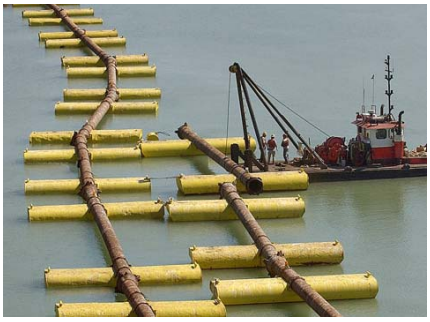
THEA FOSS AND WHEELER-OSGOOD WATERWAYS REMEDIATION PROJECT

YEAR 10 MONITORING

ANNUAL OPERATIONS, MAINTENANCE, AND MONITORING REPORT

NOVEMBER 14, 2016



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APPENDIX F – HEALTH AND SAFETY PLAN

APPENDIX G – ADDITIONAL PROJECT RELATED ACTIVITIES

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 2016 for the Thea Foss and Wheeler-Osgood Waterways Remediation Project (Foss Project). Operations, maintenance, and monitoring activities were performed during Year 10 in the waterway and at the habitat areas within the Foss Project site and at the confined disposal facility (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 identified recontamination which has occurred in their work area as well as on other cleanup related issues.

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 10 Operations, Maintenance, and Monitoring Report

Year 10 monitoring tasks performed and associated information provided in this report includes 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 progress and success of the benthic recolonization;
- Performance monitoring of the groundwater quality and cap and berm conditions at the St. Paul Waterway Confined Disposal Facility (CDF);
- Habitat mitigation area monitoring including qualitative monitoring of the cap and berm at the St. Paul Waterway Confined Disposal Facility (CDF); 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; and
    - Ongoing work to deauthorize the navigational channel in encroachment areas.

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

1.3 Organization of the Annual OMMP Reports

For each monitoring year, an Annual Operations, Maintenance, and Monitoring Report (Annual Report) is 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 10 Monitoring, and all 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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1-1 – Monitoring Schedule

FIGURES

1-1 – Project Location Map
1-2 – Completed Remedial Actions

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		4Q	4Q								
Performance Monitoring					X			X			X
5) Habitat Mitigation Area Monitoring											
Qualitative Ground Surveys[1]	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			

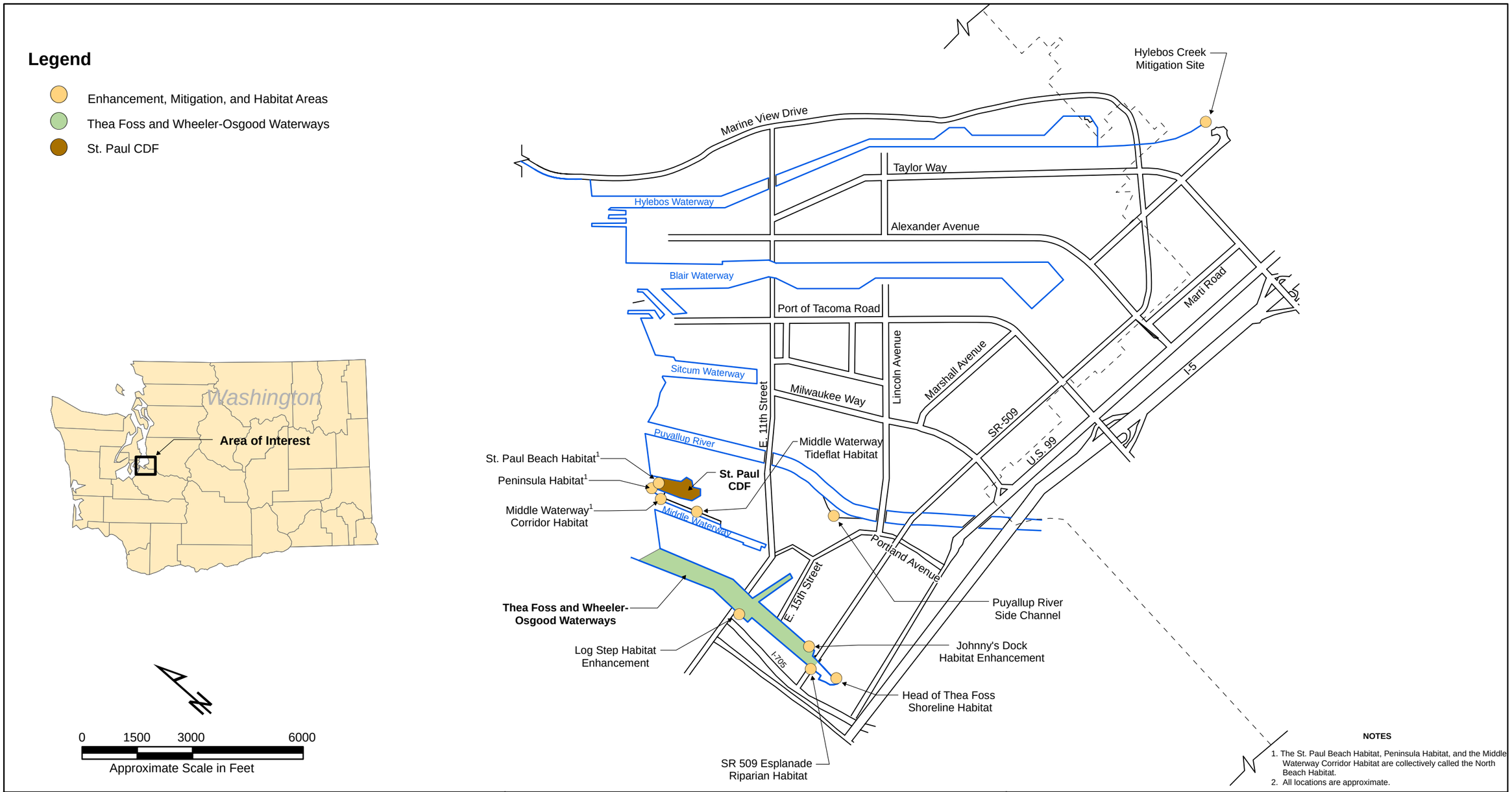
Notes:

4 Q Four quarters.

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 qualitative 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 are performed annually while monitoring of elevation stakes at other locations is 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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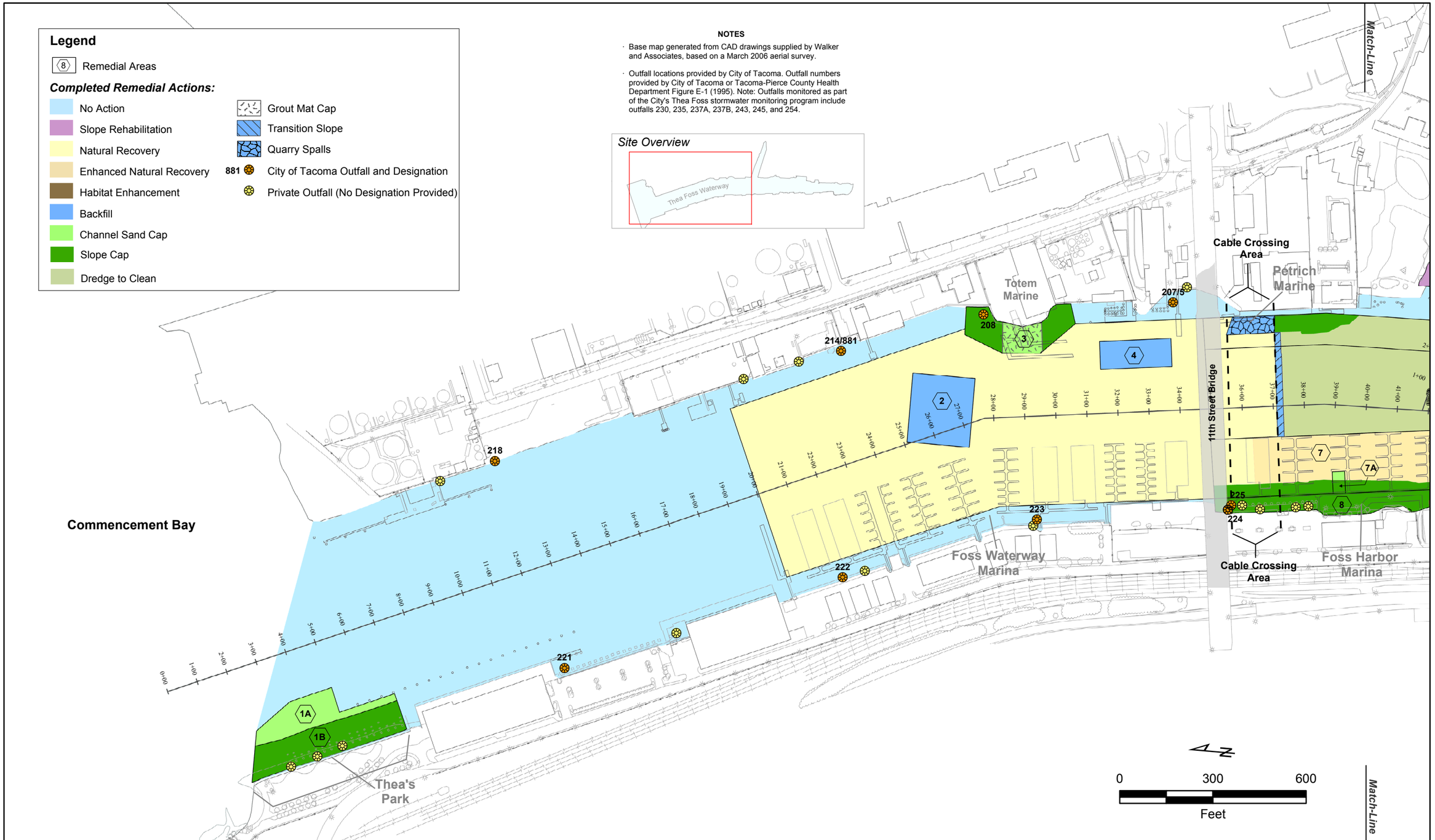

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Figure 1-2 (Page 1 of 2)
Completed Remedial Actions

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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 (Foss 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 to ensure 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 sediment physical and chemical quality data from intertidal sampling locations, channel cap sampling locations, and at 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 less than 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 10 sediment remediation performance monitoring are summarized below. Year 10 is the last monitoring year covered by the existing OMMP. Section 2.4 provides a summary of the monitoring conclusions and a brief discussion of future long-term monitoring that will be described within the Long-Term Monitoring Plan.

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 Foss 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 to 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. Year 10 results for each of the cap integrity monitoring elements are described in the following sections.

2.2.1.1 Low Tide Slope Cap Inspections

In accordance with the OMMP, Year 10 performance monitoring to evaluate the physical integrity of intertidal slope cap areas consisted of low tide inspections of the slope caps in Remedial Areas (RA) 1B, 3, 8, 14, 19A, 19B, 20, and the Sheen Source Removal Area. The results of the low tide slope cap inspections are presented in the Year 10 Low Tide Slope Cap Inspection Preliminary Findings Memorandum (Low Tide PFM) (City of Tacoma 2016a) provided in Attachment A-1 in Appendix A. This Low Tide PFM provided a characterization of the Year 10 conditions for the intertidal portions of capped areas and identified areas needing further evaluation using the Year 10 chemical performance monitoring results. Results are summarized below.

Summary of Low Tide Slope Cap Inspection Requirements

Low tide slope cap inspections are performed on the exposed shoreline portion of slope caps (including grout mat caps) when tidal elevations are at or below 0.0 feet Mean Lower Low Water (MLLW). Additionally, a low tide cap inspection is 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.

More detailed requirements are included in the Physical Cap Integrity Operations Manual in the OMMP.

Summary of Low Tide Slope Cap Field Activities

Year 10 low tide slope cap inspections were performed on the exposed shoreline portion of the slope caps in RAs 8, 19A, and 19B on June 6-7, 2016 and in RAs 1B, 3, 14, 20, and the Sheen Source Removal Area in the Wheeler-Osgood Waterway June 20-22, 2016.

All low tide slope cap inspections were performed when predicted 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.

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

Summary of Low Tide Slope Cap Inspection OMMP Findings

This section presents a summary of the results of Year 10 low tide slope cap inspections in the Thea Foss and Wheeler-Osgood Waterways, as well as results from previous inspections performed under the OMMP. The detailed results of the Year 10 low tide slope cap inspections, including field forms and photographs for each inspection interval, are presented in the Low Tide PFM. A summary of the findings from the low tide slope cap inspection includes the following:

- In general, the slope caps have remained intact and stable over time with most areas having no observed issues regarding cap integrity between the baseline and Year 10 monitoring events.
- No major deficiencies were identified upon inspection of RAs 14, 19A, 19B, and 20 in Year 10.
- A thin layer of sediment accretion and/or fines is present on capping material located on relatively flat, enclosed portions of the slope cap areas at elevations generally below 5 feet MLLW. Sediment accretion in these areas was also observed during Year 2, Year 4, and Year 7 inspection activities. This is to be anticipated, and no action is necessary as a result of the accretion of sediment and/or fines on the slope caps.
- For the remaining RAs (RA 1B, RA 3, RA 8, and the Sheen Source Removal Area), various minor slope cap deficiencies were observed in portions of these RAs during Year 10. These minor deficiencies are summarized below and include the presence of cutoff piling and possible weathering and other natural processes on a portion of the shoreline in RA 1B; small holes in the grout mat in RA 3; previous downslope movement near Outfall 230 in RA 8 noted during the Year 4 slope cap inspection; the presence of multiple cutoff piling and exposed geotextile fabric in a portion of RA 8 (Monitoring Interval RA 8-10); and sheen observed on ponded water at the base of the slope in the Sheen Source Removal Area. Chemical data from the nearby Year 10 slope cap composite samples or natural recovery/slope rehabilitation sediment composite samples were examined relative to these minor slope cap deficiencies and are summarized below

to help determine if these slope caps are performing as required. The results from the slope cap and natural recovery/slope rehabilitation chemical performance monitoring samples are further discussed below in Sections 2.2.2.1 and 2.3, respectively.

- RA 1B: Two of the five monitoring intervals (RA 1B-4 and RA 1B-5) were observed to have piling ends present at the surface of the capped area, with a total of 20 piling ends in these two monitoring intervals. Five additional piling were observed in Monitoring Interval RA 1B-5 in Year 10 compared to Year 7; however, these piling are difficult to see on the rip rap slope and may have been present but not noted during previous inspections. These piling ends do not appear to be impacting the integrity of the cap or containment of the underlying contaminated sediments. Additionally, significant wave action during winter storms may have caused some movement of slope cap material in the northern half of this remedial area (RA 1B-3 through RA 1B-5) between Year 4 and Year 10, based on multiple observations (some potential downslope movement of rip rap, missing sampling stakes, and changes to the surface of the habitat mix bench in places). However, the cap appears to have remained intact and the integrity of the cap does not appear to be affected in this northern half of RA 1B. This conclusion is also supported by a comparison of the results from the Year 7 and Year 10 subtidal hydrographic survey which also show consistent elevations in this area. Additionally, in the Year 10 slope cap composite sample SC-01-Y10 collected from RA 1B all detected analytes were well less than the SQOs (enrichment ratios of approximately 0.6 or less), as discussed further in Section 2.2.2.1. No response action is proposed for the northern portion of RA 1B at this time. No deficiencies were identified in the other two monitoring intervals in the southern half of RA 1B.
- RA 3: There are six small holes on the surface of the grout mat in Monitoring Intervals RA 3-2 and RA 3-3. Four of these holes have increased in size between the Year 7 and Year 10 inspections and were observed to be between 3 and 8 inches in diameter during the Year 10 inspection. The largest of these holes appears to have some of the grout originally placed between the fabric layers broken away and a visible hole in the underlying layer of fabric. The other two holes observed in the grout mat do not appear to have changed in size between Year 7 and Year 10. Additionally, it was observed that the fabric surface of the grout mat above the apparent high water line appears to be frayed in places with the grout underneath visible but still intact, suggesting possible weathering of the fabric due to rain and sun exposure. Despite the increases in the sizes of some of the holes over time and the fraying of the fabric near the top of the grout mat, these issues do not appear to be impacting the integrity of the cap or containment of the underlying contaminated sediments at this time. The Year 10 slope cap composite SC-03-Y10 sample collected from RA 3 had all analytes detected well less than the SQOs (enrichment ratios of approximately 0.2 or less) with the exception of benzoic acid (detected at approximately 1.7 times the SQO), as discussed further in Section 2.2.2.1. No deficiencies were identified in the other two monitoring intervals (RA 3-1 and RA 3-4) in RA 3.

- RA 8: No deficiencies were identified upon inspection of 14 of the 17 monitoring intervals in RA 8. Monitoring intervals RA 8-2, RA 8-8, and RA 8-10 have minor deficiencies noted:
    - Outfall 230 is located at the north end of monitoring interval RA 8-2. During the Year 4 slope cap inspection by this outfall, it was observed that rip rap had moved downslope of a sandy area, located below the waterline, off the mouth of

the outfall. During the Year 7 inspection, this sandy area was still present, but the rip rap further downslope was not observed, suggesting that either this rip rap had been covered over with sand and gravel coming out of the outfall or had moved further downslope. In Year 10, observations below the waterline off of Outfall 230 were not possible due to the turbidity of the water along the shoreline; however, there were no apparent changes in the vicinity of Outfall 230 above the waterline noted in Year 10 in comparison with Year 7. Additionally, the Year 10 hydrographic survey performed in this area noted that while this area continued to show evidence of scour right near the mouth of the outfall with deposition of material downslope, this was consistent with what was observed during the Year 7 hydrographic survey (refer to Section 2.2.1.2 for further details). As discussed further in Section 2.2.2.1 below, the Year 10 slope cap composite sample SC-08B-Y10, collected from the southern portion of RA 8 where Outfall 230 is located, had all detected concentrations less than the SQOs with the exception of benzoic acid that was detected at approximately 1.3 times the SQO. One of the discrete sampling locations for composite sample SC-08B-Y10 is located just off the mouth of Outfall 230. The cap appears to be performing as required in this area.

- Monitoring interval RA 8-8, located below the former Colonial Fruit warehouse, has brick and concrete debris intermixed with the rip rap on this slope possibly from the demolition of the warehouse building that occurred prior to the Year 7 monitoring. Multiple cutoff piling were also observed in the upper portion of the slope under the remaining pile supported Colonial Fruit warehouse building decking. Monitoring interval RA8-8 is included within the portion of RA 8 where slope cap composite sample SC-08B-Y10 was collected and, as noted above, this sample only had an SQO exceedance for benzoic acid. No proposed action is recommended at this time to address the remnant cutoff piling observed on the upper slope beneath the remaining decking, as this area appears stable and the cutoff piling do not appear to be affecting the integrity of the slope cap.

- Monitoring interval RA 8-10 has eight piling ends and exposed geotextile present near the waterline at the surface of the capped area. Seven of the piling ends and the exposed geotextile were also observed during the Year 4 and Year 7 inspections. There appeared to be some additional downslope movement of riprap near these piling between the Year 4 and Year 7 inspections; however, minimal additional downslope movement was apparent during Year 10. Evaluation of the Year 10 slope cap composite sample SC-08A-Y10 collected from the northern portion of RA 8, which includes Monitoring Interval RA 8-10, shows that all detected analytes were well less than the SQOs (enrichment ratios of approximately 0.5 or less) in this sample (refer to Section 2.2.2.1 for additional details). Based on this analytical data, the slope cap appears to be continuing to perform as required in this portion of RA 8.

- Sheen Source Removal Area: A slight sheen was observed on the surface of puddles of water at the base of this capped slope area during both the Year 7 and Year 10 inspections; however, no sheen was observed on the sediment surface in this monitoring interval. The source of the sheen could not be determined. The Year 10 natural recovery/slope rehabilitation performance monitoring sample SR-13-Y10 is a composite sample of material collected from the shoreline at the head of the Wheeler-Osgood

Waterway, including the portion of the slope where the Sheen Source Removal Area is located. The analytical results for this sample show that all detected analytes were less than the SQOs (enrichment ratios of approximately 0.4 or less), indicating that the capped portion of the Sheen Source Removal Area appears to continue to perform as required.

- No additional slope cap inspection activities are required to characterize the physical integrity of these capped areas in Year 10. Additionally, no remedial actions are warranted at this time based on the findings of the Year 10 slope cap physical integrity monitoring. The long-term monitoring of the physical integrity of the slope cap is discussed below in Section 2.4 Sediment Remediation Area Performance Monitoring Conclusions and Future Long-Term Monitoring.

2.2.1.2 Subtidal Cap Hydrographic Survey

In accordance with the OMMP, Year 10 performance monitoring to evaluate the physical integrity of subtidal capped areas consisted of performing multibeam hydrographic surveys of subtidal capped areas in RAs 1A, 1B, 3, 5, 6, 7A, 8, 9, 14, 16, 17, 18, 19A, 19B, 20, 21 and 22. Additionally, a hydrographic survey was performed in the Murray Morgan Bridge (MMB) Remedial Action Area during the Year 10 performance monitoring. A 6-inch thick cap was placed over the MMB Remedial Action Area in February 2015 due to elevated sediment concentrations for metals resulting from MMB rehabilitation work conducted between 2011 and 2013. The Year 10 hydrographic survey in the MMB Remedial Action Area provided a comparison with the elevation of the post-construction surface in this area completed by the contractor in February 2015. Subtidal hydrographic survey areas are shown in Figure 2-2.

The results of the Year 10 hydrographic survey are presented in the Year 10 Monitoring Subtidal Cap Hydrographic Survey Preliminary Findings Memorandum (Hydrographic Survey PFM) (City of Tacoma 2016b) provided in Attachment A-2 in Appendix A. This Hydrographic Survey PFM provides a characterization of the Year 10 conditions for the subtidal portions of capped areas, and results are summarized below.

Summary of Subtidal Cap Hydrographic Survey Requirements

The OMMP specifies that subtidal cap monitoring be performed in Years 2, 4, 7, and 10 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 (i.e., 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 Subtidal Cap Hydrographic Field Activities and Reporting

The Year 10 multibeam hydrographic survey was conducted by David Evans and Associates (DEA) on March 21-22, 2016. The objective of the Year 10 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 above. Low tide slope cap inspections are 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 10 hydrographic survey is provided in Attachment B of the Hydrographic Survey PFM.

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.

The survey was conducted aboard DEA's 33-foot survey vessel John B. Preston. For the Year 10 survey, soundings were acquired with a Reson SeaBat 7125 SV2 dual frequency multibeam sonar. This sonar was operated at 400 kHz, records 512 soundings in a single sonar ping up to a 210° swath, has an effective beam spacing of approximately 0.5 degrees and was mounted with a 30° roll bias to starboard. In previous monitoring years, a Reson SeaBat 8101 Extended Range (ER) multibeam sonar was used to acquire soundings. The Reson SeaBat 7125 was selected for the Year 10 monitoring as it offered an increase in both density and resolution which has the potential to increase data quality and coverage. Accurate positioning was determined using a Trimble SPS-851 RTK GPS rover, located on the vessel with a base station positioned at control point 2011 located on the east side of the Thea Foss Waterway.

Multibeam data was collected by running lines both parallel and perpendicular to the shoreline for the length of the project. Similar to the Year 2, Year 4, and Year 7 hydrographic surveys, the vessel was generally able to survey close to the shoreline during the Year 10 surveys. Again, there were some areas where the survey vessel had to be "walked" along tight spaces between the shoreline and docks and floats to get the maximum coverage possible. Additionally, multiple passes were performed with the survey vessel to try to acquire additional data in some areas where access was obstructed by marine structures.

In RAs 5, 6, 7A, 8, 9, 14, 16, 17, 18, 19A, 19B, 20, 21 and 22, multibeam surveys were performed during all survey events. In RAs 1A, 1B and 3, single beam surveys were performed during baseline while multibeam surveys were performed during Year 2, Year 4, Year 7, and Year 10. The baseline, Year 2, Year 4, Year 7, and Year 10 bathymetric conditions are shown for subtidal cap areas within the 16 RAs in Figures 2 through 5 and Figure 15 of the Hydrographic Survey PFM.

Summary of Subtidal Cap Hydrographic OMMP Findings

This section presents a summary of the results of the Year 10 hydrographic survey, comparison of the baseline and Year 7 surveys to the Year 10 survey, and discusses evaluations conducted in two capped areas identified as requiring response actions in the Hydrographic Survey PFM based on the Year 10 survey results. The detailed results of the hydrographic survey, including the hydrographic survey contractor reports summarizing the equipment and procedures and transect line comparisons are presented in the Hydrographic Survey PFM. A general summary of and the findings from the Year 10 hydrographic survey are provided below:

- Nearly complete coverage of the subtidal slope, grout mat, and channel sand cap areas was achieved in the Year 10 hydrographic survey.
- The Year 10 hydrographic survey was performed using equipment and procedures comparable to prior hydrographic surveys performed under the OMMP; however, an improved sonar that provides better imaging was used in Year 10.
- Single beam baseline 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 were used to supplement the hydrographic survey analysis in shoreline slope cap areas where 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. This may be the cause of some of the variances identified in shoreline slope areas during comparison of baseline survey data and the Year 10 survey data.
- In general, the Year 10 cap surface elevations are within six inches of the baseline surface elevation and within the allowable accuracy of the survey equipment.
- A comparison of the Year 7 survey to the Year 10 survey shows that the elevations in most areas have remained fairly consistent during the past three years.
- There are limited areas where the decrease in the cap surface elevation from baseline to Year 10 is greater than six inches. These locations are discussed in further detail below.

There were two types of areas identified during the Year 10 hydrographic survey where response actions have not been proposed, but which may warrant further evaluation of surface elevation changes during future long-term monitoring events. These areas include: 1) those areas that exhibit decreases in the cap surface elevation from baseline to Year 10 that are greater than six inches but less than one foot; and 2) those areas that exhibit decreases in the cap surface elevation from baseline to Year 10 that are greater than one foot but are small, localized, and non-contiguous. These two types of areas are briefly summarized below and further described in the Hydrographic Survey PFM.

There are several localized yet continuous areas in three RAs where the decrease in the cap surface elevation from baseline to Year 10 is greater than six inches but less than one foot, described above as type one. These areas are located in RAs 17, 19A, and 19B. The areas of settlement or subsidence identified in these three RAs did not generally vary in elevation between the Year 7 and Year 10 surveys. Given that the decrease in cap surface elevation in these areas is less than one foot when comparing the baseline and Year 10 surveys, and that

for most of these areas this decrease does not appear to be progressing over time as indicated by comparison of the Year 7 survey and Year 10 survey, no response actions are warranted at this time.

There are also locations in three RAs where the decrease in the cap surface elevation from baseline to Year 10 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 RAs 1, 3, and 8. These areas are potentially attributable to artifacts of the baseline single beam surveys compared to the multibeam surveys. A comparison of the Year 7 and Year 10 multibeam surveys in these areas indicates conditions are stable and do not indicate that ongoing slope compaction or subsidence is occurring. As these points are localized and do not represent a contiguous region of elevation change, and are potentially attributable to artifacts of the baseline single beam surveys compared to the multibeam surveys, no response actions are warranted at this time.

Based on the Year 10 hydrographic survey work, there were two survey areas identified with proposed response actions in the Hydrographic Survey PFM. These areas, the response actions, and the conclusions from performance of these response actions are summarized below.

The first area identified for a response action is located in RA 9 and is an area that has shown a decreased cap elevation greater than 18 inches in the Year 4, Year 7, and Year 10 surveys in comparison to the baseline survey. The observed depression is approximately 20 feet wide and has an associated area of elevated cap area adjacent to the depression. This area is located immediately adjacent to a marine float where tug boats have been moored, and previous operations at the Marine Floats facility may be impacting the cap in this area. The comparison of the Year 7 to Year 10 survey shows that no additional reduction of the cap elevation has occurred, but rather sediment has deposited within the depression area and the surface elevation has increased up to 12 inches.

The response action proposed for this area in the Hydrographic Survey PFM included the collection of an additional sediment performance monitoring sample at the deepest point of the cap scour depression in RA 9 as part of the Year 10 performance monitoring event. The Year 10 sample collection at this location is consistent with the collection of an additional sample at this location during the Year 4 and Year 7 performance monitoring events. The purpose of this additional cap performance sample collection in Year 10, as well as during the previous two monitoring events, was to provide analytical results to evaluate whether the decreased cap thickness is impacting the chemical containment effectiveness of the cap in this location.

The Year 10 sample in this depression in RA 9 (sample CC-RA9-Y10) was collected on May 16, 2016, and is discussed in further detail in the Year 10 Sediment and Cap Performance and Early Warning Monitoring Preliminary Findings Memorandum and below in Section 2.2.2.2. The only analyte to exceed the SQOs in the Year 10 sample collected at this location was benzoic acid, detected at concentration approximately 1.7 times the SQO. Other analytes detected in the Year 10 sample had concentrations less than approximately 0.7 times the SQO. The Year 7 sample collected at this location had only bis(2-ethylhexyl)phthalate (DEHP) detected greater than its SQO, with a concentration approximately 2.1 times the SQO. In Year 4, no SQOs were exceeded in the sediment sample collected from this depression. The SQO exceedances of benzoic acid in Year 10 and DEHP in Year 7 in the sediment at this location can likely be attributed to sediment that has collected within the depression since it was formed rather than

an impact to the effectiveness of the cap, as both benzoic acid and DEHP have exhibited the highest frequencies of SQO exceedances throughout the Thea Foss and Wheeler-Osgood Waterways based on the Year 10 performance monitoring results, as well as all the other previous performance monitoring events. The City will continue to work with Marine Floats to ensure that their Best Management Practices (BMPs) for overwater operations to protect the cap from tug scour in RA 9 continue to be implemented to prevent any further scour in this area. No additional response actions are warranted at this time.

The second area where a response action was proposed based on the Hydrographic Survey PFM was the area adjacent to Outfall 230 in RA 8. A small area adjacent to the mouth of this outfall has shown evidence of scour with a decrease in surface elevation and the deposition of material further downslope during the Year 4, Year 7, and Year 10 surveys. During both the Year 7 and Year 10 surveys, a small non-contiguous area of cap elevation decreases ranging from 6 inches to greater than one foot was evident at the mouth of the outfall. However, when compared to baseline, greater than a foot of increase in cap thickness remains at the mouth of the outfall as a result of slope cap maintenance work completed in the vicinity of this outfall in 2008 that placed additional material.

The response action proposed for this Outfall 230 area in the Hydrographic Survey PFM included visual observations of the outfall footprint and cap condition as part of the Year 10 low tide slope cap inspection. It was also recommended that visual observations off of this outfall be part of the City's routine stormwater source control inspections. This Year 10 response action is similar to the response actions performed in 2010 and 2013, where detailed visual observation of the cap condition near this outfall were also performed during the Year 4 and Year 7 low tide slope cap inspections. As described earlier in Section 2.2.1.1, during the Year 10 low tide slope cap inspection, observations below the waterline off of Outfall 230 were not possible due to the turbidity of the water along the shoreline; however, above the waterline there were no apparent changes in the vicinity of Outfall 230 between Year 7 and Year 10. Additionally, during the Year 4, Year 7, and Year 10 performance monitoring events a discrete slope cap sample was collected from the area adjacent to the outfall area of decreased cap thickness and used to form one of the slope cap composite samples analyzed from RA 8. The Year 10 slope cap composite sample SC-08B-Y10, collected from the portion of RA 8 where Outfall 230 is located, had only benzoic acid detected greater than its SQO, at approximately 1.3 times the SQO (refer to Section 2.2.2.1 below for further details). Previous slope cap samples collected in this portion of RA 8 had no SQO exceedances. The slope cap observations and analytical data indicate that the cap appears to be performing as required in this area. No additional response actions are warranted at this time.

No additional hydrographic surveys are required to characterize the physical integrity of the subtidal capped areas in Year 10. Additionally, no remedial actions are warranted at this time based on the findings of the Year 10 hydrographic surveys. The long-term monitoring of the physical integrity of the subtidal caps, using hydrographic surveys, is discussed below in Section 2.4 Sediment Remediation Area Performance Monitoring Conclusions and Future Long-Term Monitoring.

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.

Concentration Trends Related to Laboratory Analytical Changes

During the comparison of the OMMP performance monitoring and early warning monitoring data over the years, general concentration trends (either generally consistent increases or decreases in concentrations between monitoring years) were noted for four analytes, including benzoic acid, PCBs, silver, and nickel, that are attributed to laboratory analytical changes. These general trends for the performance monitoring and early warning samples are summarized below. Additional information on these concentration trends and laboratory analytical changes is provided in the Sediment PFM.

Overview of Benzoic Acid OMMP Results

As is common with sediment characterization, there have been several challenges with the analysis of benzoic acid over the years that have contributed in the observed variations in the benzoic acid concentrations between the OMMP monitoring years. Differences between benzoic acid concentrations were first noted in Year 4 when comparing the Year 2 and Year 4 sample results. In Year 4, benzoic acid was detected in all but three of the performance monitoring and early warning sediment samples analyzed, with nine of these samples having benzoic acid concentrations exceed the SQO. The greatest Year 4 exceedance was reported at approximately 1.5 times the SQO. In contrast, the Year 2 samples had relatively few detections of benzoic acid and no SQO exceedances. This difference between the Year 2 and Year 4 sample results was attributed to a laboratory artifact involving the acidification of the sand used for the Year 4 sample extractions. The Year 7 benzoic acid results were in general less than the Year 4 sample concentrations and more similar to the Year 2 sample results. In Year 7, benzoic acid was detected in only nine of the performance monitoring samples. However, benzoic acid was detected in 15 of the 27 Year 7 early warning samples collected (not including field duplicates) and exceeded the SQO in six of these early warning samples, with the maximum exceedance of approximately 1.4 times the SQO. The most notable change to the detected benzoic acid concentrations between monitoring years occurred in Year 10.

Benzoic acid was detected in all but four of the Year 10 performance monitoring and early warning samples analyzed, with SQO exceedances noted in the majority of these samples. Benzoic acid concentrations exceeded the SQO in 25 out of the 37 Year 10 performance monitoring samples analyzed (not including field duplicates) and in 24 out of the 27 Year 10 early warning samples analyzed (not including field duplicates). In the Year 10 performance monitoring samples the greatest SQO exceedance detected was at approximately 3.1 times the SQO, while in the Year 10 early warning samples the greatest SQO exceedance detected was at approximately 6.3 times the SQO. These higher reported detections of benzoic acid in the Year 10 samples relative to previous monitoring results are a result of improvements made to the laboratory extraction and analysis of benzoic acid in Year 10. The initial analyses of benzoic acid in Year 10, performed as part of the SVOC analyses, resulted in a high number of rejected benzoic acid results due to matrix spikes and laboratory control samples with each sample batch either not passing or borderline failing the quality control limits. Benzoic acid is known to be a chemical whose analysis is sensitive to matrix interferences that are commonly present in sediments and, therefore, often has variable analytical results. As a result, the City of Tacoma

Laboratory determined the best course of action was to perform a separate extraction and analysis for benzoic acid as a single analyte utilizing both derivatization and isotopic dilution. These method changes resulted in higher target analyte recoveries, less variability, and improved sensitivity in the benzoic acid analysis, translating to the generally higher reported concentrations of benzoic acid in the Year 10 samples.

Benzyl alcohol and benzoic acid are naturally occurring compounds commonly found in decaying terrestrial plant matter that are often detected in marine sediments (Wibbertmann et al. 2000 and Dredged Material Management Program (DMMP) 2016). Benzyl alcohol and benzoic acid are also produced naturally by many plants during plant growth. Additionally, benzoic acid is a breakdown product of benzyl alcohol. Often, but not always, these two analytes co-occur in sediment samples; however, benzyl alcohol breaks down faster than benzoic acid, so benzoic acid tends to be observed more frequently as it is more persistent in the. In addition to being naturally occurring, benzoic acid is of low concern for bioaccumulation and not highly toxic. Finally, benzoic acid has been detected at concentrations exceeding its screening level in sediment samples from several reference (non-urban) embayments, including Carr Inlet, Dabob Bay, and Samish Bay and has also been frequently detected at DMMP disposal sites. The DMMP has decided to continue to investigate benzoic acid to determine the appropriateness to apply best professional judgement when determining the necessity for further analysis of sediments when benzoic acid in the only analyte to exceed its screening level.

Overview of PCB OMMP Results

PCB results in the sediment performance monitoring and early warning monitoring samples have also shown variable concentration trends for PCBs between the OMMP monitoring events that are most likely generally attributable to changes in laboratory sample processing over time, rather than variations in the sediment conditions and PCB concentrations at the site. In both Year 7 and Year 10, PCBs (specifically Aroclor 1254) were detected in the majority of all performance monitoring samples and early warning samples. The PCB detections in the Year 10 samples were all well less than the total PCB SQO. Similarly, the Year 7 samples also had PCBs detected at concentrations well less than the SQO, with the exception of two samples that had SQO exceedances. In contrast to the Year 7 and Year 10 samples, PCBs were not detected in any of the Year 4 samples and PCBs (Aroclor 1254) were only detected in five of the Year 2 samples, with two of these samples having SQO exceedances. It was noted upon a detailed review of the monitoring events data and analyses in Year 7, that the variation in the detected Aroclor 1254 results, specifically in Year 4, is most likely attributable to laboratory sample processing changes over time. In Year 2, gel permeation chromatography (GPC) clean-up was performed on the sample extracts to reduce matrix interferences, but an acid clean-up was not performed; while in Year 4 neither GPC nor acid clean-up was performed on the sediment samples. In both Year 7 and Year 10, sample extracts were cleaned using both GPC and acid to reduce matrix interferences. Additionally, beginning in Year 7 new analytical equipment was used to perform the PCB analysis. Although the sample processing for PCBs, specifically the cleanup procedures used to reduce matrix interferences in the samples, varied between the Year 2, Year 4, Year 7, and Year 10 monitoring events, the extraction and analysis of PCBs in all four monitoring events was performed in accordance with and compliant with the approved OMMP methods for PCBs.

Overview of Silver OMMP Results

Silver concentrations generally decreased in the Year 4 samples relative to the Year 2 silver concentrations, as initially described in the Year 4 Sediment Performance Monitoring PFM. This apparent trend for silver was attributed to a change in the analytical method used for metals analyses in Year 4, ICP mass spectrometry (ICP-MS), which is a more sensitive method. The use of the more sensitive ICP-MS method likely resulted in a shift in the level of detection. In general, the Year 7 monitoring results for silver were consistent with the Year 4 results. The laboratory reporting limits for silver generally decreased in the Year 10 samples relative to the Year 4 and Year 7 reporting limits, resulting in more detections for silver in Year 10 in comparison; however, all Year 10 detections were also less than the Year 2 silver concentrations. There have been no SQO exceedances for silver in any of the OMMP monitoring samples collected over the years and most silver detections in the samples were less than half the SQO.

Overview of Nickel OMMP Results

In Year 4, nickel concentrations were significantly higher in four of the channel sand cap samples, all of the slope cap samples, two of the natural recovery/slope rehabilitation samples, and five of the early warning samples, when compared to the corresponding Year 2 samples at these locations. While detected at higher concentrations, nickel only exceeded the SQO in one of the Year 4 samples (sample CC-30-Y4 at approximately 1.1 times the SQO). Similar to silver, these changes in the nickel concentrations between Year 2 and Year 4 were also attributed to the change in the analytical method for metals between these two monitoring events. Concentrations of nickel in Year 7 and Year 10 generally remained comparable with or decreased from the Year 4 concentrations in all of the monitoring samples. No detected concentrations of nickel in the Year 7 or Year 10 samples exceeded the SQO.

2.2.2.1 Slope Cap Chemical Performance Monitoring

Year 10 performance slope cap samples were collected from the intertidal areas in RAs 1B, 3, 8, 14, 19A, 19B, and 20 in accordance with the OMMP. This is the fourth monitoring event following project completion that slope cap composite samples were collected for analysis. The results of the slope cap chemical performance monitoring are presented in the Year 10 Sediment and Cap Performance and Early Warning Monitoring Preliminary Findings Memorandum (Sediment PFM) (City of Tacoma 2016c) included as Attachment B-1 in Appendix B and are summarized below.

Summary of Slope Cap Chemical Performance Monitoring Requirements

Performance slope cap samples are collected from the intertidal areas in RAs 1B, 3, 8, 14, 19A, RA 19B and 20 when tidal elevations are at or below 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 and with previous performance monitoring analytical results to evaluate trends.

Summary of Slope Cap Chemical Performance Monitoring Field Activities, Analyses, and Reporting

Slope cap performance surface sediment (0 to 10 cm) samples were collected for chemical analysis on June 6-7, and June 20-22, 2016. 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 RAs 1B, 3, 14, 19A, 19B and 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, 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 discrete sample stations were selected in the field to be between approximately 0 feet and -2 feet MLLW and to be evenly spaced along the RA, while targeting any observed sediment accumulation areas on the slope cap. Figure 2-1 identifies the slope cap discrete sample locations.

The slope cap discrete sample 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-Y10-D1). The slope cap composite sample names are designated by SC, followed by the RA, the sample year (e.g., SC-01-Y10).

The slope cap surface samples were collected using a stainless steel spoon and bowl. Due to the gravelly nature of the slope cap material, generally a portion of the material collected at each discrete location, large rocks and/or gravel, was discarded and was not included in the sample. Field forms were completed and photographs were taken to document observations during the sampling.

The samples were submitted to the City of Tacoma Laboratory under approved sample 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.

Due to an elevated DEHP concentration that exceeded the SQO in the Year 10 slope cap composite sample from RA 14 (sample SC-14-Y10), the City elected to perform additional analyses on the three archived discrete samples that were collected from RA 14 as a response action. The three discrete samples from RA 14 were analyzed for select SVOCs, including phthalates and polycyclic aromatic hydrocarbons (PAHs), by the City of Tacoma Laboratory. This additional analysis of the discrete samples was performed to gain additional information on the extent and magnitude of elevated DEHP concentrations within the slope cap area in this RA. The results of the discrete sample analysis are included in the discussion below.

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 10 slope cap surface sample analytical results provided in Table 2-1 and in the summary of Year 10 Slope Cap SC-14 Discrete and Composite Sample Results for PAHs and Phthalates provided in Table 2-2. All final data are considered valid and acceptable for use as qualified. The data validation reports for these samples are included in Sediment PFM (Attachment B-1) and in Attachment B-2 for the discrete samples report.

Summary of Slope Cap Monitoring Analytical Results

The analytical results from the Year 10 samples collected from the slope cap areas are presented below and are summarized in Table 2-1. The supplemental analytical results for PAHs and phthalates from the discrete samples collected from the slope cap area in RA 14 are also presented below and are summarized in Table 2-2. The results for the samples were compared to the SQOs to identify whether there are any exceedances of the performance criteria. Concentrations that are greater than the SQOs are highlighted in red in the tables. The detailed results of the low tide slope cap sampling, including field forms and photographs for the samples, are presented in the Sediment PFM.

Detected chemical concentrations did not exceed the SQOs in two of the eight slope cap samples (samples SC-01-Y10 and SC-08A-Y10) collected as part of the Year 10 performance monitoring. Four slope cap samples had exceedances for benzoic acid only (samples SC-03-Y10, SC-08B-Y10, SC-19A-Y10, and SC-19B-Y10) with SQO enrichment ratios of approximately 1.7 or less. Samples SC-14-Y10 and SC-20-Y10 had detected concentrations of DEHP that exceeded the SQO, detected at approximately 3.2 and 1.1 times the SQO, respectively. While DEHP exceeded the SQO in sample SC-20-Y10, the corresponding field duplicate sample from this location had DEHP detected less than the SQO.

As noted earlier, due to the elevated DEHP detection in composite sample SC-14-Y10, the three archived discrete samples collected from Station SC-14 (SC-14-Y10-D1, SC-14-Y10-D2, and SC-14-Y10-D3) were recently analyzed for select SVOCs to help gain additional information on the extent and magnitude of DEHP in RA 14. The analytical results for these discrete samples and the composite sample are included in Table 2-2. Discrete sample SC-14-Y10-D1 had DEHP detected greater than the SQO, at approximately 1.4 times the SQO, while DEHP was detected well less than the SQO in the other two discrete samples. Discrete sample SC-14-Y10-D1 was collected from the south end of the shoreline in RA 14. The DEHP concentrations in the discrete samples are much less than the DEHP concentration in the composite sample, detected at approximately 3.2 times the SQO. All other PAHs and phthalates detected in the discrete or composite samples from RA 14 had concentrations well less than their SQOs.

Summary of Slope Cap Analytical Results Comparisons

In accordance with the OMMP, Year 10 performance monitoring slope cap sample results were compared to the Year 2, Year 4, and Year 7 slope cap sample results. The Year 2, Year 4, and Year 7 samples used for this comparison were collected as part of the Year 2, Year 4, and Year 7 OMMP performance monitoring that occurred in 2008, 2010, and 2013, respectively. Refer to Tables 17 through 24 in the Sediment PFM, which present the slope cap Year 2, Year 4, Year 7, and Year 10 sample comparisons.

In general, most of the detected chemical concentrations in the Year 2, Year 4, and Year 7 and Year 10 slope cap performance monitoring samples were less than approximately one-half the SQOs. There were no SQO exceedances detected in slope cap samples collected in Year 4 and in Year 2, there was only one slope cap sample with an SQO exceedance, sample SC-08A-Y2 had a benzyl alcohol exceedance. In Year 7, there was only one slope cap sample with SQO exceedances; sample SC-20-Y7 had SQO exceedances for DEHP and benzyl alcohol. In Year 10, there were six slope cap samples with SQO exceedances for either benzoic acid or

DEHP. SQO exceedances in the slope cap samples during Year 4, Year 7, and Year 10 were at or less than approximately 1.7 times the SQO, with the exception of DEHP in the Year 10 sample SC-14-Y10, at approximately 3.2 times the SQO.

Observed increases or decreases in chemical concentrations noted between the Year 2, Year 4, Year 7, and Year 10 results for the slope cap samples are discussed below.

At six slope cap stations, the DEHP concentrations have remained approximately the same or have decreased between Year 7 and Year 10 in the slope cap samples and the concentrations are generally much less than the SQO (Stations SC-01, SC-03, SC-08A, SC-08B, SC-19A, and SC-19B). In one of the Year 10 slope cap samples, sample SC-20-Y10, the DEHP concentration was similar to the Year 7 sample concentration, but DEHP exceeded the SQO in both years. DEHP was detected at approximately 1.1 times the SQO in sample SC-20-Y10. In the remaining slope cap sample, SC-14-Y10, DEHP was detected at a concentration greater than the SQO with an enrichment ratio of approximately 3.2 times the SQO, while in the Year 7 slope cap sample from this station the SQO enrichment ratio was approximately 0.4 times the SQO.

In Year 10, benzoic acid exceeded the SQO in four of the slope cap samples, samples SC-03-Y10, SC-08B-Y10, SC-19A-Y10, and SC-19B-Y10, with enrichment ratios ranging from approximately 1.1 to 1.7 times the SQO. In slope cap sample SC-20-Y10, benzoic acid was detected at the SQO. In the three other Year 10 slope cap samples, samples SC-01-Y10, SC-08A-Y10, SC-14-Y10, benzoic acid was detected at concentrations ranging from approximately 0.5 to 0.7 times the SQO. In contrast, benzoic acid in the Year 2, Year 4, and Year 7 slope cap samples was either not detected or detected at concentrations equal to or less than approximately 0.3 times the SQO. The greater concentrations in the Year 10 samples are a result of improvements made to the laboratory extraction and analysis of benzoic acid in Year 10, as described above in Section 2.2.2.

There were no exceedances for benzyl alcohol in the Year 10 slope cap samples; however, benzyl alcohol was detected in slope cap sample SC-20-Y7 greater than the SQO, with an enrichment ratio of approximately 1.6 times the SQO. In comparison, the corresponding Year 4 and Year 10 slope cap samples from Station SC-20 had benzyl alcohol detected at well less than the SQO. Benzyl alcohol also exceeded its SQO in the Year 2 slope cap sample SC-08A-Y2, detected at approximately 1.3 times the SQO. In the other slope cap samples collected at Station SC-08A, benzyl alcohol was either not detected (Year 7 and Year 10 samples) or was detected well less than the SQO (Year 4 sample).

Summary of Slope Cap Chemical Performance Monitoring OMMP Findings

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

- Out of the eight Year 10 slope cap composite samples, two samples (samples SC-01-Y10 and SC-08A-Y10) had no SQO exceedances, four samples had only benzoic acid SQO exceedances (samples SC-03-Y10, SC-08B-Y10, SC-19A-Y10, and SC-19B-Y10), and the remaining two samples had only DEHP SQO exceedances (samples SC-14-Y10 and SC-20-Y10).

- Previous rounds of slope cap monitoring also had few SQO exceedances, with only Year 2 sample SC-08A-Y2 having a benzyl alcohol exceedance and Year 7 sample SC-20-Y7 having DEHP and benzyl alcohol exceedances. In all of the slope cap composite samples collected between Year 2 and Year 10, SQO exceedance ratios were at or less than approximately 1.7 times their SQOs, with the exception of DEHP in Year 10 sample SC-14-Y10, detected at approximately 3.2 times the SQO. In general, most of the detected analyte concentrations in the Year 2, Year 4, Year 7 and Year 10 slope cap performance monitoring samples were less than approximately one-half the SQOs.
- Due to the elevated DEHP concentration noted in slope cap composite sample SC-14-Y10, the City elected to analyze the three Year 10 discrete samples from this station for DEHP to try to delineate the location of where DEHP is elevated along this shoreline. DEHP was detected greater than the SQO in only one of the discrete samples, sample SC-14-Y10-D1, collected in the slope cap area in the southern portion of the RA. The SQO enrichment ratio for DEHP in this discrete sample, approximately 1.4 times the SQO, is well less than the SQO exceedance in the composite sample, which was approximately 3.2 times the SQO. The lower concentrations of DEHP in the discrete slope cap samples in comparison to the concentration in the composite sample from RA 14 indicates there is heterogeneity in the sediment in this slope cap area.

No additional slope cap chemical performance monitoring is required to further characterize these areas as part of the Year 10 monitoring. As summarized earlier in Section 2.2.1.1, the slope caps have remained intact and stable over time with most areas having no observed issues regarding cap integrity between the baseline and Year 10 monitoring events. Additionally, in Year 10 the only two analytes that exceeded the SQOs in the slope cap samples were DEHP and benzoic acid. These two analytes also commonly exceeded their SQOs in other Year 10 OMMP sediment samples collected, including channel sand cap samples (refer to Section 2.2.2.2), natural recovery samples (refer to Section 2.3), and early warning samples (refer to Section 3.0).

DEHP is a ubiquitous urban compound and recontamination of DEHP within the waterways' sediments above the SQO of 1,300 µg/kg was predicted to occur prior to construction of the remedy due to ambient sources of contaminants in any urban waterfront, including such sources as stormwater, boat traffic, atmospheric and industrial sources. This prediction was based on the Thea Foss Sediment Quality Model which was developed during pre-remedial design using the United States Environmental Protection Agency's (EPA) Water Quality Analysis Simulation Program (also known as WASP) and later updated in 2006. In the model, concentrations were predicted to rise over time with the typical model prediction curve rising more steeply during the early years following sediment remediation, and then beginning to level off and approach a steady-state concentration after about a decade. In 2013, the City evaluated the results of the Year 7 OMMP sediment monitoring results in comparison with computer model predictions to assess changes in waterway sediment concentrations over time and to extrapolate sediment quality trends into the future (2013 Source Control and Water Year 2013 Stormwater Monitoring Report, City of Tacoma 2014). As part of this evaluation, DEHP results were compared to a biological effects level for DEHP of 4,000 ug/kg, instead of the SQO, because site-specific bioassay tests have shown that biological effects are not observed in Foss Waterway sediments until DEHP concentrations are over three times higher than the SQO. The 2013 evaluation noted that the measured sediment concentrations generally correlated well with the model's steady state predictions and it was concluded that sediment concentrations were beginning to level off in approximately Year 7 and were not expected to rise much higher in the future, with

many areas remaining relatively stable between the Year 4 and Year 7 monitoring events. A similar evaluation of the Year 10 OMMP sediment monitoring results in comparison to the model will be completed by the City in 2017. In Year 10 slope cap composite sample SC-14-Y10 had a DEHP concentration that slightly exceeded the biological effects level, detected at 4,100 ug/kg; however, the three discrete samples analyzed all had DEHP detections well below the biological effects level.

Because of challenges faced by the City and others in addressing phthalate contamination in the environment, a Sediment Phthalates Work Group comprised of the City, EPA, Washington Department of Ecology (Ecology), King County/Metro, and the City of Seattle was formed in 2006 to research the sources, pathways, and treatment options for phthalates and other ubiquitous compounds in stormwater. This group developed a Summary of Findings and Recommendations document in 2007 which is currently in the process of being implemented by the regulatory agencies.

As described above in the subsection titled Concentration Trends Related to Laboratory Analytical Changes in Section 2.2.2, benzoic acid concentrations in the Year 10 slope cap samples generally increased relative to concentrations detected in previous monitoring events and resulted in four Year 10 slope cap samples with benzoic acid SQO exceedances. The greater benzoic acid concentrations in these Year 10 samples relative to the sample concentrations from previous monitoring events are a result of improvements made to the laboratory extraction and analysis of benzoic acid in Year 10. A potential source of benzoic acid to these sediments could be the breakdown of plant material entering the waterways. Benzoic acid is a naturally occurring compound in terrestrial plants and is also a breakdown product of benzyl alcohol, which also naturally occurs in terrestrial plants. It has frequently been detected at DMMP disposal sites and has been detected at concentrations exceeding the SQO in sediment samples collected from several non-urban embayments. Refer to Section 2.2.2 for further information.

Based on this information, no remedial actions are warranted at this time based on the findings of the Year 10 slope cap chemical performance monitoring. The long-term monitoring of the chemical performance in these slope cap areas is discussed below in Section 2.4 Sediment Remediation Area Performance Monitoring Conclusions and Future Long-Term Monitoring.

2.2.2.2 Channel Sand Cap Chemical Performance Monitoring

In accordance with the OMMP, Year 10 performance channel sand cap surface sediment (0 to 10 cm) samples were collected from RAs 1A, 6, 9, 16, 17, 19A, 20, 21 and 22 at a total of 10 stations. In addition, two extra channel sand cap performance monitoring samples (0 to 10 cm) were collected during the Year 10 performance monitoring. One of these extra channel sand cap samples was collected in RA 9 where a depression in the channel cap was noted during the Year 4, Year 7, and Year 10 subtidal cap hydrographic surveys. The other extra sediment cap performance monitoring sample was collected in the MMB Remedial Action Area, an area that was dredged and then capped in February 2015 to address elevated metal concentrations in sediment resulting from MMB rehabilitation work conducted between 2011 and 2013. The results of the channel sand cap chemical performance monitoring are presented in the Sediment PFM and are summarized below.

