually. All manually entered data will be backchecked by a second party.

Data tables and reports are exported from EQuIS to Microsoft Excel tables.

17.1 Required Hardware

EQuIS Chemistry is developed as a 32-bit application. The following minimum system is required to install and properly operate *EQuIS Chemistry*:

- Pentium Processor
- Processor speed of 500 MHz or faster
- Microsoft Windows 95 or higher
- 64 MB RAM
- 40 MB hard disk space available
- 600 x 800 screen resolution

18 LABORATORY ASSESSMENTS AND RESPONSE ACTIONS

Once sediment, porewater, and near-bottom surface water data are received from the laboratory, a number of QC procedures will be followed to provide an accurate evaluation of the data quality. Specific procedures will be followed to assess data precision, accuracy, and completeness.

An EPA Level III data quality review will be performed by a qualified Data Validation Specialist on the data, in accordance with EPA National Functional Guidelines (EPA 1998 and 1999). The data will be evaluated in accordance with this QAPP. All chemical data will be reviewed with regard to the following, as appropriate to the particular analysis.

- COC/documentation
- Holding times
- Instrument calibration
- Method blanks
- Detection limits
- Surrogate recoveries
- Matrix spike/matrix spike duplicate (MS/MSD) recoveries
- Laboratory control sample recoveries
- Laboratory and field duplicate RPDs

The results of the data quality review, including text assigning qualifiers in accordance with the EPA National Functional Guidelines and a tabular summary of qualifiers, will be generated by the Data Validation Specialists and submitted to the Project QA Officer for final review and confirmation of the validity of the data (EPA 1999). A QA summary of the review will be generated by the Project QA Officer. This summary and copies of the complete review will be presented as an appendix to each year's monitoring report.

18.1 Laboratory and Field Performance Assessment

Laboratory and field performance audits consist of on-site reviews of QA systems and equipment for sampling, calibration, and measurement. Laboratory audits will not be conducted as part of this study; however, all laboratory audit reports will be made available to the Project QA Officer upon request. All laboratories are required to have written procedures addressing internal QA/QC; these procedures have been submitted and will be

reviewed by the Project QA Officer to ensure compliance with the QAPP. All laboratories must ensure that personnel engaged in sampling and analysis tasks have appropriate training.

The laboratory will, as part of the audit process, allow review of written details of any and all method modifications planned.

Response Action for Field Sampling. The Field Supervisor will be responsible for correcting equipment malfunctions during the field sampling effort. The Project QA Officer will be responsible for resolving situations identified by the Field Supervisor that may result in noncompliance with this QAPP. All corrective measures will be immediately documented in the field log book.

Responsive Action for Laboratory Analyses. All laboratories are required to comply with their Standard Operating Procedures (SOPs). The Laboratory Manager will be responsible for ensuring that appropriate corrective actions are initiated as required for conformance with this QAPP. All laboratory personnel will be responsible for reporting problems that may compromise the quality of the data.

The Laboratory Project Manager will be notified immediately if any QC sample exceeds the project-specified control limits. The analyst will identify and correct the anomaly before continuing with the sample analysis. The Laboratory Project Manager will document the corrective action taken in a memorandum submitted to the Project QA Officer within 5 days of the initial notification. A narrative describing the anomaly, the steps taken to identify and correct the anomaly, and the treatment of the relevant sample batch (e.g., recalculation, reanalysis, re-extraction) will be submitted with the data package in the form of a cover letter.

19 REPORTS TO EPA

Once all data has been validated, the monitoring data will be reported in each year's monitoring report. This report will contain all results, data qualifiers, results of QA checks, deviations, and corrective actions taken for the sampling and analysis covered by this QAPP. Any major deviations or corrective actions from procedures outlined in the FSP (Appendix A) and this QAPP will be briefly described.

20 DATA REVIEW, VALIDATION, AND VERIFICATION

Data files will be reviewed by the Data Manager to identify outliers, spurious results, or omissions. Any problems will be reported to the TPM. The QA Officer will review data for compliance with DQOs. Any problems with data quality will be included in the yearly monitoring reports.

21 VERIFICATION AND VALIDATION METHODS

Data validation includes signed entries by the field and laboratory technicians on field data sheets and laboratory datasheets, respectively; review for completeness and accuracy by the Field Supervisor and Laboratory Manager; review by the data manager for outliers and omissions; and the use of QC criteria to accept or reject specific data. All data will be entered into the EQuIS database and a raw data file printed. One hundred percent verification of database raw data file will be performed by a second data manager or designee. Any errors found will be corrected on the raw data printout sheet. After the raw data is checked, the top sheet will be marked with the date the checking is completed and the initials of the person doing the checking. Any errors in the raw data file will be corrected, and the database established.

All laboratory data will be reviewed and verified to determine whether all DQOs (Section 5) have been met, and that appropriate corrective actions have been taken, when necessary. The Project QA Officer or designee will be responsible for the final review of all data generated from analyses of sediment samples.

The first level of review will take place in the laboratory as the data are generated. The laboratory department manager or designee will be responsible for ensuring that the data generated meet minimum QA/QC requirements and that the instruments were operating under acceptable conditions during generation of data. DQOs will also be assessed at this point by comparing the results of QC measurements with pre-established criteria as a measure of data acceptability.

The analysts and/or laboratory department manager will prepare a preliminary QC checklist for each parameter and for each sample delivery group (SDG) as soon as analysis of an SDG has been completed. Any deviations from the DQOs listed on the checklist will be brought to the attention of the Laboratory Project Manager to determine whether corrective action is needed and to determine the impact on the reporting schedule.

Data packages will be checked for EPA Level II completeness immediately upon receipt from the laboratory to ensure that data and QA/QC information requested are present. Data quality

will be assessed by a reviewer using current EPA Level III validation requirements and DEQ protocols by considering the following:

1. Holding times
2. Initial calibrations
3. Continuing calibrations
4. Method blanks
5. Surrogate recoveries
6. Detection limits
7. Laboratory Control samples
8. MS/MSD samples
9. Standard reference material results

The data will be validated in accordance with the project specific data quality objectives described above, analytical method criteria and the laboratories internal performance standards based on their standard operating procedures (SOPs).

22 RECONCILIATION WITH USER REQUIREMENTS

The QA Officer will review data after each survey to determine if DQOs have been met. If data do not meet the project's specifications, the QA Officer will review the errors and determine if the problem is due to calibration/maintenance, sampling techniques, or other factors, and will suggest corrective action. It is expected that any problem encountered would be able to be corrected by retraining, revision of techniques, or replacement of supplies/equipment. If not, then the DQOs will be reviewed for feasibility. If specific DQOs are not achievable, the QA Officer will recommend appropriate modifications. Any revisions would need approval by the EPA.

23 REFERENCES

Anchor Environmental, L.L.C. (Anchor). 2006. Removal Action Completion Report. Prepared on behalf of NW Natural. January 2006. Seattle, Washington.

Anchor Environmental, L.L.C. (Anchor). 2005. Removal Action Project Plan – Final Design Submittal. Prepared on behalf of NW Natural. July 2005. Seattle, Washington.

Anchor Environmental, L.L.C. (Anchor). 2004a. NW Natural "Gasco" Site Removal Action Work Plan. Prepared on behalf of NW Natural. August 2004. Portland, Oregon.

Anchor Environmental, L.L.C., 2001. "NW Natural 'Gasco' Site Draft Screening Level Nearshore Source Control Evaluation Results Report." Prepared for NW Natural. July 2001.

MacDonald, D.D., C.G. Ingersoll, and T.A. Berger, 2000. Development and evaluation of consensus-based sediment quality guidelines for freshwater ecosystems. Arch. Environ. Contam. Toxicol. 39, 20-31.

Oregon Department of Environmental Quality (DEQ), 2001. Guidance for Ecological Risk Assessment, Level II Screening Level Values, December 2001.

Integral Consulting Inc. (Integral), 2004. Portland Harbor RI/FS – Round 2 Quality Assurance Project Plan. Prepared for the Lower Willamette Group. July 24, 2004.

