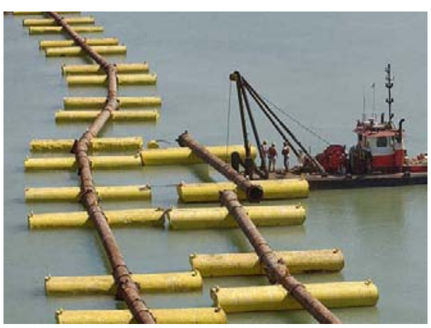
THEA FOSS AND WHEELER-OSGOOD WATERWAYS REMEDIATION PROJECT

YEAR 2 MONITORING

ANNUAL OPERATIONS, MAINTENANCE, AND MONITORING REPORT

MARCH 23, 2009



Prepared for:

U.S. ENVIRONMENTAL PROTECTION AGENCY

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1.0 INTRODUCTION

1.1 Purpose and Objectives of Operations, Maintenance, and Monitoring Plan Activities

This document presents a summary of operations, maintenance, and monitoring activities performed in 2008 for the Thea Foss and Wheeler-Osgood Waterways Remediation Project (Foss Project). Operations, maintenance, and monitoring activities were performed during Year 2 throughout the waterways, at the confined disposal facility, and at the habitat areas within the Foss Project site (Figure 1-1). The work was performed in accordance with the Operations, Maintenance, and Monitoring Plan (OMMP) for the Thea Foss and Wheeler-Osgood Waterways Remediation Project (City of Tacoma 2006). Remediation construction was completed in 2006 by the City of Tacoma (City) under a Consent Decree (CD) issued by the U.S. Environmental Protection Agency (EPA).

The OMMP describes the baseline and long-term qualitative, physical, and chemical monitoring to be completed at the site and sets forth specific performance standards for planned monitoring activities to demonstrate that the long-term objectives for the project are met. The OMMP also details the process for contingency planning and presents possible response actions in the event that performance standards are not achieved.

Figure 1-2 shows the remedial actions completed by the City in the Thea Foss and Wheeler-Osgood Waterways. The area in which the City performed remedial actions as part of the Foss Project is identified as the City's work area. Also identified on Figure 1-2 is the Utilities' work area at the head of the Thea Foss Waterway. In this area, monitoring is being performed by the Utilities in accordance with the Head of the Thea Foss Waterway Remediation Project, Operations, Maintenance and Monitoring Plan (PacifiCorp 2003). The City continues to work cooperatively with the Utilities work group to respond to the identified recontamination occurring in their work area.

The OMMP was prepared in compliance with the Record of Decision (ROD) (EPA 1989), Administrative Order on Consent (AOC) / Statement of Work (SOW) (EPA 1994) for pre-remedial design investigation and remedial design, Explanation of Significant Difference (ESD) (EPA 1997), 2000 ESD, 2004 ESD, and the CD/SOW (EPA 2003) for remediation construction. The work completed in accordance with the OMMP is also in compliance with these documents.

The OMMP establishes an integrated program designed to evaluate and ensure the effectiveness of the remedial actions relative to the project Remedial Action Objectives (RAO). Work being performed under the OMMP is intended to ensure that the completed remedial actions performed at the site achieve the performance objectives as specified in the ROD and subsequent ESDs as related to the protection of surface sediment, surface water, and biological and physical habitat quality.

The RAO for the cleanup is stated in the ROD as:

- The objective of the selected remedy is to achieve acceptable sediment quality in a reasonable timeframe.

Additional language in the ROD states that the remedy was designed to incorporate the following:

- Natural recovery considerations are used to identify sediment remedial action levels that delineate sediments that are allowed to recover naturally from those that require active sediment cleanup;
- The sediment quality objective also applies to source control requirements. Monitoring sources and sediments will be used to determine the effectiveness of source controls; and
- Habitat function and enhancement of fisheries resources will also be incorporated as part of the overall project cleanup objectives.

The OMMP was developed and results will be evaluated to ensure that the RAOs for the site are achieved.

1.2 Scope of the Year 2 Operations, Maintenance, and Monitoring Report

The monitoring tasks and information comprising Year 2 and included in this report are the following:

- Cap integrity monitoring through low tide slope cap inspections of intertidal capped areas to ensure that constructed caps remain intact;
- Subtidal hydrographic survey of capped areas to assess the integrity of the cap in terms of potential long-term changes in cap thickness within the subtidal slope cap and channel sand cap areas;
- Cap area chemical performance monitoring and analysis of surface samples to verify compliance with performance criteria;
- Natural recovery and enhanced natural recovery area chemical monitoring to evaluate progress toward natural recovery;
- Early warning chemical monitoring throughout the Thea Foss and Wheeler-Osgood Waterways including dredged to clean, capped, and natural recovery areas to evaluate the potential for recontamination;
- Benthic recolonization monitoring throughout the Thea Foss and Wheeler-Osgood Waterways to document and evaluate the success of the benthic recolonization;
- Quarterly baseline monitoring of the groundwater quality and cap and berm conditions at the St. Paul Waterway Confined Disposal Facility (CDF);
- Habitat mitigation area monitoring; and
- Status of additional project related tasks that include the following:
    - Implementation of tasks required under the Institutional Controls Plan (ICP);
    - Ongoing stormwater source control activities;
    - Response to and coordinated monitoring of the recontamination in the head of the Thea Foss Waterway work area;
    - Initiation of deauthorization of the navigational channel in encroachment areas;
    - Tracking of Simpson Log Haul Out Facility (LHOF) operations, maintenance, and monitoring; and

- o Tracking of Tacoma Metals management of waste material in the Temporary Containment Unit. (TCU).

Table 1-1 summarizes the overall monitoring schedule for OMMP activities to be performed.

1.3 Organization of the Baseline and Subsequent Annual OMMP Reports

For each monitoring year, an Annual Operations, Maintenance, and Monitoring Report (Annual Report) will be prepared presenting the final, comprehensive information and data for monitoring activities completed in the previous year. The Annual Report will also document any decisions and/or contingency actions, planned or implemented.

The structure of the Annual Report for Year 2 Monitoring, and subsequent Annual Reports, follows the outline of the OMMP to provide a consistent presentation and placement of information generated to monitor remedial actions performed as part of the Foss Project.

The following topics are presented in the Annual Report:

- Section 1.0 – Introduction
- Section 2.0 – Sediment Remediation Area Performance Monitoring
- Section 3.0 – Early Warning Monitoring for Recontamination
- Section 4.0 – Benthic Recolonization Monitoring
- Section 5.0 – Confined Disposal Facility Monitoring
- Section 6.0 – Habitat Mitigation Area Monitoring
- Section 7.0 – Additional Project Related Activities

The Annual Report also includes the following appendices:

- Appendix A – Physical Cap Integrity Monitoring
- Appendix B – Sediment and Cap Performance Monitoring
- Appendix C – Benthic Recolonization Monitoring
- Appendix D – Confined Disposal Facility Monitoring
- Appendix E – Habitat Mitigation Area Monitoring
- Appendix F – Health and Safety Plan
- Appendix G – Additional Project Related Activities

During monitoring years when any of these tasks are not required, placeholders will be maintained in the report so that information for a specific activity will consistently be in a specific section. For example, Habitat Mitigation Area Monitoring will consistently be found in Section 6.0 and Appendix E of the Annual Reports.

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FIGURES

Table 1-1
Monitoring Schedule

Activity	Monitoring Year (Calendar Year)										
	Year 0 (2006)	Year 1 (2007)	Year 2 (2008)	Year 3 (2009)	Year 4 (2010)	Year 5 (2011)	Year 6 (2012)	Year 7 (2013)	Year 8 (2014)	Year 9 (2015)	Year 10 (2016)
1) Sediment Remediation Area Performance Monitoring											
Supplemental Data Collection for Natural Recovery Area Sediment Quality	X										
Sediment Quality (0 to 10 cm) Performance Monitoring of Cap and Natural Recovery Areas			X		X			X			X
Low Tide Slope Cap Inspection for Cap Integrity	X		X		X			X			X
Subtidal Cap Hydrographic Survey for Cap Integrity			X		X			X			X
2) Early Warning Monitoring for Recontamination											
Sediment Quality (0 to 2 cm) Monitoring			X		X			X			X
3) Benthic Recolonization Monitoring											
Sediment Profile Imaging and Archive Sediment Sample (0 to 10 cm) Collection			X		X			X			X
4) Confined Disposal Facility Monitoring											
72-Hour Tidal Study and Slug Tests	X										
Baseline Monitoring[1]		4 Q	4 Q								
Performance Monitoring				TBD	TBD	TBD	TBD	TBD	TBD	TBD	TBD
5) Habitat Mitigation Area Monitoring											
Qualitative Ground Surveys	X	X	X	X	X	X	X	X	X	X	X
Quantitative Vegetation Surveys		X	X		X			X			X

Activity	Monitoring Year (Calendar Year)										
	Year 0 (2006)	Year 1 (2007)	Year 2 (2008)	Year 3 (2009)	Year 4 (2010)	Year 5 (2011)	Year 6 (2012)	Year 7 (2013)	Year 8 (2014)	Year 9 (2015)	Year 10 (2016)
Photo Documentation	X	X	X		X			X			X
Elevation Monitoring[2,3]	X	X	X	X		X		X			X
Brackish Marsh Salinity Monitoring	X	X									
Juvenile Salmonid Monitoring		X		X							
Invertebrate Monitoring		X		X							
Water Surface Elevation Monitoring	X			X		X		X			X

Notes:

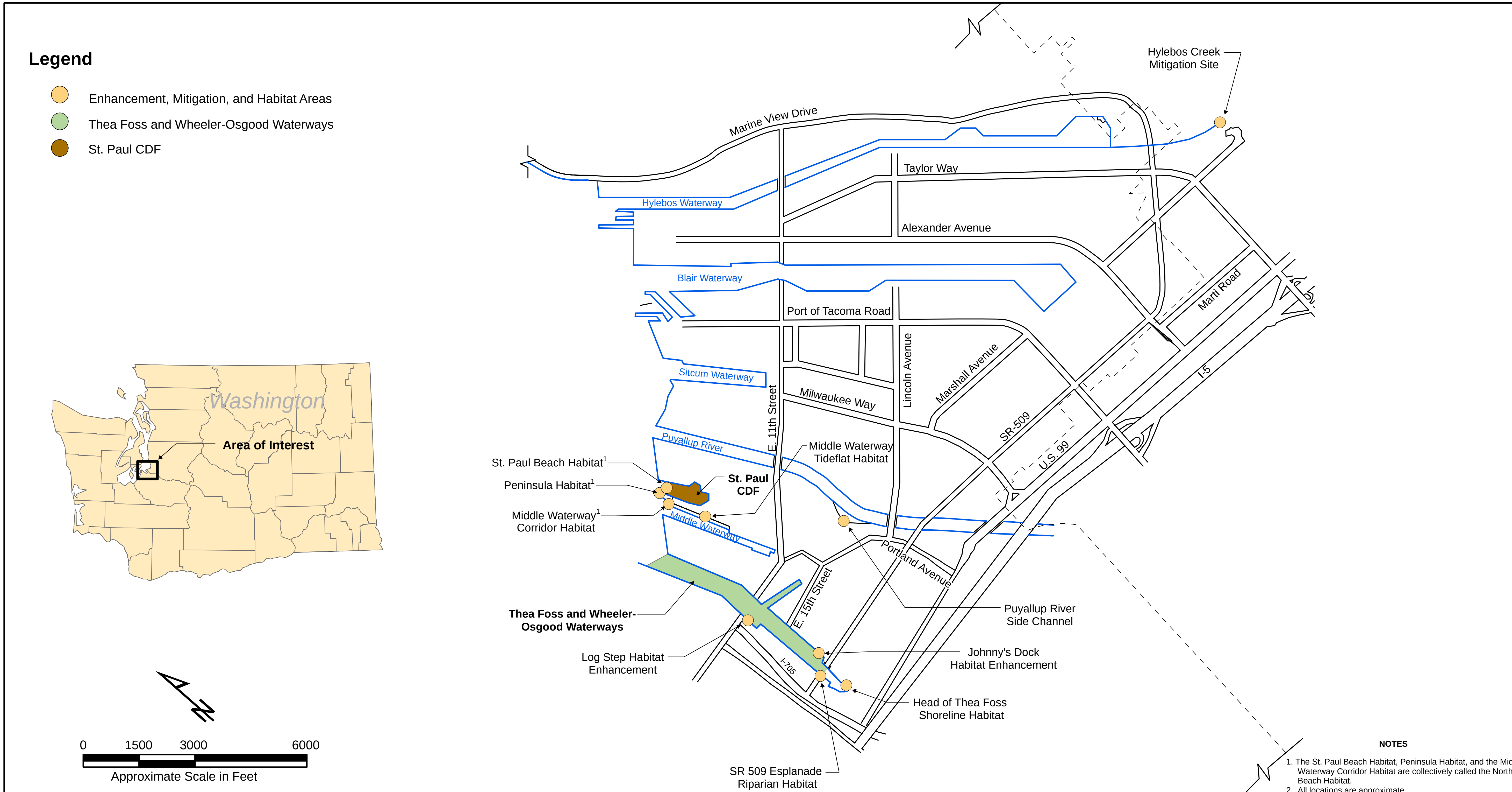
4 Q Four quarters.

TBD To be determined.

1 Includes visual observations of the containment berm and offset berm and the CDF cap. In addition, photographs will be taken at North Beach photo points P-1 through P-5 at each baseline quarterly monitoring event to track the erosion which has occurred at the site.

2 The vertical datum used during the construction phase of the project was MLLW. Due to the length of the OMMP monitoring period and the fact that MLLW changes over time, the vertical datum to be used during this phase has been designated as NGVD 29.

3 Note that survey transects of the channels at Hylebos Creek will be performed annually while monitoring of elevation stakes at other locations will be performed on the schedule shown.



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Thea Foss and Wheeler-Osgood Waterways
Annual OMMP Report

Figure 1-1
Project Location Map

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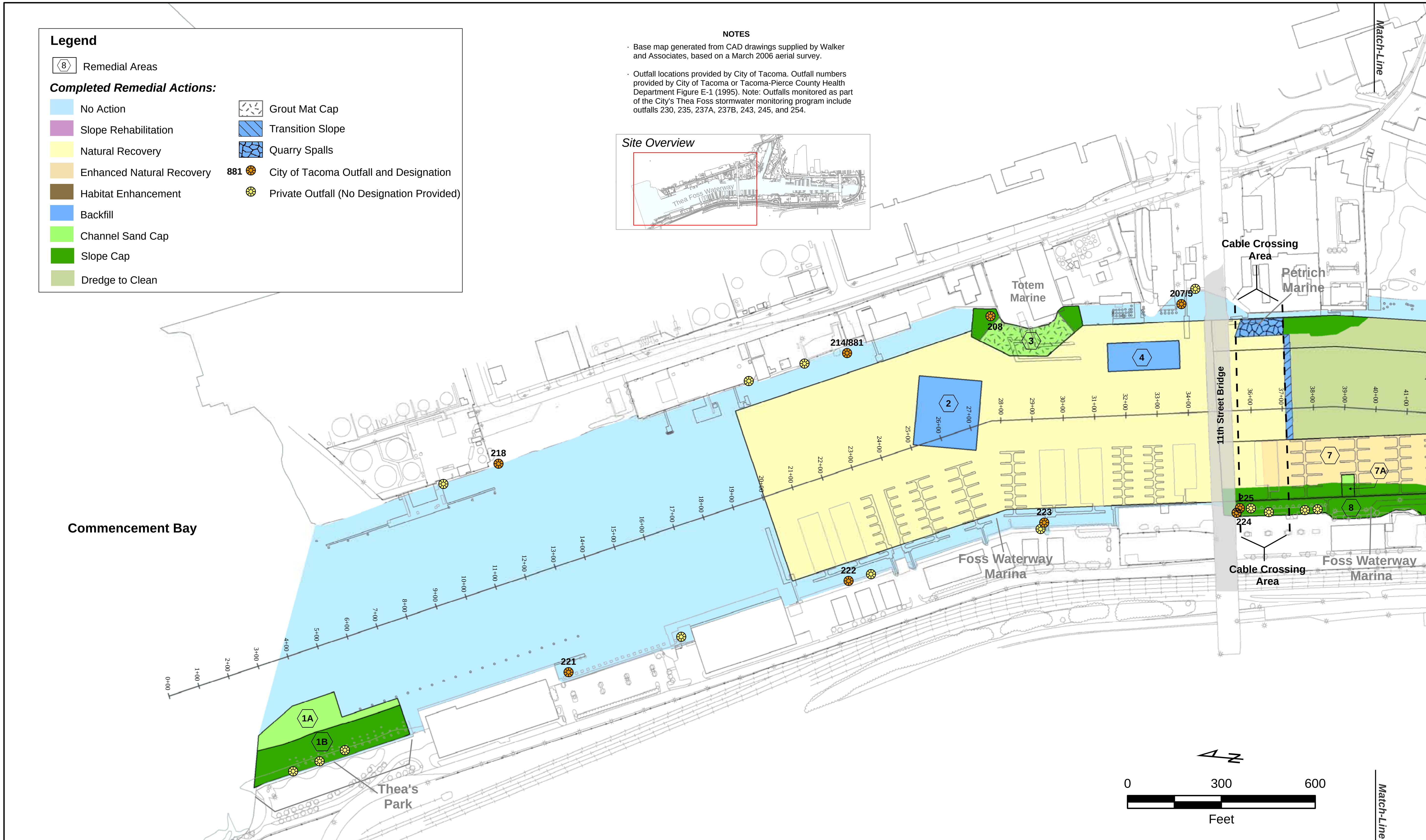
MXD NAME: F:\projects\COT-Oncall\GIS\2008 Annual OMMP Report\PDF\Figure 1-1 Project Location Map.pdf



Thea Foss and Wheeler-Osgood Waterways
Annual OMMP Report

Figure 1-2 (Page 1 of 2)
Completed Remedial Actions

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File: F:\projects\COT-Oncall\GIS\2008 Annual OMMP Report\MXD\Figure 1-2 Completed Remedial Actions (1of2).mxd
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Thea Foss and Wheeler-Osgood Waterways
Annual OMMP Report

Figure 1-2 (Page 2 of 2)
Completed Remedial Actions

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2.0 SEDIMENT REMEDIATION AREA PERFORMANCE MONITORING

2.1 Introduction

Sediment remediation area performance monitoring is performed to evaluate the long-term effectiveness of sediment caps, enhanced natural recovery, and natural recovery remedies implemented by the City of Tacoma (City) as part of the Thea Foss and Wheeler-Osgood Waterways Remediation Project. Performance monitoring activities include physical inspection of capped areas to ensure that the engineered caps remain intact; chemical monitoring of the cap surface (0 to 10 cm) sediments to confirm continued compliance with cleanup criteria and that the underlying contaminants are contained; and chemical monitoring of surface (0 to 10 cm) sediments within natural recovery and enhanced natural recovery areas to confirm that natural recovery is occurring within the compliance period. The monitoring program includes the collection, analysis, and interpretation of physical and chemical sediment quality data from intertidal sampling locations, channel cap sampling locations, and natural recovery sampling locations, and conducting hydrographic surveys and low tide slope cap inspections.

As described in Section 2.0 of the Operations, Maintenance, and Monitoring Plan (OMMP) (City of Tacoma 2006), sediment remediation area performance monitoring is performed to achieve the following objectives:

- Ensure sediment caps provide effective containment, both physically and chemically, of contaminated underlying sediments, and provide a substrate that promotes colonization by aquatic organisms; and
- Confirm that within natural recovery areas chemical concentrations will attenuate to below Sediment Quality Objectives (SQO) within the 0 to 10 cm compliance interval within 10 years of completion of remediation construction (i.e., by 2016).

The results of the Year 2 sediment remediation performance monitoring are summarized below.

2.2 Cap Area Performance Monitoring

The purpose of cap area performance monitoring is to verify cap integrity and performance (through effective containment of the underlying contaminated sediments). The cap performance monitoring is designed to detect and evaluate long-term changes in cap thickness and surface sediment quality to ensure compliance with performance criteria. Cap area performance monitoring includes cap integrity monitoring and cap area chemical performance monitoring.

2.2.1 Cap Integrity Monitoring

Cap integrity monitoring consists of low tide slope cap inspections and hydrographic surveys and is designed to verify the physical integrity of caps constructed as part of the Thea Foss and Wheeler-Osgood Waterways Remediation Project. Low tide inspections of slope caps ensure that the intertidal portions of slope caps are intact and that underlying contaminated materials are contained or identify areas needing maintenance if disturbances of the slope caps are present. Hydrographic surveys of subtidal capped areas detect and evaluate long-term changes in cap thickness to ensure compliance with performance criteria and confirm that underlying contaminated materials are contained.

2.2.1.1 Low Tide Slope Cap Inspections

Year 2 performance monitoring to evaluate the physical integrity of intertidal slope cap areas consisted of performing low tide inspection of the slope caps in Remedial Area (RA) 1B, RA 3, RA 8, RA 14, RA 19A, RA 19B, RA 20, and the Sheen Source Removal Area in the Wheeler-Osgood Waterway in accordance with the OMMP. The results of the low tide slope cap inspections are presented in the Year 2 Monitoring Low Tide Slope Cap Inspection Preliminary Findings Memorandum (City of Tacoma 2008) provided in Attachment A-1 in Appendix A and are summarized below to characterize the Year 2 conditions for the intertidal portions of capped areas and identify any areas needing maintenance.

Summary of Low Tide Slope Cap Inspection Requirements

Low tide slope cap inspections are to be performed on the exposed shoreline portion of slope caps (including grout mat caps) in RA 1B, RA 3, RA 8, RA 14, RA 19A, RA 19B, and RA 20 when tidal elevations are at or below 0.0 feet Mean Lower Low Water (MLLW). Additionally, a low tide cap inspection is to be performed in the Sheen Source Removal Area located in the Wheeler-Osgood Waterway in accordance with the OMMP. The OMMP requires that low tide slope cap inspections be conducted during Years 0 (Baseline), 2, 4, 7, and 10.

The inspections are to document the following observations:

- Slope cap surface characteristics (i.e., rip rap, quarry spalls, habitat mix, etc.);
- Area of slope cap coverage;
- Presence/absence of habitat mix;
- Any areas of exposed sediment due to washout of the slope cap;
- Any areas of sediment accretion;
- Evidence of groundwater seepage;
- Any apparent loss of slope cap material;
- Any apparent down-slope movement of cap materials;
- Presence of debris on the cap surface;
- Indicators of potential contamination (i.e., sheen or staining) within the surface sediment; and
- Verification that grout mat slope cap areas are effectively containing the underlying contaminated sediments.

The Physical Cap Integrity Operations Manual presented in the OMMP includes more detailed requirements.

Summary of Field Activities

Year 2 low tide slope cap inspections were performed June 2–5, 2008, in RA 1B, RA 3, RA 8, RA 14, RA 19A, RA 19B, RA 20, and the Sheen Source Removal Area in the Wheeler-Osgood Waterway. The low tide slope cap inspections were performed on the exposed shoreline portion of the slope caps in these areas when tidal elevations were at or below 0.0 feet MLLW.

Standardized field forms and photographs were used to document observations of the slope caps at approximate 100-foot monitoring intervals along the designated shoreline areas. Figure 2-1 presents the monitoring interval locations for low tide slope cap inspections. Baseline low tide slope cap inspections were performed in accordance with the Physical Cap Integrity Operations Manual presented in the OMMP.

While low tide slope cap inspections were occurring, slope cap composite surface sediment samples (0 to 10 cm) from the intertidal areas of the slope caps were also being collected for chemical analysis to monitor slope cap performance. Slope cap performance monitoring field sampling activities and analytical results are discussed below in Section 2.2.2.1. The slope cap sampling locations are also included on Figure 2-1.

Summary of Year 2 Findings

This section presents a summary of the results of baseline low tide slope cap inspections in the Thea Foss and Wheeler-Osgood Waterways and identifies slope areas requiring further evaluation. The detailed results of the baseline low tide slope cap inspections, including field forms and photographs for each inspection interval, are presented in the Year 2 Monitoring Low Tide Slope Cap Inspection Preliminary Findings Memorandum provided in Attachment A-1 in Appendix A. A summary of the findings from the low tide slope cap inspection includes the following:

- No disturbances to the cap were identified upon inspection of the five intervals in RA 1B, four intervals in RA 3, six intervals in RA 14, eleven intervals in RA 19A, eight intervals in RA 19B, ten intervals in RA 20, and the Sheen Source Removal Area interval.
- No disturbances to the cap were identified upon inspection of 16 of the 17 monitoring intervals in RA 8. One area is present in monitoring interval 10 of RA 8 where several pilings are located at the surface of the capped area. Further evaluation is being performed in this area to determine whether any repair actions are needed to remove or confine the pilings. Options for this area need further evaluation due to the already steep slope of the shoreline and the proximity of the authorized channel, since placing a toe berm and cap below this area would likely encroach on the channel and potentially block access to marina slips. A separate memorandum evaluating options for this area is being prepared for submittal to EPA for review.
- Small depressions are present at the surface of the cap in RA 8 (monitoring interval 2), RA 14 (monitoring interval 3), RA 19A (monitoring interval 2), and RA 20 (monitoring interval 1). These depressions will be monitored as part of subsequent low tide slope cap inspections to identify whether additional settlement or material movement has occurred in these areas.
- A float with a shed was observed to be grounded on the surface of the slope cap in monitoring interval 4 of RA 20, at Johnny's Dock Marina. Representatives of the Johnny's Dock Marina were notified by the City on July 3, 2008, and asked to relocate the float away from the area where grounding on the cap was occurring. Following notification, Johnny's Dock Marina moved the float so that it is no longer grounded; this was confirmed in an inspection by the City.
- A thin layer of sediment accretion and/or fines from capping material was present on relatively flat, enclosed portions of the slope cap areas at elevations generally below 5 feet MLLW. This is to be anticipated, and no action is necessary as a result of the

presence of sediment accretion and/or fines on slope caps. Cap area chemical performance monitoring which includes collection and analysis of samples from slope cap areas was also performed in Year 2 in accordance with the OMMP to evaluate chemical concentrations and compliance with performance criteria. The results from the slope cap chemical performance monitoring are discussed below in Section 2.2.2.1.

2.2.1.2 Subtidal Cap Hydrographic Survey

Year 2 performance monitoring to evaluate the physical integrity of subtidal capped areas consisted of performing multibeam hydrographic surveys of subtidal capped areas in RA 1, RA 3, RA 5, RA 6, RA 7A, RA 8, RA 9, RA 14, RA 16, RA 17, RA 18, RA 19A, RA 19B, RA 20, RA 21 and RA 22, in accordance with the OMMP. Subtidal hydrographic survey areas are shown in Figure 2-2.

The results of the Year 2 hydrographic survey are presented in the Year 2 Monitoring Subtidal Cap Hydrographic Survey Preliminary Findings Memorandum (City of Tacoma 2008) provided in Attachment A-2 in Appendix A and are summarized below to characterize the Year 2 conditions for the subtidal portions of capped areas.

Summary of Subtidal Cap Hydrographic Survey Requirements

The OMMP specifies that in Years 2, 4, 7, and 10 monitoring be performed to verify cap integrity and performance to ensure containment of the underlying contaminated sediments. The subtidal cap performance monitoring program is designed to detect and evaluate long-term changes in cap thickness to ensure compliance with performance criteria. Hydrographic surveys are to be performed in subtidal slope, grout mat, and channel sand cap areas to evaluate changes (scour/erosion or deposition) in cap thickness as indicated by changes in elevation over time.

The hydrographic survey results are to be compared to previous monitoring surveys to evaluate apparent changes in the cap elevation over time and to identify any potential erosional areas. Consolidation of underlying sediments will be considered in the evaluation of apparent changes in cap thickness, especially during the early years of monitoring. Hydrographic survey data will be evaluated to identify whether there are areas where a contiguous region of the cap exhibits greater than six inches of net erosion relative to previous surveys. One of the performance criteria for the long-term compliance of the sediment cap areas is to maintain a minimum cap thickness of three feet as per the Record of Decision (ROD). A loss of six inches or more of cap thickness will trigger the evaluation of potential response actions. A potential response action may include additional surveys or supplemental field inspections to delineate areas with a loss of more than one foot of cap material and to collect additional information to determine potential causes of the cap material loss, if needed.

Summary of Field Activities and Reporting

The Year 2 multibeam hydrographic survey was conducted by DEA on March 5-6, 2008, with additional quality control checks performed on March 7, 2008. The objective of the Year 2 multibeam survey was to obtain elevation data for subtidal capped areas, defined as the capped areas within RA boundaries extending up the shoreline to a target elevation of 0 feet MLLW. Intertidal slope caps placed along the shoreline at elevations above 0 feet MLLW are monitored by low tide slope cap inspections as described in the OMMP and Section 2.2.1.1 of this document. Low tide slope cap inspections were also performed along the shoreline extent of subtidal caps to supplement the hydrographic survey analysis in areas where complete hydrographic coverage is limited due to the presence of structures, marina docks, and other facilities. The hydrographic survey contractor report summarizing the equipment and procedures used for the Year 2 hydrographic survey is provided in Attachment B of the Subtidal Cap Hydrographic Survey Preliminary Findings Memorandum which is included in Attachment A-2 in Appendix A of this report.

The hydrographic survey was performed using compatible methodology in accordance with the methods described in Attachment A-1 of the Physical Cap Integrity Operations Manual in Appendix A of the OMMP and in accordance with the USACE Engineering Manual 1110-2-1003, and subsequent manual revisions.

Consistent with the baseline surveys, soundings were acquired with a Reson SeaBat 8101 multibeam bathymetric sonar using a frequency of 240 kilo hertz (kHz). The system records 101 soundings in a single sonar ping with a 150° swath and with 15° roll bias to starboard. Accurate positioning was determined using a Trimble MS750 RTK Global Positioning System (GPS) rover, located on the vessel with a base station positioned at a control point located on the south side of the Wheeler-Osgood Waterway. The survey was conducted aboard DEA's 33-foot vessel *John B Preston*.

Multibeam data was collected by running lines both parallel and perpendicular to the waterway for the length of the project. Unlike the baseline hydrographic survey, construction activities were not occurring during the Year 2 survey and as a result the vessel was able to survey closer to the shoreline. However, in many areas, the survey vessel had to be "walked" along tight spaces between the shoreline and docks and floats to get the maximum coverage possible. Very few areas were inaccessible. For this survey, the sonar head was mounted with 15° starboard angle to allow for maximum coverage of side slope areas.

The following section presents the comparison of baseline survey results to the results of Year 2 hydrographic survey performed in subtidal cap areas. In RA 5, RA 6, RA 7A, RA 8, RA 9, RA 14, RA 16, RA 17, RA 18, RA 19A, RA 19B, RA 20, RA 21 and RA 22, multibeam surveys were performed during baseline (2005/2006) and Year 2. In RA 1 and RA 3, single beam surveys were performed during baseline (2003) while multibeam surveys were performed during Year 2.

The Baseline and Year 2 bathymetric conditions are shown for each subtidal cap area within the 16 RAs in the Year 2 Monitoring Subtidal Cap Hydrographic Survey Preliminary Findings Memorandum provided in Attachment A-2 in Appendix A.

Summary of Year 2 Findings

This section presents a summary of the results of the Year 2 hydrographic survey, comparison of the baseline and Year 2 surveys, and identifies capped areas requiring further evaluation in Year 4 monitoring. The detailed results of the hydrographic survey, including the hydrographic survey contractor report summarizing the equipment and procedures and transect line comparisons are presented in the Year 2 Monitoring Subtidal Cap Hydrographic Survey Preliminary Findings Memorandum provided in Attachment A-2 in Appendix A. A summary of the findings from the Year 2 hydrographic survey includes the following:

- Nearly complete coverage of the subtidal slope, grout mat, and channel sand cap areas was achieved in the Year 2 hydrographic survey.
- The Year 2 hydrographic survey was performed using equipment and procedures comparable to the baseline (2005/2006) multibeam hydrographic survey.
- Single beam baseline (post-construction) transect lines were used, where available, in shoreline areas of limited baseline multibeam survey coverage to aid in evaluating cap surface elevations.
- Low tide slope cap inspections can be used to supplement the hydrographic survey analysis in shoreline slope cap areas where baseline hydrographic survey coverage is limited due to the presence of structures, marina docks and facilities.
- In shoreline slope areas that were inaccessible or blocked by large vessels, floats or obstructions, the baseline multibeam survey had to use wider sonar angles along the slopes and to reach under such obstructions, which can result in less accurate readings. Variances identified in shoreline slope areas of limited baseline survey coverage are potentially due in part to the wider sonar angles that were necessary to reach under obstructions during the baseline survey.
- In general, the Year 2 cap surface elevations are within six inches of the baseline surface elevation and within the allowable accuracy of the survey equipment.
- There are limited locations where the decrease in the cap surface elevation from baseline to Year 2 is greater than six inches but less than one foot. These locations are generally small, localized, and non-contiguous.

Based on the Year 2 hydrographic survey work, two types of areas have been identified that will be further evaluated in the Year 4 hydrographic survey analysis to identify whether changes in the surface elevation are occurring. These areas include: 1) those that exhibit decreases in the cap surface elevation from baseline to Year 2 that are greater than six inches but less than one foot; and 2) those that exhibit decreases in the cap surface elevation from baseline to Year 2 that are greater than one foot but are small, localized, and non-contiguous. There are six localized yet continuous areas in three RAs where the decrease in the cap surface elevation from baseline to Year 2 is greater than six inches but less than one foot, described above as type one. These areas are located in RA 17, RA 19A, and RA 19B. There are five locations in three RAs where the decrease in the cap surface elevation from baseline to Year 2 is greater than one foot, however the areas are generally small, localized, and non-contiguous, described above as type two. These areas are located in RA 1, RA 3, and RA 8. These areas with small, localized, and non-contiguous points showing a decrease in the cap surface elevation from baseline to Year 2 are potentially attributable to artifacts of the baseline single beam surveys compared to the multibeam surveys. In the case of RA 1 and RA 3, two consecutive years of multibeam surveys performed with comparable equipment and procedures will provide insightful information on any potential slope compaction or subsidence. These two types of areas are further described in the Year 2 Monitoring Subtidal Cap Hydrographic Survey Preliminary Findings Memorandum in Attachment A-2 in Appendix A. These areas will be further evaluated in the Year 4 hydrographic survey analysis.

2.2.1.3 Schedule of Subtidal Cap Integrity Monitoring Activities

No supplemental low tide inspections or hydrographic surveys are required to characterize the Year 2 conditions in capped areas. Cap integrity monitoring is scheduled to occur in 2010 as part of Year 4 cap area performance monitoring. The schedule for OMMP activities to be performed as part of the Foss Project is presented in Table 1-1. The scope of cap integrity monitoring to be conducted in Year 4, including low tide inspections and hydrographic survey, is the same as for Year 2 and is described in the OMMP.

2.2.2 Cap Area Chemical Performance Monitoring

Cap area chemical performance monitoring is designed to evaluate the long-term effectiveness of caps constructed as part of the Foss Project. Chemical performance monitoring activities consist of collection and analysis of surface samples (0 to 10 cm) from constructed caps to verify compliance with cleanup criteria and confirm that underlying contaminated materials are contained. Cap performance sampling is performed in both the intertidal slope cap and channel sand cap areas. As described in Section 2.0 of the OMMP, cap performance monitoring is separated into baseline (Year 0) and long-term (Years 2, 4, 7, and 10) performance monitoring.

2.2.2.1 Slope Cap Chemical Performance Monitoring

Year 2 performance slope cap samples were collected from the intertidal areas in RA 1B, RA 3, RA 8, RA 14, RA 19A, RA 19B, and RA 20 in accordance with the OMMP. This is the first year following installation of the slope cap that slope cap composite samples were collected for analysis. The results of the slope cap chemical performance monitoring are presented in the Year 2 Monitoring Sediment and Cap Performance and Early Warning Monitoring Preliminary Findings Memorandum (City of Tacoma 2008) included as Attachment B-1 in Appendix B and are also summarized below.

Summary of Slope Cap Chemical Performance Monitoring Requirements

As required by the OMMP, performance slope cap samples are collected from the intertidal areas in RA 1B, RA 3, RA 8, RA 14, RA 19A, RA 19B, and RA 20 when tidal elevations are at or below 0.0 feet MLLW. Slope cap areas are monitored using three-point composite surface sediment samples (0 to 10 cm) collected from the intertidal portion of the cap. The slope cap monitoring analytical results are compared to the SQOs to evaluate compliance with performance criteria.

Refer to the Sediment Sampling Operations Manual presented in the OMMP for more detailed requirements.

Summary of Field Activities, Analyses, and Reporting

Slope cap performance surface sediment (0 to 10 cm) samples were collected for chemical analysis June 2-5, 2008. The samples were collected during the low tide slope cap inspections, which are summarized above in Section 2.2.1.1. The slope cap chemical performance monitoring was performed in accordance with the Sediment Sampling Operations Manual presented in the OMMP.

Sediment samples were collected from the slope cap areas in RA 1B, RA 3, RA 14, RA 19A, RA 19B, and RA 20 and consist of composites comprised of discrete samples collected from three locations in each RA. Two composite sediment samples, each comprised of three discrete samples each, were collected within RA 8, one from the north end of the RA (designated as 08A) and one from the south end of the RA (designated as 08B). The locations of the slope cap composite subsample stations were selected in the field to be between approximately 0 feet and -2 feet MLLW and to be generally evenly spaced along the RA, while targeting any observed sediment accumulation areas on the slope cap. Figure 2-1 identifies the slope cap subsample locations.

The slope cap subsample locations were designated by SC, followed by the RA, the sample year, and then the number (D1, D2, or D3, numbered south to north) of the discrete sampling location (e.g., SC-01-Y2-D1). The slope cap composite sample names are designated by SC, followed by the RA, the sample year (e.g., SC-01-Y2).

The slope cap surface samples were collected using a stainless steel spoon and bowl. Due to the gravelly nature of the slope cap material, approximately 5 to 50 percent of the material collected at each subsample location was discarded as large rocks and gravel were not included in the sample composite. Field forms were completed and photographs were taken to document observations during the sampling. The samples were submitted to the City laboratory under approved sampling handling and chain-of-custody procedures for the analysis of conventionals (i.e., total organic carbon and total solids), metals, semi-volatile organic compounds (SVOCs), pesticides, and polychlorinated biphenyls (PCBs) in accordance with the OMMP.

Data validation was performed on the laboratory analyses for the samples in accordance with the OMMP. The qualifiers resulting from data validation are presented in the summary of the Year 2 slope cap surface sample analytical results provided in Table 2-1.

Summary of Monitoring Results

The analytical results from samples collected from the slope cap areas are presented below and are summarized in Table 2-1. The results for the samples were compared to the sediment quality objectives (SQOs) to identify if there are any exceedences of the performance criteria. Concentrations that are greater than the SQOs are highlighted in red in Table 2-1. The detailed results of the low tide slope cap sampling, including field forms and photographs for the samples, are presented in the Year 2 Monitoring Sediment and Cap Performance and Early Warning Monitoring Preliminary Findings Memorandum provided in Appendix B.

Detected chemical concentrations did not exceed the SQOs in the slope cap samples collected as part of Year 2 performance monitoring with the exception of sample SC-08A-Y2. The detected concentration of benzyl alcohol in sample SC-08A-Y2 (i.e., 93 µg/kg) had an enrichment ratio (ER) of 1.3 times the SQO. Sample SC-08A-Y2 is comprised of a composite of material collected from the shoreline located at the north end of RA 8, adjacent to the Foss Harbor Marina (formerly the Foss Waterway Marina). DEHP was detected in sample SC-20-Y2 and the corresponding sample duplicate at or just below the SQO. The remaining detected chemical concentrations in the slope cap samples were substantially less than the SQOs.

Summary of Year 2 Findings

A summary of the findings from the slope cap chemical performance monitoring includes the following:

- The detected chemical concentrations did not exceed the SQOs in the slope cap surface samples collected from RA 1B, RA 3, RA 14, RA 19A, RA 19B, and RA 20, and from the southern half of RA 8.

- Slope cap composite sample SC-08A-Y2, collected from the north end of RA 8, had a detected benzyl alcohol concentration greater than the SQO. All other chemical concentrations were substantially less than the SQOs in this sample. Benzyl alcohol was either not detected or detected at a concentration less than one-half the SQO in adjacent natural recovery and early warning samples including samples NR-12-Y2, EW-12-Y2, NR-16-Y2, and EW-16-Y2. The natural recovery performance monitoring sample results are discussed in further detail in Section 2.3 and the early warning monitoring sample results are discussed in further detail in Section 3.0.

- Elevated benzyl alcohol detections in the Year 2 sediment samples, including sample SC-08A-Y2, are anomalous relative to previous sampling events. Previous sediment sampling events on the Thea Foss and Wheeler-Osgood Waterways had very few detections of benzyl alcohol and the detected concentrations did not exceed the SQO. In Year 2, sediment samples tended to have more detections and higher concentrations of benzyl alcohol. As a result, the City laboratory has conducted further evaluation into these benzyl alcohol detections. A technical memorandum titled, "Evaluation of the detection and extraction methods used for the analysis of benzyl alcohol in Thea Foss Waterway OMMP sediment samples" has been prepared which summarizes the evaluation of several factors that could have potentially resulted in the increased detection of benzyl alcohol in Year 2. Specifically, this memorandum discusses the detections and concentrations of benzyl alcohol in Year 2 compared with previous baseline sediment sample data; the extraction method currently used by the City laboratory and potential artifacts of this method relative to previous SVOC extraction procedures; the results of a re-analysis of benzyl alcohol Year 2 sediment samples using various EPA-approved extraction methods; and the results of an evaluation of the SVOC analysis surrogate standards and potential interference. This technical memorandum is included in Appendix B as Attachment B-2.

2.2.2.2 Channel Sand Cap Chemical Performance Monitoring

Year 2 performance channel sand cap surface sediment (0 to 10 cm) samples were collected from RA 1A, RA 6, RA 9, RA 16, RA 17, RA 19A, RA 20, RA 21, and RA 22 at a total of ten stations. The results of the channel sand cap chemical performance monitoring are presented in the Year 2 Monitoring Sediment and Cap Performance and Early Warning Monitoring Preliminary Findings Memorandum included in Attachment B-1 in Appendix B and are also summarized below.

Early warning monitoring was also performed at nine of the channel sand cap monitoring stations during Year 2 activities to evaluate the potential for recontamination of the sediment surface in the Thea Foss and Wheeler-Osgood Waterways by the collection of recently deposited sediments represented by the 0 to 2 cm interval of the sediment column. The results of these early warning monitoring samples and a comparison of the Year 2 early warning monitoring samples (0 to 2 cm) to the results of the Year 2 performance monitoring surface samples (0 to 10 cm) for channel sand cap is presented in Section 3.0 of this report.

Summary of Channel Sand Cap Chemical Performance Monitoring Requirements

Remedial Areas where performance channel sand cap samples are collected include RA 1A, RA 6, RA 9, RA 16, RA 17, RA 19A, RA 20, RA 21, and RA 22. Channel sand caps are monitored using discrete surface sediment samples (0 to 10 cm) collected from the cap surface. The cap monitoring analytical results are compared to the SQOs as well as baseline monitoring results that consist of the post-construction confirmation sampling results presented in the 2003 and 2006 Remedial Action Construction Reports (RACR).

Refer to the Sediment Sampling Operations Manual presented in the OMMP for more detailed requirements.

Summary of Field Activities, Analyses, and Reporting

Ten channel sand cap performance surface sediment (0 to 10 cm) samples were collected during two monitoring events on the Thea Foss and Wheeler-Osgood Waterways. Natural recovery and enhanced natural recovery performance surface sediment (0 to 10 cm) samples, discussed in Section 2.3, and early warning (0 to 2 cm) sediment samples, discussed in Section 3.0, were also collected during these two monitoring events. The first event occurred May 27-29, 2008, and sampling was conducted at the north end of the Thea Foss Waterway (north of Station 43+00) and at the west end of the Wheeler-Osgood Waterway (west of Station 11+00). The second event occurred June 23-24, 2008, and sampling was conducted at the south end of the Thea Foss Waterway (south of Station 43+00) and at the east end of the Wheeler-Osgood Waterway (east of Station 11+00). Figure 2-3 identifies the channel sand cap sampling locations. The channel sand cap chemical performance monitoring was performed in accordance with the Sediment Sampling Operations Manual presented in the OMMP.

The channel sand cap samples were collected using a vessel deployed Van Veen grab sampler. Channel sand cap samples were designated by CC, followed by the sample station number, and then the sample year (e.g., CC-01-Y2). Sample collection forms and photographs documenting activities and observations were prepared during the two sampling events.

The samples were submitted to the City laboratory under approved sampling handling and chain-of-custody procedures for the analysis of conventionals (i.e., total organic carbon and total solids), metals, semi-volatile organic compounds (SVOCs), pesticides, and polychlorinated biphenyls (PCBs) in accordance with the OMMP.

Data validation was performed on the laboratory analyses for the samples in accordance with the OMMP. The qualifiers resulting from data validation are presented in the summary of the Year 2 channel sand cap surface sample analytical results provided in Table 2-2.

Summary of Monitoring Results

The analytical results from samples collected from the channel sand cap areas are presented below and are summarized in Table 2-2. The results for the samples were compared to the SQOs to identify if there are any exceedences of the performance criteria. Concentrations that are greater than the SQOs are highlighted in red in Table 2-2. The detailed results of the Year 2 channel sand cap sampling, including field forms and photographs for the samples, are presented in the Year 2 Monitoring Sediment and Cap Performance and Early Warning Monitoring Preliminary Findings Memorandum provided in Appendix B.

Ten channel sand cap surface samples (0 to10 cm) were collected and analyzed during Year 2 monitoring activities. Detected chemical concentrations did not exceed the SQOs in eight of the channel sand cap surface samples that were collected including:

- Sample CC-01-Y2, located in RA 1A;
- Sample CC-18-Y2, located in RA 9;
- Sample CC-26-Y2, located on the border of RA 16 and RA 17;
- Sample CC-27-Y2, located in RA 17;
- Sample CC-29-Y2, located in RA 19A;
- Sample CC-30-Y2, located in RA 21;
- Sample CC-31-Y2, located in RA 20; and
- Sample CC-33-Y2, located in RA 22.

The detected concentrations in these samples were generally less than one-half the SQO with the exception of bis(2-ethylhexyl)phthalate (DEHP). DEHP was detected at a concentration approaching the SQO in sample CC-31-Y2 and was at the SQO in sample CC-33-Y2. Samples CC-31-Y2 and CC-33-Y2 are located at the southern end of the City's work area in the Thea Foss Waterway.

Sample CC-23-Y2 had detected concentrations of benzo(g,h,i)perylene, indeno(1,2,3-cd)pyrene, DEHP, and benzyl alcohol that were greater than the SQOs. These SQO exceedences ranged from less than 1.1 to 2.4 times the SQOs. Enrichment ratios for the PAHs were less than 1.1, while the ER for benzyl alcohol was 1.8 and for DEHP was 2.4. This sample is located in the western portion of RA 6, near City Outfall 230.

Two chemicals, phenanthrene and DEHP, were detected at concentrations greater than the SQOs in sample CC-32-Y2, located in RA 19A in the southwest portion of the City's work area in the Thea Foss Waterway. DEHP was detected at a concentration with an ER of 1.8 and phenanthrene was detected at a concentration with an ER of approximately 1.1 in this sample.

Summary of Channel Sand Cap Analytical Results Comparisons

In accordance with the OMMP, Year 2 performance monitoring channel sand cap sample results were compared to baseline channel sand cap sample results. The baseline samples used for this comparison are the surface samples (0 to 10 cm) that were collected as part of post-construction confirmation sampling that occurred between 2003 and 2006, which are presented in further detail in the 2003 and 2006 Remedial Action Construction Reports (RACR). Tables 6 through 15 in the Year 2 Monitoring Sediment and Cap Performance and Early Warning Monitoring Preliminary Findings Memorandum provided in Attachment B-1 in Appendix B, present the channel sand sample baseline and Year 2 sample comparisons.

In general, the baseline channel sand cap samples were non-detect for many of the chemicals analyzed, and those chemicals that were detected were found at concentrations at or less than one-tenth of the SQO. These low chemical concentrations are representative of the fact that the source of material used for the channel sand cap was native pit run (sand and gravel obtained from a quarry) and baseline samples were collected immediately after the material was placed as cap in the Thea Foss and Wheeler-Osgood Waterways.

By Year 2, all of the channel sand cap performance monitoring samples had increased concentrations relative to the concentrations in baseline samples. However, eight of the ten Year 2 samples had detected concentrations below the SQOs, and of these eight samples, five had chemical concentrations less than approximately one-half the SQOs for all detected constituents. As stated in the Summary of Monitoring Results section above, Year 2 channel sand cap samples CC-23-Y2 and CC-32-Y2 had some low level SQO exceedences.

Summary of Year 2 Findings

A summary of the findings from the Year 2 channel sand cap chemical performance monitoring is included below. For a comparison of the Year 2 channel sand cap sampling results to the co-located Year 2 early warning sample (0 to 2 cm) results refer to Section 3.0 on Early Warning Monitoring for Recontamination which helps evaluate the potential for recontamination of remediated areas within the Thea Foss and Wheeler-Osgood Waterways. A brief summary of the early warning samples co-located with the channel sand cap samples is also provided below.

- The comparison of baseline and Year 2 performance monitoring samples shows that there has been a general increase in the chemical concentrations in surface samples (0 to 10 cm) collected from channel sand cap areas identified above from the baseline monitoring event to Year 2 monitoring. This was expected since the capping material placed during construction was native material from an upland source.

- The detected chemical concentrations did not exceed the SQOs in the Year 2 channel sand cap surface samples (0 to 10 cm) CC-01-Y2, CC-18-Y2, CC-26-Y2, CC-27-Y2, CC-29-Y2, CC-30-Y2, CC-31-Y2, and CC-33-Y2. Only DEHP was detected at concentrations approaching or at the SQO in the compliance monitoring surface samples at two of these locations. Two of the co-located early warning samples associated with channel sand samples CC-31-Y2 and CC-33-Y2 had SQO exceedences for DEHP.

- The chemical concentrations in channel sand cap performance monitoring surface sample CC-23-Y2, located in the western portion of RA 6 near City Outfall 230, were greater than the SQOs for four SVOCs including benzo(g,h,i)perylene (ER 1.07), indeno(1,2,3-cd)pyrene (ER 1.03), DEHP (ER 2.38), and benzyl alcohol (ER 1.78). The corresponding early warning sample also had SQO exceedences for the four SVOCs, plus one additional SVOC, dibenzo(a,h)anthracene. The elevated concentrations in the channel sand cap area appear to be localized as the early warning samples collected in the adjacent dredge to clean area in RA 6 (samples EW-21-Y2, EW-22-Y2, and EW-24-Y2) and the slope cap performance monitoring sample from the south end of RA-8 (sample SC-08B-Y2) did not have chemical concentrations greater than the SQOs. The City continues to monitor sediment and stormwater from Outfall 230. For additional information on the City's stormwater source control efforts at Outfall 230, refer to Section 7.3. DEHP exceedences in the sediments are discussed further in Section 7.3 and 7.4. In addition, as described above, additional evaluation has been performed on the increased frequency of detections of benzyl alcohol in sediments in Year 2. A memorandum summarizing that evaluation is included in Attachment B-1 in Appendix B.

Based on these results, no supplemental monitoring of this area appears warranted at this time. The channel sand cap location in RA 6 will be monitored again as part of Year 4 OMMP monitoring.

- Channel sand cap surface sample CC-32-Y2, located at the south end of RA 19A and the Thea Foss Waterway had detected concentrations of phenanthrene (ER 1.07) and DEHP (ER 1.77) that were greater than the SQOs. The co-located early warning sample had these chemicals and additional SVOCs detected at concentrations greater than the SQOs. The elevated concentrations in the channel sand cap area at CC-32-Y2 appear to be relatively localized as the compliance monitoring surface samples and early warning samples collected in the adjacent cap areas (samples CC-29-Y2/EW-29-Y2, CC-30-Y2/EW-30-Y2, CC-31-Y2/EW-31-Y2, and CC-33-Y2/EW-33-Y2) did not have similar chemical concentrations or exceedences of the SQOs. This area is likely a depositional area within the Thea Foss Waterway that is a result of installation of the sheet pile wall. DEHP exceedences are discussed further in Section 7.0. Based on these results, no supplemental monitoring of this area appears warranted at this time. The channel sand cap location in RA 19A will be monitored again as part of Year 4 OMMP monitoring.

2.2.2.3 Schedule of Cap Area Chemical Performance Monitoring Activities

No additional cap area chemical performance monitoring is required to characterize Year 2 conditions in capped areas. The next cap area chemical performance monitoring, including collection and analysis of samples from areas capped with channel sand cap material and from slope caps, is schedule to occur in 2010 as part of Year 4 cap area performance monitoring. The schedule for OMMP activities to be performed as part of the Foss Project is presented in Table 1-1. The scope of cap area performance monitoring to be conducted in Year 4 is the same as for Year 2 and is described in the OMMP.

2.3 Natural Recovery and Enhanced Natural Recovery Performance Monitoring

Natural recovery and enhanced natural recovery performance monitoring is designed to verify that surface sediments in natural recovery areas satisfy performance criteria within the allowed 10-year time frame. Natural recovery and enhanced natural recovery performance monitoring consists of the collection and analysis of 14 surface samples (0 to 10 cm) from natural recovery and enhanced natural recovery areas to evaluate chemical concentration trends to determine whether natural recovery is likely to be achieved within the compliance period. Additionally, three slope surface samples (0 to 10 cm) were collected from the natural recovery and slope rehabilitation in the Wheeler-Osgood Waterway. The results of the natural recovery and enhanced natural recovery chemical performance monitoring are presented in the Year 2 Monitoring Sediment and Cap Performance and Early Warning Monitoring Preliminary Findings Memorandum included as Attachment B-1 in Appendix B and are also summarized below.

Early warning monitoring was also performed at 13 of the 14 natural recovery and enhanced natural recovery monitoring stations during Year 2 activities to evaluate the potential for recontamination of the sediment surface in the Thea Foss and Wheeler-Osgood Waterways by the collection of recently deposited sediments represented by the 0 to 2 cm interval of the sediment column. The results of these early warning monitoring samples and a comparison of the Year 2 early warning monitoring samples (0 to 2 cm) to the results of the Year 2 performance monitoring surface samples (0 to 10 cm) for the natural recovery and enhanced natural recovery areas is presented in Section 3.0 of this report.

Summary of Natural Recovery and Enhanced Natural Recovery Performance Monitoring Requirements

Natural recovery and enhanced natural recovery areas that are monitored as part of the OMMP in Year 2 include the northern portions of RA 5 and RA 6, all of RA 7, most of the area north of the 11th Street Bridge to Station 20+00, the head of the Wheeler-Osgood Waterway located between RA 12 and RA 13, an area east of RA 16 and north of RA 15, and an area located east of RA 5 near the mouth of the Wheeler-Osgood Waterway extending from Stations 41+50 to 46+50 (Figure 2-3). Additionally, slopes in the Wheeler-Osgood Waterway comprising RA 10, RA 11, and RA 13 were designated for slope rehabilitation and natural recovery during the Remedial Design phase of the project and are also monitored as part of the OMMP.

Natural recovery is monitored using discrete surface sediment samples collected from the natural recovery and enhanced natural recovery areas within the Thea Foss and Wheeler-Osgood Waterways. Composite surface sediment samples are collected to monitor natural recovery from the three natural recovery/slope rehabilitation areas within the Wheeler-Osgood Waterway.

The natural recovery and enhanced natural recovery monitoring analytical results are compared to the SQOs as well as baseline monitoring results to evaluate progress toward compliance with performance criteria. Baseline monitoring results consist of supplemental baseline natural recovery and enhanced natural recovery sampling data from Year 0 combined with existing post-construction sediment sample results collected in the natural recovery areas to establish a comprehensive baseline for natural recovery areas. The baseline monitoring results are compared to the Year 2 monitoring results to evaluate trends in chemical concentrations to identify if natural recovery, enhanced natural recovery, and natural recovery/slope rehabilitation areas have satisfied or will satisfy performance criteria within the allowed 10-year time frame.

Refer to the Sediment Sampling Operations Manual presented in the OMMP for more detailed requirements.

Summary of Field Activities, Analysis, and Reporting

Natural recovery and enhanced natural recovery performance surface sediment (0 to 10 cm) samples were collected at 14 locations during two monitoring events on the Thea Foss and Wheeler-Osgood Waterways. Channel sand cap performance surface sediment (0 to 10 cm) samples, discussed in Section 2.2.2.2, and early warning sediment (0 to 2 cm) samples, discussed in Section 3.0, were also collected during these two monitoring events. The first event occurred May 27-29, 2008, and sampling was conducted at the north end of the Thea Foss Waterway (north of Station 43+00) and at the west end of the Wheeler-Osgood Waterway (west of Station 11+00). The second event occurred June 23-24, 2008, and sampling was conducted at the south end of the Thea Foss Waterway (south of Station 43+00) and at the east end of the Wheeler-Osgood Waterway (east of Station 11+00). Figure 2-3 identifies the natural recovery and enhanced natural recovery sampling locations. The natural recovery and enhanced natural recovery chemical performance monitoring was performed in accordance with the Sediment Sampling Operations Manual presented in the OMMP.

The natural recovery and enhanced natural recovery samples were collected using a vessel deployed Van Veen grab sampler. Natural recovery and enhanced natural recovery samples were designated by NR, followed by the sample station number, and then the sample year (e.g., NR-06-Y2). Sample collection forms and photographs documenting activities and observations were prepared during the two sampling events.

Surface sediment (0 to 10 cm) samples of the natural recovery/slope rehabilitation shoreline areas (RA 10, RA 11, and RA 13) in the Wheeler-Osgood Waterway were collected on May 23, 2008, when tidal elevations were at or below 0.0 feet MLLW. The samples were composites comprised of subsamples collected from three discrete locations in each RA. The natural recovery/slope rehabilitation subsample locations were designated by SR, followed by the RA, the sample year, and then the number (D1, D2, or D3) of the discrete sampling location (e.g., SR-10-Y2-D1). The natural recovery/slope rehabilitation composite sample names are designated by SR, followed by the RA and the sample year (e.g., SR-10-Y2).

The samples were collected using a stainless steel spoon and bowl. Due to the gravelly nature of the surface sediments on the shoreline slopes in the Wheeler-Osgood Waterway, a portion of the material collected at each subsample location was discarded as large rocks and gravel were not included in the sample composite. Sample collection forms and photographs documenting activities and observations were prepared during this sampling event.

The natural recovery, enhanced natural recovery, and natural recovery/slope rehabilitation shoreline samples were submitted to the City laboratory under approved sampling handling and chain-of-custody procedures for the analysis of conventionals (i.e., total organic carbon and total solids), metals, semi-volatile organic compounds (SVOCs), pesticides, and polychlorinated biphenyls (PCBs) in accordance with the OMMP.

Data validation was performed on the laboratory analyses for the samples in accordance with the OMMP. The qualifiers resulting from data validation are presented in the summary of the Year 2 natural recovery and enhanced natural recovery surface sample analytical results provided in Table 2-3.

Summary of Monitoring Results

The analytical results from samples collected from the natural recovery and enhanced natural recovery areas are presented below and are summarized in Table 2-3. The results for the samples were compared to the SQOs to identify if there are any exceedences of the performance criteria. Concentrations that are greater than the SQOs are highlighted in red in Table 2-3. The detailed results of the Year 2 natural recovery and enhanced natural recovery sampling, including field forms and photographs for the samples, are presented in the Year 2 Monitoring Sediment and Cap Performance and Early Warning Monitoring Preliminary Findings Memorandum provided in Attachment B-1 in Appendix B.

<u>Natural Recovery Area North of 11th Street Bridge</u> – Five of the six sample stations in the natural recovery area north of the 11th Street Bridge in the Thea Foss Waterway (i.e., samples NR-06-Y2, NR-07-Y2, NR-08-Y2, NR-09-Y2, and NR-10-Y2) had detected chemical concentrations less than the SQOs. In the sixth sample, NR-11-Y2 collected from the natural recovery area north of the 11th Street Bridge, only DEHP was detected at a concentration greater than the SQO, with an ER of 1.2. In addition, benzyl alcohol was not detected at the

detection limit (i.e., 90 µg/kg) in sample NR-06-Y2, but the detection limit was just above the SQO (i.e., 73 µg/kg).

Natural Recovery Area Immediately South of 11th Street Bridge – Detected chemical concentrations did not exceed the SQOs in the three natural recovery surface samples, samples NR-12-Y2, NR-13-Y2, and NR-14-Y2, collected south and adjacent to the 11th Street Bridge in the Thea Foss Waterway. However, samples NR-12-Y2 and NR-13-Y2 had detected DEHP concentrations that were at the SQO (i.e., 1,300 µg/kg) and sample NR-13-Y2 had a detected benzyl alcohol concentration that was also at the SQO (i.e. 73 µg/kg).

Enhanced Natural Recovery Area in RA 7 – Detected chemical concentrations were substantially less than the SQOs in sample NR-16-Y2, collected from the enhanced natural recovery area located south of the 11th Street Bridge on the west side of the Thea Foss Waterway in RA 7.

Natural Recovery Area at the Mouth of the Wheeler-Osgood Waterway – Detected chemical concentrations were less than the SQOs in sample NR-17-Y2, collected from the natural recovery area located at the mouth of the Wheeler-Osgood Waterway.