Early warning monitoring was performed concurrently with the channel sand cap monitoring during Year 10 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 are presented in Section 3.0 of this report, along with a comparison of the Year 10 early warning monitoring samples (0 to 2 cm) to the results of the Year 10 performance monitoring channel sand cap surface samples (0 to 10 cm) and to the results of the Year 2, Year 4, and Year 7 early warning monitoring samples.

Summary of Channel Sand Cap Chemical Performance Monitoring Requirements

Remedial Areas where channel sand cap performance samples are collected include RAs 1A, 6, 9, 16, 17, 19A, 20, 21 and 22 in accordance with the OMMP; however, as noted above two extra channel sand cap performance samples were collected in Year 10. 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 to evaluate compliance with performance criteria and with previous performance monitoring analytical results to evaluate trends.

Summary of Channel Sand Cap Chemical Performance Monitoring Field Activities, Analyses, and Reporting

Channel sand cap performance surface sediment (0 to 10 cm) samples were collected at 12 stations during two monitoring events in the Thea Foss and Wheeler-Osgood Waterways. Natural recovery and enhanced natural recovery performance surface sediment samples (0 to 10 cm) discussed in Section 2.3, and early warning sediment samples (0 to 2 cm) discussed in Section 3.0, were also collected during these two monitoring events. The first event occurred May 16-17, 2016, 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 27-28, 2016, 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.

Due to the presence of a 20-foot wide depression in the channel cap in RA 9 within the Wheeler-Osgood Waterway (at approximate Station 7+30), a Year 10 channel sand cap performance monitoring sample (sample CC-RA9-Y10) was collected within this depression to evaluate whether the decreased cap thickness is impacting the chemical containment effectiveness of the cap in this location. This depression was first noted in the channel cap at this location during the Year 4 subtidal cap hydrographic survey and was still present during the Year 7 and Year 10 subtidal cap hydrographic surveys, as discussed earlier in Section 2.2.1.2. During the Year 4 and Year 7 surveys, this depression was located immediately adjacent to a marine float where a tug boat was moored, and it was thought that operations at the Marine Floats facility may be impacting the cap in this area. During the Year 10 survey, it was observed that the configuration of floats and vessels at the Marine Floats facility had changed and that the depression was now located adjacent to a marine float used to moor smaller vessels, while the tug boat was moored further east in the waterway. Channel sand cap performance monitoring samples were also collected from this depression in Year 4 and Year 7 to help assess the effectiveness of the cap in this area.

An extra sediment cap performance monitoring sample was also collected in the MMB Remedial Action Area. In February 2015, remedial activities were implemented to address an area in the vicinity of the MMB that was contaminated with elevated metal concentrations during bridge rehabilitation work conducted between 2011 and 2013. To address the contaminated sediments, an area of approximately 3,000 square feet was then capped to the pre-remedial action surface elevation. After capping was completed, two confirmation surface sediment samples were collected to characterize the post-remedial action sediment quality conditions for comparison against the Thea Foss SQOs and future OMMP monitoring events. These confirmation surface sediment samples were collected from sample locations MMB-PC-1 and MMB-PC-2 and were analyzed for select metals (mercury, lead, zinc, and copper), total organic carbon, and total solids. The Year 10 cap performance monitoring sample collected within the MMB remedial action area was designated as CC-MMB-Y10 and was collected in close proximity to the post-remedial action confirmation sample location MMB-PC-2.

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-Y10), with the exceptions of the additional Year 10 samples CC-RA9-Y10 and CC-MMB-Y10 described above. Sample collection forms and photographs documenting activities and observations were prepared during the two sampling events. The samples were submitted to the City of Tacoma Laboratory under approved sample handling and chain-of-custody procedures for the analysis of conventionals (i.e., total organic carbon and total solids), metals, SVOCs, pesticides, and 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 10 channel sand cap surface sample analytical results provided in Table 2-3. All final data are considered valid and acceptable for use as qualified. The data validation reports for these samples are included in Attachment D of the Sediment PFM (Attachment B-1).

Summary of Channel Sand Cap Monitoring Analytical Results

The analytical results for the Year 10 samples collected from the channel sand cap 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 exceedances of the performance criteria. Concentrations that are greater than the SQOs are highlighted in red in the tables. Figure 2-4 presents detected concentrations from the Year 10 performance monitoring surface samples (0 to 10 cm) that exceed the SQOs. The detailed results of the Year 10 channel sand cap sampling, including field forms and photographs for the samples, are presented in the Sediment PFM.

Twelve channel sand cap surface samples (0 to10 cm) were collected and analyzed during the Year 10 monitoring activities. Detected chemical concentrations did not exceed the SQOs in two of the channel sand cap surface samples that were collected, including sample CC-18-Y10, located in RA9, and sample CC-26-Y10, located on the border of RA 16 and RA 17. The detected concentrations in these samples were less than one-half the SQO with the exception of DEHP in CC-26-Y10 and benzoic acid in samples CC-18-Y10 and CC-26-Y10.

Channel sand cap samples with analytes detected at concentrations greater than the SQO are summarized below.

Five channel sand cap samples, samples CC-01-Y10, CC-29-Y10, CC-30-Y10, CC-RA9-Y10, and CC-MMB-Y10, had only benzoic acid detected at concentrations greater than the SQO and one sample, CC-31-Y10, only had benzoic acid and DEHP detected at concentrations exceeding their respective SQOs. Benzoic acid SQO exceedance enrichment ratios in these samples ranged from 1.3 to 1.9, and DEHP was detected at approximately 1.8 times the SQO in sample CC-31-Y10.

Four channel sand cap samples had SQO exceedances of multiple analytes; CC-23-Y10, CC-27-Y10, CC-32-Y10, and CC-33-Y10. In samples CC-23-Y10, CC-27-Y10, and CC-33-Y10, collected from the central to southern portion of the Thea Foss Waterway, the same four chemicals were detected at concentrations that exceeded their respective SQOs: benzo(g,h,i)perylene, indeno(1,2,3-cd)pyrene, DEHP, and benzoic acid. DEHP detections in these three samples ranged from 1.5 to 2.9 times the SQO, with the maximum enrichment ratio for DEHP occurring in sample CC-33-Y10. Detections of benzoic acid in these three samples had SQO exceedances ranging from 1.2 to 1.9, with sample CC-27-Y10 having the greatest benzoic acid SQO exceedance. Benzo(g,h,i)perylene and indeno(1,2,3-cd)pyrene detections in samples CC-23-Y10 and CC-27-Y10 were just greater than their respective SQOs, with the greatest SQO ratios being 1.04 times the indeno(1,2,3-cd)pyrene SQO in both samples. Detections of benzo(g,h,i)perylene and indeno(1,2,3-cd)pyrene in sample CC-33-Y10 were slightly higher with SQO exceedances of 1.4 and 1.3, respectively. In sample CC-32-Y10, four of the seven low molecular weight polynuclear aromatic hydrocarbons (LPAHs) analyzed, total LPAHs, all high molecular weight polynuclear aromatic hydrocarbons (HPAHs) analyzed with the exception of chrysene, and total HPAHs exceeded their respective SQOs. The detections of these polynuclear aromatic hydrocarbons (PAHs) ranged from approximately 1.1 to 3.0 times their respective SQOs in this sample. Additionally, sample CC-32-Y10 had DEHP and benzoic acid concentrations that exceeded their SQOs, with corresponding exceedance ratios of 2.8 and 1.7, respectively. This sample was collected in RA 19A in the southwest portion of Thea Foss Waterway.

Summary of Channel Sand Cap Analytical Results Comparisons

In accordance with the OMMP, Year 10 performance monitoring channel sand cap sample results were compared to baseline, Year 2, Year 4, and Year 7 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). The Year 2, Year 4, and Year 7 samples used for this comparison were collected as part of the Year 2, Year 4, and Year 7 OMMP performance monitoring that occurred in 2008, 2010, and 2013, respectively. Refer to Tables 6 through 15 in the Sediment PFM that present the channel sand baseline, Year 2, Year 4, Year 7 and Year 10 sample comparisons for the ten OMMP channel sand cap stations. Additionally, refer to Table 16 in the Sediment PFM that presents the channel sand sample results for sampling station CC-RA9 from Year 4, Year 7, and Year 10, the three monitoring events where samples have been collected from this depression area and refer to Table 48 in the Sediment PFM that presents the channel sand cap metals results for sampling station CC-MMB from Year 10 and compares it to the metals results from the two MMB post-remedial action confirmation samples collected within the remedial action area in 2015. Figure 2-5 presents a comparison of the SQO enrichment ratio exceedances in the performance monitoring surface samples between the Year 7 and Year 10 monitoring events.

Overall, the baseline channel sand cap samples were non-detect for many of the analytes, and those analytes that were detected were 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. In general and as expected, throughout Year 2, Year 4, Year 7, and Year 10 channel sand cap performance monitoring samples have slowly increased in concentrations relative to the concentrations in the baseline samples as the waterway comes to equilibrium with current sources. However, many analytes have remained at similar concentrations during these last four monitoring events.

DEHP concentrations in samples from six out of 11 channel sand cap stations showed an increase between Year 7 and Year 10. At the remaining five channel sand cap stations, four of these stations showed DEHP concentrations decreasing between Year 7 and Year 10 and one of these stations showed DEHP concentrations staying approximately the same between Year 7 and Year 10. At five of these channel sand cap stations, the Year 10 DEHP concentrations exceeded the SQO with a maximum enrichment of approximately 2.9. In comparison, there were seven channel sand cap stations with DEHP SQO exceedances in Year 7 with a maximum enrichment of approximately 3.5.

As summarized earlier in Section 2.2.2 under the subsection titled Concentration Trends Related to Laboratory Analytical Changes, benzoic acid concentrations were reported at higher concentrations in the Year 10 samples in comparison to results from earlier monitoring events, due to changes to the analytical method for benzoic acid that increased analytical sensitivity. In Year 10, 10 out of the 12 channel sand cap monitoring stations had channel sand cap samples with benzoic acid SQO exceedances. These Year 10 benzoic acid exceedances ranged from approximately 1.2 to 1.9 times the SQO. In contrast, benzoic acid was detected in only two of the Year 7 channel sand cap samples, but these detections were both less than the SQO (at approximately 0.9 and 0.8 times the SQO). Benzoic acid was detected in all of the Year 4 channel sand cap samples, but again there were no SQO exceedances, with detections at or less than approximately 0.7 times the SQO. In Year 2, benzoic acid was detected in two of the channel sand cap samples, but the greatest enrichment ratio for these detections was 0.4 times the SQO.

Additionally, refer to Section 2.2.2 for a general summary of concentrations trends for PCBs, silver, and nickel in the monitoring samples over the years related to laboratory analytical changes. The observed trends for these analytes were first identified during previous OMMP monitoring events (in Year 7 for PCBs and in Year 4 for silver and nickel). In general, the Year 10 monitoring results for PCBs, silver, and nickel are consistent with the Year 7 monitoring results as there were no changes in the analytical methods for these analytes between Year 7 and Year 10.

The results of channel sand cap sample comparisons at each station are summarized below by the analytes that exceeded the SQOs in the samples.

There have been no SQO exceedances in the channel sand cap performance monitoring samples from Station CC-18 or Station CC-26 during the Year 2, Year 4, Year 7, or Year 10 monitoring events. The Year 7 and Year 10 channel sand cap samples from these two stations had all analytes detected at less than approximately one-half their SQOs, with the exception of benzoic acid and DEHP. Benzoic acid was detected at approximately 0.8 times the SQO in

sample CC-18-Y10, while previously it was not detected or was detected at a concentration of approximately 0.2 times the SQO at this sampling location. A similar pattern was observed for benzoic acid at Station CC-26, as Year 10 sample CC-26-Y10 had benzoic acid detected at approximately 0.9 times the SQO, but in prior monitoring years it was either not detected or detected at less than 0.2 times the SQO. The DEHP concentration in sample CC-26-Y10 was approximately 0.8 times the SQO and was also higher than detected in previous monitoring years at this station where prior detections did not exceed 0.6 times the SQO. In contrast, the DEHP concentration in sample CC-18-Y10, detected at approximately 0.2 times the SQO, dropped in comparison to the DEHP concentrations detected during the other three previous monitoring events at this station. In Year 7, DEHP was detected at approximately 0.9 times the SQO in sample CC-18-Y7.

At Station CC-01, all analytes were detected at less than approximately one-half their SQOs in the channel sand cap samples collected during the Year 2, Year 4, Year 7, or Year 10 monitoring events, with the exception of benzoic acid that exceeded its SQO in the Year 10 sample CC-01-Y10. This sample had benzoic acid detected at approximately 1.5 times the SQO, while benzoic acid was either not detected or was detected at approximately 0.3 times the SQO in the three previous channel sand cap samples collected from this station.

At three of the stations, Stations CC-29, CC-31, and CC-RA9, DEHP and benzoic acid have been the only SQO exceedances in channel sand cap samples collected over the past four monitoring events. Benzoic acid exceeded its SQO in all three of the Year 10 samples collected from these stations, detected at approximately 1.5 times the SQO in sample CC-29-Y10, approximately 1.7 times the SQO in sample CC-31-Y10, and at approximately 1.7 times the SQO in sample CC-RA9-Y10. During the Year 2, Year 4, and Year 7 monitoring events, the channel sand cap samples collected at these three stations either did not have benzoic acid detected or had benzoic acid concentrations detected at or less than 0.8 times the SQO. At Station CC-29, DEHP concentrations exceeded the SQO in the Year 4 and Year 7 samples, with the greatest SQO exceedance of approximately 1.5 occurring in the Year 4 sample. In contrast, the Year 10 sample CC-29-Y10, had DEHP detected less than the SQO, with a SQO enrichment ratio of approximately 0.9. At Station CC-31, DEHP concentrations exceeded the SQO in both the Year 7 and the Year 10 samples, with the DEHP concentration slightly higher in the Year 10 samples compared within the Year 7 sample. The Year 10 sample CC-31-Y10 had a concentration of 1.8 times the SQO. At Station CC-RA9, DEHP exceeded the SQO in the Year 7 sample CC-RA9-Y7, detected at approximately 2.1 times the SQO; however, in Year 4 and Year 10 DEHP was detected at approximately 0.7 times the SQO.

At Station CC-30, the only detected analytes to exceed the SQOs in the channel sand cap samples were benzoic acid in the Year 10 sample and nickel in the Year 4 sample. Benzoic acid was detected at approximately 1.3 times its SQO in sample CC-30-Y10. In previous monitoring years at this station, benzoic acid was either not detected or was detected at approximately 0.1 times the SQO. Nickel was detected at a concentration just greater than its SQO in the Year 4 sample CC-30-Y4, but was less than 0.2 times the SQO in the other three monitoring samples collected from this station. DEHP at Station CC-30 has been increasing over time, but still remains less than its SQO. The remaining analytes were all detected at less than approximately one-half their SQOs during the four monitoring events at this station.

Over the past four monitoring events at Station CC-23, there have been various SQO exceedances for multiple HPAHs, DEHP, benzyl alcohol, and benzoic acid in the channel sand cap samples. DEHP in the Station CC-23 channel sand sample has exceeded the SQO during

all four monitoring events. In Year 2, DEHP exceeded the SQO with an enrichment ratio of approximately 2.4. Between Years 4 and Year 7 the DEHP concentrations at this station remained stable, with both samples having SQO enrichment ratios of approximately 3.5. In Year 10, the DEHP concentration dropped compared to the previous monitoring event, detected at approximately 1.6 times the SQO. Other chemical concentrations detected greater than their SQOs in channel sand cap sample from this station include benzo(g,h,i)perylene (Year 2, Year 7, and Year 10), indeno(1,2,3-cd)pyrene (Year 2, Year 7, and Year 10), dibenzo(a,h)anthracene, (Year 7), benzyl alcohol (Year 2), and benzoic acid (Year 10). SQO exceedances for these other analytes were at or less than approximately 1.8 times the SQO.

At Station CC-27, benzo(g,h,i)perylene, indeno(1,2,3-cd)pyrene, DEHP, and benzoic acid exceeded the SQOs in the Year 10 channel sand cap sample CC-27-Y10. In Year 7, only DEHP exceeded its SQO in the channel sand cap sample at this station. DEHP concentrations increased between Year 7 and Year 10, detected at approximately 1.1 times the SQO in sample CC-27-Y7 and 1.5 times the SQO in sample CC-27- Y10. There were no SQO exceedances in the Year 2 or Year 4 channel sand cap samples from Station CC-27.

In the Year 10 sample from Station CC-32, concentrations for all but three of the LPAHs and all but one HPAH, chrysene, exceeded their SQOs with enrichment ratios, with ratios ranging from approximately 1.1 to 3.0. All of the previous monitoring events have also had select PAHs exceed their SQOs; however, SQO exceedances were at or less than approximately 1.5 times the SQO. DEHP was detected greater than the SQO during all four monitoring events, with detections between 1.8 and 3.3 times the SQO. The highest DEHP SQO exceedance was in the Year 4 sample from Station CC-32. Benzoic acid only exceeded the SQO in the Year 10 sample from this station, detected at approximately 1.7 times the SQO.

At Station CC-33, the Year 10 channel sand cap sample CC-33-Y10 had SQO exceedances for benzo(g,h,i)perylene, indeno(1,2,3-cd)pyrene, DEHP, and benzoic acid, while in the Year 4 and Year 7 channel sand cap samples from this station only had SQO exceedances for DEHP. There were no SQO exceedances in the Year 2 channel sand cap sample from Station 33, but DEHP was detected at the SQO. The DEHP SQO exceedances in samples CC-33-Y4, CC-33-Y7, and CC-33-Y10 were 2.4, 2.8, and 2.9 times the SQO, respectively. While benzoic acid exceeded in sample CC-33-Y10, it was either not detected or was detected at approximately 0.4 times the SQO in the three previous channel sand samples collected from this station.

A comparison of select metals (copper, lead, zinc, and mercury) results in sample CC-MMB-Y10 to the two 2015 post-remedial action confirmation samples from the MMB remedial action area, show that metals concentrations have increased slightly. However, concentrations of these metals in sample CC-MMB-Y10 were detected at or less than approximately 0.2 times the SQOs.

Summary of Channel Sand Cap Chemical Performance Monitoring OMMP Findings

A summary of the findings from the Year 10 channel sand cap chemical performance monitoring is included below, as well as a comparison to previous channel sand cap chemical performance monitoring results. A brief summary of the early warning samples co-located with the channel sand cap samples is also provided below. For a more detailed comparison of the Year 10 channel sand cap sampling results to the co-located Year 10 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. The analytical results for the early warning samples are compared to the SQOs as specified in the OMMP; however, the early warning sample results are not for the purpose of determining compliance with performance criteria, but are only used to evaluate the potential for recontamination. Early warning sample analytical data in Section 3 is also compared with early warning threshold concentrations.

- In Year 10, a total of two of the 12 channel sand cap samples had no SQO exceedances (samples CC-18-Y10 and CC-26-Y10). Five of the 12 stations had only one SQO exceedance in Year 10 for benzoic acid (samples CC-01-Y10, CC-29-Y10, CC-30-Y10, CC-RA9-Y10, and CC-MMB-Y10), and five station samples had multiple SQO exceedances (samples CC-31-Y10, CC-23-Y10, CC-27-Y10, CC-32-Y10, and CC-33-Y10). In comparison, in Year 7 a total of four of the 11 channel sand cap samples had no SQO exceedances, five of the 11 had only one SQO exceedance, for DEHP, and two stations had multiple SQO exceedances (samples CC-23-Y7 and CC-32-Y7).
- The comparison of baseline and Year 10 channel sand cap 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 from the baseline monitoring event to Year 10 monitoring. This was expected since the capping material placed during construction was native material from an upland source.
- As indicated above, the detected chemical concentrations did not exceed the SQOs in two of the Year 10 channel sand cap samples, samples CC-18-Y10 and CC-26-Y10. Similar to sample CC-26-Y10, the corresponding Year 10 early warning sample from Station 26 also had no SQO exceedances and analytical results were generally comparable. An early warning sample was not collected at Station 18, in accordance with the OMMP. The Year 10 channel sand cap sample concentrations were generally comparable to the Year 2, Year 4, and Year 7 channel sand sample concentrations at both Stations 18 and 26, with some exceptions for benzoic acid, DEHP, and dimethyl phthalate, which showed more variation over the years.
- Two channel sand cap samples, samples CC-RA9-Y10 and CC-MMB-Y10, were collected in Year 10 in addition to the ten routine OMMP sediment performance monitoring samples. Consistent with Year 4 and Year 7, Year 10 sample CC-RA9-Y10 was collected within an approximate 20 feet wide depression that was noted in the channel cap adjacent to the Marine Floats facility in RA 9 during the Year 4 subtidal cap hydrographic survey. There were no SQO exceedances in the Year 4 sample, DEHP was the only SQO exceedance in the Year 7 sample, and benzoic acid was the only SQO exceedance in the Year 10 sample. All other analytes at this station were detected at concentrations much lower than their SQOs. Results of the chemical analyses in the three channel sand cap samples collected from this depression have shown that although there is a decrease cap thickness at this location, the cap is still effectively providing chemical containment. The Year 7 SQO exceedance for DEHP (SQO enrichment ratio of approximately 2.1) and the Year 10 SQO exceedance for benzoic acid (SQO enrichment ratio of approximately 1.7) detected at this location is likely a result of more recent sediments accumulating in the depression and are typical of the concentrations for these analytes measured in other performance monitoring samples collected throughout the Thea Foss and Wheeler-Osgood Waterways in Year 10.

  Sample CC-MMB-Y10 was collected for the first time in Year 10, following completion of the MMB remedial action in 2015, where dredging and capping was performed under a portion of the bridge. This sample was collected from the MMB Remedial Action Area

(shown on Figure 2-3). Only benzoic acid was detected at a concentration greater than the SQO in sample CC-MMB-Y10, at approximately 1.9 times the SQO. A comparison of select metals (copper, lead, zinc, and mercury) from two 2015 post-remedial action confirmation samples collected from the MMB remedial action area to results from sample CC-MMB-Y10 showed consistently low concentrations for these metals, well less than the SQOs. All other analytes detected in sample CC-MMB-Y10 were less than one-half the SQOs. Similar to above, the benzoic acid exceedance at this station is likely the result of recent sediment accumulation in this area and is comparable with other benzoic acid concentrations measured in Year 10 performance monitoring samples.

- Benzoic acid was also the only analyte detected at concentrations greater than the SQO in Year 10 channel sand cap samples collected from Stations 1, 29, and 30, similar to Year 10 samples CC-RA9-Y10 and CC-MMB-Y10 discussed above. The benzoic acid SQO exceedance ratios in these channel sand cap samples ranged from 1.3 to 1.5. The co-located Year 10 early warning samples from these stations also had SQO exceedances for benzoic acid, with detections slightly lower in the early warning samples from Station 1 and 30, but higher at Station 29. The Year 10 early warning sample from Station 30 also had DEHP detected just greater than the SQO. In prior channel sand cap and early warning samples collected from Station 1, analyte concentrations were detected at less than approximately 0.5 times the SQO, with the exception of benzoic acid detected in the Year 4 early warning sample detected just less than the SQO. At Station 29, DEHP was previously detected at concentrations greater than the SQO in both the Year 4 and Year 7 channel sand cap and early warning samples, with detections at or less than approximately 1.5 times the SQO, while DEHP was detected just less than the SQO in the Year 10 samples. Station 30 had DEHP detected at or just greater than the SQO in the Year 7 and Year 10 early warning samples; however, DEHP concentrations in the corresponding channel sand cap samples were always less than the early warning concentrations.

- Station 31 had SQO exceedances of DEHP and benzoic acid in both the Year 10 channel sand cap and early warning samples. DEHP was detected at a greater concentration in the early warning sample in comparison to sample CC-31-Y10, at concentrations of approximately 2.4 and 1.8 times the SQO, respectively. In contrast, benzoic acid was detected at a greater concentration in the sample CC-31-Y10 in comparison to the early warning sample, at concentrations of approximately 1.7 and 1.2 times the SQO, respectively. DEHP has also exceeded the SQO in prior samples from this station, including in the Year 2 early warning sample and the Year 7 channel sand cap and early warning samples. The greatest DEHP concentration detected at this station was in the Year 7 early warning sample, where DEHP was detected at approximately 4.6 times the SQO.

- Three of the channel sand cap stations, Stations 23, 27, and 33, located in the central to southern portion of the Thea Foss Waterway, had detections of benzo(g,h,i)perylene, indeno(1,2,3-cd)pyrene, DEHP, and benzoic acid at concentrations exceeding their SQOs in the Year 10 channel sand cap samples.

  Station 23 is located in the western portion of RA 6 adjacent to Outfall 230 where the City continues to monitor stormwater sediment and stormwater and perform source control activities. The four analytes (DEHP, benzoic acid, and 2 HPAHs) with SQO exceedances in Year 10 sample CC-23-Y10 were detected at or less than approximately 1.6 times the SQO, with the greatest exceedance for DEHP. Only DEHP and benzoic

acid exceeded the SQOs in the co-located Year 10 early warning sample; however, concentrations were greater in the early warning sample. All prior channel sand cap and early warning samples collected from Station 23 also had DEHP SQO exceedances; however, DEHP concentrations in the Year 10 samples are lower in comparison to the Year 4 and Year 7 DEHP sample concentrations. Benzoic acid also exceeded its SQO in the Year 7 early warning sample from Station 23; however, it was detected at less than half the concentration in the Year 10 early warning sample, but comparable to the concentration in the Year 10 channel sand cap sample. Various PAHs have also exceeded their SQOs in previous channel sand cap and early warning samples from Station 23; however, the PAH concentrations in the Year 10 samples generally were less than the PAH concentrations detected in the samples previously collected at this station.

At Station 27, the SQO exceedances of benzo(g,h,i)perylene, indeno(1,2,3-cd)pyrene, DEHP, and benzoic acid in sample CC-27-Y10 were detected at or less than approximately 1.9 times the SQO, with the greatest SQO exceedance for benzoic acid. DEHP has been the only other analyte to exceed the SQO in past samples collected from Station 27, exceeding the SQO in the Year 10 early warning sample and in the Year 7 channel sand cap and early warning samples. The greatest DEHP concentration detected at this station was in sample CC-27-Y10 at approximately 1.5 times the SQO. Besides sample CC-27-Y10, benzoic acid was either not detected or was detected much less than the SQOs in all other samples collected from Station 27. In general, PAH concentrations at Station 27, while generally still at or less than half the SQOs, have gradually increased in the Year 10 samples relative to the samples collected in previous years.

Station 33 had SQO exceedances of four analytes (DEHP, benzoic acid, and 2 HPAHs) in the Year 10 channel sand cap sample CC-33-Y10 and in the corresponding early warning sample, with concentrations for these analytes slightly greater in the early warning sample. DEHP had the greatest SQO exceedance ratios in both of these Year 10 samples, detected at approximately 2.9 and 3.4 times the SQO in the channel sand cap and early warning samples, respectively. Detections of DEHP in the Year 4, Year 7, and Year 10 channel sand cap samples from Station 33 are generally comparable, while the concentration of DEHP in the Year 10 early warning sample has dropped considerably in comparison to the DEHP concentrations in the Year 4 and Year 7 early warning samples. With the exception of benzo(g,h,i)perylene and indeno(1,2,3-cd)pyrene, the remaining PAH concentrations in the Year 10 samples from Station 33 were generally comparable to the PAH concentrations in the Year 7 samples.

- The Year 10 channel sand cap sample CC-32-Y10 from Station 32, located at the south end of RA 19A in the Thea Foss Waterway, had concentrations for multiple constituents that were greater than the SQOs, including most PAHs, DEHP, and benzoic acid. A comparison of the concentrations in the Year 10 channel sand cap sample to the Year 10 early warning sample shows that concentrations are less in the early warning sample. The greatest SQO exceedance ratio in channel sand cap sample CC-32-Y10 is approximately 3.0 times the SQO, while the greatest in early warning sample EW-32-Y10 is approximately 1.9 times the SQO. The concentrations for many of these PAHs and benzoic acid have generally increased over time in the Year 10 channel sand cap sample relative to concentrations detected in the previous channel sand cap samples collected from this station, while DEHP was detected at its greatest concentration in the Year 4 channel sand cap sample. In contrast, detections of PAHs, DEHP, and benzoic acid in the Year 10 early warning sample from Station 32 have generally decreased

relative to the concentrations in the Year 4 and Year 7 early warning samples. The elevated PAH concentrations in the channel sand cap area at Station 32 appear to be relatively localized as the compliance monitoring surface samples and early warning samples collected in the adjacent cap areas to the north and west (samples CC-29-Y10/EW-29-Y10, CC-30-Y10/EW-30-Y10, and CC-31-Y10/EW-31-Y10) did not have similar concentrations or SQO exceedances; yet, these three stations also had SQO exceedances for DEHP and benzoic acid. Station 33, located at the southern end of the Thea Foss Waterway in RA 22, the closest station to Station 32 to the south, also had detections of two PAHs, DEHP, and benzoic acid exceed their SQOs in the Year 10 samples, as well as exceedances for several PAHs and DEHP in prior samples collected from Station 33. This southern end of the Thea Foss Waterway is a depositional area within the Thea Foss Waterway.

- Refer to the subsection titled Concentration Trends Related to Laboratory Analytical Changes in Section 2.2.2 for discussions on the benzoic acid, PCB, silver and nickel variations in the sediment samples noted when comparing concentrations between Year 2, Year 4, Year 7, and Year 10. The reason for some of the concentration variability for these analytes between the past four monitoring events can be attributed to analytical method changes. These analytical changes affecting concentration trends were first noted for PCBs in Year 7 and for silver and nickel in Year 4. In general, the concentrations of PCBs, silver, and nickel were comparable between the Year 7 and Year 10 channel sand cap samples and were less than their SQOs. In Year 10, it was noted that benzoic acid concentrations generally increased relative to concentrations detected in previous monitoring events and resulted in many SQO exceedances for benzoic acid in the Year 10 channel sand cap samples. The greater benzoic acid concentrations in the Year 10 samples relative to the sample concentrations from previous monitoring events are a result of improvements made to the laboratory extraction and analysis of benzoic acid in Year 10.

No additional channel cap chemical performance monitoring is required to further characterize these areas as part of the Year 10 monitoring. As summarized earlier in Section 2.2.1.2, the channel cap areas have remained intact and stable over time with most areas having no observed issues regarding cap integrity between the baseline and Year 10 hydrographic monitoring events. Additionally, the analytes that most commonly exceeded their SQOs during the Year 10 channel cap chemical monitoring included DEHP and benzoic acid, as well as low levels of PAHs in a few channel sand cap monitoring locations. DEHP and benzoic acid also commonly exceeded their SQOs in other Year 10 OMMP sediment samples collected, including slope cap samples (refer to Section 2.2.2.1), natural recovery samples (refer to Section 2.3), and early warning samples (refer to Section 3.0).

As described in further detail earlier in the Summary of Slope Cap Chemical Performance Monitoring OMMP Findings (part of Section 2.2.2.1), DEHP is a ubiquitous urban compound and recontamination of DEHP above the SQO within the waterways' sediments was predicted to occur prior to construction of the remedy. In 2013 an evaluation of the Year 7 OMMP sediment monitoring results in comparison with the Thea Foss Sediment Quality Model predictions was conducted by the City to assess changes in waterway sediment concentrations over time and to extrapolate sediment quality trends into the future (City of Tacoma 2014). This evaluation generally concluded that sediment concentrations were beginning to level off in approximately Year 7 and were not expected to rise much higher in the future, with many areas remaining relatively stable between the Year 4 and Year 7 monitoring events. A similar evaluation of the Year 10 OMMP sediment monitoring results in comparison to the model will be completed by

the City in 2017. As part of this modeling evaluation, DEHP results were compared to a biological effects level for DEHP of 4,000 µg/kg. In Year 10 all DEHP concentrations in the channel cap samples were detected below this biological effects level.

As indicated in Section 2.2.2.1 above, because of challenges faced by the City and others in addressing phthalate contamination in the environment, a Sediment Phthalates Work Group was formed in 2006 to research the sources, pathways, and treatment options for phthalates and other ubiquitous compounds in stormwater. This group developed a Summary of Findings and Recommendations document which is currently in the process of being implemented by the regulatory agencies.

As noted in the last bullet above and described further in the subsection titled Concentration Trends Related to Laboratory Analytical Changes in Section 2.2.2, benzoic acid concentrations in the Year 10 channel sand cap samples generally increased relative to concentrations detected in previous monitoring events. The greater benzoic acid concentrations in these Year 10 samples relative to the sample concentrations from previous monitoring events are a result of improvements made to the laboratory extraction and analysis of benzoic acid in Year 10. A potential source of benzoic acid to these sediments could be the breakdown of plant material entering the waterways. Benzoic acid is a naturally occurring compound in terrestrial plants and is also a breakdown product of benzyl alcohol, which also naturally occurs in terrestrial plants. It has frequently been detected at DMMP disposal sites and has been detected at concentrations exceeding the SQO in sediment samples collected from several non-urban embayments. Refer to Section 2.2.2 for further information.

Additionally, the benthic community and recolonization at stations located within the channel sand cap areas continue to show evidence of healthy colonization, with these areas showing evidence of mature infaunal communities and benthic ecosystem recovery (refer to Section 4.0 for further details).

Based on this information, no remedial actions are warranted at this time based on the findings of the Year 10 channel sand cap chemical performance monitoring. The long-term monitoring of the chemical performance in these channel sand cap areas is discussed below in Section 2.4 Sediment Remediation Area Performance Monitoring Conclusions and Future Long-Term Monitoring.

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 consisted of the collection and analysis of surface samples (0 to 10 cm) from 14 stations in 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 areas in the Wheeler-Osgood Waterway. The results of the natural recovery and enhanced natural recovery chemical performance monitoring are presented in the Sediment PFM, and are summarized below.

Early warning monitoring was also performed at 13 of the 14 natural recovery and enhanced natural recovery monitoring stations during Year 10 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 are presented in Section 3.0 of this report, along with a comparison of the Year 10 early warning monitoring samples (0 to 2 cm) to the results of the Year 10 performance monitoring natural recovery and enhanced natural recovery surface samples (0 to 10 cm) and to the results of the Year 2, Year 4, and Year 7 early warning monitoring samples.

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 10 include the northern portions of RAs 5 and 6, all of RA 7, most of the area north of the MMB to Station 20+00, the head of the Wheeler-Osgood Waterway located between RAs 12 and 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 RAs 10, 11 and 13 were designated for natural recovery and slope rehabilitation during the Remedial Design phase of the project and were also monitored as part of the OMMP in Year 10.

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 previous performance monitoring analytical results and baseline monitoring results. The baseline, Year 2, Year 4, Year 7, and Year 10 monitoring results at each station are compared to each other to evaluate trends in chemical concentrations at that location to identify if natural recovery, enhanced natural recovery, and natural recovery/slope rehabilitation areas will satisfy or have satisfied performance criteria within the allowed 10-year time frame.

Summary of Natural Recovery and Enhanced Natural Recovery Performance Monitoring 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 primary 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 16-17, 2016, 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 27-28, 2016, 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-Y10). Sample collection forms and photographs documenting activities and observations were prepared during the two sampling events. The sample collection forms and photographs from the Year 10 sampling events are included in the Sediment PFM.

Surface sediment (0 to 10 cm) samples of the natural recovery/slope rehabilitation shoreline areas (RAs 10, 11, and 13) in the Wheeler-Osgood Waterway were collected on June 22, 2016, when tidal elevations were at or below 0 feet MLLW. The samples were composites comprised of subsamples collected from three discrete locations in each RA. The natural recovery/slope rehabilitation discrete sample 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-Y10-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-Y10).

The natural recovery/slope rehabilitation 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, generally a portion of the material collected at each discrete location, large rocks and/or gravel, was discarded and was not included in the sample composite. Sample collection forms and photographs documenting activities and observations were prepared during this sampling event and are included in the Sediment PFM.

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

PCBs were also analyzed by the City of Tacoma Laboratory on the three Year 10 discrete samples collected from the natural recovery/slope rehabilitation in RA 10 (Station SR-10) in accordance with the Year 7 Annual Report and the OMMP Revisions Based on Year 7 Monitoring Technical Memorandum. Analysis for PCBs on these Year 10 discrete samples was recommend in the Year 7 Annual Report due to elevated total PCB concentrations that exceeded the SQO in the Year 7 natural recovery/slope rehabilitation composite sample SR-10-Y7 and in two of the three Year 7 discrete sample (samples SR-10-Y7-D2 and SR-10-Y7-D3) used for this composite sample. Additionally, due to elevated PAH concentrations that exceeded the SQO in the Year 10 natural recovery/slope rehabilitation composite sample from Station SR-10 (sample SR-10-Y10), the City elected to perform additional analyses on the three archived Year 10 discrete samples that were collected from RA 10 as a Year 10 response action. The three discrete samples from RA 10 were analyzed for select SVOCs, including PAHs and phthalates, by the City of Tacoma Laboratory. This additional analysis of the discrete samples in Year 10 was performed to gain additional information on the extent and magnitude of PCBs and PAHs in this RA and the results from this Year 10 discrete sample analysis are included in the discussion below.

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 10 natural recovery and enhanced natural recovery surface sample analytical results provided in Table 2-4 and in the summary of Year 10 slope rehabilitation SR-10 discrete and

composite sample results for PAHs, phthalates, and PCBs provided in Table 2-5. All final data are considered valid and acceptable for use as qualified. The data validation reports for these samples are included in Attachment D of the Sediment PFM (Attachment B-1) and in Attachment B-2 for the discrete samples report.

Summary of Natural Recovery and Enhanced Natural Recovery Monitoring Analytical Results

The analytical results from the Year 10 samples collected from the natural recovery, enhanced natural recovery, and natural recovery/slope rehabilitation areas are presented below and are summarized in Table 2-4. The supplemental analytical results for PAHs, phthalates, and PCBs from the discrete samples collected from the natural recovery/slope rehabilitation shoreline area in RA 10 are also presented below and are summarized in Table 2-5. The results for these samples were compared to the SQOs to identify any exceedances of the performance criteria. Concentrations that are greater than the SQOs are highlighted in red in Tables 2-4 and 2-5. Figure 2-4 presents detected concentrations from the Year 10 performance monitoring surface samples (0 to 10 cm) that exceed the SQOs. The detailed results of the Year 10 natural recovery and enhanced natural recovery sampling, including field forms and photographs for the samples, are presented in the Sediment PFM.

All of the 14 natural recovery and enhanced natural recovery locations had at least one SQO exceedance in Year 10. Eight of the 14 stations had samples with only one SQO exceedance detected, for either indeno(1,2,3-cd)pyrene, DEHP, benzoic acid, or butylbenzylphthalate, described below. Additionally, four stations had samples with SQO exceedances of both DEHP and benzoic acid and one station had SQO exceedances of indeno(1,2,3-cd)pyrene and benzoic acid. The final station, where sample NR-19-Y10 was collected, had a total of eight SQO exceedances, seven PAHs exceedances and one for benzoic acid. Two of the three natural recovery/slope rehabilitation stations had composite samples with no SQO exceedances. Natural recovery/slope rehabilitation composite sample SR-10-Y10 had SQO exceedances for multiple PAHs. As a result of this finding, the three archived discrete samples making up composite sample SR-10-Y10 were also analyzed for PAHs, and only one of these discrete samples had fluoranthene detected just greater than the SQO.

The results of the natural recovery and enhanced natural recovery samples are summarized below moving from stations north to south along the waterway.

Natural Recovery Area North of the MMB – Six Year 10 natural recovery samples were collected north of the MMB, samples NR-06-Y10 through NR-11-Y10. Three of the natural recovery samples had only one SQO exceedance, samples NR-06-Y10 and NR-09-Y10 for benzoic acid and sample NR-10-Y10 for butyl benzyl phthalate. Samples NR-06-Y10 and NR-09-Y10 had benzoic acid detections at approximately 1.2 times the SQO and sample NR-10-Y10 had butyl benzyl phthalate detected at 1.04 times the SQO. Samples NR-07-Y10 and NR-11-Y10 had both DEHP and benzoic acid SQOs exceedances. In sample NR-07-Y10, the SQO enrichment ratios for DEHP and benzoic acid were 1.1 and 3.1, respectively; while for sample NR-11-Y10, the DEHP and benzoic acid SQO enrichment ratios were 1.6 and 1.2, respectively. Sample NR-08-Y10 had SQO exceedances of indeno(1,2,3-cd)pyrene and benzoic acid, detected at approximately 1.03 and 1.5 times their respective SQOs.

Natural Recovery Area Immediately South of the MMB – Three natural recovery surface samples, samples NR-12-Y10, NR-13-Y10, and NR-14-Y10, were collected south of the

locations described above, and adjacent to the MMB in the Thea Foss Waterway. Each of these samples had only one SQO exceedance. Sample NR-12-Y10 and its corresponding field duplicate sample NR-12-Y10-2 had DEHP detected greater than the SQO, at approximately 1.1 and 1.2 times the SQO, respectively. Sample NR-13-Y10 barely exceeded the SQO for indeno(1,2,3-cd)pyrene, at approximately 1.03 times the SQO. Sample NR-14-Y10 exceeded the SQO for benzoic acid, at approximately 1.2 times the SQO.

Enhanced Natural Recovery Area in RA 7 – Sample NR-16-Y10 was collected from the enhanced natural recovery area located south of the MMB on the west side of the Thea Foss Waterway and within the Foss Waterway Marina. Detected chemical concentrations of DEHP and benzoic acid were greater than their SQOs in this sample, with SQO enrichment ratios of approximately 1.2 and 2.3, respectively.

Natural Recovery Area at the Mouth of the Wheeler-Osgood Waterway – Sample NR-17-Y10 was collected from the natural recovery area located at the mouth of the Wheeler-Osgood Waterway. The detected concentration of benzoic acid exceeded the SQO with an enrichment ratio of approximately 1.1.

Natural Recovery Area at Head of the Wheeler-Osgood Waterway – Two natural recovery surface samples, samples NR-19-Y10 and NR-20-Y10, were collected from near the head of the Wheeler-Osgood Waterway. Eight analytes were detected at concentrations greater than SQOs in sample NR-19-Y10, including phenanthrene, benzo(a)anthracene, benzo(g,h,i)perylene, dibenz(a,h)anthracene, fluoranthene, indeno(1,2,3-cd)pyrene, pyrene, and benzoic acid. The SQO exceedances in sample NR-19-Y10 were detected at or less than approximately 1.3 times the SQO. In sample NR-20-Y10, DEHP and benzoic acid exceeded their SQOs with SQO enrichment ratios of approximately 1.2 and 2.0, respectively.

Natural Recovery/Slope Rehabilitation Shoreline on the Wheeler-Osgood Waterway – Detected concentrations of all analytes in slope rehabilitation samples SR-11-Y10 and SR-13-Y10 were less than their SQOs. The detections in these samples were all less than one-half the SQOs, with the exception of benzoic acid in sample SR-11-Y10 that was detected at approximately 0.8 times the SQO. Sample SR-11-Y10 is a composite of material collected from the shoreline on the south side of the Wheeler-Osgood Waterway and sample SR-13-Y10 is a composite of material collected from the shoreline at the head of the Wheeler-Osgood Waterway.

Slope rehabilitation sample SR-10-Y10 had SQO exceedances for multiple PAHs, including phenanthrene, total LPAHs, all HPAHs with the exceptions of benzo(a)anthracene and benzo(a)pyrene, and total HPAHs. SQO enrichment ratios ranged from approximately 1.2 to 6.4 (the greatest exceedance was for fluoranthene). Four of the detected analytes had SQO exceedances greater than 2.0 times their SQOs, including phenanthrene, fluoranthene, pyrene, and total HPAHs. A field duplicate sample was also collected at this sample location, sample SR-10-Y10-2, and this field duplicate did not have any SQO exceedances. PAHs in this field duplicate sample were all detected at less than 0.6 times their SQOs. As noted earlier, due to these elevated PAH concentration in composite sample SR-10-Y10, the City elected to analyze the three discrete samples used for this composite sample (samples SR-10-Y10-D1 through SR-10-Y10-D3) for select SVOCs (refer to Table 2-5). Discrete samples SR-10-Y10-D1 and SR-10-Y10-D2 had no SQO exceedances for PAHs, with all detections at or less than approximately 0.5 times the SQOs. Discrete sample SR-10-Y10-D3 had only fluoranthene detected greater than its SQO, at 1.04 times the SQO, while all other PAHs were at or less than

approximately 0.8 times the SQO. The differences between the parent sample and field duplicate and discrete samples are likely attributable to the heterogeneity of sediment at this slope rehabilitation monitoring station. Sample SR-10-Y10 is comprised of a composite of material collected from the shoreline on the north side of the Wheeler-Osgood Waterway.

Additionally, due to the elevated total PCB concentrations detected in the Year 7 slope rehabilitation composite sample SR-10-Y7 and in two of the three discrete samples (samples SR-10-Y7-D2 and SR-10-Y7-D3) used for this composite sample, the three Year 10 discrete samples used for composite sample SR-10-Y10 were also analyzed for PCBs. Composite sample SR-10-Y10 did not have PCBs detected and PCBs were only detected in one of the Year 10 discrete samples, sample SR-10-Y10-D3, at a concentration just lower than the SQO (approximately 0.9 times the SQO). These PCB results are shown in Table 2-5.

Natural Recovery Area Adjacent to RA 15 and RA 16 – Sample NR-25-Y10 was collected from the natural recovery area located east of RA 16 and north of RA 15 on the mudflat within the Delin Docks Marina. Benzoic acid was detected at a concentration greater than the SQO, at approximately 2.0 times the SQO, and DEHP was detected at the SQO in sample NR-25-Y10. In the corresponding field duplicate sample NR-25-Y10-2 collected at this station, both benzoic acid and DEHP exceeded their SQOs, with SQO enrichment ratios of approximately 1.5 and 1.3 respectively.

Summary of Natural Recovery and Enhanced Natural Recovery Analytical Results Comparisons

In accordance with the OMMP, Year 10 performance monitoring natural recovery and enhanced natural recovery sample results were compared to baseline, Year 2, Year 4, and Year 7 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. Refer to Tables 25 through 38 in the Sediment PFM, which present the natural recovery and enhanced natural recovery RI, baseline, Year 2, Year 4, Year 7, and Year 10 sample comparisons. Figure 2-5 presents a comparison of the SQO enrichment ratio exceedances in the performance monitoring surface samples between the Year 7 and Year 10 monitoring events.

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 10 natural recovery samples.

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 Year 2, Year 4, and Year 7 natural recovery samples used for this comparison were collected as part of the Year 2, Year 4, and Year 7 OMMP performance monitoring that occurred in 2008, 2010, and 2013, respectively. The analytical results from the Year 4 natural recovery samples collected at Stations NR-12 and NR-17 showed multiple chemical concentrations that were greater than the SQOs and concentrations that were substantially higher than concentrations detected in previous natural recovery samples collected at these two stations. Due to these elevated chemical concentrations in the Year 4 natural recovery samples at these two stations additional natural recovery confirmation and verification sampling was conducted at these two stations in the fall of 2010. Elevated concentrations were not detected in the confirmation and verification samples, indicating heterogeneity of the sediments in these areas. The results from the additional Year 4 confirmation and verification sampling performed at Stations NR-12 and NR-17 are also briefly discussed below.

Natural recovery/slope rehabilitation stations were compared to baseline samples collected as part of supplemental baseline sampling performed in 2006 and to Year 2, Year 4, and Year 7 samples collected during the 2008, 2010, and 2013 OMMP performance monitoring, respectively. Tables 39 through 41 in the Sediment PFM present the slope rehabilitation baseline, Year 2, Year 4, Year 7, and Year 10 sample comparisons. Additionally, Table 47 in the Sediment PFM presents the comparison of the Year 7 and Year 10 slope rehabilitation PCB results for both the composite and discrete samples collected at Station SR-10.

As summarized earlier in Section 2.2.2 under the subsection titled Concentration Trends Related to Laboratory Analytical Changes, benzoic acid concentrations were generally reported at higher concentrations in the Year 10 samples in comparison to results from earlier monitoring events, due to changes to the analytical method for benzoic acid that increased the analytical sensitivity in Year 10. In Year 10, 11 out of the 14 natural recovery monitoring stations had natural recovery performance monitoring samples with benzoic acid SQO exceedances. The greatest SQO exceedance in these Year 10 samples was approximately 3.1 times the SQO. At 11 of these stations, the benzoic acid concentrations in the Year 10 natural recovery samples were well above any Year 2, Year 4, or Year 7 detections in the natural recovery samples from these stations. Most of these previous natural recovery samples either had benzoic acid not detected or detections between 0.1 and 0.9 times the SQO. There were three natural recovery stations where the benzoic acid concentrations in Year 10 natural recovery samples were comparable to or lower than previous detections of benzoic acid at these stations (Stations NR-12, NR-13, and NR-17). At the three natural recovery/slope rehabilitation stations, the Year 10 benzoic acid concentrations were comparable to previous concentrations at two of the stations (Stations SR-10 and SR-13), while at the third station (SR-11), benzoic acid in the Year 10 sample concentrations was detected at a greater concentration in comparison to samples from previous years collected at this station.

Additionally, refer to Section 2.2.2 for a general summary of concentrations trends for PCBs, silver, and nickel in the monitoring samples over the years related to laboratory analytical changes. The observed trends for these analytes were first identified during previous OMMP monitoring events (in Year 7 for PCBs and in Year 4 for silver and nickel). In general, the Year 10 monitoring results for PCBs, silver, and nickel are consistent with the Year 7 monitoring results as there were no changes in the analytical methods for these analytes between Year 7 and Year 10.

Generally, the results of the natural recovery sample comparisons are summarized below moving from stations north to south along the waterway.

Natural Recovery Area North of the MMB – At three of the six of the natural recovery monitoring stations located north of the MMB, Stations NR-06, NR-07, and NR-09, similar trends were observed over time from the RI samples to the Year 10 natural recovery samples. The trend observed at these three stations had detected concentrations greater than the SQOs in the RI samples, but detected chemical concentrations less than the SQOs in the baseline, Year 2, Year 4, and Year 7 samples. Up until Year 10, there had been four consecutive rounds of performance monitoring (0 to 10 cm) with chemical concentrations less than the SQOs. In Year 10, there were exceedances of the benzoic acid SQO in the natural recovery samples at all three stations and the Year 10 sample from Station NR-07 also had a SQO exceedance for DEHP. In both samples NR-06-Y10 and NR-09-Y10, benzoic acid exceeded the SQO, with an enrichment ratio of approximately 1.2, while the enrichment ratio at Station NR-07 was approximately 3.1. In the baseline, Year 2, and Year 7 natural recovery samples collected from these three stations, benzoic acid was not detected, while benzoic acid was detected at or less than approximately 0.7 times the SQO in the Year 4 natural recovery samples from these stations. DEHP has shown an overall downward trend over time between Year 2 and Year 10 in the natural recovery samples from Station NR-06, with the Year 10 sample NR-06-Y10 having an enrichment ratio of less than one-half the SQO. In contrast, the DEHP concentrations in the natural recovery samples from Stations NR-07 and NR-09 have generally increased over time between Year 2 and Year 10. The Year 10 sample from Station NR-07 had DEHP detected just greater than the SQO, at approximately 1.1 times the SQO. The Year 10 sample NR-09-Y10 had an enrichment ratio of approximately 0.6 times the SQO. With the exceptions of benzoic acid at all three stations and DEHP at Station NR-07, the Year 10 samples NR-06-Y10, NR-07-Y10, and NR-09-Y10, in general, had SQO enrichment ratios for detected chemicals comparable to the SQO enrichment ratios for the detected chemicals in the baseline, Year 2, Year 4, and Year 7 natural recovery samples at these stations and enrichment ratios were at or less than approximately 0.8 times the SQOs.

Station NR-08 had no SQO exceedances in the baseline, Year 2, or Year 4 natural recovery samples. The Year 7 sample NR-08-Y7 had only a DEHP exceedance and the Year 10 sample NR-08-Y10 had only exceedances for indeno(1,2,3-cd)pyrene and benzoic acid. At Station NR-08, the Year 7 DEHP concentration increased relative to the baseline, Year 2, and Year 4 natural recovery samples collected at this station and DEHP in the Year 7 sample exceeded the SQO, with an approximate SQO enrichment ratio of 1.2. In Year 10, DEHP did not exceed the SQO with an enrichment ratio of approximately 0.8. In Year 10 sample NR-08-Y10, benzoic acid exceeded the SQO with an enrichment ratio of approximately 1.5. In previous monitoring years, this station had benzoic acid detected at or less than approximately 0.8 times the SQO or not detected in the natural recovery samples. Indeno(1,2,3-cd)pyrene had an SQO enrichment ratio just greater than its SQO in sample NR-08-Y10, but previous natural recovery samples from this station had SQO enrichments ratios for this analyte of approximately 0.7 or less.

At Station NR-10, also located north of the MMB, the DEHP concentrations have fluctuated over time in the natural recovery samples, with the greatest detection occurring in the RI sample at approximately 1.6 times the SQO. The Year 2, Year 4, Year 7, and Year 10 DEHP concentration at this station were approximately 0.9, 1.1, 0.8, and 0.7 times the SQO, respectively. Butyl benzyl phthalate exceeded the SQO for the first time in Year 10 at Station NR-10, detected just greater than the SQO with an enrichment ratio of 1.04. Benzoic acid was detected just less than its SQO in Year 10 sample NR-10-Y10. To date, concentrations of other analytes at Station NR-10 have all been detected less than the SQOs.

The remaining natural recovery station located north of the MMB is Station NR-11. In each year of monitoring conducted at this station, DEHP concentrations have exceeded their SQOs in the natural recovery samples. The greatest DEHP detection occurred in the RI sample, with a detection at approximately 2.9 times the SQO. DEHP concentrations in the baseline, Year 2, Year 4, Year 7, and Year 10 natural recovery samples from Station NR-11 have ranged between approximately 1.2 and 1.6 times the SQO. In the Year 10 sample NR-11-Y10, DEHP was detected at 1.6 times the SQO. Similar to four of the other natural recovery stations in this area north of the MMB, discussed above, Station NR-11 also had benzoic acid detected at concentrations greater than its SQO in only the Year 10 natural recovery sample. In Year 10, benzoic acid exceeded the SQO with an enrichment ratio of approximately 1.2. During previous monitoring events at this station benzoic acid was either not detected or was detected at or less than approximately 0.8 times the SQO. The only other SQO exceedances at Station NR-11 prior to Year 10 occurred in the RI sample, where five other chemicals had concentrations greater than the SQOs.