U.S. Environmental Protection Agency (EPA), 2005. Letter to NW Natural, Subject: "GASCO Removal Action; October 2005 MARP Comments", dated November 16, 2005.

U.S. Environmental Protection Agency (EPA), 2004a. National Recommended Water Quality Criteria. 2004.

U.S. Environmental Protection Agency (EPA), 2004b. Administrative Order on Consent for Removal Action between NW Natural and the U.S. Environmental Protection Agency, April 28, 2004.

U.S. Environmental Protection Agency (EPA), 2001. EPA Requirements for Quality Assurance Project Plans (QA/R-5). EPA/240/B-01/003, March 2001.

U.S. Environmental Protection Agency (EPA), 1999. USEPA Contract Laboratory Program National Functional Guidelines for Organic Data Review. EPA540/R-99/008, October 1999.

U.S. Environmental Protection Agency (EPA), 1998. EPA Guidance for Quality Assurance Project Plans (QA/G-5). EPA/600/R-98/018, February 1998.

U.S. Environmental Protection Agency (EPA), 1996. The Volunteer Monitor's Guide to QA Project Plans. EPA 841-B-96-003, September 1996.

U.S. Environmental Protection Agency (EPA), 1990. Quality Assurance/Quality Control Guidance for Removal Activities: Sampling QA/QC Plan and Data Validation Procedures. OSWER Directive No. 9360.4-01, April 1, 1990.

TABLES

Table 1a
Analytes, Analysis Methods, and Targeted Reporting Limits – Bulk Sediments

Conventionals				
Total solids (%)	NA	NA	EPA 160.M	0.1
Total organic carbon (%)	NA	NA	PSEP	0.1
Grain size (%)	NA	NA	ASTM D 422	0.1
Cyanide (mg/kg)	57-12-5	NA	EPA 335.2	0.1
Semivolatile Organic Compounds (µg/kg dry weight) (Partial List)				
LPAHs				
Naphthalene	91203	US EPA Method 3550	US EPA Method 8270C-SIM	5
Acenaphthylene	208968	US EPA Method 3550	US EPA Method 8270C-SIM	5
Acenaphthene	83329	US EPA Method 3550	US EPA Method 8270C-SIM	5
Fluorene	86737	US EPA Method 3550	US EPA Method 8270C-SIM	5
Phenanthrene	85018	US EPA Method 3550	US EPA Method 8270C-SIM	5
Anthracene	1201727	US EPA Method 3550	US EPA Method 8270C-SIM	5
2-Methylnaphthalene	91576	US EPA Method 3550	US EPA Method 8270C-SIM	5
HPAHs				
Fluoranthene	206440	US EPA Method 3550	US EPA Method 8270C-SIM	5
Pyrene	129000	US EPA Method 3550	US EPA Method 8270C-SIM	5
Benz(a)anthracene	56553	US EPA Method 3550	US EPA Method 8270C-SIM	5
Chrysene	218019	US EPA Method 3550	US EPA Method 8270C-SIM	5
Benzofluoranthene	205992	US EPA Method 3550	US EPA Method 8270C-SIM	5
Benzo(a)pyrene	50328	US EPA Method 3550	US EPA Method 8270C-SIM	5
Indeno(1,2,3-cd)pyrene	193395	US EPA Method 3550	US EPA Method 8270C-SIM	5
Dibenz(a,h)anthracene	53703	US EPA Method 3550	US EPA Method 8270C-SIM	5
Benzo(g,h,i)perylene	191242	US EPA Method 3550	US EPA Method 8270C-SIM	5
Volatile Organic Compounds (µg/kg dry weight) (Partial List)				
Benzene	71-43-2	US EPA Method 5030	US EPA Method 8260	1[a]
Toluene	108-88-3	US EPA Method 5030	US EPA Method 8260	5
Ethylbenzene	100414	US EPA Method 5030	US EPA Method 8260	5
Total Xylenes	1330207	US EPA Method 5030	US EPA Method 8260	5
Metals (mg/kg dry weight) (Partial List)				
Arsenic	1888-71-7	US EPA Method 6020	US EPA Method 6020	0.5
Chromium	32774-16-6	US EPA Method 6020	US EPA Method 6020	0.2
Copper	33820-53-0	US EPA Method 6020	US EPA Method 6020	0.1
Lead	56-53-1	US EPA Method 6020	US EPA Method 6020	0.05
Nickel	624-92-0	US EPA Method 6020	US EPA Method 6020	0.2
Zinc	7440-66-6	US EPA Method 6020	US EPA Method 6020	0.5
Total Petroleum Hydrocarbons (TPH) (mg/kg dry weight)				
NW Total Petroleum Hydrocarbons	NA	Northwest TPH	Northwest TPH-Dx	10

Table 1a
Analytes, Analysis Methods, and Targeted Reporting Limits – Bulk Sediments

Parameter	CAS Number	Preparation Method	Analytical Method	Targeted Reporting Limit
Polychlorinated Biphenyls (PCBs) (µg/kg dry weight)				
Aroclor 1016	12674	US EPA Method SW 3540	US EPA Method 8082	10
Aroclor 1221	11104	US EPA Method SW 3540	US EPA Method 8082	20
Aroclor 1232	11141	US EPA Method SW 3540	US EPA Method 8082	10
Aroclor 1242	53469	US EPA Method SW 3540	US EPA Method 8082	10
Aroclor 1248	12672	US EPA Method SW 3540	US EPA Method 8082	10
Aroclor 1254	11097	US EPA Method SW 3540	US EPA Method 8082	10
Aroclor 1260	11096	US EPA Method SW 3540	US EPA Method 8082	10
Aroclor 1262	37324	US EPA Method SW 3540	US EPA Method 8082	10
Aroclor 1268	11100	US EPA Method SW 3540	US EPA Method 8082	10
Pesticides (µg/kg dry weight)				
4,4'-DDD	53-19-0	US EPA Method SW 3540	US EPA Method 8081	1
4,4'-DDE	3424-82-6	US EPA Method SW 3540	US EPA Method 8081	1
4,4'-DDT	789-02-6	US EPA Method SW 3540	US EPA Method 8081	1
Aldrin	309-00-2	US EPA Method SW 3540	US EPA Method 8081	1
alpha-BHC	319-84-6	US EPA Method SW 3540	US EPA Method 8081	1
alpha-Chlordane	319-85-7	US EPA Method SW 3540	US EPA Method 8081	1
beta-BHC	319-85-7	US EPA Method SW 3540	US EPA Method 8081	1
delta-BHC	319-86-8	US EPA Method SW 3540	US EPA Method 8081	1
Dieldrin	60-57-1	US EPA Method SW 3540	US EPA Method 8081	1
Endosulfan I	959-98-8	US EPA Method SW 3540	US EPA Method 8081	1
Endosulfan II	33213-65-9	US EPA Method SW 3540	US EPA Method 8081	1
Endosulfan Sulfate	1031-07-8	US EPA Method SW 3540	US EPA Method 8081	1
Endrin	72-20-8	US EPA Method SW 3540	US EPA Method 8081	1
Endrin aldehyde	7421-93-4	US EPA Method SW 3540	US EPA Method 8081	1
Endrin ketone	53494-70-5	US EPA Method SW 3540	US EPA Method 8081	1
gamma-BHC (Lindane)	58-89-9	US EPA Method SW 3540	US EPA Method 8081	1
gamma-Chlordane	5103-71-9	US EPA Method SW 3540	US EPA Method 8081	1
Heptachlor	5103-74-2	US EPA Method SW 3540	US EPA Method 8081	1
Heptachlor Epoxide	27304-13-8	US EPA Method SW 3540	US EPA Method 8081	1
Methoxychlor	72-43-5	US EPA Method SW 3540	US EPA Method 8081	1
Toxaphene	2385-85-5	US EPA Method SW 3540	US EPA Method 8081	50

Notes:
a – The value presented lies between the method reporting limit and the method detection limit.
b – The list of pesticides will be identical to the pesticide compounds analyzed for the post-removal surface sediment samples.