Natural Recovery Area at Head of the Wheeler-Osgood Waterway – Two natural recovery surface samples, samples NR-19-Y2 and NR-20-Y2, were collected from near the head of the Wheeler-Osgood Waterway. Detected chemical concentrations were substantially less than the SQOs in sample NR-19-Y2. Detected chemical concentrations were also substantially less than the SQOs in sample NR-20-Y2 with the exception of DEHP. The DEHP concentration detected in sample NR-20-Y2 was approximately 1.9 times the SQO.

Natural Recovery/Slope Rehabilitation Shoreline on the Wheeler-Osgood Waterway – Detected chemical concentrations were substantially less than the SQOs in slope rehabilitation sample SR-11-Y2, collected from the shoreline on the south side of the Wheeler-Osgood Waterway. Slope rehabilitation sample SR-13-Y2, collected from the head of the Wheeler-Osgood Waterway, had a DEHP concentration corresponding to an ER of approximately 5.5. The detected concentrations for all other chemicals in sample SR-13-Y2 were substantially less than the SQOs. Slope rehabilitation sample SR-10-Y2 and its sample duplicate (i.e., SR-10-Y2-2) were collected from the shoreline on the north side of the Wheeler-Osgood Waterway. The parent sample (i.e., SR-10-Y2) did not have detected chemical concentrations greater than the SQOs. In the duplicate sample, total PCBs were detected at a concentration corresponding to an ER of approximately 1.7. The remaining detected concentrations in both the parent and duplicate sample were similar, and substantially less than the SQOs, indicating that PCBs were likely present in a subcomponent of the sample and not homogeneous within the sediment matrix.

Natural Recovery Area Adjacent to RA 15 and RA 16 – Seven chemicals were detected at concentrations greater than the SQOs in sample NR-25-Y2 collected from the natural recovery area located east of RA 16 and north of RA 15. The chemicals include phenanthrene, fluoranthene, pyrene, total high molecular weight polynuclear aromatic hydrocarbons (total HPAH), buytl benzyl phthalate, DEHP, and total PCBs. The concentrations of these chemicals were all below two times the SQOs, with enrichment ratios ranging from 1.0 to 1.9.

Summary of Natural Recovery and Enhanced Natural Recovery Analytical Results Comparisons

In accordance with the OMMP, Year 2 performance monitoring natural recovery and enhanced natural recovery sample results were compared to baseline natural recovery and enhanced natural recovery sample results. These results were also compared to samples collected during the remedial investigation (RI) of the Thea Foss and Wheeler-Osgood Waterways.

The baseline natural recovery samples used in this comparison are comprised of a combination of post-construction confirmation and supplemental baseline surface samples. Post-construction confirmation surface samples (0 to 10 cm) collected in 2004 and 2005 were used as baseline natural recovery samples at six performance monitoring stations. Additional information on post-construction sample collection and analysis is presented in the 2006 Remedial Action Construction Report (RACR). Supplemental baseline surface samples (0 to 10 cm) were collected in 2006 within designated natural recovery and enhanced natural recovery areas as part of Year 0 monitoring where there was insufficient existing post-construction data to complete the baseline characterization. The results for supplemental samples were used as the baseline for eight natural recovery monitoring stations.

The RI samples used for this comparison are surface sediment (0 to 10 cm) samples collected between 1994 and 1997. The closest and most recent RI sample available was selected for comparison to each of the Year 2 natural recovery samples. Two RI samples were selected for comparison to natural recovery sample NR-20-Y2, as this natural recovery sampling station is located between these two RI stations.

Tables 16 through 29 in the Year 2 Sediment and Cap Performance and Early Warning Monitoring Preliminary Findings Memorandum provided in Attachment B-1 in Appendix B, present the comparison of Year 2 natural recovery sample concentrations to both baseline and RI samples.

Natural recovery / slope rehabilitation stations were also compared to baseline samples collected as part of supplemental baseline sampling performed in 2006. Tables 30 through 32, in Attachment B-1 in Appendix B, present the comparison of Year 2 slope rehabilitation sample concentrations to baseline samples.

Natural Recovery Area North of 11^{th} Street Bridge – Similar trends were observed over time from RI samples to the Year 2 samples at five of the natural recovery monitoring stations north of the 11^{th} Street Bridge, including stations NR-06, NR-07, NR-08, NR-09, and NR-10. The trend observed at the five stations includes the following:

- RI samples had detected concentrations that were greater than the SQOs;
- Baseline natural recovery area samples collected almost a decade later had detected chemical concentrations less than the SQOs; and
- Year 2 natural recovery samples collected approximately two years after baseline sampling at each of the stations continue to have concentrations that are less than the SQOs.

At these five natural recovery sample stations, there have been two consecutive rounds of performance monitoring (0 to 10 cm) with chemical concentrations less than the SQOs. In general, the five samples also had enrichment ratios for the detected chemicals in the baseline samples comparable to the ratios for the detected chemicals in the Year 2 samples. However, the ratios for PAHs and phthalates indicated a slight increase in samples from stations NR-06 and NR-10 between baseline and Year 2 sampling. Additionally, DEHP showed an increase between baseline and Year 2 in samples from stations NR-08 and NR-09.

Station NR-11 has had detected concentrations of DEHP greater than or equal to the SQO in the RI, baseline, and Year 2 samples. However, DEHP concentrations have continued to steadily decrease over time. The RI sample collected in the vicinity of station NR-11 had six chemicals with concentrations greater than the SQOs. The baseline sample, in contrast, had only one chemical, DEHP, at a concentration greater than the SQOs. The DEHP concentration decreased from approximately 2.9 times the SQO in the RI sample to approximately 1.6 in the baseline sample. In the Year 2 sample the DEHP ratio decreased to approximately 1.2 times the SQO.

Natural Recovery Area Immediately South of 11th Street Bridge – Samples NR-12-Y2, NR-13-Y2, and NR-14-Y2 were collected south and adjacent to the 11th Street Bridge in the Thea Foss Waterway. At station NR-12, the corresponding RI sample had five chemicals detected at concentrations greater than the SQOs. DEHP was detected at approximately 2.8 times the SQO in the RI sample. The baseline sample for station NR-12 had concentrations for all constituents that were less than the SQOs, and DEHP was detected at approximately 0.2 times the SQO. The Year 2 sample also had detected concentrations that were less than the SQOs. However, DEHP in sample NR-12-Y2 increased so that the DEHP concentration was at the SQO.

Detected concentrations of DEHP have been greater than or equal to the SQO in the RI, baseline, and Year 2 samples from natural recovery monitoring station NR-13. However, DEHP concentrations have continued to steadily decrease over time. The RI sample collected near station NR-13 had four analytes with concentrations greater than the SQOs. The concentrations of three of the analytes had decreased to below the SQOs in the baseline sample and only DEHP remained at a concentration above the SQO. DEHP decreased from 2.4 times the SQO in the RI sample to approximately 1.2 times the SQO in the baseline sample. The DEHP concentration in the Year 2 sample had decreased further and was at the SQO. In contrast to DEHP, the benzyl alcohol concentration has increased between the baseline sample and the Year 2 sample NR-13-Y2. Benzyl alcohol was not detected in the baseline sample and was detected at the SQO in sample NR-13-Y2. Benzyl alcohol exceedences are being further evaluated as described above.

Station NR-14 shows a generally decreasing concentration trend between RI sampling and baseline and Year 2 monitoring. The RI sample had multiple chemical concentrations that were greater than the SQOs, while the baseline sample from NR-14 had no SQO exceedences and only DEHP was detected at the SQO. The Year 2 sample NR-14-Y2 had detected concentrations that were less than SQOs and DEHP decreased to 0.85 times the SQO. The other chemicals detected in this sample generally had comparable enrichment ratios between the baseline sample and Year 2 samples with some small decreases or increases in chemical concentrations.

Enhanced Natural Recovery Area in RA 7 – Similar to many of the natural recovery stations north of the 11th Street Bridge, station NR-16 located in the enhanced natural recovery area south of the 11th Street Bridge, has had two consecutive rounds of performance monitoring (0 to

10 cm) with chemical concentrations less than the SQOs. Only the RI sample from this location had detected concentrations that were greater than the SQOs. Detected chemicals in the baseline sample generally were comparable to the ratios for the detected chemicals in the Year 2 sample, with the exception of DEHP which showed an increase between baseline and Year 2 samples.

Natural Recovery Area at the Mouth of the Wheeler-Osgood Waterway – Detected concentrations in RI, baseline, and Year 2 monitoring samples from station NR-17 generally show a decreasing concentration trend over time. The RI sample had multiple chemical concentrations that were greater than the SQOs, while the baseline sample had only pyrene exceeding the SQO, at 1.24 times the SQO. The Year 2 sample NR-17-Y2 had detected concentrations that were less than SQOs, with pyrene detected at only 0.85 times the SQO. Other detected chemicals in the baseline and Year 2 samples generally had comparable ratios with some small decreases or increases in chemical concentrations.

Natural Recovery Area at Head of the Wheeler-Osgood Waterway – At natural recovery monitoring station NR-19, chemical concentrations in both the Year 2 natural recovery sample and the RI sample were less than the SQOs. The baseline sample, however, had three analytes including benzo(a)anthracene, pyrene, and n-nitrosodiphenylamine with concentrations greater than the SQOs. The concentrations for chemicals that exceeded the SQOs in the baseline sample have concentrations in Year 2 samples that are substantially below the SQOs. This variability in concentrations may be attributable to the heterogeneity of the sediment in this area of the Wheeler-Osgood Waterway.

Two RI samples collected in the vicinity of station NR-20 both had DEHP detections greater than the SQO, at 2.8 and 3.2 times the SQO. The RI samples also had up to seven other analytes with detections exceeding SQOs. The baseline sample NR-20-Y0-D had 13 chemicals, primarily PAHs, with concentrations greater than the SQOs. DEHP also exceeded the SQO in the baseline sample. In contrast, the field duplicate of sample NR-20-Y0-D, sample NR-20-Y0-D1, only had three chemicals, including DEHP, with concentrations greater than the SQOs. The DEHP concentrations in both the parent and duplicate baseline samples were 1.2 times the SQO. The difference in the number of PAH exceedences between the baseline parent sample and the field duplicate is attributed to the possible presence of a piece of creosote treated wood in the sample. The Year 2 sample NR-20-Y2 only had DEHP detected at a concentration greater than the SQO. The DEHP concentration was approximately 1.8 times the SQO. The DEHP concentration in the Year 2 sample is lower than the RI samples, but higher than the concentrations detected in the baseline samples. All other analytes detected in sample NR-20-Y2 were well below the SQOs.

Natural Recovery/Slope Rehabilitation Shoreline on the Wheeler-Osgood Waterway – The three samples, samples SR-10-Y2, SR-11-Y2, and SR-13-Y2, collected from the natural recovery / slope rehabilitation areas of the Wheeler-Osgood Waterway were compared to the baseline samples collected in 2006. Station SR-10, comprising the northern shoreline of the Wheeler-Osgood Waterway, had Year 2 and baseline samples with detected chemical concentrations for all constituents less than one-half the SQOs. The field duplicate collected in Year 2, sample SR-10-Y2-D, was generally similar in chemical concentrations to the parent sample, sample SR-10-Y2, with the exception of total PCBs which were detected with an ER of approximately 1.7 . As mentioned above, this PCB concentration in the duplicate sample likely is a result of a subcomponent within the sample.

Year 2 sample SR-11-Y2 was similar to the baseline sample, SR-11-Y0-D, with both samples having detected concentrations for nearly all constituents less than one-half of the SQOs. Baseline sample SR-13-Y0-D had chemical concentrations well below the SQOs. However, the Year 2 sample SR-13-Y2 had DEHP detected at a concentration above the SQO. The DEHP enrichment ratio increased from 0.29 in the baseline sample to 5.54 in sample SR-13-Y2.

Natural Recovery Area Adjacent to RA 15 and RA 16 – At natural recovery monitoring station NR-25, the RI, baseline, and Year 2 samples each had multiple detected chemical concentrations that were greater than the SQOs, with the specific chemicals exceeding the SQOs and the associated concentrations changing over time. The RI sample had five analytes with concentrations greater than the SQOs, with the enrichment ratios for these five analytes ranging from 1.03 to 5.5 times the SQO. DEHP had the highest enrichment ratio in the RI sample. The baseline sample had eight analytes detected at concentrations greater than the SQOs and one analyte detected at the SQO. The enrichment ratios for the analytes with concentrations greater than the SQOs in the baseline sample ranged from 1.02 to 2.9, with DEHP again having the highest ratio. Year 2 sample NR-25-Y2 had seven analytes with detected concentrations greater than the SQOs, with enrichment ratios up to 1.9 times the SQOs. Some of the analytes with concentrations that exceeded SQOs increased in concentration in the Year 2 sample relative to the baseline sample, while others decreased. The variability in the concentrations and trends for chemicals at station NR-25 is likely the result of the heterogeneity of sediment at this natural recovery monitoring station. However, the magnitude of the maximum enrichment ratio has decreased over time from a high of 5.5 in the RI sample to 1.9 in the Year 2 performance sample.

Summary of Year 2 Findings

A summary of the findings from the Year 2 natural recovery and enhanced natural recovery performance monitoring is included below. For a comparison of the Year 2 natural recovery and enhanced natural recovery sampling results to the co-located Year 2 early warning sample (0 to 2 cm) results refer to Section 3.0 on Early Warning Monitoring for Recontamination which evaluates the potential for recontamination of remediation areas within the Thea Foss and Wheeler-Osgood Waterways. A brief summary of the early warning samples co-located with the natural recovery and enhanced natural recovery samples is also provided below.

- Natural recovery samples from stations NR-6, NR-7, NR-8, NR-9, and NR-10 from north of the 11th Street Bridge have met the performance monitoring criteria specified in the OMMP. The baseline and Year 2 natural recovery performance monitoring surface samples (0-10 cm) collected from these natural recovery stations had detected chemical concentrations less than the SQOs. The SQO ratios between the baseline and the Year 2 samples were generally comparable; however, PAHs and phthalates showed a slight increase in Year 2 samples from stations NR-06 and NR-10 and DEHP showed an increase in Year 2 samples from stations NR-08 and NR-09. The detected chemical concentrations for the Year 2 early warning samples that are co-located with the Year 2 natural recovery surface samples were also less than the SQOs. The performance criteria outlined in the OMMP include performance monitoring surface samples with chemical concentrations less than the SQOs for two consecutive monitoring events (i.e., baseline and Year 2 monitoring) and chemical concentration trends not showing an increase over time. Based on the results of baseline and Year 2 performance and early warning monitoring, the need for additional monitoring at these five natural recovery stations will be discussed further with EPA.

- Natural recovery station NR-11 located north of the 11th Street Bridge had a DEHP concentration greater than the SQO in the Year 2 natural recovery performance surface sample. However, the DEHP concentration at this natural recovery location has consistently dropped over time from the sample collected during the RI, to the Year 2 sample. Additionally, the co-located Year 2 early warning sample had a DEHP concentration less than the concentration detected in the Year 2 natural recovery performance monitoring sample, indicating that the DEHP concentration is likely to continue to decrease in the future.

- Year 2 natural recovery samples were collected in the natural recovery area located south of and adjacent to the 11th Street Bridge at stations NR-12, NR-13, and NR-14. The detected chemical concentrations did not exceed the SQOs in the Year 2 performance surface samples (0 to 10 cm) collected from the three sample locations although DEHP was detected at the SQO in samples NR-12-Y2 and NR-13-Y2. Baseline samples collected at stations NR-13 and NR-14 had detected DEHP concentrations that were greater than the SQO. While the baseline sample collected at NR-12 had DEHP detected below the SQO, there was an increase in the DEHP concentration in the Year 2 sample. Additionally, co-located early warning sample EW-12-Y2, associated with sample NR-12-Y2, had a detected concentration of DEHP at 1.2 times the SQO, which is slightly above the DEHP concentration detected in sample NR-12-Y2. Similar to sample NR-13-Y2, the co-located early warning sample EW-13-Y2 had DEHP detected at the SQO.

- Natural recovery station NR-16 is located within the enhanced natural recovery area located south of the 11th Street Bridge on the west side of the waterway. The detected chemical concentrations for the baseline sample and Year 2 sample were less than the SQOs. Detected concentrations in the baseline sample and the Year 2 sample are generally comparable with no significant increases in concentrations identified in the Year 2 sample. The detected chemical concentrations in the Year 2 early warning sample were also less than the SQOs. However, the DEHP concentration was just below the SQO in the early warning sample so the area should continue to be monitored in Year 4.

- The Year 2 natural recovery performance surface sample from station NR-17, located at the mouth of the Wheeler-Osgood Waterway, had detected chemical concentrations that were less than the SQOs. The Year 2 early warning sample also had chemical concentrations less than SQOs. However, pyrene was greater than the SQO in the baseline sample collected from station NR-17. Concentration trends from baseline monitoring to Year 2 monitoring show a decrease in chemical concentrations indicating that the pyrene concentration is likely to continue to decrease in the future.

- Natural recovery station NR-19 is located near the head of the Wheeler-Osgood Waterway. Detected chemical concentrations in the Year 2 natural recovery sample from station NR-19 were less than the SQOs. However, the co-located early warning sample EW-19-Y2 had 12 SVOCs detected at concentrations greater than the SQOs. The source of the elevated concentrations in sample EW-19-Y2 is unclear, but may not be representative of the area due to the heterogeneity in the sediment in this portion of the waterway. Alternatively, a subcomponent of the early warning sample, such as a piece of creosote treated wood for example, may be the cause of the elevated SVOC concentrations. The baseline surface sample at station NR-19 also had detected concentrations of three SVOCs that were greater than the SQOs.

- Natural recovery station NR-20 is located at the head of the Wheeler-Osgood Waterway. The baseline sample collected at station NR-20 had detected concentrations of multiple chemicals that were greater than the SQOs. The Year 2 natural recovery performance monitoring surface sample and early warning sample from station NR-20 contained DEHP at concentrations greater than the SQO. Additionally, the slope rehabilitation sample SR-13-Y2 collected adjacent to station NR-20 also had DEHP detected at a concentration greater than the SQO.

- Natural recovery station NR-25, located in the natural recovery area north of RA 15 and east of RA 16, had detected chemical concentrations exceeding the SQOs in samples collected as part of Year 2 monitoring. The Year 2 performance monitoring surface sample NR-25-Y2 had seven analytes with detected concentrations greater than the SQOs. Some analyte concentrations appear to have increased while other analyte concentrations appear to have decreased in the Year 2 sample compared to the baseline sample. The Year 2 early warning sample also had detected concentrations that were greater than the SQOs for 10 analytes and the concentrations in the early warning sample tended to be slightly higher than the concentrations detected in the corresponding natural recovery performance sample. The trends in sample concentrations at station NR-25 may, in part, be the result of the heterogeneity in the sediment in this natural recovery area.

- Three Year 2 natural recovery / slope rehabilitation performance monitoring composite samples were collected from the shoreline slopes of the Wheeler-Osgood Waterway. The baseline and Year 2 sample collected from station SR-11 have demonstrated that the southern shoreline of the Wheeler-Osgood Waterway meets performance monitoring criteria and that it has naturally recovered. The detected chemical concentrations in the baseline and Year 2 performance monitoring samples have been less than the SQOs for two consecutive rounds of monitoring and chemical concentrations appear to have stabilized. Therefore, future monitoring at natural recovery station SR-11 is not required as the natural recovery process is complete.

  At station SR-10, the detected chemical concentrations in the baseline and Year 2 samples had detected concentrations less than SQOs. However, the field duplicate collected at SR-10 during Year 2 had PCBs detected at a concentration greater than the SQOs. The differing PCB concentrations in the parent and duplicate sample from station SR-10 are likely the result of the heterogeneity in the sediment in this portion of the waterway and that PCBs were present in a subcomponent of the duplicate sample.

  The detected chemical concentrations in samples collected from station SR-13, located at the head of the Wheeler-Osgood Waterway, were substantially below the SQO in the baseline and Year 2 performance monitoring samples except for DEHP. DEHP was less than the SQO in the baseline sample but the Year 2 sample had a DEHP concentration greater than the SQO. Station SR-13 is located adjacent to City Outfall 254, which has a likely, recent upland source of DEHP identified through the City's stormwater source control program. A sample of sediment was collected by the City from a catch basin at a newer correctional facility in the drainage basin for Outfall 254. DEHP was detected at a concentration exceeding 600,000 µg/kg, in the sample as reported in the City

Stormwater Source Control Report from 2006. A new building is located at the facility that has a large membrane roof that may be a source of DEHP to the stormwater catch basin. Other new industrial buildings within this outfall drainage basin may also be using a similar membrane roof. The City plans to revisit businesses within this outfall drainage basin to evaluate possible DEHP sources. See Section 7.3 for more comprehensive stormwater source control information. Station SR-13 will be monitored again as part of Year 4 OMMP monitoring.

2.3.1 Schedule of Natural Recovery and Enhanced Natural Recovery Monitoring Activities

No supplemental natural recovery or enhanced natural recovery monitoring is required to characterize Year 2 conditions in natural recovery or enhanced natural recovery areas. The next natural recovery or enhanced natural recovery area chemical performance monitoring, including collection and analysis of samples, is scheduled to occur in 2010 as part of Year 4 natural recovery or enhanced natural recovery performance monitoring. The schedule for OMMP activities to be performed as part of the Foss Project is presented in Table 1-1. The scope of natural recovery and enhanced natural recovery performance monitoring to be conducted in Year 4 is currently the same as for Year 2 and is described in the OMMP; however, the City would like to discuss with EPA the need for continued monitoring at five of the natural recovery stations mentioned above that appear to meet the performance criteria outlined in the OMMP.

TABLES

FIGURES

Table 2-1
Summary of Year 2 Slope Cap Surface Sample (0 to 10 cm) Results

	Station		SC-01		SC-03		SC-08A		SC-08B		SC-14		SC-19A		SC-19B		SC-20			
	Sample ID		SC-01-Y2		SC-03-Y2		SC-08A-Y2		SC-08B-Y2		SC-14-Y2		SC-19A-Y2		SC-19B-Y2		SC-20-Y2		SC-20-Y2-2	
	Sample Date		6/4/2008	Enrichment	6/4/2008	Enrichment	6/3/2008	Enrichment	6/3/2008	Enrichment	6/4/2008	Enrichment	6/2/2008	Enrichment	6/2/2008	Enrichment	6/5/2008	Enrichment	6/5/2008	Enrichment
	Sample Depth		0 to10 cm	Ratio	0 to10 cm	Ratio	0 to10 cm	Ratio	0 to10 cm	Ratio	0 to10 cm	Ratio	0 to10 cm	Ratio	0 to10 cm	Ratio	0 to10 cm	Ratio	0 to10 cm	Ratio
Parameter	**Units**	**SQO**																		
Conventionals																				
Total Organic Carbon	mg/kg	NC	1,610	NA	2,470	NA	1,660	NA	2,750 J	NA	4,200	NA	6,500	NA	9,960	NA	13,500	NA	14,500	NA
Total Solids	%	NC	93.2	NA	93.2	NA	89.8	NA	90.0	NA	81.2	NA	89.3	NA	83.7	NA	74.3	NA	70.0	NA
Metals																				
Antimony	mg/kg	150	0.86 U	NA	1.0 U	NA	1.0 U	NA	0.72 U	NA	0.84 U	NA	0.84 U	NA	1.1 U	NA	0.84 U	NA	1.0 U	NA
Arsenic	mg/kg	57	3.62 J	0.06	3.0 J	0.05	7.6	0.13	4.46	0.08	6.64	0.12	2.81 J	0.05	3.5 J	0.06	8.17	0.14	6.8	0.12
Cadmium	mg/kg	5.1	0.051 J	0.01	0.128 J	0.03	0.386	0.08	0.493	0.10	0.455	0.09	0.13 J	0.03	0.216 J	0.04	0.440	0.09	0.342	0.07
Copper	mg/kg	390	5.39	0.01	13.1	0.03	11.5	0.03	6.68	0.02	24.0	0.06	7.37	0.02	16.6	0.04	34.4	0.09	25.0	0.06
Lead	mg/kg	450	7.5	0.02	8.7	0.02	5.8	0.01	6.76	0.02	12.3	0.03	5.82	0.01	18.6	0.04	21.6	0.05	26.8	0.06
Nickel	mg/kg	140	13.6	0.10	20.9	0.15	20.0	0.14	12.3	0.09	17.8	0.13	8.65	0.06	10.4	0.07	17.0	0.12	17.7	0.13
Silver	mg/kg	6.1	1.36 J	0.22	2.03 J	0.33	2.33 J	0.38	2.09 J	0.34	2.28 J	0.37	1.04 J	0.17	1.41 J	0.23	2.05 J	0.34	1.73 J	0.28
Zinc	mg/kg	410	26.2	0.06	35.1	0.09	45.2	0.11	34.8	0.08	45.0	0.11	21.0	0.05	42.0	0.10	80.8	0.20	89.0	0.22
Mercury	mg/kg	0.59	0.009	0.02	0.015	0.03	0.013 U	NA	0.016	0.03	0.035	0.06	0.021	0.04	0.040	0.07	0.051	0.09	0.045	0.08
SVOCs																				
LPAHs																				
2-Methylnaphthalene	µg/kg	670	3.0 J	0.00	26	0.04	2.9 J	0.004	2.6 U	NA	20	0.03	16 J	0.02	36	0.05	30	0.04	28	0.04
Acenaphthene	µg/kg	500	3.3 J	0.01	20	0.04	2.2 U	NA	2.3 U	NA	22	0.04	13 J	0.03	45	0.09	17	0.03	19	0.04
Acenaphthylene	µg/kg	1,300	3.6 J	0.00	19	0.01	4.6	0.004	2.3 U	NA	18	0.01	8.9 J	0.01	23	0.02	19	0.01	15	0.01
Anthracene	µg/kg	960	15	0.02	78	0.08	7.1	0.01	3.7 J	0.004	50	0.05	25 J	0.03	72	0.08	140	0.15	51	0.05
Fluorene	µg/kg	540	4.4	0.01	27	0.05	2.1 J	0.004	1.9 U	NA	26	0.05	12 J	0.02	29	0.05	28	0.05	20	0.04
Naphthalene	µg/kg	2,100	8.6	0.00	42	0.02	4.4	0.002	3.5 J	0.002	34	0.02	37 J	0.02	88	0.04	58	0.03	58	0.03
Phenanthrene	µg/kg	1,500	65	0.04	150	0.10	17	0.01	23	0.02	320	0.21	78 J	0.05	190	0.13	200	0.13	180	0.12
Total LPAH	µg/kg	5,200	103 J	0.02	362	0.07	38 J	0.01	30 J	0.01	490	0.09	190 J	0.04	483	0.09	492	0.09	371	0.07
HPAHs																				
Benzo(a)anthracene	µg/kg	1,600	56	0.04	92	0.06	25	0.02	15	0.01	120	0.08	66	0.04	120	0.08	280	0.18	150	0.09
Benzo(a)pyrene	µg/kg	1,600	63	0.04	100	0.06	35 U	NA	36 U	NA	110	0.07	120	0.08	160	0.10	240	0.15	200	0.13
Benzofluoranthenes (total)	µg/kg	3,600	99	0.03	220	0.06	76	0.02	53	0.01	310	0.09	250	0.07	340	0.09	570	0.16	520	0.14
Benzo(g,h,i)perylene	µg/kg	720	36 U	NA	44 J	0.06	34 U	NA	35 U	NA	81 J	0.11	100	0.14	96	0.13	150	0.21	140	0.19
Chrysene	µg/kg	2,800	63	0.02	150	0.05	49	0.02	27	0.01	270	0.10	100	0.04	180	0.06	400	0.14	270	0.10
Dibenzo(a,h)anthracene	µg/kg	230	42 U	NA	42 U	NA	41 U	NA	41 U	NA	42 U	NA	52	0.23	42 U	NA	47	0.20	42 U	0.18
Fluoranthene	µg/kg	2,500	110	0.04	290	0.12	35	0.01	46	0.02	420	0.17	160 J	0.06	280	0.11	550	0.22	410	0.16
Indeno(1,2,3-cd)pyrene	µg/kg	690	39 U	NA	42 J	0.06	38 U	NA	38 U	NA	77 J	0.11	95	0.14	87	0.13	120	0.17	120	0.17
Pyrene	µg/kg	3,300	130	0.04	370	0.11	29	0.01	43	0.01	360	0.11	140	0.04	310	0.09	520	0.16	430	0.13
Total HPAH	µg/kg	17,000	521	0.03	1,308 J	0.08	214	0.01	184	0.01	1,748 J	0.10	1,083 J	0.06	1,573	0.09	2,877	0.17	2,240	0.13
Other																				
Dimethyl phthalate	µg/kg	160	1.6 U	NA	1.6 U	NA	1.5 U	NA	1.5 U	NA	4.3	0.03	5.5 J	0.03	2.7 J	0.02	7.4	0.05	6.4	0.04
Diethylphthalate	µg/kg	200	32 U	NA	32 U	NA	31 U	NA	32 U	NA	32 U	NA	32 UJ	NA	32 U	NA	32 U	NA	32 U	NA
Di-n-butyl phthalate	µg/kg	1,400	33 U	NA	33 U	NA	32 U	NA	32 U	NA	33 U	NA	33 UJ	NA	33 U	NA	52	0.04	110	0.08
Butyl benzyl phthalate	µg/kg	900	31 U	NA	31 U	NA	30 U	NA	30 U	NA	60 J	0.07	54 J	0.06	49 J	0.05	780	0.87	830	0.92
Bis(2-ethylhexyl)phthalate	µg/kg	1,300	46 J	0.04	64 J	0.05	82	0.06	140	0.11	530	0.41	330	0.25	520	0.40	1,200	0.92	1,300	1.00
Di-n-octyl phthalate	µg/kg	6,200	36 U	NA	36 U	NA	34 U	NA	35 U	NA	35 U	NA	36 U	NA	36 U	NA	65 J	0.01	71 J	0.01
Phenol	µg/kg	420	5.3 J	0.01	9.2	0.02	11	0.03	8.7	0.02	21	0.05	21 J	0.05	16	0.04	50	0.12	34	0.08
2-Methylphenol	µg/kg	63	4.7 U	NA	4.7 U	NA	4.5 U	NA	4.5 U	NA	4.6 U	NA	4.6 UJ	NA	37	0.59	4.6 U	NA	4.7 U	NA
4-Methylphenol	µg/kg	670	2.5 U	NA	2.5 U	NA	2.4 U	NA	2.4 U	NA	6.2	0.01	2.5 UJ	NA	2.5 U	NA	2.5 U	NA	5.1	0.01
2,4-Dimethylphenol	µg/kg	29	1.8 U	NA	1.8 U	NA	1.8 U	NA	1.8 U	NA	1.8 U	NA	1.8 UJ	NA	1.8 U	NA	1.8 U	NA	1.8 U	NA
Pentachlorophenol	µg/kg	360	43 U	NA	43 U	NA	42 U	NA	42 U	NA	43 UJ	NA	43 UJ	NA	43 U	NA	43 UJ	NA	43 UJ	NA
Benzyl alcohol	µg/kg	73	23 U	NA	23 U	NA	**93**	1.27	23 U	NA	23 U	NA	23 UJ	NA	23 U	NA	23 U	NA	23 U	NA
Benzoic acid	µg/kg	650	62 U	NA	62 U	NA	60 U	NA	61 U	NA	62 U	NA	110 J	0.17	62 U	NA	61 U	NA	62 U	NA
1,2-Dichlorobenzene	µg/kg	50	2.2 UJ	NA	2.2 UJ	NA	2.2 UJ	NA	2.2 UJ	NA	2.2 UJ	NA	2.2 UJ	NA	2.2 UJ	NA	2.2 UJ	NA	2.2 UJ	NA
1,3-Dichlorobenzene	µg/kg	170	2.5 UJ	NA	2.5 UJ	NA	2.4 UJ	NA	2.4 UJ	NA	2.5 UJ	NA	2.5 UJ	NA	2.5 UJ	NA	2.5 UJ	NA	2.5 UJ	NA
1,4-Dichlorobenzene	µg/kg	110	2.6 UJ	NA	2.6 UJ	NA	2.5 UJ	NA	2.5 UJ	NA	2.6 UJ	NA	2.6 UJ	NA	2.6 UJ	NA	2.5 UJ	NA	2.6 UJ	NA
1,2,4-Trichlorobenzene	µg/kg	51	2.6 U	NA	2.6 U	NA	2.5 U	NA	2.5 U	NA	2.6 U	NA	2.6 UJ	NA	2.6 U	NA	2.5 U	NA	2.6 U	NA
Hexachlorobenzene	µg/kg	22	1.7 U	NA	1.7 U	NA	1.7 U	NA	1.7 U	NA	1.7 U	NA	1.7 UJ	NA	1.7 U	NA	1.7 U	NA	1.7 U	NA
Dibenzofuran	µg/kg	540	3.6 J	0.01	22	0.04	2.2 U	NA	2.2 U	NA	26	0.05	8.6 J	0.02	13	0.02	17	0.03	17	0.03
Hexachlorobutadiene	µg/kg	11	2.7 U	NA	2.7 U	NA	2.6 U	NA	2.7 U	NA	2.7 U	NA	2.7 UJ	NA	2.7 U	NA	2.7 U	NA	2.7 U	NA
N-Nitrosodiphenylamine	µg/kg	28	2.0 U	NA	2.0 U	NA	1.9 U	NA	1.9 U	NA	2.5 J	0.09	3.2 J	0.11	3.3 J	0.12	3.8 J	0.14	4.1 J	0.15
Pesticides																				
p,p'-DDD	µg/kg	16	5.0 U	NA	5.0 U	NA	4.8 U	NA	4.9 U	NA	4.9 U	NA	5.0 U	NA	5.0 U	NA	4.9 U	NA	5.0 U	NA
p,p'-DDE	µg/kg	9	2.5 U	NA	2.5 U	NA	2.4 U	NA	2.4 U	NA	2.5 U	NA	2.5 U	NA	2.5 U	NA	2.5 U	NA	2.5 U	NA
p,p'-DDT	µg/kg	34	7.5 UJ	NA	7.5 UJ	NA	7.2 UJ	NA	7.3 UJ	NA	7.4 UJ	NA	7.4 UJ	NA	7.5 UJ	NA	7.4 UJ	NA	7.5 UJ	NA
PCBs																				
PCB-1016	µg/kg	NC	10 U	NA	10 U	NA	9.6 U	NA	9.7 U	NA	9.9 U	NA	9.9 U	NA	10 U	NA	9.8 U	NA	10 U	NA
PCB-1221	µg/kg	NC	10 U	NA	10 U	NA	9.6 U	NA	9.7 U	NA	9.9 U	NA	9.9 U	NA	10 U	NA	9.8 U	NA	10 U	NA
PCB-1232	µg/kg	NC	10 U	NA	10 U	NA	9.6 U	NA	9.7 U	NA	9.9 U	NA	9.9 U	NA	10 U	NA	9.8 U	NA	10 U	NA
PCB-1242	µg/kg	NC	12 U	NA	12 U	NA	12 U	NA	12 U	NA	12 U	NA	12 U	NA	12 U	NA	12 U	NA	12 U	NA
PCB-1248	µg/kg	NC	12 U	NA	12 U	NA	12 U	NA	12 U	NA	12 U	NA	12 U	NA	12 U	NA	12 U	NA	12 U	NA
PCB-1254	µg/kg	NC	12 U	NA	12 U	NA	12 U	NA	12 U	NA	20 J	NA	12 U	NA	12 U	NA	12 U	NA	12 U	NA
PCB-1260	µg/kg	NC	12 U	NA	12 U	NA	12 U	NA	12 U	NA	12 U	NA	12 U	NA	12 U	NA	12 U	NA	12 U	NA
PCBs (total)	µg/kg	300	12 U	NA	12 U	NA	12 U	NA	12 U	NA	20 J	0.07	12 U	NA	12 U	NA	12 U	NA	12 U	NA

Notes:

Concentrations highlighted in **red** exceed the SQO.

NA: Not applicable

NC: No SQO criterion.

Qualifiers:

U - Undetected

J - The analyte was analyzed for and positively identified, but the associated numerical value is an estimate.

UJ - The analyte was analyzed for and not detected, but the associated numerical value is an estimate.

Table 2-2

Summary of Year 2 Channel Sand Cap Surface Sample (0 to 10 cm) Results

	Station		CC-01		CC-18		CC-23		CC-26		CC-27		CC-29		CC-30				CC-31		CC-32		CC-33	
	Sample ID		CC-01-Y2		CC-18-Y2		CC-23-Y2		CC-26-Y2		CC-27-Y2		CC-29-Y2		CC-30-Y2		CC-30-Y2-2		CC-31-Y2		CC-32-Y2		CC-33-Y2	
	Sample Date		5/29/2008	Enrichment Ratio	5/29/2008	Enrichment Ratio	6/23/2008	Enrichment Ratio	6/23/2008	Enrichment Ratio	6/23/2008	Enrichment Ratio	6/23/2008	Enrichment Ratio	6/24/2008	Enrichment Ratio	6/24/2008	Enrichment Ratio	6/24/2008	Enrichment Ratio	6/24/2008	Enrichment Ratio	6/24/2008	Enrichment Ratio
	Sample Depth		0 to 10 cm		0 to 10 cm		0 to 10 cm		0 to 10 cm		0 to 10 cm		0 to 10 cm		0 to 10 cm		0 to 10 cm		0 to 10 cm		0 to 10 cm		0 to 10 cm	
Parameter	**Units**	**SQO**																						
Conventionals																								
Total Organic Carbon	mg/kg	NC	5,080	NA	14,900	NA	21,900	NA	10,000	NA	8,700	NA	9,800	NA	6,160 J	NA	8,180 J	NA	15,700 J	NA	32,000 J	NA	17,600 J	NA
Total Solids	%	NC	71.4	NA	66.7	NA	54.3	NA	83.1	NA	87.2	NA	80.4	NA	85.8	NA	84.2	NA	78.8	NA	62.2	NA	77.9	NA
Metals																								
Antimony	mg/kg	150	1.2 U	NA	0.9 U	NA	2.0 U	NA	2.3 U	NA	2.3 U	NA	2.3 U	NA	1.1 U	NA	1.1 U	NA	1.0 U	NA	1.8 U	NA	0.86 U	NA
Arsenic	mg/kg	57	4.5 J	0.08	7.6	0.13	10.4	0.18	7.0 J	0.12	3.4 J	0.06	7.0 J	0.12	4.9	0.09	4.9 J	0.09	6.8	0.12	9.9	0.17	6.01	0.11
Cadmium	mg/kg	5.1	0.447	0.09	0.43	0.08	2.15	0.42	1.82	0.36	1.73	0.34	1.19	0.23	0.988	0.19	1.18	0.23	1.41	0.28	1.84	0.36	1.31	0.26
Copper	mg/kg	390	33.4	0.09	37.6	0.10	59.3	0.15	29.4	0.08	16.3	0.04	21.1	0.05	17.2	0.04	17.1	0.04	26.3	0.07	53.3	0.14	27.5	0.07
Lead	mg/kg	450	7.8	0.02	20.7	0.05	60.7	0.13	10.4	0.02	7.75 J	0.02	15.1	0.03	8.0	0.02	8.9	0.02	18.6	0.04	56.7	0.13	18.1	0.04
Nickel	mg/kg	140	12.2	0.09	14.8	0.11	23.6	0.17	15.2	0.11	12.2	0.09	14.9	0.11	15.5	0.11	23.0	0.16	13.7	0.10	20.3	0.15	17.2	0.12
Silver	mg/kg	6.1	2.07 J	0.34	2.01 J	0.33	2.70 J	0.44	2.20 J	0.36	2.38 J	0.39	2.02 J	0.33	1.44 J	0.24	1.82 J	0.30	2.14	0.35	2.89 J	0.47	1.73 J	0.28
Zinc	mg/kg	410	35.5	0.09	59.3	0.14	139	0.34	34.5	0.08	31.8	0.08	41.9	0.10	34.3	0.08	31.8	0.08	57.0	0.14	116	0.28	61.5	0.15
Mercury	mg/kg	0.59	0.027	0.05	0.082	0.14	0.188	0.32	0.0437	0.07	0.0348	0.06	0.058	0.10	0.027	0.05	0.025	0.04	0.047	0.08	0.164	0.28	0.048	0.08
SVOCs																								
LPAHs																								
2-Methylnaphthalene	µg/kg	670	15	0.02	42	0.06	58	0.09	19	0.03	12	0.02	45	0.07	14	0.02	14	0.02	93	0.14	280	0.42	36	0.05
Acenaphthene	µg/kg	500	5.9	0.01	14	0.03	70	0.14	12	0.02	7.8	0.02	30	0.06	11	0.02	8.6	0.02	43	0.09	490	0.98	32	0.06
Acenaphthylene	µg/kg	1,300	13	0.01	29	0.02	29	0.02	11	0.01	6.9	0.01	20	0.02	9.4	0.01	6.9	0.01	21	0.02	160	0.12	19	0.01
Anthracene	µg/kg	960	50	0.05	68	0.07	180	0.19	33	0.03	21	0.02	59	0.06	25	0.03	24	0.03	91	0.09	670	0.70	71	0.07
Fluorene	µg/kg	540	13	0.02	25	0.05	100	0.19	17	0.03	10	0.02	33	0.06	13	0.02	11	0.02	49	0.09	300	0.56	31	0.06
Naphthalene	µg/kg	2,100	23	0.01	69	0.03	180	0.09	48	0.02	28	0.01	120	0.06	31	0.01	32	0.02	230	0.11	760	0.36	94	0.04
Phenanthrene	µg/kg	1,500	77	0.05	130	0.09	1,100	0.73	81	0.05	58	0.04	150	0.10	87	0.06	83	0.06	220	0.15	**1,600**	1.07	240	0.16
Total LPAH	µg/kg	5,200	197	0.04	377	0.07	1,717	0.33	221	0.04	144	0.03	457	0.09	190	0.04	180	0.03	747	0.14	4,260	0.82	523	0.10
HPAHs																								
Benzo(a)anthracene	µg/kg	1,600	75	0.05	130	0.08	830	0.52	70	0.04	52	0.03	110	0.07	72	0.05	66	0.04	140	0.09	820	0.51	190	0.12
Benzo(a)pyrene	µg/kg	1,600	80	0.05	150	0.09	730	0.46	92	0.06	69 J	0.04	110	0.07	63 J	0.04	95	0.06	150	0.09	770	0.48	170	0.11
Benzofluoranthenes (total)	µg/kg	3,600	140	0.04	350	0.10	2,100	0.58	200	0.06	150	0.04	240	0.07	150	0.04	220	0.06	340	0.09	1,300	0.36	420	0.12
Benzo(g,h,i)perylene	µg/kg	720	34 J	0.05	92	0.13	**770**	1.07	77	0.11	53 J	0.07	83	0.12	57 J	0.08	63 J	0.09	110	0.15	410	0.57	130	0.18
Chrysene	µg/kg	2,800	97	0.03	200	0.07	1,200	0.43	120	0.04	79	0.03	150	0.05	110	0.04	120	0.04	210	0.08	960	0.34	290	0.10
Dibenzo(a,h)anthracene	µg/kg	230	35 U	NA	42 U	NA	220	0.96	39 U	NA	42 U	NA	42 U	NA	42 U	NA	42 U	NA	42 U	NA	120	0.52	42 U	NA
Fluoranthene	µg/kg	2,500	150	0.06	280	0.11	2,100	0.84	200	0.08	120	0.05	190	0.08	160	0.06	170	0.07	290	0.12	1,300	0.52	440	0.18
Indeno(1,2,3-cd)pyrene	µg/kg	690	33 U	NA	76 J	0.11	**710**	1.03	66 J	0.10	46 J	0.07	79 J	0.11	55 J	0.08	66 J	0.10	110	0.16	410	0.59	130	0.19
Pyrene	µg/kg	3,300	220	0.07	410	0.12	2,400	0.73	220	0.07	140	0.04	340	0.10	200	0.06	210	0.06	480	0.15	3,100	0.94	680	0.21
Total HPAH	µg/kg	17,000	796 J	0.05	1,688 J	0.10	11,060	0.65	1,045 J	0.06	709 J	0.04	1,302 J	0.08	867 J	0.05	1,010 J	0.06	1,830	0.11	9,190	0.54	2,450	0.14
Other																								
Dimethyl phthalate	µg/kg	160	1.3 U	NA	4.4	0.03	10	0.06	5.6	0.04	2.5 J	0.02	6.4	0.04	4.3	0.03	2.1 J	0.01	7.3	0.05	12	0.08	6.5	0.04
Diethylphthalate	µg/kg	200	27 U	NA	32 U	NA	39 U	NA	30 U	NA	32 U	NA	32 U	NA	32 U	NA	32 U	NA	32 U	NA	32 U	NA	32 U	NA
Di-n-butyl phthalate	µg/kg	1,400	28 U	NA	33 U	NA	50	0.04	31 U	NA	33 U	NA	33 U	NA	33 U	NA	33 U	NA	33	0.02	49	0.04	33 U	NA
Butyl benzyl phthalate	µg/kg	900	45 J	0.05	70 J	0.08	190	0.21	46 J	0.05	42 J	0.05	84	0.09	48 J	0.05	49 J	0.05	250	0.28	210	0.23	110	0.12
Bis(2-ethylhexyl)phthalate	µg/kg	1,300	160	0.12	910	0.70	**3,100**	2.38	290	0.22	240	0.18	590	0.45	380	0.29	390	0.30	1,100	0.85	**2,300**	1.77	1,300	1.00
Di-n-octyl phthalate	µg/kg	6,200	30 U	NA	38 J	0.01	43 U	NA	33 U	NA	35 U	NA	36 U	NA	36 U	NA	36 U	NA	36 U	NA	66 J	0.01	36 U	NA
Phenol	µg/kg	420	17	0.04	55	0.13	74	0.18	23	0.05	13	0.03	28	0.07	17	0.04	16	0.04	30	0.07	39	0.09	31	0.07
2-Methylphenol	µg/kg	63	13	0.21	4.6 U	NA	6 UR	NA	4.3 U	NA	4.6 U	NA	4.6 U	NA	4.6 U	NA	4.7 U	NA	4.6 U	NA	4.7 U	NA	4.7 U	NA
4-Methylphenol	µg/kg	670	2.1 U	NA	11	0.02	7.4 J	0.01	4.6	0.01	2.5 U	NA	2.5 U	NA	2.5 U	NA	2.5 U	NA	5.9 J	0.01	31	0.05	2.5 U	NA
2,4-Dimethylphenol	µg/kg	29	1.5 U	NA	1.8 U	NA	7 J	0.24	2.5 J	0.09	1.8 U	NA	3.0 J	0.10	1.8 UJ	NA	2.0 J	0.07	2.2 J	0.08	6.7 J	0.23	1.8 UJ	NA
Pentachlorophenol	µg/kg	360	36 U	NA	43 U	NA	52 UJ	NA	40 U	NA	43 U	NA	43 U	NA	43 U	NA	43 U	NA	43 U	NA	43 U	NA	43 U	NA
Benzyl alcohol	µg/kg	73	19 U	NA	28 J	0.38	**130 J**	1.78	22 U	NA	24 J	0.33	39 J	0.53	23 U	NA	23 U	NA	23 U	NA	54 J	0.74	23 U	NA
Benzoic acid	µg/kg	650	52 UJ	NA	62 U	NA	240	0.37	71 J	0.11	62 U	NA	62 U	NA	62 U	NA	62 U	NA	62 U	NA	62 U	NA	62 U	NA
1,2-Dichlorobenzene	µg/kg	50	1.9 U	NA	2.2 UJ	NA	2.7 UJ	NA	2.1 UJ	NA	2.2 UJ	NA	2.2 UJ	NA	2.2 UJ	NA	2.2 UJ	NA	2.2 UJ	NA	2.2 UJ	NA	2.2 UJ	NA
1,3-Dichlorobenzene	µg/kg	170	2.1 U	NA	2.5 UJ	NA	3.0 UJ	NA	2.3 UJ	NA	2.5 UJ	NA	2.5 UJ	NA	2.5 UJ	NA	2.5 UJ	NA	2.5 UJ	NA	2.5 UJ	NA	2.5 UJ	NA
1,4-Dichlorobenzene	µg/kg	110	2.1 UJ	NA	3.0 J	0.03	4.3 J	0.04	2.4 UJ	NA	2.6 UJ	NA	13 J	0.12	2.6 UJ	NA	2.6 UJ	NA	3.6 J	0.03	7.1 J	0.06	2.6 UJ	NA
1,2,4-Trichlorobenzene	µg/kg	51	2.1 U	NA	2.6 U	NA	3.3 J	0.06	2.4 U	NA	2.6 U	NA	2.6 U	NA	2.6 U	NA	2.6 U	NA	2.6 U	NA	2.6 U	NA	2.6 U	NA
Hexachlorobenzene	µg/kg	22	1.5 U	NA	1.7 U	NA	2.1 U	NA	1.6 U	NA	1.7 U	NA	2.5 J	0.11	1.7 U	NA	1.7 U	NA	1.7 U	NA	1.7 U	NA	1.7 U	NA
Dibenzofuran	µg/kg	540	8.9	0.02	21	0.04	66	0.12	11	0.02	6.9	0.01	20	0.04	9.2	0.02	8.6	0.02	31	0.06	95	0.18	18	0.03
Hexachlorobutadiene	µg/kg	11	2.3 U	NA	2.7 U	NA	3.3 U	NA	2.5 U	NA	2.7 U	NA	2.7 U	NA	2.7 U	NA	2.7 U	NA	2.7 U	NA	2.7 U	NA	2.7 U	NA
N-Nitrosodiphenylamine	µg/kg	28	1.7 U	NA	4.6	0.16	5.5	0.20	1.8 U	NA	2.0 U	NA	5.3	0.19	4.9	0.18	2.3 J	0.08	5.7	0.20	18	0.64	5.8	0.21
Pesticides																								
p,p'-DDD	µg/kg	16	5.0 U	NA	6.0 U	NA	6.0 U	NA	4.6 U	NA	4.9 U	NA	5.0 U	NA	5.0 U	NA	5.0 U	NA	5.0 U	NA	5.0 U	NA	5.0 U	NA
p,p'-DDE	µg/kg	9	2.5 U	NA	3.0 U	NA	3.0 U	NA	2.3 U	NA	2.5 U	NA	2.5 U	NA	2.5 U	NA	2.5 U	NA	2.5 U	NA	2.5 U	NA	2.5 U	NA
p,p'-DDT	µg/kg	34	7.5 U	NA	8.9 UJ	NA	9.0 U	NA	6.9 U	NA	7.4 U	NA	7.4 U	NA	7.5 U	NA	7.5 U	NA	7.5 U	NA	7.5 U	NA	7.5 U	NA
PCBs																								
PCB-1016	µg/kg	NC	12 U	NA	12 U	NA	12 U	NA	9.2 U	NA	10 U	NA	9.9 U	NA	10 U	NA	10 U	NA	9.9 U	NA	10 U	NA	10 U	NA
PCB-1221	µg/kg	NC	12 U	NA	12 U	NA	12 U	NA	9.2 U	NA	10 U	NA	9.9 U	NA	10 U	NA	10 U	NA	9.9 U	NA	10 U	NA	10 U	NA
PCB-1232	µg/kg	NC	12 U	NA	12 U	NA	12 U	NA	9.2 U	NA	10 U	NA	9.9 U	NA	10 U	NA	10 U	NA	9.9 U	NA	10 U	NA	10 U	NA
PCB-1242	µg/kg	NC	15 U	NA	15 U	NA	15 U	NA	12 U	NA	12 U	NA	12 U	NA	12 U	NA	12 U	NA	12 U	NA	12 U	NA	12 U	NA
PCB-1248	µg/kg	NC	15 U	NA	15 U	NA	15 U	NA	12 U	NA	12 U	NA	12 U	NA	12 U	NA	12 U	NA	12 U	NA	12 U	NA	12 U	NA
PCB-1254	µg/kg	NC	15 U	NA	15 U	NA	15 U	NA	12 U	NA	12 U	NA	12 U	NA	12 U	NA	12 U	NA	12 U	NA	12 U	NA	12 U	NA
PCB-1260	µg/kg	NC	15 U	NA	15 U	NA	15 U	NA	12 U	NA	12 U	NA	12 U	NA	12 U	NA	12 U	NA	12 U	NA	12 U	NA	12 U	NA
PCBs (total)	µg/kg	300	15 U	NA	15 U	NA	15 U	NA	12 U	NA	12 U	NA	12 U	NA	12 U	NA	12 U	NA	12 U	NA	12 U	NA	12 U	NA

Notes:

Concentrations highlighted in **red** exceed the SQO.

NA: Not applicable

NC: No SQO criterion.

Qualifiers:

U - Undetected

J - The analyte was analyzed for and positively identified, but the associated numerical value is an estimate.

UJ - The analyte was analyzed for and not detected, but the associated numerical value is an estimate.

UR - The analyte was analyzed for and not detected, but the result was rejected due to holding time exceedance.

Table 2-3

Summary of Year 2 Natural Recovery and Enhanced Natural Recovery Surface Sample (0 to 10 cm) Results

	Station		NR-06		NR-07		NR-08		NR-09		NR-10				NR-11		NR-12		NR-13		NR-14		NR-16		NR-17	
	Sample ID		NR-06-Y2		NR-07-Y2		NR-08-Y2		NR-09-Y2		NR-10-Y2		NR-10-Y2-2		NR-11-Y2		NR-12-Y2		NR-13-Y2		NR-14-Y2		NR-16-Y2		NR-17-Y2	
	Sample Date		5/27/2008	Enrichment	5/28/2008	Enrichment	5/27/2008	Enrichment	5/27/2008	Enrichment	5/28/2008	Enrichment	5/28/2008	Enrichment	5/28/2008	Enrichment	5/28/2008	Enrichment	5/29/2008	Enrichment	5/28/2008	Enrichment	5/29/2008	Enrichment	5/29/2008	Enrichment
	Sample Depth		0 to 10 cm	Ratio	0 to 10 cm	Ratio	0 to 10 cm	Ratio	0 to 10 cm	Ratio	0 to 10 cm	Ratio	0 to 10 cm	Ratio	0 to 10 cm	Ratio	0 to 10 cm	Ratio	0 to 10 cm	Ratio	0 to 10 cm	Ratio	0 to 10 cm	Ratio	0 to 10 cm	Ratio
Parameter	**Units**	**SQO**																								
Conventionals																										
Total Organic Carbon	mg/kg	NC	17,200	NA	15,200	NA	7,370	NA	6,800	NA	18,400	NA	18,000	NA	19,500	NA	17,800	NA	20,800	NA	16,500	NA	14,100	NA	22,200	NA
Total Solids	%	NC	49.7	NA	47.2	NA	69.1	NA	69.2	NA	51.1	NA	50.8	NA	46.2	NA	53.2	NA	54.8	NA	57.4	NA	78.3	NA	59.7	NA
Metals																										
Antimony	mg/kg	150	2.2 U	NA	2.0 U	NA	2.2 U	NA	2.3 U	NA	2.2 U	NA	2.2 U	NA	2.2 U	NA	2.0 U	NA	2.1 J	0.01	2.2 U	NA	1.9 U	NA	2.2 U	NA
Arsenic	mg/kg	57	12.8	0.22	11.2	0.20	4.7 J	0.08	6.1 J	0.11	12.8	0.22	14.0	0.25	14.0	0.25	16.3	0.29	16.3	0.29	14.1	0.25	5.1 J	0.09	4.8 J	0.08
Cadmium	mg/kg	5.1	0.97	0.19	0.98	0.19	0.53	0.10	0.47 J	0.09	1.50	0.29	1.20	0.24	1.24	0.24	1.15	0.23	1.13	0.22	1.10	0.22	0.10 U	NA	0.20 J	0.04
Copper	mg/kg	390	76.8	0.20	90.4	0.23	41.5	0.11	35.8	0.09	99.0	0.25	88.6	0.23	94.2	0.24	87.8	0.23	92.5	0.24	68.4	0.18	24.0	0.06	66.5	0.17
Lead	mg/kg	450	50.1	0.11	52.1	0.12	21.1	0.05	21.5	0.05	81.0	0.18	86.5	0.19	66.5	0.15	76.2	0.17	82.3	0.18	70.3	0.16	13.6	0.03	28.5	0.06
Nickel	mg/kg	140	16.9	0.12	17.6	0.13	16.8	0.12	16.0	0.11	21.0	0.15	21.3	0.15	19.4	0.14	19.7	0.14	22.4	0.16	18.0	0.13	8.92	0.06	10.0	0.07
Silver	mg/kg	6.1	3.15 J	0.52	2.98 J	0.49	2.75 J	0.45	2.89 J	0.47	3.90 J	0.64	4.26 J	0.70	3.53 J	0.58	3.03 J	0.50	3.57 J	0.59	3.63 J	0.60	1.69 J	0.28	2.79 J	0.46
Zinc	mg/kg	410	90.0	0.22	110	0.27	53.6	0.13	47.6	0.12	122	0.30	129	0.31	139	0.34	139	0.34	137	0.33	104	0.25	37.7	0.09	71.1	0.17
Mercury	mg/kg	0.59	0.225	0.38	0.296	0.50	0.101	0.17	0.108	0.18	0.314	0.53	0.377	0.64	0.253	0.43	0.369	0.63	0.288	0.49	0.321	0.54	0.0393	0.07	0.111	0.19
SVOCs																										
LPAHs																										
2-Methylnaphthalene	µg/kg	670	190	0.28	86	0.13	46	0.07	68	0.10	160	0.24	170	0.25	92	0.14	120	0.18	190	0.28	160	0.24	14	0.02	390	0.58
Acenaphthene	µg/kg	500	92	0.18	46	0.09	23	0.05	35	0.07	87	0.17	87	0.17	50	0.10	76	0.15	97	0.19	76	0.15	6.8	0.01	92	0.18
Acenaphthylene	µg/kg	1,300	180	0.14	66	0.05	32	0.02	41	0.03	100	0.08	98	0.08	66	0.05	140	0.11	130	0.10	110	0.08	9.1	0.01	170	0.13
Anthracene	µg/kg	960	460	0.48	190	0.20	92	0.10	110	0.11	280	0.29	270	0.28	190	0.20	630	0.66	370	0.39	290	0.30	27	0.03	730	0.76
Fluorene	µg/kg	540	140	0.26	65	0.12	39	0.07	49	0.09	120	0.22	120	0.22	65	0.12	140	0.26	140	0.26	120	0.22	10	0.02	270	0.50
Naphthalene	µg/kg	2,100	390	0.19	160	0.08	89	0.04	130	0.06	340	0.16	340	0.16	190	0.09	280	0.13	410	0.20	350	0.17	27	0.01	390	0.19
Phenanthrene	µg/kg	1,500	820	0.55	310	0.21	160	0.11	210	0.14	470	0.31	470	0.31	350	0.23	750	0.50	660	0.44	500	0.33	62	0.04	1,200	0.80
Total LPAH	µg/kg	5,200	2,272	0.44	923	0.18	481	0.09	643	0.12	1,557	0.30	1,555	0.30	1,003	0.19	2,136	0.41	1,997	0.38	1,606	0.31	156	0.03	3,242	0.62
HPAHs																										
Benzo(a)anthracene	µg/kg	1,600	810	0.51	320	0.20	180	0.11	190	0.12	530	0.33	460	0.29	380	0.24	760	0.48	670	0.42	450	0.28	63	0.04	590	0.37
Benzo(a)pyrene	µg/kg	1,600	890	0.56	410	0.26	210	0.13	250	0.16	780	0.49	710	0.44	500	0.31	790	0.49	930	0.58	640	0.40	86	0.05	680	0.43
Benzofluoranthenes (total)	µg/kg	3,600	1,500	0.42	820	0.23	410	0.11	460	0.13	1,500	0.42	1,300	0.36	1,100	0.31	1,600	0.44	1,900	0.53	1,200	0.33	210	0.06	940	0.26
Benzo(g,h,i)perylene	µg/kg	720	510	0.71	260	0.36	140	0.19	170	0.24	500	0.69	410	0.57	240	0.33	390	0.54	490	0.68	390	0.54	59 J	0.08	240	0.33
Chrysene	µg/kg	2,800	930	0.33	500	0.18	240	0.09	250	0.09	780	0.28	670	0.24	570	0.20	1,100	0.39	1,000	0.36	620	0.22	100	0.04	660	0.24
Dibenzo(a,h)anthracene	µg/kg	230	170	0.74	85	0.37	46 J	0.20	52 J	0.23	170	0.74	140	0.61	76	0.33	120	0.52	150	0.65	110	0.48	42 U	NA	71	0.31
Fluoranthene	µg/kg	2,500	1,300	0.52	580	0.23	330	0.13	370	0.15	800	0.32	720	0.29	570	0.23	1,700	0.68	1,300	0.52	780	0.31	130	0.05	970	0.39
Indeno(1,2,3-cd)pyrene	µg/kg	690	460	0.67	230	0.33	130	0.19	150	0.22	430	0.62	370	0.54	220	0.32	370	0.54	440	0.64	330	0.48	48 J	0.07	210	0.30
Pyrene	µg/kg	3,300	2,500	0.76	900	0.27	590	0.18	670	0.20	1,400	0.42	1,200	0.36	980	0.30	2,300	0.70	2,000	0.61	1,300	0.39	180	0.05	2,800	0.85
Total HPAH	µg/kg	17,000	9,070	0.53	4,105	0.24	2,276 J	0.13	2,562 J	0.15	6,890	0.41	5,980	0.35	4,636	0.27	9,130	0.54	8,880	0.52	5,820	0.34	876 J	0.05	7,161	0.42
Other																										
Dimethyl phthalate	µg/kg	160	15	0.09	9.5	0.06	8.2	0.05	7.5	0.05	16	0.10	13	0.08	38	0.24	15	0.09	19	0.12	12	0.08	3.2 J	0.02	3.8 J	0.02
Diethylphthalate	µg/kg	200	41	0.21	27 U	NA	35	0.18	32 U	NA	27 U	NA	27 U	NA	27 U	NA	27 U	NA	32 U	NA	32	0.16	32 U	NA	32 U	NA
Di-n-butyl phthalate	µg/kg	1,400	60	0.04	29	0.02	45	0.03	43	0.03	40	0.03	36	0.03	28 U	NA	29	0.02	41	0.03	36	0.03	33 U	NA	33 U	NA
Butyl benzyl phthalate	µg/kg	900	360	0.40	190	0.21	150	0.17	110	0.12	210	0.23	210	0.23	220	0.24	220	0.24	260	0.29	210	0.23	37 J	0.04	76 J	0.08
Bis(2-ethylhexyl)phthalate	µg/kg	1,300	1,100	0.85	880	0.68	510	0.39	490	0.38	1,100	0.85	1,100	0.85	**1,600**	1.23	1,300	1.00	1,300	1.00	1,100	0.85	510	0.39	400	0.31
Di-n-octyl phthalate	µg/kg	6,200	36 U	NA	30 U	NA	36 U	NA	36 U	NA	30 U	NA	30 U	NA	51 J	0.01	32 J	0.01	52 J	0.01	39 J	0.01	36 U	NA	35 U	NA
Phenol	µg/kg	420	43	0.10	32	0.08	20 U	NA	24	0.06	45	0.11	42	0.10	39	0.09	39	0.09	55	0.13	43	0.10	15	0.04	58	0.14
2-Methylphenol	µg/kg	63	4.6 U	NA	3.9 U	NA	4.7 U	NA	4.6 U	NA	3.9 U	NA	3.9 U	NA	3.9 U	NA	4.8 J	0.08	6.9 J	0.11	4.7 U	NA	4.6 U	NA	8.2 J	0.13
4-Methylphenol	µg/kg	670	27	0.04	17	0.03	2.5 U	NA	2.5 U	NA	2.1 U	NA	2.1 U	NA	20	0.03	34	0.05	37	0.06	33	0.05	2.5 U	NA	170	0.25
2,4-Dimethylphenol	µg/kg	29	6.0	0.21	4.2	0.14	1.8 U	NA	1.8 U	NA	6.8	0.23	7.9	0.27	4.8	0.17	8.9	0.31	8.4	0.29	6.9	0.24	1.8 U	NA	12	0.41
Pentachlorophenol	µg/kg	360	43 U	NA	36 U	NA	43 U	NA	43 U	NA	36 U	NA	36 U	NA	36 UJ	NA	36 UJ	NA	43 U	NA	43 U	NA	43 U	NA	43 U	NA
Benzyl alcohol	µg/kg	73	**90 U**	NA	28 J	0.38	73 U	NA	73 U	NA	22 J	0.30	29 J	0.40	51 J	0.70	32 J	0.44	73 J	1.00	43 J	0.59	25 J	0.34	38 J	0.52
Benzoic acid	µg/kg	650	62 UJ	NA	52 UJ	NA	63 UJ	NA	62 UJ	NA	52 UJ	NA	52 UJ	NA	52 UJ	NA	52 UJ	NA	62 U	NA	62 U	NA	62 U	NA	62 U	NA
1,2-Dichlorobenzene	µg/kg	50	2.2 U	NA	1.9 U	NA	2.2 U	NA	2.2 U	NA	1.9 U	NA	2.0 J	0.04	1.9 U	NA	1.9 U	NA	3.5 J	0.07	2.2 UJ	NA	2.2 UJ	NA	2.4 J	0.05
1,3-Dichlorobenzene	µg/kg	170	2.5 U	NA	2.1 U	NA	2.5 U	NA	2.5 U	NA	2.1 U	NA	2.1 U	NA	2.1 U	NA	2.1 U	NA	2.5 UJ	NA	2.5 UJ	NA	2.5 UJ	NA	2.5 UJ	NA
1,4-Dichlorobenzene	µg/kg	110	11 J	0.10	7.2 J	0.07	4.2 J	0.04	5.8 J	0.05	13 J	0.12	14 J	0.13	12 J	0.11	11 J	0.10	16 J	0.15	18 J	0.16	2.6 UJ	NA	5.9 J	0.05
1,2,4-Trichlorobenzene	µg/kg	51	2.6 U	NA	2.1 U	NA	2.6 U	NA	2.6 U	NA	2.1 U	NA	2.1 U	NA	2.2 U	NA	2.1 U	NA	2.6 U	NA	2.6 U	NA	2.6 U	NA	2.6 U	NA
Hexachlorobenzene	µg/kg	22	1.7 U	NA	1.5 U	NA	1.8 U	NA	1.7 U	NA	1.5 U	NA	1.5 U	NA	1.5 U	NA	1.5 U	NA	1.7 U	NA	1.7 U	NA	1.7 U	NA	1.7 U	NA
Dibenzofuran	µg/kg	540	100	0.19	63	0.12	27	0.05	37	0.07	100	0.19	99	0.18	64	0.12	93	0.17	120	0.22	81	0.15	8.8	0.02	110	0.20
Hexachlorobutadiene	µg/kg	11	2.7 U	NA	2.3 U	NA	2.8 U	NA	2.7 U	NA	2.3 U	NA	2.3 U	NA	2.3 U	NA	2.3 U	NA	2.7 U	NA	2.7 U	NA	2.7 U	NA	2.7 U	NA
N-Nitrosodiphenylamine	µg/kg	28	12	0.43	7.3	0.26	5.1	0.18	5.5	0.20	15	0.54	13	0.46	8.2	0.29	11	0.39	18	0.64	14	0.50	2.2 J	0.08	14	0.50
Pesticides																										
p,p'-DDD	µg/kg	16	5.0 U	NA	5.0 U	NA	5.0 U	NA	5.0 U	NA	5.0 U	NA	5.0 U	NA	5.0 U	NA	5.0 U	NA	6.0 U	NA	6.0 U	NA	6.0 U	NA	5.9 U	NA
p,p'-DDE	µg/kg	9	2.5 U	NA	2.5 U	NA	2.5 U	NA	2.5 U	NA	2.5 U	NA	2.5 U	NA	2.5 U	NA	2.5 U	NA	3.0 U	NA	3.0 U	NA	3.0 U	NA	3.0 U	NA
p,p'-DDT	µg/kg	34	7.4 U	NA	7.5 U	NA	7.5 U	NA	7.5 U	NA	7.5 U	NA	7.5 U	NA	7.5 U	NA	7.5 U	NA	9.0 UJ	NA	9.0 UJ	NA	9.0 U	NA	8.9 UJ	NA
PCBs																										
PCB-1016	µg/kg	NC	12 U	NA	12 U	NA	12 U	NA	12 U	NA	12 U	NA	12 U	NA	12 U	NA	12 U	NA	12 U	NA	12 U	NA	12 U	NA	12 U	NA
PCB-1221	µg/kg	NC	12 U	NA	12 U	NA	12 U	NA	12 U	NA	12 U	NA	12 U	NA	12 U	NA	12 U	NA	12 U	NA	12 U	NA	12 U	NA	12 U	NA
PCB-1232	µg/kg	NC	12 U	NA	12 U	NA	12 U	NA	12 U	NA	12 U	NA	12 U	NA	12 U	NA	12 U	NA	12 U	NA	12 U	NA	12 U	NA	12 U	NA
PCB-1242	µg/kg	NC	15 U	NA	15 U	NA	15 U	NA	15 U	NA	15 U	NA	15 U	NA	15 U	NA	15 U	NA	15 U	NA	15 U	NA	15 U	NA	15 U	NA
PCB-1248	µg/kg	NC	15 U	NA	15 U	NA	15 U	NA	15 U	NA	15 U	NA	15 U	NA	15 U	NA	15 U	NA	15 U	NA	15 U	NA	15 U	NA	15 U	NA
PCB-1254	µg/kg	NC	15 U	NA	15 U	NA	15 U	NA	15 U	NA	15 U	NA	15 U	NA	15 U	NA	15 U	NA	15 U	NA	15 U	NA	15 U	NA	15 U	NA
PCB-1260	µg/kg	NC	15 U	NA	15 U	NA	15 U	NA	15 U	NA	15 U	NA	15 U	NA	15 U	NA	15 U	NA	15 U	NA	15 U	NA	15 U	NA	15 U	NA
PCBs (total)	µg/kg	300	15 U	NA	15 U	NA	15 U	NA	15 U	NA	15 U	NA	15 U	NA	15 U	NA	15 U	NA	15 U	NA	15 U	NA	15 U	NA	15 U	NA

Notes:

Concentrations highlighted in **red** exceed the SQO.
NA: Not applicable
NC: No SQO criterion.