Natural Recovery Area Immediately South of the MMB – Year 10 samples NR-12-Y10, NR-13-Y10, and NR-14-Y10 were collected south of and adjacent to the MMB in the Thea Foss Waterway. At Station NR-12, the corresponding RI sample had five analytes (mercury, three PAHs, and DEHP) detected at concentrations greater than the SQOs. The baseline and Year 2 samples for Station NR-12 had concentrations that were all less than the SQOs, except for DEHP in sample NR-12-Y2 which was at the SQO. In Year 4, DEHP, all HPAHs, and approximately half the LPAHs exceeded the SQOs in sample NR-12-Y4. Phenanthrene had the greatest SQO exceedance in the Year 4 sample at approximately 3.9 times the SQO. DEHP was detected at approximately 1.4 times the SQO in the Year 4 sample, lower than the RI concentration, but higher than the baseline and Year 2 concentrations at this station. In 2010, as described above, confirmation and verification samples were collected at and surrounding Station NR-12. Based on the confirmation and verification sampling results, it was concluded that the multiple elevated PAH concentrations detected in the original sample NR-12-Y4 were not generally indicative of the sediment quality in the vicinity of Station 12, and the initial NR-12-Y4 results are likely attributable to sample heterogeneity. However, DEHP concentrations remained relatively constant between sample NR-12-Y4 and the confirmation and verification samples collected in this area and are at concentrations, in general, approximately 1.2 to 1.6 times the SQO. In Year 7, all HPAHs and DEHP exceeded the SQOs in the field duplicate sample NR-12-Y7-2, while only DEHP exceeded the SQO in the parent sample NR-12-Y7 collected from this station. In the Year 7 duplicate sample NR-12-Y7-2 chrysene and fluoranthene had the greatest SQO at approximately 12.1 and 10.8 times the SQO, respectively. Similar to the Year 4 confirmation and verification sampling results, the differences in detected concentrations of PAHs between the parent and duplicate Year 7 samples indicate substantial sediment heterogeneity within the vicinity of this station. DEHP was detected at approximately 1.2 times the SQO in the Year 7 duplicate sample, less than the Year 4 concentration. In Year 10, DEHP was the only analyte detected greater than the SQO in sample NR-12-Y10. The detected concentration in this sample was approximately 1.2 times the SQO, identical to the detection in Year 7. This station is located within the Foss Waterway Marina, just south of the MMB.

Two natural recovery monitoring stations, Stations NR-13 and NR-14, had no SQO exceedances during Year 2, Year 4 or Year 7 monitoring. During the Year 10 monitoring, the natural recovery sample from Station NR-13 had an SQO exceedance for indeno(1,2,3-cd)pyrene and the natural recovery sample from Station NR-14 had an SQO exceedance for benzoic acid. At Station NR-13, indeno(1,2,3-cd)pyrene exceeded the SQO with an enrichment

ratio of 1.03 in the Year 10 sample NR-13-Y10 and pyrene was detected at the SQO in the Year 7 sample NR-13-Y7; however, pyrene was detected less than the SQO in the Year 10 sample with an enrichment ratio of approximately 0.7. In general, the enrichment ratios for PAHs in the natural recovery samples were similar at Station NR-13 between Year 7 and Year 10. At Station NR-14, benzoic acid exceeded the SQO in the Year 10 sample with an enrichment ratio of approximately 1.2. Benzoic acid was either not detected or was detected at or less than approximately 0.7 times the SQO in previous natural recovery samples from Station NR-14. Concentrations of DEHP in the natural recovery samples at both of these stations have been relatively steady between the Year 2 and Year 10 monitoring events and the Year 10 DEHP concentrations are less than the SQO. At Station NR-13, the corresponding RI and baseline samples had DEHP concentrations greater than the SQO and at Station NR-14, DEHP exceeded the SQO in the RI sample.

Enhanced Natural Recovery Area in RA 7 – Up until Year 10, Station NR-16, which is in the enhanced natural recovery area located south of the MMB within the Foss Waterway Marina, has had no SQO exceedances in the natural recovery samples since the remedial action occurred. In general, the detected concentrations in the baseline, Year 2, Year 4, and Year 7 natural recovery samples have remained significantly less than the SQOs, with the exceptions of DEHP and butyl benzyl phthalate. DEHP concentrations at this station have been increasing over time at this station, with DEHP detected at approximately 0.2, 0.4, 0.6, 0.7, and 1.2 times the SQO in the baseline, Year 2, Year 4, Year 7, and Year 10 samples, respectively. The butyl benzyl phthalate concentration was greatest in Year 4 natural recovery sample at approximately 0.9 times the SQO, whereas in the Year 2 sample it was less than 0.1 times the SQO, in the Year 7 sample it was not detected, and in the Year 10 samples it was detected at approximately 0.2 times the SQO. Benzoic acid exceeded the SQO in the Year 10 sample NR-16-Y10 with an enrichment ratio of approximately 2.3. In contrast, benzoic acid in all previous monitoring years was either not detected (or was detected at approximately 0.4 times the SQO.

Natural Recovery Area at the Mouth of the Wheeler-Osgood Waterway – Prior to Year 4, Station NR-17 located at the mouth of the Wheeler-Osgood Waterway appeared to have a generally decreasing concentration trend between the RI, baseline, and Year 2 natural recovery samples. The RI sample in the vicinity of this station had four chemical concentrations (mercury, phenanthrene, total benzofluoranthenes, and DEHP) that were greater than the SQOs, while the baseline sample only had pyrene detected greater than the SQO. No detected chemicals exceeded the SQOs in the Year 2 sample. However, the Year 4 sample showed large increases in concentrations, greater than the SQOs, for zinc, mercury, most of the PAHs, 4-methylphenol, benzoic acid, and dibenzofuran. The chemical exceedances in the Year 4 sample ranged up to approximately 6.9 times the SQOs. The sample description included on the field form indicated that the sample had significant woody and organic debris present. Therefore, confirmation and verification sampling was conducted to confirm the exceedances detected in the initial Year 4 sample. The Year 4 confirmation and verification sampling results generally showed substantially lower concentrations of the elevated analytes and indicated that the initial higher detected concentrations are not generally indicative of the sediment quality in the vicinity of Station 17, and likely associated with the elevated wood debris and TOC, and sample heterogeneity. The Year 7 and Year 10 natural recovery sample results at Station NR-17 were generally consistent with the Year 4 conformation and verification sampling results, where no detected concentrations exceeded the SQOs, with the exception of benzoic acid in the Year 10 sample. The detected concentrations of PAHs in the Year 7 and Year 10 natural recovery samples decreased relative to the Year 4 concentrations. Benzoic acid exceeded the SQO in the Year 4 natural recovery sample NR-17-Y4, detected at approximately 1.4 times the

SQO, but was not detected in Year 7. In Year 10, benzoic acid again exceeded the SQO with an enrichment ratio of approximately 1.1.

Natural Recovery Area at Head of the Wheeler-Osgood Waterway – At Station NR-19, chemical concentrations in the Year 2, Year 4, and Year 7 natural recovery samples and the RI sample were less than the SQOs, whereas the Year 10 natural recovery sample had multiple SQO exceedances. Overall, there was a general increase in the SQO enrichment ratios in the baseline sample versus the SQO enrichment ratios for the RI sample. However, samples NR-19-Y2 and NR-19-Y4 collected approximately two and four years after baseline monitoring, respectively, had generally comparable chemical concentrations that were generally all less than half the SQOs. In the Year 7 sample NR-19-Y7, the detected concentrations of PAHs increased slightly relative to Year 2 and Year 4, yet remained less than the SQOs. In Year 10, phenanthrene, a LPAH, and six HPAHs exceeded their respective SQOs in sample NR-19-Y10 and the PAH enrichment ratios ranged up to approximately 1.3 times the SQO (both phenanthrene and indeno(1,2,3-cd)pyrene were detected at approximately 1.3 times the SQOs). Benzoic acid also exceeded the SQO in the Year 10 natural recovery sample from Station NR-19. Sample NR-19-Y10 had benzoic acid detected at approximately 1.3 times the SQO. In Year 2, Year 4, and Year 7 benzoic acid was detected in the natural recovery samples, but at concentrations well less than the SQO.

Both the RI samples collected in the vicinity of Station NR-20 and the baseline sample collected at Station NR-20 had multiple analytes with detections exceeding the SQOs. However, the Year 2 and Year 4 natural recovery samples only had DEHP detected at concentrations greater than the SQO, but these DEHP concentrations were higher than the DEHP concentration detected in the baseline sample. The DEHP concentration was approximately 1.9 times the SQO in sample NR-20-Y2 and approximately 1.7 times the SQO in sample NR-20-Y4. In the Year 7 natural recovery sample, DEHP was also detected at a concentration that exceeded the SQO with an enrichment ratio of approximately 3.4. In Year 10, DEHP decreased to the same concentration detected in the baseline sample, with an enrichment ratio of approximately 1.2. In the Year 7 sample NR-20-Y7, dibenzo(a,h)anthracene and n-nitrosodiphenylamine were also detected at concentrations that exceeded the SQOs with enrichment ratios of approximately 1.0 and 1.1, respectively. Concentrations of these two analytes were much lower in the Year 10 natural recovery sample. Also, in the Year 7 natural recovery sample, the detected concentrations of PAHs increased relative to Year 2 and Year 4 with the Year 7 SQO enrichment ratios ranging from approximately 0.1 to 1.0, whereas in Year 4 the PAH SQO enrichment ratios ranged from approximately 0.1 to 0.7. In the Year 10 natural recovery sample detected PAHs decreased to concentrations similar to the concentrations in the Year 2 natural recovery sample, with SQO enrichment ratios ranging from approximately 0.1 to 0.3. Besides DEHP, the only other analyte that exceeded its SQO in the Year 10 sample NR-20-Y10 was benzoic acid. Benzoic acid was detected at approximately 2.0 times the SQO in sample NR-20-Y10. Previous detections of benzoic acid in the natural recovery samples from this station were all at or less than approximately 0.5 times the SQO.

Natural Recovery/Slope Rehabilitation Shoreline on the Wheeler-Osgood Waterway – Three composite samples, samples SR-10-Y10, SR-11-Y10 and SR-13-Y10, were collected from the natural recovery/slope rehabilitation areas of the Wheeler-Osgood Waterway in Year 10 and results from these samples were compared to baseline, Year 2, Year 4, and Year 7 sample results.

Station SR-10 is a composite sample that is comprised of the northern shoreline of this waterway (RA 10). In general, most of the analytes at this station were detected at concentrations significantly less than the SQOs between baseline (Year 0) and Year 7, with the exception of some PCB (Year 2 and Year 7 samples) SQO exceedances and a mercury (Year 4 sample) SQO exceedance. In Year 10, the parent sample SR-10-Y10, had phenanthrene, total LPAHs, all the HPAHs except for benzo(a)anthracene and benzo(a)pyrene, and total HPAHs exceed their respective SQOs with enrichment ratios ranging from approximately 1.2 to 6.4. The greatest SQO exceedance in sample SR-10-Y10 was for fluoranthene. In the Year 10 duplicate sample SR-10-Y10-2, none of the PAHs exceeded their respective SQOs and the enrichment ratios for PAHs in the duplicate sample ranged from approximately 0.1 to 0.6 times the SQO. Based on these elevated PAH results in composite sample SR-10-Y10, the three discrete samples used for this composite sample (samples SR-10-Y10-D1 through SR-10-Y10-D3) were then analyzed for select SVOCs. Only discrete sample SR-10-Y10-D3 had an SQO exceedance, where fluoranthene was detected just greater than its SQO (see Table 2-5). Prior to Year 10, PAHs had been detected in previous sampling events at this station, but at concentrations much less than SQOs.

As noted above, PCBs exceeded the SQO in Year 2 and Year 7 samples from Station SR-10. The field duplicate collected in Year 2 (sample SR-10-Y2-2) had PCB Aroclor 1254 detected greater than the total PCB SQO with an enrichment ratio of approximately 1.7 times the SQO. No other PCB Aroclors were detected in this field duplicate sample. PCBs were not detected in the Year 2 parent sample SR-10-Y2, the baseline sample, or in the Year 4 sample SR-10-Y4 at this station. However, Aroclor 1254 was also detected in the Year 7 sample SR-10-Y7 from Station SR-10, with a total PCB concentration detected at approximately 1.6 times the SQO. In Year 10 sample SR-10-Y10 PCBs were not detected. Analysis of the three Year 7 discrete samples used for composite sample SR-10-Y7 for PCBs showed SQO exceedances in two of the discrete samples, samples SR-10-Y7-D2 and SR-10-Y7-D3, with detections at approximately 2.2 and 2.4 times the SQO, respectively. These PCB concentrations in the two Year 7 discrete samples were higher than the Year 7 composite sample concentration. In the three Year 10 discrete samples (samples SR-10-Y10-D1 through SR-10-Y10-D3) analyzed, PCBs were only detected in one of the Year 10 discrete samples, sample SR-10-Y10-D3, at a concentration approximately 0.9 times the SQO. Mercury was detected slightly greater than the SQO in Year 4 sample from this station, with a SQO enrichment ratio of 1.04. Mercury detections in the baseline, Year 2, Year 7, and Year 10 samples from station SR-10 were all well less than the SQO. These inconsistent concentrations of PAHs, total PCBs, and mercury over time in the samples at Station SR-10 are likely indicative of heterogeneity in the sediment in this portion of the waterway.

At Station SR-11, the Year 10 composite sample SR-11-Y10 was similar to the composite baseline, Year 2, Year 4, and Year 7 samples, with all five samples having detected concentrations much less than the SQOs. Station SR-11 is a composite sample that is comprised of the southern shoreline of the Wheeler-Osgood Waterway.

Station SR-13 is a composite sample located at the head of the Wheeler-Osgood Waterway. The baseline, Year 4, Year 7, and Year 10 composite samples from this station all had chemical concentrations much less than the SQOs. However, the Year 2 sample SR-13-Y2 had DEHP detected at a concentration greater than the SQO, at approximately 5.5 times the SQO. The DEHP SQO ratios in the baseline, Year 4, Year 7, and Year 10 samples from this station ranged from approximately 0.3 to 0.7 times the SQO.

Natural Recovery Area Adjacent to RA 15 and RA 16 – At natural recovery monitoring Station NR-25, the RI, baseline, Year 2, Year 4, and Year 7 natural recovery 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 Year 10 natural recovery sample from Station NR-10 only had benzoic acid exceed its SQO, but Year 10 was the first year this analyte exceeded at this station. The RI sample had five analytes with concentrations greater than the SQOs, including mercury, pyrene, total HPAHs, DEHP, and total PCBs, with SQO exceedances ranging up to 5.5 times the SQO. The baseline sample had eight analytes detected at concentrations greater than the SQOs, including mercury, phenanthrene, benzo(a)anthracene, benzo(g,h,i)perylene, pyrene, total HPAHs, butyl benzyl phthalate, and DEHP, with SQO exceedances as high as approximately 2.8 times the SQO. Year 2 sample NR-25-Y2 had seven analytes with detected concentrations greater than the SQOs, including phenanthrene, fluoranthene, pyrene, total HPAHs, butyl benzyl phthalate, DEHP, and total PCBs, with the greatest SQO exceedance ratio of 1.9 times the SQO. The Year 4 natural recovery sample had nine analytes with concentrations greater than the SQOs, including phenanthrene, total LPAHs, total benzofluoranthenes, fluoranthene, indeno(1,2,3-cd)pyrene, pyrene, total HPAHs, butyl benzyl phthalate, and DEHP. The greatest SQO exceedance in the Year 4 natural recovery sample was 1.9 times the SQO, for DEHP. Fewer SQO exceedances were detected in the Year 7 natural recovery sample, with a total of five analytes exceeding in both parent and duplicate samples at Station NR-25. Exceedances in the parent and duplicate Year 7 natural recovery samples included anthracene, indeno(1,2,3-cd)pyrene, pyrene, butyl benzyl phthalate, and DEHP. The greatest SQO exceedance in the Year 7 samples was for DEHP with an SQO enrichment ratio of approximately 2.5 times the SQO. As stated above, only benzoic acid exceeded its SQO in the Year 10 sample NR-25-Y10 with an SQO enrichment ratio of approximately 2.0 times the SQO. Prior benzoic acid detections at this station were all less than the SQO. Indeno(1,2,3-cd)pyrene and pyrene, which have exceeded the SQO in most previous sampling events, did not exceed their SQOs in the Year 10 sample NR-25-Y10. Additionally, butyl benzyl phthalate and DEHP, which have exceeded their respective SQOs in the baseline, Year 2, Year 4, and Year 7 samples were detected but did not exceed their SQOs in the Year 10 natural recovery sample and had enrichment ratios of approximately 0.5 and 1.0 in the Year 10 natural recovery sample, respectively. In Year 7, in the parent sample NR-25-Y7, total PCBs exceeded the SQO and had a corresponding SQO enrichment ratio of approximately 1.7. The duplicate sample NR-25-Y7-2 had a lower total PCB concentration with an SQO enrichment ratio for total PCBs of 0.9 times the SQO. In comparison the Year 10 sample NR-25-Y10 had a total PCB enrichment ratio of approximately 0.3. PCBs were not detected in Year 4, due to matrix interferences and quantitation challenges as described earlier, but total PCBs were detected in the Year 2 sample at approximately 1.3 times the SQO.

Summary of Natural Recovery and Enhanced Natural Recovery OMMP Findings

A summary of the findings from the Year 10 natural recovery and enhanced natural recovery performance monitoring (0 to 10 cm) is included below, as well as a comparison to previous natural recovery and enhanced natural recovery performance monitoring results. For a comparison of the Year 10 natural recovery and enhanced natural recovery sampling results to the co-located Year 10 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.

- In Year 10, all of the 14 natural recovery and enhanced natural recovery stations had at least one SQO exceedance in the performance monitoring samples (0 to 10 cm). Eight of these Year 10 samples had only one SQO exceedance detected, for either benzoic acid (in five of the samples), indeno(1,2,3-cd)pyrene, butyl benzyl phthalate, or DEHP. Five of the Year 10 samples had two SQO exceedances each, with four of the stations having SQO exceedances for both DEHP and benzoic acid and the fifth station with SQO exceedances of indeno(1,2,3-cd)pyrene and benzoic acid. Finally, Year 10 sample NR-19-Y10 had a total of eight SQO exceedances, for various PAHs and benzoic acid.
- Two of the three natural recovery/slope rehabilitation stations, Station SR-11 and SR-13, had Year 10 performance monitoring samples with no SQO exceedances. At Station SR-10, sample SR-10-Y10 had SQO exceedances for multiple PAHs. Only one of the three discrete samples used to create composite sample SR-10-Y10 also had a PAH SQO exceedance, but only for fluoranthene with an exceedance ratio of 1.04. The corresponding field duplicate composite sample also did not have any SQO exceedances for PAHs. These results again reflecting the heterogeneity of the slope sediments in this area that has been noted in the past.
- Natural recovery performance monitoring samples from Stations 6 and 9, located north of the MMB, had no detected analyte concentrations greater than the SQOs for four consecutive monitoring events, including the baseline, Year 2, Year 4, and Year 7 monitoring events. However, both of these stations had benzoic acid SQO exceedances in the Year 10 natural recovery performance monitoring samples, with both stations having detections at approximately 1.2 times the SQO. Other analytes detected in the Year 10 natural recovery performance monitoring from these two stations were much less than their SQOs.

  The Year 10 co-located early warning samples at these two stations also had benzoic acid exceedances of the SQO, with benzoic acid detected at approximately 2.3 and 3.5 times the SQO in early warning samples EW-06-Y10 and EW-09-Y10, respectively. Additionally, early warning sample EW-06-Y10 had p,p'-DDE detected just greater than the SQO, yet this analyte was not detected in sample NR-06-Y10. Similar to the prior natural recovery performance monitoring samples collected from Station 9, the prior early warning samples collected in Year 2, Year 4, and Year 7 also did not have any SQO exceedances. However at Station 6, the early warning samples from Year 4, Year 7, and Year 10 all had benzoic acid detected at concentrations greater than the SQO, with the greatest detection in these early warning samples occurring in Year 10.
- At Station 7, another station located north of the MMB, both DEHP and benzoic acid exceeded the SQO in the Year 10 natural recovery performance monitoring and early warning samples. DEHP was detected at the same concentration in both of these Year 10 samples, at levels just greater than the SQO. Benzoic acid had a much higher SQO exceedance in these samples and was detected at a higher concentration in the early warning sample, with SQO exceedances of approximately 3.1 and 4.0 for samples NR-07-Y10 and EW-07-Y10, respectively. The Year 10 early warning sample also had an SQO exceedance for fluoranthene, just greater than the SQO. Similar to Stations 6 and 9, there were no SQO exceedances in the Year 2, Year 4, or Year 7 natural recovery performance monitoring samples from Station 7. Prior early warning samples from Station 7 did have SQO exceedances for DEHP (Year 4 early warning sample) and benzoic acid (Year 4 and Year 7 early warning samples).

- Station 8, also located north of the MMB, had no SQO exceedances in the baseline, Year 2, or Year 4 natural recovery performance monitoring samples, while the Year 7 sample NR-08-Y7 had only a DEHP exceedance and the Year 10 sample NR-08-Y10 had only indeno(1,2,3-cd)pyrene and benzoic acid exceedances. The SQO exceedances in these Year 7 and Year 10 natural recovery samples were all at or less than approximately 1.5 times the SQOs. The Year 10 early warning sample also had benzoic acid detected greater than the SQO, at approximately 1.9 times the SQO, higher compared to the benzoic acid concentration in sample NR-08-Y10 (approximately 1.5 times the SQO). Previous natural recovery performance monitoring and early warning samples from Station 8 did not have any SQO exceedances of benzoic acid; however, benzoic was detected just less than the SQO in the Year 4 early warning sample. Other SQO exceedances in prior early warning samples collected from Station 8 included DEHP (Year 4 and Year 7 early warning samples) and dibenzo(a,h)anthracene (Year 7 early warning sample).
- At Station 10, another station located north of the MMB, natural recovery sample NR-10-Y10 had only butyl benzyl phthalate exceed the SQO, detected just greater than the SQO, while the corresponding Year 10 early warning sample and all previous natural recovery and early warning samples from this station had this phthalate detected at concentrations much less than its SQO. The Year 2 and Year 7 performance monitoring samples from Station 10 did not have any detected SQO exceedances and the Year 4 performance monitoring sample had only an SQO exceedance for DEHP, just greater than the SQO. The Year 10 early warning sample had an exceedance of benzoic acid, detected just greater than the SQO, while benzoic acid was detected just less than the SQO in sample NR-10-Y10. Benzoic acid was also detected just greater than the SQO in the Year 4 early warning sample from Station 10; however, all other prior natural recovery and early warning samples from this station had either much lower concentrations of benzoic acid or this analyte was not-detected.
- The final natural recovery station located north of the MMB is Station 11. In each year of monitoring conducted at this station, DEHP concentrations have exceeded the SQO in the natural recovery performance monitoring and early warning samples. The greatest DEHP detection occurred in the RI sample, at approximately 2.9 times the SQO. DEHP concentrations in the baseline through Year 10 natural recovery and early warning samples from Station 11 have ranged between approximately 1.1 and 1.9 times the SQO. In both the Year 10 natural recovery and early warning samples, DEHP was detected at approximately 1.6 times the SQO. Benzoic acid was also detected at a concentration greater than its SQO in both the Year 10 natural recovery and early warning samples, with enrichment ratios of approximately 1.2 and 3.4, respectively. In Year 4 and Year 7, the natural recovery samples from Station 11 had SQO enrichment ratios for benzoic acid of approximately 0.8 and 0.7, respectively; while benzoic acid concentrations exceeded the SQO in the Year 4 and Year 7 early warning samples at approximately 1.4 and 1.2 times the SQO, respectively.
- The Year 10 natural recovery performance monitoring sample from Station 12, collected in the natural recovery area located adjacent to and southwest of the MMB, had only DEHP exceeding its SQO, at approximately 1.2 times the SQO. The corresponding Year 10 early warning sample had DEHP detected just greater than its SQO as well, but also had fluoranthene and benzoic acid exceeding the SQOs, with concentrations detected at approximately 1.1 and 1.5 times their SQOs, respectively. Prior natural recovery performance monitoring samples collected from this station in Year 4 and Year

7 also had DEHP SQO exceedances, but the Year 4 sample and the Year 7 field duplicate sample also had multiple PAHs detected well above their SQOs. The early warning samples from Station 12 collected in Year 2, Year 4, and Year 7 also had DEHP exceedances, but no PAH exceedances. Significantly lower PAH concentrations in the Year 4 and Year 7 early warning samples in comparison to the Year 4 and Year 7 (field duplicate) performance monitoring samples imply that the elevated concentrations in the performance monitoring samples are not the result of a continuing, top-down source of recontamination, but are likely from a historical source. Additional confirmation and verification sampling was performed at and nearby Station 12 in the fall of 2010 to compare with the Year 4 performance monitoring sample results. Based on the confirmation and verification sampling results, it was concluded that the multiple elevated PAH concentrations detected in the original Year 4 performance monitoring sample were not generally indicative of the sediment quality in the vicinity of Station 12, and that these results were likely attributable to heterogeneity. The PAH results from the Year 7 parent and field duplicate performance monitoring samples indicate heterogeneity in the sediment at this station as well. The DEHP concentrations in the Year 2, Year 4, Year 7, and Year 10 natural recovery performance monitoring and early warning samples from Station 12 are all relatively similar and near the SQO.

- Two other natural recovery stations, Stations 13 and 14, are located within the natural recovery area located south of and adjacent to the MMB. These two stations have had no SQO exceedances in the natural recovery performance monitoring samples collected during Year 2, Year 4, or Year 7; however, each of the Year 10 natural recovery performance monitoring samples from these stations had one SQO exceedance. The Station 13 Year 10 natural recovery performance monitoring sample had indeno(1,2,3-cd)pyrene detected just greater than the SQO at an enrichment ratio of 1.03, while the Year 10 natural recovery sample from Station 14 had an SQO exceedance for benzoic acid detected at approximately 1.2 times the SQO. While there were no detected SQO exceedances in the Year 7 performance monitoring sample from Station 13, this sample had detections of DEHP and dibenz(a,h)anthracene just less than the SQO and pyrene detected at the SQO.

  The Year 10 co-located early warning sample from Station 13, had SQO exceedances of indeno(1,2,3-cd)pyrene, DEHP, and benzoic acid, all detected at or less than approximately 1.2 times the SQOs. These three analytes also exceeded their SQOs in the Year 4 early warning sample from Station 13, with nearly identical concentrations to the Year 10 concentrations. In contrast, the Year 7 early warning sample from Station 13 had only pyrene detected just greater than the SQO. No early warning samples have been collected at Station 14, in accordance with the OMMP.

- Natural recovery Station 16 is located within the enhanced natural recovery area located south of the MMB on the west side of the waterway. Both the Year 10 natural recovery performance monitoring sample and early warning sample had SQO exceedances for DEHP and benzoic acid. Concentrations of DEHP in these Year 10 samples were just greater than the SQO, while the benzoic acid concentrations in samples NR-16-Y10 and EW-16-Y10 were detected at approximately 2.3 and 2.2 times the SQO, respectively. The Station 16 performance monitoring baseline, Year 2, Year 4, and Year 7 samples all had detected analyte concentrations less than the SQOs. Detected analyte concentrations in the Station 16 performance monitoring samples over the years have remained significantly less than the SQOs, with the exception of some concentrations for DEHP, benzoic acid, and butyl benzyl phthalate. Prior early warning samples from

Station 16 have had no SQO exceedances with the exception of benzyl alcohol in the Year 4 early warning sample.

- The Year 10 natural recovery performance monitoring sample from Station 17, located at the mouth of the Wheeler-Osgood Waterway, had only an SQO exceedance for benzoic acid, detected just greater than the SQO, while the Year 2 and Year 7 natural recovery performance monitoring samples from Station 17 did not have any SQO exceedances. In contrast, the Year 4 natural recovery performance monitoring sample had 19 parameters with detected concentrations greater than the SQOs, which included zinc, mercury, most of the PAHs, 4-methylphenol, benzoic acid, and dibenzofuran. The Year 4 co-located early warning sample from Station 17, had only SQO exceedances for 2-methylnaphthalene, phenanthrene, pyrene, and benzoic acid and the concentrations for these analytes were lower in the early warning sample compared to the Year 4 natural recovery sample. The early warning samples from Year 4 and Year 10 had similar SQO exceedances and relatively similar concentrations, while the Year 2 and Year 7 early warning samples from Station 17 did not have any SQO exceedances.

  The elevated concentrations in the Year 4 natural recovery performance monitoring sample, relative to the other Station 17 performance monitoring and early warning samples collected over the years, imply that these higher concentrations are likely from a historical source. Sediment collected from this station in Year 4 was observed to have significant woody and organic debris present, and the elevated analyte concentrations may be attributable to treated wood being present in the sample. Due to the elevated concentration levels noted in the Year 4 performance monitoring sample, additional confirmation and verification sampling was conducted at and in the vicinity of this station in 2010. The Year 4 confirmation and verification sampling results generally showed substantially lower concentrations of the elevated analytes and indicated that the initial higher detected concentrations in the Year 4 natural recovery sample were not generally indicative of the sediment quality in the vicinity of Station 17, and are likely associated with the elevated wood debris and TOC noted in the Year 4 sample and sample heterogeneity. The Year 7 and Year 10 sample results also support the conclusion that the Year 4 natural recovery sample results are not generally representative of the sediment quality at Station 17.

- Natural recovery Station 19 is located near the head of the Wheeler-Osgood Waterway. Detected analyte concentrations in the Year 2, Year 4, and Year 7 natural recovery performance monitoring samples from this station have all been less than the SQOs. However, the Year 10 natural recovery sample had eight analytes detected at concentrations exceeding the SQOs, including phenanthrene, benzo(a)anthracene, benzo(g,h,i)perylene, dibenz(a,h)anthracene, fluoranthene, indeno(1,2,3-cd)pyrene, pyrene, and benzoic acid, with enrichment ratios of approximately 1.3 times the SQO or less. The co-located Year 10 early warning sample, in contrast, only had benzoic acid detected just greater than the SQO. The Year 7 early warning sample from Station 19 also had only benzoic acid detected greater than the SQO.

- Natural recovery Station 20 is located at the head of the Wheeler-Osgood Waterway. Both the Year 10 natural recovery performance monitoring sample NR-20-Y10 and corresponding early warning sample had SQO exceedances for DEHP and benzoic acid. Concentrations of both analytes were greater in the early warning sample compared to the natural recovery sample, with DEHP detected at approximately 1.2 and 1.7 times the SQO in samples NR-20-Y10 and EW-20-Y10, respectively, and benzoic acid detected at approximately 2.0 and 2.6, respectively. In the previous natural recovery performance

monitoring and early warning samples collected from Station 20, detections of benzoic acid have all been at or less than approximately 0.5 times the SQO; whereas, concentrations of DEHP in the previous samples have all exceeded the SQO. The greatest DEHP concentrations were detected in the Year 7 samples, with DEHP detected at concentrations approximately 3.4 and 3.8 times the SQO in samples NR-20-Y7 and EW-20-Y7, respectively. Additionally, the Year 7 natural recovery performance monitoring and early warning samples both had SQO exceedances for n-nitrosodiphenylamine and the Year 7 natural recovery performance monitoring sample had an SQO exceedance for dibenzo(a,h)anthracene, with detections of these analytes just greater than the SQOs in these Year 7 samples. Concentrations of these two analytes were much lower in the Year 10 natural recovery and early warning samples.

- Natural recovery Station 25, located in the natural recovery area north of RA 15 and east of RA 16, had benzoic acid detected at approximately 2.0 times the SQO and DEHP detected at the SQO in the Year 10 sample NR-25-Y10. In the field duplicate sample NR-25-Y10-2, benzoic acid was detected at a lower concentration and DEHP was detected at a higher concentration. Previous natural recovery samples collected at this station each had multiple detected chemical concentrations that were greater than the SQOs, with exceedances noted for mercury (RI and baseline samples), various PAHs (RI, baseline, Year 2, Year 4, and Year 7 samples), butyl benzyl phthalate (baseline, Year 2, Year 4, and Year 7 samples), DEHP (RI, baseline, Year 2, Year 4, and Year 7 samples), and PCBs (RI, Year 2, and Year 7 samples). In addition, all four of the early warning samples collected from this station have had multiple detected analyte concentrations exceeding SQOs. The Year 10 early warning sample from Station 25 had SQO exceedances for fluoranthene, DEHP, and benzoic acid. The sample concentrations found at Station 25 may, in part, be the result of the heterogeneity in the sediment at this natural recovery area.
- Three Year 10 natural recovery/slope rehabilitation performance monitoring composite samples were collected from the shoreline slopes of the Wheeler-Osgood Waterway. The baseline and Year 2 through Year 10 samples collected from Station SR-11 have demonstrated that the southern shoreline of the Wheeler-Osgood Waterway meets performance monitoring criteria and that this area has naturally recovered. The detected analyte concentrations in the baseline, Year 2, Year 4, Year 7, and Year 10 samples at this station have been substantially less than the SQOs for five consecutive rounds of monitoring and analyte concentrations appear to be relatively stable.

  Station SR-10 comprises the northern shoreline of the Wheeler-Osgood Waterway. The Year 10 slope rehabilitation composite sample SR-10-Y10 had SQO exceedances for phenanthrene, total LPAHs, most of the HPAHs, and total HPAHs. Four of these analytes had SQO exceedances greater than 2.0 times their SQOs, including phenanthrene, fluoranthene, pyrene, and total HPAHs. Fluoranthene had the greatest SQO exceedance, at 6.4 times the SQO. In contrast, the field duplicate for this Year 10 composite sample, sample SR-10-Y10-2, had no SQO exceedances, with all PAHs detected at or less than approximately 0.6 times the SQOs. The three discrete samples used to create composite sample SR-10-Y10 also had PAH results at much lower concentrations compared with the composite sample results. Discrete samples SR-10-Y10-D1 and SR-10-Y10-D2 had no SQO exceedances and discrete sample SR-10-Y10-D3 had only fluoranthene detected just greater than its SQO. In previous composite samples collected from Station SR-10 there have been no PAH exceedances, but there have been some occasional PCB and mercury SQO exceedances. The Year 2 field

duplicate sample and the Year 7 sample Station SR-10 both had PCB Aroclor 1254 detected at concentrations greater than the total PCB SQO, with enrichment ratios of approximately 1.7 and 1.6 times the SQO, respectively. PCBs were not detected in the baseline sample, the Year 2 parent sample, the Year 4 sample, or the Year 10 sample at this station. Due to the elevated PCB concentrations noted at this station in Year 2 and Year 7 composite samples, both sets of the Year 7 and Year 10 discrete samples from this station were analyzed for PCBs to try to delineate the location of where PCBs are elevated along this shoreline. Two of the three discrete samples from Year 7, samples SR-10-Y7-D2 and SR-10-Y7-D3, had SQO exceedances for PCBs, with detections at approximately 2.2 and 2.4 times the SQO, respectively. PCBs were only detected in one of the Year 10 discrete samples, sample SR-10-Y10-D3, at a concentration just less than the SQO. Mercury was detected at concentrations just greater than the SQO in both the Year 4 composite sample and its field duplicate collected at this station, with much lower concentrations in the baseline, Year 2, Year 7, and Year 10 samples. The inconsistent concentrations of PAHs, total PCBs, and mercury detected in the samples at Station SR-10 indicate heterogeneity in the sediment in this portion of the waterway.

Sample SR-13-Y10 is a composite of material collected from the shoreline at the head of the Wheeler-Osgood Waterway. The detected analyte concentrations in Year 10 sample SR-13-Y10 were all substantially less than the SQOs. The baseline, Year 4, and Year 7 samples collected at Station SR-13 also had analyte concentrations much less than the SQOs. However, the Year 2 sample had DEHP detected at a concentration significantly greater than the SQO (over five times the SQO). The detected analyte concentrations in samples at this station have been substantially less than the SQOs for three consecutive rounds of monitoring and analyte concentrations appear to be relatively stable.

- Refer to the subsection titled Concentration Trends Related to Laboratory Analytical Changes in Section 2.2.2 for discussions on the benzoic acid, PCB, silver and nickel variations in the sediment samples noted when comparing concentrations between Year 2, Year 4, Year 7, and Year 10. The reason for some of the concentration variability for these analytes between the past four monitoring events can be attributed to analytical method changes. These analytical changes affecting concentration trends were first noted for PCBs in Year 7 and for silver and nickel in Year 4. In general, the concentrations of PCBs, silver, and nickel were comparable between the Year 7 and Year 10 natural recovery samples and were less than their SQOs (with the exception of the PCB results at Station NR-25 and Station SR-10). In Year 10, it was noted that benzoic acid concentrations generally increased relative to concentrations detected in previous monitoring events and resulted in many SQO exceedances for benzoic acid in the Year 10 natural recovery samples. The greater benzoic acid concentrations in the Year 10 samples relative to the sample concentrations from previous monitoring events are a result of improvements made to the laboratory extraction and analysis of benzoic acid in Year 10.

No additional natural recovery performance monitoring is required to further characterize these areas as part of the Year 10 monitoring. The SQO exceedances within the natural recovery monitoring areas are largely limited to benzoic acid and DEHP, with a few areas also showing generally low level PAH SQO exceedances. DEHP and benzoic acid also commonly exceeded their SQOs in other Year 10 OMMP sediment samples collected, including slope cap samples (refer to Section 2.2.2.1), channel sand cap samples (refer to Section 2.2.2.2), and early warning samples (refer to Section 3.0).

As described in further detail earlier in the Summary of Slope Cap Chemical Performance Monitoring OMMP Findings (part of Section 2.2.2.1), DEHP is a ubiquitous urban compound and recontamination of DEHP above the SQO within the waterways' sediments was predicted to occur prior to construction of the remedy. In 2013 an evaluation of the Year 7 OMMP sediment monitoring results in comparison with the Thea Foss Sediment Quality Model predictions was conducted by the City to assess changes in waterway sediment concentrations over time and to extrapolate sediment quality trends into the future (City of Tacoma 2014). This evaluation generally concluded that sediment concentrations were beginning to level off in approximately Year 7 and were not expected to rise much higher in the future, with many areas remaining relatively stable between the Year 4 and Year 7 monitoring events. A similar evaluation of the Year 10 OMMP sediment monitoring results in comparison to the model will be completed by the City in 2017. As part of this modeling evaluation, DEHP results were compared to a biological effects level for DEHP of 4,000 µg/kg. In Year 10 all DEHP concentrations in the natural recovery, enhanced natural recovery, and natural recovery/slope rehabilitation samples were detected well below this biological effects level.

As indicated in Section 2.2.2.1 above, because of challenges faced by the City and others in addressing phthalate contamination in the environment, a Sediment Phthalates Work Group was formed in 2006 to research the sources, pathways, and treatment options for phthalates and other ubiquitous compounds in stormwater. The group developed a Summary of Findings and Recommendations document which is currently in the process of being implemented by the regulatory agencies.

As noted in the last bullet above and described further in the subsection titled Concentration Trends Related to Laboratory Analytical Changes in Section 2.2.2, benzoic acid concentrations in the Year 10 natural recovery samples generally increased relative to concentrations detected in previous monitoring events. The greater benzoic acid concentrations in these Year 10 samples relative to the sample concentrations from previous monitoring events are a result of improvements made to the laboratory extraction and analysis of benzoic acid in Year 10. A potential source of benzoic acid to these sediments could be the breakdown of plant material entering the waterways. Benzoic acid is a naturally occurring compound in terrestrial plants and is also a breakdown product of benzyl alcohol, which also naturally occurs in terrestrial plants. It has frequently been detected at DMMP disposal sites and has been detected at concentrations exceeding the SQO in sediment samples collected from several non-urban embayments. Refer to Section 2.2.2 for further information.

Additionally the benthic community and recolonization at stations located within the natural recovery areas continue to show evidence of healthy colonization, with these areas showing evidence of mature infaunal communities and benthic ecosystem recovery (refer to Section 4.0 for further details).

Based on this information, no remedial actions are warranted at this time based on the findings of the Year 10 natural recovery chemical performance monitoring. The long-term monitoring of the chemical performance in these natural recovery areas is discussed below in Section 2.4 Sediment Remediation Area Performance Monitoring Conclusions and Future Long-Term Monitoring.

2.4 Sediment Remediation Area Performance Monitoring Conclusions and Future Long-Term Monitoring

No additional sediment remediation area performance monitoring activities are required to characterize the Year 10 conditions. Additionally, no remedial actions are warranted at this time based on the findings of the Year 10 sediment remediation area performance monitoring, as described in the OMMP findings sections above for the slope cap inspections, hydrographic surveys, slope cap chemical monitoring, channel cap chemical monitoring, and natural recovery chemical monitoring.

The results of the Year 10 sediment performance monitoring events, as well as results from the Year 10 early warning monitoring and previous sediment remediation area performance monitoring and early warning monitoring events, will be used to help prepare the Long-Term Monitoring Plan for the Thea Foss and Wheeler-Osgood Waterways Remediation Project. The Long-Term Monitoring Plan will identify the future type and frequency of the sediment remediation area performance monitoring activities to be conducted through the waterway. It is anticipated that the Long-Term Monitoring Plan for the Thea Foss and Wheeler-Osgood Waterways Remediation Project will be prepared by the City in coordination with EPA in 2017.

TABLES

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

2-2 – Summary of Year 10 Slope Cap SC-14 Discrete and Composite Sample Results for PAHs and Phthalates

2-3 – Summary of Year 10 Channel Sand Cap Surface Sample (0 to 10 cm) Results

2-4 – Summary of Year 10 Natural Recovery and Enhanced Natural Recovery Surface Sample (0 to 10 cm) Results

2-5 – Summary of Year 10 Slope Rehabilitation SR-10 Discrete and Composite Sample Results for PAHs, Phthalates, and PCBs

FIGURES

2-1 – Year 10 Low Tide Slope Cap Monitoring Intervals and Slope Cap Sampling Locations

2-2 – Year 10 Subtidal Hydrographic Survey Areas

2-3 – Year 10 Performance Monitoring and Early Warning Sampling Locations

2-4 – Year 10 SQO Exceedances in Performance Monitoring Surface Samples (0 to 10 cm)

2-5 – Comparison of Year 7 and Year 10 SQO Exceedances in Performance Monitoring Surface Samples (0-10 cm)

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

		Station	SC-01		SC-03		SC-08A		SC-08B		SC-14		SC-19A	
		Sample ID	SC-01-Y10		SC-03-Y10		SC-08A-Y10		SC-08B-Y10		SC-14-Y10		SC-19A-Y10	
		Sample Date	6/21/2016	Enrichment	6/21/2016	Enrichment	6/7/2016	Enrichment	6/7/2016	Enrichment	6/22/2016	Enrichment	6/6/2016	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
Parameter	**Units**	**SQO**												
Conventionals														
Total Organic Carbon	mg/kg	NC	10,400	NA	8,130	NA	5,830	NA	11,500	NA	20,900	NA	8,420	NA
Total Solids	%	NC	84.9	NA	75.6	NA	85.1	NA	81.3	NA	67.7	NA	85.1	NA
Metals														
Antimony	mg/kg	150	0.490 U	NA	0.490 U	NA	0.481 U	NA	0.642	0.004	1.24	0.01	0.490 U	NA
Arsenic	mg/kg	57	3.75	0.07	4.95	0.09	3.67	0.06	4.47	0.08	8.27	0.15	4.40	0.08
Cadmium	mg/kg	5.1	0.490 U	NA	0.490 U	NA	0.481 U	NA	0.472 U	NA	0.481 U	NA	0.490 U	NA
Copper	mg/kg	390	43.3	0.11	20.3	0.05	25.2	0.06	32.1	0.08	101	0.26	31.0	0.08
Lead	mg/kg	450	19.7	0.04	15.3	0.03	9.97	0.02	19.5	0.04	41.1	0.09	16.4	0.04
Nickel	mg/kg	140	20.6	0.15	13.5	0.10	25.3	0.18	26.4	0.19	24.4	0.17	22.6	0.16
Silver	mg/kg	6.1	0.490 U	NA	0.490 U	NA	0.481 U	NA	0.472 U	NA	0.481 U	NA	0.490 U	NA
Zinc	mg/kg	410	73.2	0.18	54.0	0.13	54.1	0.13	79.9	0.19	122	0.30	68.1	0.17
Mercury	mg/kg	0.59	0.0295	0.05	0.0190	0.03	0.0284	0.05	0.0439	0.07	0.0886	0.15	0.0372	0.06
SVOCs														
LPAHs														
2-Methylnaphthalene	µg/kg	670	83 U	NA	83 U	NA	83 U	NA	83 U	NA	83 U	NA	82 U	NA
Acenaphthene	µg/kg	500	83 U	NA	83 U	NA	83 U	NA	83 U	NA	83 U	NA	82 U	NA
Acenaphthylene	µg/kg	1,300	83 U	NA	83 U	NA	83 U	NA	83 U	NA	83 U	NA	82 U	NA
Anthracene	µg/kg	960	83 U	NA	83 U	NA	83 U	NA	83 U	NA	190	0.20	82 U	NA
Fluorene	µg/kg	540	83 U	NA	83 U	NA	83 U	NA	83 U	NA	83 U	NA	82 U	NA
Naphthalene	µg/kg	2,100	83 U	NA	83 U	NA	83 U	NA	83 U	NA	120	0.06	82 U	NA
Phenanthrene	µg/kg	1,500	110	0.07	83 U	NA	83 U	NA	1,400	0.93	200	0.13	82 U	NA
Total LPAH	µg/kg	5,200	110	0.02	83 U	NA	83 U	NA	1,400	0.27	510	0.10	82 U	NA
HPAHs														
Benzo(a)anthracene	µg/kg	1,600	83 U	NA	83 U	NA	83 U	NA	140	0.09	300	0.19	82 U	NA
Benzo(a)pyrene	µg/kg	1,600	83	0.05	83 U	NA	83 U	NA	200	0.13	340	0.21	82 U	NA
Benzofluoranthenes (total)	µg/kg	3,600	170 U	NA	170 U	NA	170 U	NA	510	0.14	880	0.24	160 U	NA
Benzo(g,h,i)perylene	µg/kg	720	83 U	NA	83 U	NA	83 U	NA	99	0.14	320	0.44	82 U	NA
Chrysene	µg/kg	2,800	140	0.05	83 U	NA	83 U	NA	390	0.14	630	0.23	82 U	NA
Dibenz(a,h)anthracene	µg/kg	230	22	0.10	12	0.05	8 U	NA	26	0.11	90	0.39	12	0.05
Fluoranthene	µg/kg	2,500	250	0.10	83 U	NA	83 U	NA	1,200	0.48	510	0.20	82 U	NA
Indeno(1,2,3-cd)pyrene	µg/kg	690	83	0.12	83 U	NA	83 U	NA	110	0.16	330	0.48	82 U	NA
Pyrene	µg/kg	3,300	190	0.06	83 U	NA	83 U	NA	790	0.24	490	0.15	82 U	NA
Total HPAH	µg/kg	17,000	770	0.05	12	0.001	170 U	NA	3,500	0.21	3,900	0.23	12	0.001
Other														
Dimethyl phthalate	µg/kg	160	33 U	NA	33 U	NA	33 U	NA	33 U	NA	33 U	NA	33 U	NA
Diethylphthalate	µg/kg	200	83 U	NA	83 U	NA	83 U	NA	83 U	NA	83 U	NA	82 U	NA
Di-n-butyl phthalate	µg/kg	1,400	83 U	NA	83 U	NA	83 U	NA	83 U	NA	83 U	NA	82 U	NA
Butyl benzyl phthalate	µg/kg	900	83 U	NA	83 U	NA	83 U	NA	83 U	NA	160	0.18	82 U	NA
Bis(2-ethylhexyl)phthalate	µg/kg	1,300	170	0.13	93	0.07	110	0.08	210	0.16	**4,100**	3.15	190	0.15
Di-n-octyl phthalate	µg/kg	6,200	83 U	NA	83 U	NA	83 U	NA	83 U	NA	110	0.02	82 U	NA
Phenol	µg/kg	420	83 U	NA	83 U	NA	83 U	NA	83 U	NA	83 U	NA	82 U	NA
2-Methylphenol	µg/kg	63	4 U	NA	4 U	NA	4 U	NA	4 U	NA	4	0.06	4 U	NA
4-Methylphenol	µg/kg	670	83 U	NA	83 U	NA	83 U	NA	83 U	NA	83 U	NA	82 U	NA
2,4-Dimethylphenol	µg/kg	29	4 U	NA	4 U	NA	4 U	NA	4 U	NA	5	0.17	4 U	NA
Pentachlorophenol	µg/kg	360	83 U	NA	83 U	NA	83 U	NA	83 U	NA	83 U	NA	82 U	NA
Benzyl alcohol	µg/kg	73	9	0.12	9	0.12	10 UJ	NA	14 UJ	NA	8	0.11	13 UJ	NA
Benzoic acid	µg/kg	650	400 J	0.62	**1,100 J**	1.69	300 J	0.46	**820 J**	1.26	440 J	0.68	**710 J**	1.09
1,2-Dichlorobenzene	µg/kg	50	4 U	NA	4 U	NA	4 U	NA	4 U	NA	4 U	NA	4 U	NA
1,3-Dichlorobenzene	µg/kg	170	33 U	NA	33 U	NA	33 U	NA	33 U	NA	33 U	NA	33 U	NA
1,4-Dichlorobenzene	µg/kg	110	33 U	NA	33 U	NA	33 U	NA	33 U	NA	33 U	NA	33 U	NA
1,2,4-Trichlorobenzene	µg/kg	51	4 U	NA	4 U	NA	4 U	NA	4 U	NA	4 U	NA	4 U	NA
Hexachlorobenzene	µg/kg	22	4 U	NA	4 U	NA	4 U	NA	4 U	NA	4 U	NA	4 U	NA
Dibenzofuran	µg/kg	540	83 U	NA	83 U	NA	83 U	NA	83 U	NA	83 U	NA	82 U	NA
Hexachlorobutadiene	µg/kg	11	4 U	NA	4 U	NA	4 U	NA	4 U	NA	4 U	NA	4 U	NA
N-Nitrosodiphenylamine	µg/kg	28	8 U	NA	8 U	NA	8 U	NA	8 U	NA	15	0.54	8 U	NA
Pesticides														
p,p'-DDD	µg/kg	16	4.0 U	NA	4.0 U	NA	4.0 U	NA	4.0 U	NA	4.0 U	NA	4.0 U	NA
p,p'-DDE	µg/kg	9	4.0 U	NA	4.0 U	NA	4.0 U	NA	4.0 U	NA	4.0 U	NA	4.0 U	NA
p,p'-DDT	µg/kg	34	4.0 U	NA	4.0 U	NA	4.0 U	NA	4.0 U	NA	4.0 U	NA	4.0 U	NA
PCBs														
PCB-1016	µg/kg	NC	20 U	NA	20 U	NA	20 U	NA	20 U	NA	20 U	NA	20 U	NA
PCB-1221	µg/kg	NC	20 U	NA	20 U	NA	20 U	NA	20 U	NA	20 U	NA	20 U	NA
PCB-1232	µg/kg	NC	20 U	NA	20 U	NA	20 U	NA	20 U	NA	20 U	NA	20 U	NA
PCB-1242	µg/kg	NC	20 U	NA	20 U	NA	20 U	NA	20 U	NA	20 U	NA	20 U	NA
PCB-1248	µg/kg	NC	20 U	NA	20 U	NA	20 U	NA	20 U	NA	20 U	NA	20 U	NA
PCB-1254	µg/kg	NC	20 U	NA	20 U	NA	150	NA	20 U	NA	46	NA	20 U	NA
PCB-1260	µg/kg	NC	20 U	NA	20 U	NA	20 U	NA	20 U	NA	20 U	NA	20 U	NA
PCBs (total)	µg/kg	300	20 U	NA	20 U	NA	150	0.50	20 U	NA	46	0.15	20 U	NA

Notes:

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

NA Not applicable.

NC No SQO criterion.

Qualifiers:

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

U Not detected at the given reporting limit.

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

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

		Station	SC-19B		SC-20			
		Sample ID	SC-19B-Y10		SC-20-Y10		SC-20-Y10-2	
		Sample Date	6/6/2016	Enrichment	6/20/2016	Enrichment	6/20/2016	Enrichment
		Sample Depth	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	26,800	NA	27,100	NA	28,400	NA
Total Solids	%	NC	71.4	NA	70.7	NA	69.1	NA
Metals								
Antimony	mg/kg	150	1.12	0.01	1.19	0.01	1.42	0.01
Arsenic	mg/kg	57	7.27	0.13	7.90	0.14	8.39	0.15
Cadmium	mg/kg	5.1	0.472 U	NA	0.500 U	NA	0.500 U	NA
Copper	mg/kg	390	58.6	0.15	59.5	0.15	62.1	0.16
Lead	mg/kg	450	48.5	0.11	40.9	0.09	42.3	0.09
Nickel	mg/kg	140	25.6	0.18	22.4	0.16	22.8	0.16
Silver	mg/kg	6.1	0.472 U	NA	0.500 U	NA	0.500 U	NA
Zinc	mg/kg	410	143	0.35	170	0.41	176	0.43
Mercury	mg/kg	0.59	0.0874	0.15	0.0936	0.16	0.0808	0.14
SVOCs								
LPAHs								
2-Methylnaphthalene	µg/kg	670	83 U	NA	83 U	NA	83 U	NA
Acenaphthene	µg/kg	500	83 U	NA	83 U	NA	83 U	NA
Acenaphthylene	µg/kg	1,300	83 U	NA	83 U	NA	83 U	NA
Anthracene	µg/kg	960	83 U	NA	83 U	NA	83 U	NA
Fluorene	µg/kg	540	83 U	NA	83 U	NA	83 U	NA
Naphthalene	µg/kg	2,100	83 U	NA	83 U	NA	83 U	NA
Phenanthrene	µg/kg	1,500	160	0.11	170	0.11	130	0.09
Total LPAH	µg/kg	5,200	160	0.03	170	0.03	130	0.03
HPAHs								
Benzo(a)anthracene	µg/kg	1,600	120	0.08	110	0.07	140	0.09
Benzo(a)pyrene	µg/kg	1,600	190	0.12	170	0.11	180	0.11
Benzofluoranthenes (total)	µg/kg	3,600	470	0.13	360	0.10	410	0.11
Benzo(g,h,i)perylene	µg/kg	720	190	0.26	240	0.33	270	0.38
Chrysene	µg/kg	2,800	210	0.08	180	0.06	230	0.08
Dibenz(a,h)anthracene	µg/kg	230	36	0.16	49	0.21	57	0.25
Fluoranthene	µg/kg	2,500	320	0.13	270	0.11	330	0.13
Indeno(1,2,3-cd)pyrene	µg/kg	690	170	0.25	200	0.29	220	0.32
Pyrene	µg/kg	3,300	300	0.09	270	0.08	290	0.09
Total HPAH	µg/kg	17,000	2,000	0.12	1,800	0.11	2,100	0.12
Other								
Dimethyl phthalate	µg/kg	160	33 U	NA	33 U	NA	33 U	NA
Diethylphthalate	µg/kg	200	83 U	NA	83 U	NA	83 U	NA
Di-n-butyl phthalate	µg/kg	1,400	83 U	NA	83 U	NA	83 U	NA
Butyl benzyl phthalate	µg/kg	900	83 U	NA	610	0.68	500	0.56
Bis(2-ethylhexyl)phthalate	µg/kg	1,300	770	0.59	**1,400**	1.08	1,200	0.92
Di-n-octyl phthalate	µg/kg	6,200	83 U	NA	130	0.02	130	0.02
Phenol	µg/kg	420	83 U	NA	83 U	NA	83 U	NA
2-Methylphenol	µg/kg	63	4 U	NA	5	0.08	5	0.08
4-Methylphenol	µg/kg	670	83 U	NA	83 U	NA	83 U	NA
2,4-Dimethylphenol	µg/kg	29	4 U	NA	6	0.21	6	0.21
Pentachlorophenol	µg/kg	360	83 U	NA	83 U	NA	83 U	NA
Benzyl alcohol	µg/kg	73	21 UJ	NA	13	0.18	12	0.16
Benzoic acid	µg/kg	650	**710 J**	1.09	650 J	1.00	510 J	0.78
1,2-Dichlorobenzene	µg/kg	50	4 U	NA	4 U	NA	4 U	NA
1,3-Dichlorobenzene	µg/kg	170	33 U	NA	33 U	NA	33 U	NA
1,4-Dichlorobenzene	µg/kg	110	33 U	NA	33 U	NA	33 U	NA
1,2,4-Trichlorobenzene	µg/kg	51	4 U	NA	4 U	NA	4 U	NA
Hexachlorobenzene	µg/kg	22	4 U	NA	4 U	NA	4 U	NA
Dibenzofuran	µg/kg	540	83 U	NA	83 U	NA	83 U	NA
Hexachlorobutadiene	µg/kg	11	4 U	NA	4 U	NA	4 U	NA
N-Nitrosodiphenylamine	µg/kg	28	8 U	NA	8 U	NA	8 U	NA
Pesticides								
p,p'-DDD	µg/kg	16	4.0 U	NA	4.0 U	NA	4.0 U	NA
p,p'-DDE	µg/kg	9	4.0 U	NA	4.0 U	NA	4.0 U	NA
p,p'-DDT	µg/kg	34	4.0 U	NA	4.0 UJ	NA	4.0 U	NA
PCBs								
PCB-1016	µg/kg	NC	20 U	NA	20 U	NA	20 U	NA
PCB-1221	µg/kg	NC	20 U	NA	20 U	NA	20 U	NA
PCB-1232	µg/kg	NC	20 U	NA	20 U	NA	20 U	NA
PCB-1242	µg/kg	NC	20 U	NA	20 U	NA	20 U	NA
PCB-1248	µg/kg	NC	20 U	NA	20 U	NA	20 U	NA
PCB-1254	µg/kg	NC	20 U	NA	20 U	NA	24	NA
PCB-1260	µg/kg	NC	20 U	NA	20 U	NA	20 U	NA
PCBs (total)	µg/kg	300	20 U	NA	20 U	NA	24	0.08

Notes:

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

NA Not applicable.