Table 1b
Analytes, Analysis Methods, and Targeted Reporting Limits - Depositional Sediment (If Applicable)

Analyte	CAS number	MDL[b]	MRL[c]
Conventional Analyses			
Total solids (percent of whole weight)	--	0.01	0.01
Grain size (percent)[d]	--	0.1	0.1
Total sulfides (mg/kg)	--	0.1	0.2
Ammonia (mg/kg)	7664-41-7	0.05	0.1
Total organic carbon (percent)	--	0.02	0.05
Metals			
Aluminum	7429-90-5	2.0	2.0
Antimony	7440-36-0	0.02	0.05
Arsenic	7440-38-2	0.05	0.1
Cadmium	7440-43-9	0.006	0.02
Chromium	7440-47-3	0.04	0.2
Copper	7440-50-8	0.07	0.1
Lead	7439-92-1	0.02	0.05
Mercury	7439-97-6	0.01	0.02
Nickel	7440-02-0	0.03	0.2
Selenium	7782-49-2	0.05	0.1
Silver	7440-22-4	0.02	0.02
Zinc	7440-66-6	0.1	0.5
Hexavalent chromium	18540-29-9	0.2	0.5
Petroleum hydrocarbons			
Gasoline-range petroleum hydrocarbons	--	3.2	10
Diesel-range petroleum hydrocarbons	--	7.1	25
Motor oil-range petroleum hydrocarbons	--	4.6	100
Butyltins			
Monobutyltin	78763-54-9	0.071	1
Dibutyltin	14488-53-0	0.041	1
Tributyltin	36643-28-4	0.16	1
Tetrabutyltin	1461-25-2	0.12	1
Chlorinated Herbicides and Pentachlorophenol			
Dalapon	75-99-0	tbd	5
Dicamba	1918-00-9	tbd	5
MCPA	94-74-6	tbd	5
Dichlorprop	120-36-5	tbd	5
2,4-D	94-75-7	tbd[e]	5
2,4,5-TP (Silvex)	93-72-1	tbd[e]	8
2,4,5-T	93-76-5	tbd[e]	8
2,4-DB	94-82-6	tbd[e]	5
Dinoseb	88-85-7	tbd	8
MCPP	93-65-2	tbd	5
Pentachlorophenol	87-86-5	tbd[e]	5
Organochlorine Pesticides and Selected SVOCs			
2,4'-DDD	53-19-0	tbd	0.2
2,4'-DDE	3424-82-6	tbd	0.2
2,4'-DDT	789-02-6	tbd	0.2
4,4'-DDD	72-54-8	tbd	0.2
4,4'-DDE	72-55-9	tbd	0.2
4,4'-DDT	50-29-3	tbd	0.2
Total DDT		tbd	
Aldrin	309-00-2	tbd	0.2
a - BHC	319-84-6	tbd	0.2
b - BHC	319-85-7	tbd	0.2
d - BHC	319-86-8	tbd	0.2
g - BHC (Lindane)	58-89-9	tbd	0.2

Table 1b
Analytes, Analysis Methods, and Targeted Reporting Limits - Depositional Sediment (If Applicable)

Analyte	CAS number	MDL[b]	MRL[c]
a - Chlordane	5103-71-9	tbd	0.2
g - Chlordane	5103-74-2	tbd	0.2
Oxychlordane	27304-13-8	tbd	0.2
cis - Nonachlor	5103-73-1	tbd	0.2
trans - Nonachlor	39765-80-5	tbd	0.2
Total chlordane[f]		tbd	
Dieldrin	60-57-1	tbd	0.2
Endosulfan I	959-98-8	tbd	0.2
Endosulfan II	33213-65-9	tbd	0.2
Endosulfan sulfate	1031-07-8	tbd	0.2
Endrin	72-20-8	tbd	0.2
Endrin aldehyde	7421-93-4	tbd	0.2
Endrin ketone	53494-70-5	tbd	0.2
Heptachlor	76-44-8	tbd	0.2
Heptachlor epoxide	1024-57-3	tbd	0.2
Methoxychlor	72-43-5	tbd	0.2
Mirex	2385-85-5	tbd	0.2
Toxaphene	8001-35-2	tbd	20
Hexachlorobenzene	118-74-1	tbd	tbd
Hexachlorobutadiene	87-68-3	tbd	tbd
Hexachloroethane	67-72-1	tbd	tbd
PCB Aroclors			
Aroclor 1016	12674-11-2	tbd	4
Aroclor 1221	11104-28-2	tbd	4
Aroclor 1232	11141-16-5	tbd	4
Aroclor 1242	53469-21-9	tbd	4
Aroclor 1248	12672-29-6	tbd	4
Aroclor 1254	11097-69-1	tbd	4
Aroclor 1260	11096-82-5	tbd	4
Aroclor 1262	37324-23-5	tbd	4
Aroclor 1268	11100-14-4	tbd	4
Volatile Organic Compounds			
1,1,1,2-Tetrachloroethane	630-20-6	tbd	1
1,1,1-Trichloroethane	71-55-6	tbd	1
1,1,2,2-Tetrachloroethane	79-34-5	tbd	1
1,1,2-Trichloroethane	79-00-5	tbd	1
1,1-Dichloroethane	75-34-3	tbd	1
1,2,3-Trichloropropane	96-18-4	tbd	1
1,2-Dichloroethane	107-06-2	tbd	1
1,2-Dichloropropane	78-87-5	tbd	1
1,4-Dichlorobenzene	106-46-7	tbd	1
2-Butanone	78-93-3	tbd	4
2-Chloroethyl Vinyl Ether	110-75-8	tbd	2
2-Hexanone	591-78-6	tbd	4
4-Methyl-2-Pentanone	108-10-1	tbd	4
Acetone	67-64-1	tbd	4
Acrolein	107-02-8	tbd	20
Acrylonitrile	107-13-1	tbd	4
Bromochloromethane	74-97-5	tbd	1
Bromodichloromethane	75-27-4	tbd	1
Bromoethane	74-96-4	tbd	NE
Bromoform	75-25-2	tbd	1
Bromomethane	74-83-9	tbd	1
Carbon Disulfide	75-15-0	tbd	1
Carbon Tetrachloride	56-23-5	tbd	1

Table 1b
Analytes, Analysis Methods, and Targeted Reporting Limits - Depositional Sediment (If Applicable)

Analyte	CAS number	MDL[b]	MRL[c]
Chlorobenzene	108-90-7	tbd	1
Chlorodibromomethane	124-48-1	tbd	1
Chloroethane	75-00-3	tbd	1
Chloroform	67-66-3	tbd	1
Chloromethane	74-87-3	tbd	1
cis - 1,3-Dichloropropene	10061-01-5	tbd	1
Dibromomethane	74-95-3	tbd	1
Dichlorodifluoromethane	75-71-8	tbd	1
Iodomethane	74-88-4	tbd	4
Isopropyl benzene	98-82-8	tbd	4
Methylene chloride	75-09-2	tbd	2
Naphthalene	91-20-3	tbd	4
Styrene	100-42-5	tbd	1
trans -1,4-Dichloro-2-butene	110-57-6	tbd	4
Trichlorofluoromethane	75-69-4	tbd	1
Vinyl Acetate	108-05-4	tbd	4
1,1-Dichloroethene	75-35-4	tbd	1
Benzene	71-43-2	tbd	1
Ethyl Benzene	100-41-4	tbd	1
m,p -Xylene	179601-23-1	tbd	1
Methyl-*t* -butyl ether (MTBE)	1634-04-4	tbd	1
o -Xylene	95-47-6	tbd	1
Tetrachloroethene	127-18-4	tbd	1
Toluene	108-88-3	tbd	1
trans -1,2-Dichloroethene	156-60-5	tbd	1
trans -1,3-Dichloropropene	10061-02-6	tbd	1
Trichloroethene	79-01-6	tbd	1
Vinyl Chloride	75-01-4	tbd	1
Semivolatile Organic Compounds			
Halogenated Compounds			
1,2-Dichlorobenzene	95-50-1	tbd	20
1,3-Dichlorobenzene	541-73-1	tbd	20
1,4-Dichlorobenzene[g]	106-46-7	tbd	20
1,2,4-Trichlorobenzene	120-82-1	tbd	20
Hexachlorobenzene[h]	118-74-1	tbd	100
2-Chloronaphthalene	91-58-7	tbd	20
Hexachloroethane[h]	67-72-1	tbd	5
Hexachlorobutadiene[h]	87-68-3	tbd	100
Hexachlorocyclopentadiene	77-47-4	tbd	100
2,2'-oxybis(1-chloropropane)	108-60-1	tbd	20
Bis-(2-chloroethoxy) methane	111-91-1	tbd	20
Bis-(2-chloroethyl) ether	111-44-4	tbd	40
4-Chlorophenyl-phenyl ether	7005-72-3	tbd	20
4-bromophenyl-phenyl ether	101-55-3	tbd	20
3,3'-Dichlorbenzidine	91-94-1	tbd	100
4-Chloroaniline	106-47-8	tbd	tbd
Organonitrogen Compounds			
Nitrobenzene	98-95-3	tbd	20
Aniline	62-53-3	tbd	20
2-Nitroaniline	88-74-4	tbd	20
3-Nitroaniline	99-09-2	tbd	120
4-Nitroaniline	100-01-6	tbd	60
n-Nitrosodimethylamine	62-75-9	tbd	100
n-Nitroso-di-n-propylamine	621-64-7	tbd	20