Qualifiers:

U - Undetected
J - The analyte was analyzed for and positively identified, but the associated numerical value is an estimate.
UJ - The analyte was analyzed for and not detected, but the associated numerical value is an estimate.

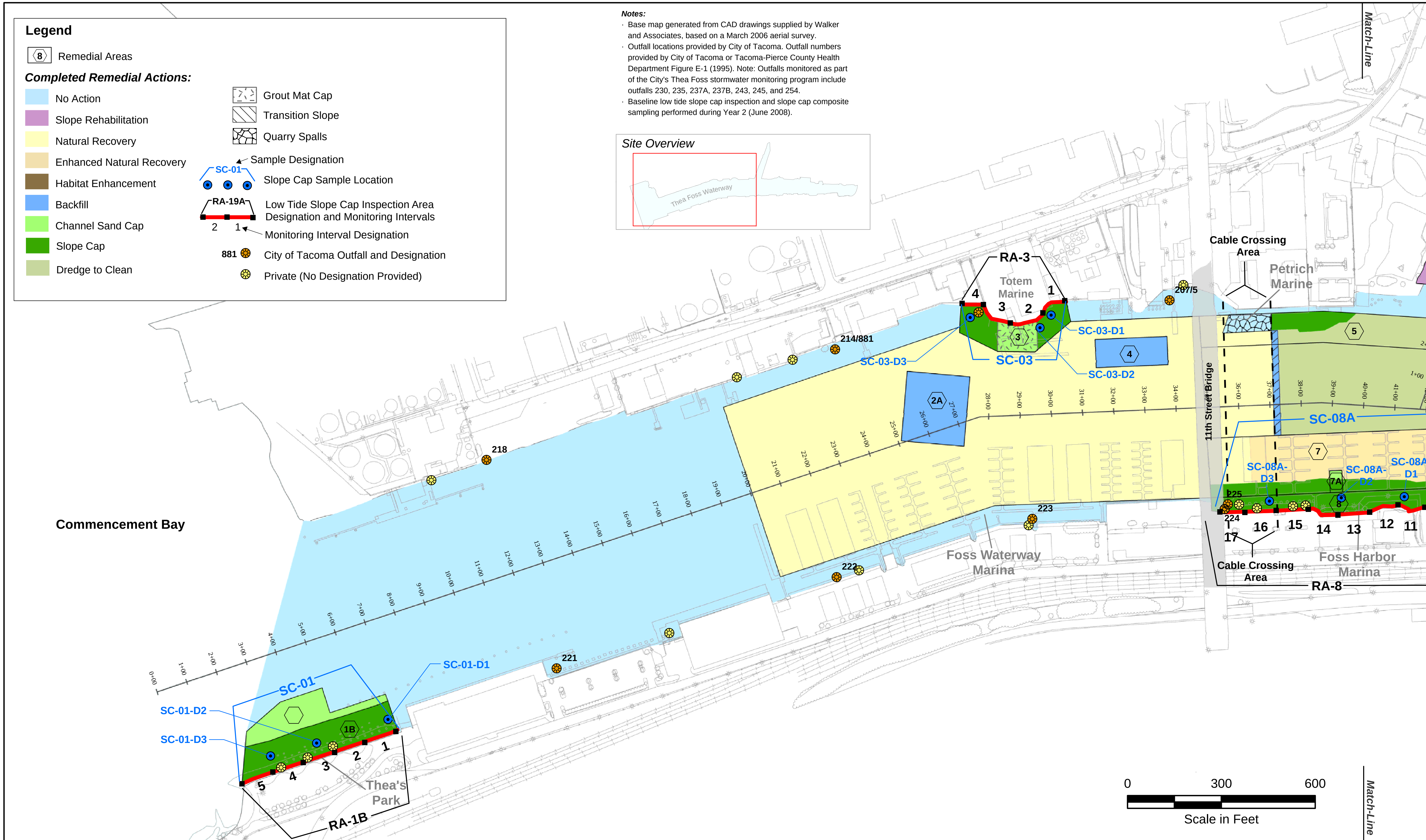
	Station		NR-19		NR-20		NR-25		SR-10				SR-11		SR-13	
	Sample ID		NR-19-Y2		NR-20-Y2		NR-25-Y2		SR-10-Y2		SR-10-Y2-2		SR-11-Y2		SR-13-Y2	
	Sample Date		6/23/2008	Enrichment	6/23/2008	Enrichment	6/24/2008	Enrichment	5/23/2008	Enrichment	5/23/2008	Enrichment	5/23/2008	Enrichment	5/23/2008	Enrichment
	Sample Depth		0 to 10 cm	Ratio	0 to 10 cm	Ratio	0 to 10 cm	Ratio	0 to 10 cm	Ratio	0 to 10 cm	Ratio	0 to 10 cm	Ratio	0 to 10 cm	Ratio
Parameter	**Units**	**SQO**														
Conventionals																
Total Organic Carbon	mg/kg	NC	14,300	NA	12,600	NA	140,000	NA	9,140	NA	7,660 J	NA	3,340 J	NA	7,460	NA
Total Solids	%	NC	66.9	NA	67.8	NA	37.6	NA	84.4	NA	81.6	NA	81.2	NA	82.1	NA
Metals																
Antimony	mg/kg	150	2.2 U	0.01	5.7 J	0.04	7.9 J	0.05	1.1 U	NA	1.1 U	NA	1.1 U	NA	1.0 U	NA
Arsenic	mg/kg	57	11.1	0.19	11.2	0.20	34.4	0.60	6.0	0.11	5.1	0.09	4.6 J	0.08	5.1	0.09
Cadmium	mg/kg	5.1	1.68	0.33	1.73	0.34	4.04	0.79	0.214 J	0.04	0.244 J	0.05	0.309	0.06	0.284	0.06
Copper	mg/kg	390	52.8	0.14	59.5	0.15	209	0.54	41.9	0.11	43.3	0.11	30.6	0.08	35.7	0.09
Lead	mg/kg	450	43.1	0.10	44.3	0.10	144	0.32	39.8	0.09	38.2	0.08	20.2	0.04	17.8	0.04
Nickel	mg/kg	140	14.7	0.11	16.0	0.11	23.9	0.17	12.9	0.09	15.2	0.11	11.4	0.08	17.2	0.12
Silver	mg/kg	6.1	2.23 J	0.37	2.31 J	0.38	5.26 J	0.86	1.92 J	0.31	2.18 J	0.36	2.03 J	0.33	2.10 J	0.34
Zinc	mg/kg	410	103	0.25	142	0.35	253	0.62	70.1	0.17	74.1	0.18	56.2	0.14	63.3	0.15
Mercury	mg/kg	0.59	0.178	0.30	0.103	0.17	0.428	0.73	0.066	0.11	0.089	0.15	0.025	0.04	0.061	0.10
SVOCs																
LPAHs																
2-Methylnaphthalene	µg/kg	670	270	0.40	170	0.25	270	0.40	61	0.09	74	0.11	29	0.04	46	0.07
Acenaphthene	µg/kg	500	78	0.16	45	0.09	270	0.54	22	0.04	26	0.05	4.2	0.01	18	0.04
Acenaphthylene	µg/kg	1,300	140	0.11	85	0.07	240	0.18	69	0.05	71	0.05	25	0.02	33	0.03
Anthracene	µg/kg	960	300	0.31	170	0.18	920	0.96	110	0.11	120	0.13	49	0.05	53	0.06
Fluorene	µg/kg	540	130	0.24	63	0.12	380	0.70	39	0.07	30	0.06	14	0.03	31	0.06
Naphthalene	µg/kg	2,100	380	0.18	230	0.11	800	0.38	120	0.06	160	0.08	44	0.02	110	0.05
Phenanthrene	µg/kg	1,500	660	0.44	460	0.31	**2,000**	1.33	460	0.31	350	0.23	160	0.11	520	0.35
Total LPAH	µg/kg	5,200	1,958	0.38	1,223	0.24	4,880	0.94	881	0.17	831	0.16	325	0.06	811	0.16
HPAHs																
Benzo(a)anthracene	µg/kg	1,600	500	0.31	360	0.23	1,400	0.88	280	0.18	190	0.12	120	0.08	120	0.08
Benzo(a)pyrene	µg/kg	1,600	490	0.31	320	0.20	960	0.60	210	0.13	200	0.13	98	0.06	130	0.08
Benzofluoranthenes (total)	µg/kg	3,600	760	0.21	620	0.17	2,500	0.69	540	0.15	480	0.13	170	0.05	360	0.10
Benzo(g,h,i)perylene	µg/kg	720	180	0.25	200	0.28	580	0.81	190	0.26	180	0.25	69 J	0.10	110	0.15
Chrysene	µg/kg	2,800	670	0.24	510	0.18	2,000	0.71	530	0.19	360	0.13	150	0.05	270	0.10
Dibenzo(a,h)anthracene	µg/kg	230	58 J	0.25	67 J	0.29	190	0.83	52 J	0.23	47 J	0.20	42 U	NA	42 U	NA
Fluoranthene	µg/kg	2,500	720	0.29	640	0.26	**3,000**	1.20	1,100	0.44	710	0.28	220	0.09	770	0.31
Indeno(1,2,3-cd)pyrene	µg/kg	690	160	0.23	170	0.25	600	0.87	150	0.22	150	0.22	60 J	0.09	100	0.14
Pyrene	µg/kg	3,300	1,700	0.52	1,200	0.36	**5,800**	1.76	1,300	0.39	500	0.15	320	0.10	730	0.22
Total HPAH	µg/kg	17,000	5,238 J	0.31	4,087 J	0.24	**17,030**	1.002	4,352 J	0.26	2,817 J	0.17	1,207 J	0.07	2,590	0.15
Other																
Dimethyl phthalate	µg/kg	160	6.3	0.04	11	0.07	31	0.19	3.0 J	0.02	4.5	0.03	3.6 J	0.02	7.5	0.05
Diethylphthalate	µg/kg	200	32 U	NA	32 U	NA	39 U	NA	32 U	NA	36	0.18	32 U	NA	32 U	NA
Di-n-butyl phthalate	µg/kg	1,400	33 U	NA	37	0.03	190	0.14	40	0.03	36	0.03	33	0.02	33 U	NA
Butyl benzyl phthalate	µg/kg	900	200	0.22	350	0.39	**1,700**	1.89	93	0.10	57 J	0.06	82 J	0.09	330	0.37
Bis(2-ethylhexyl)phthalate	µg/kg	1,300	650	0.50	**2,400**	1.85	**2,000**	1.54	130	0.10	180	0.14	83	0.06	**7,200**	5.54
Di-n-octyl phthalate	µg/kg	6,200	44 J	0.01	100	0.02	43 U	NA	36 U	NA	36 U	NA	35 U	NA	51 J	0.01
Phenol	µg/kg	420	79	0.19	190	0.45	77	0.18	85	0.20	130	0.31	59	0.14	240	0.57
2-Methylphenol	µg/kg	63	6.0 J	0.10	7.4 J	0.12	5.6 U	NA	4.6 U	NA	4.7 U	NA	36	0.57	4.9 J	0.08
4-Methylphenol	µg/kg	670	83	0.12	110	0.16	17	0.03	13	0.02	9.8	0.01	2.5 U	NA	2.5 U	NA
2,4-Dimethylphenol	µg/kg	29	6.0	0.21	7.2	0.25	3.9 J	0.13	2.8 J	0.10	1.8 U	NA	1.8 U	NA	1.8 U	NA
Pentachlorophenol	µg/kg	360	43 U	NA	43 U	NA	52 U	NA	61 J	0.17	43 U	NA	43 U	NA	43 U	NA
Benzyl alcohol	µg/kg	73	33 J	0.45	36 J	0.49	43 J	0.59	73 U	NA	73 U	NA	73 U	NA	73 U	NA
Benzoic acid	µg/kg	650	71 J	0.11	68 J	0.10	250	0.38	130 J	0.20	62 UJ	NA	62 UJ	NA	62 UJ	NA
1,2-Dichlorobenzene	µg/kg	50	6.7 J	0.13	29 J	0.58	5.2 J	0.10	2.2 U	NA	2.2 U	NA	2.2 U	NA	3.2 J	0.06
1,3-Dichlorobenzene	µg/kg	170	2.5 UJ	NA	2.5 UJ	NA	3.0 UJ	NA	2.5 U	NA	2.5 U	NA	2.5 U	NA	2.5 U	NA
1,4-Dichlorobenzene	µg/kg	110	9.3 J	0.08	16 J	0.15	18 J	0.16	2.6 UJ	NA	2.6 UJ	NA	2.6 UJ	NA	2.6 UJ	NA
1,2,4-Trichlorobenzene	µg/kg	51	2.6 U	NA	2.6 U	NA	3.1 U	NA	2.6 U	NA	2.6 U	NA	2.6 U	NA	5.7	0.11
Hexachlorobenzene	µg/kg	22	1.7 U	NA	1.7 U	NA	2.1 U	NA	1.7 U	NA	1.7 U	NA	1.7 U	NA	1.7 U	NA
Dibenzofuran	µg/kg	540	87	0.16	53	0.10	220	0.41	32	0.06	38	0.07	12	0.02	39	0.07
Hexachlorobutadiene	µg/kg	11	2.7 U	NA	2.7 U	NA	3.3 U	NA	2.7 U	NA	2.7 U	NA	2.7 U	NA	2.7 U	NA
N-Nitrosodiphenylamine	µg/kg	28	17	0.61	13	0.46	24	0.86	4.3	0.15	5.5	0.20	2.0 U	NA	2.3 J	0.08
Pesticides																
p,p'-DDD	µg/kg	16	5.0 U	NA	5.0 U	NA	6.0 U	NA	5.0 U	NA	5.0 U	NA	5.0 U	NA	5.0 U	NA
p,p'-DDE	µg/kg	9	2.5 U	NA	2.5 U	NA	3.0 U	NA	2.5 U	NA	2.5 U	NA	2.5 U	NA	2.5 U	NA
p,p'-DDT	µg/kg	34	7.4 U	NA	7.5 U	NA	9.0 U	NA	7.4 U	NA	7.5 U	NA	7.4 U	NA	7.5 U	NA
PCBs																
PCB-1016	µg/kg	NC	9.9 U	NA	9.9 U	NA	12 U	NA	12 U	NA	12 U	NA	12 U	NA	12 U	NA
PCB-1221	µg/kg	NC	9.9 U	NA	9.9 U	NA	12 U	NA	12 U	NA	12 U	NA	12 U	NA	12 U	NA
PCB-1232	µg/kg	NC	9.9 U	NA	9.9 U	NA	12 U	NA	12 U	NA	12 U	NA	12 U	NA	12 U	NA
PCB-1242	µg/kg	NC	12 U	NA	12 U	NA	15 U	NA	15 U	NA	15 U	NA	15 U	NA	15 U	NA
PCB-1248	µg/kg	NC	12 U	NA	12 U	NA	15 U	NA	15 U	NA	15 U	NA	15 U	NA	15 U	NA
PCB-1254	µg/kg	NC	12 U	NA	12 U	NA	380	NA	15 U	NA	500	NA	15 U	NA	15 U	NA
PCB-1260	µg/kg	NC	12 U	NA	12 U	NA	15 U	NA	15 U	NA	15 U	NA	15 U	NA	15 U	NA
PCBs (total)	µg/kg	300	12 U	NA	12 U	NA	**380**	1.27	15 U	NA	**500**	1.67	15 U	NA	15 U	NA

Notes:

Concentrations highlighted in **red** exceed the SQO.
NA: Not applicable
NC: No SQO criterion.

Qualifiers:

U - Undetected
J - The analyte was analyzed for and positively identified, but the associated numerical value is an estimate.
UJ - The analyte was analyzed for and not detected, but the associated numerical value is an estimate.



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Annual OMMP Report

Figure 2-1 (Page 1 of 2)
Low Tide Slope Cap Inspection Monitoring Intervals and Slope Cap Sample Locations

File: F:\projects\COT-Oncall\GIS\2008 Yr 2 Annual OMMP Report\Figure 2-1 (Low-tide SC Insp Monitoring Intervals and Samp Loc (1of2)).mxd
Date: 1/22/2009

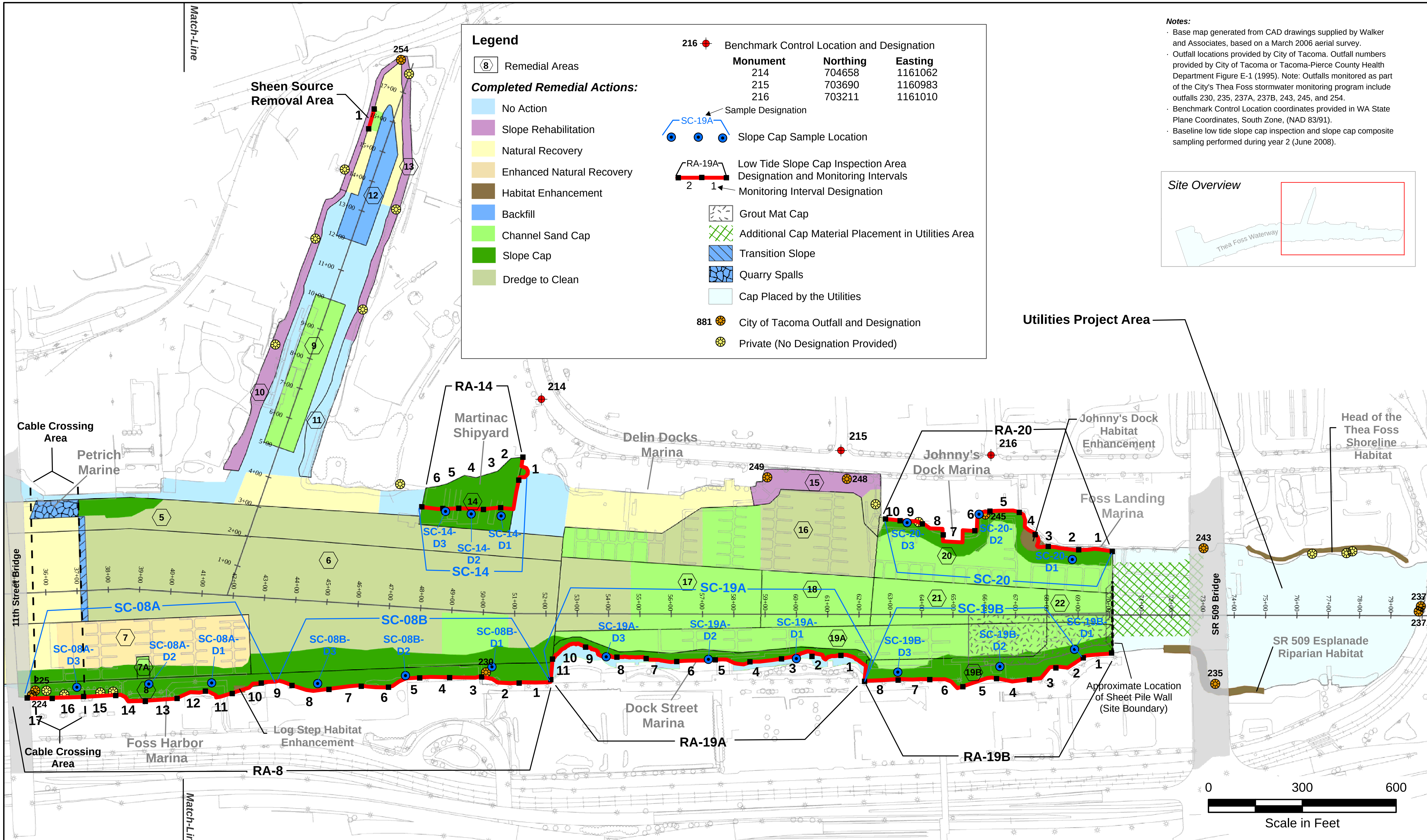

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Figure 2-1 (Page 2 of 2) Low Tide Slope Cap Inspection Monitoring Intervals and Slope Cap Sample Locations

File: F:\projects\COT-Oncall\GIS\2008 Yr 2 Annual OMMP Report\Figure 2-1 (Low-tide SC Insp Monitoring Intervals and Samp Loc (2of2)).mxd
Date: 1/22/2009

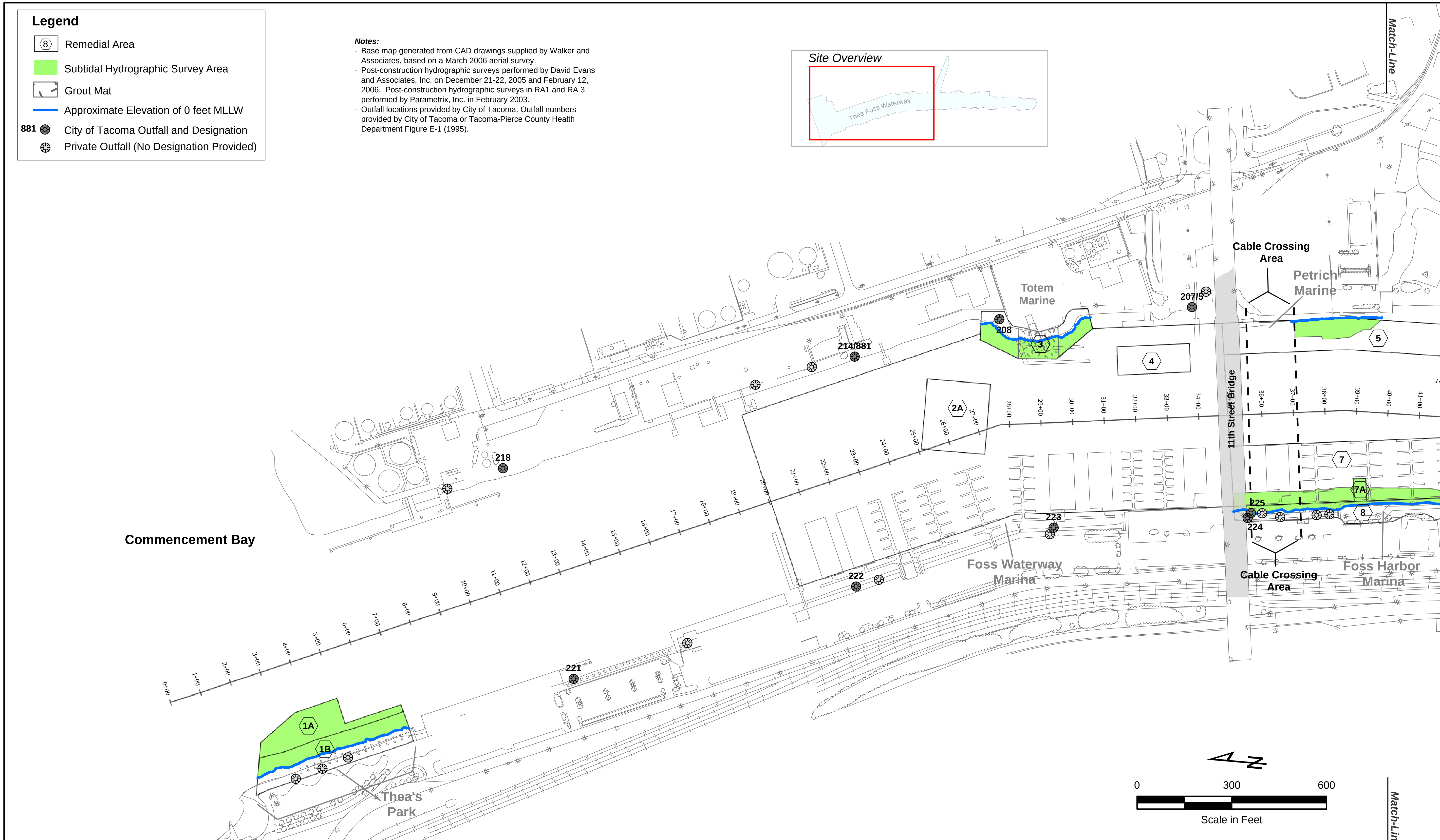

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Figure 2-2 (Page 1 of 2)
Subtidal Hydrographic Survey Areas

File: F:\projects\COT-Oncall\GIS\2008 Yr 2 Annual OMMP Report\Figure 2-2 (Subtidal Hydrographic Survey Areas (1of2)).mxd
Date: 1/22/2009

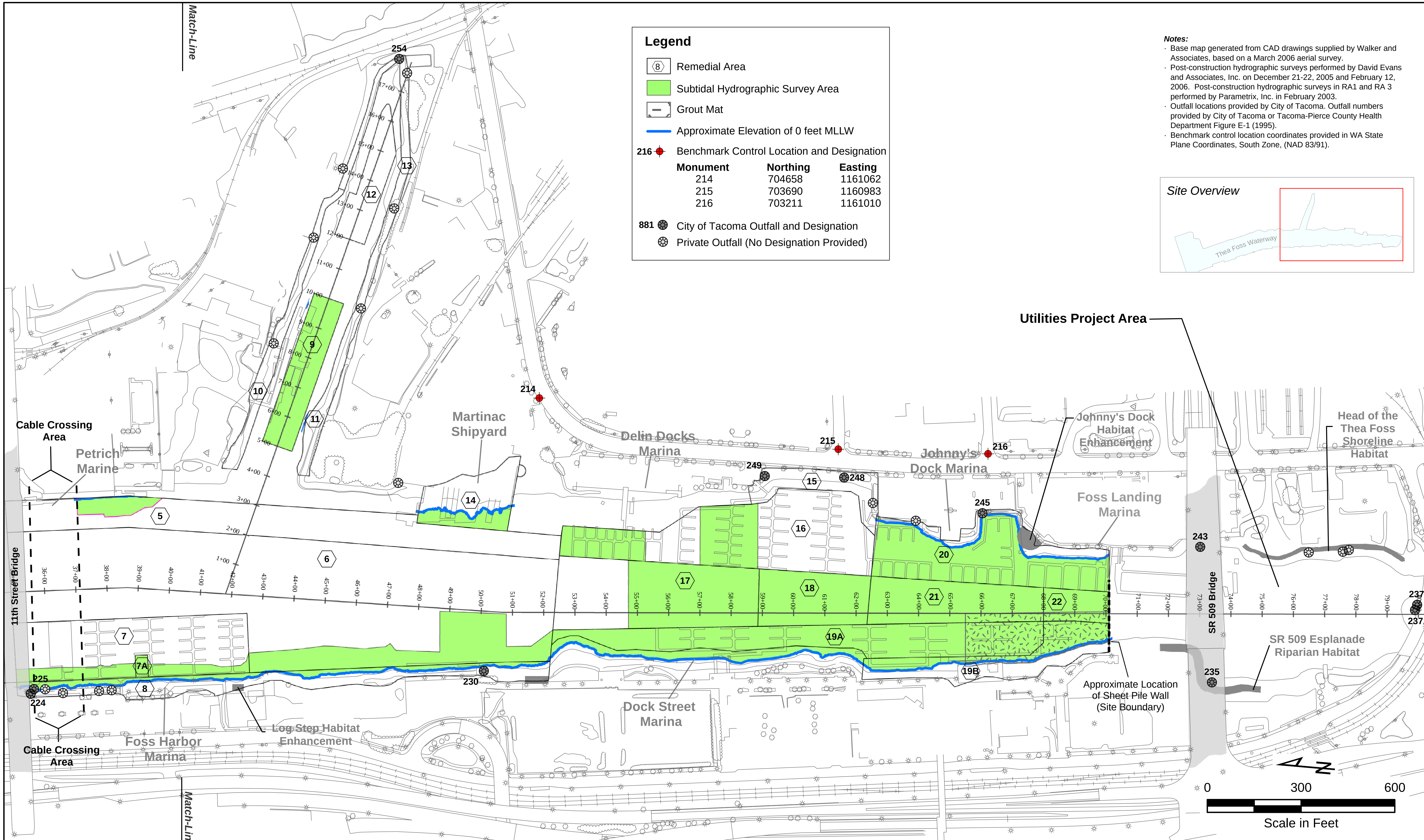

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Figure 2-2 (Page 2 of 2)
Subtidal Hydrographic Survey Areas

File: F:\projects\COT-Oncall\GIS\2008 Yr 2 Annual OMMP Report\Figure 2-2 (Subtidal Hydrographic Survey Areas (2of2)).mxd
Date: 1/22/2009

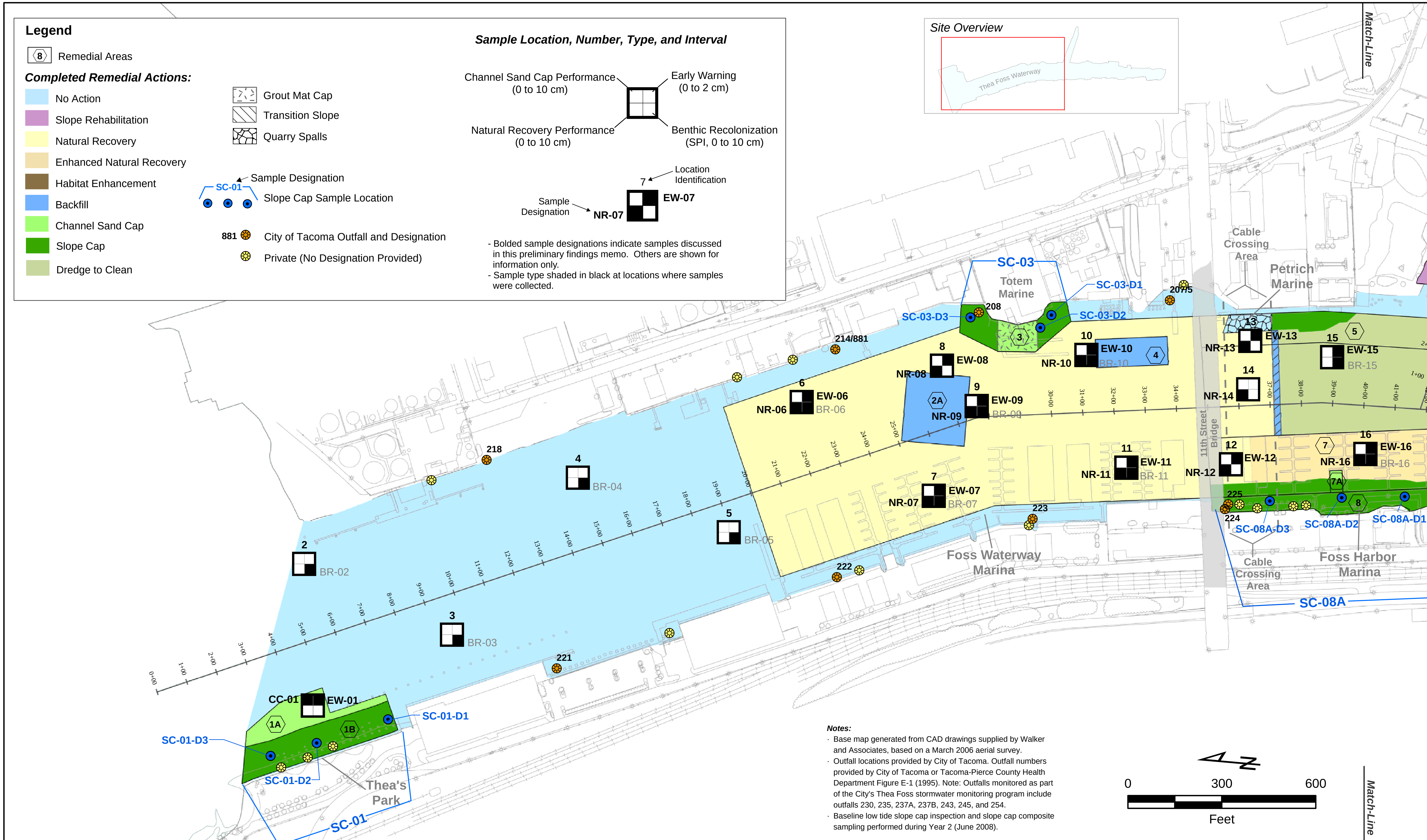

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Figure 2-3 (Page 1 of 2)
Year 2 Performance Monitoring and Early Warning Sampling Locations

File: F:\projects\COT-Oncall\GIS\2008 Yr 2 Annual OMMP Report\Figure 2-3 (Perf Mon and Early Warn Samp Loc Frame 1).mxd
Date: 2/6/2009

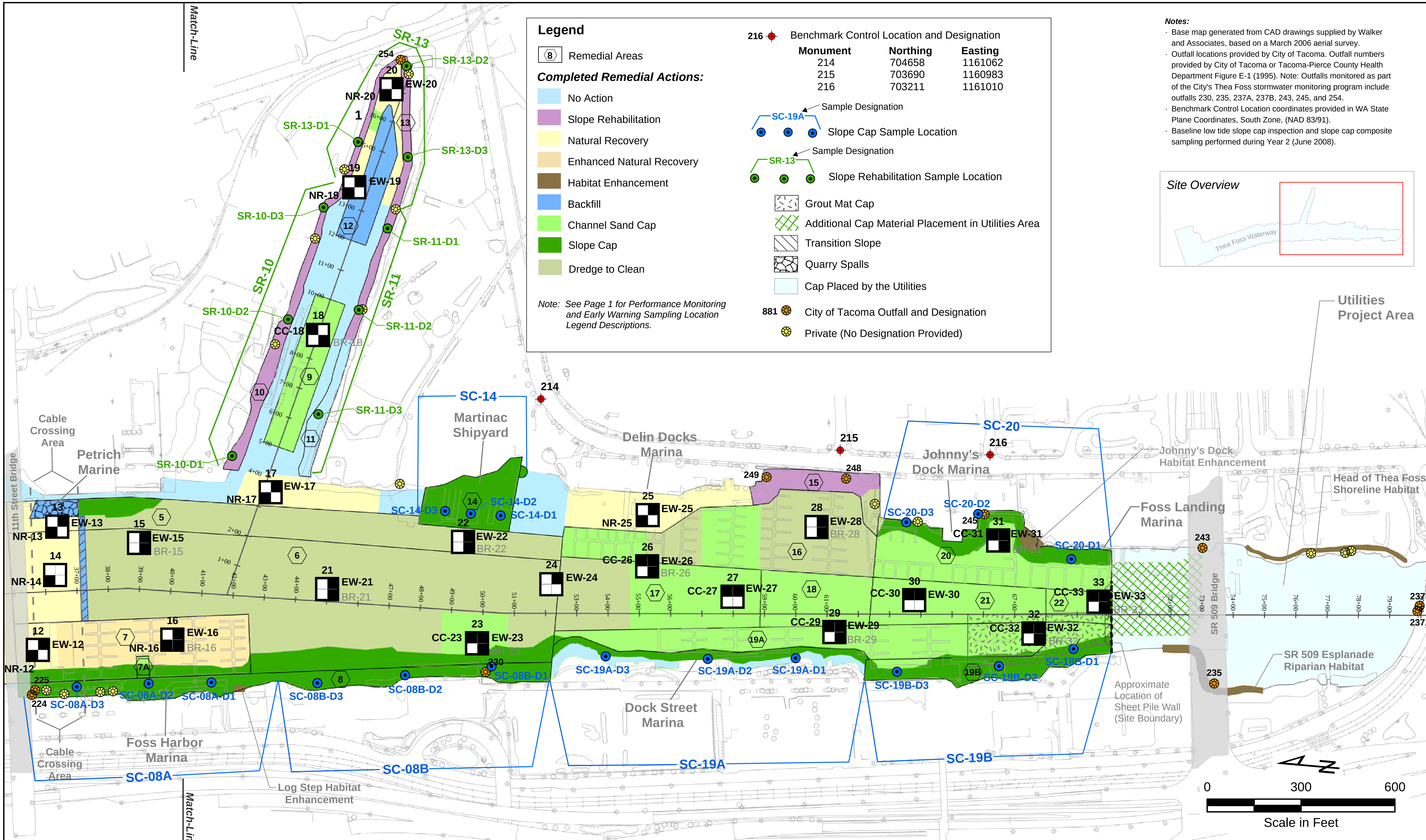

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Figure 2-3 (Page 2 of 2)
Year 2 Performance Monitoring and Early Warning Sampling Locations

File: F:\projects\COT-Oncall\GIS\2008 Yr 2 Annual OMMP Report\Figure 2-3 (Perf Mon and Early Warn Samp Loc Frame 2).mxd
Date: 2/6/2009

3.0 EARLY WARNING MONITORING FOR RECONTAMINATION

3.1 Introduction

Early warning monitoring for recontamination, referred to as early warning monitoring, is performed to evaluate the potential for recontamination in the Thea Foss and Wheeler-Osgood Waterways. As described in Section 3.0 of the Operations, Maintenance, and Monitoring Plan (OMMP) (City of Tacoma 2006), early warning monitoring includes collection and analysis of recently deposited sediments represented by the 0 to 2 cm interval of the sediment column. The upper 2 cm of the sediment column is not a compliance interval for remediation of the waterway, but was selected because it represents the most recently deposited sediment that can be effectively sampled. The 0 to 10 cm interval is the compliance interval for the remediation project. Early warning sampling and analysis data are used to evaluate the potential for recontamination and identify potential sources of recontamination (if suspected) before the remediated sediments become out of compliance with the remedial action and long-term monitoring objectives. Early warning monitoring is performed throughout the Thea Foss and Wheeler-Osgood Waterways including dredged to clean, capped, and natural recovery areas.

Early warning monitoring is specifically designed to achieve the following objectives:

- Monitor the chemical quality of recently deposited sediments in remediation areas of the Thea Foss and Wheeler-Osgood Waterways with attention to potential sources of recontamination (i.e., marinas, outfalls, industrial facilities, etc.); and
- Identify potential sources of recontamination if exceedences of chemical Sediment Quality Objectives (SQO) and early warning threshold concentrations have occurred or are predicted to occur.

The results of the Year 2 early warning monitoring are presented in the Year 2 Sediment and Cap Performance and Early Warning Monitoring Preliminary Findings Memorandum (City of Tacoma 2008) included as Attachment B-1 in Appendix B and are also summarized below.

3.2 Summary of Early Warning Monitoring Requirements

Year 2 early warning sample locations are located throughout the Thea Foss and Wheeler-Osgood waterways in dredged to clean, channel sand capped, and natural recovery areas. There are a total of 27 early warning monitoring locations. Early warning monitoring locations are monitored using discrete surface sediment samples (0 to 2 cm).

The early warning analytical results are compared to the SQOs and the early warning threshold concentrations as specified in the OMMP. The results are initially compared to SQO criteria and if chemical concentrations exceed SQO criteria the results are then compared to the early warning threshold sediment concentrations. The use of model predicted threshold sediment concentrations was selected during the remedial design to provide a potential recontamination trigger and to be consistent with the remedial action objectives for the project. The early warning threshold concentrations provide contaminant levels for the 0 to 2 cm interval which are expected to correlate to compliance with the SQOs in the 10 cm compliance interval. Several years are required to accumulate 10 cm of new sediment assuming a sedimentation rate of 1 to 2 cm/yr, during which time contaminants are attenuated by pore water advection, dispersion, and biodegradation. It should be noted that threshold criteria were only established for a subset of the parameters analyzed for on the project, PAHs and DEHP, as they were recognized as the constituents with the highest probability for recontamination. Threshold concentrations for other parameters were set at their respective SQO.

The early warning data are also compared to the results for co-located performance monitoring samples (i.e., channel sand cap, natural recovery, and enhanced natural recovery samples) where available. The results of the performance monitoring samples are presented in Section 2.0 of this report.

Additionally, in future early warning monitoring events (Years 4, 7, and 10) early warning concentrations will be evaluated for through-time concentration trends. Early warning monitoring sampling and analysis was performed for the first time as part of Year 2 monitoring so the trend evaluation will begin after Year 4 monitoring.

Refer to the Sediment Sampling Operations Manual presented in the OMMP for more detailed requirements.

3.3 Summary of Field Activities, Analyses, and Reporting

Early warning surface sediment (0 to 2 cm) samples were collected at 27 locations during two monitoring events on the Thea Foss and Wheeler-Osgood Waterways. These early warning monitoring locations included nine channel sand cap monitoring stations, 13 natural recovery and enhanced natural recovery monitoring stations, and five dredged to clean stations. Channel sand cap performance surface sediment (0 to 10 cm) samples, discussed in Section 2.2.2.2, and natural recovery and enhanced natural recovery performance surface sediment (0 to 10 cm) samples, discussed in Section 2.3, were also collected during these two monitoring events. The first event occurred May 27-29, 2008, and sampling was conducted at the north end of the Thea Foss Waterway (north of Station 43+00) and at the west end of the Wheeler-Osgood Waterway (west of Station 11+00). The second event occurred on June 23-24, 2008, and sampling was conducted at the south end of the Thea Foss Waterway (south of Station 43+00) and at the east end of the Wheeler-Osgood Waterway (east of Station 11+00). Figure 2-3 in Section 2 identifies the early warning sampling locations. The early warning monitoring was performed in accordance with the Sediment Sampling Operations Manual presented in the OMMP.

The early warning samples were collected using a vessel deployed Van Veen grab sampler. Early warning samples were designated by EW, followed by the sample station number, and then the sample year (e.g., EW-15-Y2). Sample collection forms and photographs documenting activities and observations were prepared during the two sampling events. The early warning samples were submitted to the City of Tacoma laboratory under approved sampling handling and chain-of-custody procedures for the analysis of conventionals (i.e., total organic carbon and total solids), metals, semi-volatile organic compounds (SVOCs), pesticides, and polychlorinated biphenyls (PCBs) in accordance with the OMMP.

Data validation was performed on the laboratory analyses for the samples in accordance with the OMMP. The qualifiers resulting from data validation are presented in the summary of the Year 2 early warning sample analytical results provided in Table 3-1.

3.4 Summary of Monitoring Results

The analytical results from early warning samples collected in the channel sand cap areas, natural recovery and enhanced natural recovery areas, and dredged to clean areas are presented below and are summarized in Table 3-1. The analytical results for early warning samples were compared to the SQOs as specified in the OMMP. As discussed earlier in this section, early warning sample results are not for the purpose of determining compliance with performance criteria, but are used to evaluate the potential for recontamination. Concentrations that are greater than the SQOs are highlighted in red in Table 3-1. The early warning samples with chemical concentrations that were greater than the SQOs were also compared to early warning threshold concentrations as required by the OMMP. The comparison of early warning sample results to the threshold concentrations is presented in Table 3-2. Early warning threshold concentrations are used to predict the potential for recontamination. Chemical concentrations that are below threshold concentrations in the 0 to 2 cm interval (i.e., presumed to be the most recent deposition) are expected to correlate to chemical concentrations that are less than the SQOs in the compliance interval (i.e., 0 to 10 cm) after several years of sediment deposition, when 10 cm of sediment accumulation has occurred, and during which time contaminants are attenuated by pore water advection, dispersion, and biodegradation.

The detailed results of the Year 2 early warning sampling, including field forms and photographs for the samples, are presented in the Year 2 Sediment and Cap Performance and Early Warning Monitoring Preliminary Findings Memorandum provided in Attachment B-1 in Appendix B.

The detected concentrations in samples collected from 17 of 27 early warning sample stations did not exceed the SQOs. Bis(2-ethylhexyl)phthalate (DEHP) was the only chemical to exceed the SQOs in samples collected from 5 of the remaining 10 early warning sample stations, and the DEHP concentrations detected in samples from these locations did not exceed the early warning threshold concentration. Samples collected from the five remaining early warning locations had one or more chemicals detected at concentrations that were greater than the SQOs and early warning threshold concentrations.

Early Warning Samples in Channel Sand Cap Areas – Of the nine early warning samples collected from channel sand cap areas, five of these samples had detected concentrations below the SQOs, including:

- Sample EW-01-Y2 from RA 1A;
- Sample EW-26-Y2 located on the border of RA 16 and RA 17;
- Sample EW-27-Y2 from RA 17;
- Sample EW-29-Y2 from RA 19A; and
- Sample EW-30-Y2 from RA 21.

The detected concentrations in these five samples were generally less than one-half the SQOs. However, DEHP was detected in sample EW-27-Y2 at a concentration (i.e. 1,200 µg/kg) just below the SQO.

Early warning sample EW-23-Y2 was collected from the channel sand cap area in RA 6, near City Outfall 230. Sample EW-23-Y2 had detections of benzo(g,h,i)perylene, dibenzo(a,h)-

anthracene, indeno(1,2,3-cd)pyrene, DEHP, and benzyl alcohol greater than the SQOs. Detections of these SVOCs were less than 2.3 times the SQOs. The detected concentrations of dibenzo(a,h)anthracene (i.e., 310 µg/kg) and benzyl alcohol (i.e., 78 J µg/kg also exceeded the threshold concentrations (i.e., 288 µg/kg and 73 µg/kg, respectively).

Three of the early warning samples collected in the channel sand cap areas in RA 19A, RA 20, and RA 22 located in the southern portion of the Thea Foss Waterway had detected concentrations greater than the SQOs (i.e., samples EW-31-Y2, EW-32-Y2, and EW-33-Y2). Early warning samples EW-31-Y2 and EW-33-Y2 had only DEHP detected above the SQO, with detections at or less than 2.3 times the SQO. DEHP detections in these two samples were below the DEHP threshold concentration. The remaining chemical concentrations in these samples were substantially below the SQOs. The detected concentrations of seven chemicals including acenaphthene, anthracene, fluorene, phenanthrene, total LPAH, pyrene, and DEHP, were greater than the SQOs in sample EW-32-Y2 located at the south end of RA 19A. Only DEHP (i.e., 3,900 µg/kg) also exceeded the threshold concentration in sample EW-32-Y2.

Early Warning Samples in Natural Recovery and Enhanced Natural Recovery Areas – Six early warning samples were collected from natural recovery areas north of the 11th Street Bridge (EW-06 through EW-11) and only one of these samples, sample EW-11-Y2, had a detected chemical concentration that was greater than the SQOs. The detected concentrations of all other chemicals in these early warning samples were substantially below the SQOs. DEHP was approximately 1.1 times the SQO in sample EW-11-Y2, but the detected concentration did not exceed the DEHP threshold concentration.

Early warning samples EW-12-Y2 and EW-13-Y2 collected from the natural recovery area south and adjacent to the 11th Street Bridge had detected chemical concentrations below the SQOs except for the concentrations of DEHP. DEHP was detected in sample EW-12-Y2 at approximately 1.2 times the SQO, but this concentration did not exceed the early warning threshold concentration for DEHP. The DEHP concentration in sample EW-13-Y2 (i.e., 1,300 µg/kg) was at the SQO.

Early warning sample EW-16-Y2 was collected from the enhanced natural recovery area located on the west side of the Thea Foss Waterway in the Foss Harbor Marina. The detected chemical concentrations in sample EW-16-Y2 were less than one-half the SQOs, with the exception of DEHP. DEHP was detected at a concentration (i.e., 1,200 µg/kg) that is approximately 0.9 times the SQO.

Early warning sample EW-17-Y2 collected from the natural recovery area located near the mouth of the Wheeler-Osgood Waterway had detected chemical concentrations substantially below the SQOs.

Early warning sample EW-19-Y2 located in the natural recovery area near the head of the Wheeler-Osgood Waterway had multiple detected chemical concentrations that were greater than the SQOs. Twelve SVOCs were detected at concentrations greater than the SQOs in sample EW-19-Y2 as shown in Table 3-1. The exceedences ranged from approximately 1.1 to 4.5 times the SQOs, with the highest SQO exceedence being for phenanthrene (i.e., 6,800 µg/kg). Only one chemical, n-nitrosodiphenylamine at 75 µg/kg in sample EW-19-Y2 also exceeded the threshold concentration (i.e., 28 µg/kg), which, for the reasons described above, is set at the same concentration as the SQO. Early warning sample EW-20-Y2 and its associated field duplicate are also located in the natural recovery area near the head of the

Wheeler-Osgood Waterway and had detected DEHP concentrations approximately 1.4 to 1.5 times the SQO, however, these DEHP concentrations did not exceed the DEHP threshold concentration.

The detected concentrations of ten chemicals were greater than the SQOs in sample EW-25-Y2, located in the natural recovery area east of RA 16 and north of RA 15. Chemicals with concentrations greater than the SQOs include anthracene, phenanthrene, total LPAH, benzo(a)anthracene, fluoranthene, pyrene, total HPAH, butyl benzyl phthalate, DEHP, and benzyl alcohol. The enrichment ratio for these compounds ranged from approximately 1.04 to 2.9 times the SQOs. Benzyl alcohol had the highest enrichment ratio. The concentrations for the remaining chemicals were less than two times the SQO. Butyl benzyl phthalate (i.e., 1,000 µg/kg) and benzyl alcohol (i.e., 210 J µg/kg) in sample EW-25-Y2 also exceeded the threshold concentrations (i.e., 900 and 73 µg/kg, respectively).

Early Warning Samples in Dredged to Clean Areas – Detected chemical concentrations were less than the SQOs in the four early warning samples collected from the dredge to clean areas in RAs 5 and 6 (samples EW-15-Y2, EW-21-Y2, EW-22-Y2, and EW-24-Y2) except for the DEHP concentration in sample EW-22-Y2. The DEHP concentration in sample EW-22-Y2 (i.e., 1,300 µg/kg), located on the east side of the Thea Foss Waterway, was at the SQO.

Sample EW-28-Y2 was collected in the dredge to clean area located at the southern end of RA 16. Sample EW-28-Y2 had six SVOCs detected at concentrations greater than the SQOs, including DEHP, 2,4-dimethylphenol, benzyl alcohol, hexachlorobenzene, hexachlorobutidiene, and n-nitrosodiphenylamine. The detected concentrations of the SVOCs were less than approximately 2.2 times the SQOs. With the exception of DEHP, the remaining SVOCs also exceed the threshold concentrations, which are the same concentrations as the SQOs for these analytes.

3.5 Summary of Early Warning Monitoring to Performance Monitoring Results Comparisons

The OMMP specifies that performance monitoring sample results be used in conjunction with early warning sample results to evaluate concentration trends. The following sections provide the comparison of Year 2 early warning and Year 2 performance monitoring results for channel sand cap and natural recovery areas.

3.5.1 Channel Sand Cap Sample Comparisons

This section compares the results of the Year 2 early warning monitoring samples (0 to 2 cm) to the results of the Year 2 performance monitoring surface samples (0 to 10 cm) in channel sand cap areas as required by the OMMP. Channel sand cap performance surface sample results are discussed in further detail in Section 2.2.2.2. Table 6 and Tables 8 through 15 in the Year 2 Sediment and Cap Performance and Early Warning Monitoring Preliminary Findings Memorandum provided in Attachment B-1 in Appendix B, present the results of channel sand cap surface samples compared to the results of co-located early warning samples.

The comparison of Year 2 channel sand cap performance monitoring surface samples to the co-located early warning samples at stations 01, 26, and 29 (samples CC-01-Y2/EW-01-Y2, CC-26-Y2/EW-26-Y2, and CC-29-Y2/EW-29-Y2) generally indicate comparable, but slightly higher concentrations in the early warning samples. However, the detected concentrations for both the channel sand cap performance and early warning samples remained approximately at or below one-half the SQOs.

The results for channel sand cap performance and early warning samples for stations 27 and 30 (samples CC-27-Y2/EW-27-Y2 and CC-30-Y2/EW-30-Y2) had all detected concentrations less than SQOs, but had higher concentrations for several analytes in the early warning samples when compared to the channel sand cap performance samples. In sample EW-27-Y2, the DEHP concentration was 0.92 times the SQO and the benzyl alcohol was 0.89 times the SQO while the DEHP and benzyl alcohol enrichment ratios in performance sample CC-27-Y2 were 0.18 and 0.33. DEHP was also higher in sample EW-30-Y2 at 0.77 times the SQO while the DEHP enrichment ratio was 0.29 in sample CC-30-Y2. The other detected concentrations in both the early warning and performance samples from these stations were well below SQOs.

Samples CC-31-Y2/EW-31-Y2 and CC-33-Y2/EW-33-Y2 for stations 31 and 33 located in the southern portion of the Thea Foss Waterway had detected concentrations of DEHP that were greater than the SQO in the early warning samples, but not in the channel sand cap performance samples. DEHP was detected at approximately 2.3 times the SQO in sample EW-31-Y2, but was only 0.85 times the SQO in sample CC-31-Y2. Similarly, sample EW-33-Y2 had a DEHP concentration that was approximately 1.4 times the SQO while the DEHP concentration was at the SQO in sample CC-33-Y2. DEHP concentrations in the early warning samples did not exceed the early warning threshold concentrations, as previously discussed. Butyl benzyl phthalate was detected below the SQO in both samples CC-31-Y2 and EW-31-Y2; however, the butyl benzyl phthalate concentration was higher in the early warning sample (0.88 times the SQO) when compared to the channel sand cap performance sample (0.28 times the SQO). The remaining detected concentrations in both the early warning and performance samples from these stations were well below SQOs.