NC No SQO criterion.

Qualifiers:

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

U Not detected at the given reporting limit.

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

Table 2-2
Summary of Year 10 Slope Cap SC-14 Discrete and Composite Sample Results for PAHs and Phthalates

		Station	SC-14							
		Sample ID	SC-14-Y10-D1		SC-14-Y10-D2		SC-14-Y10-D3		SC-14-Y10	
		Sample Type	Discrete		Discrete		Discrete		Composite	
		Sample Date	6/22/2016	Enrichment	6/22/2016	Enrichment	6/22/2016	Enrichment	6/22/2016	Enrichment
		Sample Depth	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	33,200	NA	23,400	NA	9,850	NA	20,900	NA
Total Solids	%	NC	52.9	NA	70	NA	79.9	NA	67.7	NA
SVOCs										
LPAHs										
2-Methylnaphthalene	µg/kg	670	83 U	NA	83 U	NA	82 U	NA	83 U	NA
Acenaphthene	µg/kg	500	83 U	NA	83 U	NA	82 U	NA	83 U	NA
Acenaphthylene	µg/kg	1,300	120	0.09	83 U	NA	82 U	NA	83 U	NA
Anthracene	µg/kg	960	300	0.31	110	0.11	82 U	NA	190	0.20
Fluorene	µg/kg	540	83 U	NA	83 U	NA	82 U	NA	83 U	NA
Naphthalene	µg/kg	2,100	160	0.08	83 U	NA	82 U	NA	120	0.06
Phenanthrene	µg/kg	1,500	410	0.27	200	0.13	82 U	NA	200	0.13
Total LPAH	µg/kg	5,200	990	0.19	310	0.06	82 U	NA	510	0.10
HPAHs										
Benzo(a)anthracene	µg/kg	1,600	560	0.35	290	0.18	130	0.08	300	0.19
Benzo(a)pyrene	µg/kg	1,600	650	0.41	280	0.18	160	0.10	340	0.21
Benzofluoranthenes (total)	µg/kg	3,600	1,900	0.53	740	0.21	410	0.11	880	0.24
Benzo(g,h,i)perylene	µg/kg	720	460	0.64	150	0.21	84	0.12	320	0.44
Chrysene	µg/kg	2,800	1,100	0.39	510	0.18	290	0.10	630	0.23
Dibenz(a,h)anthracene	µg/kg	230	110	0.48	35	0.15	25	0.11	90	0.39
Fluoranthene	µg/kg	2,500	1,100	0.44	600	0.24	160	0.06	510	0.20
Indeno(1,2,3-cd)pyrene	µg/kg	690	450	0.65	150	0.22	91	0.13	330	0.48
Pyrene	µg/kg	3,300	1,400	0.42	510	0.15	160	0.05	490	0.15
Total HPAH	µg/kg	17,000	7,700	0.45	3,300	0.19	1,500	0.09	3,900	0.23
Phthalates										
Dimethyl phthalate	µg/kg	160	33 U	NA	33 U	NA	33 U	NA	33 U	NA
Diethylphthalate	µg/kg	200	83 U	NA	83 U	NA	83 U	NA	83 U	NA
Di-n-butyl phthalate	µg/kg	1,400	83 U	NA	83 U	NA	83 U	NA	83 U	NA
Butyl benzyl phthalate	µg/kg	900	260	0.29	83 U	NA	82 U	NA	160	0.18
Bis(2-ethylhexyl)phthalate	µg/kg	1,300	**1,800**	1.38	830	0.64	310	0.24	**4,100**	3.15
Di-n-octyl phthalate	µg/kg	6,200	130	0.02	83 U	NA	82 U	NA	110	0.02

Notes:

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

NA Not applicable.

NC No SQO criterion.

Qualifiers:

U Not detected at the given reporting limit.

Table 2-3
Summary of Year 10 Channel Sand Cap Surface Samples (0 to 10 cm) Results

		Station	CC-01		CC-18		CC-23		CC-26		CC-27		CC-29	
		Sample ID	CC-01-Y10		CC-18-Y10		CC-23-Y10		CC-26-Y10		CC-27-Y10		CC-29-Y10	
		Sample Date	5/16/2016	Enrichment	5/16/2016	Enrichment	6/28/2016	Enrichment	6/27/2016	Enrichment	6/27/2016	Enrichment	6/27/2016	Enrichment
		Sample Depth	0 to 9 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	7,980	NA	17,300	NA	40,200	NA	17,900	NA	33,700	NA	17,300	NA
Total Solids	%	NC	76.2	NA	80.5	NA	43.1	NA	73.3	NA	51.6	NA	66.3	NA
Metals														
Antimony	mg/kg	150	0.529	0.004	0.554	0.004	1.48	0.01	0.607	0.004	1.17	0.01	0.681	0.005
Arsenic	mg/kg	57	5.59	0.10	5.55	0.10	7.77	0.14	5.70	0.10	9.58	0.17	6.15	0.11
Cadmium	mg/kg	5.1	0.500 U	NA	0.481 U	NA	0.800	0.16	0.481 U	NA	0.751	0.15	0.500 U	NA
Copper	mg/kg	390	30.0	0.08	50.4	0.13	73.0	0.19	54.5	0.14	86.0	0.22	50.0	0.13
Lead	mg/kg	450	11.2	0.02	24.0	0.05	68.7	0.15	30.6	0.07	64.3	0.14	32.4	0.07
Nickel	mg/kg	140	17.7	0.13	23.1	0.17	24.5	0.18	21.6	0.15	26.3	0.19	23.7	0.17
Silver	mg/kg	6.1	0.500 U	NA	0.481 U	NA	0.639	0.10	0.481 U	NA	0.802	0.13	0.500 U	NA
Zinc	mg/kg	410	49.2	0.12	86.2	0.21	188	0.46	87.7	0.21	150	0.37	98.3	0.24
Mercury	mg/kg	0.59	0.0667	0.11	0.0768	0.13	0.212	0.36	0.117	0.20	0.259	0.44	0.126	0.21
SVOC														
LPAHs														
2-Methylnaphthalene	µg/kg	670	77 U	NA	72 U	NA	83 U	NA	82 U	NA	110	0.16	83 U	NA
Acenaphthene	µg/kg	500	77 U	NA	72 U	NA	83 U	NA	82 U	NA	87	0.17	83 U	NA
Acenaphthylene	µg/kg	1,300	77 U	NA	72 U	NA	83 U	NA	82 U	NA	130	0.10	83 U	NA
Anthracene	µg/kg	960	100	0.10	72 U	NA	190	0.20	90	0.09	270	0.28	99	0.10
Fluorene	µg/kg	540	77 U	NA	72 U	NA	87	0.16	82 U	NA	120	0.22	83 U	NA
Naphthalene	µg/kg	2,100	77 U	NA	72 U	NA	130	0.06	82 U	NA	300	0.14	130	0.06
Phenanthrene	µg/kg	1,500	190	0.13	72 U	NA	660	0.44	160	0.11	500	0.33	210	0.14
Total LPAH	µg/kg	5,200	290	0.06	72 U	NA	1,100	0.21	250	0.05	1,500	0.29	440	0.08
HPAHs														
Benzo(a)anthracene	µg/kg	1,600	140	0.09	72 U	NA	620	0.39	140	0.09	490	0.31	190	0.12
Benzo(a)pyrene	µg/kg	1,600	170	0.11	72 U	NA	770	0.48	230	0.14	780	0.49	320	0.20
Benzofluoranthenes (total)	µg/kg	3,600	220	0.06	140 U	NA	1,700	0.47	430	0.12	1,500	0.42	630	0.18
Benzo(g,h,i)perylene	µg/kg	720	77 U	NA	72 U	NA	**740**	1.03	210	0.29	**740**	1.03	310	0.43
Chrysene	µg/kg	2,800	180	0.06	72 U	NA	910	0.33	190	0.07	650	0.23	270	0.10
Dibenz(a,h)anthracene	µg/kg	230	19	0.08	9	0.04	180	0.78	45	0.20	160	0.70	70	0.30
Fluoranthene	µg/kg	2,500	280	0.11	110	0.04	1,500	0.60	270	0.11	960	0.38	390	0.16
Indeno(1,2,3-cd)pyrene	µg/kg	690	77 U	NA	72 U	NA	**720**	1.04	210	0.30	**720**	1.04	310	0.45
Pyrene	µg/kg	3,300	280	0.08	110	0.03	1,200	0.36	330	0.10	1,200	0.36	470	0.14
Total HPAH	µg/kg	17,000	1,300	0.08	230	0.01	8,300	0.49	2,100	0.12	7,200	0.42	3,000	0.18
Other														
Dimethyl phthalate	µg/kg	160	31 U	NA	29 U	NA	33 U	NA	33 U	NA	33 U	NA	33 U	NA
Diethylphthalate	µg/kg	200	77 U	NA	72 U	NA	83 U	NA	82 U	NA	83 U	NA	83 U	NA
Di-n-butyl phthalate	µg/kg	1,400	77 U	NA	72 U	NA	83 U	NA	82 U	NA	83 U	NA	83 U	NA
Butyl benzyl phthalate	µg/kg	900	77 U	NA	72 U	NA	210	0.23	94	0.10	280	0.31	140	0.16
Bis(2-ethylhexyl)phthalate	µg/kg	1,300	86	0.07	220	0.17	**2,100**	1.62	980	0.75	**2,000**	1.54	1,200	0.92
Di-n-octyl phthalate	µg/kg	6,200	77 U	NA	72 U	NA	150	0.02	82 U	NA	200	0.03	110	0.02
Phenol	µg/kg	420	77 U	NA	72 U	NA	83 U	NA	82 U	NA	83 U	NA	83 U	NA
2-Methylphenol	µg/kg	63	4 U	NA	4 U	NA	10	0.16	4 U	NA	10	0.16	5	0.08
4-Methylphenol	µg/kg	670	77 U	NA	72 U	NA	83 U	NA	82 U	NA	83 U	NA	83 U	NA
2,4-Dimethylphenol	µg/kg	29	4 U	NA	4 U	NA	11	0.38	4	0.14	13	0.45	5	0.17
Pentachlorophenol	µg/kg	360	77 U	NA	72 U	NA	83 U	NA	82 U	NA	83 U	NA	83 U	NA
Benzyl alcohol	µg/kg	73	8 U	NA	7 U	NA	29	0.40	16	0.22	34	0.47	17	0.23
Benzoic acid	µg/kg	650	**1,000 J**	1.54	520 J	0.80	**800 J**	1.23	600 J	0.92	**1,200 J**	1.85	**980 J**	1.51
1,2-Dichlorobenzene	µg/kg	50	4 U	NA	4 U	NA	4 U	NA	4 U	NA	4 U	NA	7 UJ	NA
1,3-Dichlorobenzene	µg/kg	170	31 U	NA	29 U	NA	33 U	NA	33 U	NA	33 U	NA	33 U	NA
1,4-Dichlorobenzene	µg/kg	110	31 U	NA	29 U	NA	33 U	NA	33 U	NA	33 U	NA	33 U	NA
1,2,4-Trichlorobenzene	µg/kg	51	4 U	NA	4 U	NA	4 U	NA	4 U	NA	4 U	NA	4 U	NA
Hexachlorobenzene	µg/kg	22	4 U	NA	4 U	NA	4 U	NA	4 U	NA	4 U	NA	4 U	NA
Dibenzofuran	µg/kg	540	77 U	NA	72 U	NA	83 U	NA	82 U	NA	83 U	NA	83 U	NA
Hexachlorobutadiene	µg/kg	11	4 U	NA	4 U	NA	4 U	NA	4 U	NA	4 U	NA	4 U	NA
N-Nitrosodiphenylamine	µg/kg	28	8 U	NA	7 U	NA	8 U	NA	8 U	NA	12	0.43	8 U	NA
Pesticides														
p,p'-DDD	µg/kg	16	3.7 U	NA	3.5 U	NA	4.0 UJ	NA	3.9 U	NA	4.0 U	NA	4.0 U	NA
p,p'-DDE	µg/kg	9	3.7 U	NA	3.5 U	NA	4.0 UJ	NA	3.9 U	NA	4.0 U	NA	4.0 U	NA
p,p'-DDT	µg/kg	34	3.7 U	NA	3.5 U	NA	4.0 UJ	NA	3.9 U	NA	4.0 U	NA	4.0 U	NA
PCBs														
PCB-1016	µg/kg	NC	18 U	NA	17 U	NA	20 UJ	NA	20 U	NA	20 U	NA	20 U	NA
PCB-1221	µg/kg	NC	18 U	NA	17 U	NA	20 UJ	NA	20 U	NA	20 U	NA	20 U	NA
PCB-1232	µg/kg	NC	18 U	NA	17 U	NA	20 UJ	NA	20 U	NA	20 U	NA	20 U	NA
PCB-1242	µg/kg	NC	18 U	NA	17 U	NA	20 UJ	NA	20 U	NA	20 U	NA	20 U	NA
PCB-1248	µg/kg	NC	18 U	NA	17 U	NA	20 UJ	NA	20 U	NA	20 U	NA	20 U	NA
PCB-1254	µg/kg	NC	18 U	NA	17 U	NA	49 J	NA	20 U	NA	45	NA	20 U	NA
PCB-1260	µg/kg	NC	18 U	NA	17 U	NA	20 UJ	NA	20 U	NA	20 U	NA	20 U	NA
PCBs (total)	µg/kg	300	18 U	NA	17 U	NA	49 J	0.16	20 U	NA	45	0.15	20 U	NA

Notes:

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

NA Not applicable.

NC No SQO criterion.

Qualifiers:

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

U Not detected at the given reporting limit.

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

Table 2-3
Summary of Year 10 Channel Sand Cap Surface Samples (0 to 10 cm) Results

		Station	CC-30		CC-31		CC-32		CC-33		CC-RA9		CC-MMB	
		Sample ID	CC-30-Y10		CC-31-Y10		CC-32-Y10		CC-33-Y10		CC-RA9-Y10		CC-MMB-Y10	
		Sample Date	6/27/2016	Enrichment	6/27/2016	Enrichment	6/27/2016	Enrichment	6/27/2016	Enrichment	5/16/2016	Enrichment	5/17/2016	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
Parameter	**Units**	**SQO**												
Conventionals														
Total Organic Carbon	mg/kg	NC	21,000	NA	29,900	NA	35,100	NA	43,300	NA	26,100	NA	23,500	NA
Total Solids	%	NC	69.4	NA	54.4	NA	53.0	NA	46.6	NA	63.4	NA	84.9	NA
Metals														
Antimony	mg/kg	150	0.740	0.005	1.02	0.01	1.25	0.01	1.75	0.01	0.881	0.01	0.550	0.004
Arsenic	mg/kg	57	6.38	0.11	8.12	0.14	9.77	0.17	11.4	0.20	8.74	0.15	5.51	0.10
Cadmium	mg/kg	5.1	0.500 U	NA	0.662	0.13	0.992	0.19	1.12	0.22	0.682	0.13	0.472 U	NA
Copper	mg/kg	390	54.2	0.14	66.8	0.17	76.2	0.20	93.5	0.24	71.6	0.18	42.6	0.11
Lead	mg/kg	450	37.4	0.08	46.3	0.10	68.8	0.15	73.1	0.16	42.7	0.09	23.0	0.05
Nickel	mg/kg	140	25.5	0.18	25.5	0.18	27.6	0.20	31.0	0.22	23.0	0.16	22.9	0.16
Silver	mg/kg	6.1	0.500 U	NA	0.481 U	NA	0.544	0.09	0.615	0.10	0.500 U	NA	0.472 U	NA
Zinc	mg/kg	410	105	0.26	146	0.36	178	0.43	206	0.50	149	0.36	66.9	0.16
Mercury	mg/kg	0.59	0.144	0.24	0.144	0.24	0.209	0.35	0.214	0.36	0.109	0.18	0.0781	0.13
SVOC														
LPAHs														
2-Methylnaphthalene	µg/kg	670	83 U	NA	83 U	NA	440	0.66	150	0.22	77 U	NA	77 U	NA
Acenaphthene	µg/kg	500	83 U	NA	83 U	NA	**1,400**	2.80	140	0.28	77 U	NA	77 U	NA
Acenaphthylene	µg/kg	1,300	83 U	NA	83 U	NA	570	0.44	130	0.10	77 U	NA	77 U	NA
Anthracene	µg/kg	960	92	0.10	160	0.17	**2,300**	2.40	350	0.36	110	0.11	77 U	NA
Fluorene	µg/kg	540	83 U	NA	83 U	NA	**790**	1.46	140	0.26	77 U	NA	77 U	NA
Naphthalene	µg/kg	2,100	110	0.05	140	0.07	1,100	0.52	530	0.25	77 U	NA	77 U	NA
Phenanthrene	µg/kg	1,500	210	0.14	380	0.25	**4,500**	3.00	810	0.54	460	0.31	77 U	NA
Total LPAH	µg/kg	5,200	410	0.08	680	0.13	**11,000**	2.12	2,300	0.44	570	0.11	77 U	NA
HPAHs														
Benzo(a)anthracene	µg/kg	1,600	190	0.12	300	0.19	**2,200**	1.38	680	0.43	200	0.13	77 U	NA
Benzo(a)pyrene	µg/kg	1,600	340	0.21	420	0.26	**2,700**	1.69	940	0.59	270	0.17	77 U	NA
Benzofluoranthenes (total)	µg/kg	3,600	680	0.19	1,000	0.28	**3,800**	1.06	2,100	0.58	660	0.18	150 U	NA
Benzo(g,h,i)perylene	µg/kg	720	330	0.46	490	0.68	**1,700**	2.36	**1,000**	1.39	140	0.19	77 U	NA
Chrysene	µg/kg	2,800	280	0.10	460	0.16	2,600	0.93	1,000	0.36	430	0.15	77 U	NA
Dibenz(a,h)anthracene	µg/kg	230	66	0.29	100	0.43	**440**	1.91	220	0.96	33	0.14	8 U	NA
Fluoranthene	µg/kg	2,500	400	0.16	740	0.30	**3,900**	1.56	1,700	0.68	1,300	0.52	77 U	NA
Indeno(1,2,3-cd)pyrene	µg/kg	690	320	0.46	430	0.62	**1,800**	2.61	**900**	1.30	160	0.23	77 U	NA
Pyrene	µg/kg	3,300	500	0.15	710	0.22	**5,200**	1.58	1,600	0.48	920	0.28	77 U	NA
Total HPAH	µg/kg	17,000	3,100	0.18	4,700	0.28	**24,000**	1.41	10,000	0.59	4,100	0.24	150 U	NA
Other														
Dimethyl phthalate	µg/kg	160	33 U	NA	120	0.75	33 U	NA	40	0.25	31 U	NA	31 U	NA
Diethylphthalate	µg/kg	200	83 U	NA	83 U	NA	83 U	NA	83 U	NA	77 U	NA	77 U	NA
Di-n-butyl phthalate	µg/kg	1,400	83 U	NA	84	0.06	83 U	NA	100	0.07	77 U	NA	77 U	NA
Butyl benzyl phthalate	µg/kg	900	160	0.18	300	0.33	400	0.44	350	0.39	77	0.09	77 U	NA
Bis(2-ethylhexyl)phthalate	µg/kg	1,300	1,100	0.85	**2,300**	1.77	**3,600**	2.77	**3,700**	2.85	890	0.68	140	0.11
Di-n-octyl phthalate	µg/kg	6,200	120	0.02	200	0.03	280	0.05	230	0.04	100	0.02	77 U	NA
Phenol	µg/kg	420	83 U	NA	83 U	NA	87	0.21	83	0.20	77 U	NA	77 U	NA
2-Methylphenol	µg/kg	63	4	0.06	8	0.13	12	0.19	12	0.19	4	0.06	4 U	NA
4-Methylphenol	µg/kg	670	83 U	NA	83 U	NA	83 U	NA	83 U	NA	77 U	NA	77 U	NA
2,4-Dimethylphenol	µg/kg	29	4	0.14	7	0.24	12	0.41	11	0.38	4 U	NA	4 U	NA
Pentachlorophenol	µg/kg	360	83 U	NA	83 U	NA	83 U	NA	120	0.33	77 U	NA	77 U	NA
Benzyl alcohol	µg/kg	73	16	0.22	28	0.38	31	0.42	39	0.53	12	0.16	31	0.42
Benzoic acid	µg/kg	650	**870 J**	1.34	**1,100 J**	1.69	**1,100 J**	1.69	**790 J**	1.22	**1,100 J**	1.69	**1,200 J**	1.85
1,2-Dichlorobenzene	µg/kg	50	6 UJ	NA	5 UJ	NA	7 UJ	NA	6 UJ	NA	4 U	NA	4 U	NA
1,3-Dichlorobenzene	µg/kg	170	33 U	NA	33 U	NA	33 U	NA	33 U	NA	31 U	NA	31 U	NA
1,4-Dichlorobenzene	µg/kg	110	33 U	NA	33 U	NA	33 U	NA	33 U	NA	31 U	NA	31 U	NA
1,2,4-Trichlorobenzene	µg/kg	51	4 U	NA	4 U	NA	4 U	NA	4 U	NA	4 U	NA	4 U	NA
Hexachlorobenzene	µg/kg	22	4 U	NA	4 U	NA	4 U	NA	4 U	NA	4 U	NA	4 U	NA
Dibenzofuran	µg/kg	540	83 U	NA	83 U	NA	160	0.30	83 U	NA	77 U	NA	77 U	NA
Hexachlorobutadiene	µg/kg	11	4 U	NA	4 U	NA	4 U	NA	4 U	NA	4 U	NA	4 U	NA
N-Nitrosodiphenylamine	µg/kg	28	8 U	NA	8	0.29	14	0.50	10	0.36	9	0.32	8 U	NA
Pesticides														
p,p'-DDD	µg/kg	16	4.0 U	NA	4.0 U	NA	4.0 UJ	NA	4.1 U	NA	3.7 U	NA	3.7 U	NA
p,p'-DDE	µg/kg	9	4.0 U	NA	4.0 U	NA	4.0 UJ	NA	4.1 U	NA	3.7 U	NA	3.7 U	NA
p,p'-DDT	µg/kg	34	4.0 UJ	NA	4.0 U	NA	4.0 UJ	NA	4.1 U	NA	3.7 U	NA	3.7 U	NA
PCBs														
PCB-1016	µg/kg	NC	20 U	NA	20 U	NA	20 U	NA	20 U	NA	18 U	NA	18 U	NA
PCB-1221	µg/kg	NC	20 U	NA	20 U	NA	20 U	NA	20 U	NA	18 U	NA	18 U	NA
PCB-1232	µg/kg	NC	20 U	NA	20 U	NA	20 U	NA	20 U	NA	18 U	NA	18 U	NA
PCB-1242	µg/kg	NC	20 U	NA	20 U	NA	20 U	NA	20 U	NA	18 U	NA	18 U	NA
PCB-1248	µg/kg	NC	20 U	NA	20 U	NA	20 U	NA	20 U	NA	18 U	NA	18 U	NA
PCB-1254	µg/kg	NC	26	NA	20 U	NA	59	NA	48	NA	20	NA	18 U	NA
PCB-1260	µg/kg	NC	20 U	NA	20 U	NA	20 U	NA	20 U	NA	18 U	NA	18 U	NA
PCBs (total)	µg/kg	300	26	0.09	20 U	NA	59	0.20	48	0.16	20	0.07	18 U	NA

Notes:

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

NA Not applicable.

NC No SQO criterion.

Qualifiers:

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

U Not detected at the given reporting limit.

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

Table 2-4
Summary of Year 10 Natural Recovery and Enhanced Natural Recovery Surface Samples (0 to 10 cm) Results

		Station	NR-06		NR-07		NR-08		NR-09		NR-10		NR-11	
		Sample ID	NR-06-Y10		NR-07-Y10		NR-08-Y10		NR-09-Y10		NR-10-Y10		NR-11-Y10	
		Sample Date	5/16/2016	Enrichment	5/17/2016	Enrichment	5/17/2016	Enrichment	5/16/2016	Enrichment	5/16/2016	Enrichment	5/17/2016	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
Parameter	**Units**	**SQO**												
Conventionals														
Total Organic Carbon	mg/kg	NC	22,200	NA	29,200	NA	21,000	NA	19,300	NA	24,400	NA	26,200	NA
Total Solids	%	NC	53.2	NA	46.9	NA	51.6	NA	54.7	NA	51.1	NA	45.7	NA
Metals														
Antimony	mg/kg	150	0.840	0.01	0.921	0.01	0.931	0.01	0.772	0.01	0.833	0.01	1.36	0.01
Arsenic	mg/kg	57	9.02	0.16	11.0	0.19	8.94	0.16	8.74	0.15	9.42	0.17	10.1	0.18
Cadmium	mg/kg	5.1	0.487	0.10	0.647	0.13	0.517	0.10	0.500 U	NA	0.493	0.10	0.696	0.14
Copper	mg/kg	390	68.6	0.18	80.0	0.21	72.0	0.18	62.6	0.16	73.1	0.19	89.2	0.23
Lead	mg/kg	450	44.1	0.10	43.4	0.10	49.6	0.11	43.8	0.10	53.2	0.12	51.6	0.11
Nickel	mg/kg	140	18.4	0.13	20.1	0.14	20.0	0.14	19.0	0.14	20.3	0.15	21.0	0.15
Silver	mg/kg	6.1	0.559	0.09	0.524	0.09	0.616	0.10	0.543	0.09	0.587	0.10	0.511	0.08
Zinc	mg/kg	410	88.1	0.21	122	0.30	95.9	0.23	85.7	0.21	96.5	0.24	132	0.32
Mercury	mg/kg	0.59	0.201	0.34	0.182	0.31	0.216	0.37	0.201	0.34	0.215	0.36	0.193	0.33
SVOCs														
LPAHs														
2-Methylnaphthalene	µg/kg	670	120	0.18	120	0.18	120	0.18	120	0.18	140	0.21	80	0.12
Acenaphthene	µg/kg	500	78 U	NA	96	0.19	81	0.16	87	0.17	97	0.19	79 U	NA
Acenaphthylene	µg/kg	1,300	100	0.08	160	0.12	140	0.11	150	0.12	130	0.10	100	0.08
Anthracene	µg/kg	960	340	0.35	410	0.43	350	0.36	360	0.38	390	0.41	270	0.28
Fluorene	µg/kg	540	110	0.20	140	0.26	130	0.24	130	0.24	130	0.24	89	0.16
Naphthalene	µg/kg	2,100	250	0.12	310	0.15	260	0.12	350	0.17	340	0.16	180	0.09
Phenanthrene	µg/kg	1,500	570	0.38	660	0.44	510	0.34	570	0.38	570	0.38	420	0.28
Total LPAH	µg/kg	5,200	1,500	0.29	1,900	0.37	1,600	0.31	1,800	0.35	1,800	0.35	1,100	0.21
HPAHs														
Benzo(a)anthracene	µg/kg	1,600	520	0.33	640	0.40	630	0.39	590	0.37	610	0.38	490	0.31
Benzo(a)pyrene	µg/kg	1,600	730	0.46	820	0.51	910	0.57	850	0.53	920	0.58	660	0.41
Benzofluoranthenes (total)	µg/kg	3,600	1,200	0.33	1,600	0.44	1,500	0.42	1,400	0.39	1,700	0.47	1,300	0.36
Benzo(g,h,i)perylene	µg/kg	720	330	0.46	460	0.64	690	0.96	440	0.61	510	0.71	530	0.74
Chrysene	µg/kg	2,800	720	0.26	1,100	0.39	820	0.29	750	0.27	890	0.32	800	0.29
Dibenz(a,h)anthracene	µg/kg	230	90	0.39	110	0.48	170	0.74	100	0.43	130	0.57	120	0.52
Fluoranthene	µg/kg	2,500	1,000	0.40	1,600	0.64	1,000	0.40	1,100	0.44	1,300	0.52	950	0.38
Indeno(1,2,3-cd)pyrene	µg/kg	690	360	0.52	490	0.71	**710**	1.03	460	0.67	530	0.77	530	0.77
Pyrene	µg/kg	3,300	1,200	0.36	2,000	0.61	1,600	0.48	1,400	0.42	1,500	0.45	1,500	0.45
Total HPAH	µg/kg	17,000	6,200	0.36	8,800	0.52	8,000	0.47	7,100	0.42	8,100	0.48	6,900	0.41
Other														
Dimethyl phthalate	µg/kg	160	31 U	NA	32 U	NA	32 U	NA	32 U	NA	32 U	NA	32 U	NA
Diethylphthalate	µg/kg	200	78 U	NA	79 U	NA	80 U	NA	79 U	NA	80 U	NA	79 U	NA
Di-n-butyl phthalate	µg/kg	1,400	78 U	NA	79 U	NA	80 U	NA	79 U	NA	80 U	NA	79 U	NA
Butyl benzyl phthalate	µg/kg	900	120	0.13	160	0.18	220	0.24	140	0.16	**940 J**	1.04	190	0.21
Bis(2-ethylhexyl)phthalate	µg/kg	1,300	570	0.44	**1,400**	1.08	1,000	0.77	810	0.62	940	0.72	**2,100**	1.62
Di-n-octyl phthalate	µg/kg	6,200	78 U	NA	110	0.02	80 U	NA	79 U	NA	80 U	NA	140	0.02
Phenol	µg/kg	420	78 U	NA	79 U	NA	80 U	NA	79 U	NA	80 U	NA	79 U	NA
2-Methylphenol	µg/kg	63	4	0.06	5	0.08	6	0.10	5	0.08	6	0.10	6	0.10
4-Methylphenol	µg/kg	670	78 U	NA	79 U	NA	80 U	NA	79 U	NA	80 U	NA	79 U	NA
2,4-Dimethylphenol	µg/kg	29	5	0.17	6	0.21	7	0.24	6	0.21	8	0.28	4	0.14
Pentachlorophenol	µg/kg	360	78 U	NA	79 U	NA	80 U	NA	79 U	NA	80 U	NA	79 U	NA
Benzyl alcohol	µg/kg	73	11	0.15	24	0.33	16	0.22	19	0.26	21	0.29	31	0.42
Benzoic acid	µg/kg	650	**780 J**	1.20	**2,000 J**	3.08	**970 J**	1.49	**780 J**	1.20	640 J	0.98	**780 J**	1.20
1,2-Dichlorobenzene	µg/kg	50	4 U	NA	4 U	NA	4 U	NA	4 U	NA	4 U	NA	4 U	NA
1,3-Dichlorobenzene	µg/kg	170	31 U	NA	32 U	NA	32 U	NA	32 U	NA	32 U	NA	32 U	NA
1,4-Dichlorobenzene	µg/kg	110	31 U	NA	32 U	NA	32 U	NA	32 U	NA	32 U	NA	32 U	NA
1,2,4-Trichlorobenzene	µg/kg	51	4 U	NA	4 U	NA	4 U	NA	4 U	NA	4 U	NA	4 U	NA
Hexachlorobenzene	µg/kg	22	4 U	NA	4 U	NA	4 U	NA	4 U	NA	4 U	NA	4 U	NA
Dibenzofuran	µg/kg	540	78 U	NA	110	0.20	82	0.15	84	0.16	97	0.18	79 U	NA
Hexachlorobutadiene	µg/kg	11	4 U	NA	4 U	NA	4 U	NA	4 U	NA	4 U	NA	4 U	NA
N-Nitrosodiphenylamine	µg/kg	28	16	0.57	18	0.64	16	0.57	18	0.64	20	0.71	13	0.46
Pesticides														
p,p'-DDD	µg/kg	16	3.7 U	NA	3.8 U	NA	3.8 U	NA	3.8 U	NA	3.8 U	NA	3.8 U	NA
p,p'-DDE	µg/kg	9	3.7 U	NA	3.8 U	NA	3.8 U	NA	3.8 U	NA	3.8 U	NA	3.8 U	NA
p,p'-DDT	µg/kg	34	3.7 UJ	NA	3.8 U	NA	3.8 U	NA	3.8 U	NA	3.8 U	NA	3.8 U	NA
PCBs														
PCB-1016	µg/kg	NC	19 U	NA	19 U	NA	19 U	NA	19 U	NA	19 U	NA	19 U	NA
PCB-1221	µg/kg	NC	19 U	NA	19 U	NA	19 U	NA	19 U	NA	19 U	NA	19 U	NA
PCB-1232	µg/kg	NC	19 U	NA	19 U	NA	19 U	NA	19 U	NA	19 U	NA	19 U	NA
PCB-1242	µg/kg	NC	19 U	NA	19 U	NA	19 U	NA	19 U	NA	19 U	NA	19 U	NA
PCB-1248	µg/kg	NC	19 U	NA	19 U	NA	19 U	NA	19 U	NA	19 U	NA	19 U	NA
PCB-1254	µg/kg	NC	19 U	NA	42	NA	49	NA	45	NA	57	NA	41	NA
PCB-1260	µg/kg	NC	19 U	NA	19 U	NA	19 U	NA	19 U	NA	19 U	NA	19 U	NA
PCBs (total)	µg/kg	300	19 U	NA	42	0.14	49	0.16	45	0.15	57	0.19	41	0.14

Notes:

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

NA Not applicable.

NC No SQO criterion.

Qualifiers:

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

U Not detected at the given reporting limit.

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

Table 2-4
Summary of Year 10 Natural Recovery and Enhanced Natural Recovery Surface Samples (0 to 10 cm) Results

		Station	NR-12				NR-13		NR-14		NR-16		NR-17	
		Sample ID	NR-12-Y10		NR-12-Y10-2		NR-13-Y10		NR-14-Y10		NR-16-Y10		NR-17-Y10	
		Sample Date	5/16/2016	Enrichment	5/16/2016	Enrichment	5/17/2016	Enrichment	5/17/2016	Enrichment	5/16/2016	Enrichment	5/17/2016	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 9 cm	Ratio	0 to 10 cm	Ratio
Parameter	**Units**	**SQO**												
Conventionals														
Total Organic Carbon	mg/kg	NC	22,000	NA	24,400	NA	26,600	NA	25,300	NA	26,400	NA	28,600	NA
Total Solids	%	NC	54.1	NA	53.3	NA	53.7	NA	54.0	NA	59.4	NA	55.2	NA
Metals														
Antimony	mg/kg	150	0.856	0.01	0.887	0.01	1.73	0.01	1.23	0.01	1.04	0.007	1.13	0.01
Arsenic	mg/kg	57	9.21	0.16	9.65	0.17	11.4	0.20	11.2	0.20	9.64	0.17	7.89	0.14
Cadmium	mg/kg	5.1	0.589	0.12	0.578	0.11	0.658	0.13	0.558	0.11	0.595	0.12	0.636	0.12
Copper	mg/kg	390	68.2	0.17	83.4	0.21	87.8	0.23	76.1	0.20	78.3	0.20	66.2	0.17
Lead	mg/kg	450	52.8	0.12	55.3	0.12	79.0	0.18	66.0	0.15	54.9	0.12	110	0.24
Nickel	mg/kg	140	18.0	0.13	17.9	0.13	22.1	0.16	19.9	0.14	20.8	0.15	14.1	0.10
Silver	mg/kg	6.1	0.506	0.08	0.533	0.09	0.733	0.12	0.785	0.13	0.548	0.09	0.500 U	NA
Zinc	mg/kg	410	111	0.27	113	0.28	304	0.74	107	0.26	130.0	0.32	118	0.29
Mercury	mg/kg	0.59	0.193	0.33	0.194	0.33	0.273	0.46	0.244	0.41	0.229	0.39	0.105	0.18
SVOCs														
LPAHs														
2-Methylnaphthalene	µg/kg	670	92	0.14	110	0.16	150	0.22	150	0.22	80 U	NA	250	0.37
Acenaphthene	µg/kg	500	99	0.20	82 U	NA	120	0.24	91	0.18	80 U	NA	91	0.18
Acenaphthylene	µg/kg	1,300	110	0.08	150	0.12	170	0.13	140	0.11	80 U	NA	170	0.13
Anthracene	µg/kg	960	330	0.34	360	0.38	440	0.46	360	0.38	130	0.14	630	0.66
Fluorene	µg/kg	540	150	0.28	130	0.24	160	0.30	140	0.26	80 U	NA	250	0.46
Naphthalene	µg/kg	2,100	280	0.13	270	0.13	390	0.19	350	0.17	98	0.05	300	0.14
Phenanthrene	µg/kg	1,500	600	0.40	570	0.38	750	0.50	640	0.43	220	0.15	1,200	0.80
Total LPAH	µg/kg	5,200	1,700	0.33	1,600	0.31	2,200	0.42	1,900	0.37	450	0.09	2,900	0.56
HPAHs														
Benzo(a)anthracene	µg/kg	1,600	500	0.31	580	0.36	720	0.45	500	0.31	220	0.14	570	0.36
Benzo(a)pyrene	µg/kg	1,600	780	0.49	810	0.51	970	0.61	770	0.48	340	0.21	770	0.48
Benzofluoranthenes (total)	µg/kg	3,600	1,500	0.42	1,500	0.42	1,700	0.47	1,400	0.39	710	0.20	1,100	0.31
Benzo(g,h,i)perylene	µg/kg	720	420	0.58	400	0.56	710	0.99	380	0.53	230	0.32	460	0.64
Chrysene	µg/kg	2,800	850	0.30	860	0.31	1,000	0.36	660	0.24	310	0.11	720	0.26
Dibenz(a,h)anthracene	µg/kg	230	96	0.42	95	0.41	170	0.74	94	0.41	52	0.23	120	0.52
Fluoranthene	µg/kg	2,500	1,200	0.48	1,400	0.56	1,500	0.60	1,100	0.44	470	0.19	1,400	0.56
Indeno(1,2,3-cd)pyrene	µg/kg	690	440	0.64	440	0.64	**710**	1.03	390	0.57	230	0.33	470	0.68
Pyrene	µg/kg	3,300	1,600	0.48	1,800	0.55	2,300	0.70	1,400	0.42	580	0.18	2,700	0.82
Total HPAH	µg/kg	17,000	7,400	0.44	7,900	0.46	9,800	0.58	6,700	0.39	3,100	0.18	8,300	0.49
Other														
Dimethyl phthalate	µg/kg	160	32 U	NA	33 U	NA	32 U	NA	31 U	NA	32 U	NA	31 U	NA
Diethylphthalate	µg/kg	200	80 U	NA	82 U	NA	79 U	NA	79 U	NA	80 U	NA	76 U	NA
Di-n-butyl phthalate	µg/kg	1,400	80 U	NA	82 U	NA	79 U	NA	79 U	NA	80 U	NA	76 U	NA
Butyl benzyl phthalate	µg/kg	900	180	0.20	200	0.22	220	0.24	160	0.18	180	0.20	98	0.11
Bis(2-ethylhexyl)phthalate	µg/kg	1,300	**1,500**	1.15	**1,400**	1.08	1,200	0.92	1,100	0.85	**1,500**	1.15	610	0.47
Di-n-octyl phthalate	µg/kg	6,200	86	0.01	100	0.02	79 U	NA	79 U	NA	110	0.02	76 U	NA
Phenol	µg/kg	420	80 U	NA	82 U	NA	79 U	NA	79 U	NA	80 U	NA	76 U	NA
2-Methylphenol	µg/kg	63	5	0.08	4 U	NA	6	0.10	4	0.06	4	0.06	7	0.11
4-Methylphenol	µg/kg	670	80 U	NA	82 U	NA	79 U	NA	79 U	NA	80 U	NA	76	0.11
2,4-Dimethylphenol	µg/kg	29	5	0.17	5	0.17	8	0.28	6	0.21	4 U	NA	5	0.17
Pentachlorophenol	µg/kg	360	80 U	NA	82 U	NA	79 U	NA	79 U	NA	80 U	NA	76 U	NA
Benzyl alcohol	µg/kg	73	21	0.29	20	0.27	21	0.29	19	0.26	18	0.25	13	0.18
Benzoic acid	µg/kg	650	410 J	0.63	460 J	0.71	460 J	0.71	**780 J**	1.20	**1,500 J**	2.31	**710 J**	1.09
1,2-Dichlorobenzene	µg/kg	50	4 U	NA	4 U	NA	4	0.08	4 U	NA	4 U	NA	4 U	NA
1,3-Dichlorobenzene	µg/kg	170	32 U	NA	33 U	NA	32 U	NA	31 U	NA	32 U	NA	31 U	NA
1,4-Dichlorobenzene	µg/kg	110	32 U	NA	33 U	NA	32 U	NA	31 U	NA	32 U	NA	31 U	NA
1,2,4-Trichlorobenzene	µg/kg	51	4 U	NA	4 U	NA	4 U	NA	4 U	NA	4 U	NA	4 U	NA
Hexachlorobenzene	µg/kg	22	4 U	NA	4 U	NA	4 U	NA	4 U	NA	4 U	NA	4 U	NA
Dibenzofuran	µg/kg	540	83	0.15	82 U	NA	120	0.22	93	0.17	80 U	NA	88	0.16
Hexachlorobutadiene	µg/kg	11	4 U	NA	4 U	NA	4 U	NA	4 U	NA	4 U	NA	4 U	NA
N-Nitrosodiphenylamine	µg/kg	28	18	0.64	16	0.57	22	0.79	20	0.71	9	0.32	**37 UJ**	NA
Pesticides														
p,p'-DDD	µg/kg	16	3.8 U	NA	3.9 U	NA	3.8 U	NA	3.8 U	NA	3.8 U	NA	3.7 U	NA
p,p'-DDE	µg/kg	9	3.8 U	NA	3.9 U	NA	3.8 U	NA	3.8 U	NA	3.8 U	NA	3.7 U	NA
p,p'-DDT	µg/kg	34	3.8 U	NA	3.9 U	NA	3.8 U	NA	3.8 UJ	NA	3.8 U	NA	3.7 U	NA
PCBs														
PCB-1016	µg/kg	NC	19 U	NA	20 U	NA	19 U	NA	19 U	NA	19 U	NA	18 U	NA
PCB-1221	µg/kg	NC	19 U	NA	20 U	NA	19 U	NA	19 U	NA	19 U	NA	18 U	NA
PCB-1232	µg/kg	NC	19 U	NA	20 U	NA	19 U	NA	19 U	NA	19 U	NA	18 U	NA
PCB-1242	µg/kg	NC	19 U	NA	20 U	NA	19 U	NA	19 U	NA	19 U	NA	18 U	NA
PCB-1248	µg/kg	NC	19 U	NA	20 U	NA	19 U	NA	19 U	NA	19 U	NA	18 U	NA
PCB-1254	µg/kg	NC	48	NA	47	NA	57	NA	68	NA	33	NA	25	NA
PCB-1260	µg/kg	NC	19 U	NA	20 U	NA	19 U	NA	19 U	NA	19 U	NA	18 U	NA
PCBs (total)	µg/kg	300	48	0.16	47	0.16	57	0.19	68	0.23	33	0.11	25	0.08

Notes:

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

NA Not applicable.

NC No SQO criterion.

Qualifiers:

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

U Not detected at the given reporting limit.

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

Table 2-4
Summary of Year 10 Natural Recovery and Enhanced Natural Recovery Surface Samples (0 to 10 cm) Results

		Station	NR-19		NR-20		NR-25				SR-10				SR-11	
		Sample ID	NR-19-Y10		NR-20-Y10		NR-25-Y10		NR-25-Y10-2		SR-10-Y10		SR-10-Y10-2		SR-11-Y10	
		Sample Date	6/27/2016	Enrichment	6/27/2016	Enrichment	6/27/2016	Enrichment	6/27/2016	Enrichment	6/22/2016	Enrichment	6/22/2016	Enrichment	6/22/2016	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	22,300	NA	19,600	NA	89,200	NA	96,500	NA	21,200	NA	16,600	NA	3,830	NA
Total Solids	%	NC	60.5	NA	66.9	NA	32.6	NA	32.2	NA	73.5	NA	78.7	NA	80.8	NA
Metals																
Antimony	mg/kg	150	0.955	0.01	1.13	0.01	8.44	0.06	5.95	0.04	3.19	0.02	2.40	0.02	0.463 U	NA
Arsenic	mg/kg	57	8.07	0.14	5.59	0.10	23.0	0.40	20.0	0.35	8.12	0.14	6.59	0.12	3.51	0.06
Cadmium	mg/kg	5.1	0.481 U	NA	0.500 U	NA	1.89	0.37	2.01	0.39	0.500 U	NA	0.500 U	NA	0.463 U	NA
Copper	mg/kg	390	63.3	0.16	57.4	0.15	156	0.40	160	0.41	58.1	0.15	66.6	0.17	21.9	0.06
Lead	mg/kg	450	44.0	0.10	40.5	0.09	134	0.30	145	0.32	51.5	0.11	55.7	0.12	17.5	0.04
Nickel	mg/kg	140	16.5	0.12	17.9	0.13	23.2	0.17	24.0	0.17	21.5	0.15	20.5	0.15	16.3	0.12
Silver	mg/kg	6.1	0.481 U	NA	0.500 U	NA	1.65	0.27	1.72	0.28	0.500 U	NA	0.500 U	NA	0.463 U	NA
Zinc	mg/kg	410	104	0.25	147	0.36	238	0.58	237	0.58	123	0.30	119	0.29	50.7	0.12
Mercury	mg/kg	0.59	0.142	0.24	0.0793	0.13	0.446	0.76	0.438	0.74	0.131	0.22	0.104	0.18	0.0226	0.04
SVOCs																
LPAHs																
2-Methylnaphthalene	µg/kg	670	290	0.43	93	0.14	160	0.24	140	0.21	130	0.19	92	0.14	83 U	NA
Acenaphthene	µg/kg	500	170	0.34	83 U	NA	130	0.26	120	0.24	180	0.36	83 U	NA	83 U	NA
Acenaphthylene	µg/kg	1,300	360	0.28	83 U	NA	200	0.15	200	0.15	290	0.22	120	0.09	83 U	NA
Anthracene	µg/kg	960	870	0.91	140	0.15	490	0.51	460	0.48	580	0.60	170	0.18	83 U	NA
Fluorene	µg/kg	540	310	0.57	83 U	NA	210	0.39	180	0.33	330	0.61	83 U	NA	83 U	NA
Naphthalene	µg/kg	2,100	350	0.17	110	0.05	500	0.24	410	0.20	220	0.10	180	0.09	83 U	NA
Phenanthrene	µg/kg	1,500	**1,900**	1.27	270	0.18	790	0.53	670	0.45	**6,700**	4.47	610	0.41	110	0.07
Total LPAH	µg/kg	5,200	4,300	0.83	610	0.12	2,500	0.48	2,200	0.42	**8,400**	1.62	1,200	0.23	110	0.02
HPAHs																
Benzo(a)anthracene	µg/kg	1,600	**1,700**	1.06	210	0.13	600	0.38	650	0.41	1,300	0.81	390	0.24	83 U	NA
Benzo(a)pyrene	µg/kg	1,600	1,500	0.94	230	0.14	550	0.34	690	0.43	1,200	0.75	430	0.27	97	0.06
Benzofluoranthenes (total)	µg/kg	3,600	2,100	0.58	480	0.13	1,400	0.39	1,500	0.42	**4,400**	1.22	980	0.27	170 U	NA
Benzo(g,h,i)perylene	µg/kg	720	**810**	1.13	200	0.28	400	0.56	450	0.63	**1,000**	1.39	390	0.54	83 U	NA
Chrysene	µg/kg	2,800	1,900	0.68	330	0.12	970	0.35	1,000	0.36	**4,300**	1.54	710	0.25	110	0.04
Dibenz(a,h)anthracene	µg/kg	230	**240**	1.04	51	0.22	110	0.48	120	0.52	**270**	1.17	100	0.43	25	0.11
Fluoranthene	µg/kg	2,500	**2,700**	1.08	440	0.18	1,800	0.72	1,600	0.64	**16,000**	6.40	1,200	0.48	130	0.05
Indeno(1,2,3-cd)pyrene	µg/kg	690	**900**	1.30	170	0.25	360	0.52	450	0.65	**1,100**	1.59	380	0.55	93	0.13
Pyrene	µg/kg	3,300	**3,500**	1.06	470	0.14	1,900	0.58	2,100	0.64	**11,000**	3.33	910	0.28	140	0.04
Total HPAH	µg/kg	17,000	15,000	0.88	2,600	0.15	8,100	0.48	8,600	0.51	**41,000**	2.41	5,500	0.32	600	0.04
Other																
Dimethyl phthalate	µg/kg	160	33 U	NA	33 U	NA	33 U	NA	32 U	NA	33 U	NA	33 U	NA	33 U	NA
Diethylphthalate	µg/kg	200	83 U	NA	83 U	NA	83 U	NA	81 U	NA	83 U	NA	83 U	NA	83 U	NA
Di-n-butyl phthalate	µg/kg	1,400	83 U	NA	83 U	NA	83 U	NA	81 U	NA	83 U	NA	83 U	NA	83 U	NA
Butyl benzyl phthalate	µg/kg	900	160	0.18	160	0.18	420	0.47	570	0.63	83 U	NA	83 U	NA	83 U	NA
Bis(2-ethylhexyl)phthalate	µg/kg	1,300	920	0.71	**1,600**	1.23	1,300	1.00	**1,700**	1.31	210	0.16	190	0.15	230	0.18
Di-n-octyl phthalate	µg/kg	6,200	83 U	NA	93	0.02	110	0.02	160	0.03	85	0.01	83 U	NA	83 U	NA
Phenol	µg/kg	420	110	0.26	100	0.24	83 U	NA	81 U	NA	250	0.60	170	0.40	86	0.20
2-Methylphenol	µg/kg	63	12	0.19	9	0.14	11	0.17	14	0.22	19	0.30	11	0.17	7	0.11
4-Methylphenol	µg/kg	670	83 U	NA	83 U	NA	83 U	NA	81 U	NA	83 U	NA	83 U	NA	83 U	NA
2,4-Dimethylphenol	µg/kg	29	7	0.24	5	0.17	9	0.31	12	0.41	9	0.31	5	0.17	4 U	NA
Pentachlorophenol	µg/kg	360	83 U	NA	83 U	NA	93	0.26	81 U	NA	83 U	NA	83 U	NA	83 U	NA
Benzyl alcohol	µg/kg	73	17	0.23	21	0.29	28 J	0.38	48 J	0.66	17	0.23	8 U	NA	8 U	NA
Benzoic acid	µg/kg	650	**840 J**	1.29	**1,300 J**	2.00	**1,300 J**	2.00	**940 J**	1.45	250 UJ	NA	240 UJ	NA	490 J	0.75
1,2-Dichlorobenzene	µg/kg	50	4	0.08	18	0.36	9	0.18	6	0.12	4 U	NA	4 U	NA	4 U	NA
1,3-Dichlorobenzene	µg/kg	170	33 U	NA	33 U	NA	33 U	NA	32 U	NA	33 U	NA	33 U	NA	33 U	NA
1,4-Dichlorobenzene	µg/kg	110	33 U	NA	33 U	NA	33 U	NA	32 U	NA	33 U	NA	33 U	NA	33 U	NA
1,2,4-Trichlorobenzene	µg/kg	51	4 U	NA	4 U	NA	4 U	NA	4 U	NA	4 U	NA	4 U	NA	4 U	NA
Hexachlorobenzene	µg/kg	22	4 U	NA	4 U	NA	4 U	NA	4 U	NA	4 U	NA	4 U	NA	4 U	NA
Dibenzofuran	µg/kg	540	110	0.20	83 U	NA	120	0.22	100	0.19	110	0.20	83 U	NA	83 U	NA
Hexachlorobutadiene	µg/kg	11	4 U	NA	4 U	NA	4 U	NA	4 U	NA	4 U	NA	4 U	NA	4 U	NA
N-Nitrosodiphenylamine	µg/kg	28	8 U	NA	8 U	NA	8 U	NA	11	0.39	8 U	NA	8 U	NA	8 U	NA
Pesticides																
p,p'-DDD	µg/kg	16	4.0 U	NA	4.0 U	NA	4.0 UJ	NA	3.9 U	NA	4.0 U	NA	4.0 U	NA	4.0 U	NA
p,p'-DDE	µg/kg	9	4.0 U	NA	4.0 U	NA	4.0 UJ	NA	3.9 U	NA	4.0 U	NA	4.0 U	NA	4.0 U	NA
p,p'-DDT	µg/kg	34	4.0 U	NA	4.0 U	NA	4.0 UJ	NA	3.9 U	NA	4.0 U	NA	4.0 U	NA	4.0 U	NA
PCBs																
PCB-1016	µg/kg	NC	20 U	NA	20 U	NA	20 U	NA	19 U	NA	20 U	NA	20 U	NA	20 U	NA
PCB-1221	µg/kg	NC	20 U	NA	20 U	NA	20 U	NA	19 U	NA	20 U	NA	20 U	NA	20 U	NA
PCB-1232	µg/kg	NC	20 U	NA	20 U	NA	20 U	NA	19 U	NA	20 U	NA	20 U	NA	20 U	NA
PCB-1242	µg/kg	NC	20 U	NA	20 U	NA	20 U	NA	19 U	NA	20 U	NA	20 U	NA	20 U	NA
PCB-1248	µg/kg	NC	20 U	NA	20 U	NA	20 U	NA	19 U	NA	20 U	NA	20 U	NA	20 U	NA
PCB-1254	µg/kg	NC	38	NA	21	NA	80	NA	81	NA	20 U	NA	20 U	NA	20 U	NA
PCB-1260	µg/kg	NC	20 U	NA	20 U	NA	20 U	NA	19 U	NA	20 U	NA	20 U	NA	20 U	NA
PCBs (total)	µg/kg	300	38	0.13	21	0.07	80	0.27	81	0.27	20 U	NA	20 U	NA	20 U	NA

Notes:

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

NA Not applicable.