Table 1b
Analytes, Analysis Methods, and Targeted Reporting Limits - Depositional Sediment (If Applicable)

Analyte	CAS number	MDL[b]	MRL[c]
n-Nitrosodiphenylamine	86-30-6	tbd	20
1,2-Diphenylhydrazine	122-66-7	tbd	tbd
2,4-Dinitrotoluene	121-14-2	tbd	100
2,6-Dinitrotoluene	606-20-2	tbd	100
Carbazole	86-74-8	tbd	5
Oxygen-Containing Compounds			
Benzoic Acid	65-85-0	tbd	200
Benzyl Alcohol	100-51-6	tbd	20
Dibenzofuran	132-64-9	tbd	5
Isophorone	78-59-1	tbd	20
Phenols and Substituted Phenols			
Phenol	108-95-2	tbd	20
2-Methylphenol	95-48-7	tbd	20
4-Methylphenol	106-44-5	tbd	20
2,4-Dimethylphenol	105-67-9	tbd	20
2-Chlorophenol	95-57-8	tbd	20
2,4-Dichlorophenol	120-83-2	tbd	60
2,4,5-Trichlorophenol	95-95-4	tbd	100
2,4,6-Trichlorophenol	88-06-2	tbd	100
2,3,4,6-Tetrachlorophenol	58-90-2	tbd	100
2,3,4,5- and 2,3,5,6-Tetrachlorophenol	4901-51-3; 935-95-5	tbd	100
Pentachlorophenol[i]	87-86-5	tbd	34
4-Chloro-3-methylphenol	59-50-7	tbd	40
2-Nitrophenol	88-75-5	tbd	100
4-Nitrophenol	100-02-7	tbd	100
2,4-Dinitrophenol	51-28-5	tbd	200
4,6-Dinitro-2-methylphenol	534-52-1	tbd	200
Phthalate Esters			
Dimethylphthalate	131-11-3	tbd	20
Diethylphthlalate	84-66-2	tbd	20
Di-n-butylphthalate	84-74-2	tbd	20
Butylbenzylphthalate	85-68-7	tbd	20
Di-n-octylphthalate	117-84-0	tbd	20
bis(2-Ethylhexyl)phthalate	117-81-7	tbd	20
Polycyclic Aromatic Hydrocarbons			
Naphthalene	91-20-3	tbd	20
2-Methylnaphthalene	91-57-6	tbd	20
Acenaphthylene	208-96-8	tbd	20
Acenaphthene	83-32-9	tbd	20
Fluorene	86-73-7	tbd	20
Phenanthrene	85-01-8	tbd	20
Anthracene	120-12-7	tbd	20
Fluoranthene	206-44-0	tbd	20
Pyrene	129-00-0	tbd	20
Benzo(a)anthracene	56-55-3	tbd	5
Chrysene	218-01-9	tbd	5
Benzo(b)fluoranthene	205-99-2	tbd	5
Benzo(k)fluoranthene	207-08-9	tbd	5
Benzo(a)pyrene	50-32-8	tbd	5
Indeno(1,2,3-cd)pyrene	193-39-5	tbd	5
Dibenz(a,h)anthracene	53-70-3	tbd	5
Benzo(g,h,i)perylene	191-24-2	tbd	5
PCB congeners			
2-MoCB	PCB-1	tbd	tbd
3-MoCB	PCB-2	tbd	tbd

Table 1b
Analytes, Analysis Methods, and Targeted Reporting Limits - Depositional Sediment (If Applicable)

Analyte	CAS number	MDL[b]	MRL[c]
4-MoCB	PCB-3	tbd	tbd
2,2'-DiCB	PCB-4	tbd	tbd
2,3-DiCB	PCB-5	tbd	tbd
2,3'-DiCB	PCB-6	tbd	tbd
2,4-DiCB	PCB-7	tbd	tbd
2,4'-DiCB	PCB-8	tbd	tbd
2,5-DiCB	PCB-9	tbd	tbd
2,6-DiCB	PCB-10	tbd	tbd
3,3'-DiCB	PCB-11	tbd	tbd
3,4-DiCB	PCB-12	tbd	tbd
3,4'-DiCB	PCB-13	tbd	tbd
3,5-DiCB	PCB-14	tbd	tbd
4,4'-DiCB	PCB-15	tbd	tbd
2,2',3-TrCB	PCB-16	tbd	tbd
2,2',4-TrCB	PCB-17	tbd	tbd
2,2',5-TrCB	PCB-18	tbd	tbd
2,2',6-TrCB	PCB-19	tbd	tbd
2,3,3'-TrCB	PCB-20	tbd	tbd
2,3,4-TrCB	PCB-21	tbd	tbd
2,3,4'-TrCB	PCB-22	tbd	tbd
2,3,5-TrCB	PCB-23	tbd	tbd
2,3,6-TrCB	PCB-24	tbd	tbd
2,3',4-TrCB	PCB-25	tbd	tbd
2,3',5-TrCB	PCB-26	tbd	tbd
2,3',6-TrCB	PCB-27	tbd	tbd
2,4,4'-TrCB	PCB-28	tbd	tbd
2,4,5-TrCB	PCB-29	tbd	tbd
2,4,6-TrCB	PCB-30	tbd	tbd
2,4',5-TrCB	PCB-31	tbd	tbd
2,4',6-TrCB	PCB-32	tbd	tbd
2',3,4-TrCB	PCB-33	tbd	tbd
2',3,5-TrCB	PCB-34	tbd	tbd
3,3',4-TrCB	PCB-35	tbd	tbd
3,3',5-TrCB	PCB-36	tbd	tbd
3,4,4'-TrCB	PCB-37	tbd	tbd
3,4,5-TrCB	PCB-38	tbd	tbd
3,4',5-TrCB	PCB-39	tbd	tbd
2,2',3,3'-TeCB	PCB-40	tbd	tbd
2,2',3,4-TeCB	PCB-41	tbd	tbd
2,2',3,4'-TeCB	PCB-42	tbd	tbd
2,2',3,5-TeCB	PCB-43	tbd	tbd
2,2',3,5'-TeCB	PCB-44	tbd	tbd
2,2',3,6-TeCB	PCB-45	tbd	tbd
2,2',3,6'-TeCB	PCB-46	tbd	tbd
2,2',3,4'-TeCB	PCB-47	tbd	tbd
2,2',4,5-TeCB	PCB-48	tbd	tbd
2,2',4,5'-TeCB	PCB-49	tbd	tbd
2,2',4,6-TeCB	PCB-50	tbd	tbd
2,2',4,6'-TeCB	PCB-51	tbd	tbd
2,2',5,5'-TeCB	PCB-52	tbd	tbd
2,2',5,6'-TeCB	PCB-53	tbd	tbd
2,2',6,6'-TeCB	PCB-54	tbd	tbd
2,3,3',4'-TeCB	PCB-55	tbd	tbd
2,3,3',4'-TeCB	PCB-56	tbd	tbd
2,3,3',5-TeCB	PCB-57	tbd	tbd