Channel sand cap performance and early warning samples from the remaining two channel sand cap sample stations (sample CC-23-Y2/EW-23-Y2 and CC-32-Y2/EW-32-Y2) had chemical concentrations for some constituents that were greater than the SQOs. Benzo(g,h,i)perylene, dibenzo(a,h)anthracene, indeno(1,2,3-cd)pyrene, DEHP, and benzyl alcohol, were detected at concentrations at or greater than the SQOs in the channel sand cap performance monitoring sample CC-23-Y2 and early warning sample EW-23-Y2. The early warning sample enrichment ratios were either comparable to the enrichment ratios in the channel sand cap sample or were slightly higher with the exception of benzyl alcohol. Benzyl alcohol was detected at a concentration of 1.78 times the SQO in sample CC-23-Y2 but was only 1.07 times the SQO in sample EW-23-Y2. Both dibenzo(a,h)anthracene and benzyl alcohol concentrations in early warning sample EW-23-Y2 exceed the early warning threshold concentrations set forth in the OMMP. Sample CC-32-Y2 had phenanthrene and DEHP at concentrations greater than the SQOs, while early warning sample EW-32-Y2 had acenapthene, anthracene, fluorene, phenanthrene, total LPAH, pyrene, and DEHP at concentrations greater than the SQOs. The enrichment ratios for sample EW-32-Y2 were higher than the enrichment ratios in sample CC-32-Y2. The DEHP concentration in sample EW-32-Y2 also exceeded the threshold concentration.

3.5.2 Natural Recovery Sample Comparisons

This section compares the results of the Year 2 early warning monitoring samples (0 to 2 cm) to the results of the Year 2 performance monitoring surface samples (0 to 10 cm) in natural recovery and enhanced natural recovery areas as required by the OMMP. Natural recovery and enhanced natural recovery performance surface sample results are discussed in further detail in Section 2.3. Tables 16 through 23 and Tables 25 through 29 in the Year 2 Sediment and Cap Performance and Early Warning Monitoring Preliminary Findings Memorandum provided in Attachment B-1 in Appendix B, present the results natural recovery and enhanced natural recovery surface samples compared to the results of co-located early warning samples.

The detected concentrations for Year 2 natural recovery and enhanced natural recovery performance monitoring surface samples and co-located early warning samples at stations 06, 07, 08, 09, 10, 16, and 17 (sample NR-06-Y2/EW-06-Y2, NR-07-Y2/EW-07-Y2, NR-08-Y2/EW-08-Y2, NR-09-Y2/EW-09-Y2, NR-10-Y2/EW-10-Y2, NR-16-Y2/EW-16-Y2, and NR-17-Y2/EW-17-Y2) were less than the SQOs. Early warning samples EW-06-Y2, EW-10-Y2, and EW-17-Y2 tended to have detected analytes at lower concentrations than what was detected in the corresponding natural recovery performance samples. Detected concentrations in early warning samples EW-07-Y2 and EW-09-Y2 were similar to concentrations detected in the co-located natural recovery performance monitoring surface samples, with no overall discernable concentration trends. Early warning sample EW-08-Y2 and EW-16-Y2 tended to have detected analytes at slightly higher concentrations than what was detected in the co-located natural recovery samples. The overall, relatively minor variability in concentrations and trends between early warning and natural recovery performance monitoring samples could be the result of the heterogeneity of sediment at the sample locations or even analytical variability, but indicate that the chemical concentrations have generally stabilized at concentrations less than the SQOs. The largest difference was observed for DEHP in early warning sample EW-16-Y2 where DEHP was detected at 0.92 times the SQO, while DEHP in the natural recovery performance monitoring sample NR-16-Y2 was only 0.39 times the SQO.

The detected DEHP concentration was at the SQO in the performance monitoring sample from station NR-12 collected as part of Year 2 monitoring. DEHP was detected in the co-located Year 2 early warning sample EW-12-Y2 at a concentration greater than the SQO (1.15 times the SQO). The remaining detected concentrations in sample pair NR-12-Y2/EW-12-Y2 were well below the SQOs.

Chemical concentrations in sample NR-13-Y2 and the co-located early warning sample EW-13-Y2 did not exceed the SQOs. However, DEHP was detected in both samples at a concentration at the SQO. Benzyl alcohol was also detected at a concentration at the SQO in sample NR-13-Y2 but was slightly lower in the early warning sample at 0.92 times the SQO.

The results for stations 11 and 20 (sample NR-11-Y2/EW-11-Y2 and NR-20-Y2/EW-20-Y2) had detected DEHP concentrations that were greater than the SQOs in both the early warning samples and natural recovery performance samples. The DEHP concentrations in the early warning samples were less than the concentrations in the co-located natural recovery performance samples. In sample EW-11-Y2 the DEHP enrichment ratio was approximately 1.1 and the enrichment ratio in sample NR-11-Y2 was approximately 1.2. In sample EW-20-Y2, the DEHP enrichment ratio was approximately 1.5 compared to the enrichment ratio for sample NR-20-Y2 of approximately 1.9.

In early warning sample EW-19-Y2, 12 SVOCs were detected at concentrations greater than SQOs, including 2-methylnaphthalene, acenapthene, anthracene, fluorene, phenanthrene, total LPAH, benzo(a)anthracene, dibenzo(a,h)anthracene, fluoranthene, pyrene, total HPAH, and n-nitrosodiphenylamine. N-nitrosodiphenylamine in sample EW-19-Y2 also exceeded the threshold concentration set forth in the OMMP. The corresponding natural recovery sample

NR-19-Y2 had detections of these 12 SVOCs that were well below the SQO. Detected concentrations in the early warning sample may be the result of heterogeneity in the sediment in this portion of the Wheeler-Osgood Waterway or associated with a subcomponent of the early warning sample. Other Year 2 samples collected in the vicinity of this station did not have similar elevated SVOC concentrations as seen in EW-19-Y2.

The detected concentrations of some constituents in both the early warning and natural recovery performance monitoring samples from station NR-25 (samples NR-25-Y2/EW-25-Y2) were greater than the SQOs. Seven analytes, including phenanthrene, fluoranthene, pyrene, total HPAH, butyl benzyl phthalate, DEHP, and total PCBs, were detected at concentrations exceeding the SQOs in the natural recovery performance monitoring sample NR-25-Y2. Early warning sample EW-25-Y2 had 10 analytes detected at concentrations greater than the SQOs that included six of the seven analytes present in the natural recovery performance sample (i.e., excluding PCBs) and also included anthracene, total LPAH, benzo(a)anthracene, and benzyl alcohol. In general, detected analyte concentrations were higher in the early warning sample when compared to the natural recovery performance sample. In addition, butyl benzyl phthalate and benzyl alcohol concentrations in the early warning sample exceed the early warning threshold concentrations.

3.6 Summary of Year 2 Findings

A summary of the findings from the Year 2 early warning monitoring is included below. A brief summary comparing the early warning samples to the co-located channel sand cap and natural recovery and enhanced natural recovery performance monitoring samples is also provided below as well as in the Year 2 Findings portions of Sections 2.2.2.2 and 2.3.

As a general note, benzyl alcohol was detected in over half of the Year 2 sediment samples analyzed, with three of the early warning samples (samples EW-23-Y2, EW-25-Y2, and EW-28-Y2) having benzyl alcohol concentrations that were greater than the SQO. Previous sampling events in the Thea Foss and Wheeler-Osgood Waterways had very few detections of benzyl alcohol and the detected concentrations did not exceed the SQO. As previously mentioned in Section 2.0, the more recent detections and higher concentrations of benzyl alcohol in the sediment may be a laboratory artifact. A technical memo titled "Evaluation of the detection and extraction methods used for the analysis of benzyl alcohol in Thea Foss Waterway OMMP sediment samples" summarizes the evaluation of several factors that could have potentially resulted in the increased detection of benzyl alcohol in Year 2 (2008). This technical memorandum is included in Appendix B as Attachment B-2. Also, as indicated above, the early warning threshold concentration for benzyl alcohol was set at the SQO because it was not considered to be a large recontamination risk during the design phase.

Dredge to Clean Areas

The following provides a summary of the findings for Year 2 early warning samples in the dredge to clean areas:

- Early warning samples EW-15-Y2, EW-21-Y2, EW-22-Y2, and EW-24-Y2 were collected from the dredge to clean areas located in RA 5 and RA 6. The detected concentrations did not exceed the SQO criteria or the threshold concentrations.

- Early warning sample EW-28-Y2 collected from the dredge to clean area in RA 16 had detected concentrations of six SVOCs, including DEHP, 2,4-dimethylphenol, benzyl alcohol, hexachlorobenzene, hexachlorobutadiene, and n-nitrosodiphenylamine, that were greater than the SQOs. This is the first early warning sample to be collected from the dredge to clean area in RA 16. Six dredging confirmation samples were collected over the course of dredging this area during the remedial action. None of the dredging confirmation samples had SQO exceedences of the six SVOCs and only DEHP and 2,4-dimethylphenol were detected in the dredging confirmation samples. Based on the confirmation sample results, the SVOCs appear to be relatively recent contaminants in RA 16. Catch basin samples FD21 and FD22 from the stormwater line upgradient of Outfall 248 collected in 2007 by the City of Tacoma did not have detections of hexachlorobenzene, hexachlorobutadiene or n-nitrosodiphenylamine. The City is visiting businesses in the basin under the stormwater source control program to evaluate potential sources of these contaminants. For additional information the City's stormwater source control efforts refer to Section 7.3. With the exception of DEHP, the remaining SVOCs also exceeded the threshold concentrations, which are the same concentrations as the SQOs for these analytes. It is likely that if threshold concentrations for these chemicals were recalculated, they would be higher than the SQOs. The early warning sample location will be monitored again as part of Year 4 OMMP monitoring.

Channel Sand Cap Areas

The following provides a summary of the findings for Year 2 early warning samples in the channel sand cap areas and a comparison of the early warning samples to co-located channel sand cap performance samples:

- The detected chemical concentrations did not exceed the SQOs or threshold concentrations in the Year 2 early warning samples (0 to 2 cm) EW-01-Y2, EW-26-Y2, EW-27-Y2, EW-29-Y2, and EW-30-Y2. Detected concentrations in these early warning samples were generally well below the SQOs with the exception of DEHP in sample EW-27-Y2 which was just below the SQO. The channel sand cap performance samples (0 to 10 cm) that were co-located with these early warning samples also had detected concentrations generally well below the SQOs. Early warning samples EW-01-Y2, EW-26-Y2, and EW-29-Y2 generally had comparable, but slightly higher concentrations compared to their co-located channel sand cap performance samples. In early warning sample EW-27-Y2, DEHP and benzyl alcohol were detected at higher concentrations compared to the concentrations in their corresponding channel sand cap performance sample. DEHP was also detected at a higher concentration in early warning sample EW-30-Y2 compared to its corresponding channel sand cap performance sample.
- Early warning samples EW-31-Y2 and EW-33-Y2, located in the southern portion of the Thea Foss Waterway, had only DEHP detected above the SQO, with detections at or less than 2.3 times the SQO. However, the DEHP concentrations detected in these early warning samples were well below the early warning threshold concentration for DEHP. The co-located Year 2 channel sand cap performance samples did not have any detected chemical concentrations exceed the SQOs.

- The chemical concentrations for early warning sample EW-23-Y2, located in the western portion of RA 6 adjacent to City of Tacoma Outfall 230 had SQO exceedences for benzo(g,h,i)perylene, dibenzo(a,h)-anthracene, indeno(1,2,3-cd)pyrene, DEHP, and benzyl alcohol. Dibenzo(a,h)anthracene and benzyl alcohol also exceeded the threshold concentrations in this early warning sample. Similar to EW-23-Y2, the co-located channel sand cap performance monitoring sample, Sample CC-23-Y2, also had benzo(g,h,i)perylene, indeno(1,2,3-cd)pyrene, DEHP, and benzyl alcohol concentrations greater than the SQOs. The detected concentrations in the early warning sample were comparable or just slightly higher than the concentrations in the performance monitoring sample, with the exception of benzyl alcohol which was considerably lower in the early warning sample. The elevated concentrations in this channel sand cap area appear to be localized as the early warning samples collected in the adjacent dredge to clean area in RA 6 (samples EW-21-Y2, EW-22-Y2, and EW-24-Y2) and the slope cap performance monitoring sample from the south end of RA-8 (sample SC-08B-Y2), discussed in Section 2, did not have chemical concentrations greater than the SQOs. As stated in Section 2.2.2.2, the City continues to monitor sediment and stormwater from Outfall 230. In addition, a comprehensive cleaning of the stormwater lines associated with Outfall 230 was performed in 2007. Refer to Section 7.3 for additional information on the City's stormwater source control efforts at Outfall 230. The channel sand cap location in RA 6 will be monitored again as part of Year 4 OMMP monitoring.
- Early warning sample EW-32-Y2, located at the south end of RA 19A and the Thea Foss Waterway, had acenapthene, anthracene, fluorene, phenanthrene, total LPAH, pyrene, and DEHP at concentrations greater than the SQOs. The DEHP concentration in sample EW-32-Y2 also exceeded the threshold concentration. The co-located channel sand cap performance sample, sample CC-32-Y2, had phenanthrene and DEHP at concentrations greater than the SQOs. The detected concentrations in sample EW-32-Y2 generally were higher than in sample CC-32-Y2. The elevated concentrations in this channel sand cap area appear to be relatively localized as the compliance monitoring surface samples and early warning samples collected in the adjacent cap areas (samples CC-29-Y2/EW-29-Y2, CC-30-Y2/EW-30-Y2, CC-31-Y2/EW-31-Y2, and CC-33-Y2/EW-33-Y2) did not have similar chemical concentrations or exceedences of the SQOs. This area is likely a depositional area within the Thea Foss Waterway that is a result of installation of the sheet pile wall. The channel sand cap location in RA 19A will be monitored again as part of Year 4 OMMP monitoring.

Natural Recovery Areas

The following provides a summary of the findings for Year 2 early warning samples in the natural recovery and enhanced natural recovery areas and a comparison of the early warning samples to the co-located natural recovery and enhanced natural recovery performance samples:

- In early warning samples EW-06-Y2, EW-07-Y2, EW-08-Y2, EW-09-Y2, and EW-10-Y2, collected from natural recovery areas north of the 11th Street Bridge, all detected concentrations were substantially below the SQOs. The natural recovery performance monitoring surface samples co-located with these early warning samples also had detected chemical concentrations that were less than the SQOs. Of these five early warning samples, only early warning sample EW-08-Y2 tended to have detected analytes at slightly higher concentrations than what was detected in its co-located natural recovery sample, sample NR-08-Y2.

- Early warning sample EW-11-Y2 was also collected from a natural recovery area north of the 11th Street Bridge; however, this early warning sample had DEHP detected at a concentration slightly greater than the SQO. The DEHP concentration detected in this early warning sample was well below the early warning threshold concentration for DEHP. The co-located Year 2 natural recovery performance monitoring sample, NR-11-Y2, also had DEHP detected at a concentration exceeding the SQO. The DEHP concentration in the early warning sample was less than the concentrations in the co-located natural recovery performance sample, indicating that the DEHP concentration at this station is likely to continue to decrease in the future.
- Two early warning samples, samples EW-12-Y2 and EW-13-Y2, were collected in the natural recovery area located south of and adjacent to the 11th Street Bridge. Detected chemical concentrations in these two samples were below the SQOs with the exception of DEHP. DEHP was detected in sample EW-12-Y2 at approximately 1.2 times the SQO, while DEHP was detected at the SQO in sample EW-13-Y2. The detected DEHP concentrations in the two samples were significantly below the threshold concentration for DEHP. The DEHP concentration in sample EW-12-Y2 was greater than its co-located natural recovery performance monitoring sample NR-12-Y2 which had DEHP detected at the SQO. Similar to sample EW-13-Y2, the co-located natural recovery performance monitoring sample NR-13-Y2 had DEHP detected at the SQO.
- Early warning sample EW-16-Y2 was collected within the enhanced natural recovery area located south of the 11th Street Bridge on the west side of the waterway in the Foss Harbor Marina. The detected chemical concentrations in this early warning sample, as well as its co-located natural recovery performance monitoring sample NR-16-Y2, were less than the SQOs; however, the detected concentrations in sample EW-16-Y2 tended to be slightly higher than the detected concentrations in sample NR-16-Y2. The largest difference in concentrations between these two samples was for DEHP, where DEHP in the early warning sample was detected at 0.9 times the SQO while DEHP in the natural recovery performance monitoring sample was only 0.4 times the SQO. As the DEHP concentration is just below the SQO in the early warning sample, it is recommended that this area continue to be monitored as part of the Year 4 OMMP monitoring.
- The Year 2 early warning sample EW-17-Y2, collected at the mouth of the Wheeler-Osgood Waterway, had detected chemical concentrations that were substantially less than the SQOs. The co-located Year 2 natural recovery performance monitoring sample, sample NR-17-Y2, also had chemical concentrations less than SQOs. The early warning sample detections tended to be lower than the detections in the natural recovery performance sample.
- Twelve detected SVOCs exceeded their SQOs in early warning sample EW-19-Y2, collected from the natural recovery area located near the head of the Wheeler-Osgood Waterway. The exceedences ranged from approximately 1.1 to 4.5 times the SQOs, with the highest SQO exceedence being for phenanthrene. Only the detected concentration of n-nitrosodiphenylamine also exceeded the threshold concentration, which is set at the same concentration as the SQO. Unlike sample EW-19-Y2, the co-located Year 2 natural recovery performance monitoring sample

NR-19-Y2 had all detected chemical concentrations well below the SQOs. The source of the elevated concentration in sample EW-19-Y2 is unclear, but this sample may not be representative of the area due to the heterogeneity of the sediment in this portion of the waterway. Also, a subcomponent of the early warning sample, such as a piece of creosote treated wood for example, may be the cause of the elevated SVOC concentrations.

- In the natural recovery area located at the head of the Wheeler-Osgood Waterway, both the early warning sample EW-20-Y2 and the natural recovery performance sample NR-20-Y2 collected from this area had DEHP detected at concentrations that were greater than the SQO. The DEHP concentration in the early warning sample, detected at 1.5 times the SQO, was less than the DEHP concentration in the natural recovery performance sample, which was detected at 1.9 times the SQO. The detected DEHP concentration in the early warning sample did not exceed the DEHP threshold concentration.
- Early warning sample EW-25-Y2 was collected in the natural recovery area north of RA 15 and east of RA 16. This Year 2 early warning sample had ten chemicals detected at concentrations greater than the SQOs, including anthracene, phenanthrene, total LPAH, benzo(a)anthracene, fluoranthene, pyrene, total HPAH, butyl benzyl phthalate, DEHP, and benzyl alcohol. The enrichment ratios for these chemicals ranged from 1.04 to 2.9 times the SQOs, with benzyl alcohol having the highest enrichment ratio. Butyl benzyl phthalate and benzyl alcohol in sample EW-25-Y2 exceeded their early warning threshold concentrations. The early warning threshold concentrations for these two chemicals were set at the SQO as they weren't considered as primary parameters at risk for recontamination during design. The co-located natural recovery performance monitoring sample, sample NR-25-Y2, also had detected concentrations for seven analytes exceed the SQOs. In general, detected analyte concentrations were higher in the early warning sample when compared to the natural recovery performance sample. The trends in sample concentrations at station 25 may, in part, be the result of the heterogeneity in the sediment in this natural recovery area.

3.7 Schedule of Early Warning Monitoring Activities

No supplemental early warning monitoring is required to characterize Year 2 conditions in the Thea Foss or Wheeler-Osgood Waterways. The next early warning monitoring, including collection and analysis of samples, is scheduled to occur in 2010 as part of Year 4 early warning monitoring. The schedule for OMMP activities to be performed as part of the Foss Project is presented in Table 1-1. The scope of early warning monitoring to be conducted in Year 4 is the same as for Year 2 and is described in the OMMP.

TABLES

Table 3-1
Summary of Year 2 Early Warning Monitoring Sample (0 to 2 cm) Results

	Station		EW-01		EW-06		EW-07		EW-08		EW-09		EW-10		EW-11		EW-12		EW-13		EW-15			
	Sample ID		EW-01-Y2		EW-06-Y2		EW-07-Y2		EW-08-Y2		EW-09-Y2		EW-10-Y2		EW-11-Y2		EW-12-Y2		EW-13-Y2		EW-15-Y2		EW-15-Y2-2	
	Sample Date		5/27/2008	Enrichment	5/27/2008	Enrichment	5/28/2008	Enrichment	5/27/2008	Enrichment	5/27/2008	Enrichment	5/28/2008	Enrichment	5/28/2008	Enrichment	5/28/2008	Enrichment	5/29/2008	Enrichment	5/29/2008	Enrichment	5/29/2008	Enrichment
	Sample Depth		0 to 2 cm	Ratio	0 to 2 cm	Ratio	0 to 2 cm	Ratio	0 to 2 cm	Ratio	0 to 2 cm	Ratio	0 to 2 cm	Ratio	0 to 2 cm	Ratio	0 to 2 cm	Ratio	0 to 2 cm	Ratio	0 to 2 cm	Ratio	0 to 2 cm	Ratio
Parameter	**Units**	**SQO**																						
Conventionals																								
Total Organic Carbon	mg/kg	NC	11,400	NA	15,200	NA	14,700	NA	11,800	NA	11,100	NA	12,500	NA	17,600	NA	15,300	NA	20,500	NA	12,600	NA	11,800	NA
Total Solids	%	NC	51.1	NA	45.5	NA	45.5	NA	52.2	NA	58.4	NA	56.9	NA	43.1	NA	47.9	NA	50.3	NA	54.4	NA	54.6	NA
Metals																								
Antimony	mg/kg	150	2.2 U	NA	2.0 U	NA	2.0 U	NA	2.0 U	NA	2.1 U	NA	2.0 U	NA	2.1 U	NA	1.9 U	NA	2.1 U	NA	1.9 U	NA	3.0 U	NA
Arsenic	mg/kg	57	8.9 J	0.16	9.5	0.17	9.4	0.16	10.7	0.19	9.7	0.17	7.4 J	0.13	16.9	0.30	12.9	0.23	16.3	0.29	12.3	0.22	14.6	0.26
Cadmium	mg/kg	5.1	0.55	0.11	0.88	0.17	0.91	0.18	0.82	0.16	0.61	0.12	0.88	0.17	1.00	0.20	0.74	0.15	0.91	0.18	0.82	0.16	1.11	0.22
Copper	mg/kg	390	37.9	0.10	68.8	0.18	83.7	0.21	60.0	0.15	54.2	0.14	55.5	0.14	87.9	0.23	80.5	0.21	85.4	0.22	51.2	0.13	65.4	0.17
Lead	mg/kg	450	10.3	0.02	38.1	0.08	40.9	0.09	34.2	0.08	31.8	0.07	38.7	0.09	57.5	0.13	62.1	0.14	75.5	0.17	45.4	0.10	61.0	0.14
Nickel	mg/kg	140	11.2	0.08	15.4	0.11	16.2	0.12	17.4	0.12	16.5	0.12	17.1	0.12	18.5	0.13	17.5	0.13	20.1	0.14	15.0	0.11	20.5	0.15
Silver	mg/kg	6.1	2.30 J	0.38	2.89 J	0.47	3.19 J	0.52	2.62 J	0.43	2.96 J	0.49	2.56 J	0.42	3.34 J	0.55	2.80 J	0.46	3.67 J	0.60	3.02 J	0.50	4.35 J	0.71
Zinc	mg/kg	410	40.7	0.10	78.5	0.19	102	0.25	68.5	0.17	61.9	0.15	78.0	0.19	122	0.30	127	0.31	126	0.31	83.9	0.20	112	0.27
Mercury	mg/kg	0.59	0.064	0.11	0.163	0.28	0.183	0.31	0.137	0.23	0.142	0.24	0.115	0.19	0.267	0.45	0.232	0.39	0.250	0.42	0.246	0.42	0.205	0.35
SVOCs																								
LPAHs																								
2-Methylnaphthalene	µg/kg	670	38	0.06	130	0.19	81	0.12	90	0.13	100	0.15	87	0.13	81	0.12	140	0.21	210	0.31	160	0.24	160	0.24
Acenaphthene	µg/kg	500	15	0.03	59	0.12	46	0.09	44	0.09	47	0.09	90	0.18	42	0.08	89	0.18	120	0.24	62	0.12	62	0.12
Acenaphthylene	µg/kg	1,300	31	0.02	86	0.07	75	0.06	64	0.05	57	0.04	55	0.04	61	0.05	98	0.08	130	0.10	99	0.08	100	0.08
Anthracene	µg/kg	960	91	0.09	230	0.24	210	0.22	170	0.18	160	0.17	260	0.27	170	0.18	410	0.43	370	0.39	270	0.28	290	0.30
Fluorene	µg/kg	540	28	0.05	93	0.17	70	0.13	70	0.13	70	0.13	87	0.16	60	0.11	120	0.22	150	0.28	100	0.19	120	0.22
Naphthalene	µg/kg	2,100	67	0.03	240	0.11	160	0.08	170	0.08	190	0.09	180	0.09	170	0.08	310	0.15	410	0.20	280	0.13	280	0.13
Phenanthrene	µg/kg	1,500	140	0.09	420	0.28	350	0.23	300	0.20	270	0.18	310	0.21	320	0.21	600	0.40	680	0.45	440	0.29	460	0.31
Total LPAH	µg/kg	5,200	410	0.08	1,258	0.24	992	0.19	908	0.17	894	0.17	1,069	0.21	904	0.17	1,767	0.34	2,070	0.40	1,411	0.27	1,472	0.28
HPAHs																								
Benzo(a)anthracene	µg/kg	1,600	140	0.09	440	0.28	380	0.24	320	0.20	230	0.14	260	0.16	340	0.21	630	0.39	600	0.38	360	0.23	390	0.24
Benzo(a)pyrene	µg/kg	1,600	160	0.10	500	0.31	430	0.27	420	0.26	310	0.19	320	0.20	420	0.26	680	0.43	790	0.49	490	0.31	530	0.33
Benzofluoranthenes (total)	µg/kg	3,600	290	0.08	980	0.27	860	0.24	840	0.23	610	0.17	710	0.20	1,000	0.28	1,400	0.39	1,700	0.47	880	0.24	950	0.26
Benzo(g,h,i)perylene	µg/kg	720	67	0.09	320	0.44	260	0.36	270	0.38	200	0.28	210	0.29	200	0.28	420	0.58	400	0.56	250	0.35	250	0.35
Chrysene	µg/kg	2,800	190	0.07	580	0.21	560	0.20	450	0.16	380	0.14	430	0.15	540	0.19	930	0.33	870	0.31	490	0.18	540	0.19
Dibenzo(a,h)anthracene	µg/kg	230	31 U	NA	99	0.43	80	0.35	86	0.37	54 J	0.23	58 J	0.25	64 J	0.28	100	0.43	110	0.48	73	0.32	79	0.34
Fluoranthene	µg/kg	2,500	290	0.12	820	0.33	660	0.26	650	0.26	510	0.20	640	0.26	730	0.29	1,200	0.48	1,100	0.44	620	0.25	640	0.26
Indeno(1,2,3-cd)pyrene	µg/kg	690	66	0.10	270	0.39	230	0.33	230	0.33	170	0.25	180	0.26	180	0.26	350	0.51	330	0.48	210	0.30	220	0.32
Pyrene	µg/kg	3,300	420	0.13	1,400	0.42	840	0.25	1,000	0.30	580	0.18	750	0.23	900	0.27	2,000	0.61	1,900	0.58	1,100	0.33	1,100	0.33
Total HPAH	µg/kg	17,000	1,623	0.10	5,409	0.32	4,300	0.25	4,266	0.25	3,044 J	0.18	3,558 J	0.21	4,374 J	0.26	7,710	0.45	7,800	0.46	4,473	0.26	4,699	0.28
Other																								
Dimethyl phthalate	µg/kg	160	4.7	0.03	11	0.07	11	0.07	9.8	0.06	9.3	0.06	7.7	0.05	17	0.11	15	0.09	19	0.12	8.0	0.05	11	0.07
Diethylphthalate	µg/kg	200	23 U	NA	36	0.18	27 U	NA	32 U	NA	32 U	NA	27 U	NA	27 U	NA	32 U	NA	32 U	NA	32 U	NA	32 U	NA
Di-n-butyl phthalate	µg/kg	1,400	29	0.02	57	0.04	28 U	NA	46	0.03	41	0.03	27 U	NA	28 U	NA	33 U	NA	62	0.04	33 U	NA	33 U	NA
Butyl benzyl phthalate	µg/kg	900	49 J	0.05	230	0.26	120	0.13	200	0.22	110	0.12	70	0.08	140	0.16	190	0.21	330	0.37	92	0.10	99	0.11
Bis(2-ethylhexyl)phthalate	µg/kg	1,300	250	0.19	1,100	0.85	940	0.72	900	0.69	470	0.36	570	0.44	**1,400**	1.08	**1,500**	1.15	1,300	1.00	610	0.47	660	0.51
Di-n-octyl phthalate	µg/kg	6,200	26 U	NA	36 U	NA	30 U	NA	36 U	NA	36 U	NA	29 U	NA	73	0.01	43 J	0.01	50 J	0.01	36 U	NA	36 U	NA
Phenol	µg/kg	420	20	0.05	43	0.10	36	0.09	36	0.09	32	0.08	20	0.05	40	0.10	43	0.10	69	0.16	37	0.09	43	0.10
2-Methylphenol	µg/kg	63	3.4 U	NA	4.7 U	NA	3.9 U	NA	4.7 U	NA	4.7 U	NA	3.8 U	NA	3.9 U	NA	4.7 U	NA	6.5 J	0.10	4.7 U	NA	4.7 U	NA
4-Methylphenol	µg/kg	670	4.0	0.01	18	0.03	2.1 U	NA	2.5 U	NA	2.5 U	NA	2.1 U	NA	20	0.03	28	0.04	41	0.06	71	0.11	54	0.08
2,4-Dimethylphenol	µg/kg	29	1.3 U	NA	4.9	0.17	4.0	0.14	1.8 U	NA	1.8 U	NA	1.5 U	NA	5.6	0.19	6.4	0.22	9.2	0.32	6.1	0.21	5.9	0.20
Pentachlorophenol	µg/kg	360	31 U	NA	43 U	NA	36 U	NA	43 U	NA	43 U	NA	36 U	NA	36 UJ	NA	43 U	NA	43 U	NA	43 U	NA	43 U	NA
Benzyl alcohol	µg/kg	73	73 U	NA	73 U	NA	28 J	0.38	73 U	NA	73 U	NA	23 J	0.32	65 J	0.89	32 J	0.44	67 J	0.92	45 J	0.62	56 J	0.77
Benzoic acid	µg/kg	650	45 UJ	NA	62 UJ	NA	52 UJ	NA	62 UJ	NA	62 UJ	NA	51 UJ	NA	69 J	0.11	140	0.22	62 U	NA	62 U	NA	62 U	NA
1,2-Dichlorobenzene	µg/kg	50	1.6 U	NA	2.2 U	NA	1.9 U	NA	2.2 U	NA	2.2 U	NA	1.8 U	NA	1.9 U	NA	2.2 UJ	NA	2.2 UJ	NA	2.2 UJ	NA	3.2 J	0.06
1,3-Dichlorobenzene	µg/kg	170	1.8 U	NA	2.5 U	NA	2.1 U	NA	2.5 U	NA	2.5 U	NA	2.1 U	NA	2.1 U	NA	2.5 UJ	NA	2.5 UJ	NA	2.5 UJ	NA	11 J	0.06
1,4-Dichlorobenzene	µg/kg	110	2.1 J	0.02	8.2 J	0.07	7.8 J	0.07	6.1 J	0.06	7.4 J	0.07	5.8 J	0.05	9.3 J	0.08	15 J	0.14	12 J	0.11	8.4 J	0.08	41 J	0.37
1,2,4-Trichlorobenzene	µg/kg	51	1.9 U	NA	2.6 U	NA	2.1 U	NA	2.6 U	NA	2.6 U	NA	2.1 U	NA	2.2 U	NA	2.6 U	NA	2.6 U	NA	2.6 U	NA	2.6 U	NA
Hexachlorobenzene	µg/kg	22	1.3 U	NA	1.7 U	NA	1.5 U	NA	1.7 U	NA	1.7 U	NA	1.4 U	NA	1.5 U	NA	1.7 U	NA	1.7 U	NA	1.7 U	NA	1.7 U	NA
Dibenzofuran	µg/kg	540	20	0.04	74	0.14	58	0.11	55	0.10	54	0.10	65	0.12	51	0.09	120	0.22	130	0.24	69	0.13	71	0.13
Hexachlorobutadiene	µg/kg	11	2.0 U	NA	2.7 U	NA	2.3 U	NA	2.7 U	NA	2.7 U	NA	2.3 U	NA	2.3 U	NA	2.7 U	NA	2.7 U	NA	2.7 U	NA	2.7 U	NA
N-Nitrosodiphenylamine	µg/kg	28	2.2 J	0.08	9.0	0.32	7.2	0.26	6.7	0.24	7.3	0.26	6.6	0.24	7.8	0.28	10	0.36	17	0.61	11	0.39	11	0.39
Pesticides																								
p,p'-DDD	µg/kg	16	5.0 U	NA	5.0 U	NA	5.0 U	NA	5.0 U	NA	5.0 U	NA	4.9 U	NA	5.0 U	NA	6.0 U	NA	6.0 U	NA	6.0 U	NA	6.0 U	NA
p,p'-DDE	µg/kg	9	2.5 U	NA	2.5 U	NA	2.5 U	NA	2.5 U	NA	2.5 U	NA	2.5 U	NA	2.5 U	NA	3.0 U	NA	3.0 U	NA	3.0 U	NA	3.0 U	NA
p,p'-DDT	µg/kg	34	7.5 U	NA	7.5 U	NA	7.5 U	NA	7.5 U	NA	7.5 U	NA	7.4 U	NA	7.5 U	NA	9.0 UJ	NA	9.0 UJ	NA	9.0 UJ	NA	9.0 UJ	NA
PCBs																								
PCB-1016	µg/kg	NC	12 U	NA	12 U	NA	12 U	NA	12 U	NA	12 U	NA	12 U	NA	12 U	NA	12 U	NA	12 U	NA	12 U	NA	12 U	NA
PCB-1221	µg/kg	NC	12 U	NA	12 U	NA	12 U	NA	12 U	NA	12 U	NA	12 U	NA	12 U	NA	12 U	NA	12 U	NA	12 U	NA	12 U	NA
PCB-1232	µg/kg	NC	12 U	NA	12 U	NA	12 U	NA	12 U	NA	12 U	NA	12 U	NA	12 U	NA	12 U	NA	12 U	NA	12 U	NA	12 U	NA
PCB-1242	µg/kg	NC	15 U	NA	15 U	NA	15 U	NA	15 U	NA	15 U	NA	15 U	NA	15 U	NA	15 U	NA	15 U	NA	15 U	NA	15 U	NA
PCB-1248	µg/kg	NC	15 U	NA	15 U	NA	15 U	NA	15 U	NA	15 U	NA	15 U	NA	15 U	NA	15 U	NA	15 U	NA	15 U	NA	15 U	NA
PCB-1254	µg/kg	NC	15 U	NA	15 U	NA	15 U	NA	15 U	NA	15 U	NA	15 U	NA	15 U	NA	66	NA	15 U	NA	15 U	NA	15 U	NA
PCB-1260	µg/kg	NC	15 U	NA	15 U	NA	15 U	NA	15 U	NA	15 U	NA	15 U	NA	15 U	NA	15 U	NA	15 U	NA	15 U	NA	15 U	NA
PCBs (total)	µg/kg	300	15 U	NA	15 U	NA	15 U	NA	15 U	NA	15 U	NA	15 U	NA	15 U	NA	66	0.22	15 U	NA	15 U	NA	15 U	NA

Notes:

Concentrations highlighted in **red** exceed the SQO.
NA: Not applicable
NC: No SQO criterion.

Qualifiers:

U - Undetected
J - The analyte was analyzed for and positively identified, but the associated numerical value is an estimate.

UJ - The analyte was analyzed for and not detected, but the associated numerical value is an estimate.

	Station		EW-16		EW-17		EW-19		EW-20				EW-21		EW-22		EW-23		EW-24		EW-25		EW-26	
	Sample ID		EW-16-Y2		EW-17-Y2		EW-19-Y2		EW-20-Y2		EW-20-Y2-2		EW-21-Y2		EW-22-Y2		EW-23-Y2		EW-24-Y2		EW-25-Y2		EW-26-Y2	
	Sample Date		5/29/2008	Enrichment	5/29/2008	Enrichment	6/23/2008	Enrichment	6/23/2008	Enrichment	6/23/2008	Enrichment	6/23/2008	Enrichment	6/23/2008	Enrichment	6/23/2008	Enrichment	6/23/2008	Enrichment	6/24/2008	Enrichment	6/23/2008	Enrichment
	Sample Depth		0 to 2 cm	Ratio	0 to 2 cm	Ratio	0 to 2 cm	Ratio	0 to 2 cm	Ratio	0 to 2 cm	Ratio	0 to 2 cm	Ratio	0 to 2 cm	Ratio	0 to 2 cm	Ratio	0 to 2 cm	Ratio	0 to 2 cm	Ratio	0 to 2 cm	Ratio
Parameter	**Units**	**SQO**																						
Conventionals																								
Total Organic Carbon	mg/kg	NC	6,850	NA	15,300	NA	22,500	NA	15,200	NA	26,800	NA	7,350	NA	12,200	NA	60,000	NA	18,000	NA	140,000	NA	15,000	NA
Total Solids	%	NC	67.2	NA	63.9	NA	56.3	NA	63.9	NA	63.4	NA	62.4	NA	56.4	NA	37.0	NA	64.9	NA	33.7	NA	78.0	NA
Metals																								
Antimony	mg/kg	150	1.6 U	NA	2.0 U	NA	2.2 U	NA	2.0 U	NA	1.2 U	0.01	1.9 U	NA	2.1 U	NA	2.2 U	NA	2.2 U	NA	4.7 J	0.03	2.0 U	NA
Arsenic	mg/kg	57	5.3 J	0.09	7.3 J	0.13	12.4	0.22	10.2	0.18	10.4	0.18	9.7	0.17	12.9	0.23	13.9	0.24	7.6 J	0.13	21.1	0.37	6.5 J	0.11
Cadmium	mg/kg	5.1	0.40	0.08	0.28 J	0.05	1.79	0.35	1.84	0.36	1.56	0.31	2.09	0.41	2.46	0.48	2.27	0.45	2.08	0.41	3.01	0.59	1.54	0.30
Copper	mg/kg	390	28.8	0.07	49.4	0.13	62.2	0.16	61.6	0.16	63.0	0.16	40.4	0.10	82.3	0.21	70.8	0.18	48.2	0.12	157	0.40	26.8	0.07
Lead	mg/kg	450	20.5	0.05	27.0	0.06	49.0	0.11	42.9	0.10	46.8	0.10	27.3	0.06	46.9	0.10	88.2	0.20	47.4	0.11	100	0.22	14.2	0.03
Nickel	mg/kg	140	11.6	0.08	10.00	0.07	14.2	0.10	15.4	0.11	14.4	0.10	12.7	0.09	15.9	0.11	19.5	0.14	14.4	0.10	19.8	0.14	16.9	0.12
Silver	mg/kg	6.1	1.89 J	0.31	2.55 J	0.42	2.36 J	0.39	2.77 J	0.45	2.32 J	0.38	2.98 J	0.49	3.40 J	0.56	3.48 J	0.57	3.07 J	0.50	4.59 J	0.75	2.42 J	0.40
Zinc	mg/kg	410	55.8	0.14	59.1	0.14	103	0.25	127	0.31	150	0.37	57.9	0.14	107	0.26	203	0.50	78.5	0.19	190	0.46	44.8	0.11
Mercury	mg/kg	0.59	0.053	0.09	0.097	0.16	0.178	0.30	0.103	0.17	0.104	0.18	0.176	0.30	0.213	0.36	0.259	0.44	0.237	0.40	0.410	0.69	0.055	0.09
SVOCs																								
LPAHs																								
2-Methylnaphthalene	µg/kg	670	27	0.04	430	0.64	**990**	1.48	200	0.30	220	0.33	110	0.16	170	0.25	100	0.15	230	0.34	330	0.49	30	0.04
Acenaphthene	µg/kg	500	13	0.03	110	0.22	**1,200**	2.40	53	0.11	120	0.24	65	0.13	150	0.30	100	0.20	190	0.38	310	0.62	18	0.04
Acenaphthylene	µg/kg	1,300	17	0.01	130	0.10	270	0.21	63	0.05	71	0.05	66	0.05	110	0.08	46	0.04	100	0.08	300	0.23	16	0.01
Anthracene	µg/kg	960	48	0.05	630	0.66	**1,600**	1.67	170	0.18	280	0.29	220	0.23	370	0.39	240	0.25	350	0.36	**1,000**	1.04	90	0.09
Fluorene	µg/kg	540	19	0.04	270	0.50	**1,000**	1.85	78	0.14	140	0.26	110	0.20	180	0.33	150	0.28	240	0.44	500	0.93	35	0.06
Naphthalene	µg/kg	2,100	52	0.02	440	0.21	850	0.40	200	0.10	240	0.11	230	0.11	390	0.19	280	0.13	690	0.33	1,000	0.48	68	0.03
Phenanthrene	µg/kg	1,500	110	0.07	1,000	0.67	**6,800**	4.53	510	0.34	900	0.60	380	0.25	640	0.43	1,200	0.80	720	0.48	**2,200**	1.47	150	0.10
Total LPAH	µg/kg	5,200	286	0.06	3,010	0.58	**12,710**	2.44	1,274	0.25	1,971	0.38	1,181	0.23	2,010	0.39	2,116	0.41	2,520	0.48	**5,640**	1.08	407	0.08
HPAHs																								
Benzo(a)anthracene	µg/kg	1,600	110	0.07	430	0.27	**2,000**	1.25	330	0.21	470	0.29	270	0.17	480	0.30	960	0.60	440	0.28	**1,700**	1.06	96	0.06
Benzo(a)pyrene	µg/kg	1,600	160	0.10	490	0.31	1,600	1.00	290	0.18	340	0.21	280	0.18	610	0.38	730	0.46	500	0.31	1,000	0.63	120	0.08
Benzofluoranthenes (total)	µg/kg	3,600	370	0.10	930	0.26	2,200	0.61	570	0.16	650	0.18	500	0.14	1,200	0.33	2,300	0.64	940	0.26	3,000	0.83	250	0.07
Benzo(g,h,i)perylene	µg/kg	720	110	0.15	220	0.31	670	0.93	190	0.26	190	0.26	170	0.24	370	0.51	**730**	1.01	280	0.39	660	0.92	92	0.13
Chrysene	µg/kg	2,800	190	0.07	660	0.24	2,400	0.86	460	0.16	650	0.23	360	0.13	650	0.23	1,300	0.46	570	0.20	2,600	0.93	200	0.07
Dibenzo(a,h)anthracene	µg/kg	230	42 U	NA	68	0.30	**270**	1.17	47 J	0.20	53 J	0.23	45 J	0.20	94	0.41	**310**	1.35	72 J	0.31	230	1.00	42 U	NA
Fluoranthene	µg/kg	2,500	250	0.10	860	0.34	**2,800**	1.12	570	0.23	830	0.33	480	0.19	850	0.34	1,900	0.76	780	0.31	**3,300**	1.32	180	0.07
Indeno(1,2,3-cd)pyrene	µg/kg	690	93	0.13	190	0.28	680	0.99	170	0.25	180	0.26	160	0.23	360	0.52	**740**	1.07	270	0.39	690	1.00	80 J	0.12
Pyrene	µg/kg	3,300	310	0.09	2,100	0.64	**6,100**	1.85	1,200	0.36	1,700	0.52	1,000	0.30	1,800	0.55	2,700	0.82	2,000	0.61	**6,000**	1.82	250	0.08
Total HPAH	µg/kg	17,000	1,593	0.09	5,948	0.35	**18,720**	1.10	3,827 J	0.23	5,063 J	0.30	3,265 J	0.19	6,414	0.38	11,670	0.69	5,852 J	0.34	**19,180**	1.13	1,268 J	0.07
Other																								
Dimethyl phthalate	µg/kg	160	6.6	0.04	3.9 J	0.02	8.2	0.05	12	0.08	12	0.08	5.5	0.03	12	0.08	30	0.19	6.9	0.04	33	0.21	6.2	0.04
Diethylphthalate	µg/kg	200	32 U	NA	32 U	NA	32 U	NA	32 U	NA	32 U	NA	32 U	NA	32 U	NA	39 U	NA	32 U	NA	39	0.20	32 U	NA
Di-n-butyl phthalate	µg/kg	1,400	33 U	NA	33 U	NA	45	0.03	39	0.03	33 U	NA	33 U	NA	41	0.03	390	0.28	40	0.03	67	0.05	33 U	NA
Butyl benzyl phthalate	µg/kg	900	63 J	0.07	53 J	0.06	190	0.21	370	0.41	400	0.44	100	0.11	180	0.20	230	0.26	130	0.14	**1,000**	1.11	69 J	0.08
Bis(2-ethylhexyl)phthalate	µg/kg	1,300	1,200	0.92	360	0.28	960	0.74	**1,900**	1.46	**1,800**	1.38	530	0.41	1,300	1.00	**3,000**	2.31	990	0.76	**2,100**	1.62	440	0.34
Di-n-octyl phthalate	µg/kg	6,200	36 J	0.01	36 U	NA	38 J	0.01	61 J	0.01	36 U	NA	36 U	NA	39 J	0.01	160	0.03	36 U	NA	43 U	NA	35 U	NA
Phenol	µg/kg	420	23	0.05	53	0.13	140	0.33	210	0.50	180	0.43	41	0.10	60	0.14	100	0.24	44	0.10	65	0.15	29	0.07
2-Methylphenol	µg/kg	63	4.6 U	NA	8.5	0.13	12	0.19	8.1 J	0.13	10	0.16	4.6 U	NA	6 J	0.10	5.6 U	NA	4.7 U	NA	15 J	0.24	4.6 U	NA
4-Methylphenol	µg/kg	670	2.5 U	NA	250	0.37	100	0.15	120	0.18	140	0.21	36	0.05	43	0.06	8.7 J	0.01	41	0.06	100 J	0.15	6.7	0.01
2,4-Dimethylphenol	µg/kg	29	1.8 U	NA	12	0.41	14	0.48	5.9	0.20	7.3 J	0.25	6.3	0.22	11	0.38	3.9 J	0.13	27	0.93	13 J	0.45	2.4 J	0.08
Pentachlorophenol	µg/kg	360	43 U	NA	43 U	NA	43 U	NA	43 U	NA	43 U	NA	43 U	NA	43 U	NA	52 U	NA	43 U	NA	52 UJ	NA	43 U	NA
Benzyl alcohol	µg/kg	73	23 U	NA	38 J	0.52	45 J	0.62	42 J	0.58	23 U	NA	42 J	0.58	48 J	0.66	**78 J**	1.07	38 J	0.52	**210 J**	2.88	29 J	0.40
Benzoic acid	µg/kg	650	62 U	NA	62 U	NA	62 U	NA	99	0.15	70 U	NA	62 U	NA	62 U	NA	240	0.37	62 U	NA	120 UJ	NA	61 U	NA
1,2-Dichlorobenzene	µg/kg	50	2.2 UJ	NA	5.0 J	0.10	9.7 J	0.19	49 J	0.98	47 J	0.94	2.2 UJ	NA	2.2 UJ	NA	2.7 UJ	NA	2.2 UJ	NA	6.1 J	0.12	2.2 UJ	NA
1,3-Dichlorobenzene	µg/kg	170	2.5 UJ	NA	2.5 UJ	NA	2.5 UJ	NA	3.0 J	0.02	3.5 J	0.02	2.5 UJ	NA	2.5 UJ	NA	3.0 UJ	NA	2.5 UJ	NA	3.0 UJ	NA	2.5 UJ	NA
1,4-Dichlorobenzene	µg/kg	110	2.9 J	0.03	6.6 J	0.06	12 J	0.11	23 J	0.21	45 J	0.41	8.1 J	0.07	6.7 J	0.06	9.0 J	0.08	19 J	0.17	21 J	0.19	2.5 UJ	NA
1,2,4-Trichlorobenzene	µg/kg	51	2.6 U	NA	2.6 U	NA	2.6 U	NA	2.6 U	NA	2.6 U	NA	2.6 U	NA	2.6 U	NA	3.1 U	NA	2.6 U	NA	3.1 U	NA	2.5 U	NA
Hexachlorobenzene	µg/kg	22	1.7 U	NA	1.7 U	NA	1.7 U	NA	1.7 U	NA	1.7 U	NA	1.7 U	NA	1.7 U	NA	2.1 U	NA	1.7 U	NA	2.1 U	NA	3.2 J	0.15
Dibenzofuran	µg/kg	540	16	0.03	120	0.22	300	0.56	55	0.10	70	0.13	66	0.12	120	0.22	96	0.18	190	0.35	240	0.44	18	0.03
Hexachlorobutadiene	µg/kg	11	2.7 U	NA	2.7 U	NA	2.7 U	NA	2.7 U	NA	2.7 U	NA	2.7 U	NA	2.7 U	NA	3.3 U	NA	2.7 U	NA	3.3 U	NA	8.4	0.76
N-Nitrosodiphenylamine	µg/kg	28	4.5	0.16	13	0.46	**75**	2.68	14	0.50	14	0.50	8.0	0.29	12	0.43	6.2	0.22	12	0.43	25	0.89	2.5 J	0.09
Pesticides																								
p,p'-DDD	µg/kg	16	6.0 U	NA	6.0 U	NA	5.0 U	NA	5.0 U	NA	5.0 U	NA	5.0 U	NA	5.0 U	NA	6.0 U	NA	5.0 U	NA	6.0 U	NA	4.9 U	NA
p,p'-DDE	µg/kg	9	3.0 U	NA	3.0 U	NA	2.5 U	NA	2.5 U	NA	2.5 U	NA	2.5 U	NA	2.5 U	NA	3.0 U	NA	2.5 U	NA	3.0 U	NA	2.5 U	NA
p,p'-DDT	µg/kg	34	9.0 UJ	NA	9.0 UJ	NA	7.4 U	NA	7.5 U	NA	7.5 U	NA	7.5 U	NA	7.5 U	NA	9.0 U	NA	7.5 U	NA	9.0 U	NA	7.4 U	NA
PCBs																								
PCB-1016	µg/kg	NC	12 U	NA	12 U	NA	9.9 U	NA	10 U	NA	10 U	NA	10 U	NA	10 U	NA	12 U	NA	10 U	NA	12 U	NA	10 U	NA
PCB-1221	µg/kg	NC	12 U	NA	12 U	NA	9.9 U	NA	10 U	NA	10 U	NA	10 U	NA	10 U	NA	12 U	NA	10 U	NA	12 U	NA	10 U	NA
PCB-1232	µg/kg	NC	12 U	NA	12 U	NA	9.9 U	NA	10 U	NA	10 U	NA	10 U	NA	10 U	NA	12 U	NA	10 U	NA	12 U	NA	10 U	NA
PCB-1242	µg/kg	NC	15 U	NA	15 U	NA	12 U	NA	12 U	NA	12 U	NA	12 U	NA	12 U	NA	15 U	NA	12 U	NA	15 U	NA	12 U	NA
PCB-1248	µg/kg	NC	15 U	NA	15 U	NA	12 U	NA	12 U	NA	12 U	NA	12 U	NA	12 U	NA	15 U	NA	12 U	NA	15 U	NA	12 U	NA
PCB-1254	µg/kg	NC	15 U	NA	15 U	NA	12 U	NA	12 U	NA	12 U	NA	12 U	NA	170	NA	15 U	NA	12 U	NA	15 U	NA	12 U	NA
PCB-1260	µg/kg	NC	15 U	NA	15 U	NA	12 U	NA	12 U	NA	12 U	NA	12 U	NA	12 U	NA	15 U	NA	12 U	NA	15 U	NA	12 U	NA
PCBs (total)	µg/kg	300	15 U	NA	15 U	NA	12 U	NA	12 U	NA	12 U	NA	12 U	NA	170	0.57	15 U	NA	12 U	NA	15 U	NA	12 U	NA

Notes:

Concentrations highlighted in **red** exceed the SQO.

NA: Not applicable

NC: No SQO criterion.

Qualifiers:

U - Undetected

J - The analyte was analyzed for and positively identified, but the associated numerical value is an estimate.

UJ - The analyte was analyzed for and not detected, but the associated numerical value is an estimate.

	Station		EW-27		EW-28		EW-29		EW-30		EW-31		EW-32		EW-33	
	Sample ID		EW-27-Y2		EW-28-Y2		EW-29-Y2		EW-30-Y2		EW-31-Y2		EW-32-Y2		EW-33-Y2	
	Sample Date		6/23/2008	Enrichment	6/23/2008	Enrichment	6/23/2008	Enrichment	6/24/2008	Enrichment	6/24/2008	Enrichment	6/24/2008	Enrichment	6/24/2008	Enrichment
	Sample Depth		0 to 2 cm	Ratio	0 to 2 cm	Ratio	0 to 2 cm	Ratio	0 to 2 cm	Ratio	0 to 2 cm	Ratio	0 to 2 cm	Ratio	0 to 2 cm	Ratio
Parameter	**Units**	**SQO**														
Conventionals																
Total Organic Carbon	mg/kg	NC	20,000	NA	30,000	NA	13,600	NA	15,400 J	NA	33,600 J	NA	37,700 J	NA	26,000 J	NA
Total Solids	%	NC	66.3	NA	55.6	NA	76.1	NA	74.1	NA	49.6	NA	46.5	NA	69.4	NA
Metals																
Antimony	mg/kg	150	1.8 U	NA	2.0 U	NA	2.2 U	NA	1.0 U	NA	2.0 U	NA	2.0 U	NA	1.1 U	NA
Arsenic	mg/kg	57	9.2	0.16	12.4	0.22	6.7 J	0.12	6.9	0.12	11.6	0.20	14.5	0.25	6.4	0.11
Cadmium	mg/kg	5.1	1.96	0.38	2.34	0.46	1.34	0.26	1.24	0.24	2.12	0.42	2.92	0.57	1.42	0.28
Copper	mg/kg	390	42.9	0.11	56.7	0.15	28.0	0.07	28.0	0.07	66.1	0.17	93.9	0.24	38.0	0.10
Lead	mg/kg	450	27.8	0.06	51.7	0.11	20.6	0.05	18.2	0.04	51.8	0.12	98.4	0.22	29.5	0.07
Nickel	mg/kg	140	19.0	0.14	16.0	0.11	15.4	0.11	13.8	0.10	19.8	0.14	28.0	0.20	15.8	0.11
Silver	mg/kg	6.1	2.92 J	0.48	3.43 J	0.56	1.97 J	0.32	2.09 J	0.34	2.87 J	0.47	3.44 J	0.56	1.95 J	0.32
Zinc	mg/kg	410	71.2	0.17	91.3	0.22	56.1	0.14	52.8	0.13	142	0.35	196	0.48	88.7	0.22
Mercury	mg/kg	0.59	0.122	0.21	0.224	0.38	0.073	0.12	0.068	0.12	0.153	0.26	0.401	0.68	0.056	0.09
SVOCs																
LPAHs																
2-Methylnaphthalene	µg/kg	670	62	0.09	180	0.27	47	0.07	37	0.06	89	0.13	670	1.00	51	0.08
Acenaphthene	µg/kg	500	42	0.08	160	0.32	36	0.07	24	0.05	61	0.12	**940**	1.88	33	0.07
Acenaphthylene	µg/kg	1,300	34	0.03	140	0.11	26	0.02	21	0.02	37	0.03	250	0.19	24	0.02
Anthracene	µg/kg	960	110	0.11	340	0.35	74	0.08	65	0.07	110	0.11	**1,000**	1.04	86	0.09
Fluorene	µg/kg	540	48	0.09	190	0.35	36	0.07	31	0.06	69	0.13	**620**	1.15	36	0.07
Naphthalene	µg/kg	2,100	150	0.07	400	0.19	120	0.06	84	0.04	430	0.20	1,900	0.90	120	0.06
Phenanthrene	µg/kg	1,500	300	0.20	580	0.39	190	0.13	220	0.15	500	0.33	**3,000**	2.00	330	0.22
Total LPAH	µg/kg	5,200	746	0.14	1,990	0.38	529	0.10	482	0.09	1,296	0.25	**8,380**	1.61	680	0.13
HPAHs																
Benzo(a)anthracene	µg/kg	1,600	240	0.15	480	0.30	130	0.08	170	0.11	370	0.23	1,500	0.94	290	0.18
Benzo(a)pyrene	µg/kg	1,600	340	0.21	480	0.30	140	0.09	170	0.11	310	0.19	950	0.59	360	0.23
Benzofluoranthenes (total)	µg/kg	3,600	750	0.21	870	0.24	300	0.08	400	0.11	1100	0.31	2,100	0.58	910	0.25
Benzo(g,h,i)perylene	µg/kg	720	210	0.29	270	0.38	100	0.14	140	0.19	380	0.53	640	0.89	260	0.36
Chrysene	µg/kg	2,800	360	0.13	600	0.21	180	0.06	270	0.10	660	0.24	2,100	0.75	480	0.17
Dibenzo(a,h)anthracene	µg/kg	230	77 J	0.33	79 J	0.34	42 U	0.18	45 J	0.20	110	0.48	190	0.83	91	0.40
Fluoranthene	µg/kg	2,500	530	0.21	690	0.28	240	0.10	400	0.16	830	0.33	2,300	0.92	640	0.26
Indeno(1,2,3-cd)pyrene	µg/kg	690	200	0.29	260	0.38	96	0.14	150	0.22	370	0.54	650	0.94	240	0.35
Pyrene	µg/kg	3,300	780	0.24	1,600	0.48	400	0.12	560	0.17	1,400	0.42	**5,600**	1.70	960	0.29
Total HPAH	µg/kg	17,000	3,487 J	0.21	5,329 J	0.31	1,586	0.09	2,305 J	0.14	5,530	0.33	16,030	0.94	4,231	0.25
Other																
Dimethyl phthalate	µg/kg	160	10	0.06	40	0.25	7.1	0.04	6.1	0.04	16	0.10	19	0.12	9.7	0.06
Diethylphthalate	µg/kg	200	32 U	NA	70	0.35	32 U	NA	32 U	NA	39 U	NA	39 U	NA	32 U	NA
Di-n-butyl phthalate	µg/kg	1,400	41	0.03	62	0.04	33 U	NA	37	0.03	71	0.05	69	0.05	40	0.03
Butyl benzyl phthalate	µg/kg	900	170	0.19	390	0.43	81 J	0.09	140	0.16	790	0.88	410	0.46	170	0.19
Bis(2-ethylhexyl)phthalate	µg/kg	1,300	1,200	0.92	**1,400**	1.08	650	0.50	1,000	0.77	**3,000**	2.31	**3,900**	3.00	**1,800**	1.38
Di-n-octyl phthalate	µg/kg	6,200	49 J	0.01	57 J	0.01	35 U	NA	36 U	NA	210	0.03	43 U	NA	110	0.02
Phenol	µg/kg	420	45	0.11	78	0.19	26	0.06	27	0.06	32 J	0.08	41 J	0.10	49	0.12
2-Methylphenol	µg/kg	63	4.6 U	NA	30	0.48	4.6 U	NA	4.7 U	NA	14 J	0.22	14 J	0.22	4.7 U	NA
4-Methylphenol	µg/kg	670	12	0.02	77	0.11	5.9 J	0.01	6.3 J	0.01	42 J	0.06	72 J	0.11	12	0.02
2,4-Dimethylphenol	µg/kg	29	5.7 J	0.20	**40 J**	1.38	2.7 J	0.09	2.3 J	0.08	9 J	0.31	16 J	0.55	4.2 J	0.14
Pentachlorophenol	µg/kg	360	43 U	NA	43 U	NA	43 U	NA	43 U	NA	51 UJ	NA	52 UJ	NA	43 U	NA
Benzyl alcohol	µg/kg	73	65 J	0.89	**100**	1.37	40 J	0.55	23 U	NA	43 J	0.59	43 J	0.59	23 U	NA
Benzoic acid	µg/kg	650	100 U	NA	210 U	NA	62 U	NA	62 U	NA	74 UJ	NA	120 UJ	NA	86 U	NA
1,2-Dichlorobenzene	µg/kg	50	2.2 UJ	NA	24 J	0.48	2.2 UJ	NA	2.2 UJ	NA	2.7 UJ	NA	2.7 UJ	NA	2.2 UJ	NA
1,3-Dichlorobenzene	µg/kg	170	2.5 UJ	NA	24 J	0.14	2.5 UJ	NA	2.5 UJ	NA	3.0 UJ	NA	3.0 UJ	NA	2.5 UJ	NA
1,4-Dichlorobenzene	µg/kg	110	4.4 J	0.04	33 J	0.30	6.7 J	0.06	3.7 J	0.03	4.5 J	0.04	9.2 J	0.08	3.4 J	0.03
1,2,4-Trichlorobenzene	µg/kg	51	2.6 U	NA	26	0.51	2.6 U	NA	2.6 U	NA	3.1 U	NA	3.1 U	NA	2.6 U	NA
Hexachlorobenzene	µg/kg	22	1.7 U	NA	**29**	1.32	1.7 U	NA	1.7 U	NA	2.1 U	NA	2.1 U	NA	1.7 U	NA
Dibenzofuran	µg/kg	540	37	0.07	120	0.22	22	0.04	23	0.04	50	0.09	210	0.39	27	0.05
Hexachlorobutadiene	µg/kg	11	2.7 U	NA	**24**	2.18	2.7 U	NA	2.7 U	NA	3.3 U	NA	3.3 U	NA	2.7 U	NA
N-Nitrosodiphenylamine	µg/kg	28	5.2	0.19	**29**	1.04	6.2	0.22	5.7	0.20	3.8 J	0.14	20	0.71	5.7	0.20
Pesticides																
p,p'-DDD	µg/kg	16	5.0 U	NA	5.0 U	NA	5.0 U	NA	5.0 U	NA	6.0 U	NA	6.0 U	NA	5.0 U	NA
p,p'-DDE	µg/kg	9	2.5 U	NA	2.5 U	NA	2.5 U	NA	2.5 U	NA	3.0 U	NA	3.0 U	NA	2.5 U	NA
p,p'-DDT	µg/kg	34	7.5 U	NA	7.5 U	NA	7.4 U	NA	7.5 U	NA	9.0 U	NA	9.0 U	NA	7.5 U	NA
PCBs																
PCB-1016	µg/kg	NC	10 U	NA	10 U	NA	9.9 U	NA	10 U	NA	12 U	NA	12 U	NA	10 U	NA
PCB-1221	µg/kg	NC	10 U	NA	10 U	NA	9.9 U	NA	10 U	NA	12 U	NA	12 U	NA	10 U	NA
PCB-1232	µg/kg	NC	10 U	NA	10 U	NA	9.9 U	NA	10 U	NA	12 U	NA	12 U	NA	10 U	NA
PCB-1242	µg/kg	NC	12 U	NA	12 U	NA	12 U	NA	12 U	NA	15 U	NA	15 U	NA	12 U	NA
PCB-1248	µg/kg	NC	12 U	NA	12 U	NA	12 U	NA	12 U	NA	15 U	NA	15 U	NA	12 U	NA
PCB-1254	µg/kg	NC	12 U	NA	12 U	NA	12 U	NA	12 U	NA	15 U	NA	15 U	NA	12 U	NA
PCB-1260	µg/kg	NC	12 U	NA	12 U	NA	12 U	NA	12 U	NA	15 U	NA	15 U	NA	12 U	NA
PCBs (total)	µg/kg	300	12 U	NA	12 U	NA	12 U	NA	12 U	NA	15 U	NA	15 U	NA	12 U	NA

Notes:

Concentrations highlighted in **red** exceed the SQO.
NA: Not applicable
NC: No SQO criterion.