NC No SQO criterion.

Qualifiers:

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

U Not detected at the given reporting limit.

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

Table 2-4
Summary of Year 10 Natural Recovery and Enhanced Natural Recovery Surface Samples (0 to 10 cm) Results

		Station	SR-13	
		Sample ID	SR-13-Y10	
		Sample Date	6/22/2016	Enrichment
		Sample Depth	0 to 10 cm	Ratio
Parameter	**Units**	**SQO**		
Conventionals				
Total Organic Carbon	mg/kg	NC	11,100	NA
Total Solids	%	NC	81.0	NA
Metals				
Antimony	mg/kg	150	1.29	0.01
Arsenic	mg/kg	57	4.91	0.09
Cadmium	mg/kg	5.1	0.500 U	NA
Copper	mg/kg	390	39.7	0.10
Lead	mg/kg	450	36.6	0.08
Nickel	mg/kg	140	16.5	0.12
Silver	mg/kg	6.1	0.500 U	NA
Zinc	mg/kg	410	82.2	0.20
Mercury	mg/kg	0.59	0.0537	0.09
SVOCs				
LPAHs				
2-Methylnaphthalene	µg/kg	670	82 U	NA
Acenaphthene	µg/kg	500	82 U	NA
Acenaphthylene	µg/kg	1,300	82 U	NA
Anthracene	µg/kg	960	82 U	NA
Fluorene	µg/kg	540	82 U	NA
Naphthalene	µg/kg	2,100	82 U	NA
Phenanthrene	µg/kg	1,500	130	0.09
Total LPAH	µg/kg	5,200	130	0.03
HPAHs				
Benzo(a)anthracene	µg/kg	1,600	150	0.09
Benzo(a)pyrene	µg/kg	1,600	220	0.14
Benzofluoranthenes (total)	µg/kg	3,600	380	0.11
Benzo(g,h,i)perylene	µg/kg	720	210	0.29
Chrysene	µg/kg	2,800	210	0.08
Dibenz(a,h)anthracene	µg/kg	230	59	0.26
Fluoranthene	µg/kg	2,500	220	0.09
Indeno(1,2,3-cd)pyrene	µg/kg	690	200	0.29
Pyrene	µg/kg	3,300	250	0.08
Total HPAH	µg/kg	17,000	1,900	0.11
Other				
Dimethyl phthalate	µg/kg	160	33 U	NA
Diethylphthalate	µg/kg	200	82 U	NA
Di-n-butyl phthalate	µg/kg	1,400	82 U	NA
Butyl benzyl phthalate	µg/kg	900	240	0.27
Bis(2-ethylhexyl)phthalate	µg/kg	1,300	360	0.28
Di-n-octyl phthalate	µg/kg	6,200	82 U	NA
Phenol	µg/kg	420	96	0.23
2-Methylphenol	µg/kg	63	7	0.11
4-Methylphenol	µg/kg	670	82 U	NA
2,4-Dimethylphenol	µg/kg	29	4 U	NA
Pentachlorophenol	µg/kg	360	82 U	NA
Benzyl alcohol	µg/kg	73	8 U	NA
Benzoic acid	µg/kg	650	250 J	0.38
1,2-Dichlorobenzene	µg/kg	50	4 U	NA
1,3-Dichlorobenzene	µg/kg	170	33 U	NA
1,4-Dichlorobenzene	µg/kg	110	33 U	NA
1,2,4-Trichlorobenzene	µg/kg	51	4 U	NA
Hexachlorobenzene	µg/kg	22	4 U	NA
Dibenzofuran	µg/kg	540	82 U	NA
Hexachlorobutadiene	µg/kg	11	4 U	NA
N-Nitrosodiphenylamine	µg/kg	28	8 U	NA
Pesticides				
p,p'-DDD	µg/kg	16	3.9 U	NA
p,p'-DDE	µg/kg	9	3.9 U	NA
p,p'-DDT	µg/kg	34	3.9 U	NA
PCBs				
PCB-1016	µg/kg	NC	20 U	NA
PCB-1221	µg/kg	NC	20 U	NA
PCB-1232	µg/kg	NC	20 U	NA
PCB-1242	µg/kg	NC	20 U	NA
PCB-1248	µg/kg	NC	20 U	NA
PCB-1254	µg/kg	NC	20 U	NA
PCB-1260	µg/kg	NC	20 U	NA
PCBs (total)	µg/kg	300	20 U	NA

Notes:

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

NA Not applicable.

NC No SQO criterion.

Qualifiers:

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

U Not detected at the given reporting limit.

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

Table 2-5
Summary of Year 10 Slope Rehabilitation SR-10 Discrete and Composite Sample Results for PAHs, Phthalates, and PCBs

		Station	SR-10									
		Sample ID	SR-10-Y10-D1		SR-10-Y10-D2		SR-10-Y10-D3		SR-10-Y10		SR-10-Y10-2	
		Sample Type	Discrete		Discrete		Discrete		Composite		Composite - Field Duplicate	
		Sample Date	6/22/2016	Enrichment	6/22/2016	Enrichment	6/22/2016	Enrichment	6/22/2016	Enrichment	6/22/2016	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
Parameter	**Units**	**SQO**										
Conventionals												
Total Organic Carbon	mg/kg	NC	7,010	NA	21,300	NA	47,000	NA	21,200	NA	16,600	NA
Total Solids	%	NC	88.9	NA	71.5	NA	63.3	NA	73.5	NA	78.7	NA
SVOCs												
LPAHs												
2-Methylnaphthalene	µg/kg	670	83 U	NA	190	0.28	250	0.37	130	0.19	92	0.14
Acenaphthene	µg/kg	500	83 U	NA	83 U	NA	83 U	NA	180	0.36	83 U	NA
Acenaphthylene	µg/kg	1,300	83 U	NA	180	0.14	140	0.11	290	0.22	120	0.09
Anthracene	µg/kg	960	83 U	NA	350	0.36	280	0.29	580	0.60	170	0.18
Fluorene	µg/kg	540	83 U	NA	120	0.22	110	0.20	330	0.61	83 U	NA
Naphthalene	µg/kg	2,100	83 U	NA	350	0.17	310	0.15	220	0.10	180	0.09
Phenanthrene	µg/kg	1,500	83 U	NA	760	0.51	1,100	0.73	**6,700**	4.47	610	0.41
Total LPAH	µg/kg	5,200	83 U	NA	2,000	0.38	2,200	0.42	**8,400**	1.62	1,200	0.23
HPAHs												
Benzo(a)anthracene	µg/kg	1,600	100	0.06	580	0.36	460	0.29	1,300	0.81	390	0.24
Benzo(a)pyrene	µg/kg	1,600	100	0.06	570	0.36	680	0.43	1,200	0.75	430	0.27
Benzofluoranthenes (total)	µg/kg	3,600	180	0.05	880	0.24	2,300	0.64	**4,400**	1.22	980	0.27
Benzo(g,h,i)perylene	µg/kg	720	83 U	NA	390	0.54	500	0.69	**1,000**	1.39	390	0.54
Chrysene	µg/kg	2,800	120	0.04	700	0.25	2,100	0.75	**4,300**	1.54	710	0.25
Dibenz(a,h)anthracene	µg/kg	230	17	0.07	87	0.38	110	0.48	**270**	1.17	100	0.43
Fluoranthene	µg/kg	2,500	160	0.06	1,200	0.48	**2,600**	1.04	**16,000**	6.40	1,200	0.48
Indeno(1,2,3-cd)pyrene	µg/kg	690	83 U	NA	350	0.51	500	0.72	**1,100**	1.59	380	0.55
Pyrene	µg/kg	3,300	190	0.06	1,600	0.48	2,500	0.76	**11,000**	3.33	910	0.28
Total HPAH	µg/kg	17,000	870	0.05	6,400	0.38	12,000	0.71	**41,000**	2.41	5,500	0.32
Other												
Dimethyl phthalate	µg/kg	160	33 U	NA	33 U	NA	33 U	NA	33 U	NA	33 U	NA
Diethylphthalate	µg/kg	200	83 U	NA	83 U	NA	83 U	NA	83 U	NA	83 U	NA
Di-n-butyl phthalate	µg/kg	1,400	83 U	NA	83 U	NA	83 U	NA	83 U	NA	83 U	NA
Butyl benzyl phthalate	µg/kg	900	83 U	NA	83 U	NA	83 U	NA	83 U	NA	83 U	NA
Bis(2-ethylhexyl)phthalate	µg/kg	1,300	110	0.08	190	0.15	730	0.56	210	0.16	190	0.15
Di-n-octyl phthalate	µg/kg	6,200	83 U	NA	83 U	NA	83 U	NA	85	0.01	83 U	NA
PCBs												
PCB-1016	µg/kg	NC	20 U	NA	20 U	NA	20 U	NA	20 U	NA	20 U	NA
PCB-1221	µg/kg	NC	20 U	NA	20 U	NA	20 U	NA	20 U	NA	20 U	NA
PCB-1232	µg/kg	NC	20 U	NA	20 U	NA	20 U	NA	20 U	NA	20 U	NA
PCB-1242	µg/kg	NC	20 U	NA	20 U	NA	20 U	NA	20 U	NA	20 U	NA
PCB-1248	µg/kg	NC	20 U	NA	20 U	NA	20 U	NA	20 U	NA	20 U	NA
PCB-1254	µg/kg	NC	20 U	NA	20 U	NA	270	NA	20 U	NA	20 U	NA
PCB-1260	µg/kg	NC	20 U	NA	20 U	NA	20 U	NA	20 U	NA	20 U	NA
PCBs (total)	µg/kg	300	20 U	NA	20 U	NA	270	0.90	20 U	NA	20 U	NA

Notes:

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

NA Not applicable.

NC No SQO criterion.

Qualifiers:

U Not detected at the given reporting limit.

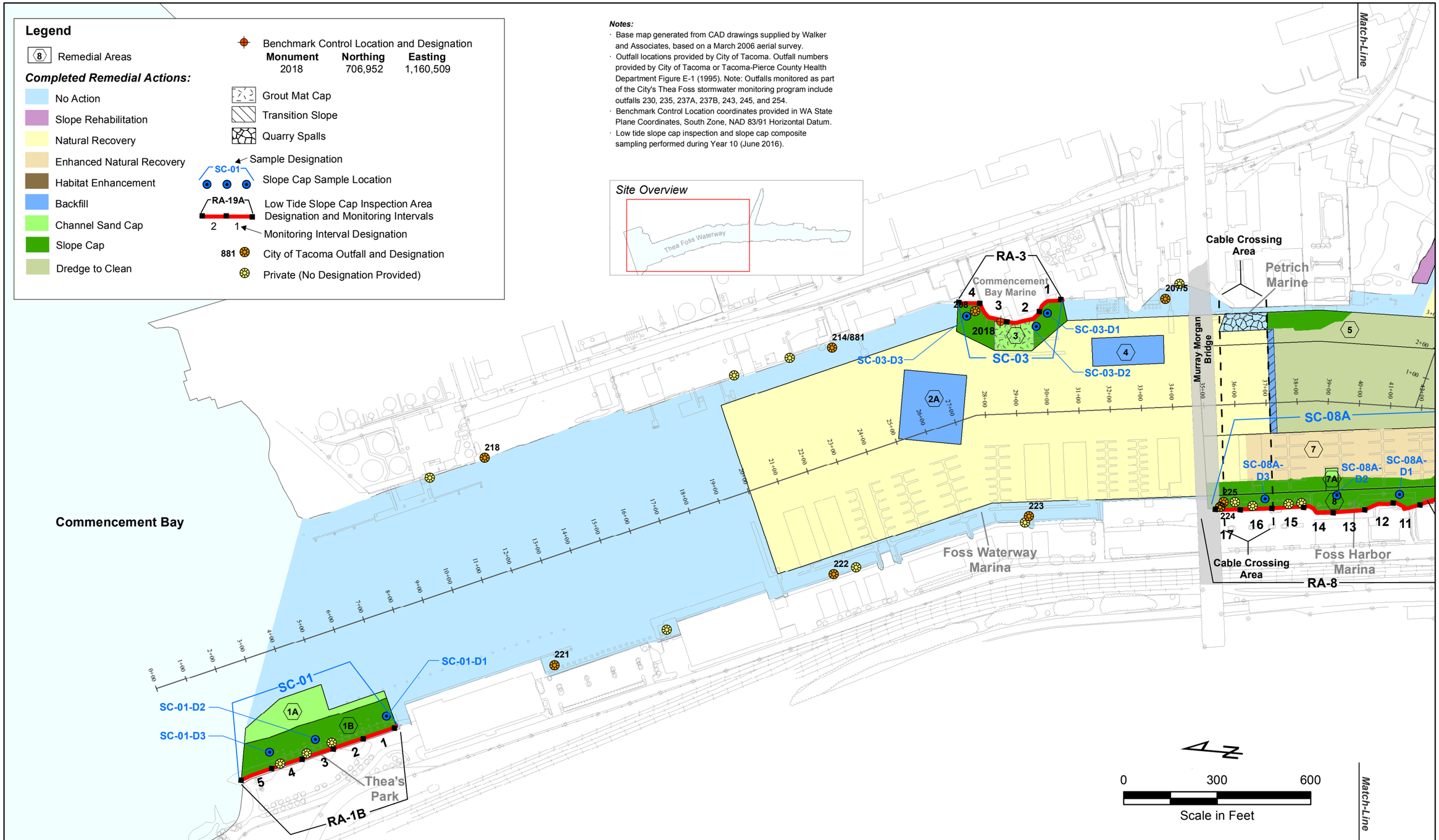

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Figure 2-1 (Page 1 of 2)
Year 10 Low Tide Slope Cap Inspection Monitoring Intervals and Slope Cap Sample Locations

File: I:\GIS\Projects\COT_ON_CALL\MXD\2016 Yr 10 Annual OMMP Report\Figure 2-1 (Low-tide SC Insp Monitoring Intervals and Samp Loc (1of2)).mxd
Date: 9/30/2016

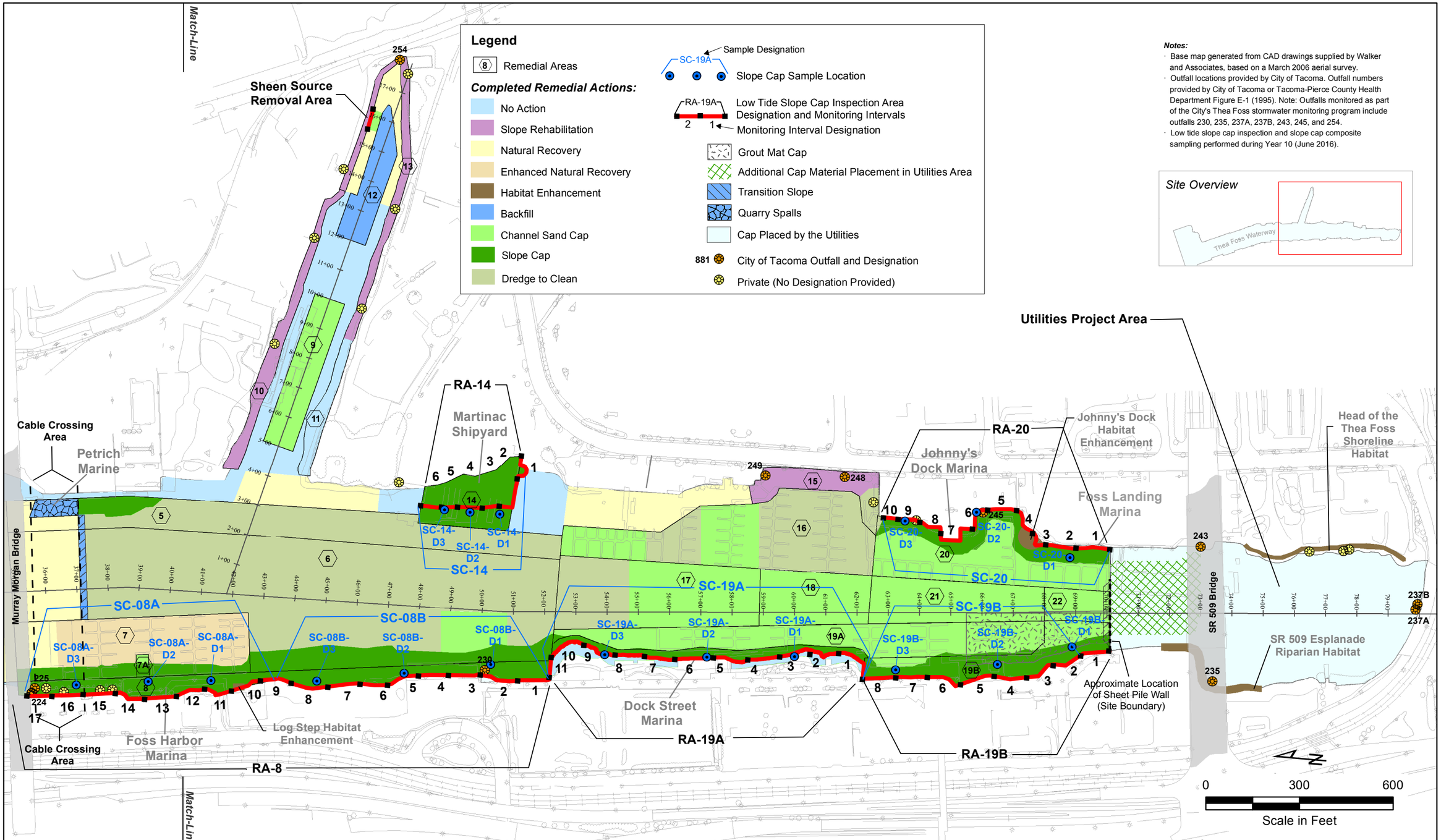

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Figure 2-1 (Page 2 of 2)
Year 10 Low Tide Slope Cap Inspection Monitoring Intervals and Slope Cap Sample Locations

File: I:\GIS\Projects\COT_ON_CALL\MXD\2016 Yr 10 Annual OMMP Report\Figure 2-1 (Low-tide SC Insp Monitoring Intervals and Samp Loc (2of2)).mxd
Date: 9/30/2016

Legend

- Remedial Area
- Subtidal Hydrographic Survey Area
- Grout Mat
- Approximate Elevation of 0 feet MLLW
- 881 City of Tacoma Outfall and Designation
- Private Outfall (No Designation Provided)
- 2018 Benchmark Control Location and Designation

Monument	Northing	Easting
2000	709,236	1,158,829
2018	706,952	1,160,509
3000	708,339	1,159,088

Notes:

- Base map generated from CAD drawings supplied by Walker and Associates, based on a March 2006 aerial survey.
- Post-construction hydrographic surveys performed by David Evans and Associates, Inc. on December 21-22, 2005 and February 12, 2006. Post-construction hydrographic surveys in RA1 and RA 3 performed by Parametrix, Inc. in February 2003.
- Outfall locations provided by City of Tacoma. Outfall numbers provided by City of Tacoma or Tacoma-Pierce County Health Department Figure E-1 (1995).
- Benchmark Control Location coordinates provided in WA State Plane Coordinates, South Zone, NAD 83/91 Horizontal Datum.

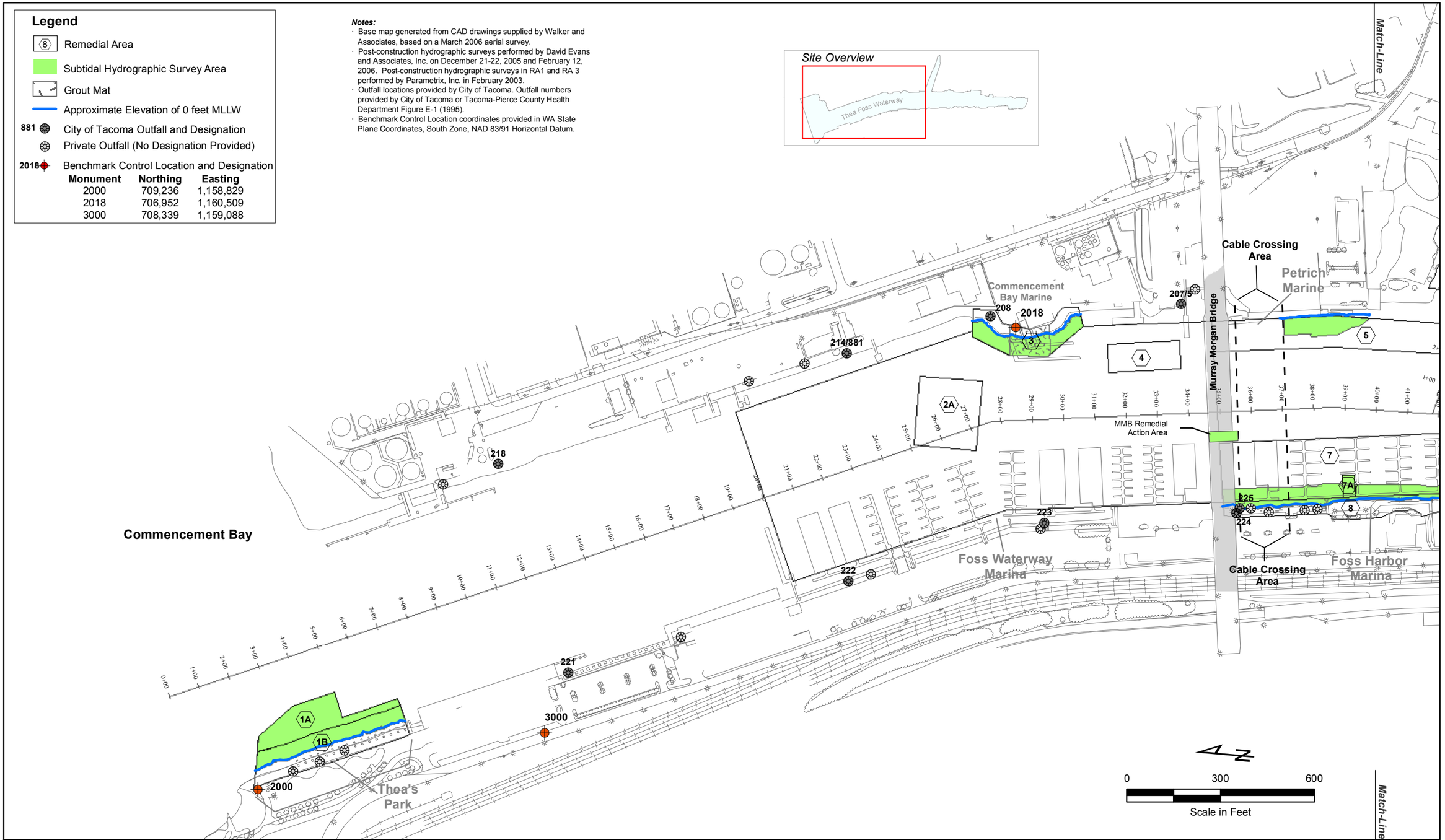

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Figure 2-2 (Page 1 of 2)
Year 10 Subtidal Hydrographic Survey Areas

File: I:\GIS\Projects\COT_ON_CALL\MXD\2016 Yr 10 Annual OMMP Report\Figure 2-2 (Subtidal Hydrographic Survey Areas (1of2)).mxd
Date: 10/14/2016

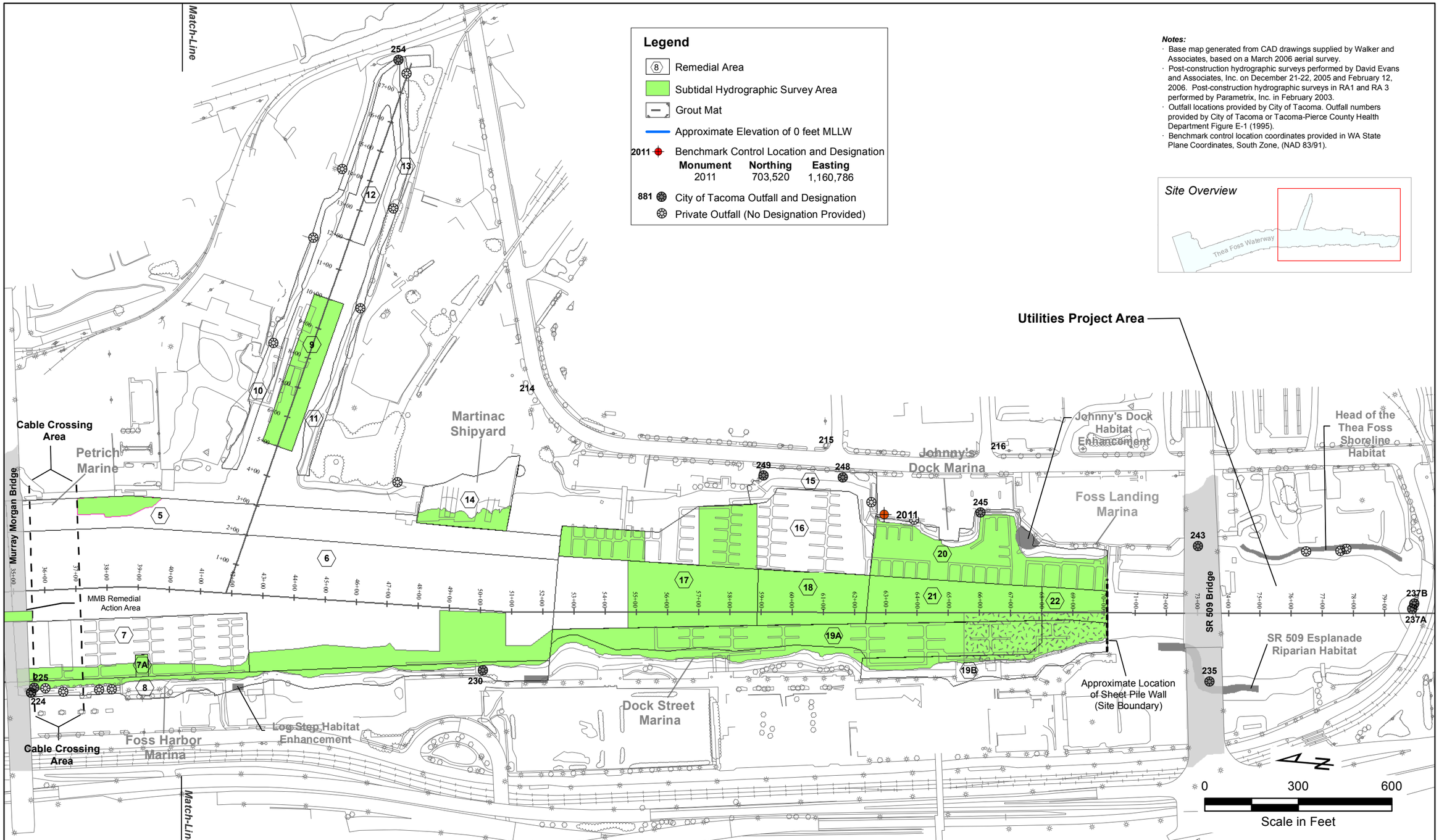

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Figure 2-2 (Page 2 of 2)
Year 10 Subtidal Hydrographic Survey Areas

File: I:\GIS\Projects\COT_ON_CALL\MXD\2016 Yr 10 Annual OMMP Report\Figure 2-2 (Subtidal Hydrographic Survey Areas (2of2)).mxd
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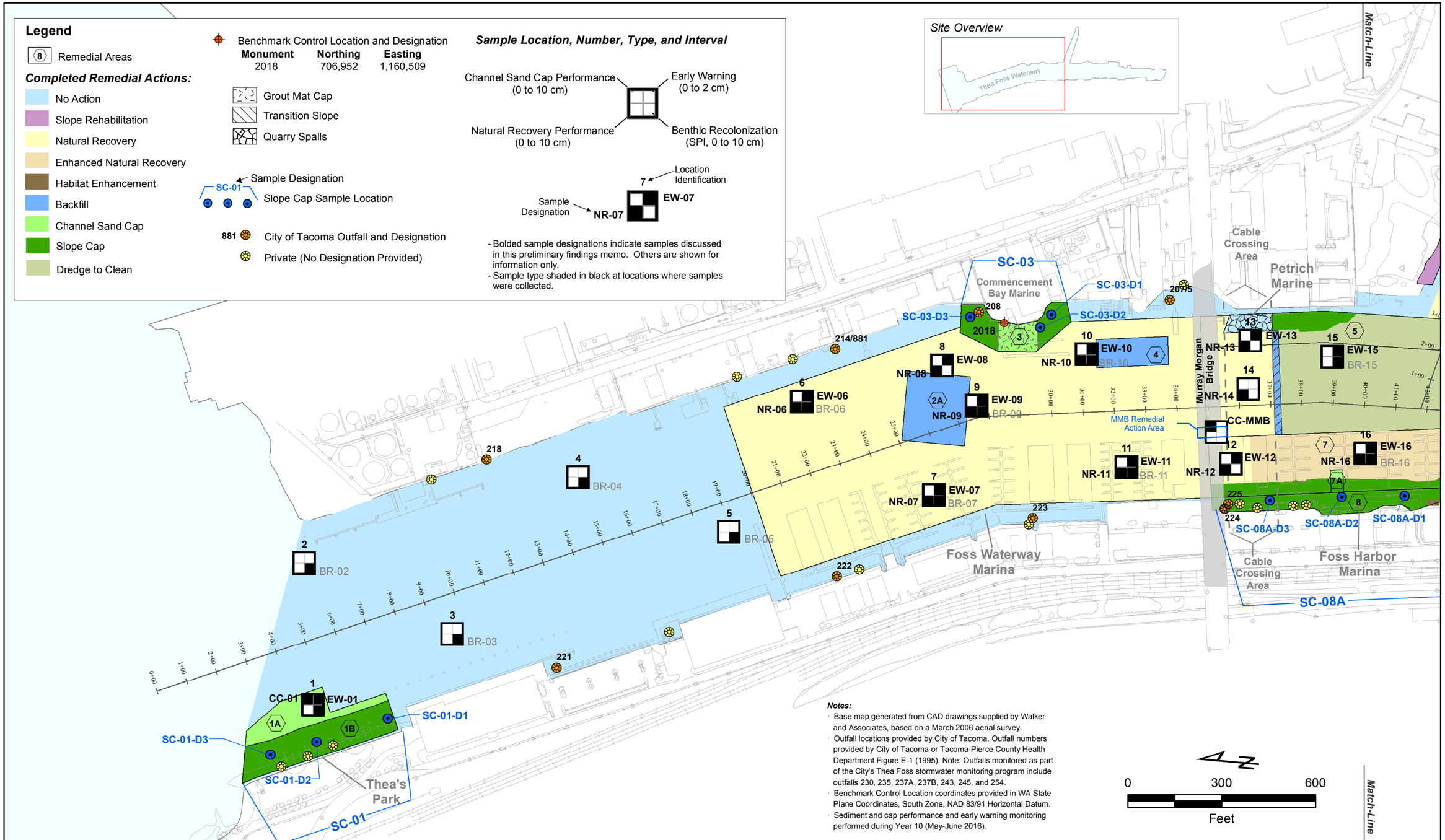

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Figure 2-3 (Page 1 of 2)
Year 10 Performance Monitoring and Early Warning Sampling Locations

File: I:\GIS\Projects\COT_ON_CALL\MXD\2016 Yr 10 Annual OMMP Report\Figure 2-3 (Perf Mon and Early Warn Samp Loc Frame 1).mxd
Date: 9/30/2016

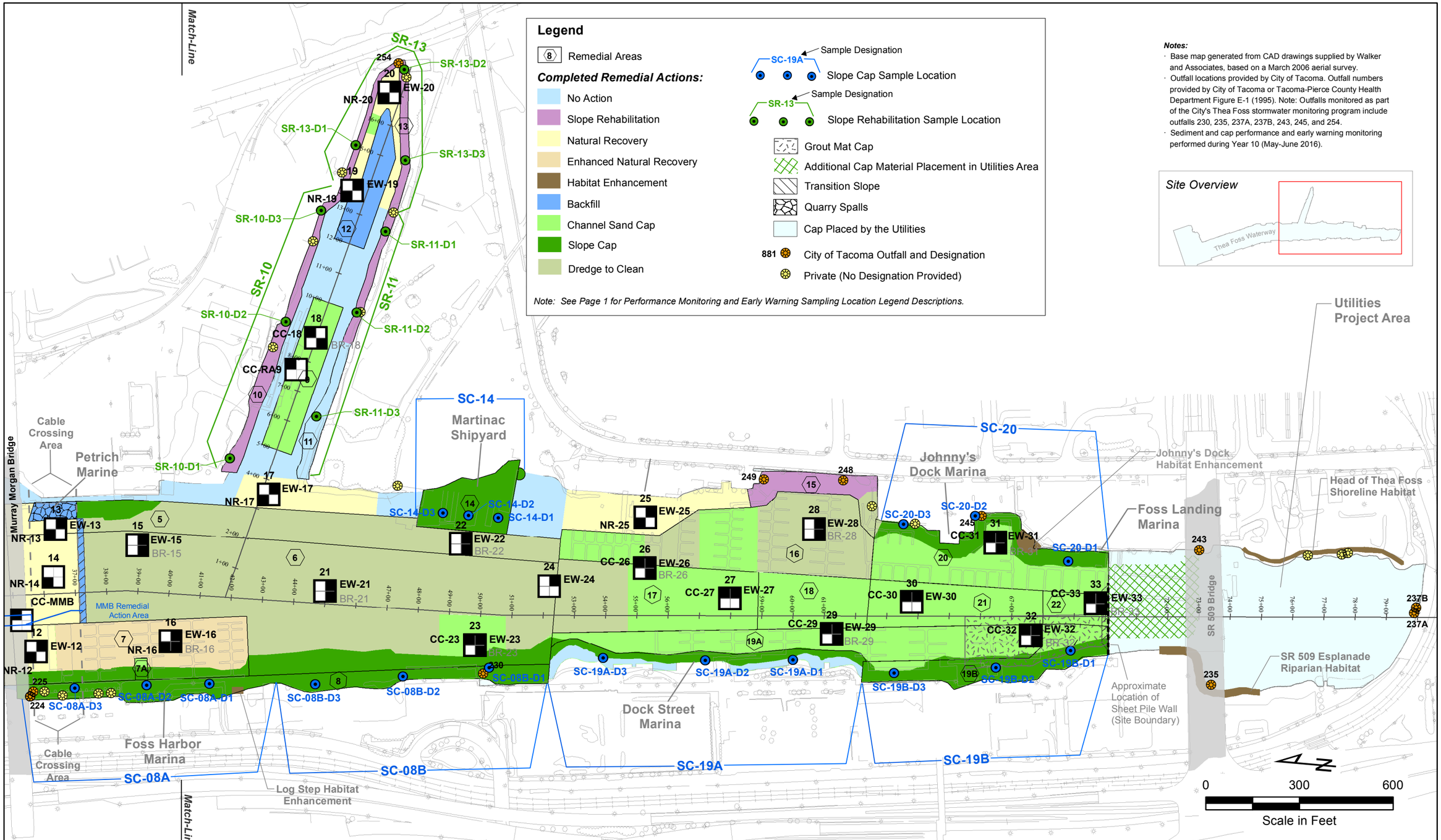

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Figure 2-3 (Page 2 of 2)
Year 10 Performance Monitoring and Early Warning Sampling Locations

File: I:\GIS\Projects\COT_ON_CALL\MXD\2016 Yr 10 Annual OMMP Report\Figure 2-3 (Perf Mon and Early Warn Samp Loc Frame 2).mxd
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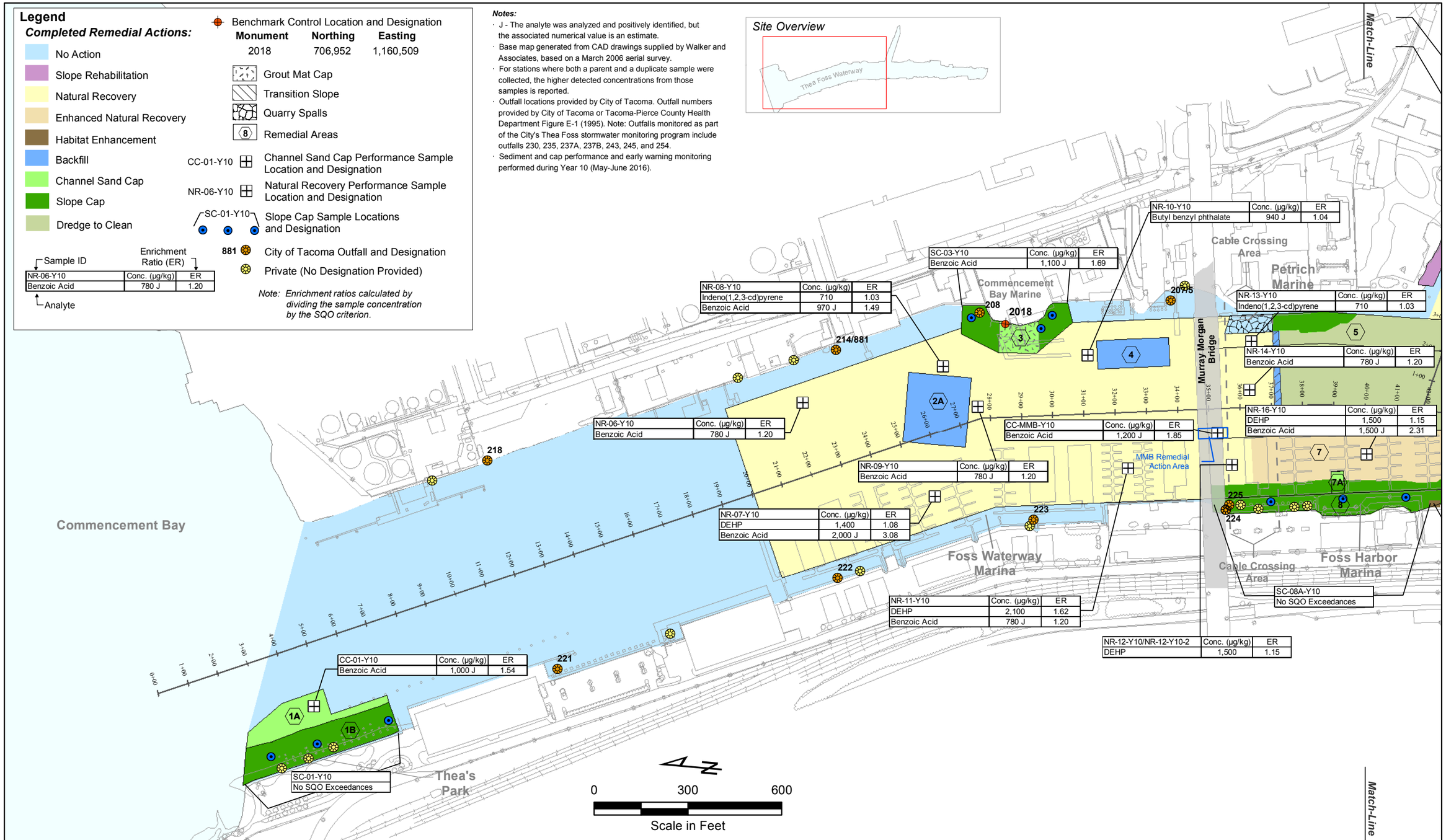

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Figure 2-4 (Page 1 of 2)
Year 10 SQO Exceedances in Performance Monitoring Surface Samples (0-10 cm)

File: I:\GIS\Projects\COT_ON_CALL\MXD\2016 Yr 10 Annual OMMP Report\Figure 2-4 (Year 10 SQO Exceed in Perf Mon Samp (0-10 cm)) Frame 1.mxd
Date: 10/14/2016

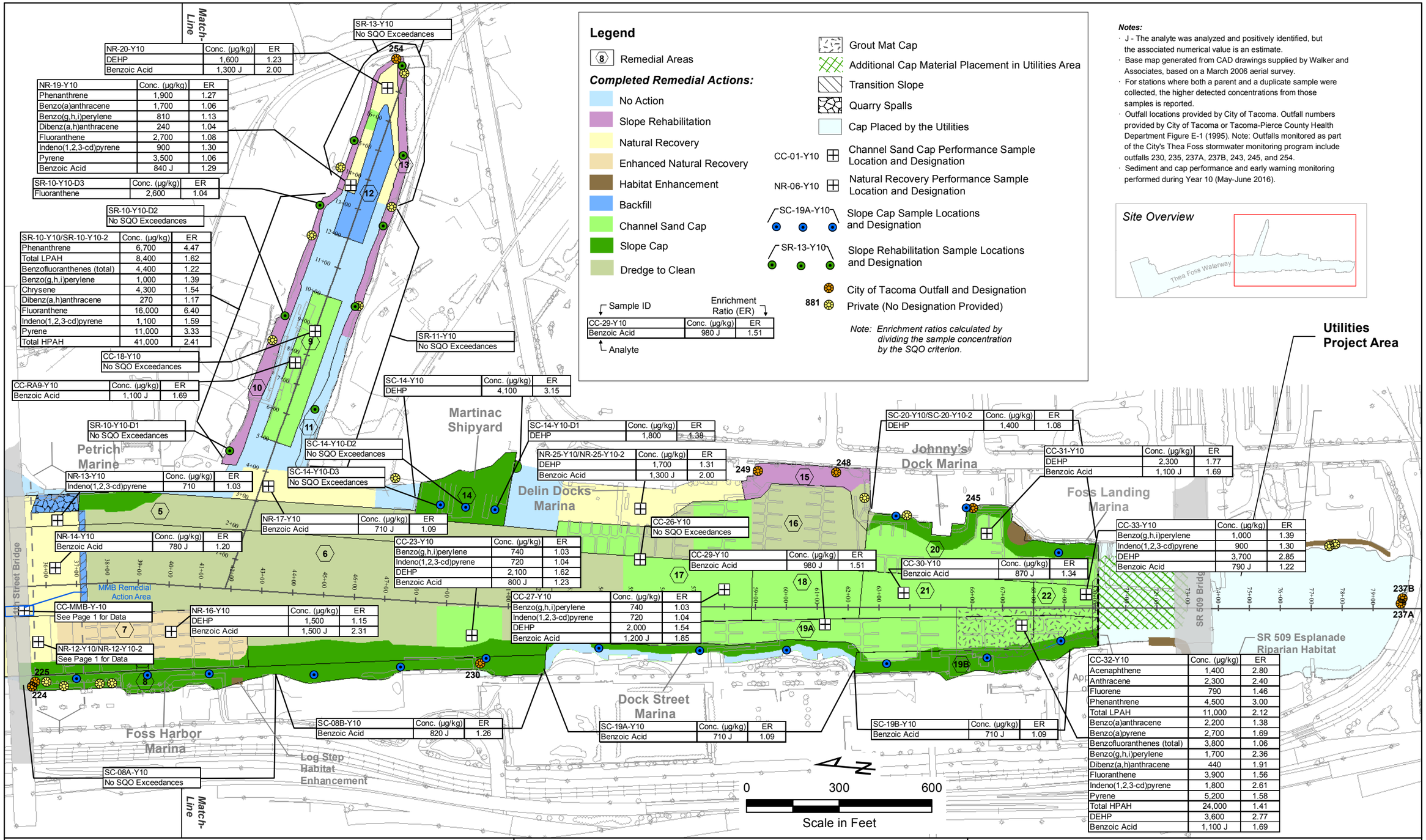

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Figure 2-4 (Page 2 of 2)
Year 10 SQO Exceedances in Performance Monitoring Surface Samples (0-10 cm)

File: I:\GIS\Projects\COT_ON_CALL\MXD\2016 Yr 10 Annual OMMP Report\Figure 2-4 (Year 10 SQO Exceed in Perf Mon Samp (0-10 cm)) Frame 2.mxd
Date: 10/14/2016

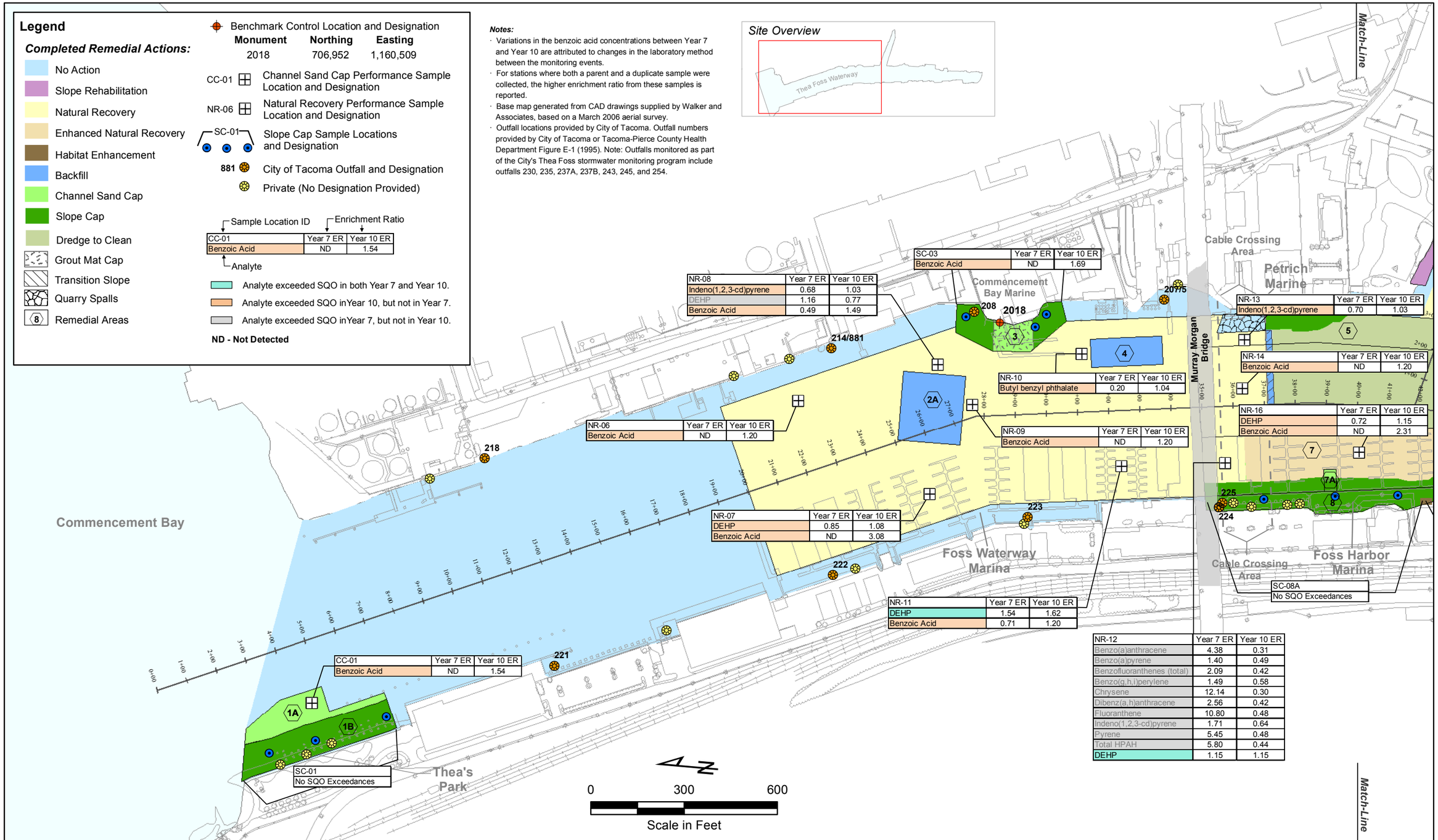

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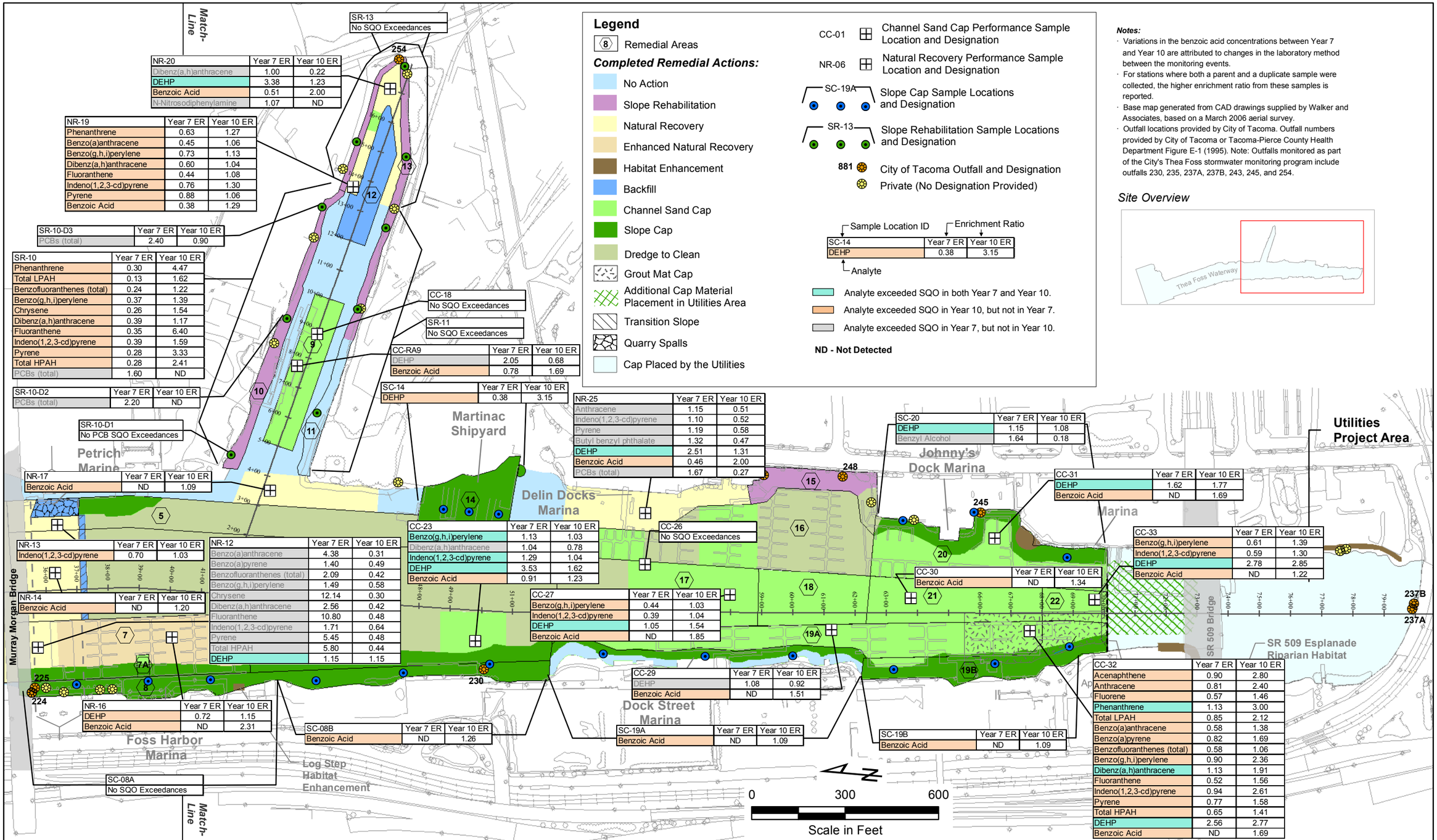
Figure 2-5 (Page 1 of 2)
Comparison of Year 7 and Year 10 SQO Exceedances in Performance Monitoring Surface Samples (0-10 cm)

File: I:\GIS\Projects\COT_ON_CALL\MXD\2016 Yr 10 Annual OMMP Report\Figure 2-5 (Year 10 SQO Exceed in Perf Mon Samp (0-10 cm)) Frame 1.mxd
Date: 10/14/2016



SR-13
No SQO Exceedances

NR-20	Year 7 ER	Year 10 ER
Dibenz(a,h)anthracene	1.00	0.22
DEHP	3.38	1.23
Benzoic Acid	0.51	2.00
N-Nitrosodiphenylamine	1.07	ND

NR-19	Year 7 ER	Year 10 ER
Phenanthrene	0.63	1.27
Benzo(a)anthracene	0.45	1.06
Benzo(g,h,i)perylene	0.73	1.13
Dibenz(a,h)anthracene	0.60	1.04
Fluoranthene	0.44	1.08
Indeno(1,2,3-cd)pyrene	0.76	1.30
Pyrene	0.88	1.06
Benzoic Acid	0.38	1.29

SR-10-D3	Year 7 ER	Year 10 ER
PCBs (total)	2.40	0.90

SR-10	Year 7 ER	Year 10 ER
Phenanthrene	0.30	4.47
Total LPAH	0.13	1.62
Benzofluoranthenes (total)	0.24	1.22
Benzo(g,h,i)perylene	0.37	1.39
Chrysene	0.26	1.54
Dibenz(a,h)anthracene	0.39	1.17
Fluoranthene	0.35	6.40
Indeno(1,2,3-cd)pyrene	0.39	1.59
Pyrene	0.28	3.33
Total HPAH	0.28	2.41
PCBs (total)	1.60	ND

SR-10-D2	Year 7 ER	Year 10 ER
PCBs (total)	2.20	ND

SR-10-D1
No PCB SQO Exceedances

CC-18
No SQO Exceedances

SR-11
No SQO Exceedances

CC-RA9	Year 7 ER	Year 10 ER
DEHP	2.05	0.68
Benzoic Acid	0.78	1.69

SC-14	Year 7 ER	Year 10 ER
DEHP	0.38	3.15

NR-25	Year 7 ER	Year 10 ER
Anthracene	1.15	0.51
Indeno(1,2,3-cd)pyrene	1.10	0.52
Pyrene	1.19	0.58
Butyl benzyl phthalate	1.32	0.47
DEHP	2.51	1.31
Benzoic Acid	0.46	2.00
PCBs (total)	1.67	0.27

SC-20	Year 7 ER	Year 10 ER
DEHP	1.15	1.08
Benzyl Alcohol	1.64	0.18

CC-31	Year 7 ER	Year 10 ER
DEHP	1.62	1.77
Benzoic Acid	ND	1.69

NR-17	Year 7 ER	Year 10 ER
Benzoic Acid	ND	1.09

NR-13	Year 7 ER	Year 10 ER
Indeno(1,2,3-cd)pyrene	0.70	1.03

NR-14	Year 7 ER	Year 10 ER
Benzoic Acid	ND	1.20

NR-12	Year 7 ER	Year 10 ER
Benzo(a)anthracene	4.38	0.31
Benzo(a)pyrene	1.40	0.49
Benzofluoranthenes (total)	2.09	0.42
Benzo(g,h,i)perylene	1.49	0.58
Chrysene	12.14	0.30
Dibenz(a,h)anthracene	2.56	0.42
Fluoranthene	10.80	0.48
Indeno(1,2,3-cd)pyrene	1.71	0.64
Pyrene	5.45	0.48
Total HPAH	5.80	0.44
DEHP	1.15	1.15

CC-23	Year 7 ER	Year 10 ER
Benzo(g,h,i)perylene	1.13	1.03
Dibenz(a,h)anthracene	1.04	0.78
Indeno(1,2,3-cd)pyrene	1.29	1.04
DEHP	3.53	1.62
Benzoic Acid	0.91	1.23

CC-26
No SQO Exceedances

CC-27	Year 7 ER	Year 10 ER
Benzo(g,h,i)perylene	0.44	1.03
Indeno(1,2,3-cd)pyrene	0.39	1.04
DEHP	1.05	1.54
Benzoic Acid	ND	1.85

CC-30	Year 7 ER	Year 10 ER
Benzoic Acid	ND	1.34

CC-33	Year 7 ER	Year 10 ER
Benzo(g,h,i)perylene	0.61	1.39
Indeno(1,2,3-cd)pyrene	0.59	1.30
DEHP	2.78	2.85
Benzoic Acid	ND	1.22

CC-29	Year 7 ER	Year 10 ER
DEHP	1.08	0.92
Benzoic Acid	ND	1.51

NR-16	Year 7 ER	Year 10 ER
DEHP	0.72	1.15
Benzoic Acid	ND	2.31

SC-08B	Year 7 ER	Year 10 ER
Benzoic Acid	ND	1.26

SC-19A	Year 7 ER	Year 10 ER
Benzoic Acid	ND	1.09

SC-19B	Year 7 ER	Year 10 ER
Benzoic Acid	ND	1.09

SC-08A
No SQO Exceedances

CC-32	Year 7 ER	Year 10 ER
Acenaphthene	0.90	2.80
Anthracene	0.81	2.40
Fluorene	0.57	1.46
Phenanthrene	1.13	3.00
Total LPAH	0.85	2.12
Benzo(a)anthracene	0.58	1.38
Benzo(a)pyrene	0.82	1.69
Benzofluoranthenes (total)	0.58	1.06
Benzo(g,h,i)perylene	0.90	2.36
Dibenz(a,h)anthracene	1.13	1.91
Fluoranthene	0.52	1.56
Indeno(1,2,3-cd)pyrene	0.94	2.61
Pyrene	0.77	1.58
Total HPAH	0.65	1.41
DEHP	2.56	2.77
Benzoic Acid	ND	1.69

Notes:

- Variations in the benzoic acid concentrations between Year 7 and Year 10 are attributed to changes in the laboratory method between the monitoring events.
- For stations where both a parent and a duplicate sample were collected, the higher enrichment ratio from these samples is reported.
- Base map generated from CAD drawings supplied by Walker and Associates, based on a March 2006 aerial survey.
- Outfall locations provided by City of Tacoma. Outfall numbers provided by City of Tacoma or Tacoma-Pierce County Health Department Figure E-1 (1995). Note: Outfalls monitored as part of the City's Thea Foss stormwater monitoring program include outfalls 230, 235, 237A, 237B, 243, 245, and 254.