Table 1b
Analytes, Analysis Methods, and Targeted Reporting Limits - Depositional Sediment (If Applicable)

Analyte	CAS number	MDL[b]	MRL[c]
2,3,3',5'-TeCB	PCB-58	tbd	tbd
2,3,3',6-TeCB	PCB-59	tbd	tbd
2,3,4,4'-TeCB	PCB-60	tbd	tbd
2,3,4,5-TeCB	PCB-61	tbd	tbd
2,3,4,6-TeCB	PCB-62	tbd	tbd
2,3,4',5-TeCB	PCB-63	tbd	tbd
2,3,4',6-TeCB	PCB-64	tbd	tbd
2,3,5,6-TeCB	PCB-65	tbd	tbd
2,3',4,4'-TeCB	PCB-66	tbd	tbd
2,3',4,5-TeCB	PCB-67	tbd	tbd
2,3',4,5'-TeCB	PCB-68	tbd	tbd
2,3',4,6-TeCB	PCB-69	tbd	tbd
2,3',4',5-TeCB	PCB-70	tbd	tbd
2,3',4',6-TeCB	PCB-71	tbd	tbd
2,3',5,5'-TeCB	PCB-72	tbd	tbd
2,3',5',6-TeCB	PCB-73	tbd	tbd
2,4,4',5-TeCB	PCB-74	tbd	tbd
2,4,4',6-TeCB	PCB-75	tbd	tbd
2',3,4',5-TeCB	PCB-76	tbd	tbd
3,3',4,4'-TeCB	PCB-77	tbd	tbd
3,3',4,5-TeCB	PCB-78	tbd	tbd
3,3',4,5'-TeCB	PCB-79	tbd	tbd
3,3',5,5'-TeCB	PCB-80	tbd	tbd
3,4,4',5-TeCB	PCB-81	tbd	tbd
2,2',3,3',4-PeCB	PCB-82	tbd	tbd
2,2',3,3',5-PeCB	PCB-83	tbd	tbd
2,2',3,3',6-PeCB	PCB-84	tbd	tbd
2,2',3,4,4'-PeCB	PCB-85	tbd	tbd
2,2',3,4,5-PeCB	PCB-86	tbd	tbd
2,2',3,4,5'-PeCB	PCB-87	tbd	tbd
2,2',3,4,6-PeCB	PCB-88	tbd	tbd
2,2',3,4,6'-PeCB	PCB-89	tbd	tbd
2,2',3,4',5-PeCB	PCB-90	tbd	tbd
2,2',3,4',6-PeCB	PCB-91	tbd	tbd
2,2',3,5,5'-PeCB	PCB-92	tbd	tbd
2,2',3,5,6-PeCB	PCB-93	tbd	tbd
2,2',3,5,6'-PeCB	PCB-94	tbd	tbd
2,2',3,5',6-PeCB	PCB-95	tbd	tbd
2,2',3,6,6'-PeCB	PCB-96	tbd	tbd
2,2',3',4,5-PeCB	PCB-97	tbd	tbd
2,2',3',4,6-PeCB	PCB-98	tbd	tbd
2,2',4,4',5-PeCB	PCB-99	tbd	tbd
2,2',4,4',6-PeCB	PCB-100	tbd	tbd
2,2',4,5,5'-PeCB	PCB-101	tbd	tbd
2,2',4,5,6'-PeCB	PCB-102	tbd	tbd
2,2',4,5,6'-PeCB	PCB-103	tbd	tbd
2,2',4,6,6'-PeCB	PCB-104	tbd	tbd
2,3,3'4,4'-PeCB	PCB-105	tbd	tbd
2,3,3',4,5-PeCB	PCB-106	tbd	tbd
2,3,3',4',5-PeCB	PCB-107	tbd	tbd
2,3,3',4,5'-PeCB	PCB-108	tbd	tbd
2,3,3',4,6-PeCB	PCB-109	tbd	tbd
2,3,3',4',6-PeCB	PCB-110	tbd	tbd
2,3,3',5,5'-PeCB	PCB-111	tbd	tbd
2,3,3',5,6-PeCB	PCB-112	tbd	tbd

Table 1b
Analytes, Analysis Methods, and Targeted Reporting Limits - Depositional Sediment (If Applicable)

Analyte	CAS number	MDL[b]	MRL[c]
2,3,3',5',6-PeCB	PCB-113	tbd	tbd
2,3,4,4',5-PeCB	PCB-114	tbd	tbd
2,3,4,4',6-PeCB	PCB-115	tbd	tbd
2,3,4,5,6-PeCB	PCB-116	tbd	tbd
2,3,4',5,6-PeCB	PCB-117	tbd	tbd
2,3',4,4',5-PeCB	PCB-118	tbd	tbd
2,3',4,4',6-PeCB	PCB-119	tbd	tbd
2,3',4,5,5'-PeCB	PCB-120	tbd	tbd
2,3',4,5,6-PeCB	PCB-121	tbd	tbd
2',3,3',4,5-PeCB	PCB-122	tbd	tbd
2',3,4,4',5-PeCB	PCB-123	tbd	tbd
2',3,4,5,5'-PeCB	PCB-124	tbd	tbd
2',3,4,5,6'-PeCB	PCB-125	tbd	tbd
3,3',4,4',5-PeCB	PCB-126	tbd	tbd
3,3',4,5,5'-PeCB	PCB-127	tbd	tbd
2,2',3,3',4,4'-HxCB	PCB-128	tbd	tbd
2,2',3,3',4,5-HxCB	PCB-129	tbd	tbd
2,2',3,3',4,5'-HxCB	PCB-130	tbd	tbd
2,2',3,3',4,6-HxCB	PCB-131	tbd	tbd
2,2',3,3',4,6'-HxCB	PCB-132	tbd	tbd
2,2',3,3',5,5'-HxCB	PCB-133	tbd	tbd
2,2',3,3',5,6-HxCB	PCB-134	tbd	tbd
2,2',3,3',5,6'-HxCB	PCB-135	tbd	tbd
2,2',3,3',6,6'-HxCB	PCB-136	tbd	tbd
2,2',3,4,4',5-HxCB	PCB-137	tbd	tbd
2,2',3,4,4',5'-HxCB	PCB-138	tbd	tbd
2,2',3,4,4',6-HxCB	PCB-139	tbd	tbd
2,2',3,4,4',6'-HxCB	PCB-140	tbd	tbd
2,2',3,4,5,5'-HxCB	PCB-141	tbd	tbd
2,2',3,4,5,6-HxCB	PCB-142	tbd	tbd
2,2',3,4,5,6'-HxCB	PCB-143	tbd	tbd
2,2',3,4,5',6-HxCB	PCB-144	tbd	tbd
2,2',3,4,6,6'-HxCB	PCB-145	tbd	tbd
2,2',3,4',5,5'-HxCB	PCB-146	tbd	tbd
2,2',3,4',5,6-HxCB	PCB-147	tbd	tbd
2,2',3,4',5,6'-HxCB	PCB-148	tbd	tbd
2,2',3,4',5',6-HxCB	PCB-149	tbd	tbd
2,2',3,4',6,6'-HxCB	PCB-150	tbd	tbd
2,2',3,5,5',6-HxCB	PCB-151	tbd	tbd
2,2',3,5,6,6'-HxCB	PCB-152	tbd	tbd
2,2',4,4',5,5'-HxCB	PCB-153	tbd	tbd
2,2',4,4',5',6-HxCB	PCB-154	tbd	tbd
2,2',4,4',6,6'-HxCB	PCB-155	tbd	tbd
2,3,3',4,4',5-HxCB	PCB-156	tbd	tbd
2,3,3',4,4',5'-HxCB	PCB-157	tbd	tbd
2,3,3',4,4',6-HxCB	PCB-158	tbd	tbd
2,3,3',4,5,5'-HxCB	PCB-159	tbd	tbd
2,3,3',4,5,6-HxCB	PCB-160	tbd	tbd
2,3,3',4,5',6-HxCB	PCB-161	tbd	tbd
2,3,3',4',5,5'-HxCB	PCB-162	tbd	tbd
2,3,3',4',5,6-HxCB	PCB-163	tbd	tbd
2,3,3',4',5',6-HxCB	PCB-164	tbd	tbd
2,3,3',5,5',6-HxCB	PCB-165	tbd	tbd
2,3,4,4',5,6-HxCB	PCB-166	tbd	tbd
2,3,4,4',5,5'-HxCB	PCB-167	tbd	tbd