Qualifiers:

U - Undetected
J - The analyte was analyzed for and positively identified, but the associated numerical value is an estimate.

UJ - The analyte was analyzed for and not detected, but the associated numerical value is an estimate.

Table 3-2

Early Warning SQO Exceedances Compared to Early Warning Threshold Concentrations

Sample ID	Parameter	SQO (µg/kg)	Threshold Concentration (µg/kg)	Sample Concentration (µg/kg)
EW-11-Y2	Bis(2-ethylhexyl)phthalate	1,300	3,250	1,400
EW-12-Y2	Bis(2-ethylhexyl)phthalate	1,300	3,250	1,500
EW-19-Y2	2-Methylnaphthalene	670	3,350	990
	Acenaphthene	500	2,500	1,200
	Anthracene	960	4,319	1,600
	Fluorene	540	2,700	1,000
	Phenanthrene	1,500	7,500	6,800
	Total LPAH	5,200	NC	12,710
	Benzo(a)anthracene	1,600	2,080	2,000
	Dibenzo(a,h)anthracene	230	288	270
	Fluoranthene	2,500	7,251	2,800
	Pyrene	3,300	8,580	6,100
	Total HPAH	17,000	NC	18,720
	N-Nitrosodiphenylamine	28	28	**75**
EW-20-Y2	Bis(2-ethylhexyl)phthalate	1,300	3,250	1,900
EW-20-Y2-2	Bis(2-ethylhexyl)phthalate	1,300	3,250	1,800
EW-23-Y2	Benzo(g,h,i)perylene	720	768	730
	Dibenzo(a,h)anthracene	230	288	**310**
	Indeno(1,2,3-cd)pyrene	690	828	740
	Bis(2-ethylhexyl)phthalate	1,300	3,250	3,000
	Benzyl alcohol	73	73	**78 J**
EW-25-Y2	Anthracene	960	4,319	1,000
	Phenanthrene	1,500	7,500	2,200
	Total LPAH	5,200	NC	5,640
	Benzo(a)anthracene	1,600	2,080	1,700
	Fluoranthene	2,500	7,251	3,300
	Pyrene	3,300	8,580	6,000
	Total HPAH	17,000	NC	19,180
	Butyl benzyl phthalate	900	900	**1,000**
	Bis(2-ethylhexyl)phthalate	1,300	3,250	2,100
	Benzyl alcohol	73	73	**210 J**
EW-28-Y2	Bis(2-ethylhexyl)phthalate	1,300	3,250	1,400
	2,4-Dimethylphenol	29	29	**40 J**
	Benzyl alcohol	73	73	**100**
	Hexachlorobenzene	22	22	**29**
	Hexachlorobutadiene	11	11	**24**
	N-Nitrosodiphenylamine	28	28	**29**
EW-31-Y2	Bis(2-ethylhexyl)phthalate	1,300	3,250	3,000
EW-32-Y2	Acenaphthene	500	2,500	940
	Anthracene	960	4,319	1,000
	Fluorene	540	2,700	620
	Phenanthrene	1,500	7,500	3,000
	Total LPAH	5,200	NC	8,380
	Pyrene	3,300	8,580	5,600
	Bis(2-ethylhexyl)phthalate	1,300	3,250	**3,900**
EW-33-Y2	Bis(2-ethylhexyl)phthalate	1,300	3,250	1,800

Notes:

Concentrations highlighted in **red** exceed both the SQO and the Early Warning Threshold Concentration.

NC - Not applicable, no Early Warning Threshold Concentration available.

Qualifiers:

J - The analyte was analyzed for and positively identified, but the associated numerical value is an estimate.

4.0 BENTHIC RECOLONIZATION MONITORING

4.1 Introduction

Year 2 benthic recolonization monitoring was performed in the Thea Foss and Wheeler-Osgood Waterways during June and July 2008, to document and evaluate the success of benthic recolonization.

Benthic habitat was altered by historical contamination and the subsequent sediment dredging and capping actions completed in the waterways. Given the improvements in the habitat resulting from the completed remedial actions, the waterway is expected to be recolonized by benthic infauna and epifauna common to Commencement Bay. The benthic recolonization monitoring was performed in accordance with the Operations, Maintenance, and Monitoring Plan (OMMP) for the Thea Foss and Wheeler-Osgood Waterways Remediation Project (City of Tacoma 2006).

The results of the Year 2 benthic recolonization monitoring are presented in the Year 2 Monitoring Benthic Recolonization Monitoring Preliminary Findings Memorandum (City of Tacoma 2008) included Attachment C-1 in Appendix C and are also summarized below.

4.2 Summary of Benthic Recolonization Monitoring Requirements

The monitoring plan includes 17 locations within the remediation areas and 4 background locations near the mouth of the waterway in an area where no remedial action was required (Figure 4-1). The monitoring approach consists of collection of three types of samples:

- Sediment Profile Imagery (SPI) – For evaluation of sediment composition, benthic habitat classification, infaunal successional stages, redox potential discontinuity (RPD), and organism-sediment index (OSI).
- Benthic Grab Samples – Archived for potential benthic community analysis, if SPI results are inconclusive or require verification.
- Co-Located Sediment Samples – Archived for future chemical analysis, if needed (collected only at those locations that are not co-located with performance samples).

The success of benthic recolonization monitoring will be evaluated at each monitoring location over the course of OMMP monitoring relative to previous years of monitoring results at the same location based on the parameters measured using SPI. Intra-location qualitative comparisons will be made to evaluate the quality of the benthic habitat in remediation areas. Background benthic monitoring results will provide additional information on the benthic community in non-remediated areas. All sampling locations, sampling methods, and other protocols are described in detail in the OMMP for the Thea Foss and Wheeler-Osgood Waterways Remediation Project and the Year 2 Monitoring Benthic Recolonization Monitoring Preliminary Findings Memorandum.

4.3 Summary of Field Activities, Analyses, and Reporting

SPI was conducted on June 20, 2008, by Germano and Associates, with additional support and equipment provided by Floyd|Snider and Research Support Services. Benthic grab sampling was performed on July 14-16, 2008, by personnel from the City of Tacoma, Floyd|Snider and

Washington Conservation Corps. Weather conditions for both sampling events were sunny and clear, with light breezes and calm water. Detailed results are presented in the Year 2 Monitoring Benthic Recolonization Monitoring Preliminary Findings Memorandum and are summarized here to characterize the Year 2 benthic conditions.

SPI and benthic grab sampling were conducted at 21 locations (Figure 4-1). SPI captured three replicate images per location, and these images were subsequently processed and interpreted by Germano and Associates. The benthic grab sampling collected five replicate samples per location. The four locations requiring co-located sediment chemistry samples each had additional grab samples collected. All benthic and sediment samples were processed and preserved on-site in accordance with the OMMP and archived for future analysis, if needed.

Only one sample station required relocating from the planned GPS coordinates. BR-18, in the Wheeler-Osgood Waterway, was blocked by rafted floats. For both the SPI event and the benthic grab sampling event, this location was moved south and adjacent to the floats. Location coordinates and descriptions are provided in the Year 2 Monitoring Benthic Recolonization Monitoring Preliminary Findings Memorandum.

4.4 Summary of Benthic Recolonization Monitoring Results

The SPI survey was performed in the Thea Foss and Wheeler-Osgood Waterways to document and evaluate the success of the benthic recolonization. The following parameters are measured and evaluated using the SPI method:

- Sediment Type Determination;
- Surface (Sediment-Water Interface) Boundary Roughness;
- Prism Penetration Depth;
- Apparent Redox Potential Discontinuity (RPD) Depth;
- Infaunal Successional Stages;
- Biological Mixing Depth; and
- Organism-Sediment Index (OSI).

A summary of the SPI results for each of these parameters is provided below and presented in Table 4-1.

Sediment Type (Grain size)

The sediments throughout the Thea Foss and Wheeler-Osgood Waterways were primarily very fine-grained silts and clays (all stations had a sediment grain size major mode of $\geq$4 phi), with many of the stations showing some very fine to fine sand in the surface 1-3 cm. The stations sampled where the channel sand cap material had been placed showed coarser sediments at depth but generally the sediment surface seen by biological receptors is similar throughout the entire waterway due to natural depositional processes.

Surface Boundary Roughness

Surface boundary roughness was determined by measuring the vertical distance between the highest and lowest points of the sediment-water interface. The surface boundary roughness typically ranges from 0.02 to 3.8 cm, and may be related to either physical structures (ripples, rip-up structures, mud clasts) or biogenic features (burrow openings, fecal mounds, foraging depressions). Biogenic roughness is related to the interaction of bottom turbulence and bioturbational activities.

Surface boundary roughness ranged from 0.57 cm to 2.33 cm, with the larger values (>2 cm) caused by natural physical processes within the waterway or as a result of sampling artifacts. The overall average surface boundary roughness for the entire survey area was 1.17 cm.

Prism Penetration Depth

The prism penetration is a noteworthy parameter if the number of weights used in the camera is held constant through the survey. This was not possible in the Thea Foss sampling. In order to obtain the necessary penetration depths, the weights required adjustment due to changes in the sediment type. However examination of the weight settings and penetration depths does allow for a general comparison between areas for relative sediment similarities.

The channel sand cap area required the heaviest weights and had one of the shallower penetration depths, indicating the greater resistance provided by the coarse sands and gravels deposited in these areas. The areas with the greatest penetration depths and requiring the least amount of weight, and therefore indicating the softest sediments, were the dredge to clean areas. The weight settings and penetration depths were similar in the no action and natural recovery areas, indicating similar sediment types, with slightly more resistance than the dredge to clean areas.

Apparent Redox Potential Discontinuity Depth

The apparent redox potential discontinuity (RPD) depth in the sediment column is an important time-integrator of dissolved oxygen conditions within sediment porewaters. The depth is related to the supply rate of molecular oxygen by diffusion into the bottom sediments and the consumption of that oxygen by the sediment and associated microflora. In the presence of bioturbating macrofauna, the thickness of the redox layer may be several centimeters. The RPD depth can also be affected by local erosion. The actual RPD must be measured with microelectrodes. SPI measures an apparent RPD (aRPD), based on color changes in sediment related to oxidation states.

The mean aRPD depths ranged from a low of 0.30 cm at Station BR-33 at the southern end of the City’s work area to a high of 3.32 cm at Station BR-09 in the natural recovery area. The overall station-averaged mean aRPD depth was 2.26 cm.

Some of the lowest values were found in the area surveyed at the far southern end of the channel sand cap area (BR-33). This is likely the result of scouring of surficial sediment at this location. The scouring likely occurs as water moving up the waterway encounters the sheetpile wall, a restriction to flow, then accelerates and picks up the fine, oxygenated surface sediment.

Low oxygen conditions as indicated by the presence of sulfur-reducing bacterial colonies were not observed in any of the SPI images. In addition, no subsurface methane was found in any of the replicate images.

Infaunal Successional Stage

Infaunal successional stages are recognized in SPI images by the presence of dense assemblages of near-surface polychaetes and/or the presence of subsurface feeding voids; both may be present in the same image. Mapping of successional stages is based on the theory that organism-sediment interactions in fine-grained sediments follow a predictable sequence after a major disturbance. This continuum of change in animal communities after a disturbance (secondary succession) has been divided into three stages: Stage 1 is the initial community of tiny, densely populated polychaete assemblages; Stage 2 is the start of the transition to head-down deposit feeders; and Stage 3 is the mature, equilibrium community of deep-dwelling, head-down deposit feeders. Stages 1 and 3 can occur together (1 on 3), indicating organic enrichment. These invertebrate community successional stages are well characterized for fine-grained sediments, but are less well-known in sand and coarser sediments.

Over 90 percent of all images taken as part of Year 2 benthic recolonization monitoring, regardless of remedial area type, have evidence of Stage 3 infaunal taxa present. Seventy-eight percent of the images had evidence of Stage 1 infauna above Stage 3 (1 on 3); 8 percent had just Stage 2 assemblages, and 13 percent showed Stage 2 transitioning to Stage 3 (2 to 3). There were no stations in the study area that showed photos dominated by Stage 1, or even mixed Stage 1 and 2 infaunal successional assemblages. The enhanced natural recovery area showed extensive burrowing activities at depth.

Based on the Year 2 benthic recolonization monitoring results, all of the remedial areas sampled showed benthic recovery as evidenced by the presence of mature infaunal communities. A summary of the distribution of infaunal successional stages for all of the sediment profile images collected in the Thea Foss and Wheeler-Osgood Waterways is presented in Figure 11 of the Year 2 Benthic Recolonization Monitoring Preliminary Findings Memorandum, provided in Appendix C.

Biological Mixing Depth

The depth to which sediments are bioturbated, or the biological mixing depth, can be an important parameter for studying either nutrient or contaminant flux in sediments. While the aRPD is one potential measure of biological mixing depth, it is quite common in profile images to see evidence of biological activity (burrows, voids, or actual animals) well below the mean aRPD.

In the Year 2 benthic recolonization monitoring, evidence of burrowing infauna and deposit feeding activity was present at the majority of stations surveyed. The range of maximum bioturbation depths measured in the Thea Foss and Wheeler Osgood Waterway stations was from 6.43 cm at station BR-33 to 18.86 cm at station BR-32. The average biological mixing depth across all of the stations was 12.26 cm.

Organism-Sediment Index

The Organism-Sediment Index (OSI) is a summary statistic that is calculated on the basis of four independently measured SPI parameters: apparent mean RPD depth, presence of methane gas, low/no dissolved oxygen at the sediment-water interface, and infaunal successional stage. Possible scores range from a high of +11, indicating a mature benthic community in relatively undisturbed conditions, to a low of -10, indicating that the sediment has a high inventory of anaerobic metabolites, high oxygen demand, and is azoic (without life). An OSI of +6 or less generally indicates that a benthic habitat has experienced physical disturbances, eutrophication, or excessive bioavailable contamination in the recent past.

The overall median OSI for the entire study area was +8, with median station values ranging from +5 to the maximum value of +11. Only 3 of the 21 stations sampled had median station values below +7. Two stations in the channel sand cap areas (BR-18 and BR-33) had median OSI values of +6, and one station in the dredge to clean area, BR-22, had a median OSI of +5.

All three replicates for BR-33 had OSI values of +6, and were driven by very shallow aRPD depths, even though they had Stage 1 on 3 benthic communities. As previously discussed, the aRPDs at BR-33 are likely the result of scour at this location. BR-18 had one replicate with an OSI of +9 and two replicates with +6. One of the two +6 replicates was driven by a low aRPD, which may have been due to an equipment artifact; the second +6 was driven by a Stage 2 benthic community.

The three replicates at BR-22 had OSI values of +4, +5, and +6. These OSI values were driven by shallow aRPD depths for this location. The mean aRPDs for each replicate were at or below 1.0 cm at this location with an overall median value of 0.72 cm. At BR-22, the infaunal successional stage was dominated by the transitional Stage 2 going to Stage 3 assemblages. Therefore, benthic recovery is occurring and evidence of mature infaunal communities is present.

4.5 Summary of Year 2 Findings

The primary objectives of the SPI survey were to document the physical nature of the benthic habitat and observable organism-sediment interactions at the sediment-water interface to evaluate benthic recolonization in the Thea Foss and Wheeler-Osgood Waterways. The following summarizes the preliminary findings from the Year 2 SPI survey:

- The benthic habitat classification is the same for the entire area: very fine sand surface over a silt/clay base. Evidence of the gravel cap was seen at depth at a few of the stations, but the sediment surface seen by biological receptors is very similar throughout the entire waterway due to natural depositional processes.
- All of the remedial areas sampled showed evidence of mature infaunal communities present and benthic ecosystem recovery processes.
- In general, all of the stations except for the two at the mouth of the waterway closest to Commencement Bay, showed evidence of mature benthic communities at depth. The later successional recolonization of opportunistic Stage 1 assemblages indicates that there is additional organic input to the system through natural depositional processes.

- The dredge to clean and channel sand cap areas have had enough natural deposition over the final treatment sediment-water interface to allow mature infaunal communities to develop.
- Channel sand cap materials were detected at some of the locations by SPI technology; however, it is very difficult to discern the interface between recently deposited sediments and the underlying materials exposed by dredging in the dredge to clean areas.

4.6 Recommendations for Future Monitoring

No further action is warranted based on the results of benthic recolonization monitoring performed in Year 2. SPI results do not require verification; therefore, analysis of the archived sediment samples does not appear warranted. Benthic recolonization monitoring will be performed again as part of Year 4 OMMP activities.

4.7 Schedule of Benthic Recolonization Monitoring Activities

Benthic recolonization monitoring is scheduled to occur in 2010 as part of Year 4 monitoring. The schedule for OMMP activities to be performed as part of the Foss Project is presented in Table 1-1. The scope of benthic recolonization monitoring to be conducted in Year 4 is the same as for Year 2 and is described in the OMMP.

TABLES

FIGURES

Table 4-1
Summary of Sediment Profile Imaging Results

Remediation Area	Average Surface Boundary Roughness (cm)	Apparent Redox Potential Discontinuity Depth (average of site means) (cm)	Infaunal Successional Stages	Maximum Biological Mixing Depth (cm)	Organism-Sediment Index (average of site median scores)
Background/No Action	1.07	2.77	2 1 on 3	13.57	+8
Natural Recovery	0.91	2.50	1 on 3 2 to 3	14.88	+8
Enhanced Natural Recovery	1.16	2.27	1 on 3 2 to 3	10.02	+9
Dredge to Clean	1.00	2.20	1 on 3	18.15	+9
Channel Sand Cap	1.59	1.78	1 on 3 2 to 3	18.86	+7.5

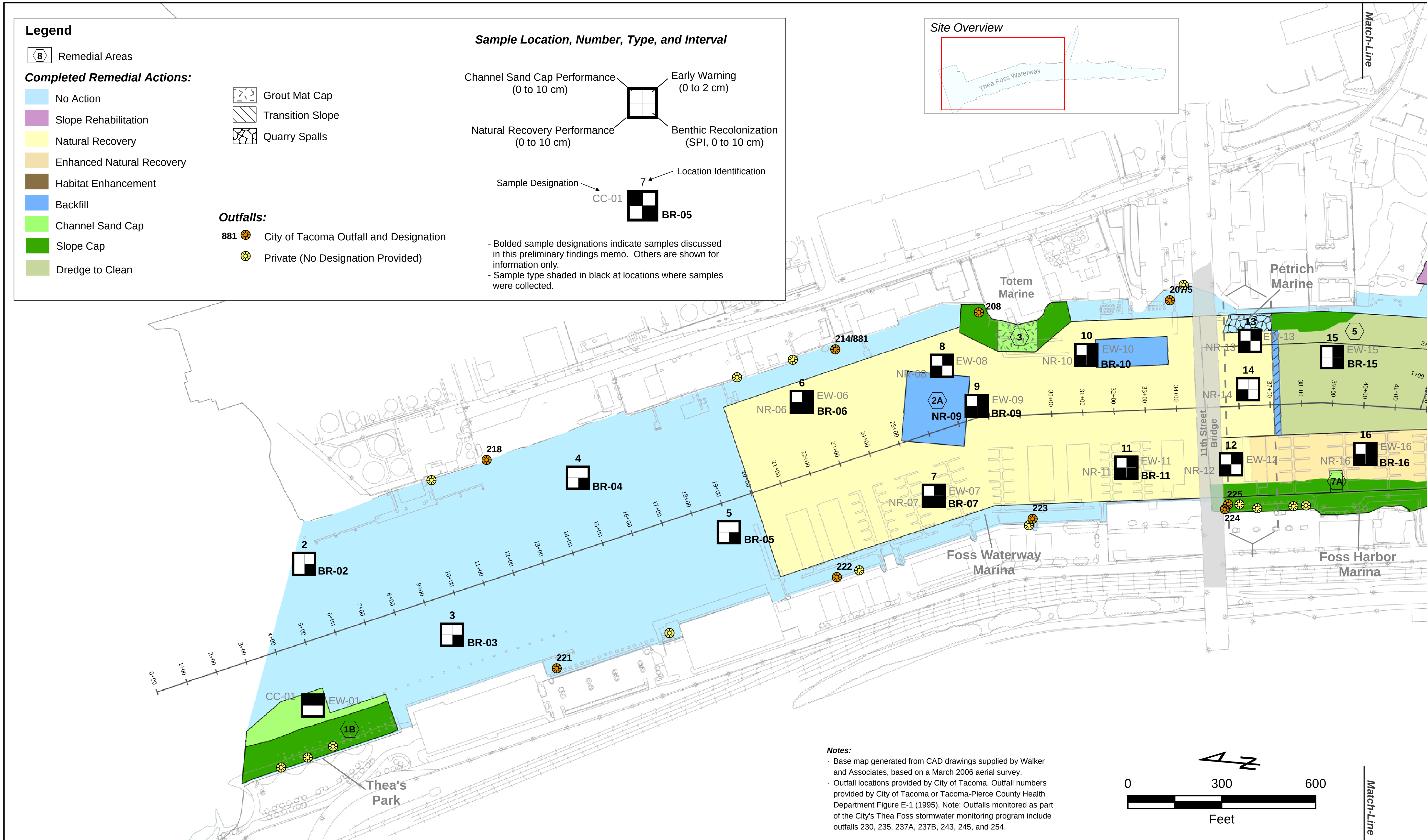

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Figure 4-1 (Page 1 of 2)
Benthic Recolonization Monitoring Locations

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Date: 1/22/2009

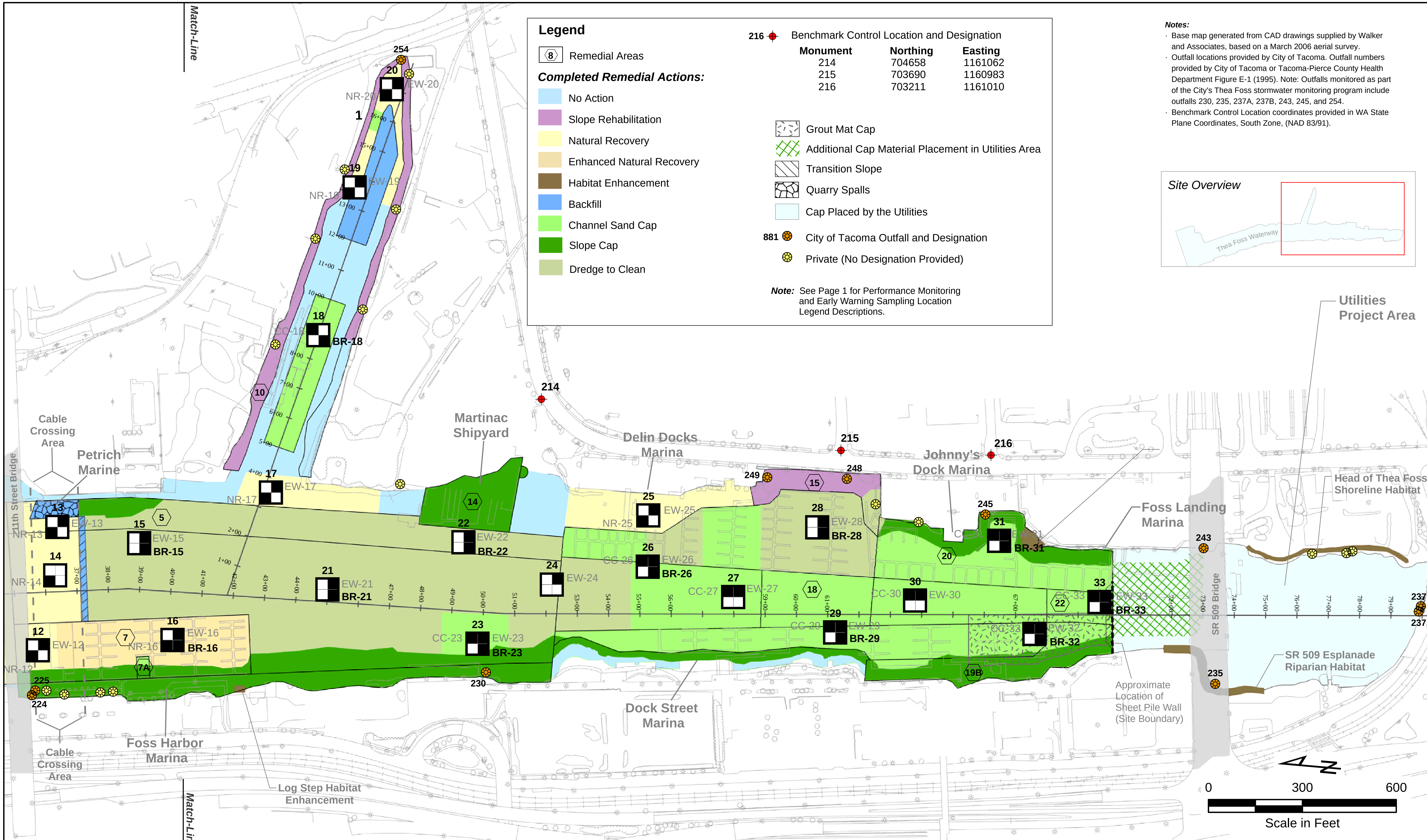

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Figure 4-1 (Page 2 of 2)
Benthic Recolonization Monitoring Locations

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Date: 1/22/2009

5.0 CONFINED DISPOSAL FACILITY MONITORING

5.1 Introduction

Baseline monitoring of the St. Paul Waterway confined disposal facility (CDF) was performed for eight quarters during Years 1 and 2. Quarterly monitoring was performed in March, June, September, and December of 2007 and 2008. This monitoring included surface water and groundwater sampling and analysis as well as CDF berm and cap inspections. The results of quarterly monitoring events were documented in Preliminary Findings Memoranda that were submitted to the U.S. Environmental Protection Agency (EPA). CDF monitoring was performed in accordance with requirements specified in Section 5.0 of the Operations, Maintenance, and Monitoring Plan (OMMP) for the Thea Foss and Wheeler-Osgood Waterways Remediation Project (City of Tacoma 2006).

The OMMP required that quarterly CDF monitoring include collection of an ambient surface water sample adjacent to the end of the St. Paul / Middle Waterway Peninsula near the mouths of the St. Paul and Middle Waterways and Puyallup River, and that groundwater samples be collected from selected baseline monitoring wells. Quarterly sampling was scheduled to occur for two years to characterize baseline groundwater and surface water quality conditions. The CDF monitoring performed in Years 1 and 2 completes the planned baseline groundwater and surface water monitoring.

As part of baseline quarterly monitoring events, the OMMP also required that the CDF containment and offset berms and cap be inspected for signs of erosion or contamination. In addition, following habitat area baseline monitoring performed in 2006, topsoil located along the face of the containment berm was observed to have experienced some erosion. As discussed with EPA, monitoring of this erosion at the North Beach habitat area was also performed quarterly in conjunction with CDF monitoring. The monitoring performed in Year 1 and Year 2 completes the planned cap and berm monitoring.

The following sections summarize the baseline CDF monitoring requirements and the findings from the last four quarters, the fifth through eighth quarters, of CDF monitoring activities performed during Year 2. The Year 2 Preliminary Findings Memoranda for the last four quarters of baseline monitoring are provided in Appendix D, Attachment D-1. With completion of all eight quarters of the baseline CDF monitoring, a Baseline Water Quality Conditions Report (City of Tacoma 2009) has been developed and submitted for EPA approval. This document is included as Attachment D-2 in Appendix D. In this report, a statistical analysis was performed which provides the basis for determination of the baseline groundwater quality conditions at the CDF.

As indicated above, monitoring of the containment and offset berms, cap, and the erosion at the containment berm was performed coincident with the quarterly CDF monitoring. A summary of the results of this year's monitoring of the berms and cap are included in the following sections. A brief summary of the results of the erosion monitoring is also included in the following sections and a more detailed description is included in Section 6.0.

Following EPA approval of the Baseline Water Quality Conditions Report, the City will prepare a Performance Monitoring Plan which will include a proposal for long-term water quality monitoring at the CDF as well as a proposed monitoring schedule for the CDF cap and berms.

5.2 Summary of CDF Monitoring Requirements

CDF monitoring activities required by the OMMP that have been performed since the completion of CDF construction in March 2006 include the following:

- Installation and development of 15 monitoring wells in and adjacent to the CDF was performed on August 28, 2006 through September 18, 2006;
- Slug testing of the wells was performed on September 27-28, 2006;
- Performance of a 72-hour tidal study was performed on October 3-6, 2006;
- Submittal of the Post-Construction Hydrogeologic Conditions Report and memorandum identifying the wells to be monitored to establish baseline conditions to EPA for review on November 22, 2006;
- Finalization of the Post-Construction Hydrogeologic Conditions Report and memorandum identifying the wells to be monitored to establish baseline conditions at the CDF in response to EPA comments on January 16, 2007;
- Performance of all eight quarters of baseline CDF monitoring and reporting for surface water and groundwater sampling and analysis and berm and cap inspections between March 2007 and March 2009; and
- Reporting of baseline groundwater conditions in the Baseline Water Quality Conditions Report that was submitted to EPA on March 16, 2009.

Baseline CDF monitoring included the collection of a surface water sample from one location as well as groundwater samples from 10 monitoring wells installed within and adjacent to the CDF (Figure 5-1). Surface water sampling and analysis was performed adjacent to the end of the St. Paul / Middle Waterway Peninsula near the mouths of the St. Paul and Middle Waterways and Puyallup River to establish ambient (i.e., background) surface water quality conditions. Baseline groundwater sampling and analysis was performed for the purpose of establishing baseline conditions to monitor possible future changes in groundwater conditions from contaminated sediment placed in the CDF. Groundwater samples were collected from CDF monitoring wells MW-01, MW-02, MW-04 thru MW-08, and MW-10 thru MW-12 that were selected for quarterly baseline monitoring.

Water sampling and berm and cap inspections were performed during baseline monitoring using the EPA-approved methods and procedures described in the Confined Disposal Facility Monitoring Operations Manual (Appendix D of the OMMP).

As specified in the OMMP, following the completion of two years of baseline groundwater monitoring, statistical analysis of the results of quarterly monitoring were performed on individual wells to establish the baseline groundwater quality for the individual wells. Results will be used to evaluate possible changes in groundwater quality in the individual wells during long-term performance monitoring. The results of these statistical analyses based on the two years of baseline groundwater monitoring are reported in the Baseline Water Quality Conditions Report included in Appendix D. In the future, the results of long-term performance monitoring for an individual well will be compared to the baseline groundwater quality conditions for that individual well (i.e., intra-well comparison) to evaluate whether there is a significant change in groundwater quality conditions at that location.

5.3 Summary of Field Activities, Analyses, and Reporting

Field activities for quarterly baseline CDF monitoring conducted during Year 2, the fifth through eighth quarter baseline monitoring events, were performed on the following dates:

- Fifth Quarter: March 24-April 3, 2008;
- Sixth Quarter: June 16-20, 2008;
- Seventh Quarter: September 22-25, 2008; and
- Eighth Quarter: December 9-11, 2008.

During each of the CDF monitoring events, surface water samples were collected using the City of Tacoma boat at the surface water monitoring station adjacent to the end of the St. Paul / Middle Waterway Peninsula (Figure 5-1). The surface water samples were collected during high tide in accordance with the OMMP. Surface water samples were submitted under chain of custody to Analytical Resources Incorporated (ARI) of Tukwila, Washington, for total mercury and dissolved metals analyses.

During each of the CDF monitoring events, groundwater samples were collected from 10 monitoring wells in general accordance with the procedures specified in the OMMP. The groundwater samples were submitted to ARI under chain of custody for total organic carbon (TOC), total mercury, and dissolved metals analyses. Groundwater samples were also submitted to the City of Tacoma laboratory under chain of custody for polycyclic aromatic hydrocarbons (PAHs), salinity, and total suspended solids (TSS) analyses.

Water quality field parameters were measured and recorded on field sampling forms during each surface water and groundwater sampling event.

CDF berm and cap inspections were also performed during each quarterly monitoring event and photographs were taken from a total of 10 photo points (Figure 5-2). Field forms were completed documenting observations during each monitoring event.

A Preliminary Findings Memorandum was prepared for each quarter of baseline CDF monitoring that documented field activities, presented the results of water quality parameter measurements and surface water and groundwater sample analyses, and provided observations from berm and cap inspections and erosion monitoring. The Preliminary Findings Memoranda include attachments that provide sample collection field forms, the laboratory analytical reports and data quality review, and the completed inspection forms and photographs for berm, cap, and habitat area monitoring. The Preliminary Findings Memoranda for CDF monitoring that occurred during Year 2 were submitted to EPA on the following dates:

- Fifth Quarter: June 19, 2008;
- Sixth Quarter: August 29, 2008;
- Seventh Quarter: December 5, 2008; and
- Eighth Quarter: March 3, 2009.

Copies of these memoranda are included in Appendix D. The following sections summarize the findings from the last four quarters of baseline CDF monitoring that occurred during Year 2.

5.4 Summary of Quarterly CDF Monitoring Results

The results from the fifth through eighth quarters of CDF baseline monitoring completed during Year 2 are summarized in the following sections. Appendix D contains the four Preliminary Findings Memoranda that provide additional detail concerning the results of CDF monitoring for the fifth through eighth quarters. In general, the results of CDF baseline monitoring performed in Year 2 were relatively consistent between quarters, and compared to monitoring performed during the first four quarters. Tables 5-1 through 5-3 provide a tabulated summary of the analytical results for surface water and groundwater samples for the four quarters of CDF baseline monitoring that occurred during Year 2.

5.4.1 Surface Water Monitoring

Salinity ranged from 24.4 to 30.9 ppt during quarterly surface water monitoring performed in Year 2. The measured conductivity ranged from 30,640 to 47,480 umhos/cm.

The only metals detected in surface water samples in all four quarterly events which occurred during Year 2 were copper and nickel (Table 5-1). Lead, zinc, and mercury were not detected in quarterly surface water samples. The copper concentrations detected in all four quarters ranged from 6 to 23 ug/L. The nickel concentrations in all four quarters were similar, ranging from 6 to 17 ug/L.

5.4.2 Groundwater Monitoring

Salinity ranged from 2.7 to 29.4 ppt during quarterly groundwater monitoring performed during Year 2. The measured conductivity ranged from 4,210 and 46,150 umhos/cm. The lowest salinities and conductivities were measured in shallow monitoring wells MW-04 within the CDF and MW-02 located northwest of the CDF. The highest salinities and conductivities were measured in deep wells MW-05 within the CDF and MW-08 located west of the CDF.

Total organic carbon (TOC) ranged from 2.19 to 58.2 mg/L in groundwater during Year 2. The lowest TOC concentrations were measured in shallow monitoring wells MW-01 and MW-06. The highest TOC concentrations were measured in shallow monitoring well MW-04.

Total suspended solids (TSS) ranged from 4.2 to 1,450 mg/L. The highest TSS was measured in groundwater collected from MW-04. MW-04 was installed within the silty sediments disposed of in the CDF and groundwater from this well generally does not clear up during purging prior to sampling. The lowest TSS concentrations were generally detected in shallow monitoring well, MW-01, located in the containment berm, adjacent to the CDF.

The predominant metals detected in groundwater monitoring wells during the four quarters of CDF monitoring occurring during Year 2 were copper and nickel (Tables 5-2 and 5-3). Consistent with the first four quarterly monitoring events, zinc was only detected in MW-06 and not in groundwater collected in any other wells in or adjacent to the CDF during Year 2. Concentrations of zinc detected in groundwater from MW-06 were similar in all four quarters of monitoring occurring during Year 2. Total mercury was detected in the two wells located within the CDF during the fifth and seventh quarters in groundwater samples from MW-04 and in the eighth quarter groundwater sample from MW-05. In MW-04, during both the fifth and seventh quarters, when total mercury was detected, the highest TSS levels of all wells in all monitoring events were also measured.

Detected copper concentrations were generally similar at each individual monitoring well location in all four quarters during Year 2. Copper concentrations in MW-06 were the highest in all four quarterly monitoring events, ranging from 38 ug/L in the seventh quarter to 82 ug/L in the fifth quarter. Detected copper concentrations in the remaining wells ranged from approximately 1.4 to 12 ug/L in all four quarters during Year 2.

Nickel was detected in all groundwater samples collected during Year 2. The concentrations of nickel were also generally similar at each individual monitoring well location during these four quarters. The highest nickel concentrations detected were from groundwater samples collected from MW-01 and MW-06. Nickel concentrations in MW-01 ranged from 17 to 94 ug/L, with the highest concentration occurring in the sixth quarter. The nickel concentrations in MW-06 ranged from 17 to 191 ug/L, with the highest concentration detected in the field duplicate collected during the fifth quarter. In Year 2, nickel concentrations ranged from approximately 5 to 17 ug/L in all remaining CDF monitoring wells during the four quarters of monitoring.

It appears that the metal concentrations detected in MW-06 may be associated with a localized source, as copper and zinc were either not detected in the case of zinc, or as in the case of copper were detected at lower concentrations in the shallow upgradient well located within the CDF (MW-04) and in other shallow groundwater wells (MW-01, MW-02, and MW-10).

No PAHs were detected in monitoring wells MW-01, MW-07, MW-08, and MW-12 during any of the four quarters of CDF monitoring during Year 2. Two or more PAHs were detected in monitoring wells MW-02, MW-10 and MW-11 during these four quarters of monitoring. During the fifth quarter monitoring event all PAHs, except acenaphthylene were detected in the groundwater sample collected from MW-06. However, no PAHs were detected in MW-06 during Year 1 monitoring events, or in the sixth and seventh quarters, and only naphthalene was detected in MW-06 during the eighth quarter.

As expected due to its location within the sediment disposal facility, nearly all PAHs were detected in groundwater collected from MW-04 during the fifth, seventh, and eighth quarters of monitoring. During the sixth quarter of monitoring at MW-04, five high molecular weight polycyclic aromatic hydrocarbons (HPAHs) were not detected. All PAHs were detected in groundwater collected from MW-05, also located within the CDF, in the four quarters of monitoring during Year 2. The highest PAH concentrations in MW-05 were detected in the eighth quarter of monitoring.

5.4.3 CDF Cap and Berm Inspections

No seeps, sheen, or any indications of contamination were observed in the CDF berms or on the CDF cap during quarterly monitoring performed in Year 2. Additionally, no indications of erosion or material loss were observed on the cap or in the offset berm. Logs continue to be stored over a significant area of the cap, and a gravel, hammerhead turnaround/storage area associated with the planned co-generation facility was constructed on the cap prior to the seventh quarter of monitoring.

Erosion of topsoil has been observed within the habitat area on the bayward face of the containment berm. In general, the same magnitude of topsoil erosion was observed during all eight quarters of monitoring performed to date and the integrity of the containment berm does not appear to be compromised. This issue is described in more detail in Section 6.0.

5.5 Summary of Findings for the Second Four Quarters of CDF Monitoring

The following summarizes the findings from the four quarters of baseline CDF monitoring conducted in Year 2:

- Surface Water Monitoring
  - Lead, zinc, and mercury were not detected in the ambient surface water samples.
  - Copper and nickel were detected in all ambient surface water samples at similar concentrations.

- Groundwater Monitoring
  - Dissolved lead and mercury were not detected in any groundwater samples.
  - Zinc was only detected in MW-06.
  - Total mercury was detected in MW-04 during the fifth and seventh quarters of monitoring and in MW-05 during the fourth quarter of monitoring. Both of these wells are located within the contaminated sediment disposed of in the CDF.
  - Nickel was detected in all groundwater samples in all quarters of monitoring.
  - Copper was not detected in groundwater samples collected from MW-05 within the CDF. Copper was only detected in the groundwater samples collected from MW-04, also located within the CDF, during the seventh quarter.
  - Copper was detected in groundwater samples collected from seven of the eight wells located adjacent to the CDF.
  - The highest concentrations of copper and nickel were detected in MW-06.
  - PAHs were not detected in monitoring wells MW-01, MW-07, MW-08, and MW-12.
  - Two or more PAHs were detected in monitoring wells MW-02, MW-10, and MW-11 adjacent to the CDF.
  - Nearly all PAHs were detected in MW-06 during the fifth quarter of monitoring, but PAHs were not detected in groundwater samples from this well during the sixth and seventh quarter monitoring events and only naphthalene was detected during the eighth quarter of monitoring at MW-06.
  - Nearly all PAHs were detected in groundwater from MW-04 and MW-05 located within contaminated sediment disposed of in the CDF.

- CDF Berm and Cap Inspections
  - No seeps, sheens, or other indications of contamination were identified during berm and cap inspections.
  - Stored logs and some ponded water were observed on the surface of the CDF cap.
  - At the containment berm the maximum observed loss of topsoil due to erosion was a height of approximately 3.50 feet. Some rip rap is exposed on the upper slope of the beach, but the containment berm does not appear to be compromised (see Section 6.0 for additional detail).
  - No deficiencies were identified upon inspection of the offset berm and CDF cap.

5.6 Schedule of CDF Monitoring

Baseline monitoring for the CDF was completed during Years 1 and 2. With completion of these two years of quarterly baseline monitoring, a Baseline Water Quality Conditions Report was prepared and submitted to EPA for review on March 16, 2009. Following EPA's approval of the Baseline Water Quality Conditions Report and the groundwater baseline conditions, the City will submit a Performance Monitoring Plan for the CDF for review and approval that will include proposals for both long-term water quality monitoring and cap and berm monitoring.

TABLES

FIGURES

Table 5-1
Comparison of Surface Water Analytical Results
for Quarters Five through Eight of Baseline Monitoring

	Event	5th Quarter Baseline		6th Quarter Baseline		7th Quarter Baseline		8th Quarter Baseline	
	Station	SWM-01	SWM-01	SWM-01	SWM-01	SWM-01	SWM-01	SWM-01	SWM-01
	Sample ID	SWM-01-032708	SWM-01-032708-B[1]	SWM-01-061608	SWM-01-061608-B[1]	SWM-01-092308	SWM-01-092308-B[1]	SWM-01-121008	SWM-01-121008-B[1]
Parameter	Sample Date	3/27/2008	3/27/2008	6/16/2008	6/16/2008	9/23/2008	9/23/2008	12/10/2008	12/10/2008
Conventionals	**Units**								
Conductivity	umhos/cm	30,640	30,640	38,100	38,100	47,480	47,480	42,250	42,250
Salinity	ppt	29.4	29.4	24.4	24.4	30.9	30.9	27.7	27.7
Metals Dissolved									
Copper	µg/L	**8**	**8**	**23**	**6**	**10**	**11**	**13**	**10**
Lead	µg/L	5 U	5 U	5 U	5 U	10 U	10 U	10 U	20 U
Nickel	µg/L	**10**	**9**	**8**	**6**	**16**	**17**	**12**	**10**
Zinc	µg/L	20 U	20 U	20 U	20 U	40 U	40 U	40 U	100 U
Mercury	µg/L	0.10 U	0.10 U	0.10 U	0.10 U	0.10 U	0.10 U	0.1 U	0.1 U
Metals Total									
Mercury	µg/L	0.10 U	0.10 U	0.10 U	0.10 U	0.10 U	0.10 U	0.1 U	0.1 U

Note:
1 Samples are field duplicates of Samples SWM-01-032607, SWM-01-062707, SWM-01-092507, SWM-01-121307, SWM-01-032708, SWM-01-061608, SWM-01-092308, and SWM-01-121008.

Qualifiers:
U - Undetected
Bolded results indicate detected concentrations.

Table 5-2
Comparison of Groundwater Analytical Results for Wells Within the CDF
for Quarters Five through Eight of Baseline Monitoring

Parameter	Location	Center of CDF				Center of CDF				
	Event	5th Quarter	6th Quarter	7th Quarter	8th Quarter	5th Quarter	6th Quarter	7th Quarter	8th Quarter	
	Well Screen Interval	Shallow				Deep				
	Station	MW-04				MW-05				
	Sample ID	MW-04-032608	MW-04-061608	MW-04-092408	MW-04-121108	MW-05-040208	MW-05-061608	MW-05-092408	MW-05-121108	MW-05-121108-B[1]
	Sample Date	3/26/2008	6/16/2008	9/24/2008	12/11/2008	4/2/2008	6/16/2008	9/24/2008	12/11/2008	12/11/2008
Conventionals	Units									
Conductivity	umhos/cm	4,210	5,540	6,280	5,200	37,200	46,150	44,560	34,260	34,260
Salinity	ppt	3.3	2.7	3.4	2.9	28	28.7	29.4	21.5	21.5
Total Organic Carbon (TOC)	mg/L	48.8	45.6	49.6	58.2	17.1	18.3	16.4	22.8	17.8
Total Suspended Soilds (TSS)	mg/L	1,450	247	1,040	461	77.2	161	11.7	118	119
Metals Dissolved										
Copper	µg/L	2 U	2 U	**1.4**	2 U	2 U	2 U	0.5 U	5 U	5 U
Lead	µg/L	5 U	5 U	1 U	5 U	5 U	5 U	10 U	10 U	10 U
Nickel	µg/L	**8**	**5**	**5**	**5**	**8**	**11**	**17**	**7**	**11**
Zinc	µg/L	20 U	20 U	4 U	20 U	20 U	20 U	40 U	40 U	40 U
Mercury	µg/L	0.10 U	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U
Metals Total										
Mercury	µg/L	**0.3**	0.1 U	**0.4**	0.1 U	0.1 U	0.1 U	0.1 U	**0.7**	0.1 U
Polycyclic Aromatic Hydrocarbons (PAHs)										
LPAHs										
2-Methylnaphthalene	µg/L	**0.17**	**0.187**	**0.877** J	**0.569**	**7.56**	**5.91**	**11** J	**11.2 J**	**11.7**
Acenaphthene	µg/L	**1**	**1.45**	**2.66**	**1.69**	**11.7**	**7.04**	**15**	**16.7 J**	**21.8**
Acenaphthylene	µg/L	**0.032**	**0.026**	**0.131**	**0.030**	**0.1**	**0.065**	**0.204**	**0.985 J**	**1.72**
Anthracene	µg/L	**0.14**	**0.063**	**0.516**	**0.151**	**1.18**	**0.978**	**2.3**	**5.60 J**	**13.4**
Fluorene	µg/L	**0.495**	**0.428**	**1.41**	**0.615**	**3.85**	**2.52**	**4.96**	**6.68 J**	**9.78**
Naphthalene	µg/L	**5.5**	**19.9**	**26.7** J	**21.0**	**90.3**	**66.5**	**100** J	**105 J**	**89.1**
Phenanthrene	µg/L	**0.442**	**0.109**	**1.57**	**0.325**	**6.96**	**5.73**	**9.94**	**23.3 J**	**37.3**
HPAHs										
Benzo(a)anthracene	µg/L	**0.126**	**0.014**	**0.412**	**0.057**	**0.357**	**0.194**	**0.701**	**6.24 J**	**12.0**
Benzo(a)pyrene	µg/L	**0.079**	0.010 U	**0.295**	**0.035**	**0.28**	**0.113**	**0.573**	**3.36 J**	**8.65**
Benzofluoranthenes (total)	µg/L	**0.155**	**0.010 J**	**0.493**	**0.065**	**0.336**	**0.138**	**0.640**	**6.52 J**	**11.4**
Benzo(g,h,i)perylene	µg/L	**0.061**	0.010 U	**0.158**	**0.026 J**	**0.097**	**0.044**	**0.207**	**2.62 J**	**4.50 J**
Chrysene	µg/L	**0.136**	0.010 U	**0.464**	**0.056**	**0.294**	**0.133**	**0.558**	**5.22 J**	**9.27**
Dibenzo(a,h)anthracene	µg/L	**0.014**	0.010 U	**0.041**	0.012 UJ	**0.025**	**0.011**	**0.061**	**0.559 J**	**0.974 J**
Fluoranthene	µg/L	**0.746**	**0.106**	**2.24**	**0.365**	**1.22**	**1.01**	**2.32**	**13.7 J**	**24.7**
Indeno(1,2,3-cd)pyrene	µg/L	**0.048**	0.010 U	**0.129**	**0.024 J**	**0.086**	**0.036**	**0.186**	**2.70 J**	**4.69 J**
Pyrene	µg/L	**0.468**	**0.075**	**1.49**	**0.199**	**1.61**	**1.20**	**2.61**	**15.6 J**	**29.1**

Note:

MW Monitoring Well

1 Samples are field duplicates of Samples MW-04-032907 and MW-05-121108.

Qualifiers:

U - Undetected

J - The analyte was analyzed for and positively identified, but the associated numerical value is an estimated quantity.

Bolded results indicate detected concentrations.

Table 5-3
Comparison of Groundwater Analytical Results for Wells Adjacent to the CDF for Quarters Five through Eight of Baseline Monitoring

Parameter	Location	Containment Berm			
	Event	5th Quarter	6th Quarter	7th Quarter	8th Quarter
	Well Screen Interval	Shallow			
	Station	MW-01			
	Sample ID	MW-01-032408	MW-01-061708	MW-01-092508	MW-01-120908
	Sample Date	3/24/2008	6/17/2008	9/25/2008	12/9/2008
Conventionals	**Units**				
Conductivity	umhos/cm	19,740	26,910	34,130	36,600
Salinity	ppt	18.7	15	22	23.2
Total Organic Carbon (TOC)	mg/L	3	2.4	2.38	2.19
Total Suspended Soilds (TSS)	mg/L	17.6	21.2	20.4	4.20
Metals Dissolved					
Copper	µg/L	**7**	**11**	**8**	**12**
Lead	µg/L	10 U	5 U	10 U	10 U
Nickel	µg/L	**40**	**94**	**17**	**18**
Zinc	µg/L	20 U	20 U	40 U	40 U
Mercury	µg/L	0.1 U	0.1 U	0.1 U	0.1 U
Metals Total					
Mercury	µg/L	0.1 U	0.1 U	0.1 U	0.1 U
Polycyclic Aromatic Hydrocarbons (PAHs)					
LPAHs					
2-Methylnaphthalene	µg/L	0.01 U	0.010 U	0.011 UJ	0.010 U
Acenaphthene	µg/L	0.01 U	0.010 U	0.011 U	0.010 U
Acenaphthylene	µg/L	0.01 U	0.010 U	0.011 U	0.010 U
Anthracene	µg/L	0.01 U	0.010 U	0.011 U	0.010 U
Fluorene	µg/L	0.01 U	0.010 U	0.011 U	0.010 U
Naphthalene	µg/L	0.01 U	0.010 U	0.011 UJ	0.010 U
Phenanthrene	µg/L	0.01 U	0.010 U	0.011 U	0.010 U
HPAHs					
Benzo(a)anthracene	µg/L	0.01 U	0.010 U	0.011 U	0.010 U
Benzo(a)pyrene	µg/L	0.01 U	0.010 U	0.011 U	0.010 U
Benzofluoranthenes (total)	µg/L	0.01 U	0.020 U	0.021 U	0.020 U
Benzo(g,h,i)perylene	µg/L	0.01 U	0.010 U	0.011 U	0.010 UJ
Chrysene	µg/L	0.01 U	0.010 U	0.011 U	0.010 U
Dibenzo(a,h)anthracene	µg/L	0.01 U	0.010 U	0.011 U	0.010 UJ
Fluoranthene	µg/L	0.01 U	0.010 U	0.011 U	0.010 U
Indeno(1,2,3-cd)pyrene	µg/L	0.01 U	0.010 U	0.011 U	0.010 UJ
Pyrene	µg/L	0.01 U	0.010 U	0.011 U	0.010 U

Note:

1 Samples are field duplicates of Sample MW-01-092507B, MW-02-121107B, MW-06-032508-B, MW-07-040308-B, MW-06-061708, MW-07-092308.

2 Metals and conventional results are from the initial samples collected on 032508, the wells were resampled on 040308 due to laboratory PAH surrogate recoveries.

Qualifiers:

U - Undetected

J - The analyte was analyzed for and positively identified, but the associated numerical value is an estimated quantity.

Bolded results indicate detected concentrations.

Table 5-3

Comparison of Groundwater Analytical Results for Wells Adjacent to the CDF for Quarters Five through Eight of Baseline Monitoring

Parameter	Location	West of Containment Berm			
	Event	5th Quarter	6th Quarter	7th Quarter	8th Quarter
	Well Screen Interval	Shallow			
	Station	MW-02			
	Sample ID	MW-02-032408	MW-02-062008	MW-02-092408	MW-02-120908
	Sample Date	3/24/2008	6/20/2008	9/24/2008	12/9/2008
Conventionals	**Units**				
Conductivity	umhos/cm	8,230	16,240	19,890	19,150
Salinity	ppt	6.10	9.50	11.6	11.4
Total Organic Carbon (TOC)	mg/L	23.9	16.7	14.0	18.5
Total Suspended Soilds (TSS)	mg/L	98.0	74.4	171.0	75.8
Metals Dissolved					
Copper	µg/L	2 U	**4**	**4**	**6**
Lead	µg/L	5 U	5 U	5 U	5 U
Nickel	µg/L	**5**	**9**	**13**	**11**
Zinc	µg/L	20 U	20 U	20 U	20 U
Mercury	µg/L	0.10 U	0.1 U	0.1 U	0.1 U
Metals Total					
Mercury	µg/L	0.10 U	0.1 U	0.1 U	0.1 U
Polycyclic Aromatic Hydrocarbons (PAHs)					
LPAHs					
2-Methylnaphthalene	µg/L	0.010 U	0.010 U	0.010 UJ	0.010 U
Acenaphthene	µg/L	**0.017**	**0.020**	**0.041**	**0.023**
Acenaphthylene	µg/L	0.010 U	0.010 U	0.010 U	0.010 U
Anthracene	µg/L	0.010 U	0.010 U	**0.024**	**0.010**
Fluorene	µg/L	0.010 U	0.010 U	**0.018**	0.010 U
Naphthalene	µg/L	0.010 U	**0.010**	0.021 UJ	0.010 U
Phenanthrene	µg/L	0.010 U	0.010 U	**0.038**	0.010 U
HPAHs					
Benzo(a)anthracene	µg/L	0.010 U	0.010 U	**0.030**	0.010 U
Benzo(a)pyrene	µg/L	0.010 U	0.010 U	**0.025**	0.010 U
Benzofluoranthenes (total)	µg/L	0.010 U	0.020 U	**0.032**	0.020 U
Benzo(g,h,i)perylene	µg/L	0.010 U	0.010 U	**0.014**	0.010 UJ
Chrysene	µg/L	0.010 U	0.010 U	**0.022**	0.010 U
Dibenzo(a,h)anthracene	µg/L	0.010 U	0.010 U	0.010 U	0.010 UJ
Fluoranthene	µg/L	**0.022**	**0.032**	**0.103**	**0.033**
Indeno(1,2,3-cd)pyrene	µg/L	0.010 U	0.010 U	**0.011**	0.010 UJ
Pyrene	µg/L	**0.017**	**0.022**	**0.084**	**0.021**

Note:

1 Samples are field duplicates of Sample MW-01-092507B, MW

2 Metals and conventional results are from the initial samples cc

Qualifiers:

U - Undetected

J - The analyte was analyzed for and positively identified, but the associated numerical value is an estimated quantity.

Bolded results indicate detected concentrations.

Table 5-3
Comparison of Groundwater Analytical Results for Wells Adjacent to the CDF for Quarters Five through Eight of Baseline Monitoring

	Location	Northwest Corner of St. Paul/ Middle Waterway Peninsula					
	Event	5th Quarter		6th Quarter		7th Quarter	8th Quarter
	Well Screen Interval	Shallow					
	Station	MW-06					
	Sample ID	MW-06-032508	MW-06-032508-B[1]	MW-06-061708	MW-06-061708B[1]	MW-06-092507	MW-06-121108
Parameter	Sample Date	3/25/2008	3/25/2008	6/17/2008	6/17/2008	9/25/2007	12/11/2008
Conventionals	**Units**						
Conductivity	umhos/cm	21,400	21,400	39,040	39,040	34,800	29,800
Salinity	ppt	20.6	20.3	23.3	24.5	22.6	18.5
Total Organic Carbon (TOC)	mg/L	7.8	7.6	2.7	3.1	3.85	7.31
Total Suspended Soilds (TSS)	mg/L	19	22.7	32.6	73.2	37.8	10.5
Metals Dissolved							
Copper	µg/L	**82**	**49**	**51**	**50**	**38**	**74**
Lead	µg/L	5 U	5 U	5 U	1 U	10 U	10 U
Nickel	µg/L	**82**	**191**	**46**	**73**	**45**	**17**
Zinc	µg/L	**390**	**380**	**530**	**550**	**470**	**540 J**
Mercury	µg/L	0.10 U	0.10 U	0.1 U	0.1 U	0.1 U	0.1 U
Metals Total							
Mercury	µg/L	0.10 U	0.10 U	0.1 U	0.1 U	0.1 U	0.1 U
Polycyclic Aromatic Hydrocarbons (PAHs)							
LPAHs							
2-Methylnaphthalene	µg/L	**0.133**	NA	0.010 U	0.010 U	0.010 UJ	0.010 U
Acenaphthene	µg/L	**0.845**	NA	0.010 U	0.010 U	0.010 U	0.010 U
Acenaphthylene	µg/L	0.010 U	NA	0.010 U	0.010 U	0.010 U	0.010 U
Anthracene	µg/L	**0.122**	NA	0.010 U	0.010 U	0.010 U	0.010 U
Fluorene	µg/L	**0.399**	NA	0.010 U	0.010 U	0.010 U	0.010 U
Naphthalene	µg/L	**4.34**	NA	0.010 U	0.010 U	0.032 UJ	**0.036**
Phenanthrene	µg/L	**0.390**	NA	0.010 U	0.010 U	0.010 U	0.010 U
HPAHs							
Benzo(a)anthracene	µg/L	**0.102**	NA	0.010 U	0.010 U	0.010 U	0.010 U
Benzo(a)pyrene	µg/L	**0.067**	NA	0.010 U	0.010 U	0.010 U	0.010 U
Benzofluoranthenes (total)	µg/L	**0.131**	NA	0.020 U	0.020 U	0.020 U	0.020 U
Benzo(g,h,i)perylene	µg/L	**0.046**	NA	0.010 U	0.010 U	0.010 U	0.010 UJ
Chrysene	µg/L	**0.118**	NA	0.010 U	0.010 U	0.010 U	0.010 U
Dibenzo(a,h)anthracene	µg/L	**0.011**	NA	0.010 UJ	0.010 U	0.010 U	0.010 UJ
Fluoranthene	µg/L	**0.630**	NA	0.010 U	0.010 U	0.010 U	0.010 U
Indeno(1,2,3-cd)pyrene	µg/L	**0.036**	NA	0.010 U	0.010 U	0.010 U	0.010 UJ
Pyrene	µg/L	**0.383**	NA	0.010 U	0.010 U	0.010 U	0.010 U

Note:

1 Samples are field duplicates of Sample MW-01-092507B, MW

2 Metals and conventional results are from the initial samples cc

Qualifiers:

U - Undetected

J - The analyte was analyzed for and positively identified, but the associated numerical value is an estimated quantity.

Bolded results indicate detected concentrations.