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Figure 2-5 (Page 2 of 2)
Comparison of Year 7 and Year 10 SQO Exceedances in Performance Monitoring Surface Samples (0-10 cm)

File: I:\GIS\Projects\COT_ON_CALL\MXD\2016 Yr 10 Annual OMMP Report\Figure 2-5 (Year 10 SQO Exceed in Perf Mon Samp (0-10 cm)) Frame 2.mxd
Date: 10/14/2016

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 exceedances of chemical Sediment Quality Objectives (SQO) and early warning threshold concentrations have occurred or are predicted to occur.

The results of the Year 10 early warning monitoring are presented in the Year 10 Sediment and Cap Performance and Early Warning Monitoring Preliminary Finding Memorandum (Sediment PFM) (City of Tacoma 2016c) included as Attachment B-1 in Appendix B and is also summarized below.

3.2 Summary of Early Warning Monitoring Requirements

Year 10 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 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, including polycyclic aromatic hydrocarbons (PAHs) and bis(2-ethylhexyl)phthalate (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 Year 10 performance monitoring samples are presented in Section 2.0 of this report.

In addition, the early warning monitoring analytical results are compared to previous early warning monitoring results to evaluate concentration trends over time. Early warning monitoring sampling and analysis was performed for the first time as part of Year 2 monitoring that occurred in 2008. The Year 10 early warning monitoring results are compared with the Year 2, Year 4, and Year 7 early warning monitoring results below.

3.3 Summary of Early Warning Monitoring Field Activities, Analyses, and Reporting

The Year 10 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 16-17, 2016, 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 27-28, 2016, 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 2.0 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-Y10). 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 (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 early warning samples in accordance with the OMMP. The qualifiers resulting from data validation are presented in the summary of the Year 10 early warning sample analytical results provided in Table 3-1. All final data are considered valid and acceptable for use as qualified. Deviations from performance goals and project quality control (QC) limits are identified in the data validation reports and

generally resulted in the data being qualified as an estimate (i.e., J qualifier). The data validation reports for these samples are included in Attachment D of the Sediment PFM (Attachment B-1).

3.4 Concentration Trends Related to Laboratory Analytical Changes

During the comparison of the OMMP performance monitoring and early warning monitoring data over the years, general concentration trends (either generally consistent increases or decreases in concentrations between monitoring years) were noted for four analytes, including benzoic acid, PCBs, silver, and nickel, that are attributed to laboratory analytical changes. These trends over time are generally summarized below for the early warning samples and are described in further detail in Section 2.2.2 under the subsection titled Concentration Trends Related to Laboratory Analytical Changes.

Benzoic acid is a challenging analyte to measure and variable results are not uncommon, particularly in sediment samples, as the analyte is difficult to extract and sensitive to matrix effects. As summarized in Section 2.2.2, benzoic acid concentrations were reported at higher concentrations in the Year 10 early warning and performance monitoring samples in comparison to results from earlier monitoring events due to changes to the analytical method for benzoic acid in Year 10 utilizing both derivatization and isotopic dilution. These method changes resulted in higher target analyte recoveries, less variability, and improved sensitivity in the benzoic acid analysis, translating to the generally higher reported concentrations of benzoic acid in the Year 10 samples. Additionally, some of the variation in the Year 4 sample results for benzoic acid in comparison to other monitoring years was attributed to a laboratory artifact involving the acidification of the sand used for the Year 4 sample extractions. In Year 10, benzoic acid was detected in 25 of the 27 early warning samples analyzed (not including field duplicates) and exceeded the benzoic acid SQO in 24 of these samples. Half of the SQO exceedances for benzoic acid in these Year 10 early warning samples were greater than 2.0 times the SQO and the greatest SQO exceedance was detected at approximately 6.3 times the SQO. In contrast, benzoic acid was detected in 15 of the 27 Year 7 early warning samples (not including field duplicates), but these detected Year 7 early warning sample concentrations were lower compared to the Year 10 early warning concentrations at each location with the exception of one monitoring station. Only six of the Year 7 early warning samples had SQO exceedances and the maximum SQO enrichment ratio in these samples was approximately 1.4 times the SQO. Benzoic acid was detected in all of the Year 4 early warning samples, but there were only eight SQO exceedances in these Year 4 samples and the greatest exceedance was approximately 1.5 times the SQO. In Year 2, benzoic acid was detected in only four of the early warning samples and the greatest enrichment ratio for these detections was 0.4 times the SQO.

Variable concentration trends for PCBs between the OMMP monitoring events were first noted in Year 7 and are most likely generally attributable to changes in laboratory sample processing over time. In Year 2, gel permeation chromatography (GPC) clean-up was performed on the sample extracts to reduce matrix interferences, but an acid clean-up was not performed; while in Year 4 neither GPC nor acid clean-up was performed on the sediment samples. In both Year 7 and Year 10, sample extracts were cleaned using both GPC and acid to reduce matrix interferences. Additionally, beginning in Year 7 new analytical equipment was used to perform the PCB analysis. Although the sample processing for PCBs varied between the monitoring events, the extraction and analysis of PCBs in all four monitoring events was performed in accordance with and compliant with the approved OMMP methods for PCBs. In Year 10, PCBs were detected in 23 out of the 27 early warning samples with concentrations ranging from

approximately 0.1 to 0.6 times the total PCB SQO and in Year 7, PCBs were detected in 24 out of the 27 early warning samples with concentrations ranging from approximately 0.1 to 0.7 times the total PCB SQO. In contrast, there were only two detections of PCBs in the Year 2 early warning samples and PCBs were not detected in any of the Year 4 early warning samples.

Between Year 2 and Year 4 a significant decrease in silver concentrations was observed in the early warning samples, as well as the performance monitoring samples. This apparent trend for silver is potentially related to a change to a more sensitive method (ICP-MS) beginning in Year 4. In general, the Year 7 early warning monitoring results were consistent with the Year 4 early warning results for silver. The laboratory reporting limits for silver generally decreased in the Year 10 early warning samples relative to the Year 4 and Year 7 reporting limits, resulting in more detections for silver in Year 10 in comparison; however, all Year 10 detections were also less than the Year 2 silver concentrations. There have been no SQO exceedances for silver in any of the OMMP monitoring samples collected over the years and most silver detections in the samples were less than half the SQO.

Additionally, it was noted in Year 4 that there were increases in nickel concentrations in the Year 4 early warning samples compared with the Year 2 early warning samples at five stations, including Stations 19, 26, 27, 30, and 31. At these five stations, the Year 4 nickel concentrations were approximately five to eight times higher than the Year 2 nickel concentrations. Concentrations of nickel in Year 7 and Year 10 generally remained comparable with or decreased from the Year 4 concentrations in all of the monitoring samples. No detected concentrations of nickel in any of the Year 2, Year 4, Year 7, or Year 10 early warning samples exceeded the SQO. The changes in the nickel concentrations over time may also be related to the change in the analytical method for metals between Year 2 and Year 4.

3.5 Summary of Early Warning Monitoring Analytical Results

The analytical results from the Year 10 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 less than 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, 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 chemicals analyzed for on the project, including PAHs and DEHP, as they were recognized as the constituents with the highest probability for recontamination. Threshold concentrations for other analytes were set at their respective SQOs.

The detailed results of the Year 10 early warning sampling, including field forms and photographs for the samples, are presented in the Sediment PFM.

Detected concentrations in the Year 10 early warning samples collected from 25 of the 27 early warning sample stations exceeded the SQOs. Detected concentrations in the Year 10 early warning samples collected from 24 of the 27 early warning sample stations also exceeded the early warning threshold concentrations for at least one analyte. The most common SQO and early warning threshold exceedances were for benzoic acid (the SQO and early warning threshold concentration were set equal for benzoic acid), with exceedances in samples collected from 24 of the early warning samples stations. DEHP exceeded its SQO in samples collected from 14 of the early warning sample stations but exceeded the early warning threshold concentration for DEHP at only two of these stations. Early warning samples collected from ten of the early warning stations had one or more analytes other than benzoic acid or DEHP detected at concentrations that were greater than the SQOs, and six of these ten stations also had these other analytes exceed early warning threshold concentrations.

Early Warning Samples in Channel Sand Cap Areas – Nine early warning sample stations are located in the channel sand cap areas including Stations 1, 23, 26, 27, 29, 30, 31, 32, and 33. Only one early warning sample, sample EW-26-Y10, out these nine early warning samples collected from channel sand cap areas had all detected concentrations less than their SQOs. Station 26, where sample EW-26-Y10 was collected, is located on the border of RA 16 and RA 17. The remaining results for the Year 10 early warning samples collected in channel sand cap areas are summarized below by the analytes that exceeded the SQOs in these samples.

Both sample EW-01-Y10, collected from the channel sand cap area in RA 1A at the mouth of the Thea Foss Waterway, and sample EW-29-Y10, collected in RA 19A in the southern portion of the Thea Foss Waterway, had only benzoic acid detected greater than its SQO and equivalent early warning threshold, with SQO enrichment ratios of approximately 1.3 and 2.3, respectively.

Early warning sample EW-27-Y10 was collected from the channel sand cap area in RA 17 and had only DEHP detected greater than its SQO. DEHP was detected at approximately 1.3 times the SQO in this sample, but less than the early warning threshold concentration.

Three early warning samples, samples EW-23-Y10, EW-30-Y10, and EW-31-Y10, had detections of only benzoic acid and DEHP greater than their respective SQOs. Sample EW-23-Y10 was collected from the channel sand cap area in RA 6, adjacent to Outfall 230. In this sample, DEHP was detected at approximately 2.7 times the SQO and just greater than its early warning threshold concentration and benzoic acid was detected at approximately 2.9 times the SQO and its equivalent early warning threshold concentration. Samples EW-30-Y10 and EW-31-Y10 were collected in RAs 21 and 20, respectively, both located in the southern portion of the Thea Foss Waterway. Sample EW-30-Y10 had DEHP detected at approximately 1.2 times the SQO, but less than the early warning threshold concentration, and benzoic acid detected at approximately 1.1 times the SQO and equivalent early warning threshold concentration. Sample EW-31-Y10 had DEHP detected at approximately 2.4 times the SQO, but just less than the DEHP early warning threshold concentration, and benzoic acid detected at approximately 1.2 times the SQO and equivalent early warning threshold concentration.

Early warning samples EW-32-Y10 and EW-33-Y10 were collected from the channel sand cap areas in RA 19A and RA 22, respectively, both located in the southern portion of the Thea Foss

Waterway. Both samples EW-32-Y10 and EW-33-Y10 had multiple SQO exceedances. In sample EW-32-Y10, detected concentrations of nine analytes including acenaphthene, anthracene, phenanthrene, total LPAHs, benzo(g,h,i)perylene, dibenz(a,h)anthracene, indeno(1,2,3-cd)pyrene, DEHP, and benzoic acid were greater than their SQOs. In the field duplicate sample collected from this location (sample EW-32-Y10-2), six of the nine analytes detected at concentrations that exceeded the SQOs in the parent sample also exceeded the SQOs in the field duplicate sample (the exceptions were anthracene, total LPAHs, and benzoic acid). In the field duplicate sample, anthracene was detected just less than the SQO, total LPAHs was detected at the SQO, and benzoic acid was detected at approximately 0.8 times the SQO. The SQO enrichment ratios for the analytes that exceeded the SQOs in both the parent and duplicate sample from Station 32 were at or less than approximately 2.2 times the SQO. The greatest SQO exceedance at this location was for DEHP in the field duplicate sample. The concentrations of benzo(g,h,i)perylene, dibenzo(a,h)anthracene, indeno(1,2,3-cd)pyrene, and benzoic acid also exceeded the early warning threshold concentrations in sample EW-32-Y10. Sample EW-33-Y10, located in the channel of the Thea Foss Waterway near the sheet pile wall, had five analytes exceed their SQOs, including benzo(g,h,i)perylene, dibenzo(a,h)anthracene, indeno(1,2,3-cd)pyrene, DEHP, and benzoic acid. The SQO enrichment ratios for these analytes were at or less than approximately 3.4, with the greatest enrichment ratio being for DEHP. All of these analytes also exceeded their corresponding early warning threshold concentrations with the exception of dibenz(a,h)anthracene.

Early Warning Samples in Natural Recovery and Enhanced Natural Recovery Areas – Thirteen sample stations are located in the natural recovery and enhanced natural recovery areas including Stations 6, 7, 8, 9, 10, 11, 12, 13, 16, 17, 19, 20, and 25. The results for the Year 10 early warning samples collected in natural recovery and enhanced natural recovery areas are summarized below moving from stations north to south along the waterway.

Six early warning samples were collected from natural recovery areas north of the Murray Morgan Bridge (MMB), including samples EW-06-Y10 through EW-11-Y10. Three of these samples, samples EW-08-Y10, EW-09-Y10, and EW-10-Y10, had only SQO and early warning threshold exceedances for benzoic acid, with enrichment ratios of 1.9, 3.5, and 1.1, respectively. Sample EW-06-Y10 had detections of benzoic acid and p,p'-DDE greater than their SQOs and their early warning thresholds, which are equivalent for both of these analytes, with enrichment ratios of 2.3 and 1.2, respectively. Sample EW-07-Y10 had SQO exceedances for DEHP, benzoic acid, and fluoranthene, with the SQO enrichment ratios for these analytes at approximately 1.1, 4.0, and 1.2, respectively. The DEHP and fluoranthene detections in sample EW-07-Y10 did not exceed their early warning threshold concentrations. Sample EW-11-Y10 had DEHP and benzoic acid concentrations greater than their SQOs; however, the DEHP concentration did not exceed its early warning threshold concentration. DEHP was detected at approximately 1.6 times the SQO and benzoic acid was detected at approximately 3.4 times the SQO in sample EW-11-Y10.

Early warning samples EW-12-Y10 and EW-13-Y10 were both collected from the natural recovery area south and adjacent to the MMB. Sample EW-12-Y10 had benzoic acid, DEHP, and fluoranthene concentrations that exceeded their SQOs, but only benzoic acid exceeded its early warning threshold concentration. Benzoic acid was detected at a concentration approximately 1.5 times the SQO, DEHP was detected at approximately 1.1 times the SQO, and fluoranthene was detected at approximately 1.1 times the SQO in sample EW-12-Y10. Early warning sample EW-13-Y10 had benzoic acid, DEHP, and indeno(1,2,3-cd)pyrene concentrations that exceeded their SQOs, with SQO enrichment ratios of approximately 1.2,

1.2, and 1.01 times the SQOs, respectively. Again, only benzoic acid exceeded its early warning threshold concentration. Benzo(g,h,i)perylene was detected at a concentration in sample EW-13-Y10 that was just less than the SQO, with an SQO enrichment ratio of 0.99.

Early warning sample EW-16-Y10 was collected from the enhanced natural recovery area located on the west side of the Thea Foss Waterway in the Foss Waterway Marina. DEHP and benzoic acid were detected at concentrations that exceeded their SQOs, with detections at approximately 1.1 and 2.2 times the SQOs, respectively. The DEHP concentration in sample EW-16-Y10 was significantly less than the DEHP early warning threshold concentration.

In early warning sample EW-17-Y10 and its field duplicate (sample EW-17-Y10-2), collected from the natural recovery area located near the mouth of the Wheeler-Osgood Waterway, seven detected concentrations were greater than their SQOs in one or both of the samples including anthracene, phenanthrene, total LPAHs, benzo(g,h,i)perylene (duplicate sample only), indeno(1,2,3-cd)pyrene (duplicate sample only), pyrene, and benzoic acid, with SQO enrichment ratios generally ranging from approximately 1.1 to 1.8, with the exception of the benzoic acid concentration in sample EW-17-Y10 detected at approximately 2.9 times its SQO and equivalent early warning threshold concentration. The detected concentration of benzo(g,h,i)perylene in the field duplicate sample also exceeded its early warning threshold concentration.

Early warning samples EW-19-Y10 and EW-20-Y10, both located in the natural recovery area near the head of the Wheeler-Osgood Waterway, had one and two detected chemical concentrations greater than the SQOs, respectively. Sample EW-19-Y10 had benzoic acid detected at a concentration just greater than the SQO and early warning threshold concentration, with an enrichment ratio of 1.03. Sample EW-20-Y10 had DEHP detected at approximately 1.7 times the SQO, but less than the early warning threshold, and benzoic detected at approximately 2.6 times the SQO and early warning threshold concentration.

The detected concentrations of three analytes were greater than the SQOs in sample EW-25-Y10, collected in the natural recovery area east of RA 16 and north of RA 15. The analytes with concentrations greater than the SQOs included fluoranthene, DEHP, and benzoic acid, with SQO enrichment ratio for these compounds of approximately 1.3, 1.5, and 6.3 times their SQOs, respectively. Only the benzoic acid concentration in this sample also exceeded its early warning threshold concentration.

Early Warning Samples in Dredged to Clean Areas – A total of five early warning samples were collected in the dredged to clean areas within the Thea Foss Waterway including samples taken at Stations 15, 21, 22, 24 and 28. Early warning sample EW-28-Y10 had all detected concentrations substantially less than the SQOs. This sample was collected in the dredge to clean area located at the southern end of RA 16.

The remaining four early warning samples were collected from the dredge to clean areas in RAs 5 and 6 (samples EW-15-Y10, EW-21-Y10, EW-22-Y10, and EW-24-Y10) and each had at least one analyte that exceeded the SQO. All four samples had benzoic acid SQO exceedances. Only benzoic acid exceeded its SQO in sample EW-15-Y10, with an SQO enrichment ratio of approximately 1.5. Samples EW-21-Y10, EW-22-Y10, and EW-24-Y10 each had two detected analyte concentrations greater than their respective SQOs. Sample EW-21-Y10 had benzyl alcohol and benzoic acid detected at concentrations exceeding both their SQOs and equivalent early warning threshold concentrations, with enrichment ratios of 3.4 and 2.3, respectively. In

sample EW-22-Y10, DEHP and benzoic acid were detected at concentrations that exceeded their SQOs. The DEHP concentration in sample EW-22-Y10 was approximately 1.4 times the SQO, but significantly less than the DEHP early warning threshold concentration. Benzoic acid was detected in sample EW-22-Y10 at approximately 1.4 times the SQO and early warning threshold concentration. In sample EW-24-Y10, 2,4-dimethylphenol and benzoic acid were detected at concentrations that exceeded their SQOs. The 2,4-dimethylphenol concentration in sample EW-24-Y10 was approximately 1.7 times the SQO and its equivalent early warning threshold concentration. Benzoic acid was detected in sample EW-24-Y10 at approximately 2.2 times the SQO and early warning threshold concentration.

3.6 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 10 early warning and Year 10 performance monitoring results for channel sand cap and natural recovery areas.

3.6.1 Channel Sand Cap Sample Comparisons

This section compares the results of the Year 10 early warning monitoring samples (0 to 2 cm) to the results of the Year 10 performance monitoring surface samples (0 to 10 cm) in the channel sand cap areas. Channel sand cap performance surface sample results are discussed in further detail in Section 2.2.2.2. The results of channel sand cap surface samples compared to the results of co-located early warning samples are presented in Table 6 and Tables 8 through 15 in the Sediment PFM.

Of the nine channel sand cap performance monitoring stations that also had co-located early warning samples, only sample pair CC-26-Y10 and EW-26-Y10 had no SQO exceedances. For the remaining eight channel sand cap stations with early warning samples, the most common exceedances in Year 10 were for benzoic acid and DEHP. Benzoic acid exceeded the SQO at all stations in both the channel sand cap performance monitoring and early warning samples with the exception of Station 27 where the benzoic acid concentration only exceeded in the channel sand cap sample. As summarized earlier in Sections 2.2.2 and Section 3.4 Concentration Trends Related to Laboratory Analytical Changes, the frequency of benzoic acid SQO exceedances in Year 10 is much greater compared to past monitoring events and is attributed to laboratory analytical changes made in Year 10 that increased the analytical sensitivity for benzoic acid. For DEHP, five of the nine channel sand cap monitoring stations had both the channel sand cap and early warning sample concentrations exceeding the DEHP SQO in Year 10, while one additional station had DEHP detected above the SQO only in the early warning sample. Four stations had PAH exceedances, with two stations having several PAHs detected above the SQOs in both the channel sand cap performance monitoring and early warning samples and the other two stations having several PAHs detected above the SQOs in only the channel sand cap performance monitoring samples.

The results of channel sand cap sample comparisons are summarized below for each station by the analytes that exceeded the SQOs in the samples.

A comparison of the Year 10 channel sand cap performance monitoring sample to the co-located early warning sample at Station 26 (sample pair CC-26-Y10/EW-26-Y10) showed that

all analyte detections were less than the SQOs in these samples and that concentrations were generally comparable between the samples. Benzoic acid was detected in sample CC-26-Y10 at a concentration just less than the SQO with an enrichment ratio of approximately 0.9, while it was detected at approximately 0.6 times the SQO in sample EW-26-Y10.

Station 1 and Station 29 had benzoic acid as the only analyte exceeding the SQOs in both the channel sand cap performance monitoring samples and the early warning samples (sample pairs CC-01-Y10/EW-01-Y10 and CC-29-Y10/EW-29-Y10). At Station 1, benzoic acid was detected in the channel sand cap sample at approximately 1.5 times the SQO, but was slightly lower in the corresponding early warning sample EW-01-Y10, at approximately 1.3 times the SQO. At Station 29, benzoic acid was detected at a higher concentration in the early warning sample in comparison to the channel sand cap sample, with concentrations approximately 1.5 times the SQO in sample CC-29-Y10 and approximately 2.3 times the SQO in sample EW-29-Y10.

Station 30 had only one SQO exceedance, for benzoic acid, in the channel sand cap performance monitoring sample CC-30-Y10, with benzoic acid detected at approximately 1.3 times the SQO. In the corresponding early warning sample EW-30-Y10, both benzoic acid and DEHP exceeded their SQOs, with enrichment ratios of 1.1 and 1.2, respectively. Similarly, Station 31 had only SQO exceedances of DEHP and benzoic acid, and exceedances for these analytes were observed in both the channel sand cap sample CC-31-Y10 and early warning sample EW-31-Y10. DEHP was detected at concentrations approximately 1.8 times the SQO in the channel sand cap sample and 2.4 times the SQO in the early warning sample, while benzoic acid was detected at concentrations approximately 1.7 times the SQO in the channel sand cap sample and 1.2 times the SQO for the early warning sample.

Stations 23, 27, and 33 (sample pairs CC-23-Y10/EW-23-Y10, CC-27-Y10/EW-27-Y10, and CC-33-Y10/EW-33-Y10) all had SQO exceedances of benzo(g,h,i)perylene, indeno(1,2,3-cd)pyrene, DEHP, and benzoic acid in their channel sand cap performance monitoring samples. At Station 23, DEHP and benzoic acid also exceeded their SQOs in the corresponding early warning sample EW-23-Y10. Concentrations of DEHP and benzoic acid were higher in the early warning sample EW-23-Y10 in comparison to the channel sand cap sample CC-23-Y10, with DEHP detected at 1.6 and 2.7 times the SQO and benzoic acid detected at 1.2 and 2.9 times the SQO in sample CC-23-Y10 and sample EW-23-Y10, respectively. In contrast, detections of benzo(g,h,i)perylene and indeno(1,2,3-cd)pyrene in sample CC-23-Y10 were higher than in sample EW-23-Y10, with these analytes both detected just greater than the SQOs in the channel sand cap sample, but just less than the SQOs in the early warning sample. Early warning sample EW-27-Y10, from Station 27 had only DEHP exceeding the SQO with a similar concentration to the corresponding channel sand cap sample. Samples CC-27-Y10 and EW-27-Y10 had DEHP detected at approximately 1.5 and 1.3 times the SQO, respectively. While benzoic acid was detected at approximately 1.9 times the SQO in channel sand cap sample CC-27-Y10, benzoic acid was not detected in early warning sample EW-27-Y10. Similar to Station 23, at Station 27 the detections of benzo(g,h,i)perylene and indeno(1,2,3-cd)pyrene that just exceeded the SQOs in channel sand cap sample CC-27-Y10 were higher than the levels of these analytes in the corresponding early warning sample EW-27-Y10, which were detected just less than the SQOs. For early warning sample EW-33-Y10 all four analytes exceeding the SQO in the channel sand cap sample CC-33-Y10 also exceeded the SQOs in the early warning sample and were detected at higher concentrations in the early warning sample. In samples CC-33-Y10 and EW-33-Y10, DEHP was detected approximately 2.9 and 3.4 times the SQO, benzoic acid was detected at 1.2 and 1.5 times the SQO, benzo(g,h,i)perylene was

detected at 1.4 and 1.7 times the SQO, and indeno(1,2,3-cd)pyrene was detected at 1.3 and 1.6 times the SQO, respectively. In addition, early warning sample EW-33-Y10 also had an exceedance of dibenzo(a,h)anthracene just greater than the SQO, whereas this analyte was detected just less than the SQO in sample CC-33-Y10.

Channel sand cap performance monitoring and early warning samples from the remaining channel sand cap sample station (sample pair CC-32-Y10/EW-32-Y10) had chemical concentrations for multiple constituents that were greater than the SQOs, including multiple PAHs, DEHP, and benzoic acid. All SVOC concentrations were lower in the early warning samples from these stations compared to the corresponding channel sand cap performance monitoring sample concentrations. Sample CC-32-Y10 had SQO exceedances for the majority of the PAHs (14 SQO exceedances), including acenaphthene, anthracene, fluorene, phenanthrene, total LPAHs, all individual HPAHs except chrysene, and total HPAHs, with enrichment ratios for these PAHs ranging from approximately 1.1 to 3.0 times the SQOs. In early warning sample EW-32-Y10, there were only nine PAHs with SQO exceedances, including acenaphthene, anthracene, phenanthrene, total LPAHs, benzo(g,h,i)perylene, dibenzo(a,h)anthracene, and indeno(1,2,3-cd)pyrene, with enrichment ratios for these PAHs ranging from approximately 1.0 to 1.8 times the SQOs. Additionally, DEHP and benzoic acid exceeded SQOs in both the channel sand cap sample CC-32-Y10 and the early warning sample EW-32-Y10, with enrichment ratios for DEHP of 2.8 and 1.9 times the SQO, respectively, and with enrichment ratios for benzoic acid of 1.7 and 1.1 times the SQO, respectively.

3.6.2 Natural Recovery Sample Comparisons

This section compares the results of the Year 10 early warning monitoring samples to the results of the Year 10 performance monitoring surface samples 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. The results of natural recovery and enhanced natural recovery surface samples compared to the results of co-located early warning samples are presented in Tables 25 through 32 and Tables 34 through 38 in the Sediment PFM (Attachment B-1).

Of the 13 natural recovery performance monitoring stations that also had co-located early warning samples, all of the natural recovery and early warning samples had at least one SQO exceedance. The most common exceedances in Year 10 were for benzoic acid and DEHP. Benzoic acid exceeded the SQO at all stations in both the natural recovery performance monitoring and early warning samples with the exceptions of Stations 10, 12, and 13 where benzoic acid concentrations only exceeded in the early warning samples. As summarized earlier in Sections 2.2.2 and Section 3.4 Concentration Trends Related to Laboratory Analytical Changes, the frequency of benzoic acid SQO exceedances in Year 10 is much greater compared to past monitoring events and is attributed to laboratory analytical changes made in Year 10 that increased the analytical sensitivity for benzoic acid. In Year 7, benzoic acid exceeded the SQO in only four early warning samples collected at natural recovery stations and did not exceed in any natural recovery samples, and in Year 4, benzoic acid exceeded the SQO in only six early warning samples collected at natural recovery stations and in only one natural recovery sample. For DEHP, seven of the natural recovery monitoring stations had either one or both of the natural recovery and early warning samples exceeding the SQO in Year 10. This result was similar to Year 4 and Year 7, which had eight stations with DEHP exceedances and five stations with DEHP exceedances in either one or both of the natural recovery samples and early warning samples, respectively.

Generally, the results of the natural recovery sample comparisons are summarized below moving from stations north to south along the waterway.

In Year 10, at Stations 6, 8, and 9 benzoic acid was detected greater than the SQO in both the natural recovery sample and the corresponding early warning sample (sample pairs NR-06-Y10/EW-06-Y10, NR-08-Y10/EW-08-Y10, and NR-09-Y10/EW-09-Y10). At these stations benzoic acid concentrations were higher in the early warning samples in comparison to the concentrations in the natural recovery samples. At Station 6, benzoic acid was detected at approximately 1.2 and 2.3 times the SQO in samples NR-06-Y10 and EW-06-Y10, respectively. Samples NR-08-Y10 and EW-08-Y10 had benzoic acid detections of approximately 1.5 and 1.9, respectively, and samples NR-09-Y10 and EW-09-Y10 had benzoic acid detections of approximately 1.2 and 3.5, respectively. Additionally, the early warning sample from Station 6, EW-06-Y10, had p,p'-DDE detected greater than the SQO with an enrichment ratio of approximately 1.2; however, this analyte was not detected in the corresponding natural recovery sample NR-06-Y10. At Station 8, the natural recovery sample NR-08-Y10 also had indeno(1,2,3-cd)pyrene detected just greater than the SQO (1.03 times the SQO), while the corresponding early warning sample had this analyte detected just less than the SQO.

At Station 7, the detected concentrations in early warning sample EW-07-Y10 were generally similar to concentrations detected in the co-located natural recovery sample NR-07-Y10. DEHP and benzoic acid exceeded the SQOs in both early warning sample and natural recovery sample, with DEHP detected at approximately 1.1 times the SQO in both of the samples, while benzoic acid in sample NR-07-Y10 and sample EW-07-Y10 exceeded the SQO with greater enrichment ratios of 3.1 and 4.0, respectively. Additionally, in early warning sample EW-07-Y10 fluoranthene was detected at approximately 1.2 times the SQO; however, it was detected at only approximately 0.6 times the SQO in sample NR-07-Y10.

At Station 10, natural recovery sample NR-10-Y10 had only butyl benzyl phthalate exceed the SQO with an enrichment ratio of 1.04, while the corresponding early warning sample EW-10-Y10 had this analyte detected at only approximately 0.2 times the SQO. Sample EW-10-Y10 had an exceedance of benzoic acid at approximately 1.1 times the SQO while the concentration of benzoic acid in sample NR-10-Y10 was just less than the SQO.

Station 11 had DEHP exceeding the SQO and detected at the same concentrations in the Year 10 natural recovery and early warning samples, with an enrichment ratio of approximately 1.6. Benzoic acid also exceeded its SQO in both sample NR-11-Y10 and sample EW-11-Y10, but was detected at a higher concentration in the early warning sample, with enrichment ratios of 1.2 and 3.4, respectively.

For Station 12, only DEHP exceeded the SQO in both the natural recovery sample NR-12-Y10 and the corresponding early warning sample EW-12-Y10, with very similar concentrations, detected at 1.2 and 1.1 times the SQO, respectively. Fluoranthene and benzoic acid in early warning sample EW-12-Y10 also exceeded the SQOs, but these analytes were detected less than the SQOs in sample NR-12-Y10. Fluoranthene was detected at approximately 0.5 and 1.1 times the SQO and benzoic acid was detected at approximately 0.6 and 1.5 times the SQO in samples NR-12-Y10 and EW-12-Y10, respectively.

At Station 13, indeno(1,2,3-cd)pyrene slightly exceeded the SQO in natural recovery sample NR-13-Y10 with an enrichment ratio of approximately 1.01, while three analytes exceeded

SQOs in early warning EW-13-Y10, including: indeno(1,2,3-cd)pyrene (with nearly the same concentration as in sample NR-13-Y10); DEHP at 1.2 times the SQO; and benzoic acid at 1.2 times the SQO. Benzo(g,h)perylene was just less than the SQO in both samples NR-13-Y10 and EW-13-Y10 with both detections at 0.99 times the SQO.

At Station 16, both DEHP and benzoic acid exceeded the SQOs and had similar concentrations detected between the natural recovery sample NR-16-Y10 and early warning sample EW-16-Y10. Sample NR-16-Y10 and EW-16-Y10 had detected concentrations of 1.2 and 1.1 times the SQO for DEHP, and detected concentrations of 2.3 and 2.2 times the SQO for benzoic acid, respectively.

Station 17 had benzoic acid detected at concentrations exceeding the SQO in both the natural recovery performance monitoring and early warning samples, with benzoic acid detected at approximately 1.1 times the SQO in natural recovery sample NR-17-Y10 and approximately 2.9 times the SQO in early warning sample EW-17-Y10. Additionally, Station 17 had four PAHs exceeding the SQOs in the early warning sample EW-17-Y10, including anthracene, phenanthrene, total LPAHs, and pyrene, with enrichment ratios ranging from 1.1 to 1.7. These four analytes were detected at or less than approximately 0.8 times the SQOs in the corresponding natural recovery sample NR-17-Y10.

At Station 19, benzoic acid exceeded the SQO in both the natural recovery performance monitoring and early warning samples, with concentrations at approximately 1.3 times the SQO in sample NR-19-Y10 and 1.03 times the SQO in sample EW-19-Y10. Additionally, sample NR-19-Y10 had phenanthrene and a majority of the HPAHs (six out of nine) detected greater than their SQOs, with detections at or less than approximately 1.3 times the SQOs. In comparison, the concentrations for these PAHs in the co-located early warning sampling EW-19-Y10 ranged from approximately 0.6 to 0.8 times the SQO.

At Station 20, DEHP and benzoic acid exceeded the SQOs in both the natural recovery performance monitoring sample and early warning sample (sample pair NR-20-Y10/EW-20-Y10). Concentrations of both analytes in the early warning sample were greater than concentrations in the natural recovery sample, with DEHP detected at approximately 1.2 times the SQO in sample NR-20-Y10 and approximately 1.7 times the SQO in sample EW-20-Y10, and with benzoic acid detected at approximately 2.0 times the SQO in sample NR-20-Y10 and approximately 2.6 times the SQO in sample EW-20-Y10.

SQO exceedances of DEHP, benzoic acid, and fluoranthene were detected in the early warning sample EW-25-Y10 from Station 25. However, only benzoic acid exceeded the SQO in the corresponding natural recovery sample NR-25-Y10 from this station. Benzoic acid was detected at a greater concentration in sample EW-25-Y10 compared to the concentration in sample NR-25-Y10, with detections at approximately 6.3 and 2.0 times the SQO, respectively. The fluoranthene and DEHP concentrations in early warning sample EW-25-Y10 were approximately 1.3 and 1.5 times the SQO, respectively, whereas the concentration of fluoranthene in sample NR-25-Y10 was approximately 0.7 times the SQO and DEHP was detected at the SQO in sample NR-25-Y10.

3.7 Summary of Early Warning Monitoring Results Comparisons

The OMMP specifies that the results from the Year 10 early warning samples be used to develop trends to evaluate the potential for recontamination of remediation areas within the

Thea Foss and Wheeler-Osgood Waterways. The OMMP also specifies that the concentration trend plots be developed based on the results of multiple years of early warning monitoring and provides procedures for evaluating the occurrence and source of recontamination. These early warning concentration trend plots were first developed in Year 7, after three years of monitoring results were obtained, and are used again in Year 10, adding in the more recent results. The Year 10 concentration trend plots were generated based on a set of criteria established to emphasize those analytes that are detected either just less than or greater than the SQO at each early warning station. The criteria used to generate the Year 10 concentration trend plots for each early warning station included the following: 1) the analyte was detected during the last three monitoring events at the early warning station (Year 4, Year 7, and Year 10 monitoring events); and 2) at least one of the detections for that analyte (during any monitoring event) had a SQO enrichment ratio of 0.75 times the SQO or greater. Figures showing the concentration trend plots by early warning station are included in Attachment E of the Sediment PFM. The following sections compare the results of the Year 2, Year 4, Year 7, and Year 10 early warning monitoring samples in the channel sand cap, natural recovery / enhanced natural recovery, and dredge to clean areas as specified in the OMMP.

3.7.1 Comparison of Year 2, Year 4, Year 7, and Year 10 Early Warning Samples from Channel Sand Cap Areas

This section compares the results of the Year 2, Year 4, Year 7, and Year 10 early warning monitoring samples collected in the channel sand cap areas as required by the OMMP. Refer to Table 6 and Tables 8 through 15 in the Sediment PFM, which present comparisons of the results of the Year 2, Year 4, Year 7, and Year 10 early warning samples in the channel cap areas. Figures E1, E8, E9, and E11 though E13 in Attachment E of the Sediment PFM (included as Attachment B-1) show the concentration trend plots for the early warning samples in the channel cap areas, along with providing information on which analyte concentrations exceeded the SQOs and/or the early warning threshold concentrations.

Station 26 had no detected chemical concentrations that were at or exceeded the SQOs in the early warning samples from Year 2, Year 4, Year 7, and Year 10. Analyte detections at or exceeding the SQOs in the remaining early warning samples from the other channel sand cap area stations are discussed below generally in the order of moving from stations north to south along the waterway. For additional discussion on the other analytes in these early warning samples that do not exceed the SQOs, but that had notable changes in concentrations when comparing the Year 2, Year 4, Year 7, and Year 10 results, refer to the Sediment PFM.

Station 1 had no detected chemical concentrations at or exceeding the SQOs in the early warning samples from Year 2, Year 4, and Year 7. However, in the Year 10 early warning sample from Station 1, benzoic acid exceeded the SQO and the equivalent early warning threshold concentration, with an exceedance ratio of approximately 1.3. Benzoic acid had previously been detected just less than the SQO in the Year 4 early warning sample and was detected in the Year 7 early warning sample at approximately 0.4 times the SQO, but was not detected in the Year 2 early warning sample. With the exception of the benzoic acid concentrations in the Year 4 and Year 10 early warning samples, all of the other detected analytes in the early warning samples collected from Station 1 have had concentrations well below the SQOs.

At Station 23, DEHP concentrations in the Year 2, Year 4, Year 7, and Year 10 early warning samples all exceeded the SQO with enrichment ratios of approximately 2.3, 12.3 (18.5 in the

Year 4 field duplicate), 3.0, and 2.7 times the SQO, respectively. The Year 4, Year 7, and Year 10 early warning DEHP concentrations also exceeded the DEHP early warning threshold concentration, with the greatest exceedance in Year 4 at approximately 5 to 7 times the early warning threshold concentration. In both Year 7 and Year 10, benzoic acid exceeded its SQO and equivalent early warning threshold in the early warning samples, but the concentration in the Year 10 sample was over double the concentration in the Year 7 sample. The SQO enrichment ratios for benzoic acid in samples EW-23-Y7 and EW-23-Y10 were approximately 1.3 and 2.9 times the SQO, respectively. Benzoic acid concentrations in the Year 2 and Year 4 early warning samples were at or less than approximately 0.8 times the SQO. With the exception of DEHP and benzoic acid, no other analytes exceeded the SQOs in the Station 23 Year 10 early warning sample. Prior early warning samples from Stations 23 have had other SQO exceedances, including exceedances for phenanthrene (in the Year 4 and Year 7 samples), multiple HPAHs (in the Year 2, Year 4, and Year 7 samples), butyl benzyl phthalate (in the Year 4 sample), and benzyl alcohol (in the Year 2 and Year 4 samples). The SQO exceedances for these analytes were all less than 2.0 times the SQO.

At Station 27, DEHP was the only analyte to exceed the SQO in the Year 7 and Year 10 early warning samples, with very similar concentrations in both years, and SQO enrichment ratios of approximately 1.3 times the SQO. These detections of DEHP are less than the DEHP early warning threshold concentration. In Year 2 and Year 4, DEHP concentrations in the early warning samples were detected just less than the SQO.

At Station 29, DEHP exceeded the SQO in both the Year 4 and Year 7 early warning samples with SQO enrichment ratios of approximately 1.2 and 1.5 times the SQO, respectively, but did not exceed the SQO in Year 10 with an enrichment ratio of approximately 0.9. In Year 10, benzoic acid exceeded its SQO and the equivalent early warning threshold concentration for the first time in an early warning sample from this station, detected at approximately 2.3 times the SQO. Benzoic acid was not detected at Station 29 in the Year 2 or Year 7 early warning samples, but was detected at approximately 0.5 times the SQO in the Year 4 early warning sample.

Station 30 showed a slight increase in the DEHP concentration in the Year 10 early warning sample in comparison to the DEHP concentrations detected in the Year 2, Year 4, and Year 7 early warning samples. DEHP in the Year 10 early warning sample exceeded the SQO with an enrichment ratio of approximately 1.2, well below the early warning threshold criteria, while the detections in the Year 2 , Year 4, and Year 7 early warning samples were at approximately 0.8, 0.9, and 1.0 times the SQO, respectively. Additionally, benzoic acid exceeded the SQO and the equivalent early warning threshold concentration in the Year 10 early warning sample, detected at approximately 1.2 times the SQO, while it was not previously detected in Year 2 or Year 7, and was only detected in Year 4 at a concentration of about one-third the concentration in Year 10.

DEHP was detected greater than the SQO in the Year 2, Year 7, and Year 10 early warning samples from Station 31, with SQO enrichment ratios of approximately 2.3, 4.6, and 2.4 times the SQO, respectively. The early warning DEHP concentration in Year 7 was also greater than the DEHP early warning threshold concentration, while the Year 2 and Year 10 concentrations were just less (3,000 and 3,100 µg/kg, compared to the early warning threshold concentration of 3,250 µg/kg). In Year 10, benzoic acid exceeded its SQO and equivalent early warning threshold concentration for the first time in the early warning samples from this station, detected at approximately 1.2 times the SQO. Benzoic acid was not detected at Station 31 in the Year 2

or Year 7 early warning samples, and was detected at a concentration much less than the SQO in the Year 4 early warning sample.

At Station 32, multiple PAHs were detected greater than the SQOs in the Year 2, Year 4, Year 7, and Year 10 early warning samples. The Year 4 and Year 7 early warning concentrations for the PAHs generally are greater relative to the Year 2 and Year 10 early warning sample concentrations. Most of the PAHs exceed their SQOs in the Year 4 and Year 7 early warning samples, while in the Year 10 early warning sample, the number of PAHs that exceeded their SQOs decreased to only seven of 18 PAHs, similar to the Year 2 early warning sample where six of 18 PAHs exceeded SQOs. The SQO exceedances for PAHs in the Year 7 early warning sample from Station 32 were detected up to approximately 2.2 times the SQO, while the SQO exceedances for PAHs in the Year 10 early warning sample from this station were detected up to approximately 1.8 times the SQO. None of the LPAHs detected in the early warning samples have ever exceeded their early warning threshold concentrations. For the HPAHs, five exceeded their early warning threshold concentrations in the Year 4 and Year 7 early warning samples (benzo(a)pyrene, total benzofluoranthenes, benzo(g,h,i)perylene, dibenzo(a,h)anthracene, and indeno(1,2,3-cd)pyrene). This decreased to three of the HPAHs exceeding their early warning threshold concentrations (benzo(g,h,i)perylene, dibenzo(a,h)anthracene, and indeno(1,2,3-cd)pyrene) in the Year 10 early warning sample. DEHP concentrations exceeded both the SQO and early warning threshold concentration in the Year 2, Year 4, and Year 7 early warning samples, but only exceeded the SQO, and not the early warning threshold concentration, in the Year 10 early warning sample. The DEHP concentration was the greatest in the Year 4 early warning sample, detected at approximately 5.3 times the SQO and 2.1 times the early warning threshold concentration. The DEHP enrichment ratios decreased in Year 7 to approximately 4.8 times the SQO and 1.9 times the early warning threshold concentration, and in Year 10 to approximately 1.9 times the SQO and 0.8 times the early warning threshold concentration. Additional SQO exceedances in the early warning samples from Station 32 included benzoic acid in the Year 4 and Year 10 early warning samples and n-nitrosodiphenylamine in the Year 7 early warning sample. The benzoic acid concentration in the Year 10 early warning sample, detected at approximately 1.1 times the SQO, was a bit less than detected in the Year 4 early warning sample, detected at approximately 1.5 the SQO. Benzoic acid was not detected in the Year 2 early warning sample and was detected at a concentration much less than the SQO in the Year 7 early warning sample. In Year 2, Year 4, and Year 10, the concentrations of n-nitrosodiphenylamine in the early warning samples either were not detected or detected much less than the SQO, while in the Year 7 early warning sample, this analyte was detected at approximately 1.4 times the SQO.

At Station 33, the Year 4, Year 7, and Year 10 early warning concentrations for the PAHs at Station 33 are relatively similar, and have generally increased in comparison to the Year 2 early warning sample concentrations. In Year 10, benzo(g,h,i)perylene, dibenzo(a,h)anthracene, and indeno(1,2,3-cd)pyrene exceed the SQOs, with benzo(g,h,i)perylene and indeno(1,2,3-cd)pyrene also exceeding their early warning threshold concentrations. The SQO enrichment ratios for these three HPAHs are at or less than approximately 1.7 times the SQO. In Year 7, benzo(g,h,i)perylene, dibenzo(a,h)anthracene, and indeno(1,2,3-cd)pyrene also exceeded both the SQOs and early warning threshold concentrations, while in the Year 4 early warning sample only dibenzo(a,h)anthracene and indeno(1,2,3-cd)pyrene exceeded the SQOs and only indeno(1,2,3-cd)pyrene exceeded the early warning threshold concentration. DEHP exceeded the SQO in the Year 2, Year 4, Year 7, and Year 10 early warning samples from Station 33, with SQO enrichment ratios of approximately 1.4, 5.5, 5.0, and 3.4 times the SQO, respectively. The Year 4 and Year 7 DEHP concentrations were also over two times the DEHP early warning

threshold concentration, while the DEHP concentration in Year 10 was lower, at approximately 1.4 times the early warning threshold concentration. In the Year 7 early warning sample, benzyl alcohol was detected just greater than the SQO and its equivalent early warning threshold concentration; however, it was either not detected or was less than its SQO in other monitoring years. Benzoic acid exceeded its SQO and its equivalent early warning threshold concentration in the Year 10 early warning sample, the first time it has exceeded in an early warning sample at this station. It was detected at approximately 1.5 times the SQO in the Year 10 early warning sample. In the Year 4 early warning sample benzoic acid was detected just less than the SQO, but it was only detected at approximately 0.6 times the SQO in the Year 7 early warning sample.

3.7.2 Comparison of Year 2, Year 4, Year 7, and Year 10 Early Warning Samples from Natural Recovery Areas

This section compares the results of the Year 2, Year 4, Year 7, and Year 10 early warning monitoring samples collected in the natural recovery and enhanced natural recovery areas as required by the OMMP. Refer to Tables 25 through 32 and Tables 34 through 38 in the Sediment PFM, which present comparisons of the results of the Year 2, Year 4, Year 7, and Year 10 early warning samples in these areas. Figures E1 through E7 and Figure E10 in Attachment E of the Sediment PFM (included as Attachment B-1) show the concentration trend plots for the early warning samples in the natural recovery areas, along with providing information on which analyte concentrations exceeded the SQOs and/or the early warning threshold concentrations.

All of the natural recovery area stations had chemical concentrations that exceeded the SQOs in either one or more of the early warning samples from Year 2, Year 4, Year 7, and Year 10. SQO exceedances in the early warning samples from the natural recovery area stations are discussed below generally in the order of moving from stations north to south along the waterway. For additional discussion on the other analytes in these early warning samples that do not exceed the SQOs, but that had notable changes in concentrations when comparing the Year 2, Year 4, Year 7, and Year 10 early warning samples at each station refer to the Sediment PFM.

At Station 6, benzoic acid concentrations have increased over time in the early warning samples with exceedances of the SQO in Year 4, Year 7, and Year 10. It was detected at approximately 1.1, 1.3, and 2.3 times the SQO, and equivalent early warning threshold concentration, in the Year 4, Year 7, and Year 10 early warning samples, respectively. It was not detected in the Year 2 early warning sample. Hexachlorobutadiene at Station 6 exceeded the SQO, and the equivalent early warning threshold concentration, in only the Year 4 early warning sample, at approximately 2.6 times the SQO, but was not detected in the Year 2, Year 7, and Year 10 early warning samples. In the Year 10 early warning sample, p,p-DDE exceeded the SQO, and the equivalent early warning threshold concentration, detected at approximately 1.2 times the SQO. This analyte was not detected in the Year 2, Year 4, and Year 7 early warning samples.

The Year 10 early warning sample from Station 7 had SQO exceedances for benzoic acid, DEHP, and fluoranthene. DEHP was detected at approximately 1.1 times the SQO in both the Year 4 and Year 10 early warning samples. The DEHP concentration decreased slightly in the Year 7 early warning sample to approximately 0.9 times the SQO. Benzoic acid was detected at approximately 1.2, 1.1, and 4.0 times the SQO in the Year 4, Year 7, and Year 10 early warning samples, respectively. Benzoic acid was not detected at Station 7 in the Year 2 early warning sample. Fluoranthene was detected at a concentration exceeding the SQO, at

approximately 1.2 times the SQO, in the Year 10 early warning sample; whereas, it had not exceeded the SQO in previous early warning samples collected from this station, which had enrichment ratios ranging from approximately 0.3 to 0.4 times the SQO. Several other HPAHs, were detected in the Year 10 early warning sample from Station 7 at just less than their SQOs. The concentrations for these HPAHs in the Year 10 early warning sample are greater than concentrations of these analytes detected in previous early warning samples collected from this station.

At Station 8, the Year 4 and Year 7 early warning samples had DEHP concentrations that exceeded the SQOs, both with SQO enrichment ratios of approximately 1.2 times the SQO, while the concentration of DEHP in the Year 2 and Year 10 early warning samples were approximately 0.7 and 0.8 times the SQO, respectively. Dibenzo(a,h)anthracene also exceeded the SQO in the Year 7 early warning sample, detected just greater than the SQO, whereas in other monitoring events it was either not detected (Year 4) or was detected much less than the SQO (Year 2 and Year 10) in the early warning samples. The only SQO exceedance in the Year 10 early warning sample was for benzoic acid, which was detected at approximately 1.9 times the SQO. Benzoic acid was not detected in the Year 2 early warning sample, and in the Year 4 and Year 7 early warning samples benzoic acid had SQO enrichment factors of approximately 0.9 and 0.7, respectively.

At Station 9, the Year 2, Year 4, and Year 7 early warning samples did not have any detected exceedances of SQOs. In Year 10, however, the Station 9 early warning sample had an exceedance of benzoic acid, with a concentration approximately 3.5 times the SQO and equivalent early warning threshold concentration. Similarly, benzoic acid has been the only analyte to exceed its SQO in the early warning samples from Station 10, with an exceedance ratio of approximately 1.1 times the SQO in the Year 10 sample and a detection just greater than the SQO in the Year 4 sample.