Table 1b
Analytes, Analysis Methods, and Targeted Reporting Limits - Depositional Sediment (If Applicable)

Analyte	CAS number	MDL[b]	MRL[c]
2,3',4,4',5',6-HxCB	PCB-168	tbd	tbd
3,3',4,4',5,5'-HxCB	PCB-169	tbd	tbd
2,2',3,3',4,4',5-HpCB	PCB-170	tbd	tbd
2,2',3,3',4,4',6-HpCB	PCB-171	tbd	tbd
2,2',3,3',4,5,5'-HpCB	PCB-172	tbd	tbd
2,2',3,3',4,5,6-HpCB	PCB-173	tbd	tbd
2,2',3,3',4,5,6'-HpCB	PCB-174	tbd	tbd
2,2',3,3',4,5',6-HpCB	PCB-175	tbd	tbd
2,2',3,3',4,6,6'-HpCB	PCB-176	tbd	tbd
2,2',3,3',4',5,6-HpCB	PCB-177	tbd	tbd
2,2',3,3',5,5',6-HpCB	PCB-178	tbd	tbd
2,2',3,3',5,6,6'-HpCB	PCB-179	tbd	tbd
2,2',3,4,4',5,5'-HpCB	PCB-180	tbd	tbd
2,2',3,4,4',5,6-HpCB	PCB-181	tbd	tbd
2,2',3,4,4',5,6'-HpCB	PCB-182	tbd	tbd
2,2',3,4,4',5',6-HpCB	PCB-183	tbd	tbd
2,2',3,4,4',6,6'-HpCB	PCB-184	tbd	tbd
2,2',3,4,5,5',6-HpCB	PCB-185	tbd	tbd
2,2',3,4,5,6,6'-HpCB	PCB-186	tbd	tbd
2,2',3,4,5,5',6-HpCB	PCB-187	tbd	tbd
2,2',3,4',5,6,6'-HpCB	PCB-188	tbd	tbd
2,3,3',4,4',5,5'-HpCB	PCB-189	tbd	tbd
2,3,3',4,4',5,6-HpCB	PCB-190	tbd	tbd
2,3,3',4,4',5',6-HpCB	PCB-191	tbd	tbd
2,3,3',4,5,5',6-HpCB	PCB-192	tbd	tbd
2,3,3',4',5,5',6-HpCB	PCB-193	tbd	tbd
2,2',3,3',4,4',5,5'-OcCB	PCB-194	tbd	tbd
2,2',3,3',4,4',5,6-OcCB	PCB-195	tbd	tbd
2,2',3,3',4,4',5,6'-OcCB	PCB-196	tbd	tbd
2,2',3,3',4,4',6,6'-OcCB	PCB-197	tbd	tbd
2,2',3,3',4,5,5',6-OcCB	PCB-198	tbd	tbd
2,2',3,3',4,5,5',6'-OcCB	PCB-199	tbd	tbd
2,2',3,3',4,5,6,6'-OcCB	PCB-200	tbd	tbd
2,2',3,3',4,5',6,6'-OcCB	PCB-201	tbd	tbd
2,2',3,3',5,5',6,6'-OcCB	PCB-202	tbd	tbd
2,2',3,4,4',5,5',6-OcCB	PCB-203	tbd	tbd
2,2',3,4,4',5,6,6'-OcCB	PCB-204	tbd	tbd
2,3,3',4,4',5,5',6-OcCB	PCB-205	tbd	tbd
2,2',3,3',4,4',5,5',6-NoCB	PCB-206	tbd	tbd
2,2',3,3',4,4',5,6,6'-NoCB	PCB-207	tbd	tbd
2,2',3,3',4,5,5',6,6'-NoCB	PCB-208	tbd	tbd
DeCB	PCB-209	tbd	tbd
Chlorinated Dioxins and Furans[j]			
2,3,7,8-TCDD	1746-01-6	0.026	0.2
2,3,7,8-TCDF	51207-31-9	0.020	0.2
1,2,3,7,8-PeCDD	40321-76-4	0.029	0.5
1,2,3,7,8-PeCDF	57117-41-6	0.017	0.5
2,3,4,7,8-PeCDF	57117-31-4	0.017	0.5
1,2,3,4,7,8-HxCDD	39227-28-6	0.030	0.5
1,2,3,6,7,8-HxCDD	57653-85-7	0.034	0.5
1,2,3,7,8,9-HxCDD	19408-74-3	0.032	0.5
1,2,3,4,7,8-HxCDF	70648-26-9	0.013	0.5
1,2,3,6,7,8-HxCDF	57117-44-9	0.013	0.5
1,2,3,7,8,9-HxCDF	72918-21-9	0.017	0.5
2,3,4,6,7,8-HxCDF	60851-34-5	0.013	0.5

Table 1b
Analytes, Analysis Methods, and Targeted Reporting Limits - Depositional Sediment (If Applicable)

Analyte	CAS number	MDL[b]	MRL[c]
1,2,3,4,6,7,8-HpCDD	35822-46-9	0.035	0.5
1,2,3,4,6,7,8-HpCDF	67562-39-4	0.033	0.5
1,2,3,4,7,8,9-HpCDF	55673-89-7	0.052	0.5
OCDD	3268-87-9	0.061	1.0
OCDF	39001-02-0	0.065	1.0
Total tetrachlorinated dioxins	41903-57-5	--	--
Total pentachlorinated dioxins	36088-22-9	--	--
Total hexachlorinated dioxins	34465-46-8	--	--
Total heptachlorinated dioxins	37871-00-4	--	--
Total tetrachlorinated furans	30402-14-3	--	--
Total pentachlorinated furans	30402-15-4	--	--
Total hexachlorinated furans	55684-94-1	--	--
Total heptachlorinated furans	38998-75-3	--	--

Notes:

[a] Values are provided in bold font when the MRL is not expected to meet the ACG. ACGs for PCB congeners to be determined.

[b] The laboratory's current MDL is provided when an MDL study has been completed for the proposed method.
When no MDL is provided, the laboratory will complete an MDL study prior to analysis of samples for this project.

[c] The MRL is provided on a dry-weight basis and assumes 50% moisture in the samples.
The MRL for project samples will vary with moisture content in the samples.
The MRL represents the level of lowest calibration standard (i.e., the practical quantitation limit).

[d] Grain-size intervals will include the following:

Gravel	Very fine sand	Clay, phi size 8-9
Very coarse sand	Coarse silt	Clay, phi size 9-10
Coarse sand	Medium silt	Clay, phi size >10
Medium sand	Fine silt	
Fine sand	Very fine silt	

[e] The MDLs for the herbicides and pentachlorophenol are expected to be lower than the ACGs.

[f] Total chlordane will be calculated as the sum of the 5 components listed above this entry.

[g] 1,4-Dichlorobenzene will also be analyzed by purge-and-trap GC/MS with the VOCs to improve MRLs.

[h] Hexachlorobenzene, hexachloroethane, and hexachlorobutadiene will also be analyzed by GC/ECD with the pesticides to improve MRLs.

[i] Pentachlorophenol will also be analyzed with the herbicides to improve the MRL.

[j] Expected MDLs are shown. MDLs for PCB congeners and dioxins and furans are sample-dependent and will vary from the indicated values.

[k] MDLs and MRLs are shown for a sample weight of 10 g. MDLs and MRLs will be lower for a larger sample size.