Table 5-3
Comparison of Groundwater Analytical Results for Wells Adjacent to the CDF for Quarters Five through Eight of Baseline Monitoring

	Location	**Northwest Corner of St. Paul/ Middle Waterway Peninsula**					
	Event	**5th Quarter**		**6th Quarter**	**7th Quarter**		**8th Quarter**
	Well Screen Interval	**Intermediate**					
	Station	**MW-07**					
	Sample ID	**MW-07-040308[2]**	**MW-07-040308-B[1]**	**MW-07-061708**	**MW-07-092308**	**MW-07-092308B[1]**	**MW-07-121108**
Parameter	**Sample Date**	**4/3/2008**	**4/3/2008**	**6/17/2008**	**9/23/2008**	**9/23/2008**	**12/11/2008**
Conventionals	**Units**						
Conductivity	umhos/cm	36,700	36,700	40,550	35,760	35,760	31,690
Salinity	ppt	26	NA	24.5	23	23.1	19.8
Total Organic Carbon (TOC)	mg/L	3.9	NA	3.68	3.26	3.29	4.56
Total Suspended Soilds (TSS)	mg/L	27	NA	68.8	66.4	76.8	13.5
Metals Dissolved							
Copper	µg/L	**6**	NA	**7**	**7**	**8**	**8**
Lead	µg/L	5 U	NA	5 U	10 U	10 U	10 U
Nickel	µg/L	**9**	NA	**9**	**14**	**15**	**10**
Zinc	µg/L	20 U	NA	20 U	40 U	40 U	40 U
Mercury	µg/L	0.10 U	NA	0.1 U	0.1 U	0.1 U	0.1 U
Metals Total							
Mercury	µg/L	0.10 U	NA	0.1 U	0.1 U	0.1 U	0.1 U
Polycyclic Aromatic Hydrocarbons (PAHs)							
LPAHs							
2-Methylnaphthalene	µg/L	0.010 U	0.010 U	0.010 U	0.010 UJ	0.010 UJ	0.010 U
Acenaphthene	µg/L	0.010 U	0.010 U	0.010 U	0.010 U	0.010 U	0.010 U
Acenaphthylene	µg/L	0.010 U	0.010 U	0.010 U	0.010 U	0.010 U	0.010 U
Anthracene	µg/L	0.010 U	0.010 U	0.010 U	0.010 U	0.010 U	0.010 U
Fluorene	µg/L	0.010 U	0.010 U	0.010 U	0.010 U	0.010 U	0.010 U
Naphthalene	µg/L	0.010 U	0.010 U	0.010 U	0.010 UJ	0.010 UJ	0.010 U
Phenanthrene	µg/L	0.010 U	0.010 U	0.010 U	0.010 U	0.010 U	0.010 U
HPAHs							
Benzo(a)anthracene	µg/L	0.010 U	0.010 U	0.010 U	0.010 U	0.010 U	0.010 U
Benzo(a)pyrene	µg/L	0.010 U	0.010 U	0.010 U	0.010 U	0.010 U	0.010 U
Benzofluoranthenes (total)	µg/L	0.010 U	0.010 U	0.020 U	0.020 U	0.020 U	0.020 U
Benzo(g,h,i)perylene	µg/L	0.010 U	0.010 U	0.010 U	0.010 U	0.010 U	0.010 UJ
Chrysene	µg/L	0.010 U	0.010 U	0.010 U	0.010 U	0.010 U	0.010 U
Dibenzo(a,h)anthracene	µg/L	0.010 U	0.010 U	0.010 U	0.010 U	0.010 U	0.010 UJ
Fluoranthene	µg/L	0.010 U	0.010 U	0.010 U	0.010 U	0.010 U	0.010 U
Indeno(1,2,3-cd)pyrene	µg/L	0.010 U	0.010 U	0.010 U	0.010 U	0.010 U	0.010 UJ
Pyrene	µg/L	0.010 U	0.010 U	0.010 U	0.010 U	0.010 U	0.010 U

Note:

1 Samples are field duplicates of Sample MW-01-092507B, MW

2 Metals and conventional results are from the initial samples cc

Qualifiers:

U - Undetected

J - The analyte was analyzed for and positively identified, but the associated numerical value is an estimated quantity.

Bolded results indicate detected concentrations.

Table 5-3
Comparison of Groundwater Analytical Results for Wells Adjacent to the CDF for Quarters Five through Eight of Baseline Monitoring

Parameter	Location	Northwest Corner of St. Paul/ Middle Waterway Peninsula			
	Event	5th Quarter	6th Quarter	7th Quarter	8th Quarter
	Well Screen Interval	Deep			
	Station	MW-08			
	Sample ID	MW-08-040308[2]	MW-08-061708	MW-08-092308	MW-08-121108
	Sample Date	4/3/2008	6/17/2008	9/23/2008	12/11/2008
Conventionals	**Units**				
Conductivity	umhos/cm	37,100	40,620	38,320	33,700
Salinity	ppt	25.9	24.6	25	21.1
Total Organic Carbon (TOC)	mg/L	28	25.3	22.4	28.3
Total Suspended Soilds (TSS)	mg/L	35.3	103	68.4	43.6
Metals Dissolved					
Copper	µg/L	**3**	**3**	0.5 U	5 U
Lead	µg/L	5 U	5 U	10 U	10 U
Nickel	µg/L	**7**	**8**	**11**	**10**
Zinc	µg/L	20 U	20 U	40 U	40 U
Mercury	µg/L	0.1 U	0.1 U	0.1 U	0.1 U
Metals Total					
Mercury	µg/L	0.1 U	0.1 U	0.1 U	0.1 U
Polycyclic Aromatic Hydrocarbons (PAHs)					
LPAHs					
2-Methylnaphthalene	µg/L	0.010 U	0.010 U	0.010 UJ	0.010 U
Acenaphthene	µg/L	0.010 U	0.010 U	0.010 U	0.010 U
Acenaphthylene	µg/L	0.010 U	0.010 U	0.010 U	0.010 U
Anthracene	µg/L	0.010 U	0.010 U	0.010 U	0.010 U
Fluorene	µg/L	0.010 U	0.010 U	0.010 U	0.010 U
Naphthalene	µg/L	0.010 U	0.010 U	0.010 UJ	0.010 U
Phenanthrene	µg/L	0.010 U	0.010 U	0.010 U	0.010 U
HPAHs					
Benzo(a)anthracene	µg/L	0.010 U	0.010 U	0.010 U	0.010 U
Benzo(a)pyrene	µg/L	0.010 U	0.010 U	0.010 U	0.010 U
Benzofluoranthenes (total)	µg/L	0.010 U	0.020 U	0.020 U	0.021 U
Benzo(g,h,i)perylene	µg/L	0.010 U	0.010 U	0.010 U	0.010 UJ
Chrysene	µg/L	0.010 U	0.010 U	0.010 U	0.010 U
Dibenzo(a,h)anthracene	µg/L	0.010 U	0.010 U	0.010 U	0.010 UJ
Fluoranthene	µg/L	0.010 U	0.010 U	0.010 U	0.010 U
Indeno(1,2,3-cd)pyrene	µg/L	0.010 U	0.010 U	0.010 U	0.010 UJ
Pyrene	µg/L	0.010 U	0.010 U	0.010 U	0.010 U

Note:

1 Samples are field duplicates of Sample MW-01-092507B, MW

2 Metals and conventional results are from the initial samples cc

Qualifiers:

U - Undetected

J - The analyte was analyzed for and positively identified, but the associated numerical value is an estimated quantity.

Bolded results indicate detected concentrations.

Table 5-3

Comparison of Groundwater Analytical Results for Wells Adjacent to the CDF for Quarters Five through Eight of Baseline Monitoring

Parameter	Location	Western Portion of St. Paul/ Middle Waterway Peninsula			
	Event	5th Quarter	6th Quarter	7th Quarter	8th Quarter
	Well Screen Interval	Shallow			
	Station	MW-10			
	Sample ID	MW-10-032508	MW-10-061908	MW-10-092208	MW-10-121108
	Sample Date	3/25/2008	6/19/2008	9/22/2008	12/11/2008
Conventionals	**Units**				
Conductivity	umhos/cm	23,200	35,980	35,830	32,510
Salinity	ppt	22.7	21.7	23.1	20.4
Total Organic Carbon (TOC)	mg/L	6.2	5.46	6.38	8.37
Total Suspended Soilds (TSS)	mg/L	33	56	40.4	34.8
Metals Dissolved					
Copper	µg/L	**6**	**7**	**7**	**8**
Lead	µg/L	5 U	5 U	10 U	10 U
Nickel	µg/L	**7**	**8**	**12**	**11**
Zinc	µg/L	20 U	20 U	40 U	40 U
Mercury	µg/L	0.1 U	0.1 U	0.1 U	0.1 U
Metals Total					
Mercury	µg/L	0.10 U	0.1 U	0.1 U	0.1 U
Polycyclic Aromatic Hydrocarbons (PAHs)					
LPAHs					
2-Methylnaphthalene	µg/L	0.010 U	0.010 U	0.010 UJ	0.010 U
Acenaphthene	µg/L	0.010 U	0.010 U	**0.013**	**0.013**
Acenaphthylene	µg/L	0.010 U	0.010 U	0.010 U	0.010 U
Anthracene	µg/L	0.010 U	0.010 U	0.010 U	0.010 U
Fluorene	µg/L	0.010 U	0.010 U	0.010 U	0.010 U
Naphthalene	µg/L	0.010 U	0.010 U	0.010 UJ	0.010 U
Phenanthrene	µg/L	0.010 U	0.010 U	0.010 U	0.010 U
HPAHs					
Benzo(a)anthracene	µg/L	0.010 U	0.010 U	0.010 U	0.010 U
Benzo(a)pyrene	µg/L	0.010 U	0.010 U	0.010 U	0.010 U
Benzofluoranthenes (total)	µg/L	0.010 U	0.020 U	0.020 U	0.020 U
Benzo(g,h,i)perylene	µg/L	0.010 U	0.010 U	0.010 U	0.010 UJ
Chrysene	µg/L	0.010 U	0.010 U	0.010 U	0.010 U
Dibenzo(a,h)anthracene	µg/L	0.010 U	0.010 U	0.010 U	0.010 UJ
Fluoranthene	µg/L	**0.014**	**0.014**	**0.024**	**0.025**
Indeno(1,2,3-cd)pyrene	µg/L	0.010 U	0.010 U	0.010 U	0.010 UJ
Pyrene	µg/L	**0.012**	**0.012**	**0.014**	**0.019**

Note:

1 Samples are field duplicates of Sample MW-01-092507B, MW

2 Metals and conventional results are from the initial samples cc

Qualifiers:

U - Undetected

J - The analyte was analyzed for and positively identified, but the associated numerical value is an estimated quantity.

Bolded results indicate detected concentrations.

Table 5-3

Comparison of Groundwater Analytical Results for Wells Adjacent to the CDF for Quarters Five through Eight of Baseline Monitoring

Parameter	Location	Western Portion of St. Paul/ Middle Waterway Peninsula			
	Event	5th Quarter	6th Quarter	7th Quarter	8th Quarter
	Well Screen Interval	Intermediate			
	Station	MW-11			
	Sample ID	MW-11-032508	MW-11-061908	MW-11-092208	MW-11-121108
	Sample Date	3/25/2008	6/19/2008	9/22/2008	12/11/2008
Conventionals	**Units**				
Conductivity	umhos/cm	19,900	26,500	26,170	24,860
Salinity	ppt	19	15.6	16.3	15.2
Total Organic Carbon (TOC)	mg/L	8.5	7.0	7.34	9.30
Total Suspended Soilds (TSS)	mg/L	103	66.8	112	49.8
Metals Dissolved					
Copper	µg/L	**5**	**4**	0.5 U	**6**
Lead	µg/L	5 U	5 U	10 U	10 U
Nickel	µg/L	**7**	**8**	**13**	**10**
Zinc	µg/L	20 U	20 U	40 U	40 U
Mercury	µg/L	0.10 U	0.1 U	0.1 U	0.1 U
Metals Total					
Mercury	µg/L	0.10 U	0.1 U	0.1 U	0.1 U
Polycyclic Aromatic Hydrocarbons (PAHs)					
LPAHs					
2-Methylnaphthalene	µg/L	0.010 U	0.010 U	0.010 UJ	0.010 U
Acenaphthene	µg/L	**0.124**	**0.183**	**0.154**	**0.251**
Acenaphthylene	µg/L	0.010 U	0.010 U	0.010 U	0.010 U
Anthracene	µg/L	0.010 U	0.010 U	0.010 U	0.010 U
Fluorene	µg/L	**0.011**	0.010 U	**0.010** J	**0.010 J**
Naphthalene	µg/L	0.010 U	0.010 U	0.012 UJ	**0.027**
Phenanthrene	µg/L	0.010 U	0.010 U	0.010 U	0.010 U
HPAHs					
Benzo(a)anthracene	µg/L	0.010 U	0.010 U	0.010 U	0.010 U
Benzo(a)pyrene	µg/L	0.010 U	0.010 U	0.010 U	0.010 U
Benzofluoranthenes (total)	µg/L	0.010 U	0.020 U	0.021 U	0.020 U
Benzo(g,h,i)perylene	µg/L	0.010 U	0.010 U	0.010 U	0.010 UJ
Chrysene	µg/L	0.010 U	0.010 U	0.010 U	0.010 U
Dibenzo(a,h)anthracene	µg/L	0.010 U	0.010 U	0.010 U	0.010 UJ
Fluoranthene	µg/L	**0.018**	**0.012**	**0.017**	**0.016**
Indeno(1,2,3-cd)pyrene	µg/L	0.010 U	0.010 U	0.010 U	0.010 UJ
Pyrene	µg/L	**0.014**	0.010 U	**0.011**	0.010 U

Note:

1 Samples are field duplicates of Sample MW-01-092507B, MW

2 Metals and conventional results are from the initial samples cc

Qualifiers:

U - Undetected

J - The analyte was analyzed for and positively identified, but the associated numerical value is an estimated quantity.

Bolded results indicate detected concentrations.

Table 5-3

Comparison of Groundwater Analytical Results for Wells Adjacent to the CDF for Quarters Five through Eight of Baseline Monitoring

Parameter	Location	Western Portion of St. Paul/ Middle Waterway Peninsula			
	Event	5th Quarter	6th Quarter	7th Quarter	8th Quarter
	Well Screen Interval	Deep			
	Station	MW-12			
	Sample ID	MW-12-032708	MW-12-061908	MW-12-092208	MW-12-121108
	Sample Date	3/27/2008	6/19/2008	9/22/2008	12/11/2008
Conventionals	**Units**				
Conductivity	umhos/cm	21,200	32,640	28,270	26,320
Salinity	ppt	20.1	19.5	17.4	16.1
Total Organic Carbon (TOC)	mg/L	22.8	22.1	23.1	24.9
Total Suspended Soilds (TSS)	mg/L	67.6	88	102	23.4
Metals Dissolved					
Copper	µg/L	5 U	2 U	0.5 U	5 U
Lead	µg/L	10 U	5 U	10 U	10 U
Nickel	µg/L	**6**	**8**	**12**	**9**
Zinc	µg/L	40 U	20 U	40 U	40 U
Mercury	µg/L	0.10 U	0.1 U	0.1 U	0.1 U
Metals Total					
Mercury	µg/L	0.10 U	0.1 U	0.1 U	0.1 U
Polycyclic Aromatic Hydrocarbons (PAHs)					
LPAHs					
2-Methylnaphthalene	µg/L	0.010 U	0.010 U	0.010 UJ	0.010 U
Acenaphthene	µg/L	0.010 U	0.010 U	0.010 U	0.010 U
Acenaphthylene	µg/L	0.010 U	0.010 U	0.010 U	0.010 U
Anthracene	µg/L	0.010 U	0.010 U	0.010 U	0.010 U
Fluorene	µg/L	0.010 U	0.010 U	0.010 U	0.010 U
Naphthalene	µg/L	0.010 U	0.010 U	0.010 UJ	0.010 U
Phenanthrene	µg/L	0.010 U	0.010 U	0.010 U	0.010 U
HPAHs					
Benzo(a)anthracene	µg/L	0.010 U	0.010 U	0.010 U	0.010 U
Benzo(a)pyrene	µg/L	0.010 U	0.010 U	0.010 U	0.010 U
Benzofluoranthenes (total)	µg/L	0.010 U	0.020 U	0.020 U	0.021 U
Benzo(g,h,i)perylene	µg/L	0.010 U	0.010 U	0.010 U	0.010 UJ
Chrysene	µg/L	0.010 U	0.010 U	0.010 U	0.010 U
Dibenzo(a,h)anthracene	µg/L	0.010 U	0.010 U	0.010 U	0.010 UJ
Fluoranthene	µg/L	0.010 U	0.010 U	0.010 U	0.010 U
Indeno(1,2,3-cd)pyrene	µg/L	0.010 U	0.010 U	0.010 U	0.010 UJ
Pyrene	µg/L	0.010 U	0.010 U	0.010 U	0.010 U

Note:

1 Samples are field duplicates of Sample MW-01-092507B, MW

2 Metals and conventional results are from the initial samples cc

Qualifiers:

U - Undetected

J - The analyte was analyzed for and positively identified, but the associated numerical value is an estimated quantity.

Bolded results indicate detected concentrations.

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Figure 5-1
Baseline CDF Surface Water and Groundwater Monitoring Locations

File: F:\projects\COT-Oncall\GIS\2008 Annual OMMP Report\MXD\Figure 5-1 (SW and GW Baseline Locations).mxd
Date: 2/5/2008

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Figure 5-2
CDF Berm and Cap Photo Point and Observation Locations

File: F:\projects\COT-Oncall\GIS\2008 Annual OMMP Report\MXD\Figure 5-2 (CDF Berm and Cap Photo Point Locations).mxd
Date: 2/5/2008

6.0 HABITAT MITIGATION AREA MONITORING

6.1 Introduction

This section presents a summary of the Year 2 habitat mitigation area monitoring performed at the Thea Foss and Wheeler-Osgood Waterways Remediation Project (Foss Project) habitat mitigation and enhancement area sites. This habitat mitigation area monitoring was performed in accordance with the Operations, Maintenance, and Monitoring Plan (OMMP) for the Thea Foss and Wheeler-Osgood Waterways Remediation Project (City of Tacoma 2006) as modified by Annual Technical Memoranda submitted for agency review. The OMMP requires that various components of habitat mitigation monitoring occur throughout the first ten years following completion of the remedial action. After 10 years of monitoring, the City of Tacoma (City) and U.S. Environmental Protection Agency (EPA) will evaluate the need for and scope of additional monitoring. A summary of the habitat area monitoring activities performed during this monitoring year is provided in Table 6-1.

As described in Section 6.0 of the OMMP, the habitat mitigation areas for the project are identified as the North Beach Habitat, Middle Waterway Tideflat Habitat, Puyallup River Side Channel, and the Hylebos Creek Mitigation Site. Constructed acreages of these mitigation areas are provided in Table 6-2. The Thea Foss Habitat Enhancement Areas are identified as the Johnny's Dock Habitat Enhancement, Head of Thea Foss Shoreline Habitat, SR 509 Esplanade Riparian Habitat, and the Log Step Habitat Enhancement.

Following completion of the habitat mitigation area monitoring field activities described below, the City prepared the Year 2 Monitoring Habitat Mitigation Area Monitoring Preliminary Findings Memorandum (City of Tacoma 2008) which summarized the work performed and the findings. This memorandum was submitted to the agencies on August 27, 2008. A copy of this Preliminary Findings Memorandum is included as Attachment E-1 in Appendix E.

6.1.1 Habitat Mitigation Area Monitoring Objectives

The OMMP specifies that habitat mitigation monitoring be performed to achieve the following objectives:

- To evaluate the effectiveness of the development of biological features and physical features at the mitigation and enhancement sites to confirm that they are on a trajectory to provide habitat function necessary to meet the objectives for each site; and
- To confirm that the habitat sites have attained and continue to meet the objectives for each site over time.

As required by the OMMP, habitat monitoring activities are generally performed when tidal elevations are below 0.0 feet Mean Lower Low Water (MLLW) except at the Hylebos Creek Mitigation Site where the primary monitoring activities are performed when tidal elevations are below 8.78 feet MLLW. Exceptions to this were noted in the Preliminary Findings Memorandum.

6.1.2 Scope of Habitat Mitigation Area Monitoring

Year 2 mitigation area performance monitoring consists of three components: habitat mitigation area monitoring, habitat mitigation area maintenance, and contingency planning and response actions.

Year 2 habitat mitigation area monitoring included the following activities:

- Qualitative ground surveys;
- Photo documentation;
- Quantitative vegetation monitoring; and
- Elevation monitoring.

These activities are described in more detail in Section 6.2.1 below.

Routine maintenance, performed on an ongoing basis throughout the year, is the key component of the habitat maintenance and monitoring program. The City maintains a contract with the Washington Conservation Corps (WCC) to provide a crew for performance of these routine maintenance activities at the various mitigation and enhancement sites. The crew picks up garbage, repairs goose exclusion grids, tightens large woody debris (LWD) cables, pulls or cuts weeds, and replants on an as needed basis. A summary of their work during the past year is provided in Section 6.3.

Adaptive management and contingency planning procedures were established in Sections 6.4 and 6.5 of the OMMP. As issues are identified, these procedures are implemented to determine the best course of action. To date, two issues have been identified that require follow-up action. These issues, along with their current status are described in Section 6.4.

6.2 Habitat Mitigation Area Monitoring

6.2.1 Summary of Habitat Mitigation Area Monitoring

Year 2 habitat mitigation area monitoring activities are set forth in the OMMP. As indicated above, the primary function of habitat monitoring is to evaluate the effectiveness of the development of biological features and physical features at the mitigation and enhancement sites to confirm that they are on a trajectory to provide habitat function necessary to meet the objectives for each site, and to confirm that the individual habitat sites have attained and continue to meet their objectives over time. Qualitative monitoring was performed at both the mitigation and enhancement sites to document visual observations at the site and to identify any general maintenance concerns, track site naturalization, and document use of the sites by wildlife. Photo documentation was performed at both the mitigation and enhancement sites to record habitat site development over time from specific photo locations. Quantitative monitoring at the mitigation sites was performed to track survival and development of planted areas, colonization by new species, and presence of undesirable species. Finally, elevation monitoring allows for the evaluation of sediment erosion or accretion over time at the mitigation sites. Details of these activities at each of the mitigation and enhancement sites can be found in the Year 2 Monitoring Habitat Mitigation Area Monitoring Preliminary Findings Memorandum. A summary is also provided below.

6.2.2 Summary of Field Activities

Year 2 habitat monitoring activities were initiated on June 30, 2008, and continued intermittently at the various sites until August 14, 2008. Copies of the completed inspection forms and photographs for these monitoring activities are included in the Preliminary Findings Memorandum in Attachment E-1 in Appendix E. The following is a summary of activities performed at each site:

North Beach Habitat – The qualitative ground survey of the site was conducted on July 16, 2008. Photographs were taken during the survey at the six permanent photo points established at the locations shown on Figure 6-1. A total of 17 photographs were taken at these points at tidal elevations ranging from approximately -1.19 feet MLLW to -1.01 feet MLLW.

Five elevation stakes, placed at the locations shown on Figure 6-1, were inspected to evaluate changes in elevation since the previous monitoring event. Photographs showing the elevation stakes in place were taken and the amount of sediment accretion or erosion was estimated using the marks on the stakes. For reference purposes, survey information for photo point locations and elevation stakes are included in Table 6-3.

The quantitative vegetation survey of the riparian area, the marsh area, and the potential marsh area was also performed on July 16, 2008. Quantitative monitoring locations are shown on Figure 6-9.

Middle Waterway Tideflat Habitat – The qualitative ground survey of the site was completed on July 17, 2008 and July 30, 2008. Photographs were taken on July 17, 2008, at the four permanent photo points established at the locations shown on Figure 6-2. A total of eleven photographs were taken at these points at tidal elevations ranging from approximately -0.81 feet MLLW to -0.34 feet MLLW.

Six elevation stakes, placed at the locations shown on Figure 6-2, were inspected to evaluate changes in elevation since the previous monitoring event. Photographs showing the elevation stakes in place were taken and the amount of sediment accretion or erosion was estimated using the marks on the stakes. For reference purposes, survey information for photo point locations and elevation stakes are included in Table 6-3.

The quantitative vegetation survey of the brackish salt marsh area was performed on July 30, 2008, and for the riparian area was completed on July 17, 2008 and July 25, 2008. Quantitative monitoring locations are shown on Figure 6-10.

Puyallup River Side Channel – The qualitative ground survey of the site was completed on July 17, 2008 and July 25, 2008. Photographs were taken on July 17, 2008, at the six permanent photo points established at the locations shown on Figure 6-3. A total of ten photographs were taken at these points at tidal elevations ranging from approximately -1.45 feet MLLW to -1.34 feet MLLW.

Six elevation stakes, placed at the locations shown on Figure 6-3, were inspected to evaluate changes in elevation since the previous monitoring event. Photographs showing the elevation stakes in place were taken and the amount of sediment accretion or erosion was estimated using the marks on the stakes. For reference purposes, survey information for photo point locations and elevation stakes are included in Table 6-3.

The quantitative vegetation survey of the riparian area was completed on July 23, 2008 and July 25, 2008. Quantitative monitoring locations are shown on Figure 6-11.

Hylebos Creek Mitigation Site – The qualitative ground survey of the site was completed on July 17, 2008 and July 30-31, 2008. Photographs were taken on July 17, 2008, at the seven permanent photo points established at the locations shown on Figure 6-4. A total of 21 photographs were taken at these points at tidal elevations ranging from approximately -0.94 feet MLLW to -0.41 feet MLLW. In addition, a second set of photographs was taken on July 30-31, 2008, at the seven photo point locations at tidal elevations ranging from approximately 11.55 feet MLLW to 11.95 feet MLLW to show site conditions during periods of inundation.

Six elevation stakes, placed at the locations shown on Figure 6-4, were inspected to evaluate changes in elevation since the previous monitoring event. Photographs showing the elevation stakes in place were taken and the amount of sediment accretion or erosion was estimated using the marks on the stakes. For reference purposes, survey information for photo point locations and elevation stakes are included in Table 6-3. In addition, a centerline transect survey of each channel was performed on June 30, 2008.

The quantitative vegetation survey of the riparian area was completed on July 31, 2008. Quantitative monitoring locations are shown on Figure 6-12.

Johnny's Dock Habitat Enhancement – The qualitative ground survey of the site was completed on July 1, 2008. Photographs were taken on July 1, 2008, at the two permanent photo points established at the locations shown on Figure 6-5. A total of four photographs were taken at these points at a tidal elevation of approximately 3.45 feet MLLW. For reference purposes, survey information for photo point locations is included in Table 6-3.

Head of Thea Foss Shoreline Habitat – The qualitative ground survey of the site was completed on July 1, 2008. Photographs were taken on July 1, 2008, at the two permanent photo points established at the locations shown on Figure 6-6. Two photographs were taken at these points at a tidal elevation of approximately 2.0 feet MLLW. For reference purposes, survey information for photo point locations is included in Table 6-3.

SR 509 Esplanade Riparian Habitat – The qualitative ground survey of the site was completed on July 1, 2008. Photographs were taken on July 1, 2008, at the three permanent photo points established at the locations shown on Figure 6-7. A total of four photographs were taken at these points at a tidal elevation of approximately 0.21 feet MLLW. For reference purposes, survey information for photo point locations is included in Table 6-3.

Log Step Habitat Enhancement – The qualitative ground survey of the site was completed on July 1, 2008. A photograph was taken on July 1, 2008, at the one permanent photo point established at the location shown on Figure 6-8. One photograph was taken at this point at a tidal elevation of -1.21 feet MLLW. For reference purposes, survey information for photo point locations is included in Table 6-3.

6.2.3 Summary of Findings from Habitat Mitigation Area Monitoring

The primary purpose of the monitoring program is to document that the habitat mitigation and enhancement sites are in an appropriate and healthy condition required for establishment. Specifically, the OMMP requires that habitat mitigation monitoring be performed to achieve the following objectives:

- To evaluate the effectiveness of the development of biological features and physical features at the mitigation and enhancement sites to confirm that they are on a trajectory to provide habitat function necessary to meet the objectives for each site; and
- To confirm that the habitat sites have attained and continue to meet the objectives for each site over time.

Initial results of the monitoring performed at each of the sites are described in detail in the Year 2 Monitoring Habitat Mitigation Area Monitoring Preliminary Findings Memorandum, and are summarized in the sections below.

North Beach Habitat – The qualitative ground survey confirmed that the site was establishing well and the plants were beginning to spread in the riparian areas. In addition, pickleweed is spreading well throughout the potential marsh portion of the site. As expected, the pilot nodes were not establishing as well as the other nodes due to their greater exposure and a reduced amount of organics in the substrate. An on-site meeting with the agencies was held on August 14, 2008, to discuss potential alternatives for establishment of vegetation in these pilot areas. As outlined in the PFM, options were discussed, and the City is awaiting final instruction from EPA. A more detailed summary of this issue is provided in Section 6.4. Ongoing erosion along the lower face of the containment berm continued to be monitored on a regular basis as described in more detail below. Dune Grass is spreading and helping to stabilize the slope. It was noted that habitat mix/fine-grained material was present at the surface in this area. Minor repairs to the goose exclusion grids are needed along with some minor weeding of the area, tightening of the anchors on the large woody debris, and removal of trash and other debris. A summary of required maintenance activities is provided in Table 6-4.

Quantitative vegetation monitoring was performed and data were analyzed as outlined in the OMMP and summarized in Table 6-6. Quantitative monitoring activities are described in the Preliminary Findings Memorandum. For the riparian area and the salt marsh pilot area, Total Percent Cover were analyzed, and for the salt marsh area, the Area-Weighted Percent Cover, Percent of Potential Marsh with Some Vegetation, and Density were determined using the procedures outlined in Appendix E of the OMMP. Calculations for the quantitative analyses are included as Attachment E-2 in Appendix E. Results of these analyses are shown on Table 6-7 and the comparison to the performance criteria is included in Table 6-8. As shown on Table 6-9, with the exception of the Total Percent Cover at the saltmarsh pilot nodes, there was an increase in each metric at this site between Year 1 and Year 2. Based on the analyses performed, the site meets the performance criteria for vegetation survival and establishment.

Overall, the potential marsh area is becoming well established and is currently dominated by pickleweed. The pickleweed is spreading well both inside and outside the nodes with seed sources located throughout Middle Waterway. Some areas of salt grass are present, but it is much less prevalent than the pickleweed. In the riparian area, the site is dominated by hydroseed and willow. In the field notes, the top five species identified within each quadrat were determined, and in most cases included a combination of a variety of native and invasive species. The presence of invasives at the time of the inspection ranged from 2.5% - 85% within the selected quadrats, for an overall average of approximately 17%. The habitat sites are regularly maintained by the WCC to keep the invasives under control. The sloughed areas on the berm affect the quantitative evaluation of the site, given the impact that the erosion has on plant establishment. The well-draining nature of the berm materials is also affecting plant establishment to some degree in places. Despite these conditions, performance criteria were achieved as indicated on Table 6-8.

Five elevation stakes are in place at the site and during the inspection it was noted that there had been up to 2 inches of sediment accumulation in places, and loss of 1 inch of material in another location. The average change in sediment elevation relative to baseline was +1.0 inches (Table 6-5). This meets the performance standard for this element (Table 6-8).

Middle Waterway Tideflat Habitat – The qualitative ground survey confirmed that the site was establishing well and the brackish marsh plants were continuing to spread outside of the planted nodes within the sprinkled area. Vegetation within the riparian area was also doing well. Some erosion from seeps, springs, and other influences in the marsh area was identified, but is minor and consistent with the amount that would be expected in this setting. In addition, pickleweed is spreading well throughout the site from seed sources elsewhere in the Middle Waterway.

Minor repairs to the goose exclusion grids are needed, along with some limited weeding and debris removal. There is some bark and other wood debris accumulating within the goose exclusion grids which will be removed as needed to prevent impact to the plants. Sprinkler heads are repaired or replaced as needed to ensure optimal performance of the irrigation system.

Quantitative vegetation monitoring was performed and the data were analyzed as outlined in the OMMP (Table 6-6). Quantitative monitoring activities are described in the Preliminary Findings Memorandum. For the riparian area, Total Percent Cover was analyzed, and for the brackish marsh area, the Area-Weighted Percent Cover, Percent of Potential Marsh with Some Vegetation, and Density were determined using the procedures outlined in Appendix E of the OMMP. Calculations for the quantitative analyses are included as Attachment E-2 in Appendix E. Results of these analyses are shown on Table 6-7 and the comparison to the performance criteria is included in Table 6-8. As shown on Table 6-9, there was an increase in each metric at this site between Year 1 and Year 2. Based on the analyses performed, the site meets the performance criteria for vegetation survival and establishment.

Overall, the brackish marsh area is becoming very well established and is currently dominated by Lyngbyei sedge in the areas in and adjacent to the planted nodes. Away from the nodes, sand spurry is most common although some pickleweed and orache are also present. In the riparian area, the site is dominated by hydroseed although shrubs and trees are also becoming well established, especially in the irrigated areas. In the field notes, the top five species identified within each quadrat were determined, and in most cases included a combination of a variety of native and invasive species. The presence of invasives at the time of the inspection ranged from 2.0% - 50% within the selected quadrats, for an overall average of approximately 17%. The habitat sites are regularly maintained by the WCC to keep the invasives under control. On the ends of the site outside of the influence of the riparian sprinkler system, there was more bare ground measured.

Small amounts of bark were present at the site, likely from the log haul out facility located north of the habitat area. This bark did not appear to be impacting establishment of the marsh. It is estimated that the bark covered approximately 10-20% of the portion of the site between elevation 10 feet MLLW and 13 feet MLLW, with most occurring at the southern end of the site and behind the planting nodes. This bark did not appear to be affecting plant development. Only small amounts of wood debris were present within the goose exclusion grids, and the larger pieces are removed as part of routine maintenance.

Six elevation stakes are in place at the site and during the inspection it was noted that there had been up to 0.50 inch of sediment accumulation at one location, and up to 8.5 inches of erosion at another location. At this location (E4), the elevation stake was located at the edge of a localized area of erosion. Two different depths were therefore noted on the field form. The average change in sediment elevation relative to baseline using the larger of the two measurements for E4 was -1.625 inches (Table 6-5). This meets the performance standard for this element (Table 6-8).

Puyallup River Side Channel – The qualitative ground survey confirmed that the site was establishing well and the plants were becoming better established in the riparian areas relative to the previous year's monitoring. It was noted that habitat mix/fine-grained material was present at the surface in this area. Minor weeding of the area was the only maintenance activity identified at this time. A small spit of sedimentation remains inside of the side channel off of the downstream remnant levee section. Overall, this site appeared to be in good condition.

Quantitative vegetation monitoring was performed and data were analyzed as outlined in the OMMP (Table 6-6). Quantitative monitoring activities are described in the Preliminary Findings Memorandum. Total Percent Cover was analyzed for the riparian area using the procedures outlined in Appendix E of the OMMP. Calculations for the quantitative analyses are included as Attachment E-2 in Appendix E. Results of this analysis are shown on Table 6-7 and the comparison to the performance criteria is included in Table 6-8. As shown on Table 6-9, there was an increase in each metric at this site between Year 1 and Year 2. Based on the data from this year and the analyses, the site meets the performance criteria for riparian vegetation establishment.

Overall, the riparian area on the cutdown berm portion (old levee) of the site is dominated by a variety of shrubs and trees which are becoming established, albeit a bit more slowly than other sites. This could be attributed to the well-draining substrate and lack of irrigation. Approximately half of the area is dominated by native species, both planted and naturalized. Damage caused by willow weevils created a small setback in site establishment. There were some areas (approximately 40% overall) of bare ground measured within the quadrats. In the field notes, the top five species identified within each quadrat were determined, and in most cases included a combination of a variety of native and invasive species. The presence of invasives at the time of the inspection ranged from 5% - 60% within the selected quadrats, for an overall average of approximately 23%. The habitat sites are regularly maintained by the WCC to keep the invasives under control.

Six elevation stakes are in place at the site and during the inspection it was noted that there had been 4.25 inches of sediment erosion in one location, and up to 5.0 inches of sediment accumulation at remaining locations. The average change in sediment elevation relative to baseline was +1.833 inches (Table 6-5). Sediment deposition is anticipated at this site, and therefore there is no performance criteria associated with elevation at this site. In accordance with the OMMP, the sedimentation rate at this site will be evaluated for five years. After that time, if the rate is determined to be unacceptably high, contingency planning may be initiated through the Adaptive Management Team to evaluate site alternatives such as dredging or excavating an inlet/outlet to create a flow through system.

Hylebos Creek Mitigation Site – The qualitative ground survey confirmed that the site was establishing well and the emergent wetland plants were continuing to spread. Vegetation within the forested wetland area was also doing very well. No obstruction to fish passage was identified in the channel areas. Overall, this site appeared to be in excellent condition. Only minor weeding is needed at this time.

Quantitative vegetation monitoring was performed and the data were analyzed as outlined in the OMMP (Table 6-6). Quantitative monitoring activities are described in the Preliminary Findings Memorandum. For the forested wetland area, Total Percent Cover was analyzed using the procedures outlined in Appendix E of the OMMP. Calculations for the quantitative analyses are included as Attachment E-2 in Appendix E. Results of these analyses are shown on Table 6-7 and the comparison to the performance criteria is included in Table 6-8. As shown on Table 6-9, with the possible exception of a slight decrease in Percent Survival, there was an increase in each metric at this site between Year 1 and Year 2. Percent Survival is difficult to measure beyond the first year because while some of the originally planted vegetation may not have survived, established plants are spreading in the same areas. The City will be requesting that this metric be removed from future monitoring events. Based on the analyses performed, the site meets the performance criteria for vegetation survival and establishment.

Overall, the upper area of the forested wetland portion of the site is dominated by a variety of shrubs and trees which are becoming established. A good diverse plant community is developing with large areas currently dominated by red alder and willow, but several other trees and shrubs are also thriving. In the field notes, the top five species identified within each quadrat were determined, and in most cases included a combination of a variety of native and invasive species. The presence of invasives at the time of the inspection ranged from 0% - 30% within the selected quadrats, for an overall average of approximately 3.6%. The habitat sites are regularly maintained by the WCC to keep the invasives under control. The lower portion of the forested wetland portion of the site is seeing significant growth and spreading of rushes and potentilla. The upland forest area is doing well with conifers showing nicely in the winter. Also, many alder have been transplanted to the slope to provide quick shading of the node areas.

Six elevation stakes are in place at the site and during the inspection it was noted that there had been up to 1.25 inches of sediment erosion at several locations, and up to 1.0 inches of sediment accumulation at another location. Based on elevation stake measurements, the average change in sediment elevation relative to baseline was -0.333 inches (Table 6-5). A transect survey of the centerlines of both the north and south nodes was performed on June 30, 2008. Figure 6-13 shows the elevations from this Year 2 survey, along with the elevations measured during the Year 1 survey, elevations from four of the elevation stakes measured during the baseline survey performed in July 2006, and the design and as-built centerline elevations within the north and south nodes. As depicted on Figure 6-13, the as-built elevations of the lobes at the site were an average of 0.74 feet deeper in the north lobe and 1.17 feet deeper in the south lobe compared to the design elevations. Between the time that construction of this site was completed in September 2005 and the time of the baseline survey of the elevation stakes in the nodes was completed in July 2006, the site had silted in such that the elevations at Year 0 were closer to, but still below the approved design elevations at all but one location surveyed (near the mouth of the north lobe). According to the OMMP, the performance criteria relative to elevation changes at this site indicate that the average elevation change along the centerline transect of the channels must be less than 0.2 feet from as-built elevations. Based upon this criteria, the site does not meet this performance criteria (average change in south lobe relative to as-built elevations was 0.51 feet and in the north lobe was 0.37 feet). However, if the elevations are compared to either the design elevations or the Year 0 elevations, the site does meet the performance criteria.

Johnny's Dock Habitat Enhancement – The qualitative ground survey confirmed that the site was becoming well established and the planted species were continuing to spread. Additional species were also beginning to volunteer at the site including goose tongue, gumweed, orache, and coastal strawberry. Overall, the site appeared to be in excellent condition. Minor repairs or removal of the goose exclusion grids, minor trash removal, and tightening of the anchors on the large woody debris were the only maintenance activities required.

Head of Thea Foss Shoreline Habitat – The qualitative ground survey confirmed that the site was becoming well established and the planted species were continuing to spread. Additional species were also volunteering at the site including brass buttons, pickleweed, orache, plantain, and goose tongue. Overall, the site appeared to be in excellent condition. Minor repairs or removal of the goose exclusion grids, weeding, and trash removal were the only maintenance activities required.

SR 509 Esplanade Riparian Habitat – The qualitative ground survey confirmed that the site was generally continuing to establish well. Additional species were also beginning to volunteer at the site area including cottonwood, willow, plantain, pearly everlasting, and gumweed. The sprinkler system did not appear to have been functioning properly at the time of the inspection, but was subsequently inspected and repaired. Overall, the site appeared to be in very good condition, but increased watering was expected to improve the situation. Minor weeding and mulching were the only maintenance activities required. Transient trash is a notable item at this site.

A park and esplanade are being developed in 2009 on the adjacent site and the project team will coordinate with developers to minimize impacts on this site (see Section 7.2).

Log Step Habitat Enhancement – The qualitative ground survey confirmed that the site was becoming well established and the plants were continuing to spread. Additional species were also volunteering at the site including pickleweed and sand spurry. Overall, the site appeared to be in excellent condition. Minor weeding, checking the anchors on the large woody debris, and minor repair or removal of the goose exclusion grid were the only maintenance activities required.

As outlined above, very few follow-up actions were identified during this monitoring event and these are summarized in Table 6-4. The status of each of these follow-up actions is described in Section 6.3. A summary of the results of all of the habitat monitoring performed and whether or not established performance standards for each element were achieved is provided in Table 6-8.

6.2.4 Schedule of Habitat Mitigation Area Monitoring Activities

The next round of habitat mitigation area monitoring activities is scheduled for Year 3. Year 3 monitoring activities are summarized in Table 6-10 and include qualitative site surveys at both the mitigation sites and the enhancement sites. In addition, invertebrate monitoring, elevation monitoring, juvenile salmonid monitoring, and water surface elevation monitoring will be performed at the applicable mitigation sites. These activities are scheduled to be conducted in June 2009 or July 2009, during appropriate tidal cycles.

6.3 Habitat Mitigation Area Maintenance

6.3.1 Maintenance Approach

As indicated above, routine maintenance of the habitat mitigation and enhancement sites is performed for the City by the WCC crew. Both City staff and WCC have visited the sites periodically during the year for informal inspections and maintenance, as well as specifically following up on issues identified during the qualitative site surveys.

6.3.2 Completed Maintenance Activities

Since the performance of the qualitative site inspections in July 2008, the WCC has followed up on all of the maintenance issues identified. Specifically, they have performed the following activities:

- Repaired goose exclusion grids at the North Beach Habitat Area and Middle Waterway Tideflat Habitat. Removed the goose exclusion grids at the Johnny's Dock Habitat Enhancement Area, the Log Step Habitat Enhancement, and the Head of Thea Foss Shoreline Habitat;
- Picked up trash and unused portions of jute mat installation as needed from all sites;
- Removed larger pieces of wood debris from within the goose exclusion grids at the Middle Waterway Tideflat Habitat;
- Tightened large woody debris anchors and replaced anchors as needed at the North Beach Habitat, Johnny's Dock Habitat Enhancement area, and Log Step Habitat Enhancement area; and
- Weeded at all sites as needed.

In addition, City Maintenance crews maintained/repaired the sprinkler systems at the Middle Waterway Tideflat Habitat and the SR 509 Esplanade Riparian Habitat.

6.3.3 Replanting Performed as Part of Maintenance Activities

Under the approved OMMP, replanting of the sites will generally be performed as a contingency action if, upon completion of quantitative evaluation, it is determined that plant coverage is less than the performance standards. Based upon the Year 2 quantitative vegetation survey, there were no areas where vegetation performance standards were not achieved. Therefore, additional plantings are not required at this time. While not required, additional willow stakes were planted at the Puyallup River Side Channel in November to replace those that had been impacted by willow weevil.

6.4 Contingency Planning and Response Actions

The approach to adaptive management and contingency planning are set forth in Sections 6.4 and 6.5 of the OMMP, respectively. There is one remaining issue identified in the Baseline Annual Operations, Maintenance, and Monitoring Report, erosion at the North Beach Habitat, which the City is continuing to monitor. In addition, there was one new issue identified during Year 2 relative to habitat mitigation monitoring that requires review of adaptive management alternatives and/or contingency planning. This issue was related to the lack of vegetation establishment at the pilot nodes in the North Beach Habitat. A summary of these issues and their current status are provided in Sections 6.4.1 and 6.4.2, below.

6.4.1 St. Paul Beach Habitat / North Beach Habitat Erosion

After completion of the qualitative site survey in July 2006, some increasing erosion of an area of the St. Paul Beach portion of the North Beach Habitat was identified. The City verbally informed EPA that we were tracking this issue in August 2006. The City proposed the placement of some LWD at the northwest corner of the Middle/St. Paul Waterway peninsula to protect the bank.

After further discussion, it was determined that the best course of action was to conduct a meeting at the site to further evaluate the conditions. The site meeting was held on December 7, 2006. A Coastal Geologist from the Department of Ecology attended the meeting to provide additional expertise and guidance. The consensus at the meeting was that the movement of material at the site was not unusual, and that it had likely not reached a state of equilibrium. The outcomes from the meeting were to:

- Take quarterly photographs of the site at the established photo points and other relevant locations to track continued movement of the beach at the site. Since March 2007, this has been done in conjunction with the quarterly monitoring of the CDF. The photographs and an evaluation of ongoing changes are provided in the Quarterly CDF Monitoring Reports; and
- Develop a modified plan for placement of LWD at the northwest corner of the peninsula. A plan was approved and the additional LWD was placed in August 2007.

The City continued with the scheduled monitoring through 2008. It generally appears at this time that the erosion has stabilized. The vegetation on the containment berm is becoming more established which will help to minimize additional erosion. Some of the vegetation, especially dune grass, which has fallen with chunks of dirt from the bank has become established at the new lower elevation. The City recommends another on site meeting at this time to reevaluate the situation and determine whether additional monitoring or follow-up actions are required.

In summary, in terms of the Contingency Planning Procedures set forth in Section 6.5 of the OMMP, the following tasks in the Contingency Screening Process have been performed:

- **Task 1 – Screening Levels**: The City identified that erosion was taking place at the site.
- **Task 2 – Notice and Verification**: The City notified EPA verbally in August 2006 and via email on October 5, 2006.

- **Task 3 – Meeting and Consultation**: A meeting was held on December 7, 2006, to review the site conditions.
- **Task 4 – Response to Contingency Screening**: In accordance with the meeting outcome, the City placed additional large woody debris at the site at approved locations and continued to monitor the site to determine whether any future response actions were needed. A follow-up agency site visit is recommended to determine the need for additional actions.

6.4.2 North Beach Habitat Pilot Node/Planting Modifications

In June 2008, the City identified two issues related to vegetation establishment at the North Beach Habitat. First, during Year 1 quantitative monitoring performed in July 2007, minimal plant survival was observed in the three pilot nodes at the North Beach Habitat area. In June 2008, during Year 2 Quantitative Monitoring, it was noted that there was no remaining vegetation in these pilot node areas. In addition, the goose exclusion grids at these pilot node locations were in a state of disrepair. The failure of establishment of the vegetation at these pilot node locations does not appear to be related to predation.

Second, in accordance with the design documents, four additional planting nodes were required to be constructed at the St. Paul Beach and Peninsula portions of the North Beach Habitat in the first or second season following construction completion to accelerate colonization of the site. Two additional 16'x16' nodes were to be placed at each of two elevations at the St. Paul Beach and one additional 16'x16' node was to be placed at two elevations at the Peninsula portion of the site. The nodes were to be planted with a combination of Salicornia Virginica, Distichlis spicata, and Deschampsia caespitosa. Due to the erosion and shifting of the beach materials occurring at the site, the City requested reconsideration of this activity since the area does not appear to be conducive to establishment of the species indicated. The exposure appears to be too great, as evidenced by the lack of plants surviving in the pilot node at the point. In addition, the substrate is likely too rocky/cobbly for these species and there is not enough organic material available.

On June 11, 2008, the City sent an email notification to the agencies identifying these questions/concerns related to vegetation establishment at the North Beach Habitat. In the email, the City requested authorization to eliminate the requirement to continue maintenance of the goose exclusion grids at the three pilot locations. The City proposed continued monitoring of these areas for volunteer vegetation that might become established as the overall site develops and comes to equilibrium. In addition, the City requested a reconsideration of the locations and proposed species for the additional planting nodes.

In response to the email, the agencies requested an on-site meeting to review site conditions and to discuss these issues. The site meeting was held on August 14, 2008. Several concerns related to the lack of vegetation in the pilot node and additional planting node areas were discussed, including shifting beach materials, exposure, and the lack of organics in the substrate. Options for adaptive management in this area were discussed, including the following:

- Relocating the pilot node at the tip of the peninsula to another area where the beach is shifting less. One possibility is an area to the west of the current node location where a natural low area has formed. The area was visually monitored over the fall and early winter to determine whether the beach has stabilized or is continuing to shift seasonally, which would impact node sustainability. Based on these observations, there does not appear to be an issue of shifting materials in the area west of the LWD. Therefore, it appears that this might be the optimal location for the additional planting nodes required in the design report. With agency concurrence, the appropriate species for this location/elevation can be determined.

- As a means of assessment of the impact that reduced organics has on plant establishment in the pilot node areas, a revised planting approach could be considered. It was suggested that mature pickleweed plants be harvested from one of the existing restoration sites in the area such as the City's Middle Waterway NRDA restoration site. These plants could be planted in 5-gallon buckets of good, organic soil and allowed to stabilize to avoid shock. Once stable, the bucket could be buried in the ground at the pilot node locations to see if, with good organic substrate, plants could establish at these locations. Next steps would be based on the results of this assessment. The City will initiate this test pending agency approval.

In summary, in terms of the Contingency Planning Procedures set forth in Section 6.5 of the OMMP, the following tasks in the Contingency Screening Process have been performed:

- **Task 1 – Screening Levels**: The City identified that all vegetation had failed to establish during routine site inspection activities. In addition, the uncertainty regarding the additional required planting nodes was identified.
- **Task 2 – Notice and Verification**: The City notified EPA via email on June 11, 2008.
- **Task 3 – Meeting and Consultation**: A meeting was held on August 14, 2008 to review the site conditions.
- **Task 4 – Response to Contingency Screening**: Potential causes for the failed plantings were discussed at the on-site meeting, including the exposure at the site, the lack of organics in the beach surface materials, and the seasonal shifting of the beach. For establishment of plants at the pilot node locations, one alternative was discussed which was to try planting a larger mass of established pickleweed harvested from a nearby restoration site. Optimally, the plant would be set in a 5-gallon bucket with good organic material and the bucket itself would be buried in the beach in attempt to maintain the organic material. The City will implement this alternative pending agency approval. For locations of the additional planting nodes, it was suggested that continued monitoring of the beach area would performed to determine whether the beach has stabilized or will continue to shift seasonally. Based upon this information, the best locations for additional planting nodes can be determined.

TABLES

FIGURES

Table 6-1
Year 2 Monitoring Activities

	North Beach Habitat	Middle Waterway Tideflat Habitat	Puyallup River Side Channel	Hylebos Creek Mitigation Site	Thea Foss Enhancement Areas
Qualitative Ground Survey	x	x	x	x	x
Photo Documentation	x	x	x	x	x
Quantitative Vegetation Monitoring	x	x	x	x	n/a
Invertebrate Monitoring	n/a	n/a	--	--	n/a
Elevation Monitoring	x	x	x	x	n/a
Surface Water Elevation Sampling	n/a	n/a	n/a	--	n/a
Brackish Marsh Salinity Monitoring	n/a	--	n/a	n/a	n/a
Juvenile Salmonid Monitoring	--	--	--	--	n/a

x activity performed
-- activity not performed this monitoring year
n/a activity not required at this location

Table 6-2
Mitigation Area Acreage

Site	Subtidal, acres (Below -10 feet MLLW)	Littoral, acres (Between OHW and -10 feet MLLW)	Total Aquatic Habitat, acres	Riparian, acres
North Beach Habitat	0.10	7.26	7.36	0.30
Middle Waterway Tideflat Habitat	--	8.84	8.84	0.55
Puyallup River Side Channel	--	5.39	5.39	0.44
Hylebos Creek Mitigation Site	--	0.58	0.58	0.30

[1] At the Hylebos Creek Mitigation Site, the riparian area subject to performance monitoring is identified as forested wetland (see Figure 6-4).

Table 6-3
Survey Information for Photo Points and Elevation Stakes

Site	Photo Point Identification	Elevation Stake Identification	Coordinates	Elevation Top of Stake	
				Top of Stake	Depth from Top of Stake to Sediment Surface
North Beach Habitat	P-1		710023.3 / 1161327		
	P-2		709994.3 / 1161228		
	P-3		709909.6 / 1160964		
	P-4		709869.5 / 1160958		
	P-5		709671.7 / 1160934		
	P-6		710551.3 / 1160645		
		E-1	710056.7 / 1161259	-0.689	1.07
		E-2	710001.4 / 1161054	8.207	1.09
		E-3	709900.2 / 1160916	5.383	0.68
		E-4	709818.6 / 1160941	5.984	1.02
		E-5	709742.3 / 1160912	3.442	1.05
Middle Waterway Tideflat Habitat	P-1		708961.1 / 1161384		
	P-2		708534.1 / 1161575		
	P-3		708040.6 / 1161800		
	P-4		707863.4 / 1161619		
		E-1	708976.1 / 1161325	6.801	1.05
		E-2	708792.6 / 1161327	0.398	1.05
		E-3	708545.3 / 1161470	-1.133	1.05
		E-4	708494.6 / 1161558	5.429	1.02
		E-5	708269 / 1161523	0.003	1.05
		E-6	707981.6 / 1161745	5.548	1.05

Site	Photo Point Identification	Elevation Stake Identification	Coordinates	Elevation Top of Stake	
				Top of Stake	Depth from Top of Stake to Sediment Surface
Puyallup River Side Channel	P-1		706460.3 / 1164098		
	P-2		706548.9 / 1164081		
	P-3		706064.8 / 1163970		
	P-4		705490.6 / 1164036		
	P-5		705143.7 / 1164421		
	P-6		705321.7 / 1164354		
		E-1	706461.3 / 1164073	6.273	1.06
		E-2	706278.4 / 1164065	3.089	1.03
		E-3	706109.5 / 1164066	1.68	1.05
		E-4	705269.5 / 1164313	0.563	1.06
		E-5	705220.3 / 1164352	2.443	1.05
		E-6	705180.7 / 1164385	4.414	1.08
Hylebos Creek Mitigation Site	P-1		706015.6 / 1181008		
	P-2		705967.8 / 1181125		
	P-3		705840.7 / 1181168		
	P-4		705733.2 / 1181050		
	P-5		705943.3 / 1181089		
	P-6		705787.3 / 1181053		
	P-7		705708.4 / 1181016		
		E-1	705743.9 / 1181053	2.483	1.07
		E-2	705904.4 / 1181079	2.474	1.05
		E-3	705819.2 / 1181135	6.49	1.07
		E-4	705869.6 / 1181162	3.829	1.07
		E-5	705955.1 / 1181110	2.97	1.07
		E-6	705999 / 1181026	2.763	1.03

Site	Photo Point Identification	Elevation Stake Identification	Coordinates	Elevation Top of Stake	
				Top of Stake	Depth from Top of Stake to Sediment Surface
Johnny's Dock Habitat Enhancement	P-1		703065.1 / 1160772		
	P-2		703022.6 / 1160731		
Head of Thea Foss Shoreline Habitat	P-1		702352.7 / 1160773		
	P-2		701860.2 / 1160780		
SR 509 Esplanade Riparian Habitat	P-1		702697.8 / 1160410		
	P-2		702498.2 / 1160286		
	P-3		702257.3 / 1160311		
Log Step Habitat Enhancement	P-1		705509.6 / 1160052		

Note: Horizontal Datum 83-91
Vertical Datum NGVD 29

Table 6-4
Summary of Preliminary Findings from
Year 2 Habitat Mitigation Area Monitoring

Site	Corrective Action Tasks
North Beach Habitat	- minor repairs to the goose exclusion grids - minor weeding - remove portions of jute mat installation no longer in use - minor trash removal - tighten anchors on large woody debris
Middle Waterway Tideflat Habitat	- repair/replace sprinkler heads - minor repairs to the goose exclusion grids - minor weeding - remove portions of erosion control installation no longer in use - removal of wood debris within goose exclusion
Puyallup River Side Channel	- minor weeding
Hylebos Creek Mitigation Site	- minor weeding
Johnny's Dock Habitat Enhancement	- minor repair or removal of goose exclusion - reset end anchor on southernmost large woody debris - minor trash removal
Head of Thea Foss Shoreline Habitat	- minor repair or removal of goose exclusion - minor weeding - minor trash removal
SR 509 Esplanade Riparian Habitat	- minor weeding - check sprinkler system to ensure proper function
Log Step Habitat Enhancement	- minor weeding - check large woody debris anchors and tighten anchors as needed - minor repair or removal of goose exclusion

Table 6-5
Year 2 Elevation Monitoring Results

Site	Year	Stake 1	Stake 2	Stake 3	Stake 4	Stake 5	Stake 6	Average Change from Baseline	Average Change between Years
North Beach Habitat	1	+1.0	+0.5	0.0	0.0	+1.0	n/a	+0.5	n/a
	2	+1.75	+1.75	-1.0	+0.5	+2.0	n/a	+1.0	n/a
	3								n/a
	5								n/a
	7								n/a
	10								n/a
	Year 10 – Year 7							n/a	
Middle Waterway Tideflat Habitat	1	-0.25	-0.5	-1.0	-1.5	+0.75	-0.25	-0.458	n/a
	2	-0.75	-0.5	-1.0	-8.5*	+0.5	+0.5	-1.625*	n/a
	3								n/a
	5								n/a
	7								n/a
	10								n/a
	Year 10 – Year 7							n/a	
Puyallup River Side Channel	1	+2.0	-4.0	+1.5	+4.5	+2.75	+3.25	+1.667	n/a
	2	+3.5	-4.25	0.0	+5.0	+2.5	+4.25	+1.833	n/a
	3								n/a
	5								n/a
	7								n/a
	10								n/a
	Year 10 – Year 7							n/a	
Hylebos Creek Mitigation Site	1	-1.0	-1.0	+0.5	0.0	+1.25	-1.0	-0.208	n/a
	2	-1.0	-1.0	+0.25	0.0	+1.0	-1.25	-0.333	n/a
	3								n/a
	5								n/a
	7								n/a
	10								n/a
	Year 10 – Year 7							n/a	

*Erosion stake located at edge of eroded shelf. This is the higher of the two measured erosion depths and the calculated average is based on this larger number. The smaller of the two measurements is -4.5 inches and the calculated average based on this smaller number is -0.958 inches.

Table 6-6
Quantitative Vegetation Analyses by Site

Site	Strata	Sub-Strata	Metrics
North Beach Habitat	Riparian	Shrub	TPC
		Ground Cover	TPC
		Total	TPC
	Saltmarsh	n/a	AWPC, PPMV, D
	Saltmarsh, pilot area	n/a	TPC
Middle Waterway Tideflat Habitat	Riparian	Tree	TPC
		Shrub	TPC
		Ground Cover	TPC
		Total	TPC
	Brackish marsh	n/a	AWPC, PPMV, D
Puyallup River Side Channel	Riparian	Tree	TPC
		Shrub	TPC
		Ground Cover	TPC
		Total	TPC
Hylebos Creek Mitigation Site	Forested Wetland	Tree and Shrub	PS, TPC
		Total	TPC

TPC – Total Percent Cover
PS – Percent Survival
AWPC – Area-Weighted Percent Cover
PPMV – Percent of Potential Marsh with Some Vegetation
D - Density

Table 6-7
Quantitative Vegetation Monitoring Results

Site	Strata	Sub-Strata	Metric	Result	Performance Standard	Performance Standard Met?
North Beach Habitat	Riparian	Shrub	TPC	13.9%	n/a	n/a
		Ground Cover	TPC	40.5%	n/a	n/a
		Total	TPC	49.7%	20%	yes
	Saltmarsh	n/a	AWPC	10.78%	5%	yes
			PPMV	60%	20%	yes
			D	449%	75%*	yes
	Saltmarsh, pilot area	n/a	TPC	0.0%	n/a	n/a
Middle Waterway Tideflat Habitat	Riparian	Tree	TPC	8.1%	n/a	n/a
		Shrub	TPC	8.3%	n/a	n/a
		Ground Cover	TPC	51.3%	n/a	n/a
		Total	TPC	66.0%	20%	yes
	Brackish marsh	n/a	AWPC	34.71%	5%	yes
			PPMV	96%	20%	yes
			D	10336%	75%*	yes
Puyallup River Side Channel	Riparian	Tree	TPC	4.4%	n/a	n/a
		Shrub	TPC	13.8%	n/a	n/a
		Ground Cover	TPC	8.4%	n/a	n/a
		Total	TPC	24.3%	20%	yes
Hylebos Creek Mitigation Site	Forested Wetland	Tree and Shrub	PS	~95%	n/a	n/a
			TPC	~70%	n/a	n/a
		Total	TPC	78.1%	20%	yes

* Relative to density at the time of planting
TPC – Total Percent Cover
PS – Percent Survival
AWPC – Area-Weighted Percent Cover
PPMV – Percent of Potential Marsh with Some Vegetation
D - Density

Table 6-8
Performance Standard Schedule by Site

Performance Standard	2006 - Year 0	2008 - Year 2	Performance Standard Achieved?
1.0 North Beach Habitat			
Elevation			
1.1.1 Average change is less than 1 foot from Year 0.	B	X	Yes
1.1.3 Presence of habitat mix at the surface.	B	X	Yes
Riparian Vegetation			
1.2.2 Total cover native or naturalized plants is at least 20 percent.		X	Yes
1.2.6 Non-native/invasive vegetation cover is not more than 10 percent.		X	Yes[2]
Saltmarsh Vegetation			
1.3.2 Proportion of potential marsh area with vascular marsh vegetation will be at least 20 percent; area-weighted average cover of native or naturalized plants is at least 5 percent.		X	Yes
1.3.6 In planted areas, marsh vegetation density will be at least 75% of that at the time of planting.		X	Yes
1.3.10 Non-native/invasive vegetation cover is not more than 10 percent.		X	Yes[2]
Salmonid Presence			n/a[1]
2. Middle Waterway Tideflat Habitat			
Elevation			
2.1.1 Average change is less than 1 foot from Year 0.	B	X	Yes
Riparian Vegetation			
2.2.2 Total cover of native or naturalized plants is at least 20 percent.		X	Yes
2.2.6 Non-native/invasive vegetation cover is not more than 10 percent.		X	Yes[2]
Brackish Marsh Vegetation			
2.3.2 Proportion of potential marsh area with some vascular marsh vegetation will be at least 20 percent; area-weighted average cover of native or naturalized plants is at least 5 percent.		X	Yes

Performance Standard	2006 - Year 0	2008 - Year 2	Performance Standard Achieved?
2.3.6 In planted areas, marsh vegetation density will be at least 75% of that at the time of planting.		X	Yes
2.3.10 Non-native/invasive vegetation cover is not more than 10 percent.		X	Yes[2]
Salmonid Presence			n/a[1]
3. Puyallup River Side Channel			
Elevation			
3.1.1 Sediment deposition is anticipated at this site; elevation will be monitored and reported annually to the AMT along with evaluation of its affects on biological function; there is no performance standard associated with it.	B	X	n/a
3.1.2 Presence of fine-grained material in interstices of riprap between elevation 13 feet MLLW and 9 feet MLLW.	B	X	Yes
Riparian Vegetation			
3.2.2 Total cover native or naturalized plants is at least 20 percent.		X	Yes
3.2.6 Non-native/invasive vegetation cover is not more than 10 percent.		X	Yes[2]
Brackish Marsh Vegetation			
Brackish marsh vegetation at this site is based on colonization of volunteers; there are no performance standards associated with it.			n/a
Salmonid Presence			n/a[1]
4. Hylebos Creek Mitigation Site			
Elevation			
4.1.1 Average change along centerline transect of channels is less than 0.2 feet from as-built elevation.	B	X	No[3]
4.1.2 No obstruction to fish passage in channels.		X	Yes
Forested Wetland Vegetation			
4.2.2 Total cover of native or naturalized plants is at least 20 percent.		X	Yes
4.2.6 Non-native/invasive vegetation cover is not more than 10 percent.		X	Yes[2]

Performance Standard	2006 - Year 0	2008 - Year 2	Performance Standard Achieved?
Emergent Wetland Vegetation			
There is no quantitative performance standard associated with emergent wetland vegetation at this site.			n/a
Salmonid Presence			n/a[1]
Surface Water Elevation			n/a[1]

B = Baseline F = Final NC = Not completed at this time

[1] This monitoring activity was not performed during this monitoring event.