Station 11 showed DEHP concentrations in the early warning samples peaking in Year 4 and then decreasing slightly in the Year 7 and Year 10 early warning samples. DEHP in the Year 4 early warning sample was detected at approximately 1.9 times the SQO, but was detected at approximately 1.7 and 1.6 times the SQO in Year 7 and Year 10 early warning samples, respectively. DEHP was detected just greater than the SQO in the Year 2 early warning sample at 1.1 times the SQO. DEHP did not exceed its early warning threshold concentration in any year. Benzoic was detected at its greatest concentration in the Year 10 early warning sample, with an SQO enrichment ratio of approximately 3.4. Benzoic acid in the Year 4 and Year 7 early warning samples also exceeded the SQO, detected at approximately 1.4 and 1.2 times the SQO, respectively. Like DEHP, phenanthrene also had its greatest concentration in the Year 4 early warning sample, detected at approximately 1.3 times the SQO, but then decreased in concentration in both the Year 7 and Year 10 early warning samples to approximately 0.4 and 0.3 times the SQO, respectively.

At Station 12, the DEHP concentrations generally remained the same between Year 2 and Year 4 in the early warning samples, detected at approximately 1.2 times the SQO. In both Year 7 and Year 10, DEHP was detected at approximately 1.1 times the SQO. In the Year 10 early warning sample, two additional analytes were detected at concentrations exceeding their SQOs, benzoic acid and fluoranthene. Benzoic acid was detected at a concentration approximately 1.5 times the SQO in the Year 10 early warning sample. Previous detections of benzoic acid in the early warning samples were lower, with benzoic acid detected at a concentration much less than the SQO in Year 2 and detected just less than the SQO in Year 4. Benzoic acid was not

detected in the Year 7 early warning sample. Fluoranthene was detected at a concentration approximately 1.1 times the SQO in the Year 10 early warning sample. Prior to Year 10, the greatest detection for fluoranthene in the early warning samples was approximately 0.6 times the SQO, detected in the Year 4 early warning sample.

The Year 4 and Year 10 early warning samples from Station 13 both had SQO exceedances for DEHP, benzoic acid, and indeno(1,2,3-cd)pyrene. There were no SQO exceedances in the Year 2 early warning sample and the Year 7 early warning sample only had an SQO exceedance for pyrene. DEHP was detected at approximately 1.1 and 1.2 times the SQO in the Year 4 and Year 10 early warning samples, respectively. DEHP was lower in the Year 7 early warning sample, detected at approximately 0.7 times the SQO. Benzoic acid shows a similar pattern to DEHP in the early warning samples from Station 13. It was detected at approximately 1.1 times the SQO in the Year 4 and Year 10 early warning samples, but only at 0.6 times the SQO in the Year 7 early warning sample. At Station 13, the HPAH exceedances (for indeno(1,2,3-cd)pyrene (Year 4 and Year 10) and pyrene (Year 7)) in the early warning samples were detected just greater than the SQO, at or less than approximately 1.1 times the SQO. While concentrations of benzo(g,h,i)perylene and dibenzo(a,h)anthracene did not exceed their SQO, these HPAHs were detected just less than their SQO in early warning samples from Station 13 (benzo(g,h,i)perylene in the Year 4 and Year 10 samples and dibenzo(a,h)anthracene in the Year 7 sample). The Year 10 early warning sample concentrations for most analytes were very similar to the Year 4 early warning sample concentrations.

At Station 16, detections of DEHP and benzoic acid in the Year 10 early warning sample exceed the SQOs, while the Year 4 early warning sample only had an SQO exceedance for benzyl alcohol. The early warning samples from Year 2 and Year 7 had no SQO exceedances. DEHP was detected at approximately 1.1 times the SQO in the Year 10 early warning sample, just greater than the detections in the Year 2 and Year 7 early warning samples that were both approximately 0.9 times the SQO. DEHP was detected at approximately 0.4 times the SQO in the Year 7 early warning sample. Benzoic acid was detected at approximately 2.2 times the SQO in the Year 10 early warning sample. It had previously only been detected in the Year 4 early warning sample, at a concentration approximately 0.6 times the SQO. Benzyl alcohol exceeded the SQO in the Year 4 early warning sample at approximately 1.4 times the SQO, but was only detected at approximately 0.2 times the SQO in the Year 7 and Year 10 early warning samples.

At Station 17, there were no SQO exceedances in the Year 2 and Year 7 early warning samples, while the Year 4 early warning sample had exceedances for 2-methylnaphthalene, phenanthrene, pyrene, and benzoic acid and the Year 10 early warning sample had exceedances for anthracene, phenanthrene, total LPAHs, pyrene, and benzoic acid. The greatest SQO enrichment ratio for PAHs in the Year 4 early warning sample was approximately 1.6 times the SQO (for pyrene), while the greatest SQO enrichment ratio for PAHs in the Year 10 early warning sample was approximately 1.7 times the SQO (also for pyrene). The SQO enrichment ratios for pyrene in the Year 2 and Year 7 early warning samples were much lower, detected at 0.6 and 0.7 times the SQO, respectively. In general, the PAH concentrations in the Year 10 early warning sample tended to be slightly higher in comparison to the PAH concentrations detected in the previous early warning samples collected from this station. Benzoic acid was detected at approximately 1.1 times the SQO in the Year 4 early warning sample, but was not detected in the Year 2 or Year 7 early warning samples. In Year 10,

benzoic acid once again exceeded the SQO, but with a higher detection of approximately 2.9 times the SQO.

Most of the PAHs at Station 19 exceeded or were at their SQOs in the Year 2 early warning sample. The greatest SQO exceedance in the Year 2 early warning sample was for phenanthrene at approximately 4.5 times the SQO. In contrast, in the Year 4 early warning sample, all PAHs with the exception of phenanthrene (detected at approximately 1.1 times its SQO) were less than the SQOs. PAH concentrations at Station 19 declined even further in the Year 7 early warning sample, with PAH concentrations at or less than approximately 0.5 times the SQO. In the Year 10 early warning sample, all detected PAH concentrations increased compared to Year 7 but did not exceed the SQOs, with SQO enrichment ratios at or less than approximately 0.8. Additionally, in the Year 2 early warning sample from Station 19, n-nitrosodiphenylamine was detected at approximately 2.7 times the SQO; however, this chemical was either not detected or was detected well below the SQO in other early warning samples collected from this station. Benzoic acid was detected greater than the SQO in the Year 7 and Year 10 early warning samples, at approximately 1.4 and 1.03 times the SQO, respectively. However, in the Year 2 early warning sample it was not detected and in the Year 4 early warning sample it was detected well less than the SQO.

Station 20 had DEHP concentrations in the Year 2, Year 4, Year 7, and Year 10 early warning samples that exceeded the SQO and these concentrations increased over time through Year 7, and then decreased in Year 10. The DEHP exceedance ratios were approximately 1.5, 1.7, 3.8, and 1.7 times the SQO in the Year 2, Year 4, Year 7, and Year 10 samples, respectively. The Year 7 DEHP concentration exceeded the early warning threshold concentration, while the other years did not. Benzoic acid only exceeded the SQO in the Year 10 early warning sample, detected at approximately 2.6 times the SQO. In contrast, the prior early warning samples at this station had benzoic acid detected at or less than approximately 0.4 times the SQO or not detected. N-nitrosodiphenylamine exceeded the SQO in the Year 7 early warning sample, detected just greater than the SQO, whereas in other monitoring events it was either not detected (Year 4 and Year 10 samples) or was detected much less than the SQO (Year 2) in the early warning samples.

At Station 25, DEHP was the only analyte that exceeded the SQO in all four of the early warning monitoring samples (Year 2 through Year 10). DEHP concentrations in the early warning samples were similar in Year 2 and Year 4, detected at approximately 1.6 times the SQO; however, DEHP increased in concentration in the Year 7 early warning sample to approximately 2.5 times the SQO and was detected at the early warning threshold concentration. DEHP then decreased in the Year 10 early warning sample to a concentration similar to Year 2 and Year 4 early warning samples, at approximately 1.5 times the SQO. Station 25 also had butyl benzyl phthalate exceed its SQO and its equivalent early warning threshold concentration in the Year 2, Year 4, and Year 7 early warning samples, with detections at approximately 1.1, 1.6, and 1.1 times the SQO, respectively. The butyl benzyl phthalate concentration then decreased to less than the SQO in the Year 10 early warning sample, with an enrichment ratio of approximately 0.7. Benzyl alcohol was detected in the early warning samples from Station 25 greater than the SQO in Year 2 and Year 7, with exceedances of approximately 2.9 and 1.01, respectively. However, this analyte was not detected in the Year 10 early warning sample. Similar to many of the other natural recovery stations, the Year 10 early warning sample from Station 25 had benzoic acid detected greater than the SQO, whereas in previous early warning samples it did not exceed. Benzoic acid was not detected in the Year 2 sample, was detected at concentrations approximately 0.8 and 0.6 times the SQO in the Year 4 and Year 7 samples,

respectively, and was detected at approximately 6.3 times the SQO in the Year 10 sample. Various PAHs have been detected over time at concentrations greater than their SQOs in the Station 25 early warning samples. The early warning sample from Year 2 had seven PAHs with concentrations greater than the SQOs, with the greatest SQO enrichment ratio of approximately 1.8 for pyrene. The Year 4 early warning sample had pyrene as the only PAH detected greater than the SQO, with an SQO enrichment ratio of approximately 1.1, while the Year 4 early warning field duplicate had three PAHs and total HPAHs with SQO exceedances, with the greatest SQO enrichment ratio of approximately 1.8 for pyrene. In the Year 7 early warning sample, the PAH concentrations decreased in comparison to the Year 2 early warning sample and the Year 4 field duplicate early warning sample and were comparable to the Year 4 parent early warning sample. Only pyrene exceeded the SQO in the Year 7 early warning sample, detected at approximately 1.2 times the SQO. In the Year 10 early warning sample, the PAH results varied more and did not show any obvious trends compared with the early warning samples from the prior monitoring events. Only fluoranthene exceeded the SQO in the Year 10 early warning sample, detected at approximately 1.3 times the SQO.

3.7.3 Comparisons of Year 2, Year 4, Year 7, and Year 10 Early Warning Samples from Dredge to Clean Areas

This section compares the results of the Year 2, Year 4, Year 7, and Year 10 early warning monitoring samples collected in the dredge to clean areas as required by the OMMP. Refer to Tables 42 through 46 in the Sediment PFM, which present comparisons of the results of the Year 2, Year 4, Year 7, and Year 10 early warning samples in these dredge to clean areas. Figures E4, E5, E8 and E11 in Attachment E of the Sediment PFM (included as Attachment B-1) show the concentration trend plots for the early warning samples in the dredge to clean areas, along with providing information on which analyte concentrations exceeded the SQOs and/or the early warning threshold concentrations.

SQO exceedances in early warning samples from the five dredge to clean area stations are discussed below in the order of moving from stations north to south along the waterway. For additional discussion on the other analytes in these early warning samples that do not exceed the SQOs, but that had notable changes in concentrations when comparing the Year 2, Year 4, Year 7, and Year 10 early warning samples at each station refer to the Sediment PFM.

In the Year 4 and Year 10 early warning samples from Station 15, the detected benzoic acid concentrations were greater than the SQO and its equivalent early warning threshold concentration, with SQO enrichment ratios of approximately 1.0 and 1.5 times the SQO. In contrast, benzoic acid was not detected in the Year 2 and Year 7 early warning samples.

At Station 21, the Year 10 early warning sample had exceedances of benzyl alcohol and benzoic acid, with concentrations at approximately 3.4 and 2.3 times the SQOs and equivalent early warning threshold concentrations, respectively. Previous detections of these two analytes in the early warning samples from Station 21 were at or less than approximately 0.8 times their SQOs. The Year 2, Year 4, and Year 7 early warning samples from Station 21 did not have any detected exceedances of SQOs.

Station 22 had shown an increase in DEHP concentrations over time in the early warning samples, with Year 2, Year 4, and Year 7 SQO enrichment ratios of approximately 1.0, 1.5 and 1.7 times the SQO, respectively. However, in Year 10, the DEHP concentration decreased somewhat in the early warning sample to a concentration approximately 1.4 times the SQO.

Benzoic acid concentrations in the early warning samples have been increasing over time during the past four monitoring events at Station 22, and exceeded the SQO and equivalent early warning threshold concentration in the Year 7 and Year 10 early warning samples. Benzoic acid was detected just greater than the SQO in the Year 7 early warning sample and at approximately 1.4 times the SQO in the Year 10 early warning sample, but was not detected in the Year 2 early warning sample and was only detected at 0.6 times the SQO in the Year 4 early warning sample. Additionally, benzyl alcohol was detected at a higher concentration in the Year 7 early warning sample relative to the Year 2 and Year 4 early warning samples. Benzyl alcohol was detected at approximately 11.1 times the SQO in the Year 7 early warning sample, and at concentrations much less than the SQO in the Year 2 and Year 4 early warning samples. Benzyl alcohol was not detected in the Year 10 early warning sample.

At Station 24 there were no SQO exceedances in the Year 2, Year 4, and Year 7 early warning samples, while in the Year 10 early warning sample 2,4-dimethylphenol and benzoic acid exceeded their SQOs, with concentrations at approximately 1.7 and 2.2 times their SQOs and equivalent early warning threshold concentrations, respectively. In comparison, 2,4-dimethylphenol at Station 24 was detected at approximately 0.9 times the SQO in both Year 2 and Year 7 and at approximately 0.5 times the SQO in Year 4, while benzoic acid was not detected in Year 2 or Year 7, and was detected at approximately 0.5 times the SQO in Year 4.

In the Year 2 early warning sample from Station 28, six SVOCs exceeded the SQOs (including DEHP, 2,4-dimethylphenol, benzyl alcohol, hexachlorobenzene, hexachlorobutadiene, and n-nitrosodiphenylamine), with SQO enrichment ratios ranging up to approximately 2.2 times the SQOs. However, no analytes exceeded the SQOs in the Year 4, Year 7, and Year 10 early warning samples from Station 28 and most detections for these analytes after Year 2 were well below their SQOs. DEHP was detected at the SQO in the Year 7 early warning sample from this station, but was lower in the Year 10 early warning sample with a detection of approximately 0.6 times the SQO.

3.8 Summary of Early Warning Monitoring OMMP Findings

A summary of the findings from the Year 10 early warning monitoring is included below, along with a comparison to the Year 2, Year 4, and Year 7 early warning monitoring results. 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 and in the Year 10 Findings portions of Sections 2.2.2.2 and 2.3.

As discussed above in Section 3.4 and in Section 2.2.2 Concentration Trends Related to Laboratory Analytical Changes, some of the variability in the benzoic acid, PCB, silver and nickel concentrations between the past four monitoring events can be attributed to analytical method changes. These analytical changes affecting concentration trends were first noted for PCBs in Year 7 and for silver and nickel in Year 4. However, the concentrations of PCBs, silver, and nickel were generally comparable between the Year 7 and Year 10 early warning samples and were all detected less than their SQOs. In Year 10, it was noted that benzoic acid concentrations generally increased relative to concentrations detected in previous monitoring events and resulted in many SQO exceedances for benzoic acid in the Year 10 early warning samples. The greater benzoic acid concentrations in the Year 10 samples relative to the sample concentrations from previous monitoring events are a result of improvements made to the laboratory extraction and analysis of benzoic acid in Year 10.

Dredge to Clean Areas

The following provides a summary of the findings for Year 10 early warning samples in the dredge to clean areas and a comparison of these early warning samples to previous early warning samples:

- Early warning samples are the only sediment samples collected in dredge to clean areas (Stations 15, 21, 22, 24 and 28). Four of the five early warning stations in the dredge to clean areas had SQO exceedances in the Year 10 early warning samples. Analytes that exceeded the SQOs in these Year 10 early warning sample locations include benzoic acid (in four samples), benzyl alcohol, DEHP, and 2-4-dimethyphenol (each in one sample).
- No detected concentrations exceeded the SQOs in the Year 4, Year 7 or Year 10 early warning samples from Station 28, located at the southern end of RA 16. In contrast, the Year 2 early warning sample from this station had six SVOCs at concentrations greater than the SQOs.
- The Year 10 early warning sample collected from Station 15, located in RA 5, had only benzoic acid detected greater than the SQO, at approximately 1.5 times the SQO. Benzoic acid also exceeded the SQO in the Year 4 sample from this station, detected just greater than the SQO, but was not detected in the Year 2 and Year 7 early warning samples at Station 15.
- At Stations 21 and 24, both located in RA 6, the Year 2, Year 4, and Year 7 early warning samples did not have any SQO exceedances. However, the Year 10 early warning sample from Station 21 had exceedances of benzyl alcohol and benzoic acid, with concentrations at approximately 3.4 and 2.3 times the SQOs, respectively. The Year 10 early warning sample from Station 24 had SQO exceedances of 2,4-dimethylphenol and benzoic acid, with concentrations at approximately 1.7 and 2.2 times the SQOs, respectively.
- Station 22 is the third station located in the dredge to clean area in RA 6. At this station, the Year 10 sample had two SQO exceedances, for DEHP and benzoic acid, with both detected at approximately 1.4 times the SQOs. The DEHP concentration is below the early warning threshold concentration. Previous early warning samples collected from Station 22 in Year 4 and Year 7 had comparable SQO exceedances for DEHP. Benzoic acid also exceeded the SQO in the Year 7 sample from Station 22, detected just greater than the SQO, but was detected much less than the SQO in the Year 4 sample. The Year 7 early warning sample also had benzyl alcohol detected at a concentration much greater than its SQO; however, benzyl alcohol was not detected in the Year 10 sample.

Channel Sand Cap Areas

The following provides a summary of the findings for Year 10 early warning samples in the channel sand cap areas and a comparison of these early warning samples to co-located Year 10 channel sand cap performance samples and to previous early warning samples:

- One out of the nine Year 10 early warning samples collected from channel sand cap stations (Stations 1, 23, 26, 27, 29, 30, 31, 32, and 33) had no SQO exceedances (sample EW-26-Y10). Three of the nine Year 10 samples had only one SQO exceedance in Year 10, either for DEHP or benzoic acid, while three of the nine samples

had SQO exceedances of both DEHP and benzoic acid. The two remaining Year 10 early warning samples had multiple SQO exceedances.

- Detected chemical concentrations in Year 10 early warning sample EW-26-Y10 were all less than the SQOs. The Year 10 channel sand cap performance sample (0 to 10 cm), sample CC-26-Y10, co-located with this early warning sample also had all detected concentrations less than the SQOs. The Year 2, Year 4, and Year 10 early warning samples from Station 26 also had no SQO exceedances.
- Early warning sample EW-27-Y10 had only DEHP detected greater than the SQO, detected at approximately 1.3 times the SQO; however, this concentration did not exceed DEHP early warning threshold concentration. The corresponding Year 10 channel sand cap sample CC-27-Y10 had detections of DEHP, benzoic acid, benzo(g,h,i)perylene, and indeno(1,2,3-cd)pyrene greater than the SQOs. DEHP was detected slightly higher in sample CC-27-Y10 compared with sample EW-27-Y10, at approximately 1.5 times the SQO. Benzoic acid was detected at approximately 1.9 times the SQO in sample CC-27-Y10, but was not detected in sample EW-27-Y10. Benzo(g,h,i)perylene and indeno(1,2,3-cd)pyrene just exceeded the SQOs in sample CC-27-Y10, slightly greater than the concentrations detected in sample EW-27-Y10, which were detected just less than the SQOs. The Year 7 early warning samples collected from Station 27 also only had DEHP exceed the SQO, detected at approximately 1.3 times the SQO. In the Year 2 and Year 4 early warning samples, DEHP was detected just less than the SQO.
- Early warning samples EW-01-Y10 and EW-29-Y10 had only benzoic acid exceed the SQO (and its equivalent early warning threshold concentration), while the remaining detected analyte concentrations in these samples were generally at or less than one-half the SQOs. Benzoic acid was also the only analyte to exceed its SQO in the corresponding channel sand cap samples from these two stations, samples CC-01-Y10 and CC-29-Y10. At Station 1, benzoic acid was detected at approximately 1.5 and 1.3 times the SQO in samples CC-01-Y10 and EW-01-Y10, respectively. At Station 29, was detected at approximately 1.5 and 2.3 times the SQO in samples CC-29-Y10 and EW-29-Y10, respectively. Previous early warning samples collected from Station 1 have had no SQO exceedances; however, benzoic acid was detected just less than the SQO in the Year 4 early warning station. At Station 29, only DEHP exceeded its SQO in previous early warning samples, with exceedances of approximately 1.2 and 1.5 times the SQO in the Year 4 and Year 7 early warning samples, respectively.
- DEHP and benzoic acid were the only analytes to exceed the SQOs in three of the Year 10 early warning samples collected from the channel sand cap monitoring stations, including samples EW-23-Y10, EW-30-Y10, and EW-31-Y10. Sample EW-23-Y10 was collected from the channel sand cap area in RA 6, adjacent to Outfall 230, where the City continues to monitor stormwater sediment and stormwater and perform source control activities. In sample EW-23-Y10, DEHP was detected at approximately 2.7 times the SQO and just greater than its early warning threshold concentration and benzoic acid was detected at approximately 2.9 times the SQO and its equivalent early warning threshold concentration. The corresponding Year 10 channel sand cap sample CC-23-Y10 also had SQO exceedances for DEHP and benzoic acid, and had SQO exceedances for benzo(g,h,i)perylene and indeno(1,2,3-cd)pyrene as well. Concentrations of DEHP and benzoic acid were higher in the early warning sample EW-23-Y10 in comparison to the channel sand cap sample CC-23-Y10, which had detections of DEHP and benzoic acid at approximately 1.6 and 1.2 times the SQO,

respectively. In contrast, detections of benzo(g,h,i)perylene and indeno(1,2,3-cd)pyrene in sample CC-23-Y10 were slightly higher than in sample EW-23-Y10. DEHP concentrations in the Year 2, Year 4, and Year 7 early warning samples from Station 23 also exceeded the SQO with enrichment ratios of approximately 2.3, 12.3 (18.5 in the Year 4 field duplicate), and 3.0 times the SQO, respectively. Benzoic acid also exceeded its SQO in the Year 7 early warning sample from Station 23, detected at approximately 1.3 times the SQO. Prior early warning samples from Station 23 have also had other SQO exceedances, including exceedances for phenanthrene (in the Year 4 and Year 7 samples), multiple HPAHs (in the Year 2, Year 4, and Year 7 samples), butyl benzyl phthalate (in the Year 4 sample), and benzyl alcohol (in the Year 2 and Year 4 samples). The SQO exceedances for these analytes were all less than 2.0 times the SQOs.

The DEHP and benzoic acid exceedances in early warning sample EW-30-Y10 were detected at approximately 1.2 and 1.1 times the SQOs, respectively. The only SQO exceedance in the corresponding channel sand cap sample CC-30-Y10 was for benzoic acid, detected at approximately 1.3 times the SQO. Station 30 showed a slight increase in the DEHP concentration in the Year 10 early warning sample in comparison to the DEHP concentrations detected in the Year 2, Year 4, and Year 7 early warning samples. DEHP was detected at the SQO in the Year 7 early warning sample. Benzoic acid was not detected or was detected well below the SQO in previous early warning samples from Station 30. There were no SQO exceedances in the previous Station 30 early warning samples.

At Station 31, both the early warning sample EW-31-Y10 and the channel sand cap sample CC-31-Y10 had DEHP and benzoic acid SQO exceedances. DEHP was detected at approximately 1.8 and 2.4 times the SQO in samples CC-31-Y10 and EW-31-Y10, respectively; while benzoic acid was detected at approximately 1.7 and 1.2 times the SQO in samples CC-31-Y10 and EW-31-Y10, respectively. DEHP also exceeded its SQO in the Year 2 and Year 7 early warning samples from Station 31, with SQO enrichment ratios of approximately 2.3 and 4.6, respectively. The early warning DEHP concentration in Year 7 was also greater than the DEHP early warning threshold concentration, while the Year 2 and Year 10 concentrations were just less. Benzoic acid did not exceed the SQO in previous early warning samples collected from Station 31.

- Early warning sample EW-32-Y10, located at the south end of RA 19A and the Thea Foss Waterway, had detected concentrations of nine analytes exceeding the SQOs, including acenaphthene, anthracene, phenanthrene, total LPAHs, benzo(g,h,i)perylene, dibenz(a,h)anthracene, indeno(1,2,3-cd)pyrene, DEHP, and benzoic acid. An early warning field duplicate sample collected at this station in Year 10, sample EW-32-Y10-2, also had SQO exceedances for six of the analytes which exceeded in sample EW-32-Y10. Similar to sample EW-32-Y10, the corresponding Year 10 channel sand cap sample CC-32-Y10 also had concentrations for multiple constituents that were greater than the SQOs, including most of the PAHs, DEHP, and benzoic acid. The SVOC concentrations in sample EW-32-Y10 were all lower in comparison to the concentrations in sample CC-32-Y10. The greatest SQO enrichment ratio in the Station 32 early warning samples was for DEHP at approximately 2.2 times the SQO, while the highest SQO exceedance in sample CC-32-Y10 was for phenanthrene, detected at approximately 3.0 times the SQO. The concentrations of benzo(g,h,i)perylene, dibenzo(a,h)anthracene, indeno(1,2,3-cd)pyrene, and benzoic acid in sample EW-32-Y10 exceeded their early warning threshold concentrations. At Station 32, multiple

PAHs were also detected greater than the SQOs in the Year 2, Year 4, and Year 7 early warning samples. The Year 4 and Year 7 early warning concentrations for the PAHs generally are greater relative to the Year 2 and Year 10 early warning sample concentrations. The SQO exceedances for PAHs in the Year 7 early warning sample from Station 32 were detected up to approximately 2.2 times the SQOs, while in the Year 10 early warning sample they were detected up to approximately 1.8 times the SQO. DEHP concentrations exceeded both the SQO and early warning threshold concentration in the Year 2, Year 4, and Year 7 early warning samples from Station 32, but only exceeded the SQO, and not the early warning threshold concentration, in the Year 10 early warning sample. The highest DEHP detection was in the Year 4 early warning sample. Similar to the Year 10 early warning sample, the Year 4 early warning sample also had benzoic acid exceed its SQO. Additionally, n-nitrosodiphenylamine was detected greater than the SQO in the Year 7 early warning sample from Station 32.

The elevated PAH concentrations in the channel sand cap area at Station 32 appear to be relatively localized as the compliance monitoring surface samples and early warning samples collected in the adjacent cap areas to the north and west (samples CC-29-Y10/EW-29-Y10, CC-30-Y10/EW-30-Y10, and CC-31-Y10/EW-31-Y10) did not have similar concentrations or SQO exceedances; yet, these three stations also had SQO exceedances for DEHP and benzoic acid. Station 33, located at the southern end of the Thea Foss Waterway in RA 22, the closest station to Station 32 to the south, also had detections of a few PAHs, DEHP, and benzoic acid exceed their SQOs in the Year 10 samples, as well as exceedances for several PAHs and DEHP in prior samples collected from Station 33. This southern end of the Thea Foss Waterway is a depositional area within the Thea Foss Waterway. Source control for PAHs is an ongoing effort, in the municipal storm drainage system (refer to Section 7.3) as well as in marinas. DEHP exceedances are the subject of ongoing study and control where possible, as discussed in previous reports.

- At Station 33, the Year 10 early warning sample EW-33-Y10 had five analytes exceed their SQOs, including benzo(g,h,i)perylene, dibenzo(a,h)anthracene, indeno(1,2,3-cd)pyrene, DEHP, and benzoic acid. The greatest SQO enrichment ratio in sample EW-33-Y10 was for DEHP, detected at approximately 3.4 times the SQO. With the exception of dibenz(a,h)anthracene, the other four analytes exceeded their corresponding early warning threshold concentrations and were also detected greater than their SQOs in the corresponding Year 10 channel sand cap sample CC-33-Y10. SQO exceedances were higher in sample EW-33-Y10 in comparison to sample CC-33-Y10. The Year 4, Year 7, and Year 10 early warning concentrations for the PAHs at Station 33 were all relatively similar. DEHP exceeded the SQO in the Year 2, Year 4, Year 7, and Year 10 early warning samples from Station 33. The Year 4 and Year 7 DEHP concentrations were over two times the DEHP early warning threshold concentration, while the DEHP concentration in Year 10 was at approximately 1.4 times the early warning threshold concentration. Benzoic acid exceeded its SQO and its equivalent early warning threshold concentration only in the Year 10 early warning sample. In the Year 7 early warning sample, benzyl alcohol was detected just greater than the SQO. Similar to Station 32, Station 33 is located within a depositional area at the southern end of the Thea Foss Waterway. As indicated above, DEHP is the subject of ongoing study. Source control for PAHs is also an ongoing effort and the current status of the stormwater source control program is summarized in Section 7.3.

Natural Recovery Areas

The following provides a summary of the findings for Year 10 early warning samples in the natural recovery and enhanced natural recovery areas and a comparison of these early warning samples to the Year 10 co-located natural recovery and enhanced natural recovery performance samples and to previous early warning samples:

- All 13 Year 10 early warning samples collected from natural recovery stations (Stations 6, 7, 8, 9, 10, 11, 12, 13, 16, 17, 19, 20, and 25) had SQO exceedances. The most frequent exceedances in these early warning samples were for benzoic acid and DEHP, with benzoic acid exceeding its SQO in all of these early warning samples and DEHP SQO exceeding its SQO in seven of these 13 early warning samples.
- Year 10 early warning samples from natural recovery Stations 6 through 11 were collected north of the MMB. Three of these early warning samples, samples EW-08-Y10, EW-09-Y10, and EW-10-Y10, had only SQO and early warning threshold exceedances for benzoic acid. Sample EW-08-Y10 had benzoic acid detected at approximately 1.9 times its SQO. Benzoic acid also exceeded the SQO in the corresponding Year 10 natural recovery sample, sample NR-08-Y10, but it was detected at a slightly lower concentration compared with sample EW-08-Y10. Sample NR-08-Y10 also had indeno(1,2,3-cd)pyrene detected just greater than the SQO, while sample EW-08-Y10 had this analyte detected just less than the SQO. The Year 4 and Year 7 early warning samples from Station 8 had DEHP concentrations just greater than the SQO, while the Year 10 early warning sample had DEHP detected at approximately 0.8 times the SQO. Dibenzo(a,h)anthracene also exceeded the SQO in the Year 7 early warning sample, detected just greater than the SQO, whereas in other monitoring events it was either not detected or was detected much less than the SQO in the early warning samples. Past early warning samples from Station 8 did not have benzoic acid SQO exceedances, unlike the Year 10 early warning sample.

  Early warning sample EW-09-Y10 had benzoic acid detected at approximately 3.5 times its SQO. The corresponding natural recovery sample NR-09-Y10 also only had benzoic acid detected greater than the SQO, but with a lower concentration, detected at approximately 1.2 times the SQO. Previous early warning samples collected from Station 9 had no SQO exceedances.

  Benzoic acid in early warning sample EW-10-Y10 was detected just greater than its SQO, at approximately 1.1 times the SQO, while in natural recovery sample NR-10-Y10 benzoic acid was detected just less than the SQO. Sample NR-10-Y10 had only butyl benzyl phthalate exceed the SQO, detected just greater than the SQO, while it was detected well less than its SQO in sample EW-10-Y10. The only SQO exceedance in previous early warning samples collected from Station 10 was for benzoic acid in the Year 4 sample, detected just greater than the SQO.
- The other three Year 10 early warning samples from natural recovery stations located north of the MMB had two or more SQO exceedances, including samples EW-06-Y10, EW-07-Y10, and EW-11-Y10. Early warning sample EW-06-Y10 had benzoic acid and p,p'-DDE detected greater than the SQOs and their early warning thresholds, which are equivalent for both of these analytes, with enrichment ratios of 2.3 and 1.2, respectively. Benzoic acid also exceeded its SQO in the corresponding natural recovery sample NR-06-Y10, but was detected at a lower concentration, at approximately 1.2 times the SQO. Sample NR-06-Y10 did not have a detection for p,p'-DDE. Benzoic acid concentrations

also exceeded the SQO in the Year 4 and Year 7 early warning samples from Station 6, but at lower concentrations than compared with the Year 10 early warning sample. Hexachlorobutadiene also exceeded the SQO, and its equivalent early warning threshold concentration, in the Year 4 early warning sample from Station 6, at approximately 2.6 times the SQO, but was not detected in other early warning samples from this station.

At Station 7, the Year 10 early warning sample EW-07-Y10 had detections of fluoranthene, DEHP, and benzoic acid greater than their SQOs. Fluoranthene and DEHP were detected just slightly greater than their SQOs, while benzoic acid was detected at approximately 4.0 times the SQO in this sample. In the corresponding natural recovery sample NR-07-Y10, benzoic acid was detected at 3.1 times the SQO and DEHP was detected just slightly greater than its SQO, while fluoranthene was detected at only approximately 0.6 times the SQO. DEHP was also detected just slightly greater than its SQO in the Year 4 early warning sample from Station 7, but was detected just slightly less than the SQO in the Year 7 early warning sample. Benzoic acid also exceeded its SQO in the Year 4 and Year 7 early warning samples from this station, with detections at approximately 1.2 and 1.1 times the SQO, respectively. Fluoranthene only exceeded the SQO in the Year 10 early warning sample. Additionally, several other HPAHs, were detected in the Year 10 early warning sample from Station 7 at concentrations just less than their SQOs.

Early warning sample EW-11-Y10 had both DEHP and benzoic acid detected greater than their SQOs, at approximately 1.6 and 3.4 times the SQOs, respectively. The corresponding natural recovery sample NR-11-Y10 also had SQO exceedances for both DEHP and benzoic acid, with DEHP detected at the same concentration as in sample EW-11-Y10 and benzoic acid detected at a lower concentration in comparison to sample EW-11-Y10, detected at approximately 1.2 times the SQO. DEHP also exceeded the SQO in all of the previous early warning samples collected from Station 11. The highest DEHP detection was in the Year 4 early warning sample at approximately 1.9 times the SQO. DEHP has not exceeded its early warning threshold concentration in any year. Benzoic acid in the Year 4 and Year 7 early warning samples also exceeded the SQO, but was detected at lower concentrations at approximately 1.4 and 1.2 times the SQO, respectively. Phenanthrene also exceeded its SQO in the Station 11 Year 4 early warning sample.

- Year 10 early warning sample EW-12-Y10, collected on the west side of the natural recovery area located south of the MMB, had benzoic acid, DEHP, and fluoranthene concentrations exceed their SQOs. Benzoic acid was detected at a concentration approximately 1.5 times the SQO, DEHP was detected at approximately 1.1 times the SQO, and fluoranthene was detected at approximately 1.1 times the SQO in sample EW-12-Y10. The corresponding natural recovery sample NR-12-Y10 had only DEHP exceed its SQO, with a very similar concentration in comparison to the sample EW-12-Y10 concentration. Benzoic acid and fluoranthene were detected well less than the SQOs in sample NR-12-Y10. Previous early warning samples from Station 12 only had SQO exceedances for DEHP, with detections just greater than the SQO.
- Early warning sample EW-13-Y10 is another early warning sample collected in the natural recovery area located south of and adjacent to the MMB. This early warning sample had DEHP, benzoic acid, and indeno(1,2,3-cd)pyrene SQO exceedances and benzo(g,h,i)perylene detected just less than its SQO, while the corresponding natural recovery sample NR-13-Y10 had only indeno(1,2,3-cd)pyrene detected greater than its

SQO and benzo(g,h,i)perylene detected just less than its SQO. The SQO exceedances in samples EW-13-Y10 and NR-13-Y10 were all at or less than approximately 1.2 times the SQOs. Similar to the Year 10 early warning sample, the Year 4 early warning sample from Station 13 also had SQO exceedances for DEHP, benzoic acid, and indeno(1,2,3-cd)pyrene and had detections for these analytes at approximately the same concentrations as in the Year 10 early warning sample. There were no SQO exceedances in the Year 2 early warning sample and the Year 7 early warning sample only had an SQO exceedance for pyrene.

- Early warning sample EW-16-Y10 was collected within the enhanced natural recovery area located south of the MMB on the west side of the waterway in the Foss Harbor Marina. Both DEHP and benzoic acid exceeded their SQOs and had similar concentrations detected in early warning sample EW-16-Y10 and the corresponding natural recovery sample NR-16-Y10. DEHP and benzoic acid were detected at approximately 1.1 and 2.2 times the SQOs in sample EW-16-Y10, respectively. In the Year 4 early warning samples, only benzyl alcohol was detected above the SQO. There were no SQO exceedances in the Year 2 and Year 7 early warning samples from this station.

- In the Year 10 early warning sample EW-17-Y10, and its field duplicate (EW-17-Y10-2), seven detected concentrations were greater than their SQOs in one or both of the samples including anthracene, phenanthrene, total LPAHs, benzo(g,h,i)perylene (duplicate sample only), indeno(1,2,3-cd)pyrene (duplicate sample only), pyrene, and benzoic acid. Benzoic acid had the highest SQO exceedances in these samples at approximately 2.9 times its SQO. The only analyte to exceed its SQO in the corresponding Year 10 natural recovery sample was benzoic acid, detected at approximately 1.1 times the SQO. The Year 2 and Year 7 early warning samples from Station 17 both had no SQO exceedances, while the Year 4 early warning sample had exceedances for 2-methylnaphthalene, phenanthrene, pyrene, and benzoic acid.

- Station 19 is located near the head of the Wheeler-Osgood Waterway. The Year 10 early warning sample EW-19-Y10 had only benzoic acid detected greater than the SQO, while the Year 10 co-located natural recovery sample also had a benzoic acid exceedance, as well as exceedances for phenanthrene and a majority of the HPAHs. The SQO exceedances in these Year 10 samples were at or less than approximately 1.3 times the SQOs. In the Year 2 early warning sample from Station 19, most of the PAHs exceeded or were detected at their SQOs. However, in the Year 4 early warning sample only phenanthrene was detected above its SQO. The PAH concentrations at Station 19 declined even further in the Year 7 early warning sample, with PAH concentrations detected at or less than approximately 0.5 times the SQOs, before increasing in concentration again in the Year 10 early warning sample. Benzoic acid also exceeded the SQO in the Year 7 early warning sample from Station 19.

- Natural recovery Station 20 is located at the head of the Wheeler-Osgood Waterway. The Year 10 early warning sample EW-20-Y10 and the co-located natural recovery sample NR-20-Y10 both had SQO exceedances of DEHP and benzoic acid. Concentrations of DEHP and benzoic acid were higher in the early warning sample, with detected concentrations in sample EW-20-Y10 at approximately 1.7 and 2.6 times the SQOs, respectively. DEHP also exceeded its SQO in the Year 2, Year 4, and Year 7 early warning samples from Station 20. The Year 7 DEHP concentration was detected at approximately 3.8 times the SQO and exceeded the early warning threshold

concentration, while the Year 2 and Year 4 samples had DEHP concentrations at less than two times the SQO. Prior early warning samples collected at Station 20 did not have benzoic acid SQO exceedances, with benzoic acid detected much less than the SQO or not detected in these samples. N-nitrosodiphenylamine exceeded the SQO in the Year 7 early warning sample, detected just greater than the SQO, whereas it was much less than the SQO or was not detected in the other early warning samples from this station.

- Natural recovery Station 25, located in the natural recovery area north of RA 15 and east of RA 16, had fluoranthene, DEHP, and benzoic acid SQO exceedances in the Year 10 early warning sample EW-25-Y10. However, only benzoic acid exceeded the SQO in the corresponding natural recovery sample NR-25-Y10 from this station. Benzoic acid was detected at a greater concentration in sample EW-25-Y10 compared to the concentration in sample NR-25-Y10, with detections at approximately 6.3 and 2.0 times the SQO, respectively. The fluoranthene and DEHP concentrations in early warning sample EW-25-Y10 were approximately 1.3 and 1.5 times the SQOs, respectively, whereas the concentration of fluoranthene in sample NR-25-Y10 was approximately 0.7 times the SQO and DEHP was detected at the SQO in sample NR-25-Y10. Prior early warning samples collected from Station 25 all had DEHP exceedances as well. The concentrations of DEHP were similar between the Year 2, Year 4, and Year 10 early warning samples; however, the Year 7 early warning sample DEHP concentration was detected at a higher concentration, at approximately the early warning threshold concentration. Prior early warning samples also had butyl benzyl phthalate detected slightly above the SQO, whereas it was detected below the SQO in the Year 10 early warning sample. Benzoic acid only exceeded its SQO in the Year 10 early warning sample from Station 25, whereas benzyl alcohol exceeded its SQO in both the Year 2 and Year 7 early warning samples. Benzyl alcohol was detected just above the SQO in the Year 7 early warning sample and was not detected in the Year 10 early warning sample. Various PAHs have also been detected greater than their SQOs in the Station 25 early warning samples. The early warning sample from Year 2 had seven PAHs with concentrations greater than the SQOs. The Year 4 early warning sample had pyrene as the only PAH detected above the SQO, while the Year 4 early warning field duplicate had three PAHs and total HPAHs with SQO exceedances. In the Year 7 early warning sample, the PAH concentrations decreased in comparison to the Year 2 early warning sample and the Year 4 field duplicate early warning sample and were comparable to the Year 4 parent early warning sample. Only pyrene exceeded the SQO in the Year 7 early warning sample. In the Year 10 early warning sample, the PAH results varied more and did not show any obvious trends compared with the early warning samples from the prior monitoring events. As noted above only fluoranthene exceeded the SQO in the Year 10 early warning sample. The sample concentrations found at Station 25 may, in part, be the result of the heterogeneity in the sediment at this natural recovery area.

3.9 Early Warning Monitoring Conclusions and Future Long-Term Monitoring

No additional early warning monitoring is required to further characterize the dredge to clean, channel sand cap, or natural recovery areas as part of the Year 10 monitoring. The most frequent SQO exceedances in the early warning samples in Year 10 were for benzoic acid and DEHP, with a few areas also showing SQO exceedances in the early warning samples for select PAHs or other SVOCs. The benzoic acid SQO exceedances also exceed the equivalent early warning threshold concentration for this analyte. DEHP only exceeded its early warning

threshold concentration of 3,250 µg/kg in two early warning samples. DEHP and benzoic acid were also noted as commonly exceeding their SQOs in other Year 10 OMMP performance monitoring sediment samples collected, including slope cap samples (refer to Section 2.2.2.1), channel sand cap samples (refer to Section 2.2.2.2), and natural recovery samples (refer to Section 2.3).

As described in further detail earlier in the Summary of Slope Cap Chemical Performance Monitoring OMMP Findings (part of Section 2.2.2.1), DEHP is a ubiquitous urban compound and accumulation of DEHP above the SQO within the waterways' sediments was predicted to occur prior to construction of the remedy. In 2013, an evaluation of the Year 7 OMMP sediment monitoring results in comparison with the Thea Foss Sediment Quality Model predictions was conducted by the City to assess changes in waterway sediment concentrations over time and to extrapolate sediment quality trends into the future (City of Tacoma 2014). This evaluation generally concluded that sediment concentrations were beginning to level off in approximately Year 7 and were not expected to rise much higher in the future, with many areas remaining relatively stable between the Year 4 and Year 7 monitoring events. A similar evaluation of the Year 10 OMMP sediment monitoring results in comparison to the model will be completed by the City in 2017. As part of this modeling evaluation, DEHP results were compared to a biological effects level for DEHP of 4,000 ug/kg, because site-specific bioassay tests have shown that biological effects are not observed in Foss Waterway sediments until DEHP concentrations are over three times higher than the SQO. In the Year 10 early warning samples, only one sample had DEHP detected at a concentration above this biological effects level.

As described further in the Section 2.2.2 and Section 3.4 Concentration Trends Related to Laboratory Analytical Changes, benzoic acid concentrations in the Year 10 early warning samples generally increased relative to concentrations detected in previous monitoring events. The greater benzoic acid concentrations in these Year 10 samples relative to the sample concentrations from previous monitoring events are a result of improvements made to the laboratory extraction and analysis of benzoic acid in Year 10. A potential source of benzoic acid to these sediments could be the breakdown of plant material entering the waterways. Benzoic acid is a naturally occurring compound in terrestrial plants and is also a breakdown product of benzyl alcohol, which also naturally occurs in terrestrial plants. It has frequently been detected at DMMP disposal sites and has been detected at concentrations exceeding the SQO in sediment samples collected from several non-urban embayments (DMMP 2016). Refer to Section 2.2.2 for further information.

Additionally the benthic community and recolonization at stations located within all of the early warning monitoring areas continue to show evidence of healthy colonization, with these areas showing evidence of mature infaunal communities and benthic ecosystem recovery (refer to Section 4.0 for further details).

DEHP is the subject of considerable ongoing study by the City and benzoic acid in sediments is continuing to be looked at by the DMMP (DMMP 2016). General stormwater source control activities are being implemented by the City on an ongoing basis and are effectively reducing concentrations of DEHP in stormwater sediments, as well as concentrations of PAHs. Benzoic acid trends in surface sediments should continue to be monitored. Based on the information presented above, general stormwater source control activities already being performed by the City should continue to be implemented; however, no additional source control actions are

warranted at this time based on the findings of the Year 10 sediment remediation area performance monitoring.

The results of the Year 10 early warning monitoring events, as well as results from Year 10 sediment chemical performance monitoring and from the previous chemical monitoring events, will be used to help prepare the Long-Term Monitoring Plan for the Thea Foss and Wheeler-Osgood Waterways Remediation Project. It is anticipated that the Long-Term Monitoring Plan for the Thea Foss and Wheeler-Osgood Waterways Remediation Project will be prepared by the City in coordination with EPA in 2017.

TABLES

3-1 – Summary of Year 10 Early Warning Monitoring Sample (0 to 2 cm) Results

3-2 – Year 10 Early Warning SQO Exceedances Compared to Early Warning Threshold Concentrations

Table 3-1
Summary of Year 10 Early Warning Monitoring Samples (0 to 2 cm)

		Station	EW-01		EW-06		EW-07		EW-08		EW-09		EW-10	
		Sample ID	EW-01-Y10		EW-06-Y10		EW-07-Y10		EW-08-Y10		EW-09-Y10		EW-10-Y10	
		Sample Date	5/16/2016	Enrichment	5/16/2016	Enrichment	5/17/2016	Enrichment	5/17/2016	Enrichment	5/16/2016	Enrichment	5/16/2016	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
Parameter	**Units**	**SQO**												
Conventionals														
Total Organic Carbon	mg/kg	NC	16,900	NA	24,700	NA	32,900	NA	21,700	NA	21,900	NA	25,400	NA
Total Solids	%	NC	66.9	NA	50.2	NA	44.7	NA	48.5	NA	52.9	NA	47.9	NA
Metals														
Antimony	mg/kg	150	0.481 U	NA	0.736	0.00	0.971	0.01	0.928	0.01	0.758	0.01	1.12	0.01
Arsenic	mg/kg	57	5.79	0.10	9.45	0.17	10.7	0.19	9.58	0.17	8.83	0.15	10.6	0.19
Cadmium	mg/kg	5.1	0.481 U	NA	0.490 U	NA	0.685	0.13	0.490 U	NA	0.490 U	NA	0.568	0.11
Copper	mg/kg	390	33.9	0.09	67.8	0.17	84.1	0.22	74.9	0.19	75.2	0.19	72.2	0.19
Lead	mg/kg	450	12.2	0.03	42.6	0.09	46.8	0.10	50.1	0.11	45.8	0.10	53.2	0.12
Nickel	mg/kg	140	18.7	0.13	18.3	0.13	19.4	0.14	20.1	0.14	18.8	0.13	19.9	0.14
Silver	mg/kg	6.1	0.481 U	NA	0.527	0.09	0.549	0.09	0.624	0.10	0.577	0.09	0.663	0.11
Zinc	mg/kg	410	52.4	0.13	86.1	0.21	122	0.30	96.9	0.24	98.4	0.24	99.5	0.24
Mercury	mg/kg	0.59	0.0633	0.11	0.218	0.37	0.188	0.32	0.199	0.34	0.213	0.36	0.285	0.48
SVOCs														
LPAHs														
2-Methylnaphthalene	µg/kg	670	77 U	NA	120	0.18	130	0.19	130	0.19	120	0.18	150	0.22
Acenaphthene	µg/kg	500	77 U	NA	82	0.16	140	0.28	110	0.22	80 U	NA	110	0.22
Acenaphthylene	µg/kg	1,300	77 U	NA	130	0.10	200	0.15	140	0.11	110	0.08	150	0.12
Anthracene	µg/kg	960	97	0.10	360	0.38	580	0.60	360	0.38	270	0.28	440	0.46
Fluorene	µg/kg	540	77 U	NA	130	0.24	180	0.33	140	0.26	110	0.20	150	0.28
Naphthalene	µg/kg	2,100	77 U	NA	350	0.17	300	0.14	310	0.15	290	0.14	370	0.18
Phenanthrene	µg/kg	1,500	180	0.12	600	0.40	950	0.63	550	0.37	500	0.33	680	0.45
Total LPAH	µg/kg	5,200	280	0.05	1,800	0.35	2,500	0.48	1,700	0.33	1,400	0.27	2,100	0.40
HPAHs														
Benzo(a)anthracene	µg/kg	1,600	140	0.09	570	0.36	1,100	0.69	630	0.39	470	0.29	600	0.38
Benzo(a)pyrene	µg/kg	1,600	170	0.11	810	0.51	1,100	0.69	970	0.61	730	0.46	970	0.61
Benzofluoranthenes (total)	µg/kg	3,600	250	0.07	1,300	0.36	2,100	0.58	1,700	0.47	1,300	0.36	1,800	0.50
Benzo(g,h,i)perylene	µg/kg	720	77 U	NA	350	0.49	560	0.78	650	0.90	350	0.49	550	0.76
Chrysene	µg/kg	2,800	180	0.06	770	0.28	1,500	0.54	870	0.31	610	0.22	930	0.33
Dibenz(a,h)anthracene	µg/kg	230	21	0.09	93	0.40	140	0.61	140	0.61	91	0.40	140	0.61
Fluoranthene	µg/kg	2,500	300	0.12	1,000	0.40	**2,900**	1.16	1,200	0.48	930	0.37	1,400	0.56
Indeno(1,2,3-cd)pyrene	µg/kg	690	81	0.12	390	0.57	580	0.84	660	0.96	370	0.54	590	0.86
Pyrene	µg/kg	3,300	290	0.09	1,300	0.39	3,000	0.91	1,500	0.45	1,100	0.33	1,700	0.52
Total HPAH	µg/kg	17,000	1,400	0.08	6,600	0.39	13,000	0.76	8,300	0.49	6,000	0.35	8,700	0.51
Other														
Dimethyl phthalate	µg/kg	160	31 U	NA	31 U	NA	32 U	NA	32 U	NA	32 U	NA	32 U	NA
Diethylphthalate	µg/kg	200	77 U	NA	79 U	NA	79 U	NA	79 U	NA	80 U	NA	80 U	NA
Di-n-butyl phthalate	µg/kg	1,400	77 U	NA	79 U	NA	79 U	NA	79 U	NA	80 U	NA	80 U	NA
Butyl benzyl phthalate	µg/kg	900	77 U	NA	120	0.13	140	0.16	190	0.21	110	0.12	160	0.18
Bis(2-ethylhexyl)phthalate	µg/kg	1,300	77 U	NA	680	0.52	**1,400**	1.08	1,000	0.77	680	0.52	960	0.74
Di-n-octyl phthalate	µg/kg	6,200	77 U	NA	79 U	NA	94	0.02	79 U	NA	80 U	NA	80 U	NA
Phenol	µg/kg	420	77 U	NA	79 U	NA	79 U	NA	79 U	NA	80 U	NA	80 U	NA
2-Methylphenol	µg/kg	63	4 U	NA	5	0.08	5	0.08	5	0.08	4	0.06	6	0.10
4-Methylphenol	µg/kg	670	77 U	NA	79 U	NA	79 U	NA	79 U	NA	80 U	NA	80 U	NA
2,4-Dimethylphenol	µg/kg	29	4 U	NA	5	0.17	7	0.24	6	0.21	5	0.17	7	0.24
Pentachlorophenol	µg/kg	360	77 U	NA	79 U	NA	79 U	NA	79 U	NA	80 U	NA	80 U	NA
Benzyl alcohol	µg/kg	73	8 U	NA	16	0.22	39	0.53	20	0.27	15	0.21	21	0.29
Benzoic acid	µg/kg	650	**870 J**	1.34	**1,500 J**	2.31	**2,600 J**	4.00	**1,200 J**	1.85	**2,300 J**	3.54	**740 J**	1.14
1,2-Dichlorobenzene	µg/kg	50	4 U	NA	4 U	NA	4 U	NA	4 U	NA	4 U	NA	4 U	NA
1,3-Dichlorobenzene	µg/kg	170	31 U	NA	31 U	NA	32 U	NA	32 U	NA	32 U	NA	32 U	NA
1,4-Dichlorobenzene	µg/kg	110	31 U	NA	31 U	NA	32 U	NA	32 U	NA	32 U	NA	32 U	NA
1,2,4-Trichlorobenzene	µg/kg	51	4 U	NA	4 U	NA	4 U	NA	4 U	NA	4 U	NA	4 U	NA
Hexachlorobenzene	µg/kg	22	4 U	NA	4 U	NA	4 U	NA	4 U	NA	4 U	NA	4 U	NA
Dibenzofuran	µg/kg	540	77 U	NA	90	0.17	130	0.24	93	0.17	80 U	NA	120	0.22
Hexachlorobutadiene	µg/kg	11	4 U	NA	4 U	NA	4 U	NA	4 U	NA	4 U	NA	4 U	NA
N-Nitrosodiphenylamine	µg/kg	28	8 U	NA	17	0.61	23	0.82	18	0.64	17	0.61	22	0.79
Pesticides														
p,p'-DDD	µg/kg	16	3.7 U	NA	3.8 U	NA	3.8 U	NA	3.8 U	NA	3.9 U	NA	3.9 U	NA
p,p'-DDE	µg/kg	9	3.7 U	NA	**11**	1.22	3.8 U	NA	3.8 U	NA	3.9 U	NA	3.9 U	NA
p,p'-DDT	µg/kg	34	3.7 U	NA	3.8 U	NA	3.8 U	NA	3.8 U	NA	3.9 U	NA	3.9 U	NA
PCBs														
PCB-1016	µg/kg	NC	19 U	NA	19 U	NA	19 U	NA	19 U	NA	19 U	NA	19 U	NA
PCB-1221	µg/kg	NC	19 U	NA	19 U	NA	19 U	NA	19 U	NA	19 U	NA	19 U	NA
PCB-1232	µg/kg	NC	19 U	NA	19 U	NA	19 U	NA	19 U	NA	19 U	NA	19 U	NA
PCB-1242	µg/kg	NC	19 U	NA	19 U	NA	19 U	NA	19 U	NA	19 U	NA	19 U	NA
PCB-1248	µg/kg	NC	19 U	NA	19 U	NA	19 U	NA	19 U	NA	19 U	NA	19 U	NA
PCB-1254	µg/kg	NC	19 U	NA	42	NA	40	NA	44	NA	50	NA	54	NA
PCB-1260	µg/kg	NC	19 U	NA	19 U	NA	19 U	NA	19 U	NA	19 U	NA	19 U	NA
PCBs (total)	µg/kg	300	19 U	NA	42	0.14	40	0.13	44	0.15	50	0.17	54	0.18

Notes:

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

NA Not applicable.