ACG = Analytical concentration goals; established by EPA during *ad hoc* meeting with LWG May 10, 2002
MDL = Method detection limit
MRL = Method reporting limit
NA = Not applicable
tbd = To be determined
* = A risk-based ACG has not been established

Table 1c
Analytes, Analysis Methods, and Targeted Reporting Limits – Porewater, Discrete Near-Bottom Surface Water, and Field QA/QC Samples

Conventionals				
Cyanide (ug/L)	57-12-5	NA	EPA Method 335.2	10
Total Suspended Solids (mg/L)	TSS	NA	EPA Method 160.2	1
Total Organic Carbon (%)	TOC	NA	EPA Method 415.1	0.1
Semivolatile Organic Compounds (µg/L) (Partial List)				
LPAHs				
Naphthalene	91203	NA	US EPA Method 8270C-SIM	0.02
Acenaphthylene	208968	NA	US EPA Method 8270C-SIM	0.02
Acenaphthene	83329	NA	US EPA Method 8270C-SIM	0.02
Fluorene	86737	NA	US EPA Method 8270C-SIM	0.02
Phenanthrene	85018	NA	US EPA Method 8270C-SIM	0.02
Anthracene	1201727	NA	US EPA Method 8270C-SIM	0.02
2-Methylnaphthalene	91576	NA	US EPA Method 8270C-SIM	0.02
HPAHs				
Fluoranthene	206440	NA	US EPA Method 8270C-SIM	0.02
Pyrene	129000	NA	US EPA Method 8270C-SIM	0.02
Benz(a)anthracene	56553	NA	US EPA Method 8270C-SIM	0.02
Chrysene	218019	NA	US EPA Method 8270C-SIM	0.02
Benzofluoranthene	205992	NA	US EPA Method 8270C-SIM	0.02
Benzo(a)pyrene	50328	NA	US EPA Method 8270C-SIM	0.02[a]
Indeno(1,2,3-cd)pyrene	193395	NA	US EPA Method 8270C-SIM	0.02
Dibenz(a,h)anthracene	53703	NA	US EPA Method 8270C-SIM	0.02
Benzo(g,h,i)perylene	191242	NA	US EPA Method 8270C-SIM	0.02
BTEX Compounds (µg/L) (Partial List)				
Benzene	71-43-2	NA	US EPA Method 8260	0.5
Toluene	108-88-3	NA	US EPA Method 8260b	0.5
Ethylbenzene	100414	NA	US EPA Method 8260	0.5
Total Xylenes	1330207	NA	US EPA Method 8260	0.5

Table 2
Project Schedule – Monitoring and Reporting Plan Activities

Preparation of MARP	30 days	September 16, 2005
Year 0 Monitoring	5 days	November 2005
Year 0 Monitoring Report	60 days	Following receipt of validated analytical results
Year 1 Monitoring	5 days	November 2006
Year 1 Monitoring Report	60 days	Following receipt of validated analytical results
Year 3 Monitoring	5 days	November 2008
Year 3 Monitoring Report	60 days	Following receipt of validated analytical results

Table 3a
Laboratory QA/QC Guidelines – Bulk Sediments

Conventionals		
Total Solids	±20	NA
Total Organic Carbon	±20	85-115
Grain size	NA	NA
Cyanide	±30	75-125
Semivolatile Organic Compounds (Partial List)		
LPAHs		
Naphthalene	±40	43-102
Acenaphthylene	±40	51-107
Acenaphthene	±40	50-105
Fluorene	±40	54-108
Phenanthrene	±40	58-106
Anthracene	±40	61-113
2-Methylnaphthalene	±40	44-105
HPAHs		
Fluoranthene	±40	63-117
Pyrene	±40	59-121
Benz(a)anthracene	±40	57-120
Chrysene	±40	64-116
Benzofluoranthene	±40	58-126
Benzo(a)pyrene	±40	58-128
Indeno(1,2,3-cd)pyrene	±40	46-133
Dibenz(a,h)anthracene	±40	50-128
Benzo(g,h,i)perylene	±40	52-125
Volatile Organic Compounds (Partial List)		
Benzene	±40	45-150
Toluene	±40	44-153
Ethylbenzene	±40	47-151
m&p-Xylenes	±40	49-155
Xylene	±40	46-148
Pesticides/Polychlorinated Biphenyls (PCBs)	±40	40-140
Total Petroleum Hydrocarbons (TPH)	±40	40-140
Metals	±20	65-135

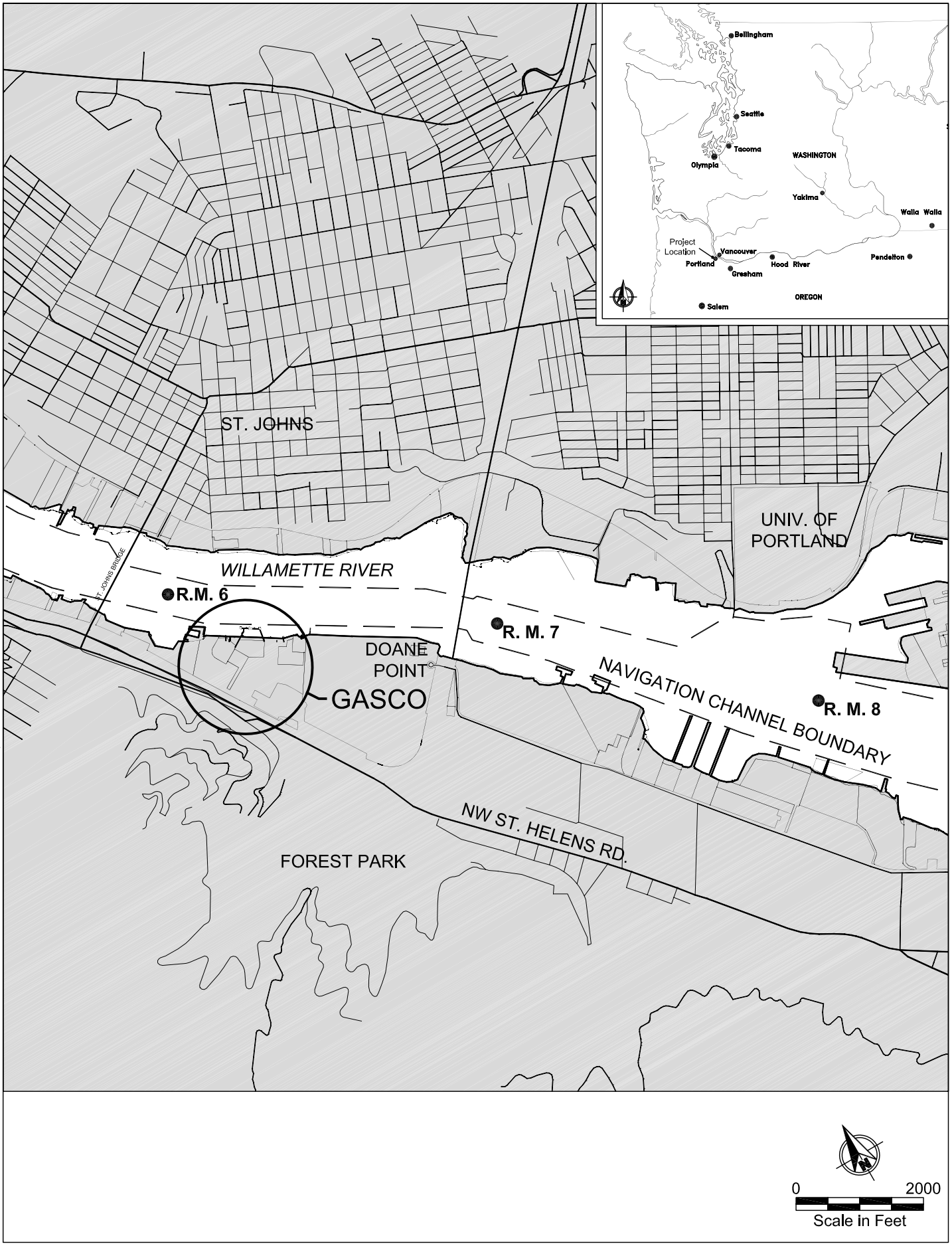
Table 3b
Laboratory QA/QC Guidelines – Porewater, Near-Bottom Surface Water, and QA/QC Samples