[2] All sites are subject to ongoing maintenance including invasive removal. Where non-native/invasive vegetation cover was greater than 10%, this was remedied through maintenance to meet this criteria.

[3] See Section 6.2.3 for additional discussion on compliance with this performance criteria.

Table 6-9
Inter-Annual Quantitative Vegetation Results

Site	Strata	Sub-Strata	Metric	Year 1	Year 2	Year 4	Year 7	Year 10
North Beach Habitat	Riparian	Shrub	TPC	11.2%	13.9%			
		Ground Cover	TPC	13.1%	40.5%			
		Total	TPC	20.8%	49.7%			
	Saltmarsh	n/a	AWPC	5.25%	10.78%			
			PPMV	32%	60%			
			D	132%	449%			
	Saltmarsh pilot area	n/a	TPC	0.667%	0.0%			
Middle Waterway Tideflat Habitat	Riparian	Tree	TPC	5.7%	8.1%			
		Shrub	TPC	6.9%	8.3%			
		Ground Cover	TPC	32%	51.3%			
		Total	TPC	35.7%	66.0%			
	Brackish marsh	n/a	AWPC	15.14%	34.71%			
			PPMV	80%	96%			
			D	6947%	10336%			
Puyallup River Side Channel	Riparian	Tree	TPC	2.0%	4.4%			
		Shrub	TPC	6.3%	13.8%			
		Ground Cover	TPC	2.7%	8.4%			
		Total	TPC	8.5%	24.3%			
Hylebos Creek Mitigation Site	Forested Wetland	Tree and Shrub	PS	97%	~95%			
			TPC	~30%	~70%			
		Total	TPC	65.7%	78.1%			

TPC – Total Percent Cover
PS – Percent Survival
AWPC – Area-Weighted Percent Cover
PPMV – Percent of Potential Marsh with Some Vegetation
D - Density

Table 6-10
Year 3 Monitoring Activities

	North Beach Habitat	Middle Waterway Tideflat Habitat	Puyallup River Side Channel	Hylebos Creek Mitigation Site	Thea Foss Enhancement Areas
Qualitative Ground Survey	x	x	x	x	x
Photo Documentation	--	--	--	--	--
Quantitative Vegetation Monitoring	--	--	--	--	n/a
Invertebrate Monitoring	n/a	n/a	x	x	n/a
Elevation Monitoring	x	x	x	x	n/a
Water Surface Elevation Sampling	n/a	n/a	n/a	x	n/a
Brackish Marsh Salinity Monitoring	n/a	--	n/a	n/a	n/a
Juvenile Salmonid Monitoring	x	x	x	x	n/a

x activity required
-- activity not required this monitoring year
n/a activity not required at this location

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Figure 6-1
North Beach Habitat

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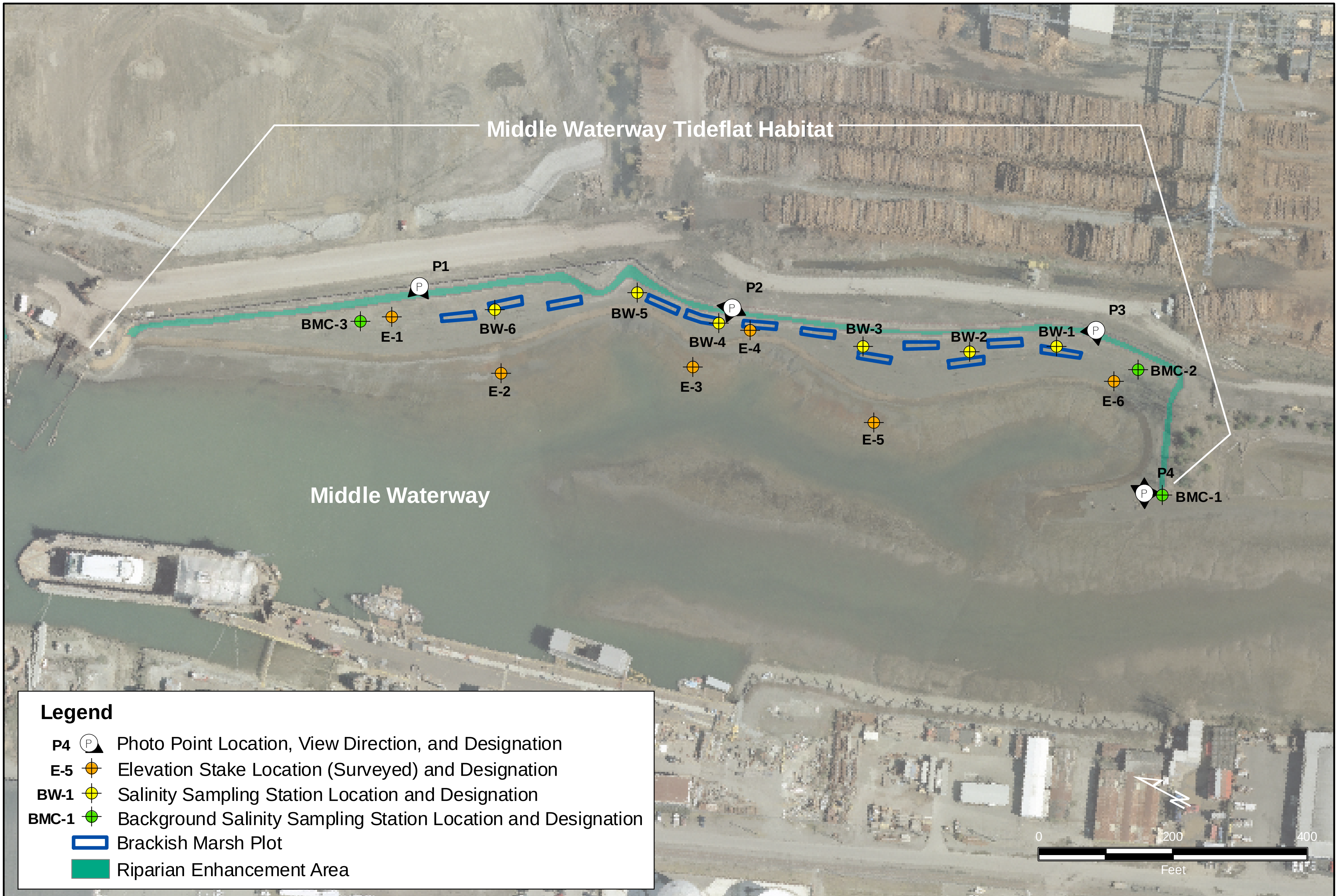
Date: 2/5/2008



Thea Foss and Wheeler-Osgood Waterways
Annual OMMP Report

Figure 6-2
Middle Waterway Tideflat Habitat

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Date: 2/5/2008

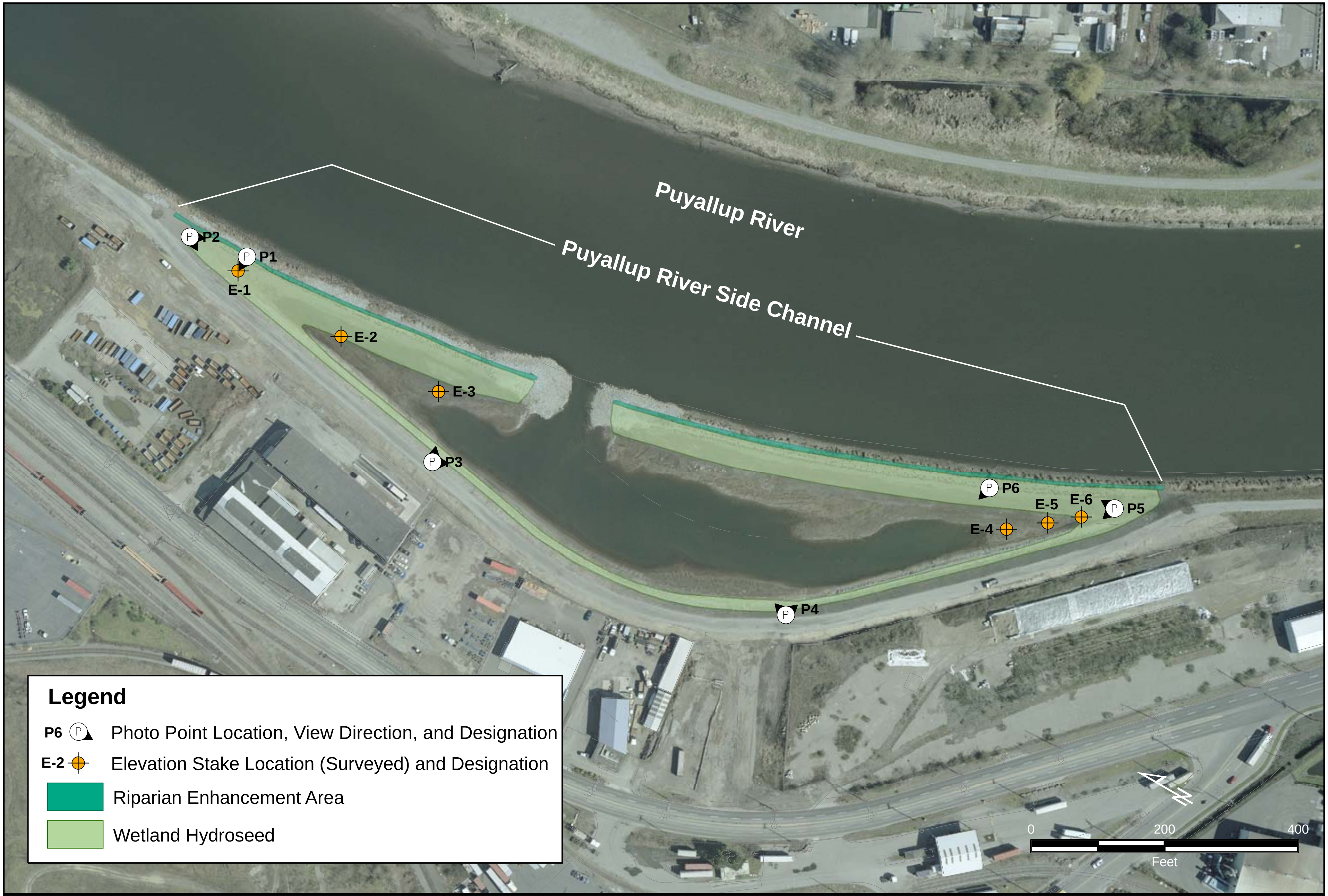

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Figure 6-3
Puyallup River Side Channel

DATE: 2/20/2007 2:56:09 PM
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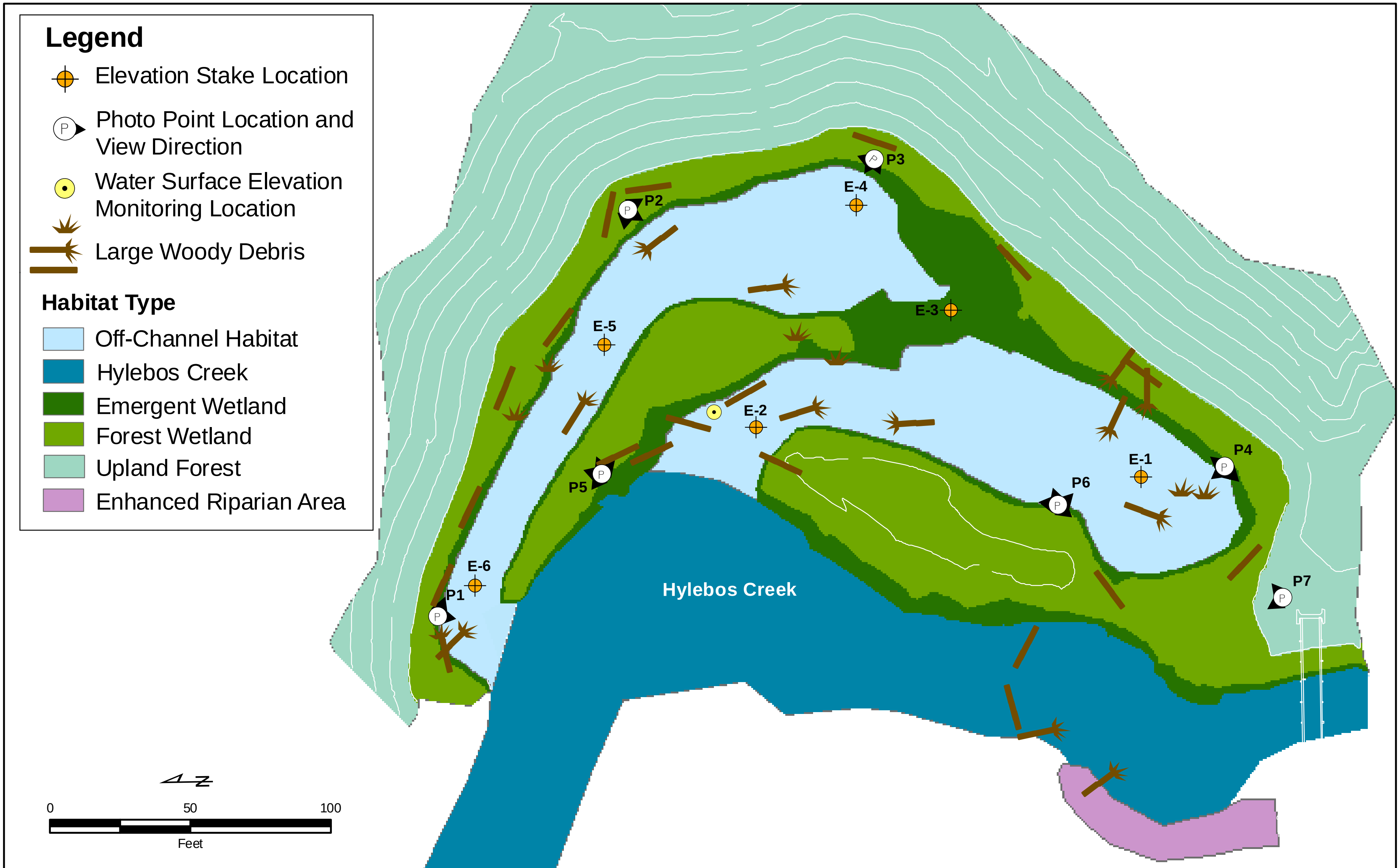

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Figure 6-4
Hylebos Creek Mitigation Site

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Date: 2/7/2008

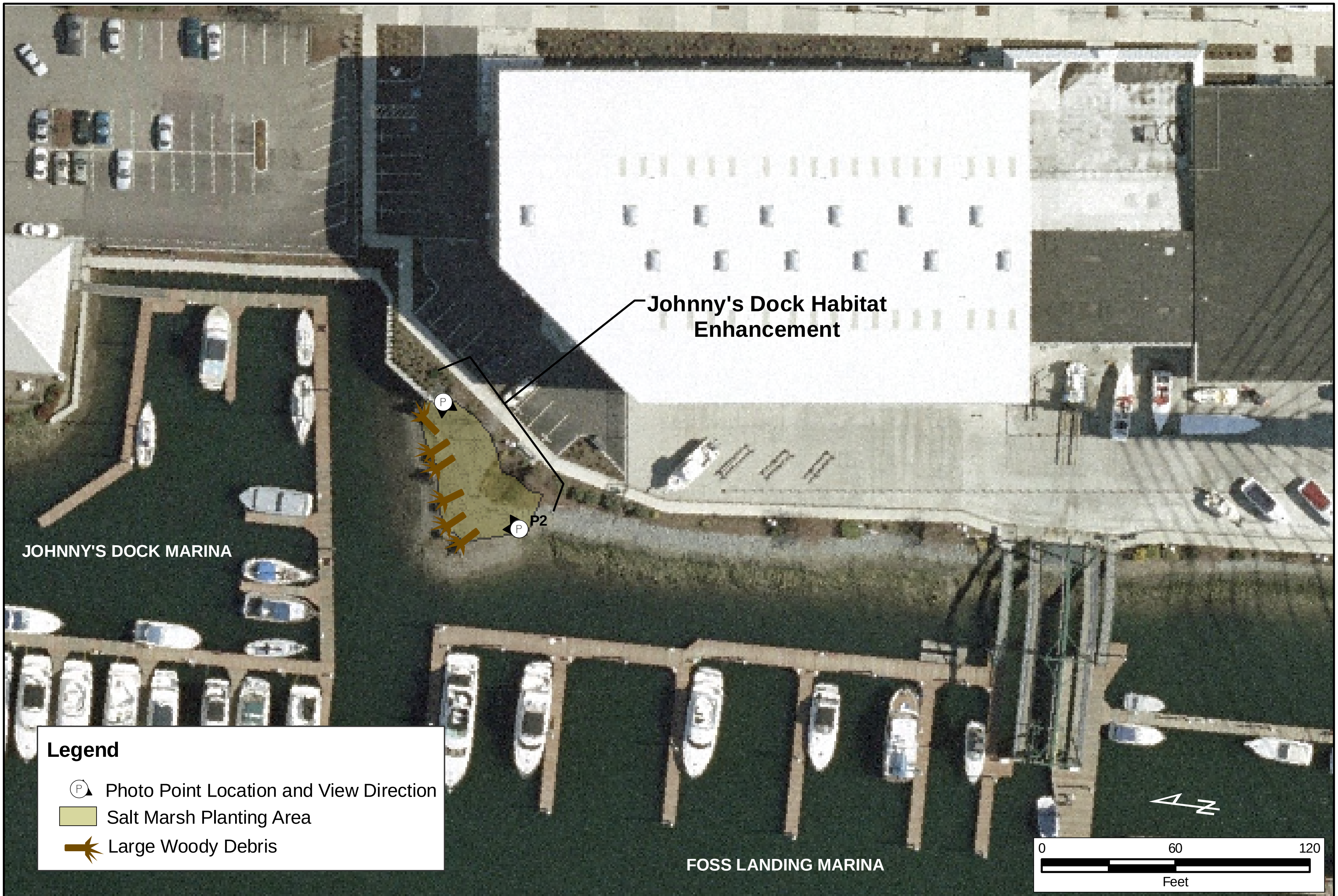

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Figure 6-5 Johnny's Dock Habitat Enhancement

File: F:\projects\COT-Oncall\GIS\2008 Annual OMMP Report\MXD\Figure 6-5 Johnny's Dock Habitat.mxd
Date: 2/7/2008

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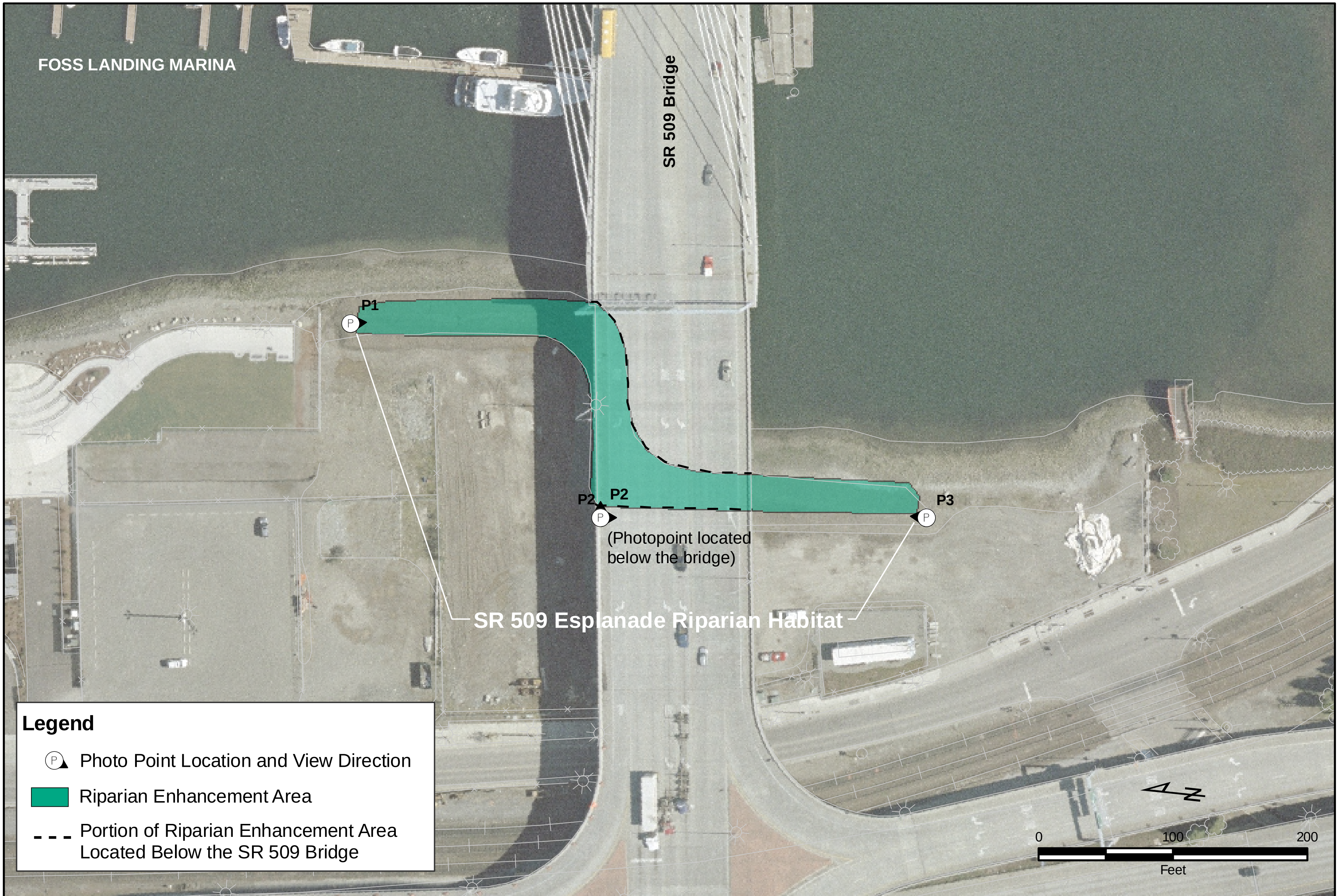
Thea Foss and Wheeler-Osgood Waterways Annual OMMP Report

Figure 6-6
Head of Thea Foss Shoreline Habitat

File: F:\projects\COT-Oncall\GIS\2008 Annual OMMP Report\MXD\Figure 6-6 Head of Thea Foss Shoreline Habitat.mxd
Date: 2/7/2008



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Thea Foss and Wheeler-Osgood Waterways Annual OMMP Report

Figure 6-7
SR 509 Esplanade Riparian Habitat

File: F:\projects\COT-Oncall\GIS\2008 Annual OMMP Report\MXD\Figure 6-7 Esplanade Riparian Habitat.mxd
Date: 2/7/2008

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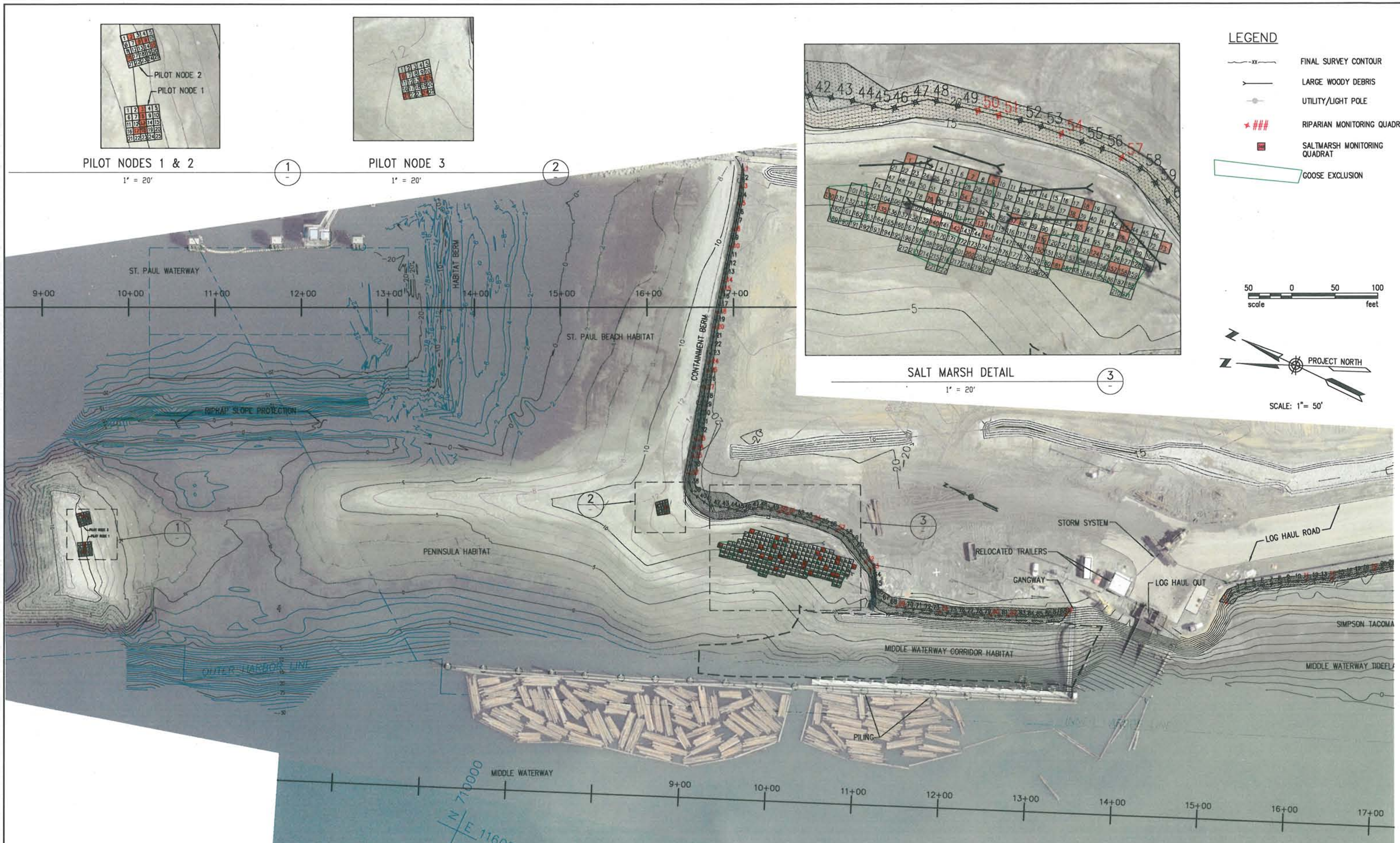
Figure 6-8
Log Step Habitat Enhancement

File: F:\projects\COT-Oncall\GIS\2008 Annual OMMP Report\MXD\Figure 6-8 Log Step Habitat Enhancement.mxd
Date: 2/7/2008



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DRAWN BY:	TAF
DATE:	8/17/07

Thea Foss and Wheeler-Osgood Waterways
Annual OMMP Report

FIGURE 6-9
NORTH BEACH HABITAT
QUANTITATIVE MONITORING LOCATIONS

DRAWN BY: TAF

DATE: 8/17/07

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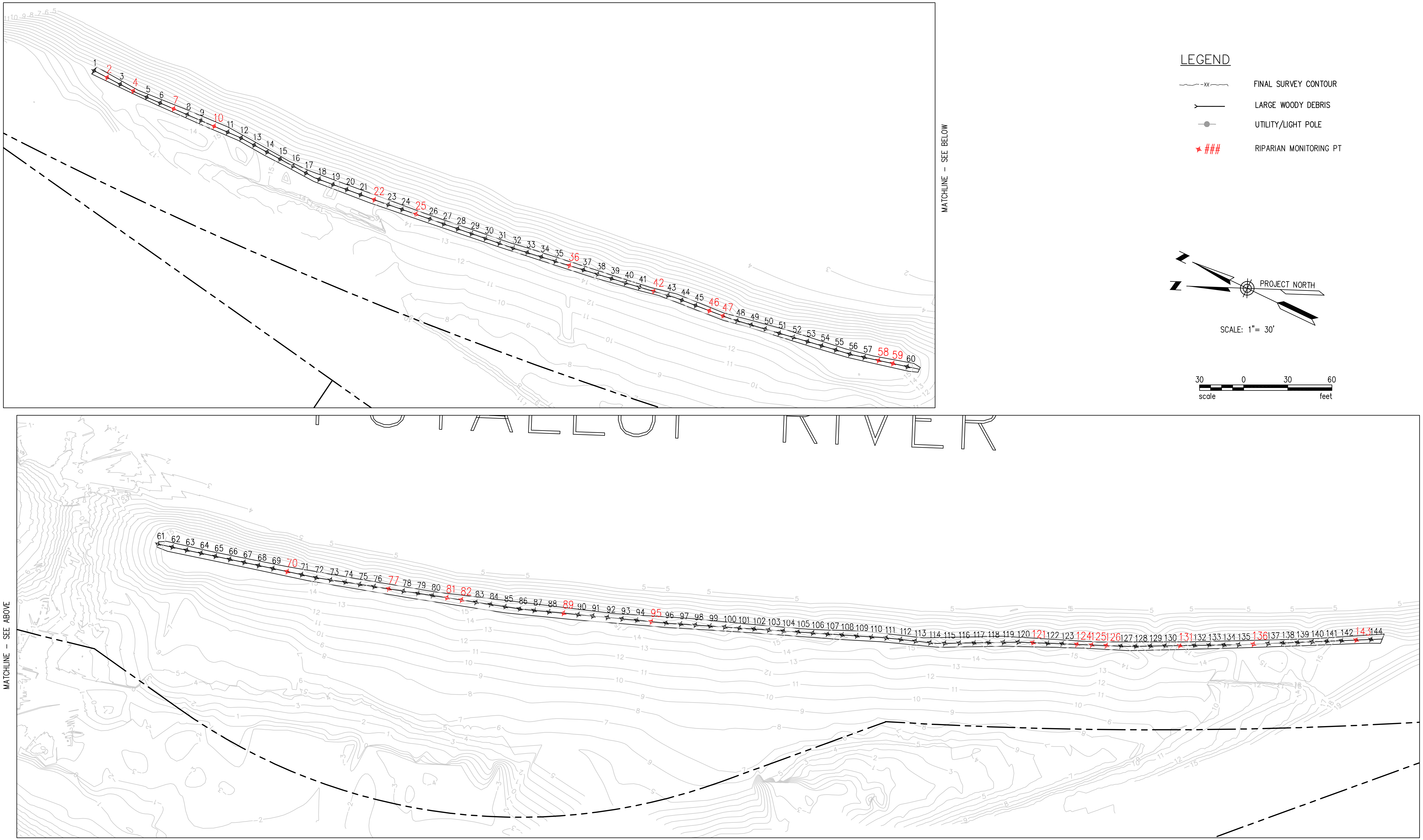
Annual OMMP Report

FIGURE 6-10

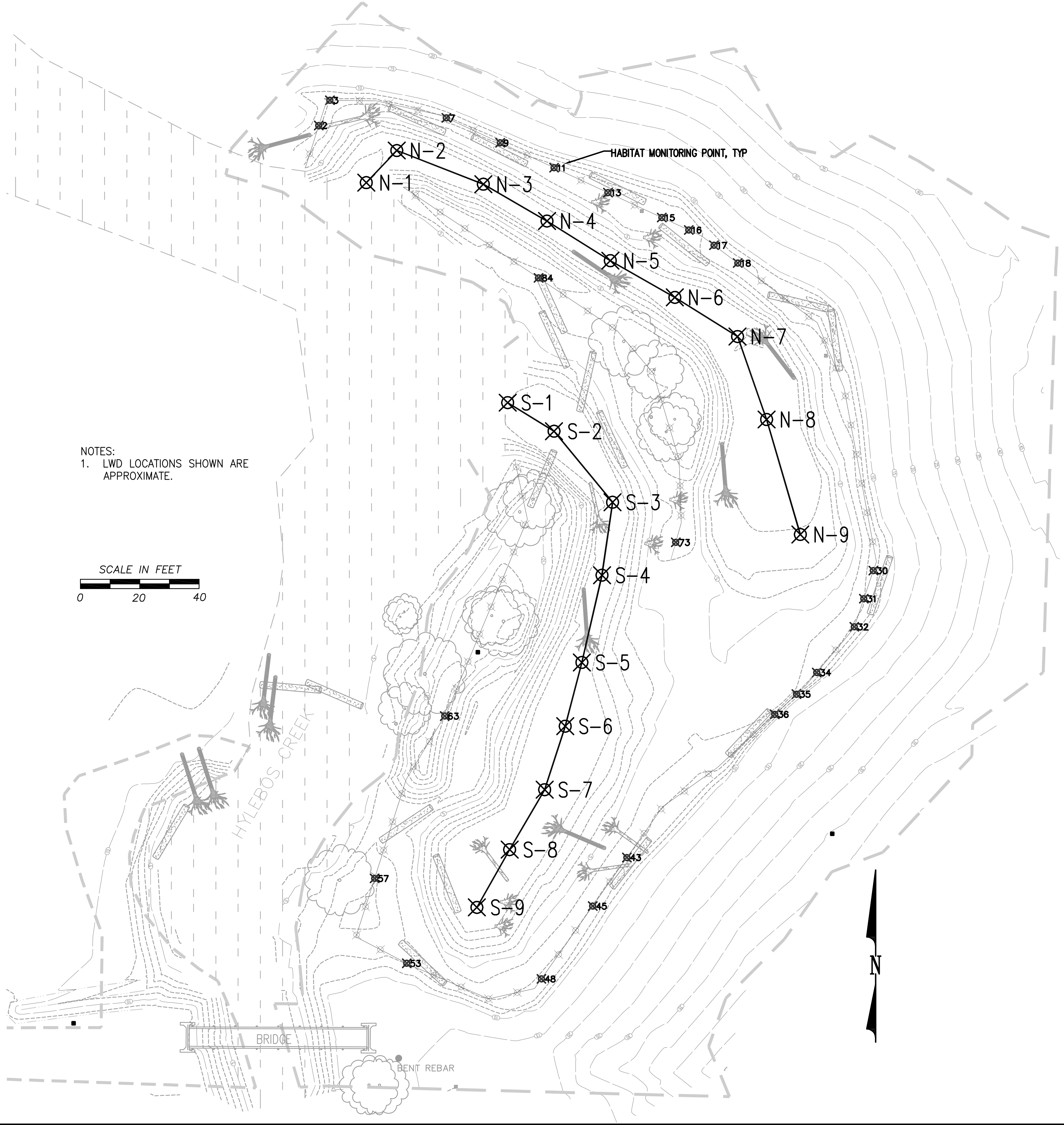
MIDDLE WATERWAY TIDEFLAT HABITAT QUANTITATIVE MONITORING LOCATIONS



DRAWN BY: TAF
DATE: 8/17/07

Thea Foss and Wheeler-Osgood Waterways
Annual OMMP Report

FIGURE 6-11
PUYALLUP RIVER SIDE CHANNEL
QUANTITATIVE MONITORING LOCATIONS



SOUTH LOBE CENTERLINE

POINT	NORTHING	EASTING	YR 2 ELEV.
S-1	705914.01	1181063.36	1.23
S-2 (E-2)	705904.40	1181079.00	1.44
S-3	705880.46	1181098.72	1.23
S-4	705855.87	1181095.14	1.36
S-5	705826.47	1181088.39	1.26
S-6	705804.98	1181082.76	0.71
S-7	705783.57	1181075.84	1.18
S-8	705763.37	1181064.01	1.04
S-9 (E-1)	705743.90	1181053.00	1.35

NORTH LOBE CENTERLINE

POINT	NORTHING	EASTING	YR 2 ELEV.
N-1	705988.18	1181015.70	1.43
N-2 (E-6)	705999.00	1181026.00	1.68
N-3	705987.66	1181055.16	2.07
N-4	705975.21	1181076.61	1.91
N-5	705961.87	1181097.96	2.05
N-6	705949.49	1181119.73	1.93
N-7	705936.30	1181140.86	1.90
N-8	705908.34	1181150.64	1.97
N-9 (E-4)	705869.60	1181162.00	2.69

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DRAWN BY: TAF
DATE: 8/19/08

THEA FOSS AND WHEELER-OSGOOD WATERWAYS

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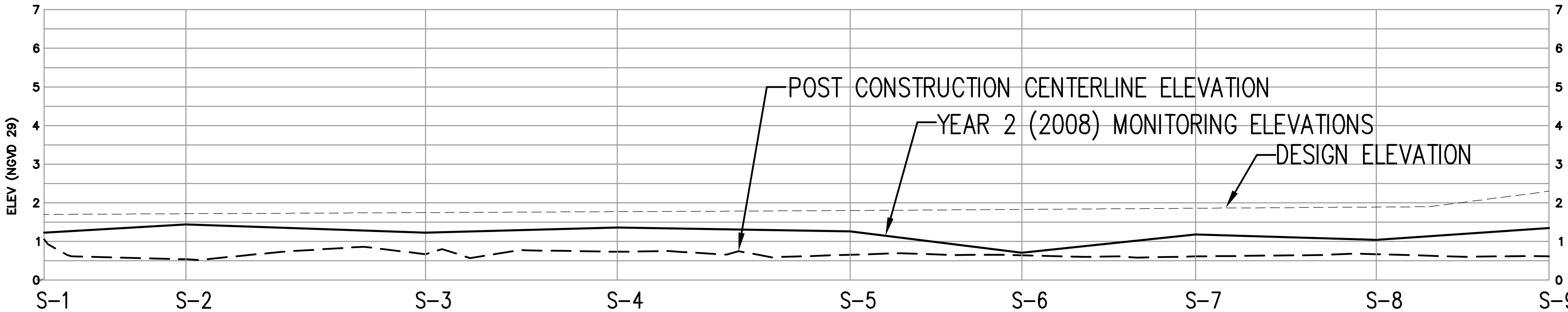
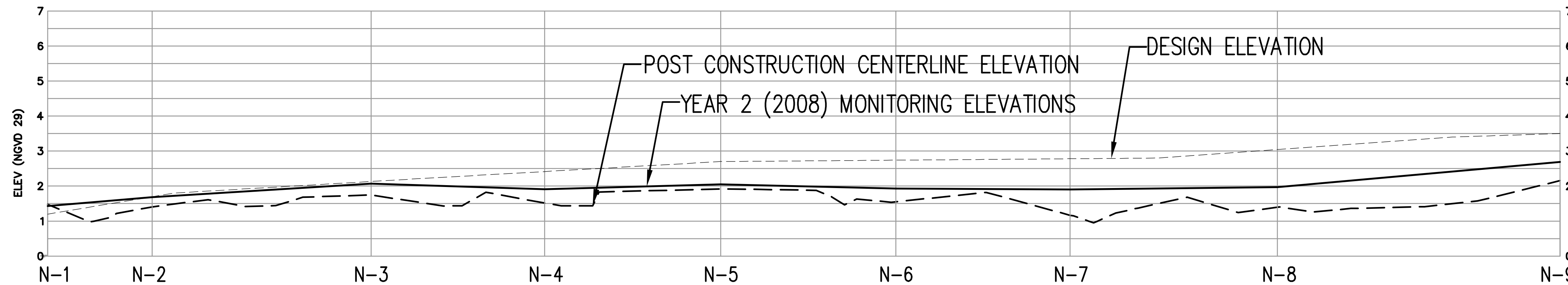
FIGURE 6-12
HYLEBOS CREEK HABITAT
QUANTITATIVE MONITORING LOCATIONS



SOUTH LOBE TRANSECT

1" = 20'h ; 1" = 2'v



NORTH LOBE TRANSECT

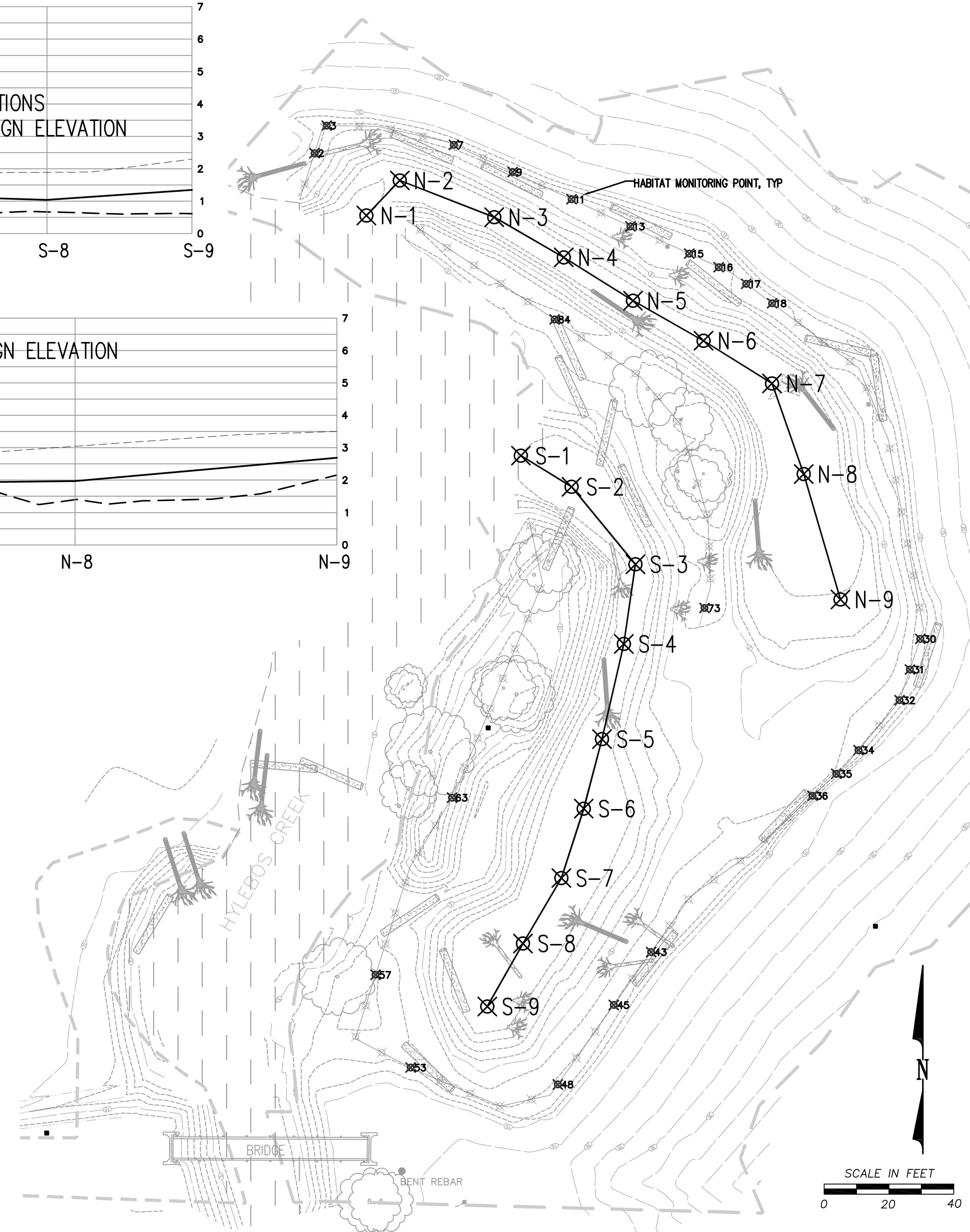
1" = 20'h ; 1" = 2'v

SOUTH LOBE BOTTOM

POINT	NORTHING	EASTING	DESIGN EL.	POST CONST EL.	YR 0 ELEV.	YR 1 ELEV.	YR 2 ELEV.
S-1	705914.01	1181063.36	1.7	1.05	–	1.30	1.23
S-2 (E-2)	705904.40	1181079.00	1.7	0.53	1.42	1.53	1.44
S-3	705880.46	1181098.72	1.7	0.67	–	1.32	1.23
S-4	705855.87	1181095.14	1.7	0.73	–	1.39	1.36
S-5	705826.47	1181088.39	1.8	0.66	–	1.27	1.26
S-6	705804.98	1181082.76	1.8	0.64	–	0.66	0.71
S-7	705783.57	1181075.84	1.8	0.61	–	1.22	1.18
S-8	705763.37	1181064.01	1.9	0.67	–	1.09	1.04
S-9 (E-1)	705743.90	1181053.00	2.3	0.62	1.41	1.33	1.35

NORTH LOBE BOTTOM

POINT	NORTHING	EASTING	DESIGN EL.	POST CONST EL.	YR 0 ELEV.	YR 1 ELEV.	YR 2 ELEV.
N-1	705988.18	1181015.70	1.2	1.48	–	1.44	1.43
N-2 (E-6)	705999.00	1181026.00	1.5	1.41	1.73	1.61	1.68
N-3	705987.66	1181055.16	2.1	1.74	–	2.08	2.07
N-4	705975.21	1181076.61	2.4	1.52	–	1.93	1.91
N-5	705961.87	1181097.96	2.7	1.92	–	2.00	2.05
N-6	705949.49	1181119.73	2.7	1.55	–	2.00	1.93
N-7	705936.30	1181140.86	2.8	1.17	–	1.95	1.90
N-8	705908.34	1181150.64	3.0	1.40	–	2.06	1.97
N-9 (E-4)	705869.60	1181162.00	3.5	2.15	2.76	2.64	2.69



Tacoma

DRAWN BY: TAF

DATE: 3/02/09

Thea Foss and Wheeler Osgood Waterways
Annual OMMP Report

Figure 6-13
Hylebos Creek Centerline Transect Elevation Comparison

7.0 ADDITIONAL PROJECT RELATED ACTIVITIES

7.1 Introduction

Numerous other activities were identified during the development of the Operations, Maintenance, and Monitoring Plan (OMMP) for the Thea Foss and Wheeler-Osgood Waterways Remediation Project (City of Tacoma 2006) that have some affect on the project. Therefore, status updates on these various activities will be provided for informational purposes in this section of the annual reports.

7.2 Institutional Controls

In September 2006, the City of Tacoma (City) received the U.S. Environmental Protection Agency's (EPA) approval of an Institutional Controls Plan for the project. The objective of the plan is to ensure that contamination capped in the Thea Foss and Wheeler-Osgood Waterways and in the Confined Disposal Facility within the St. Paul Waterway, and contamination which is otherwise left in place in the Thea Foss and Wheeler-Osgood Waterways (i.e., in natural recovery areas), remains contained and/or undisturbed for the purpose of:

- Reducing the potential exposure of marine organisms to contaminated sediments disposed of and confined in aquatic disposal sites or confined by capping; and
- Reducing the potential exposure of marine organisms to contaminated sediments left in place in the Thea Foss and Wheeler-Osgood Waterways.

Implementation of plan elements that occurred during 2006 and 2007 were reported in the Year 0 Baseline Annual Operations, Maintenance, and Monitoring Report, and the Year 1 Monitoring Annual Operations, Maintenance, and Monitoring Report, respectively. The following provides a status update on activities related to plan implementation which occurred during Year 2:

- The City previously provided a copy of the Institutional Controls Plan to the Washington State Department of Transportation with the intent to assure that maintenance of the 11th Street Bridge and the SR 509 Bridge is undertaken in a manner that protects the remedial actions within the waterways. The 11th Street Bridge is currently closed to vehicular traffic and the State and City are in discussions about the future of the bridge. Any maintenance activities performed by the City on the bridge will be coordinated with EPA to ensure that the remediated areas are not compromised.
- Project representatives continued to work with the City's Building and Land Use Services (BLUS) division to implement procedures to ensure that future development in and adjacent to the Foss Project areas where remedial actions and habitat mitigation work have been completed, are undertaken in a manner that protects the remedy and the habitat. Specifically, the following actions were undertaken:
    - An informational handout on the cleanup was developed and is given to persons seeking a building, shoreline, and/or wetlands permit in affected areas;
    - Training sessions were conducted with applicable permitting and inspection staff to provide information and to help ensure that projects being proposed in affected areas are "flagged" by BLUS for additional review; and

  - Project representatives work with BLUS and EPA on a case by case basis to review development proposals as they are submitted.

- The City submitted a request to update navigational charts to the National Oceanic and Atmospheric Administration (NOAA). On February 19, 2008, the City received a copy of an electronic screen shot of the modified chart for the area off the peninsula between the St. Paul and Middle Waterways. It showed the location of new navigational markers off of the peninsula, but did not show that the St. Paul Waterway had been filled in. Per communications with NOAA representatives on February 27, 2009, their working drawings show the modified shoreline and they hope to send the updated charts to print in mid-summer 2009.
- The City submitted a request to the United States Coast Guard (USCG) to establish a regulated navigation area (RNA) in the Thea Foss Waterway prohibiting anchorage and other activities that could disturb the cap. The USCG is currently processing this request. The request was published for public comment in August 2008, and comments were received until November 18, 2008. The City requested an update on the status of the request on February 20, 2009, and is awaiting response.
- The City is working with the USCG on the potential placement of additional signage in the waterway, but understands that the signage cannot be placed until the RNA is finalized.

Several development plans are currently under construction or consideration and are being evaluated relative to their potential impact on the cleanup areas. The City expects to review additional design submittals as they are developed. These proposals include the following:

- **21st Street Park** – The City and FWDA are implementing a park development on the west side of the head of the Thea Foss Waterway. Foss project staff has met with the development team to discuss the SR 509 Esplanade Riparian Habitat Area and the need to coordinate any impacts of development on that area. Construction of the site began on March 2, 2009, and is expected to be completed by summer 2009. The Foss project team will continue coordination during construction and during the longer term operations and maintenance period to ensure the continued integrity of the habitat area.

  The non-motorized float that had been contemplated for this area has been moved northward to a location within the Dock Street Marina. When plans for that facility are finalized, the City will provide copies for EPA review and approval.

- **Waterway Park** – The FWDA is also planning a park development on the east side of the head of the Thea Foss Waterway. The initial phase of the project is currently moving forward, and that is the installation of a kayak float and associated ramp and landing. This float will attach to the pilings which were installed by the Utilities for this project during their remedial construction activities. Construction of the ramp and float is expected to be completed in spring 2009.

  Foss project staff has also met with the FWDA to discuss the Head of the Thea Foss Shoreline Habitat Area and the need to coordinate subsequent phases of park development with that area. Plans of the habitat area have been provided to them. In addition, staff has advised the FWDA to continue to work with the Utilities and EPA as the plans for this development are finalized.

- **Simpson Cogeneration Facility** – The City was notified that Simpson is planning the development of a cogeneration facility on top of the CDF. Initial discussions have been held, and the City has provided figures showing the locations of existing monitoring wells for their consideration during design. In addition, the Foss Project team provided comments on the Shoreline Substantial Development Permit and the Mitigated Determination on Non-Significance regarding the need to ensure that eventual development is performed in a manner that does not compromise the integrity of the CDF and also requested an evaluation of drainage systems at the facility to ensure that the confined sediments and the potential for release of contaminants from the facility are not impacted by development. These comments were incorporated into the decision documents. The Foss Project team will continue coordination with Simpson through the design and construction phases of the project.

7.3 Stormwater Source Control

The Thea Foss and Wheeler-Osgood Waterways are located in a highly urbanized basin with residential, commercial and industrial land use and transportation corridors. Ongoing sources of chemicals are conveyed to the waterway via stormwater (both municipal and private industrial), aerial deposition, marinas, and groundwater seeps. The chemicals identified as having the greatest potential to affect sediment quality following the cleanup action include polycyclic aromatic hydrocarbons (PAHs) and phthalates.

The City has had a stormwater source control program in place for over 20 years. Under the Unilateral Administrative Order dated September 30, 2002, and the Consent Decree with EPA dated May 9, 2003, the City is implementing a stormwater monitoring and source control program for the municipal storm drains entering the Thea Foss and Wheeler-Osgood Waterways to help provide long-term protection of sediment quality in the waterways. The City's program is called the Thea Foss Post-Remediation Source Control Strategy. The Strategy was approved by EPA and includes the City's existing programs, studies and a decision matrix to identify the need for additional source controls.

Long-term outfall monitoring has been completed under this program for seven years. Stormwater concentrations have remained relatively stable over the past seven years at most of the outfalls. The City has directed numerous source control efforts in this watershed, aimed toward control of potential sources. Most of the COCs have undergone significant reductions in concentrations and loads compared to past monitoring efforts in the late 1980s through mid-1990s. The cumulative effect of federal, state and municipal source control efforts likely contributed toward the observed improvements in stormwater quality over that time period.

The improvements in stormwater quality since the mid-1990s indicate that source control efforts in the Thea Foss Watershed have been effective in the reduction of chemical concentrations in stormwater. Source control activities currently being implemented by the City include business inspections, response to spills and illicit discharges, street cleaning and catch basin cleaning operations, pollutant source tracing, and stormwater control systems on new and redeveloped sites. All these activities are implemented through Tacoma's Stormwater Management Program, which is divided into 10 components as required in the Phase I NPDES Municipal Stormwater Permit Section S5.

It addition to the City's stormwater source control efforts, control of other sources is also important. Many of these are outside the City's jurisdiction and must be coordinated by other federal, state, and local authorities. Reductions of air and marina pollution are expected through Ecology's Air Program and through the Marina Source Control Program which was developed specifically for the Thea Foss Waterway. Reductions in air pollution will decrease not only the direct loads from atmospheric fallout to the surface of the waterway, but will also decrease the pollutant loads washed off upland surfaces and entrained in stormwater runoff. The marina improvements implemented by the Foss Waterway Marina, Foss Landing Marina, Johnny's Dock Marina, and Delin Docks, including installation of facility improvements, will undoubtedly translate into reduced source loads for marinas. Finally, upland and in-water remedial actions implemented by Ecology and the Utilities in 2003 and 2004 were directed at controlling tar seeps in the head of the waterway. The effectiveness of these combined actions will be verified through long-term monitoring. During the post-construction period and implementation of the OMMP, computer model predictions of post-construction sediment quality will be updated using the actual sediment quality data.

With continued monitoring and source control actions, further improvements in stormwater quality may be realized. Source control activities implemented by the City between 2003 and 2008 include the following:

- Continued implementation of the Surface Water Management Manual through Ordinance 12.08 for development and redevelopment.
- Removed the coal tar seepage from the DA1 line in the Outfall 237A basin.
- Outfall 245 cleanup efforts: removed source(s) of the "oil-snakes" to storm drain line; replaced the storm drain with a sealed line to remove the "oil-snakes" conduit; remediated suspected UST; and completed Phase 1 cleanup efforts of former Northern Pacific Rail yard oil pipeline on "D" Street
- Continued business inspections/public education/complaints and spill responses.
- Monitored construction on SR-16 and I-5. As construction is completed on these highways, stormwater runoff from existing and new surfaces will be treated before it is discharged into the storm drains. Construction is expected to be completed in 2010.
- Monitoring construction plans and subsequent activities for the Sounder commuter rail southern route from Freighthouse Square/Tacoma Dome Station.
- Removal of USTs/LUSTs as part of ongoing redevelopment throughout the Thea Foss Watershed.
- Monitoring two groundwater cleanup sites in Basin 230.
- Identified capital improvement projects for Basins 230 and 235 storm line replacement and Basin 237A stormwater treatment retrofit.
- TV'ed and cleaned the storm lines in Basins 254, 230, 235, 243, and portions of 237A.
- Located and repaired collapsed storm and sanitary lines in Basin 235.
- GIS mapped SR 509 and railroad yard storm drain lines to better identify potential contaminant sources from this site.
- Located and removed a possible source(s) of mercury in Basin 230, DEHPs in Basin 235, PAHs in Basin 237A, and PAHs in Basin 237B

- Located and removed a source of repeated petroleum spills in Basins 245, 248 and 249.
- Completed a comprehensive problem statement and draft recommendations from the Sediments Phthalate Work Group.
- Completed final Report for the StormFilter unit evaluation at the WSDOT Stormwater Technology Study.

The following activities are currently underway under the program:

Stormwater Monitoring Program – The City continues to evaluate potential source(s) of the chemicals of concern in the Thea Foss Basin through monitoring of stormwater, baseflow, and particulate matter in seven outfalls. Results for each outfall are evaluated relative to other outfalls to establish the chemicals of concern for each basin. Based on this analysis, the chemicals of concern for each basin are:

- Mercury, phthalates and PCBs/pesticides in Basin 230;
- PAHs in Basin 237A;
- Mercury, PAHs, and phthalates in Basin 235;
- Acenaphthene, mercury and phthalates in Basin 243;
- PAHs in Basin 254; and
- Acenaphthene and phthalates in Basin 245.

Spills, Complaints, and Inspections – City staff responded to 776 spills/complaints in 2008 including conducting investigations as well as providing technical assistance. This included 144 spills/complaints in the Thea Foss Basin. In addition, staff conducted 1,790 business inspections in 2008. Information from various source control field activities are entered into a database. This database continues to expand and includes many data points making it an effective tool for retrieving historical information and examining trends.

Sediment Phthalate Work Group – In 2006, the City, EPA, Ecology, King County/Metro, and Seattle Public Utilities formed a work group to discuss and evaluate phthalates and their affect on sediments. Throughout 2007, the group continued to work together to investigate phthalates, including sources in the environment, source control, toxicity, and potential response actions. On October 2, 2007, the finalized work product was delivered to Jay Manning with the Ecology and all stakeholders. The final work product included all meeting notes and documents as well as recommendations for next steps in assessing the situation. Ecology agreed to take the lead on implementing the recommendations contained in the final work product. See Section 7.4.4 for additional information.

EvTec Stormwater Structural Control Study – The City is continuing to work on the evaluation of possible stormwater treatment options using a test facility located adjacent to the Ship Canal in Seattle. Data collection was completed on the StormFilter Unit and the final report was submitted to the agencies on January 17, 2008. Sampling of the AquaFilter was completed in December 2008. A final report will be prepared in 2009 to evaluate the treatment performance of this treatment system.

Under the Stormwater Source Control Program, the City generates an Annual Stormwater Source Control Report which summarizes the work performed under the program during the previous year as well as a discussion of the City's implementation of the decision matrix to identify the need for additional source controls. The 2008 Stormwater Source Control Report will be submitted to Ecology on March 31, 2009, as Attachment C of the City of Tacoma NPDES Municipal Stormwater Permit 2008 Annual Report. In addition, the August 2001-August 2008 Thea Foss Stormwater Monitoring Report is Attachment I to the 2008 Stormwater Source Control Report.

Source control evaluations were completed during 2008 for the seven major outfalls discharging to the waterways (including Outfalls 237A, 237B, 235, 230, 243, 245, and 254) and the results of those evaluations are included in the 2008 Stormwater Source Control Report. The evaluations include:

- Review ongoing studies, source control investigations, stormwater and stormwater suspended particulate matter (SSPM) data;
- Recommend future source control activities; and
- Evaluate enhanced BMPs and stormwater treatment, if necessary.

The need for additional source controls is driven by the need to protect post-remediation sediment quality in the waterways from urban contaminants conveyed in municipal stormwater. This is evaluated using a "weight of evidence" approach with several lines of investigation, including: long-term outfall monitoring, computer model predictions, and post-construction sediment quality monitoring. Post-construction sediment quality monitoring in the head of the waterway began when a group of private Utilities completed remediation of the southernmost 1,000 feet of the waterway in February 2004. This monitoring is being performed in accordance with the Utilities' Operations, Maintenance, and Monitoring Plan (OMMP) (PacifiCorp 2003).

The results of that monitoring and the subsequent activities are described below in Section 7.4. The remediation of the remainder of the waterway was completed by the City in March 2006. Post-construction monitoring in this area is being performed in accordance with the City's OMMP. Year 2 sediment monitoring was completed in 2008. Based upon the Year 2 monitoring results, there were limited areas where exceedences of the SQOs were identified. Therefore, there were few modifications to the stormwater source control priorities currently in place.

In the 2008 Stormwater Source Control Report, the City is recommending the following source control activities for 2009 and beyond:

Priority 1 tasks:

- Outfall 237A PAHs and mercury in the area draining to FD13 and FD13A. Design and construct the stormwater treatment retrofit in 2009/2010.
- Continue Outfall 245 monitoring for "oil snakes" downstream of the new stormwater line on South 19th Street.
- Outfall 245 East "D" Street and East 19th Street investigation by Ecology and cleanup by BNSF.

- Review SSPM data to confirm removal of Outfall 235 DEHP source.
- Outfall 235 PAHs source tracing between FD6 and FD6A.
- Continue Outfall 235 support of Ecology lead investigations.
- Outfall 243 mercury source tracing investigations.
- Continue to focus monitoring and inspections of Outfall 254 businesses.
- Monitor SuperValu structural BMP installation in Outfalls 245, 248 and 249.
- Review the 2008-2009 SSPM data in summer 2009 to confirm existing conditions in the basin.
- Implement the City's Surface Water Management Manual, as updated September 2008.
- Inspect 2,000-2,500 businesses per year in Tacoma and 400-500 in the Thea Foss watershed and document the inspections using the business inspections database. The goal is to canvass the entire City. In 2008, the City completed approximately 30% of the geographic area.
- Respond to and track all complaints/spills in complaints database.
- Continue Foss Stormwater Monitoring Year 8.
- Continue phthalate source investigations.
- Complete report for the WSDOT/UW Stormwater Technology Study.
- Participate with APWA in working with Ecology to develop a continuing TRC and TAPE program for Stormwater Treatment Technologies.
- Continue participation in the Marina Owners, Tenants and Operators working group formed during 2008.
- Monitor the major construction activities related to the WSDOT, Nalley Valley Viaduct/SR 16 rebuild, and construction of the Sounder Corridor, Freighthouse to South 56^{th}.

Priority 2 tasks:

- Continue Outfall 230 mercury and phthalates source tracing in branch FD3B and FD18, as needed based on 2008 sediment trap results.
- Continue Outfall 230 PCBs source tracing in branch FD3A and FD16, as needed.
- Continue Outfall 230 mercury source tracing in branch FD3A and FD18, as needed.
- Continue Outfall 230 PAHs and phthalates source tracing in Branch FD18, if needed.
- Outfall 237A source tracing for mercury and PCBs in the area draining to FD2A.
- Outfalls 245 and 248 DEHP investigation with Ecology.
- Follow-up business inspections in Basins 245, 248 and 249 (phthalates and PAHs.)
- Outfall 237A source tracing for PAHs in the area draining to FD10.
- Continue Outfall 254 PAH source tracing including:
    - Focused inspections;

  - Monitoring construction of new and expanding businesses; and
  - Ongoing street vacuum sweeping.

Priority 3 tasks:

- Outfall 237A source tracing for phthalates and PCBs in the area draining to FD10C.
- Outfall 235 mercury and phthalates source tracing using upline sediment traps, as needed.
- Outfall 243 phthalate and PCBs source tracing investigations.
- Continue Outfall 230 phthalate source tracing in branch FD3A and FD3B, as needed.
- Outfall 237A source tracing for mercury in the area draining to FD10.
- Outfall 237B source tracing for PCBs in the area draining to FD35 and FD34, as needed.
- Outfall 237B source tracing for mercury in the area draining to FD33, FD34 and FD38, as needed.
- Outfall 237B source tracing for PAHs in the area draining to FD31 and FD35.
- Outfall 245 and 243 – investigation of source of acenaphthene in baseflow.

Priority 1 tasks will be initiated in spring 2009, followed by Priority 2 and then Priority 3. Completion of each task is dependent on what is found during the preceding steps in the investigations, and therefore specific schedules cannot be set. Updates, schedules and tasks will be reported in the next Annual Source Control Report.

Conclusion – The completion of the City's sediment remediation project in 2006, coupled with the completion of the Utilities remediation project in 2004, provide a baseline in sediment quality for use in gauging the success of source control efforts for stormwater and other sources. The City continues to pursue control of sources to stormwater. In addition, the City continues to evaluate enhanced BMPs and their effectiveness on reducing COC loads to the waterway. As additional sediment sampling results become available, the areas and needs for further source control measures will be identified.

7.4 Recontamination in the Head of the Thea Foss Waterway

7.4.1 Introduction

Sediment sampling and analysis was performed in the Head of the Thea Foss Waterway by the Utilities, in coordination with the City as part of the Head of the Thea Foss Waterway Remediation Project, Year 4 (2008) Operations, Maintenance, and Monitoring Plan (OMMP) activities. Year 4 sediment sampling included the following:

- Collection and analysis of sediment samples from the compliance interval (0 to 10 cm) from seven sampling locations (i.e., WC-10 through WC-12, S-15, S-17, S-19, and S-24) in the area where additional cap material was placed to address recontamination caused by dredge residuals; and

- Collection and analysis of sediment samples from the compliance interval from 11 sampling locations (i.e., WC-01 through WC-09, WC-13, and WC-14) in the southern portion of the Head of the Thea Foss Waterway (i.e., below and south of the SR 509 bridge and south of the additional cap material placement area) where bis(2-ethylhexyl)phthalate (DEHP) was previously detected at concentrations exceeding the SQO.

The results of the Year 4 sediment sampling within the Head of the Thea Foss Waterway were presented in a technical memorandum submitted to EPA on August 6, 2008. The memorandum included field sampling logs and photographs for each sample that was collected. A copy of the technical memorandum is provided in Appendix G as Attachment G-1. The following sections summarize the field activities and laboratory analyses, analytical results, and the recommended next steps for the Head of the Thea Foss Waterway based on the Year 4 supplemental sampling and results.

7.4.2 Field Sampling Activities and Laboratory Analyses

Year 4 OMMP sampling activities within the Head of the Thea Foss Waterway were conducted on May 6-7, 2008. Sediment samples were collected from a total of 18 sampling locations as shown in Figure 7-1. Field personnel for both the City and the Utilities were present during the sampling event. The sediment samples were collected using a Van Veen grab sampler.

The grab sampler was inserted into the sediment column and brought to the surface for sample processing. The sediment sample was visually classified and the thickness of surface silt and total penetration measured. The measured silt thicknesses are presented in Table 7-1.

The 0 to 10 cm sediment interval was placed in a decontaminated stainless steel bowl and homogenized until the sediment was uniform in color and texture. Appropriate sediment sampling containers were filled with the homogenized sediment, the sample labels were completely filled out, and the containers were stored on ice. On May 7, 2008, at the completion of sampling, the Utilities' representative submitted all of the samples under chain-of-custody to Analytical Resources Incorporated (ARI) of Tukwila, Washington for analysis.

All compliance interval (0 to 10 cm) samples collected from the 18 locations within the Head of the Thea Foss Waterway were submitted for the following analyses:

- Total Organic Carbon (TOC) (PSEP);
- Total Solids (USEPA Method 160.3);
- Grain Size (PSEP);
- Semi-Volatile Organic Compounds (SVOCs) (USEPA Method 8270);
- Metals (i.e., lead, zinc, and mercury) (USEPA Method 6010B and 7471A);
- DDT (USEPA Method 8081); and
- Polychlorinated Biphenyls (PCBs) (USEPA Method 8082).

7.4.3 Analytical Results

The detected concentrations of most chemicals were substantially below the SQOs in samples collected from the compliance interval during Year 4 within the Head of the Thea Foss Waterway (Table 7-1). Only DEHP and individual high molecular weight polycyclic aromatic hydrocarbons (HPAHs) were detected at concentrations greater than the SQO at more than one sample station. Total HPAHs only exceeded the SQO at one sample station, WC-02, and mercury only exceeded the SQO at one sample station, WC-11.

DEHP and mercury were the only analytes that exceeded the SQO in samples collected from the seven locations within the additional cap material placement area (i.e., WC-10 through WC-12, S-15, S-17, S-19, and S-24) (Table 7-1 and Figure 7-2). DEHP was detected at concentrations greater than the SQO at five of the seven compliance sample locations in this area, and mercury was present at concentrations over the SQO at one of the seven locations. The detected concentrations of DEHP in samples from the additional cap placement area ranged from below the SQO, 540 ug/kg at WC-10, to greater than the SQO at 3,500 ug/kg at WC-11. The detected concentrations of mercury in this area ranged from below the SQO at 0.06 mg/kg at S-15 to greater than the SQO at 1.65 mg/kg at WC-11. The detected concentrations of all other chemicals were below the SQOs in samples collected from the additional cap material placement area.

DEHP was detected at concentrations greater than the SQO in 10 of the 11 compliance samples collected from locations within the southern portion of the Head of the Thea Foss Waterway (i.e., WC-01, WC-02, WC-04 through WC-09, WC-13, and WC-14) (Table 7-1 and Figure 7-2). The highest DEHP concentration detected in Year 4 (i.e., 8,000 ug/kg) was detected at station WC-02, consistent with previous monitoring events. The highest DEHP concentrations in Year 2 and Year 3 of 7,700 ug/kg and 4,900 ug/kg, respectively, were also detected at station WC-02. DEHP was detected at one location within the southern portion of the head of the waterway below the SQO at a concentration of 1,200 ug/kg at WC-03.

Seven individual PAHs including phenanthrene, benzo(a)pyrene, benzo(g,h,i)perlyene, dibenzo(a,h)anthracene, fluoranthene, indeno(1,2,3-cd)pyrene, and pyrene, along with total HPAHs, were detected at concentrations greater than the SQOs in the sample collected from station WC-02 (Table 7-1). Up to two individual HPAHs were also detected at concentrations greater than the SQOs at stations WC-01 and WC-07. Fluoranthene exceeded the SQO at station WC-01 while benzo(g,h,i)perlyene, and indeno(1,2,3-cd)pyrene exceeded the SQO at station WC-07 in Year 4 . In Year 3 individual PAHs were detected at concentrations that exceeded the SQOs at only one station, WC-02. The four PAHs that exceeded the SQOs at WC-02 in Year 3 were phenanthrene, benzo(a)pyrene, benzofluoranthenes (total), and fluoranthene. In Year 2, two HPAHs exceeded the SQOs at station WC-02 and one exceeded the SQO at station WC-05. The detected concentrations of all other PAHs and chemicals at stations within the southern portion of the Head of the Thea Foss Waterway were generally at or below one half of the SQOs.

Phenol was not detected at a concentration greater than the SQO in samples collected in Year 4. Phenol was only detected at two stations in Year 4, WC-01 and WC-13. The detected concentrations of phenol were well below the SQO (i.e., 420 ug/kg), at 22 ug/kg and 75 ug/kg. Phenol was detected at a concentration greater than the SQO in Year 2 at WC-01, but has not been detected at a concentration greater than the SQO in Year 3 or Year 4.

DEHP concentrations are continuing to show variability at this time. The Year 2 average concentration throughout the head of the waterway was 2,480 ug/kg, the Year 3 average concentration was 1,920 ug/kg, and the Year 4 average concentration was 2,930 ug/kg (Figure 7-2). There has been a decrease in the DEHP concentration at 2 of 18 sample stations from Year 3 to Year 4, while at 16 of the 18 sample stations the DEHP concentrations have increased. At 4 of these 16 locations, the Year 4 concentrations are lower than Year 2 concentrations.

PAH concentrations are also continuing to show variability at this time. LPAH concentrations in Year 4 have decreased in 9 and 7 of the 18 stations respectively, when compared to Year 2 and Year 3. HPAH concentrations in Year 4 have decreased in 7 and 2 of 18 stations, respectively when compared to Year 2 and Year 3. Consistent with Year 3, the detected total LPAH and HPAH concentrations are less than the SQOs throughout the Head of the Thea Foss Waterway except at station WC-02 in Year 4 where total HPAH concentrations were greater than the SQO (by a factor of 1.2 times the SQO).

The overall average concentrations for all parameters are generally higher for Year 4 relative to Year 3 in the Head of the Thea Foss Waterway. However, approximately 40 percent of the detected average concentrations in Year 4 are lower than Year 2 average concentrations. Table 7-2 presents a comparison of the average detected chemical concentrations between Year 4, Year 3, and Year 2 as well as the percent change in the averages from Year 3 and Year 2 to Year 4.

In general, the average detected concentrations for LPAHs and PCBs in Year 4 increased from Year 3, but remain lower than average concentrations from Year 2. The average detected concentrations of LPAHs and PCBs in Year 4 are substantially less than one-half the SQOs.

The average detected concentrations for HPAHs and phthalates generally increased in Year 4 relative to Year 3 and Year 2. However, the average detected concentrations of HPAHs in Year 4 remain at or below one-half the SQOs. Average detected concentrations of phthalates in Year 4 are less than one-quarter the SQOs with the exception of DEHP. The average detected concentration of phenol in Year 4 relative to Year 3 and Year 2 and is substantially below one-quarter the SQO.

The percent decrease in the average detected concentrations for all constituents between Year 2 and Year 4 ranges from 18 percent to approximately 1,240 percent while the percent increase in average detected concentration for the same years ranges from 2 to 61 percent.
The average detected DEHP concentration in the Head of the Thea Foss Waterway has increased from Year 2 and Year 3 by approximately 15 percent and 34 percent, respectively. The average detected DEHP concentration in Year 4 (i.e., 2,930 ug/kg) is 2.3 times the SQO.

Intertidal slope cap samples were collected in Year 2 and Year 4. The detected concentrations of all chemicals, except DEHP, were substantially below the SQOs in slope cap samples collected from the compliance interval during Year 4 (Table 7-3). DEHP concentrations detected in samples SC-01 and SC-02 were below the SQO and decreased from Year 2. DEHP concentrations detected in samples SC-03 and SC-04 exceeded the SQO and increased from Year 2.

7.4.4 Sediment Phthalate Work Group Findings and Recommendations

The reaccumulation of phthalates in the surface sediments at the Head of the Thea Foss Waterway was not unexpected. Due to the ubiquitous nature of this contaminant in the urban environment, it is a common constituent in stormwater. Because of its pervasiveness, and as described in the Year 1 Monitoring Annual Operations, Maintenance, and Monitoring Report, a multi-jurisdictional Sediment Phthalate Work Group was formed in 2006 to discuss and evaluate phthalates and their affect on sediments. The finalized work product from that group was delivered to Jay Manning with the Department of Ecology (Ecology) and other stakeholders in October 2007. Ecology agreed to take the lead on implementing the recommendations contained in the final work product.

A summary of the efforts and findings of the work group is provided in the Year 4 (2008) Head of the Thea Foss Waterway Results memorandum (Attachment G-1). The Work Group determined that because of the ubiquitousness of DEHP in modern society and urban atmospheres, it is not amenable to standard stormwater treatment approaches. They also concluded that it is very difficult to treat stormwater to remove fine particulates effectively because stormwater quality and flow are highly variable. No treatment methodologies have been identified to date which would be able to significantly remove these fine particulates. Even if effective control technologies and the space to implement them existed, the Work Group concluded that phthalates would still reaccumulate in sediments (although the rate of accumulation would likely be slower).

The published recommendations of the Work Group are as follows:

1. Manage phthalate reaccumulation at cleanup sites using site-specific O&M plans;
2. Studies/research to further validate our comprehensive problem statement and define other pollutants transported via an air-stormwater-sediment pathway;
3. Coordinate with Puget Sound Partnership and air agencies regarding the air-stormwater-sediment pathway and related contaminants;
4. Jointly evaluated effective solutions for the air-stormwater-sediment pathway with Puget Sound Partnership and air agencies;
5. Educate agency and community “stakeholders” regarding the comprehensive problem statement;
6. Develop recommendations regarding plasticized PVC (which could also be potentially extended to other products that are sources of air-sediment pathway contaminants);
7. Coordinate with other phthalate risk initiatives;
8. Evaluate stormwater source control and treatment options and implement where justified; and
9. Consider SMS rule amendment to address phthalates and other pervasive pollutants.

As described in that memorandum, the City of Tacoma plans to continue working with EPA and Ecology, to incorporate the recommendations from the Sediment Phthalate Work Group in its decision-making process for future actions throughout the waterway as well as source control efforts in the Thea Foss Watershed.

7.4.5 City Programs and Activities

The City continues to address phthalate reaccumulation in the Thea Foss Waterway through various programs and activities, as described in Section 7.3. As described above, the City actively participated in the Sediment Phthalate Work Group to promote identification of a resolution to phthalate reaccumulation. The City also participates in or performs programs and activities that are in line with the recommendations from the Work Group identified above.

The City will continue to monitor and evaluate sources of phthalates to sediments in the Thea Foss Waterway as part of site specific OMMP monitoring activities and stormwater program activities. Additionally, the results of both sediment and stormwater monitoring will be evaluated in coordination with actions related to implementation of recommendations of the Sediment Phthalate Work Group to identify whether additional activities can be performed to address phthalate reaccumulation.

7.4.6 Conclusions and Recommended Next Steps

The results from Year 4 monitoring performed in the Head of the Thea Foss Waterway are summarized as follows:

- DEHP and mercury are the only analytes to exceed the SQO within the additional cap material placement area;
- DEHP was detected at concentrations exceeding the SQO at 15 of 18 stations within the Head of the Thea Foss Waterway at enrichment ratios ranging from 1.23 to 6.15 times the SQO;
- The average detected DEHP concentration within the Head of the Thea Foss Waterway increased 34 percent between Year 3 and Year 4, and 15 percent between Year 2 and Year 4;
- The average detected DEHP concentration in Year 4 (i.e., 2,930 ug/kg) is 2.3 times the SQO;
- The detected concentration of seven PAHs and Total HPAH, exceeded the SQOs at one sample location, WC-02;
- The detected concentration of one PAH at sample location WC-01 and two PAHs at sample location WC-07 exceeded the SQOs;
- Generally, PAH and DEHP concentrations have increased in Year 4 relative to Year 3, but are less than or only slightly higher than Year 2 concentrations; and
- The detected concentrations of all other chemicals, including remaining PAHs and phenol, at locations within the Head of the Thea Foss Waterway were generally at or below one half of the SQOs.

The Year 2, Year 3, and Year 4 Head of the Thea Foss Waterway monitoring results indicate continuing variability in DEHP concentrations. DEHP concentrations have fluctuated (i.e., increased and/or decreased) depending on the specific location and monitoring event. The DEHP Year 4 average detected concentration was 2,930 ug/kg, Year 3 average detected concentration was 1,920 ug/kg, and the Year 2 average detected concentration was 2,480 ug/kg. The fluctuation in the DEHP concentrations may indicate that the concentrations are continuing to stabilize; however, additional monitoring is needed to identify any potential data trends.

Based on the pre-design study and analysis, the reaccumulation of phthalates is predicted to occur until a stabilization level is reached. The pre-construction model was updated in 2006 with new source loads based on whole-water monitoring data collected between 2001 and 2006, and the revised model indicated that the DEHP concentration would stabilize at an equilibrium concentration approximately four times the SQO. The current sediment monitoring data from Year 4 for the Head of the Waterway are consistent with the updated model which has been validated with post-construction stormwater data. Additionally, the Work Group determined that for expected phthalate re-accumulation, focused monitoring should be conducted to determine the extent of accumulation at levels of concern; whether these areas reach stable phthalate levels; and appropriate site-specific management approaches for these areas. The City is fully prepared to take on this obligation throughout the Foss Waterway, including within the Utilities' work area at the Head of the Thea Foss Waterway. The City has proposed taking responsibility for both future negotiations and actions related to phthalate re-accumulation.

Based on the monitoring results, modeling performed as part of the remedial design process, and the findings and recommendations of the Sediment Phthalate Work Group, the City has proposed additional monitoring in Year 5 (2009) within the Head of the Thea Foss Waterway. The existing monitoring schedule specified in the OMMP for the Head of the Thea Foss Waterway Remediation Project requires that OMMP compliance monitoring be performed in Years 2, 4, 7 and 10 after completion of the remedial action. The additional monitoring proposed for Year 5 would be performed to further characterize and evaluate chemical concentration trends in the Head of the Thea Foss Waterway including the additional cap material placement area and the southern portion of the Head of the Thea Foss Waterway. Under this proposal, the City would take the lead in this additional proposed sampling, and the work would be performed in coordination with the Utilities and supplement the Utilities' OMMP monitoring requirements.

The proposed Year 5 monitoring would focus on and test for phthalates and PAHs; those analytes that are at concentrations above the SQOs. The Year 5 monitoring would be performed at all 18 head of Thea Foss Waterway monitoring locations, which includes the 4 stations located in the area of additional cap material placement (i.e., S-15, S-17, S-19, and S-24).

In addition, the City is prepared to take the lead on additional phthalate and PAH monitoring at the 4 stations located in the area of additional cap material placement in Utilities' OMMP Year 7 (2011) and Year 10 (2014) monitoring events. Monitoring of these stations in Year 7 and Year 10 is not required in the existing Utilities' OMMP.

7.5 Deauthorization of Navigation Channel in Encroachment Areas

In accordance with a Memorandum of Agreement between the Army Corps of Engineers (Corps) and EPA, the City was required to initiate an informal process to deauthorize portions of the federally authorized channel where capping materials encroach on the authorized channel width. The City submitted a request for deauthorization to the Corps on September 25, 2007. A response from the Corps was received on July 9, 2008. The response indicated that, while navigation projects can generally be modified both formally and informally, the informal process would be best for this request at this time. This involves coordination with the congressional delegation to request language be included in the Water Resources Development Act. The Corps did indicate that they could assist with legislative drafting services for this, if requested by a member of Congress. As part of this, the Corps asked that the City provide location coordinates on each corner of each requested deauthorization area. The City submitted a draft of this mapping information for Corps review on October 30, 2008, and is awaiting response as to its adequacy prior to proceeding with coordination with congressional representatives.

7.6 Simpson Log Haul Out Operations, Maintenance, and Monitoring

Since relocation of the Log Haul Out Facility to the Middle Waterway was completed in 2004, Simpson has been required to monitor this area periodically for presence of wood debris. Copies of their annual monitoring surveys are included in the Foss annual reports when available. Per communications with Dave McEntee from Simpson on January 27, 2009, they were not required to monitor for wood debris in 2008 and the next scheduled monitoring will be performed in spring 2009. A copy of that report will be included in Appendix G of the Year 3 Monitoring Annual Operations, Maintenance, and Monitoring Report.

7.7 Tacoma Metals Waste Management

During construction of the Puyallup River Side Channel habitat mitigation site, materials being removed from the southern portion of the site were found to contain battery casings and debris. The debris was suspected as having come from a non-ferrous metal reclamation facility previously operated by Tacoma Metals on the adjacent property.

Through an agreement with Tacoma Metals' successors, and with agency approval, a lined Temporary Containment Unit (TCU) was constructed on the Tacoma Metals Property. A June 9, 2005, letter from Ecology to the property owners' representative outlined the work plan for the handling of this material. In all, an estimated 2,000 CY of material excavated from the Puyallup River Side Channel site was placed in the TCU. As indicated in previous reports, it is the City's understanding that the material stored in the TCU was treated at the site and removed for disposal in summer 2007. As of the date of this report, the property owners are continuing to work with Ecology on the completion of the overall cleanup plan for the site.

TABLES

FIGURES

Table 7-1

Head of the Thea Foss Waterway Year 4 (2008) Surface Sample (0-10cm) Results

Parameter	Area		Southern Portion of the Head of the Thea Foss Waterway										
	Station		WC-01	WC-02	WC-03	WC-04	WC-05	WC-06	WC-07	WC-08	WC-09	WC-13	WC-14
	Sample ID		WC-01-080507-G	WC-02-080506-G	WC-03-080506-G	WC-04-080506-G	WC-05-080506-G	WC-06-080506-G	WC-07-080506-G	WC-08-080506-G	WC-09-080506-G	WC-13-080506-G	WC-14-080506-G
	Sample Date		5/7/2008	5/6/2008	5/6/2008	5/6/2008	5/6/2008	5/6/2008	5/6/2008	5/6/2008	5/6/2008	5/6/2008	5/6/2008
	Sample Depth		0-10 cm	0-10 cm	0-10 cm	0-10 cm	0-10 cm	0-10 cm	0-10 cm	0-10 cm	0-10 cm	0-10 cm	0-10 cm
	Silt Thickness (cm)		2	7	6	8	13	7	8	8	8	3	13
Conventionals	**Units**	**SQO**											
Total Organic Carbon	mg/kg	NA	68,400	83,000	29,600	35,300	41,600	52,800	50,200	39,200	34,800	47,100	34,500
Total Solids	%	NA	46.7	34.2	65.1	53.6	43	55.9	52.7	54.8	51	58.6	50.6
Metals													
Lead	mg/kg	450	89	112	28	48	86	50	82	71	71	32	74
Zinc	mg/kg	410	324	348	96	152	255	145	222	176	202	106	209
Mercury	mg/kg	0.59	0.16	0.5	0.08	0.13	0.21	0.12	0.13	0.21	0.2	0.08	0.18
SVOCs													
2-Methylnaphthalene	µg/kg	670	99 U	200 U	58 U	59 U	64	100 U	67	76	60 U	22	59 U
Acenaphthene	µg/kg	500	99 U	200 U	58 U	59 U	69	100 U	120	86	60 U	24	59 U
Acenaphthylene	µg/kg	1,300	99 U	200 U	58 U	59 U	60 U	100 U	60 U	59 U	60 U	20 U	59 U
Anthracene	µg/kg	960	190	310	58 U	120	200	130	300	170	130	78	110
Fluorene	µg/kg	540	66 J	200 U	58 U	59 U	60 U	100 U	100	59 U	60 U	26	59 U
Naphthalene	µg/kg	2,100	52 J	200 U	58 U	80	160	100 U	130	200	120	53	100
Phenanthrene	µg/kg	1,500	1,100	1,800	230	540	810	560	1,300	570	530	320	460
Total LPAH	µg/kg	5,200	1,408	2,110	230	740	1,303	690	2,017	1,102	780	523	670
Benzo(a)anthracene	µg/kg	1,600	940	1,600	220	510	750	560	980	480	460	230	430
Benzo(a)pyrene	µg/kg	1,600	1,000	2,000	290	640	1,000	700	1,200	700	660	410	560
Benzofluoranthenes (total)	µg/kg	3,600	2,400	3,600	650	1,620	2,700	1,600	2,500	2,040	1,890	1210	1,620
Benzo(g,h,i)perylene	µg/kg	720	480	860	160	260	350	420	840	180	190	160	190
Chrysene	µg/kg	2,800	1,400	2,700	370	790	1,300	900	1,400	730	800	570	720
Dibenzo(a,h)anthracene	µg/kg	230	210	370	61	61	68	160	230	59 U	60 U	32	59 U
Fluoranthene	µg/kg	2,500	2,700	4,800	580	1,400	2,400	1,600	2,500	1,300	1,400	990	1,300
Indeno(1,2,3-cd)pyrene	µg/kg	690	490	860	150	250	350	400	720	170	190	150	180
Pyrene	µg/kg	3,300	2,000	3,700	610	1,100	2,000	1,400	2,400	1,300	1,100	820	1,000
Total HPAH	µg/kg	17,000	11,620	20,490	3,091	6,631	10,918	7,740	12,770	6,900	6,690	4,572	6,000
Dimethyl phthalate	µg/kg	160	99 U	200 U	58 U	59 U	60 U	100 U	60 U	59 U	60 U	20 U	59 U
Diethylphthalate	µg/kg	200	99 U	200 U	58 U	59 U	60 U	100 U	60 U	59 U	60 U	20 U	59 U
Di-n-butyl phthalate	µg/kg	1,400	100	200	58 U	59 U	60 U	100 U	74	59 U	60 U	23	59 U
Butyl benzyl phthalate	µg/kg	900	380	360	76	120	180	170	200	150	150	95	130
bis(2-ethylhexyl)phthalate	µg/kg	1,300	6,400	8,000	1,200	2,400	5,400	3,200	4,700	2,500	3,100	2,100	3,500
Di-n-octyl phthalate	µg/kg	6,200	210	440	58 U	120	220	100 U	110	84	110	96	190
Phenol	µg/kg	420	75 J	200 U	58 U	59 U	60 U	100 U	60 U	59 U	60 U	22	59 U
2-Methylphenol	µg/kg	63	99 U	200 U	58 U	59 U	60 U	100 U	60 U	59 U	60 U	20 U	59 U
3- & 4-Methylphenol	µg/kg	670	99 U	200 U	58 U	59 U	60 U	100 U	60 U	59 U	60 U	20 U	59 U
2,4-Dimethylphenol	µg/kg	29	99 U	200 U	58 U	59 U	60 U	100 U	60 U	59 U	60 U	20 U	59 U
Pentachlorophenol	µg/kg	360	500 U	990 U	290 U	300 U	300 U	500 U	300 U	300 U	300 U	100 U	300 U
Benzyl alcohol	µg/kg	73	99 U	200 U	58 U	59 U	60 U	100 U	60 U	59 U	60 U	20 U	59 U
Benzoic acid	µg/kg	650	990 U	2,000 U	580 U	590 U	600 U	1,000 U	600 U	590 U	600 U	200 U	590 U
1,2-Dichlorobenzene	µg/kg	50	99 U	200 U	58 U	59 U	60 U	100 U	60 U	59 U	60 U	20 U	59 U
1,3-Dichlorobenzene	µg/kg	170	99 U	200 U	58 U	59 U	60 U	100 U	60 U	59 U	60 U	20 U	59 U
1,4-Dichlorobenzene	µg/kg	110	99 U	200 U	58 U	59 U	60 U	100 U	60 U	59 U	60 U	20 U	59 U
1,2,4-Trichlorobenzene	µg/kg	51	99 U	200 U	58 U	59 U	60 U	100 U	60 U	59 U	60 U	20 U	59 U
Hexachlorobenzene	µg/kg	22	2.4	5.6	1.8	2.6	3.6	2.6	60 U	2.2	3.6	4	3.4
Dibenzofuran	µg/kg	540	99 U	200 U	58 U	59 U	60 U	100 U	60 U	59 U	60 U	20 U	59 U
Hexachlorobutadiene	µg/kg	11	0.98 U	0.98 U	0.96 U	1.9 U	2 U	0.97 U	60 U	0.98 U	2 U	1 U	1.9 U
N-Nitrosodiphenylamine	µg/kg	28	99 U	200 U	58 U	59 U	60 U	100 U	60 U	59 U	60 U	20 U	59 U
Pesticides								NA					
4,4'-DDE	µg/kg	9	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
4,4'-DDD	µg/kg	16	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
4,4'-DDT	µg/kg	34	2 U	2	1.9 U	3.8 U	3.9 U	2 U	2 U	2 U	4 U	2 U	3.9 U
PCBs													
Aroclor 1016	µg/kg	NA	10 U	20	9.6 U	9.8 U	10 U	9.9 U	9.8 U	9.8 U	9.9 U	10 U	9.9 U
Aroclor 1242	µg/kg	NA	10 U	20	9.6 U	9.8 U	10 U	9.9 U	9.8 U	9.8 U	9.9 U	10 U	9.9 U
Aroclor 1248	µg/kg	NA	27	18 U	8.2 JP	15	20	12 JP	20	20	17	6.4 J	19
Aroclor 1254	µg/kg	NA	48	52	18	33	44	33	48	46	43	16	48
Aroclor 1260	µg/kg	NA	45	68	25	39	42	34	44	52	56	21	57
Aroclor 1221	µg/kg	NA	10 U	20	9.6 U	9.8 U	10 U	9.9 U	9.8 U	9.8 U	9.9 U	10 U	9.9 U
Aroclor 1232	µg/kg	NA	10 U	20 U	9.6 U	9.8 U	10 U	9.9 U	9.8 U	9.8 U	9.9 U	10 U	9.9 U
PCBs (total)	µg/kg	300	120	180	51.2	87	106	79	112	118	116	43.4	124

Notes:

Concentrations highlighted in red exceed the SQO.

NA Not Available

1 Sample duplicate WC-10-080506-G-B is a duplicate of sample WC-10-080506-G.

U Undetected

J The analyte was analyzed for and positively identified, but the associated numerical value is an estimated quanity.

Parameter	Area		Addiitonal Cap Material Placement Area							
	Station		WC-10	WC-10	WC-11	WC-12	S-15	S-17	S-19	S-24
	Sample ID		WC-10-080506-G	WC-10-080506-G-B[1]	WC-11-080506-G	WC-12-080506-G	S-15-080506-G	S-17-080506-G	S-19-080506-G	S-24-080506-G
	Sample Date		5/6/2008	5/6/2008	5/6/2008	5/6/2008	5/6/2008	5/6/2008	5/6/2008	5/6/2008
	Sample Depth		0-10 cm	0-10 cm	0-10 cm	0-10 cm	0-10 cm	0-10 cm	0-10 cm	0-10 cm
	Silt Thickness (cm)		1	1	7	4	4	4	3	2
Conventionals	**Units**	**SQO**								
Total Organic Carbon	mg/kg	NA	14,700	9,920	53,600	33,700	47,300	48,200	43,700	43,300
Total Solids	%	NA	86.3	82.2	54.1	67.1	72.2	65.6	65.9	69
Metals										
Lead	mg/kg	450	11	9	60	36	23	42	31	40
Zinc	mg/kg	410	51	51	165	100	77	122	83	115
Mercury	mg/kg	0.59	0.05 U	0.05 U	1.65	0.11	0.06	0.08	0.12	0.1
SVOCs										
2-Methylnaphthalene	µg/kg	670	20 U	20 U	60 U	59 U	59 U	59 U	40	60 U
Acenaphthene	µg/kg	500	20 U	20 U	60 U	84 U	59 U	59 U	60	60 U
Acenaphthylene	µg/kg	1,300	20 U	20 U	60 U	59 U	59 U	59 U	31	60 U
Anthracene	µg/kg	960	28	21	120	160	59 U	93	110	76
Fluorene	µg/kg	540	20 U	20 U	60 U	64 U	59 U	59 U	36	60 U
Naphthalene	µg/kg	2,100	20 U	20 U	84 U	110	59 U	59	94	60 U
Phenanthrene	µg/kg	1,500	110	93	400 U	470	180	360	310	330
Total LPAH	µg/kg	5,200	138	114	120	740	180	512	681	406
Benzo(a)anthracene	µg/kg	1,600	98	89	410	390	190	350	230	320
Benzo(a)pyrene	µg/kg	1,600	130	120	540	510	240	470	350	410
Benzofluoranthenes (total)	µg/kg	3,600	300	280	1,200	1,020	580	1,060	640	930
Benzo(g,h,i)perylene	µg/kg	720	130	120	540	420	260 U	480	290	400
Chrysene	µg/kg	2,800	170	150	670	550	320	590	370	530
Dibenzo(a,h)anthracene	µg/kg	230	43	40	160 U	140 U	80	150	89	130
Fluoranthene	µg/kg	2,500	280	250	1,000	850	490	930	550	880
Indeno(1,2,3-cd)pyrene	µg/kg	690	110	98	430	350	210	390	240	330
Pyrene	µg/kg	3,300	250	230	1,000	970	470	900	650	800
Total HPAH	µg/kg	17,000	1,511	1,377	5,790	5,060	2,580	5,320	3,409	4,730
Dimethyl phthalate	µg/kg	160	20 U	20 U	60 U	59 U	59 U	59 U	20 U	60 U
Diethylphthalate	µg/kg	200	20 U	20 U	60 U	59 U	59 U	59 U	20 U	60 U
Di-n-butyl phthalate	µg/kg	1,400	20 U	20 U	60	59 U	59 U	59 U	20 U	60 U
Butyl benzyl phthalate	µg/kg	900	27	32	140	93	63	100	56	69
bis(2-ethylhexyl)phthalate	µg/kg	1,300	540	490	3,500	1,600	1,600	2,400	1,200	1,800
Di-n-octyl phthalate	µg/kg	6,200	20 U	20 U	130	59 U	67	68	30	60 U
Phenol	µg/kg	420	20 U	20 U	60 U	59 U	59 U	59 U	20 U	60 U
2-Methylphenol	µg/kg	63	20 U	20 U	20 U	59 U	59 U	59 U	20 U	60 U
3- & 4-Methylphenol	µg/kg	670	20 U	20 U	60 U	59 U	59 U	59 U	20 U	60 U
2,4-Dimethylphenol	µg/kg	29	20 U	20 U	60 U	59 U	59 U	59 U	20 U	60 U
Pentachlorophenol	µg/kg	360	98 U	98 U	300	300 U	300 U	300 U	98 U	300 U
Benzyl alcohol	µg/kg	73	20 U	20 U	60 U	59 U	59 U	59 U	20 U	60 U
Benzoic acid	µg/kg	650	200 U	200 U	600	590 U	590 U	290 U	200 U	600 U
1,2-Dichlorobenzene	µg/kg	50	20 U	20 U	60 U	59 U	59 U	59 U	20 U	60 U
1,3-Dichlorobenzene	µg/kg	170	20 U	20 U	60 U	59 U	59 U	59 U	20 U	60 U
1,4-Dichlorobenzene	µg/kg	110	20 U	20 U	60 U	59 U	59 U	59 U	20 U	60 U
1,2,4-Trichlorobenzene	µg/kg	51	20 U	20 U	60 U	59 U	59 U	59 U	20 U	60 U
Hexachlorobenzene	µg/kg	22	0.95 U	20 U	3.7	0.84	1 U	1 J	0.75 J	1 J
Dibenzofuran	µg/kg	540	20 U	20 U	60 U	59 U	59 U	59 U	20 U	60 U
Hexachlorobutadiene	µg/kg	11	0.95 U	20 U	0.98	0.96	0.97 U	0.97 U	0.97 U	0.97 U
N-Nitrosodiphenylamine	µg/kg	28	20 U	20 U	60 U	59 U	59 U	59 U	20 U	60 U
Pesticides										
4,4'-DDE	µg/kg	9	NA	NA	NA	NA	NA	NA	NA	NA
4,4'-DDD	µg/kg	16	NA	NA	NA	NA	NA	NA	NA	NA
4,4'-DDT	µg/kg	34	1.9 U	1.9 U	2 U	1.9 U	1.9 J	2 U	1.9 U	1.9 U
PCBs										
Aroclor 1016	µg/kg	NA	9.7 U	9.6 U	9.8 U	9.7 U	9.8 U	9.8 U	9.7 U	9.8 U
Aroclor 1242	µg/kg	NA	9.7 U	9.6 U	9.8 U	9.7 U	9.8 U	9.8 U	9.7 U	9.8 U
Aroclor 1248	µg/kg	NA	9.7 U	9.6 U	10	7.2 J	9.8 U	6.6 J	6.8 J	9.8 U
Aroclor 1254	µg/kg	NA	6.3 J	5 J	26	18	8.2 J	15	14	12
Aroclor 1260	µg/kg	NA	5.9 J	5.6 J	32	15	9.9	15	14	13
Aroclor 1221	µg/kg	NA	9.7 U	9.6 U	9.8 U	9.7 U	9.8 U	9.8 U	9.7 U	9.8 U
Aroclor 1232	µg/kg	NA	9.7 U	9.6 U	9.8 U	9.7 U	9.8 U	9.8 U	9.7 U	9.8 U
PCBs (total)	µg/kg	300	12.2	10.6	68	40.2	18.1	36.6	34.8	25

Notes:

Concentrations highlighted in red exceed the SQO.

NA Not Available

1 Sample duplicate WC-10-080506-G-B is a duplicate of sample WC-10-080506-G.

U Undetected

J The analyte was analyzed for and positively identified, but the associated numerical value is an estimated quanity.

Table 7-2
Detected Analyte Averages for Year 2 (2006), Year 3 (2007), and Year 4 (2008) Surface Sample (0-10cm) Results

			Head of the Thea Foss Waterway							
Parameter	**Units**	**SQO**	**2006 Average**	**2007 Average**	**2008 Average**	**Change in 2008 Average to 2006 (%)**	**Change in 2008 Average to 2007 (%)**	**Enrichment Ratio for 2006 Average**	**Enrichment Ratio for 2007 Average**	**Enrichment Ratio for 2008 Average**
Metals										
Lead	mg/kg	450	39	14	52	25	73	0.09	0.03	0.12
Zinc	mg/kg	410	104	44	158	34	72	0.25	0.11	0.38
Mercury	mg/kg	0.59	0.16	0.05	0.24	33	79	0.28	0.08	0.41
SVOCs										
2-Methylnaphthalene	µg/kg	670	100	47	54	(85)	13	0.15	0.07	0.08
Acenaphthene	µg/kg	500	125	59	72	(74)	18	0.25	0.12	0.14
Acenaphthylene	µg/kg	1300	62	32	31	(100)	(4)	0.05	0.02	0.02
Anthracene	µg/kg	960	172	107	138	(25)	23	0.18	0.11	0.14
Fluorene	µg/kg	540	115	48	57	(101)	15	0.21	0.09	0.11
Naphthalene	µg/kg	2,100	152	77	105	(44)	27	0.07	0.04	0.05
Phenanthrene	µg/kg	1,500	532	466	560	5	17	0.35	0.31	0.37
Total LPAH	µg/kg	5,200	923	754	761	(21)	1	0.18	0.15	0.15
Benzo(a)anthracene	µg/kg	1,600	422	399	486	13	18	0.26	0.25	0.30
Benzo(a)pyrene	µg/kg	1,600	494	479	628	21	24	0.31	0.30	0.39
Benzofluoranthenes (total)	µg/kg	3,600	1,151	1,314	1,465	21	10	0.32	0.36	0.41
Benzo(g,h,i)perylene	µg/kg	720	204	217	359	43	40	0.28	0.30	0.50
Chrysene	µg/kg	2,800	656	576	791	17	27	0.23	0.21	0.28
Dibenzo(a,h)anthracene	µg/kg	230	48	57	123	61	54	0.21	0.25	0.54
Fluoranthene	µg/kg	2,500	1,200	1,080	1,380	13	22	0.48	0.43	0.55
Indeno(1,2,3-cd)pyrene	µg/kg	690	171	213	319	46	33	0.25	0.31	0.46
Pyrene	µg/kg	3,300	1,041	893	1195	13	25	0.32	0.27	0.36
Total HPAH	µg/kg	17,000	5,300	5,200	6,700	21	22	0.31	0.31	0.39
Dimethyl phthalate	µg/kg	160	ND	16	ND	ND	ND	NA	NA	NA
Diethylphthalate	µg/kg	200	ND	ND	ND	ND	ND	NA	NA	NA
Di-n-butyl phthalate	µg/kg	1,400	152	42	91	(67)	54	0.11	0.03	0.07
Butyl benzyl phthalate	µg/kg	900	134	122	136	2	11	0.15	0.14	0.15
bis(2-ethylhexyl)phthalate	µg/kg	1,300	2,480	1,920	2,930	15	34	1.91	1.48	2.25
Di-n-octyl phthalate	µg/kg	6,200	116	68	144	20	53	0.02	0.01	0.02
Phenol	µg/kg	420	650	39	49	(1,240)	19	1.55	0.09	0.12
2-Methylphenol	µg/kg	63	ND	ND	ND	ND	ND	NA	NA	NA
3- & 4-Methylphenol	µg/kg	670	650	14	ND	ND	ND	0.97	0.02	NA
2,4-Dimethylphenol	µg/kg	29	ND	ND	ND	ND	ND	NA	NA	NA
Pentachlorophenol	µg/kg	360	ND	ND	300	ND	ND	NA	NA	0.83
Benzyl alcohol	µg/kg	73	ND	ND	ND	ND	ND	NA	NA	NA
Benzoic acid	µg/kg	650	ND	ND	600	ND	ND	NA	NA	0.92
1,2-Dichlorobenzene	µg/kg	50	ND	ND	ND	ND	ND	NA	NA	NA
1,3-Dichlorobenzene	µg/kg	170	ND	ND	ND	ND	ND	NA	NA	NA
1,4-Dichlorobenzene	µg/kg	110	ND	ND	ND	ND	ND	NA	NA	NA
1,2,4-Trichlorobenzene	µg/kg	51	ND	ND	ND	ND	ND	NA	NA	NA
Hexachlorobenzene	µg/kg	22	4	ND	3	ND	ND	0.16	NA	0.12
Dibenzofuran	µg/kg	540	64	26	ND	ND	ND	0.12	0.05	NA
Hexachlorobutadiene	µg/kg	11	ND	ND	1	ND	ND	NA	NA	0.09
N-Nitrosodiphenylamine	µg/kg	28	ND	ND	ND	ND	ND	NA	NA	NA
Pesticides										
4,4'-DDE	µg/kg	9	ND	ND	ND	ND	ND	NA	NA	NA
4,4'-DDD	µg/kg	16	ND	ND	ND	ND	ND	NA	NA	NA
4,4'-DDT	µg/kg	34	ND	ND	2	ND	ND	NA	NA	0.06
PCBs										
Aroclor 1016	µg/kg	NA	ND	ND	ND	ND	ND	NA	NA	NA
Aroclor 1242	µg/kg	NA	ND	ND	ND	ND	ND	NA	NA	NA
Aroclor 1248	µg/kg	NA	27	ND	14	ND	ND	NA	NA	NA
Aroclor 1254	µg/kg	NA	38	ND	28	ND	ND	NA	NA	NA
Aroclor 1260	µg/kg	NA	37	18	31	(18)	42	NA	NA	NA
Aroclor 1221	µg/kg	NA	ND	ND	ND	ND	ND	NA	NA	NA
Aroclor 1232	µg/kg	NA	ND	ND	ND	ND	ND	NA	NA	NA
PCBs (total)	µg/kg	300	90	18	71	(27)	74	0.30	0.06	0.24

Notes:

Concentrations highlighted in red exceed the SQO.

NA Not applicable

ND Not detected

Table 7-3
Head of Thea Foss Waterway
Year 2 (2006) and Year 4 (2008) Slope Cap Sample Results (0-10cm)

Parameter	Area		West Side of Waterway				East Side of Waterway			
	Station		SC-01		SC-02		SC-03		SC-04	
	Sample ID		Y2-SC01-S	Y4-SC01-S	Y2-SC02-S	Y4-SC02-S	Y2-SC03-S	Y4-SC03-S	Y2-SC04-S	Y4-SC04-S
	Sample Date		5/16/2006	5/7/2008	5/16/2006	5/7/2008	5/16/2006	5/7/2008	5/16/2006	5/7/2008
	Sample Depth		0-10 cm	0-10 cm	0-10 cm	0-10 cm	0-10 cm	0-10 cm	0-10 cm	0-10 cm
	Silt Thickness (cm)		NA	1	NA	2-4	NA	1-11	NA	<1-5
Conventionals	**Units**	**SQO**								
Total Organic Carbon	mg/kg	NA	4,600	2,150	27,500	60,300	55,200	65,700	53,300	41,300
Total Solids	%	NA	94.3	91.2	81	64.6	60	56.7	72.1	69.3
Metals										
Lead	mg/kg	450	5	4	36	58	58	64	44	53
Zinc	mg/kg	410	36.6	37	87.3	175	169	200	119	147
Mercury	mg/kg	0.59	0.04 U	0.05 U	0.05 U	0.1	0.1	0.1	0.08	0.11
SVOCs										
2-Methylnaphthalene	µg/kg	670	20 U	10 J	21 U	14 J	88 U	100 U	79 U	98 U
Acenaphthene	µg/kg	500	20 U	19 U	17 J	20 U	88 U	100 U	53 J	98 U
Acenaphthylene	µg/kg	1,300	20 U	19 U	21 U	20 U	88 U	100 U	79 U	98 U
Anthracene	µg/kg	960	20 U	25	77	47	150	140	100	82 J
Fluorene	µg/kg	540	20 U	19 U	22	14 J	88 U	52 J	79 U	98 U
Naphthalene	µg/kg	2,100	20 U	19 U	20 J	11 J	88 U	100 U	65 J	98 U
Phenanthrene	µg/kg	1,500	30	39	250	78	700	830	380	420
Total LPAH	µg/kg	5,200	30	64	390 J	164	850	1,022	600 J	502
Benzo(a)anthracene	µg/kg	1,600	26	50	150	100	570	800	290	390
Benzo(a)pyrene	µg/kg	1,600	28	51	180 J	92	670	920	340	500
Benzofluoranthenes (total)	µg/kg	3,600	62	148	400 J	280	1,600	2,300	740	1,280
Benzo(g,h,i)perylene	µg/kg	720	24	21	120 J	32	340	430	220	260
Chrysene	µg/kg	2,800	38	91	260	250	940	1,200	450	680
Dibenzo(a,h)anthracene	µg/kg	230	20 U	19 U	36 J	18 J	88 U	190	79 U	100
Fluoranthene	µg/kg	2,500	63	130	580	330	1,800	2,300	750	1,200
Indeno(1,2,3-cd)pyrene	µg/kg	690	24	21	130 J	36	260	450	170	260
Pyrene	µg/kg	3,300	59	120	270	290	1,100	1,800	610	960
Total HPAH	µg/kg	17,000	320	632	2,100 J	1,428	7,300	10,390	3,600	6,132
Dimethyl phthalate	µg/kg	160	20 U	19 U	21 U	19 J	88 U	100 U	79 U	98 U
Diethylphthalate	µg/kg	200	20 U	19 U	21 U	20 U	88 U	100 U	79 U	98 U
Di-n-butyl phthalate	µg/kg	1,400	20 U	19 U	38	20 U	110	100 U	50 J	98 U
Butyl benzyl phthalate	µg/kg	900	20 U	19 U	62	20 U	190	150	130	130
bis(2-ethylhexyl)phthalate	µg/kg	1,300	85	76	1,000	140	3,400	14,000	1,500	2,400
Di-n-octyl phthalate	µg/kg	6,200	20 U	19 U	57	20 U	140	140	62 J	100

	Area		West Side of Waterway				East Side of Waterway			
	Station		SC-01		SC-02		SC-03		SC-04	
	Sample ID		Y2-SC01-S	Y4-SC01-S	Y2-SC02-S	Y4-SC02-S	Y2-SC03-S	Y4-SC03-S	Y2-SC04-S	Y4-SC04-S
	Sample Date		5/16/2006	5/7/2008	5/16/2006	5/7/2008	5/16/2006	5/7/2008	5/16/2006	5/7/2008
	Sample Depth		0-10 cm	0-10 cm	0-10 cm	0-10 cm	0-10 cm	0-10 cm	0-10 cm	0-10 cm
Parameter	Silt Thickness (cm)		NA	1	NA	2-4	NA	1-11	NA	<1-5
Conventionals	**Units**	**SQO**								
Phenol	µg/kg	420	20 U	26	21 U	16 J	88 U	100 U	79 U	98 U
2-Methylphenol	µg/kg	63	20 U	19 U	21 U	20 U	88 U	100 U	79 U	98 U
3- & 4-Methylphenol	µg/kg	670	20 U	19 U	21 U	20 U	88 U	100 U	40 J	98 U
2,4-Dimethylphenol	µg/kg	29	20 U	19 U	21 U	20 U	88 U	100 U	79 U	98 U
Pentachlorophenol	µg/kg	360	98 U	97 U	73 J	85 J	440 U	500 U	400 U	490 U
Benzyl alcohol	µg/kg	73	20 U	19 U	21 U	20 U	88 U	100 U	79 U	98 U
Benzoic acid	µg/kg	650	200 U	190 U	480	200 U	880 U	1,000 U	790 U	980 U
1,2-Dichlorobenzene	µg/kg	50	20 U	19 U	21 U	20 U	88 U	100 U	79 U	98 U
1,3-Dichlorobenzene	µg/kg	170	20 U	19 U	21 U	20 U	88 U	100 U	79 U	98 U
1,4-Dichlorobenzene	µg/kg	110	20 U	19 U	21 U	20 U	88 U	100 U	79 U	98 U
1,2,4-Trichlorobenzene	µg/kg	51	20 U	19 U	21 U	20 U	88 U	100 U	79 U	98 U
Hexachlorobenzene	µg/kg	22	1 U	0.95 U	1 U	20 U	3.5 U	2.5	3.5 U	1.4
Dibenzofuran	µg/kg	540	20 U	19 U	21 U	13 J	88 U	100 U	79 U	98 U
Hexachlorobutadiene	µg/kg	11	1 U	0.95 U	1 U	20 U	3.5 U	0.99 U	3.5 U	0.97 U
N-Nitrosodiphenylamine	µg/kg	28	20 U	19 U	21 U	20 U	88 U	100 U	79 U	98 U
Pesticides										
4,4'-DDE	µg/kg	9	2 U	NA	2 U	NA	7 U	NA	7 U	NA
4,4'-DDD	µg/kg	16	2 U	NA	2 U	NA	7 U	NA	7 U	NA
4,4'-DDT	µg/kg	34	2 U	1.9 U	2 U	2 U	7 U	2 U	7 U	1.9 U
PCBs										
Aroclor 1016	µg/kg	NA	9.7 U	9.7 U	9.9 U	9.9 U	9.9 U	10 U	9.8 U	9.8 U
Aroclor 1242	µg/kg	NA	9.7 U	9.7 U	9.9 U	9.9 U	9.9 U	10 U	9.8 U	9.8 U
Aroclor 1248	µg/kg	NA	9.7 U	9.7 U	9.9 U	13	20 U	15	20 U	9.6 J
Aroclor 1254	µg/kg	NA	9.7 U	9.7 U	28	25	36	31	44	18
Aroclor 1260	µg/kg	NA	9.7 U	9.7 U	32 JC	26	35 JC	20	31 JC	18
Aroclor 1221	µg/kg	NA	9.7 U	9.7 U	9.9 U	9.9 U	9.9 U	10 U	9.8 U	9.8 U
Aroclor 1232	µg/kg	NA	9.7 U	9.7 U	9.9 U	9.9 U	20 U	10 U	20 U	9.8 U
PCBs (total)	µg/kg	300	9.7 U	9.7 U	60 J	64	71 JC	66	75	45.6

Notes:

Concentrations highlighted in red exceed the SQO.

NA Not Available

U Undetected

J The analyte was analyzed for and positively identified, but the associated numerical value is an estimated quanity.

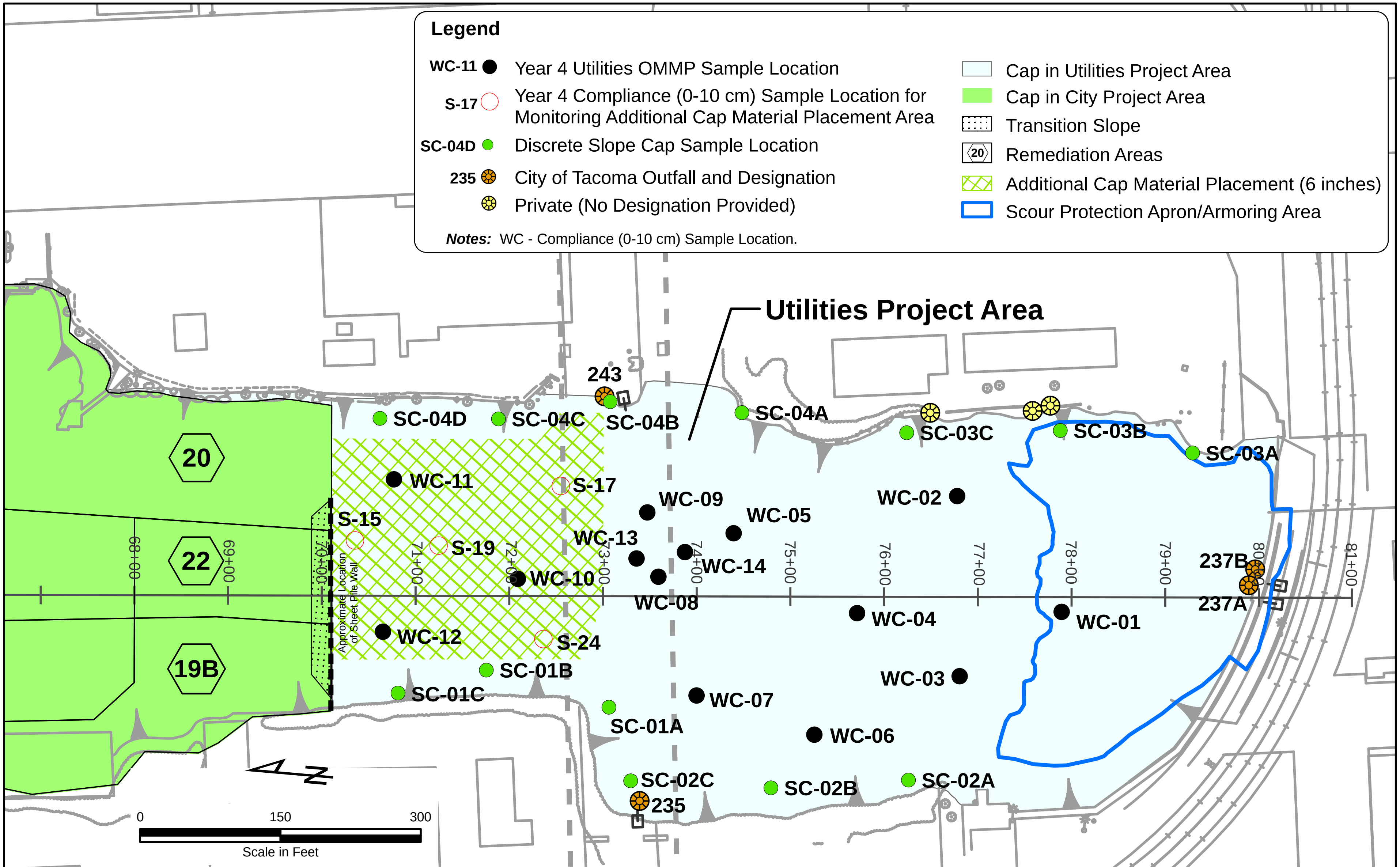


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Figure 7-1
Year 4 (2008) OMMP Sample Locations

File: F:\projects\COT-Oncall\GIS\2008 Utilities OMMP Head Sampling\Figure 7-1 (Year 4 OMMP Sample Locations).mxd
Date: 2/2/2009

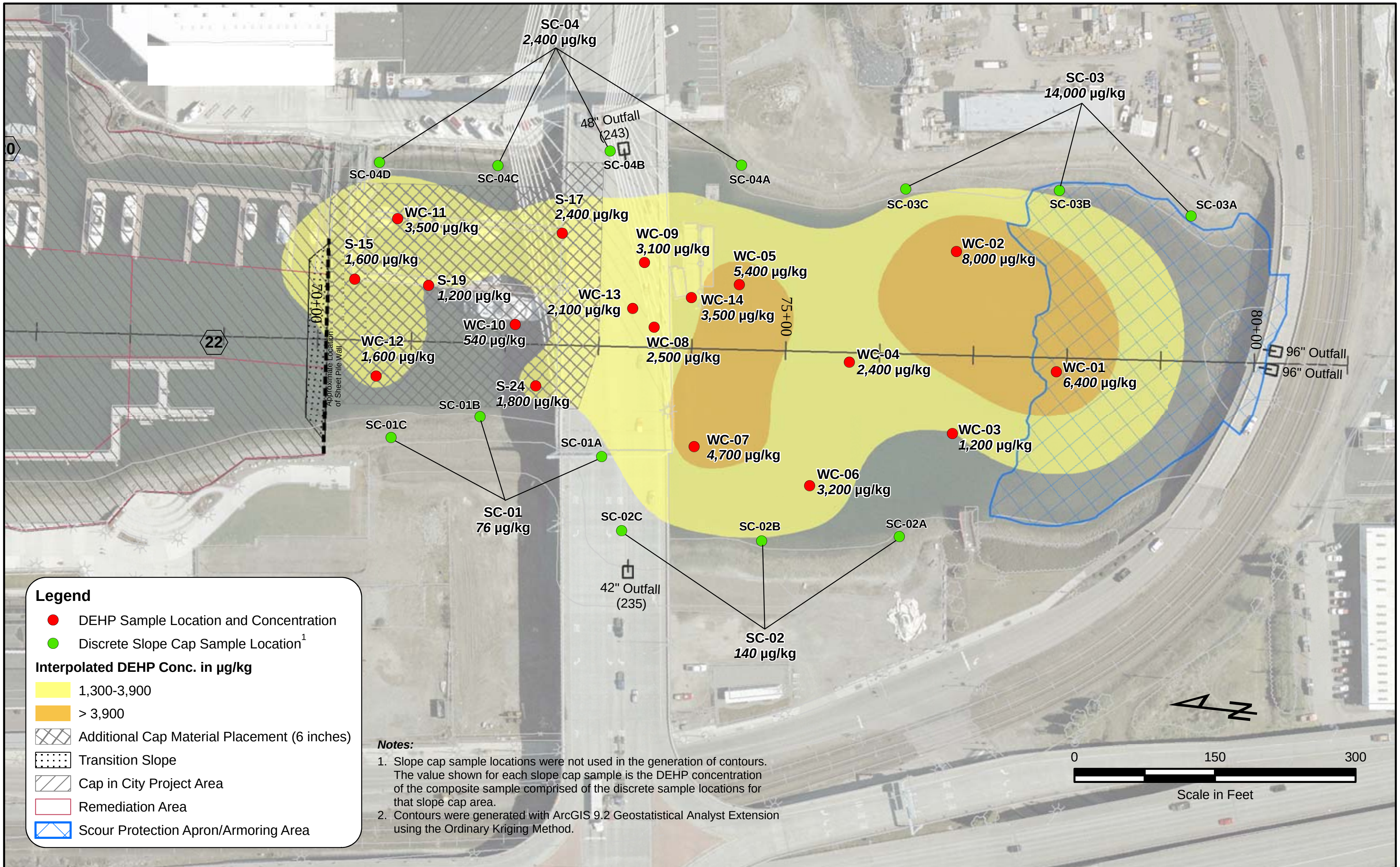

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Figure 7-2
Year 4 (2008) Bis(2-ethylhexyl)phthalate (DEHP) Concentrations (0 - 10cm)

File: F:\projects\COT-Oncall\GIS\2008 Utilities OMMP Head Sampling\Figure 7-2 (Year 4 DEHP Conc (0-10cm) Contours).mxd
Date: 2/2/2009