Conventionals		
Cyanide	20	75-125
Total Suspended Solids	20	85-115
Total Organic Carbon	17	90-109
Semivolatile Organic Compounds (Partial List)		
LPAHs		
Naphthalene	30	44-101
Acenaphthylene	30	49-114
Acenaphthene	30	48-107
Fluorene	30	55-111
Phenanthrene	30	56-108
Anthracene	30	42-117
2-Methylnaphthalene	30	36-106
HPAHs		
Fluoranthene	30	61-123
Pyrene	30	53-123
Benz(a)anthracene	30	53-123
Chrysene	30	57-118
Benzofluoranthene	30	57-132
Benzo(a)pyrene	30	38-142
Indeno(1,2,3-cd)pyrene	30	49-139
Dibenz(a,h)anthracene	30	47-138
Benzo(g,h,i)perylene	30	50-125
Volatile Organic Compounds (Partial List)		
Benzene	30	81-120
Toluene	30	61-138
Ethylbenzene	30	83-122
m&p-Xylenes	30	86-123
o-Xylene	30	82-120

Table 4
Guidelines for Sample Handling and Storage

Sediments			
BTEX compounds	2-oz Glass	14 days	Cool/4°C
Cyanide	From PAH container	14 Days	Cool/4°C
Total petroleum hydrocarbons (TPH)	2x2-oz Glass	14 days	Cool/4° C
Metals (except mercury)	8-oz Glass	6 Months	Cool/4°C
		2 Years	Freeze/-18 C
Polychlorinated biphenyls (PCBs)	8-oz Glass	14 days until extraction	Cool/4°C
		40 days after extraction	Freeze/–18 C
Pesticides	From PCB container	14 days until extraction	Cool/4°C
		40 days after extraction	Freeze/–18 C
Polycyclic Aromatic Hydrocarbons (PAHs)	16-oz Glass	14 days until extraction	Cool/4°C
		1 year until extraction	Freeze/ -18°C
		40 days after extraction	
Total solids (TS)	From PAH container	6 months	Freeze/-18°C
		14 days	Cool/4°C
Total organic carbon (TOC)	From PAH container	6 months	Freeze/-18°C
		14 days	Cool/4°C
Grain size	8-oz Glass	NA	Cool/4°C
Porewater, Near-Bottom Surface Water and Field QA/QC			
Total/Dissolved Organic Carbon	500-mL Plastic	28 days	Cool/4°C with H2SO4
Total Suspended Solids	1-Liter Plastic	7 days	Cool/4°C
BTEX compounds	3x40-mL VOA Vials	14 days	Cool/4°C
Cyanide	250-mL Plastic	14 days	Cool/4°C with NaOH to pH 12
Polycyclic Aromatic Hydrocarbons (PAHs)	1-L Amber Glass	7 days until extraction	Cool/4°C
		40 days after extraction	

FIGURES



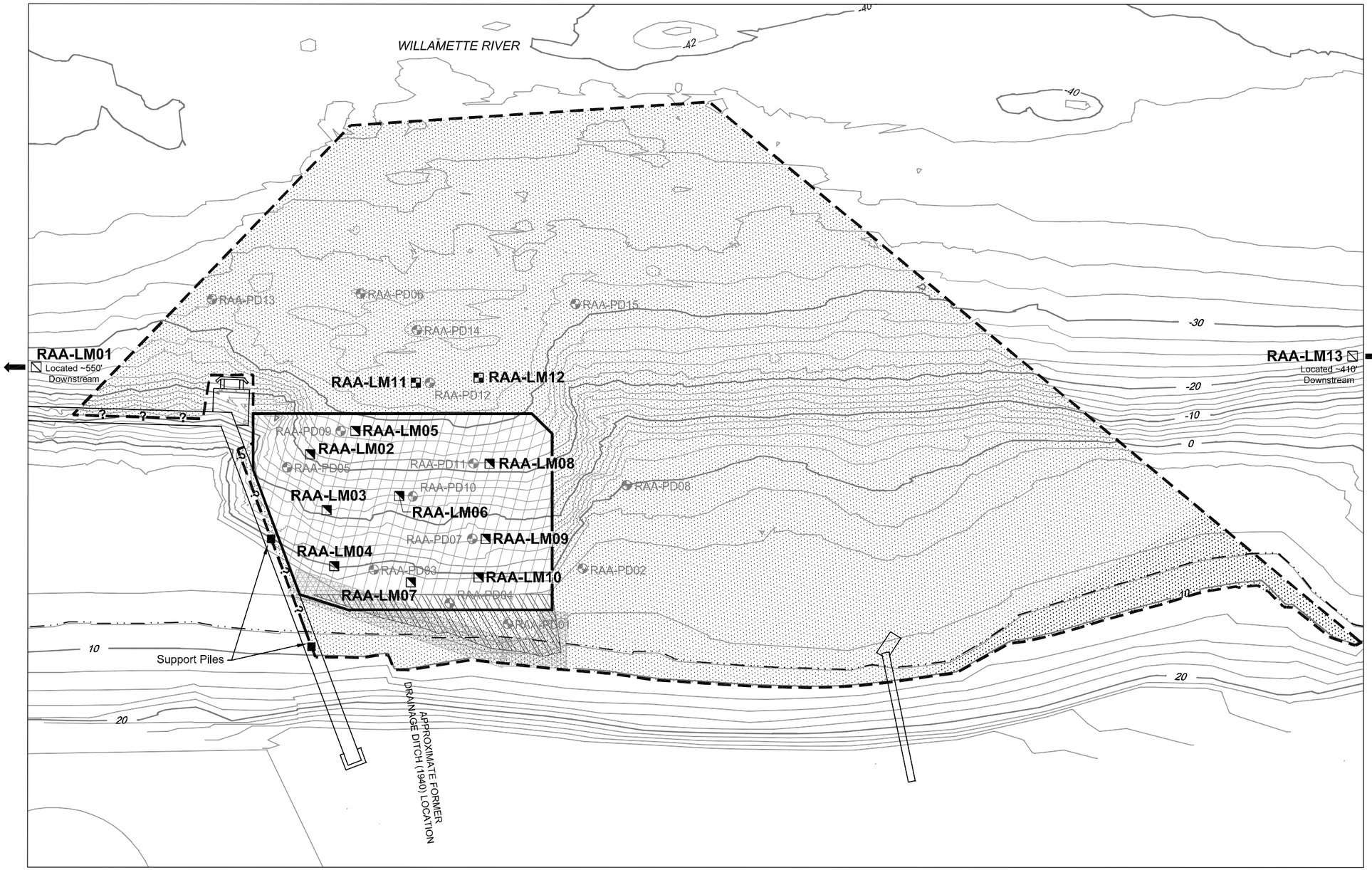
Oct 03, 2005 10:07am dholmer K:\Jobs\000029-GASCO\00002902\00002902-01.dwg FIG 1

ANCHOR ENVIRONMENTAL, L.L.C.

Figure 1
Vicinity Map
NW Natural "Gasco" Site

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
- **RAA-LM02** Proposed Co-Located Core, Porewater & Near-Bottom Surface Water Samples
- **RAA-LM01** Proposed Background Near-Bottom Surface Water Sample
- **RAA-LM11** Proposed Seepage Monitoring Core
- RAA-PD13 Post-Dredge Surface Sediment Sample (October 2005)



0 60
Scale in Feet

Notes:
1. Post-cap bathymetric contours produced from survey provided by Blue Water Engineering dated October 31, 2005.
2. Upland topography directed by Anchor Environmental as part of upland investigation (2002).
3. Horizontal Datum: Oregon State Plane North NAD 83 (ft).
4. Vertical Datum: NAVD 88 (ft).
5. Former Drainage Ditch location from Phase 1 Remedial Investigation Summary Report (HAI 1998).

Jan 23, 2006 2:35pm dholmer K:\Jobs\000029-GASCO\00002902\00002902-130.dwg FIG 2

ANCHOR ENVIRONMENTAL, L.L.C.

Figure 2
Proposed Long-Term Monitoring Sampling Stations
NW Natural "Gasco" Site