NC No SQO criterion.

Qualifiers:

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

U Not detected at the given reporting limit.

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

Table 3-1
Summary of Year 10 Early Warning Monitoring Samples (0 to 2 cm)

		Station	EW-11		EW-12		EW-13		EW-15		EW-16		EW-17			
		Sample ID	EW-11-Y10		EW-12-Y10		EW-13-Y10		EW-15-Y10		EW-16-Y10		EW-17-Y10		EW-17-Y10-2	
		Sample Date	5/17/2016	Enrichment	5/16/2016	Enrichment	5/17/2016	Enrichment	5/17/2016	Enrichment	5/16/2016	Enrichment	5/17/2016	Enrichment	5/17/2016	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	28,200	NA	22,500	NA	28,800	NA	10,400	NA	24,500	NA	46,900	NA	40,400	NA
Total Solids	%	NC	44.5	NA	52.0	NA	49.5	NA	66.5	NA	57.7	NA	45.0	NA	45.3	NA
Metals																
Antimony	mg/kg	150	1.06	0.01	0.943	0.01	1.46	0.01	0.490 U	NA	1.04	0.01	0.831	0.01	0.974	0.01
Arsenic	mg/kg	57	10.7	0.19	9.48	0.17	11.6	0.20	5.08	0.09	10.2	0.18	7.38	0.13	7.07	0.12
Cadmium	mg/kg	5.1	0.675	0.13	0.518	0.10	0.557	0.11	0.490 U	NA	0.649	0.13	0.490 U	NA	0.490 U	NA
Copper	mg/kg	390	116	0.30	70.2	0.18	90.1	0.23	36.5	0.09	79.8	0.20	265	0.68	56.0	0.14
Lead	mg/kg	450	141	0.31	67.9	0.15	70.8	0.16	21.8	0.05	63.7	0.14	37.9	0.08	38.3	0.09
Nickel	mg/kg	140	20.8	0.15	17.4	0.12	21.7	0.16	14.4	0.10	21.2	0.15	13.0	0.09	12.7	0.09
Silver	mg/kg	6.1	0.546	0.09	0.493	0.08	0.711	0.12	0.490 U	NA	0.595	0.10	0.490 U	NA	0.490 U	NA
Zinc	mg/kg	410	156	0.38	112	0.27	119	0.29	56.2	0.14	133	0.32	89.0	0.22	90.7	0.22
Mercury	mg/kg	0.59	0.370	0.63	0.544	0.92	0.239	0.41	0.0919	0.16	0.201	0.34	0.121	0.21	0.123	0.21
SVOCs																
LPAHs																
2-Methylnaphthalene	µg/kg	670	94	0.14	100	0.15	180	0.27	75 U	NA	79 U	NA	630	0.94	610	0.91
Acenaphthene	µg/kg	500	77 U	NA	94	0.19	130	0.26	75 U	NA	79 U	NA	140	0.28	160	0.32
Acenaphthylene	µg/kg	1,300	110	0.08	130	0.10	180	0.14	75 U	NA	79 U	NA	340	0.26	330	0.25
Anthracene	µg/kg	960	300	0.31	420	0.44	490	0.51	150	0.16	160	0.17	**1,300**	1.35	**1,300**	1.35
Fluorene	µg/kg	540	100	0.19	140	0.26	190	0.35	75 U	NA	79 U	NA	470	0.87	480	0.89
Naphthalene	µg/kg	2,100	210	0.10	240	0.11	430	0.20	140	0.07	110	0.05	580	0.28	580	0.28
Phenanthrene	µg/kg	1,500	460	0.31	610	0.41	820	0.55	260	0.17	270	0.18	**2,200**	1.47	**2,400**	1.60
Total LPAH	µg/kg	5,200	1,300	0.25	1,700	0.33	2,400	0.46	550	0.11	540	0.10	**5,700**	1.10	**5,900**	1.13
HPAHs																
Benzo(a)anthracene	µg/kg	1,600	510	0.32	890	0.56	690	0.43	200	0.13	240	0.15	870	0.54	970	0.61
Benzo(a)pyrene	µg/kg	1,600	720	0.45	1,000	0.63	960	0.60	330	0.21	400	0.25	1,200	0.75	1,300	0.81
Benzofluoranthenes (total)	µg/kg	3,600	1,400	0.39	1,900	0.53	1,800	0.50	520	0.14	770	0.21	1,400	0.39	1,800	0.50
Benzo(g,h,i)perylene	µg/kg	720	520	0.72	430	0.60	710	0.99	220	0.31	230	0.32	590	0.82	**790**	1.10
Chrysene	µg/kg	2,800	810	0.29	1,500	0.54	1,100	0.39	250	0.09	380	0.14	910	0.33	1,100	0.39
Dibenz(a,h)anthracene	µg/kg	230	120	0.52	110	0.48	160	0.70	53	0.23	53	0.23	150	0.65	190	0.83
Fluoranthene	µg/kg	2,500	1,000	0.40	**2,800**	1.12	1,500	0.60	390	0.16	530	0.21	1,800	0.72	2,300	0.92
Indeno(1,2,3-cd)pyrene	µg/kg	690	510	0.74	480	0.70	**700**	1.01	220	0.32	240	0.35	570	0.83	**780**	1.13
Pyrene	µg/kg	3,300	1,400	0.42	2,500	0.76	2,100	0.64	580	0.18	660	0.20	**5,500**	1.67	**6,000**	1.82
Total HPAH	µg/kg	17,000	7,000	0.41	12,000	0.71	9,700	0.57	2,800	0.16	3,500	0.21	13,000	0.76	15,000	0.88
Other																
Dimethyl phthalate	µg/kg	160	31 U	NA	32 U	NA	32 U	NA	30 U	NA	32 U	NA	32 U	NA	31 U	NA
Diethylphthalate	µg/kg	200	77 U	NA	80 U	NA	80 U	NA	75 U	NA	79 U	NA	79 U	NA	77 U	NA
Di-n-butyl phthalate	µg/kg	1,400	77 U	NA	80 U	NA	80 U	NA	75 U	NA	79 U	NA	79 U	NA	77 U	NA
Butyl benzyl phthalate	µg/kg	900	230	0.26	170	0.19	250	0.28	75 U	NA	150	0.17	79	0.09	99	0.11
Bis(2-ethylhexyl)phthalate	µg/kg	1,300	**2,100**	1.62	**1,400**	1.08	**1,500**	1.15	420	0.32	**1,400**	1.08	800	0.62	700	0.54
Di-n-octyl phthalate	µg/kg	6,200	150	0.02	90	0.01	80 U	NA	75 U	NA	130	0.02	79 U	NA	86	0.01
Phenol	µg/kg	420	77 U	NA	80 U	NA	80 U	NA	75 U	NA	79 U	NA	79 U	NA	77 U	NA
2-Methylphenol	µg/kg	63	5	0.08	4	0.06	6	0.10	4 U	NA	4 U	NA	15	0.24	13	0.21
4-Methylphenol	µg/kg	670	77 U	NA	80 U	NA	80 U	NA	75 U	NA	79 U	NA	260	0.39	240	0.36
2,4-Dimethylphenol	µg/kg	29	6	0.21	4	0.14	8	0.28	4	0.14	4 U	NA	13	0.45	11	0.38
Pentachlorophenol	µg/kg	360	77 U	NA	80 U	NA	80 U	NA	75 U	NA	79 U	NA	79 U	NA	77 U	NA
Benzyl alcohol	µg/kg	73	28	0.38	20	0.27	20	0.27	11	0.15	17	0.23	18	0.25	25	0.34
Benzoic acid	µg/kg	650	**2,200 J**	3.38	**1,000 J**	1.54	**750 J**	1.15	**990 J**	1.52	**1,400 J**	2.15	**1,900 J**	2.92	**1,100 J**	1.69
1,2-Dichlorobenzene	µg/kg	50	4 U	NA	4 U	NA	4 U	NA	4 U	NA	4 U	NA	4 U	NA	4 U	NA
1,3-Dichlorobenzene	µg/kg	170	31 U	NA	32 U	NA	32 U	NA	30 U	NA	32 U	NA	32 U	NA	31 U	NA
1,4-Dichlorobenzene	µg/kg	110	31 U	NA	32 U	NA	32 U	NA	30 U	NA	32 U	NA	32 U	NA	31 U	NA
1,2,4-Trichlorobenzene	µg/kg	51	4 U	NA	4 U	NA	4 U	NA	4 U	NA	4 U	NA	4 U	NA	4 U	NA
Hexachlorobenzene	µg/kg	22	4 U	NA	4 U	NA	4 U	NA	4 U	NA	4 U	NA	4 U	NA	4 U	NA
Dibenzofuran	µg/kg	540	77 U	NA	80 U	NA	150	0.28	75 U	NA	79 U	NA	160	0.30	160	0.30
Hexachlorobutadiene	µg/kg	11	4 U	NA	4 U	NA	4 U	NA	4 U	NA	4 U	NA	4 U	NA	4 U	NA
N-Nitrosodiphenylamine	µg/kg	28	15	0.54	15	0.54	24	0.86	8	0.29	10	0.36	**58 UJ**	NA	**61 UJ**	NA
Pesticides																
p,p'-DDD	µg/kg	16	3.7 U	NA	3.8 U	NA	3.8 U	NA	3.6 U	NA	3.8 U	NA	3.8 U	NA	3.7 U	NA
p,p'-DDE	µg/kg	9	3.7 U	NA	3.8 U	NA	3.8 U	NA	3.6 U	NA	3.8 U	NA	3.8 U	NA	3.7 U	NA
p,p'-DDT	µg/kg	34	3.7 U	NA	3.8 U	NA	3.8 U	NA	3.6 U	NA	3.8 U	NA	3.8 U	NA	3.7 U	NA
PCBs																
PCB-1016	µg/kg	NC	18 U	NA	19 U	NA	19 U	NA	18 U	NA	19 U	NA	19 U	NA	18 U	NA
PCB-1221	µg/kg	NC	18 U	NA	19 U	NA	19 U	NA	18 U	NA	19 U	NA	19 U	NA	18 U	NA
PCB-1232	µg/kg	NC	18 U	NA	19 U	NA	19 U	NA	18 U	NA	19 U	NA	19 U	NA	18 U	NA
PCB-1242	µg/kg	NC	18 U	NA	19 U	NA	19 U	NA	18 U	NA	19 U	NA	19 U	NA	18 U	NA
PCB-1248	µg/kg	NC	18 U	NA	19 U	NA	19 U	NA	18 U	NA	19 U	NA	19 U	NA	18 U	NA
PCB-1254	µg/kg	NC	48	NA	44	NA	52	NA	18 U	NA	36	NA	19 U	NA	18 U	NA
PCB-1260	µg/kg	NC	18 U	NA	19 U	NA	19 U	NA	18 U	NA	19 U	NA	19 U	NA	18 U	NA
PCBs (total)	µg/kg	300	48	0.16	44	0.15	52	0.17	18 U	NA	36	0.12	19 U	NA	18 U	NA

Notes:

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

NA Not applicable.

NC No SQO criterion.

Qualifiers:

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

U Not detected at the given reporting limit.

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

Table 3-1
Summary of Year 10 Early Warning Monitoring Samples (0 to 2 cm)

		Station	EW-19		EW-20		EW-21		EW-22		EW-23		EW-24		EW-25	
		Sample ID	EW-19-Y10		EW-20-Y10		EW-21-Y10		EW-22-Y10		EW-23-Y10		EW-24-Y10		EW-25-Y10	
		Sample Date	6/27/2016	Enrichment	6/27/2016	Enrichment	6/28/2016	Enrichment	6/28/2016	Enrichment	6/28/2016	Enrichment	6/28/2016	Enrichment	6/27/2016	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	21,500	NA	20,300	NA	22,400	NA	31,000	NA	40,100	NA	13,600	NA	115,000	NA
Total Solids	%	NC	61.3	NA	54.0	NA	47.0	NA	41.5	NA	35.5	NA	61.5	NA	28.3	NA
Metals																
Antimony	mg/kg	150	1.84	0.01	1.35	0.01	0.695	0.00	2.02	0.01	1.21	0.01	0.529	0.00	3.18	0.02
Arsenic	mg/kg	57	7.49	0.13	6.13	0.11	8.42	0.15	13.4	0.24	9.11	0.16	5.44	0.10	15.4	0.27
Cadmium	mg/kg	5.1	0.500 U	NA	0.481 U	NA	0.520	0.10	0.804	0.16	0.827	0.16	0.481 U	NA	1.78	0.35
Copper	mg/kg	390	56.7	0.15	65.7	0.17	62.6	0.16	113	0.29	75.8	0.19	42.2	0.11	121	0.31
Lead	mg/kg	450	42.6	0.09	42.8	0.10	44.3	0.10	71.5	0.16	70.8	0.16	33.9	0.08	127	0.28
Nickel	mg/kg	140	15.3	0.11	18.3	0.13	17.6	0.13	22.3	0.16	23.0	0.16	15.3	0.11	19.3	0.14
Silver	mg/kg	6.1	0.500 U	NA	0.481 U	NA	0.592	0.10	0.812	0.13	0.676	0.11	0.481 U	NA	1.47	0.24
Zinc	mg/kg	410	113	0.28	147	0.36	94.6	0.23	171	0.42	178	0.43	75.8	0.18	210	0.51
Mercury	mg/kg	0.59	0.115	0.19	0.0811	0.14	0.189	0.32	0.325	0.55	0.216	0.37	0.108	0.18	0.396	0.67
SVOCs																
LPAHs																
2-Methylnaphthalene	µg/kg	670	240	0.36	150	0.22	89	0.13	150	0.22	83 U	NA	96	0.14	230	0.34
Acenaphthene	µg/kg	500	90	0.18	140	0.28	83 U	NA	110	0.22	83 U	NA	100	0.20	200	0.40
Acenaphthylene	µg/kg	1,300	340	0.26	83 U	NA	87	0.07	170	0.13	83 U	NA	83 U	NA	310	0.24
Anthracene	µg/kg	960	600	0.63	420	0.44	230	0.24	450	0.47	210	0.22	180	0.19	920	0.96
Fluorene	µg/kg	540	200	0.37	180	0.33	100	0.19	180	0.33	90	0.17	120	0.22	310	0.57
Naphthalene	µg/kg	2,100	330	0.16	150	0.07	210	0.10	370	0.18	180	0.09	420	0.20	710	0.34
Phenanthrene	µg/kg	1,500	960	0.64	1,400	0.93	400	0.27	690	0.46	550	0.37	400	0.27	1,500	1.00
Total LPAH	µg/kg	5,200	2,800	0.54	2,400	0.46	1,100	0.21	2,100	0.40	1,000	0.19	1,300	0.25	4,200	0.81
HPAHs																
Benzo(a)anthracene	µg/kg	1,600	1,100	0.69	640	0.40	330	0.21	650	0.41	510	0.32	260	0.16	1,200	0.75
Benzo(a)pyrene	µg/kg	1,600	1,000	0.63	600	0.38	450	0.28	820	0.51	640	0.40	320	0.20	1,000	0.63
Benzofluoranthenes (total)	µg/kg	3,600	1,400	0.39	1,000	0.28	890	0.25	1,700	0.47	1,500	0.42	640	0.18	2,200	0.61
Benzo(g,h,i)perylene	µg/kg	720	540	0.75	420	0.58	390	0.54	680	0.94	660	0.92	280	0.39	680	0.94
Chrysene	µg/kg	2,800	1,300	0.46	760	0.27	460	0.16	890	0.32	700	0.25	370	0.13	1,600	0.57
Dibenz(a,h)anthracene	µg/kg	230	170	0.74	110	0.48	93	0.40	170	0.74	150	0.65	66	0.29	180	0.78
Fluoranthene	µg/kg	2,500	1,600	0.64	1,200	0.48	710	0.28	1,300	0.52	1,200	0.48	680	0.27	**3,200**	1.28
Indeno(1,2,3-cd)pyrene	µg/kg	690	510	0.74	370	0.54	350	0.51	630	0.91	600	0.87	260	0.38	630	0.91
Pyrene	µg/kg	3,300	1,900	0.58	1,500	0.45	770	0.23	1,500	0.45	980	0.30	600	0.18	3,200	0.97
Total HPAH	µg/kg	17,000	9,500	0.56	6,600	0.39	4,400	0.26	8,300	0.49	6,900	0.41	3,500	0.21	14,000	0.82
Other																
Dimethyl phthalate	µg/kg	160	33 U	NA	33 U	NA	33 U	NA	33 U	NA	33 U	NA	33 U	NA	38	0.24
Diethylphthalate	µg/kg	200	83 U	NA	83 U	NA	83 U	NA	83 U	NA	83 U	NA	83 U	NA	83 U	NA
Di-n-butyl phthalate	µg/kg	1,400	83 U	NA	83 U	NA	83 U	NA	83 U	NA	150	0.11	83 U	NA	83 U	NA
Butyl benzyl phthalate	µg/kg	900	110	0.12	250	0.28	140	0.16	250	0.28	280	0.31	90	0.10	590	0.66
Bis(2-ethylhexyl)phthalate	µg/kg	1,300	580	0.45	**2,200**	1.69	880	0.68	**1,800**	1.38	**3,500**	2.69	580	0.45	**1,900**	1.46
Di-n-octyl phthalate	µg/kg	6,200	83 U	NA	130	0.02	86	0.01	130	0.02	170	0.03	83 U	NA	140	0.02
Phenol	µg/kg	420	91	0.22	130	0.31	83 U	NA	83 U	NA	83 U	NA	83 U	NA	83 U	NA
2-Methylphenol	µg/kg	63	11	0.17	11	0.17	6	0.10	10	0.16	11	0.17	6	0.10	17	0.27
4-Methylphenol	µg/kg	670	83 U	NA	93	0.14	83 U	NA	83 U	NA	83 U	NA	83 U	NA	120	0.18
2,4-Dimethylphenol	µg/kg	29	6	0.21	5	0.17	6	0.21	12	0.41	24	0.83	**50**	1.72	6	0.21
Pentachlorophenol	µg/kg	360	110	0.31	99	0.28	83 U	NA	91	0.25	94	0.26	83 U	NA	95	0.26
Benzyl alcohol	µg/kg	73	28 UJ	NA	27 UJ	NA	**250**	3.42	37 UJ	NA	50 UJ	NA	23 UJ	NA	40 UJ	NA
Benzoic acid	µg/kg	650	**670 J**	1.03	**1,700 J**	2.62	**1,500 J**	2.31	**880 J**	1.35	**1,900 J**	2.92	**1,400 J**	2.15	**4,100 J**	6.31
1,2-Dichlorobenzene	µg/kg	50	4	0.08	19	0.38	4 U	NA	4 U	NA	4 U	NA	4 U	NA	7	0.14
1,3-Dichlorobenzene	µg/kg	170	33 U	NA	33 U	NA	33 U	NA	33 U	NA	33 U	NA	33 U	NA	33 U	NA
1,4-Dichlorobenzene	µg/kg	110	33 U	NA	33 U	NA	33 U	NA	33 U	NA	33 U	NA	33 U	NA	33 U	NA
1,2,4-Trichlorobenzene	µg/kg	51	4 U	NA	4 U	NA	4 U	NA	4 U	NA	4 U	NA	4 U	NA	4 U	NA
Hexachlorobenzene	µg/kg	22	4 U	NA	4 U	NA	4 U	NA	4 U	NA	4 U	NA	4 U	NA	4 U	NA
Dibenzofuran	µg/kg	540	83	0.15	83 U	NA	83 U	NA	99	0.18	83 U	NA	100	0.19	180	0.33
Hexachlorobutadiene	µg/kg	11	4 U	NA	4 U	NA	4 U	NA	4 U	NA	4 U	NA	4 U	NA	4 U	NA
N-Nitrosodiphenylamine	µg/kg	28	8 U	NA	8 U	NA	8	0.29	10	0.36	8 U	NA	8 U	NA	8 U	NA
Pesticides																
p,p'-DDD	µg/kg	16	4.0 U	NA	4.0 U	NA	4.0 U	NA	4.0 U	NA	4.0 UJ	NA	4.0 U	NA	4.0 U	NA
p,p'-DDE	µg/kg	9	4.0 U	NA	4.0 U	NA	4.0 U	NA	4.0 U	NA	4.0 UJ	NA	4.0 U	NA	4.0 U	NA
p,p'-DDT	µg/kg	34	4.0 U	NA	4.0 U	NA	4.0 U	NA	4.0 U	NA	4.0 UJ	NA	4.0 UJ	NA	4.0 U	NA
PCBs																
PCB-1016	µg/kg	NC	20 U	NA	20 U	NA	20 U	NA	20 U	NA	20 U	NA	20 U	NA	20 U	NA
PCB-1221	µg/kg	NC	20 U	NA	20 U	NA	20 U	NA	20 U	NA	20 U	NA	20 U	NA	20 U	NA
PCB-1232	µg/kg	NC	20 U	NA	20 U	NA	20 U	NA	20 U	NA	20 U	NA	20 U	NA	20 U	NA
PCB-1242	µg/kg	NC	20 U	NA	20 U	NA	20 U	NA	20 U	NA	20 U	NA	20 U	NA	20 U	NA
PCB-1248	µg/kg	NC	20 U	NA	20 U	NA	20 U	NA	20 U	NA	20 U	NA	20 U	NA	20 U	NA
PCB-1254	µg/kg	NC	35	NA	34	NA	39	NA	100	NA	66	NA	33	NA	170	NA
PCB-1260	µg/kg	NC	20 U	NA	20 U	NA	20 U	NA	20 U	NA	20 U	NA	20 U	NA	20 U	NA
PCBs (total)	µg/kg	300	35	0.12	34	0.11	39	0.13	100	0.33	66	0.22	33	0.11	170	0.57

Notes:

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

NA Not applicable.

NC No SQO criterion.

Qualifiers:

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

U Not detected at the given reporting limit.

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

Table 3-1
Summary of Year 10 Early Warning Monitoring Samples (0 to 2 cm)

		Station	EW-26		EW-27		EW-28		EW-29		EW-30		EW-31	
		Sample ID	EW-26-Y10		EW-27-Y10		EW-28-Y10		EW-29-Y10		EW-30-Y10		EW-31-Y10	
		Sample Date	6/27/2016	Enrichment	6/27/2016	Enrichment	6/27/2016	Enrichment	6/27/2016	Enrichment	6/27/2016	Enrichment	6/27/2016	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
Parameter	**Units**	**SQO**												
Conventionals														
Total Organic Carbon	mg/kg	NC	18,400	NA	31,700	NA	15,100	NA	18,900	NA	26,700	NA	34,500	NA
Total Solids	%	NC	60.9	NA	43.4	NA	64.7	NA	54.6	NA	51.0	NA	44.4	NA
Metals														
Antimony	mg/kg	150	0.838	0.006	1.19	0.01	0.521	0.003	0.785	0.01	0.978	0.01	1.31	0.01
Arsenic	mg/kg	57	7.33	0.13	9.80	0.17	5.85	0.10	7.27	0.13	8.19	0.14	10.4	0.18
Cadmium	mg/kg	5.1	0.481 U	NA	0.725	0.14	0.490 U	NA	0.500 U	NA	0.639	0.13	0.830	0.16
Copper	mg/kg	390	55.8	0.14	86.2	0.22	34.0	0.09	57.2	0.15	75.3	0.19	80.6	0.21
Lead	mg/kg	450	38.5	0.09	64.8	0.14	30.6	0.07	41.2	0.09	52.1	0.12	61.8	0.14
Nickel	mg/kg	140	21.3	0.15	24.7	0.18	12.8	0.09	21.8	0.16	24.5	0.18	25.1	0.18
Silver	mg/kg	6.1	0.481 U	NA	0.802	0.13	0.490 U	NA	0.500 U	NA	0.541	0.09	0.490 U	NA
Zinc	mg/kg	410	94.9	0.23	154	0.38	75.7	0.18	111	0.27	134	0.33	179	0.44
Mercury	mg/kg	0.59	0.123	0.21	0.238	0.40	0.0907	0.15	0.142	0.24	0.187	0.32	0.155	0.26
SVOCs														
LPAHs														
2-Methylnaphthalene	µg/kg	670	83 U	NA	120	0.18	100	0.15	83 U	NA	83 U	NA	84	0.13
Acenaphthene	µg/kg	500	83 U	NA	83	0.17	84	0.17	83 U	NA	83 U	NA	83 U	NA
Acenaphthylene	µg/kg	1,300	83 U	NA	110	0.08	83 U	NA	83 U	NA	83 U	NA	83 U	NA
Anthracene	µg/kg	960	150	0.16	270	0.28	230	0.24	160	0.17	170	0.18	200	0.21
Fluorene	µg/kg	540	83 U	NA	120	0.22	120	0.22	83 U	NA	83 U	NA	94	0.17
Naphthalene	µg/kg	2,100	130	0.06	310	0.15	280	0.13	160	0.08	190	0.09	200	0.10
Phenanthrene	µg/kg	1,500	270	0.18	540	0.36	390	0.26	330	0.22	390	0.26	460	0.31
Total LPAH	µg/kg	5,200	550	0.11	1,600	0.31	1,200	0.23	650	0.13	750	0.14	1,000	0.19
HPAHs														
Benzo(a)anthracene	µg/kg	1,600	230	0.14	480	0.30	310	0.19	260	0.16	330	0.21	390	0.24
Benzo(a)pyrene	µg/kg	1,600	300	0.19	660	0.41	370	0.23	350	0.22	490	0.31	540	0.34
Benzofluoranthenes (total)	µg/kg	3,600	610	0.17	1,400	0.39	670	0.19	770	0.21	1,100	0.31	1,300	0.36
Benzo(g,h,i)perylene	µg/kg	720	290	0.40	670	0.93	290	0.40	380	0.53	520	0.72	660	0.92
Chrysene	µg/kg	2,800	320	0.11	650	0.23	370	0.13	380	0.14	510	0.18	610	0.22
Dibenz(a,h)anthracene	µg/kg	230	66	0.29	150	0.65	72	0.31	83	0.36	120	0.52	140	0.61
Fluoranthene	µg/kg	2,500	520	0.21	1,100	0.44	640	0.26	630	0.25	800	0.32	970	0.39
Indeno(1,2,3-cd)pyrene	µg/kg	690	260	0.38	600	0.87	280	0.41	330	0.48	470	0.68	570	0.83
Pyrene	µg/kg	3,300	450	0.14	1,000	0.30	640	0.19	550	0.17	750	0.23	920	0.28
Total HPAH	µg/kg	17,000	3,000	0.18	6,700	0.39	3,600	0.21	3,700	0.22	5,100	0.30	6,100	0.36
Other														
Dimethyl phthalate	µg/kg	160	33 U	NA	33 U	NA	33 U	NA	33 U	NA	33 U	NA	33 U	NA
Diethylphthalate	µg/kg	200	83 U	NA	83 U	NA	83 U	NA	83 U	NA	83 U	NA	83 U	NA
Di-n-butyl phthalate	µg/kg	1,400	83 U	NA	83 U	NA	83 U	NA	83 U	NA	83 U	NA	94	0.07
Butyl benzyl phthalate	µg/kg	900	180	0.20	240	0.27	160	0.18	150	0.17	210	0.23	430	0.48
Bis(2-ethylhexyl)phthalate	µg/kg	1,300	630	0.48	**1,700**	1.31	730	0.56	1,100	0.85	**1,500**	1.15	**3,100**	2.38
Di-n-octyl phthalate	µg/kg	6,200	83 U	NA	130	0.02	83 U	NA	100	0.02	120	0.02	240	0.04
Phenol	µg/kg	420	83 U	NA	83 U	NA	83 U	NA	83 U	NA	83 U	NA	83 U	NA
2-Methylphenol	µg/kg	63	4	0.06	9	0.14	4 U	NA	6	0.10	6	0.10	11	0.17
4-Methylphenol	µg/kg	670	83 U	NA	83 U	NA	83 U	NA	83 U	NA	83 U	NA	83 U	NA
2,4-Dimethylphenol	µg/kg	29	5	0.17	12	0.41	4 U	NA	6	0.21	7	0.24	10	0.34
Pentachlorophenol	µg/kg	360	83 U	NA	83 U	NA	83 UJ	NA	83 U	NA	83 U	NA	91	0.25
Benzyl alcohol	µg/kg	73	24 UJ	NA	36 UJ	NA	17	0.23	27 UJ	NA	29 UJ	NA	42 UJ	NA
Benzoic acid	µg/kg	650	390 J	0.60	250 UJ	NA	310 UJ	NA	**1,500 J**	2.31	**730 J**	1.12	**790 J**	1.22
1,2-Dichlorobenzene	µg/kg	50	4 U	NA	4 U	NA	6 UJ	NA	4 U	NA	4 U	NA	4 U	NA
1,3-Dichlorobenzene	µg/kg	170	33 U	NA	33 U	NA	33 U	NA	33 U	NA	33 U	NA	33 U	NA
1,4-Dichlorobenzene	µg/kg	110	33 U	NA	33 U	NA	33 U	NA	33 U	NA	33 U	NA	33 U	NA
1,2,4-Trichlorobenzene	µg/kg	51	4 U	NA	4 U	NA	4 U	NA	4 U	NA	4 U	NA	4 U	NA
Hexachlorobenzene	µg/kg	22	4 U	NA	4 U	NA	4 U	NA	4 U	NA	4 U	NA	4 U	NA
Dibenzofuran	µg/kg	540	83 U	NA	83 U	NA	83 U	NA	83 U	NA	83 U	NA	83 U	NA
Hexachlorobutadiene	µg/kg	11	4 U	NA	4 U	NA	4 U	NA	4 U	NA	4 U	NA	4 U	NA
N-Nitrosodiphenylamine	µg/kg	28	8 U	NA	12	0.43	8 U	NA	8 U	NA	9	0.32	13	0.46
Pesticides														
p,p'-DDD	µg/kg	16	4.0 U	NA	4.0 U	NA	1.9 UJ	0.12	4 UJ	NA	4.0 UJ	NA	4.0 U	NA
p,p'-DDE	µg/kg	9	4.0 U	NA	4.0 U	NA	1.9 UJ	0.21	4.0 UJ	NA	4.0 UJ	NA	4.0 U	NA
p,p'-DDT	µg/kg	34	4.0 U	NA	4.0 U	NA	1.9 UJ	0.06	4.0 UJ	NA	4.0 UJ	NA	4.0 U	NA
PCBs														
PCB-1016	µg/kg	NC	20 U	NA	20 U	NA	10 U	NA	20 U	NA	20 U	NA	20 U	NA
PCB-1221	µg/kg	NC	20 U	NA	20 U	NA	10 U	NA	20 U	NA	20 U	NA	20 U	NA
PCB-1232	µg/kg	NC	20 U	NA	20 U	NA	10 U	NA	20 U	NA	20 U	NA	20 U	NA
PCB-1242	µg/kg	NC	20 U	NA	20 U	NA	10 U	NA	20 U	NA	20 U	NA	20 U	NA
PCB-1248	µg/kg	NC	20 U	NA	20 U	NA	10 U	NA	20 U	NA	20 U	NA	20 U	NA
PCB-1254	µg/kg	NC	24	NA	46	NA	32	NA	27	NA	37	NA	47	NA
PCB-1260	µg/kg	NC	20 U	NA	20 U	NA	10 U	NA	20 U	NA	20 U	NA	20 U	NA
PCBs (total)	µg/kg	300	24	0.08	46	0.15	32	0.11	27	0.09	37	0.12	47	0.16

Notes:

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

NA Not applicable.

NC No SQO criterion.

Qualifiers:

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

U Not detected at the given reporting limit.

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

Table 3-1
Summary of Year 10 Early Warning Monitoring Samples (0 to 2 cm)

		Station	EW-32				EW-33	
		Sample ID	EW-32-Y10		EW-32-Y10-2		EW-33-Y10	
		Sample Date	6/27/2016	Enrichment	6/27/2016	Enrichment	6/27/2016	Enrichment
		Sample Depth	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	39,400	NA	44,700	NA	49,900	NA
Total Solids	%	NC	45.9	NA	45.0	NA	39.4	NA
Metals								
Antimony	mg/kg	150	1.46	0.01	1.62	0.01	1.80	0.01
Arsenic	mg/kg	57	10.5	0.18	11.1	0.19	12.8	0.22
Cadmium	mg/kg	5.1	1.32	0.26	1.39	0.27	1.53	0.30
Copper	mg/kg	390	83.8	0.21	83.0	0.21	98.9	0.25
Lead	mg/kg	450	86.4	0.19	88.7	0.20	82.4	0.18
Nickel	mg/kg	140	27.7	0.20	26.0	0.19	29.4	0.21
Silver	mg/kg	6.1	0.730	0.12	0.736	0.12	0.680	0.11
Zinc	mg/kg	410	202	0.49	209	0.51	262	0.64
Mercury	mg/kg	0.59	0.220	0.37	0.259	0.44	0.296	0.50
SVOCs								
LPAHs								
2-Methylnaphthalene	µg/kg	670	290 J	0.43	280 J	0.42	190	0.28
Acenaphthene	µg/kg	500	**800 J**	1.60	**510 J**	1.02	170	0.34
Acenaphthylene	µg/kg	1,300	300 J	0.23	250 J	0.19	150	0.12
Anthracene	µg/kg	960	**1,100 J**	1.15	950 J	0.99	400	0.42
Fluorene	µg/kg	540	470 J	0.87	320 J	0.59	160	0.30
Naphthalene	µg/kg	2,100	860 J	0.41	940 J	0.45	510	0.24
Phenanthrene	µg/kg	1,500	**2,700 J**	1.80	**1,900 J**	1.27	910	0.61
Total LPAH	µg/kg	5,200	**6,500 J**	1.25	5,200 J	1.00	2,500	0.48
HPAHs								
Benzo(a)anthracene	µg/kg	1,600	1,300 J	0.81	1,100 J	0.69	760	0.48
Benzo(a)pyrene	µg/kg	1,600	1,600 J	1.00	1,300 J	0.81	1,200	0.75
Benzofluoranthenes (total)	µg/kg	3,600	2,500 J	0.69	2,300 J	0.64	2,400	0.67
Benzo(g,h,i)perylene	µg/kg	720	**1,100 J**	1.53	**1,000 J**	1.39	**1,200**	1.67
Chrysene	µg/kg	2,800	1,500 J	0.54	1,300 J	0.46	1,100	0.39
Dibenz(a,h)anthracene	µg/kg	230	**290 J**	1.26	**260 J**	1.13	**240**	1.04
Fluoranthene	µg/kg	2,500	2,500 J	1.00	2,100 J	0.84	1,600	0.64
Indeno(1,2,3-cd)pyrene	µg/kg	690	**1,100 J**	1.59	**980 J**	1.42	**1,100**	1.59
Pyrene	µg/kg	3,300	2,900 J	0.88	2,400 J	0.73	2,100	0.64
Total HPAH	µg/kg	17,000	15,000 J	0.88	13,000 J	0.76	12,000	0.71
Other								
Dimethyl phthalate	µg/kg	160	33 UJ	NA	33 UJ	NA	33	0.21
Diethylphthalate	µg/kg	200	83 UJ	NA	83 UJ	NA	83 U	NA
Di-n-butyl phthalate	µg/kg	1,400	83 UJ	NA	83 UJ	NA	120	0.09
Butyl benzyl phthalate	µg/kg	900	240 J	0.27	350 J	0.39	460	0.51
Bis(2-ethylhexyl)phthalate	µg/kg	1,300	**2,500 J**	1.92	**2,800 J**	2.15	**4,400**	3.38
Di-n-octyl phthalate	µg/kg	6,200	170 J	0.03	180 J	0.03	380	0.06
Phenol	µg/kg	420	83 UJ	NA	83 UJ	NA	140	0.33
2-Methylphenol	µg/kg	63	9 J	0.14	10 J	0.16	18	0.29
4-Methylphenol	µg/kg	670	83 UJ	NA	83 UJ	NA	83 U	NA
2,4-Dimethylphenol	µg/kg	29	8 J	0.28	4 J	0.14	24	0.83
Pentachlorophenol	µg/kg	360	83 UJ	NA	83 UJ	NA	110	0.31
Benzyl alcohol	µg/kg	73	27 UJ	NA	29 UJ	NA	63	0.86
Benzoic acid	µg/kg	650	**730 J**	1.12	530 J	0.82	**1,000 J**	1.54
1,2-Dichlorobenzene	µg/kg	50	4 UJ	NA	4 UJ	NA	4 U	NA
1,3-Dichlorobenzene	µg/kg	170	33 UJ	NA	33 UJ	NA	33 U	NA
1,4-Dichlorobenzene	µg/kg	110	33 UJ	NA	33 UJ	NA	33 U	NA
1,2,4-Trichlorobenzene	µg/kg	51	4 UJ	NA	4 UJ	NA	4 U	NA
Hexachlorobenzene	µg/kg	22	4 UJ	NA	4 UJ	NA	4 U	NA
Dibenzofuran	µg/kg	540	110 J	0.20	96 J	0.18	83 U	NA
Hexachlorobutadiene	µg/kg	11	4 UJ	NA	4 UJ	NA	4 U	NA
N-Nitrosodiphenylamine	µg/kg	28	11 J	0.39	10 J	0.36	17	0.61
Pesticides								
p,p'-DDD	µg/kg	16	4.0 UJ	NA	4.0 UJ	NA	4.0 UJ	NA
p,p'-DDE	µg/kg	9	4.0 UJ	NA	4.0 UJ	NA	4.0 UJ	NA
p,p'-DDT	µg/kg	34	4.0 UJ	NA	4.0 UJ	NA	4.0 UJ	NA
PCBs								
PCB-1016	µg/kg	NC	20 UJ	NA	20 UJ	NA	20 U	NA
PCB-1221	µg/kg	NC	20 UJ	NA	20 UJ	NA	20 U	NA
PCB-1232	µg/kg	NC	20 UJ	NA	20 UJ	NA	20 U	NA
PCB-1242	µg/kg	NC	20 UJ	NA	20 UJ	NA	20 U	NA
PCB-1248	µg/kg	NC	20 UJ	NA	20 UJ	NA	20 U	NA
PCB-1254	µg/kg	NC	39 J	NA	43 J	NA	58	NA
PCB-1260	µg/kg	NC	20 UJ	NA	20 UJ	NA	20 U	NA
PCBs (total)	µg/kg	300	39 J	0.13	43 J	0.14	58	0.19

Notes:

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

NA Not applicable.

NC No SQO criterion.

Qualifiers:

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

U Not detected at the given reporting limit.

UJ The analyte was analyzed for and not detected, and 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-01-Y10	Benzoic acid	650	650	**870 J**
EW-06-Y10	Benzoic acid	650	650	**1,500 J**
	p,p'-DDE	9	9	**11**
EW-07-Y10	Fluoranthene	2,500	7,251	2,900
	Bis(2-ethylhexyl)phthalate	1,300	3,250	1,400
	Benzoic acid	650	650	**2,600 J**
EW-08-Y10	Benzoic acid	650	650	**1,200 J**
EW-09-Y10	Benzoic acid	650	650	**2,300 J**
EW-10-Y10	Benzoic acid	650	650	**740 J**
EW-11-Y10	Bis(2-ethylhexyl)phthalate	1,300	3,250	2,100
	Benzoic acid	650	650	**2,200 J**
EW-12-Y10	Fluoranthene	2,500	7,251	2,800
	Bis(2-ethylhexyl)phthalate	1,300	3,250	1,400
	Benzoic acid	650	650	**1,000 J**
EW-13-Y10	Indeno(1,2,3-cd)pyrene	690	828	700
	Bis(2-ethylhexyl)phthalate	1,300	3,250	1,500
	Benzoic acid	650	650	**750 J**
EW-15-Y10	Benzoic acid	650	650	**990 J**
EW-16-Y10	Bis(2-ethylhexyl)phthalate	1,300	3,250	1,400
	Benzoic acid	650	650	**1,400 J**
EW-17-Y10	Anthracene	960	4,319	1,300
	Phenanthrene	1,500	7,500	2,200
	Total LPAH	5,200	NC	5,700
	Pyrene	3,300	8,580	5,500
	Benzoic acid	650	650	**1,900 J**
EW-17-Y10-2	Anthracene	960	4,319	1,300
	Phenanthrene	1,500	7,500	2,400
	Total LPAH	5,200	NC	5,900
	Benzo(g,h,i)perylene	720	768	**790**
	Indeno(1,2,3-cd)pyrene	690	828	780
	Pyrene	3,300	8,580	6,000
	Benzoic acid	650	650	**1,100 J**
EW-19-Y10	Benzoic acid	650	650	**670 J**
EW-20-Y10	Bis(2-ethylhexyl)phthalate	1,300	3,250	2,200
	Benzoic acid	650	650	**1,700 J**
EW-21-Y10	Benzyl alcohol	73	73	**250**
	Benzoic acid	650	650	**1,500 J**
EW-22-Y10	Bis(2-ethylhexyl)phthalate	1,300	3,250	1,800
	Benzoic acid	650	650	**880 J**
EW-23-Y10	Bis(2-ethylhexyl)phthalate	1,300	3,250	**3,500**
	Benzoic acid	650	650	**1,900 J**
EW-24-Y10	2,4-Dimethylphenol	29	29	**50**
	Benzoic acid	650	650	**1,400 J**
EW-25-Y10	Fluoranthene	2,500	7,251	3,200
	Bis(2-ethylhexyl)phthalate	1,300	3,250	1,900
	Benzoic acid	650	650	**4,100 J**
EW-27-Y10	Bis(2-ethylhexyl)phthalate	1,300	3,250	1,700
EW-29-Y10	Benzoic acid	650	650	**1,500 J**
EW-30-Y10	Bis(2-ethylhexyl)phthalate	1,300	3,250	1,500
	Benzoic acid	650	650	**730 J**
EW-31-Y10	Bis(2-ethylhexyl)phthalate	1,300	3,250	3,100
	Benzoic acid	650	650	**790 J**
EW-32-Y10	Acenaphthene	500	2,500	800 J
	Anthracene	960	4,319	1,100 J
	Phenanthrene	1,500	7,500	2,700 J
	Total LPAH	5,200	NC	6,500 J
	Benzo(g,h,i)perylene	720	768	**1,100 J**
	Dibenz(a,h)anthracene	230	288	**290 J**
	Indeno(1,2,3-cd)pyrene	690	828	**1,100 J**
	Bis(2-ethylhexyl)phthalate	1,300	3,250	2,500 J
	Benzoic acid	650	650	**730 J**
EW-32-Y10-2	Acenaphthene	500	2,500	510 J
	Phenanthrene	1,500	7,500	1,900 J
	Benzo(g,h,i)perylene	720	768	**1,000 J**
	Dibenz(a,h)anthracene	230	288	260 J
	Indeno(1,2,3-cd)pyrene	690	828	**980 J**
	Bis(2-ethylhexyl)phthalate	1,300	3,250	2,800 J
EW-33-Y10	Benzo(g,h,i)perylene	720	768	**1,200**
	Dibenz(a,h)anthracene	230	288	240
	Indeno(1,2,3-cd)pyrene	690	828	**1,100**
	Bis(2-ethylhexyl)phthalate	1,300	3,250	**4,400**
	Benzoic acid	650	650	**1,000 J**

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.

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

4.0 BENTHIC RECOLONIZATION MONITORING

4.1 Introduction

Year 10 benthic recolonization monitoring was performed in the Thea Foss and Wheeler-Osgood Waterways during July 2016, to document and evaluate the success of the benthic recolonization in the waterways post-remediation.

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 10 benthic recolonization monitoring are presented in the Year 10 Benthic Recolonization Monitoring Preliminary Findings Memorandum (PFM) (City of Tacoma 2016d) included as Attachment C-1 and are also summarized below. Year 10 is the last monitoring year covered by the existing OMMP. Section 4.6 provides a summary of the monitoring conclusions and a brief discussion of future long-term monitoring that will be described within the Long-Term Monitoring Plan.

4.2 Summary of Benthic Recolonization Monitoring Requirements

The monitoring plan includes 17 locations within the remediation areas and four 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 chemical performance monitoring 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 10 Benthic Recolonization Monitoring PFM.

4.3 Summary of Field Activities, Analyses, and Reporting

SPI was conducted on July 1, 2016, by INSPIRE Environmental, LLC (a Germano & Associates, Inc. partnership, the contractor who had conducted the previous OMMP SPI monitoring events), with additional support and equipment provided by Floyd|Snider and Research Support Services. Benthic grab sampling was performed on July 11-14, 2016, by a 7-person field crew made up of City of Tacoma (City), Floyd|Snider, and Washington Conservation Corps (WCC) personnel. Detailed results are presented in the PFM provided in Attachment C-1. Results are summarized here to characterize the Year 10 benthic conditions.

SPI and benthic grab sampling were conducted at 21 locations (Figure 4-1). Four replicate images were captured at each SPI location (three are required per the OMMP, but an additional image was captured at each location to ensure that at least three high quality images were available for analysis). These images were subsequently processed and interpreted by INSPIRE Environmental. Five replicate grab samples were collected at each benthic grab sampling location; each of the four dredge to clean locations requiring co-located sediment samples had additional grab samples collected for sediment. All benthic and sediment samples were processed and preserved on-site in accordance with the OMMP and archived for future analysis, if needed.

Benthic grab samples were collected at the Year 10 benthic monitoring locations (planned GPS coordinates) within approximately 10 feet of where the SPI samples were taken on July 1, 2016. Location coordinates and descriptions are provided in the Year 10 PFM.

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. Per the OMMP, 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, by remediation area type, for each of the OMMP monitoring Years (Year 2, Year 4, Year 7, and Year 10) is provided below and presented in Table 4-1. Additionally, the specific values for each of the SPI parameters for each monitoring station for Year 10 are presented in the Sediment Profiling Imaging Survey report that is included in Attachment A of the Year 10 PFM for comparison.

Sediment Type (Grain size)

The sediment throughout the Thea Foss and Wheeler-Osgood Waterways had a base of fine-grained silts and clays with the exception of two locations (BR-26 and BR-29) where the substrate was predominantly very fine sand. Eleven locations had a surface layer of silty, very fine to fine sand. In Year 2 (2008) and Year 4 (2010), distinct sedimentary layers from recent depositional events were visible in the profile images (e.g., in Year 4, the layers ranged from 3.9 cm to 8.2 cm in depth). In Year 10, however, as in the Year 7 (2013) survey, there were no distinct depositional intervals observed.

Of the six locations sampled where the channel sand cap material had been placed, only one showed any evidence of coarser sediments. The presence of the channel sand cap was noted at the surface and extending a few centimeters below the surface at location BR-31. This is in contrast to the previous monitoring in Year 2 where coarser sediments were not noted at the sediment surface at any monitoring location, but similar to the monitoring in Year 4 and Year 7, where coarser sediments were observed at two different locations: BR-32 and BR-33. These two locations are in the vicinity of BR-31 in the channel sand cap area further up the waterway near Johnny's Dock Marina. Overall, consistent with the Year 2, Year 4, and Year 7 monitoring, the sediment surface "seen" by biological receptors is essentially the same throughout the waterway (with the exception of location BR-31 in the channel sand cap area) 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 (sediment surface relief) typically ranges from 0.02 to 3.8 cm, and may be related to either physical structures (ripples, rip-up structures, or mud clasts) or biogenic features (burrow openings, fecal mounds, or foraging depressions). Biogenic roughness is related to the interaction of bottom turbulence and bioturbational activities.

Surface boundary roughness for each monitoring location ranged from 0.41 cm to 2.20 cm, with the majority of the roughness elements caused by biogenic processes. The overall average surface boundary roughness for the entire survey area was 1.13 cm. This average value is calculated using the location averages (which are the average of three replicates). As reference, the Year 10 average surface boundary roughness for the background and natural recovery areas showed increases of 0.12 cm and 0.10 cm, respectively, indicating the background conditions in this portion of the waterway.

Results for Year 10 were generally similar to Year 2, Year 4, and Year 7 monitoring, with increases observed from Year 10 in surface boundary roughness compared to Year 7 monitoring in all of the remedial areas.

Prism Penetration Depth

The range of average location prism penetration depths measured in the Thea Foss and Wheeler-Osgood Waterways was due to differences in relative sediment shear strength (from varying sediment grain-size major mode and range, depth of bioturbation, etc.) as well as differences in the camera settings (i.e., camera stop collar and weight settings) that were needed to get the necessary penetration of the SPI camera. Sediments at location BR-09 in the

natural recovery area had the lowest shear strength, with one weight used at this location. The shallowest prism penetration depths were at three locations (BR-26, BR-29, and BR-31) in the channel sand cap remedial area.

The average overall prism penetration depth in the study area ranged from 5.34 cm to 17.69 cm. The overall site average camera prism depth was 13.26 cm, greater than the Year 2 and Year 7 averages of 11.38 cm and 12.32 cm respectively, and just less than the Year 4 average of 13.48 cm.

Results for Year 10 were generally greater than those found during the Year 7 monitoring in all remediation area types with the exception of the channel sand cap area which was 0.73 cm lower on average.

Apparent Redox Potential Discontinuity Depth

The depth of the redox potential discontinuity (RPD) 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 also can 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 distribution of mean aRPD depths ranged from a low of 0.78 cm observed at BR-16 in the enhanced natural recovery area, to a high of 3.54 cm at BR-28, located in the dredge to clean remedial area. The overall location-averaged mean aRPD depth for the site was 1.43 cm.

Some of the lowest values (less than 1.0 cm; which can indicate stress or disturbance) were found at BR-07, BR-11 and BR-16 near the Foss Waterway Marina, BR-09 in the channel between the Foss Waterway Marina and Commencement Bay Marine, and BR-21 in the channel near the mouth of the Wheeler-Osgood Waterway. All of these locations had aRPD depths of replicates between 0.73 cm and 1.10 cm. These locations are different than the locations found in Year 7 to have aRPD depths of less than 1.0 cm, which included BR-10, BR-22, and BR-33.

Of the three locations in Year 7 with aRPD depths less than 1.0 cm, BR-22 showed marked improvement in Year 10 with a mean location aRPD of 3.15 cm, while BR-10 and BR-33 remained essentially the same.

Sulfur-reducing bacterial colonies (*Beggiatoa* spp.) were not observed at any locations in Year 10. These white, filamentous bacterial colonies appear at the sediment surface when oxygen concentrations in the benthic boundary layer are hypoxic. In past surveys, *Beggiatoa* was observed at BR-23. Conditions have therefore improved at this location, with no observed *Beggiatoa*, an increased aRPD, and Stage 3 fauna present in all images (discussed below).

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. The Stage 1→2 and Stage 2→3 designations indicate that the community is between successional stages and transitioning to the next stage of infaunal recolonization. Additionally, various combinations of these stages are also possible. For example, Stage 1 or 2 organisms and Stage 3 organisms can occur together, indicating organic enrichment, resulting in the assignment of a Stage 1 on 3 or Stage 2 on 3 designation. A Stage 1 or 2 on 3 designation would correspond to surface-dwelling Stage 1 or 2 organisms co-existing with a Stage 3 mature, community of deep-dwelling, head-down deposit feeders. The fauna that are present for the classification of a Stage 3 community are typically pollution sensitive species.

Ninety percent of all images (57 of 63 images) taken as part of Year 10 benthic recolonization monitoring, regardless of remedial area type, have evidence of Stage 3 infaunal taxa present, similar to the results of the Year 2, Year 4, and Year 7 surveys. Many locations were Stage 1 on 3 with small tube-building and burrowing fauna in the upper 1 to 2 cm of the sediment column and larger burrowing infauna at depth. For example, tubes of the surface-deposit feeder *Spiochaetopterus costarum* were seen at BR-26, BR-31, and BR-33 indicating Stage 2 or Stage 2→Stage 3 successional stages. Improvements in benthic community status were seen in the waterways overall in Year 10—several locations that showed Stage 1→2 or Stage 2→3 in Year 7 now show Stage 3 taxa.

In the no action area at the mouth of the waterway where SPI sampling was performed at four background locations, and in the natural recovery area north of the Murray Morgan Bridge (MMB) where SPI sampling was performed at five locations, the infaunal successional stages ranged from Stage 2→3 to Stage 2 on 3 in all replicates, indicating no obvious signs of disturbance. This was an improvement in benthic community status from Year 7 when two of these locations, BR-05 (no action) and BR-07 (natural recovery), showed Stage 1→2 assemblages, with no Stage 3 taxa present.

The images from the enhanced natural recovery area located south of the MMB showed extensive burrowing activities at depth, and the dredge to clean areas all had Stage 3 taxa present. Finally, successional assemblages found in the channel sand cap areas ranged from Stage 2→3 to Stage 2 on 3, with the exceptions of BR-29 and BR-31 that showed successional Stage 2 for all replicates, whereas in Year 7 Stage 3 taxa were present. Stage 1 or Stage 1→2 assemblages were not observed at any sampling locations, an improvement from Year 7 when two locations (BR-18 and BR-33) showed Stage 1 and Stage 1→2 assemblages.

Based on the Year 10 infaunal community analysis monitoring results, all of the remedial areas sampled show evidence of mature infaunal communities present and continue to show benthic ecosystem recovery. 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 3-10 of the INSPIRE Environmental Sediment Profile Imaging Survey provided in Attachment C-1.

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.

Evidence of burrowing infauna and deposit feeding activity was present at the majority of locations surveyed in Year 10, similar to Year 7. Feeding voids were observed in about three-quarters of the images analyzed, which is an increase from Year 7, in which feeding voids were only observed in one-third of the images analyzed. The maximum bioturbation depths observed in the Thea Foss and Wheeler-Osgood Waterways monitoring locations ranged from 4.95 cm at BR-29 (due to shallow prism penetration) to 18.25 cm at BR-06. The average biological mixing depth across all of the locations was 12.77 cm, with some relatively large infaunal deposit-feeding organisms present. The overall average biological mixing depth increased slightly from 12.55 cm in Year 7.

Maximum bioturbation depth results for Year 10 were generally similar to Year 2, Year 4, and Year 7, with some depth increase in the natural recovery, enhanced natural recovery, and dredge to clean areas and a decrease in the channel sand cap area depth, which is now similar to the Year 4 value.

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 Year 10 overall median OSI for the entire study area is +7, compared to an overall median OSI of +8 in all three of the prior surveys. OSI values range from a median for the three replicates of +5 (BR-29 and BR-31) to a maximum value of +10 (BR-28).

Of the 21 locations sampled, five had a median location value less than +7 (BR-18, BR-26, BR-29, BR-31, and BR-33), an increase over the Year 7 previous survey where only one of the locations had a median location value less than +7 (BR-33). These locations are all within the channel sand cap area. Although in Year 10 BR-18 had an OSI value of +6 compared to +8 in Year 7, its OSI value has been variable over time and does not appear to be trending downward. BR-26, BR-29, and BR-31 do show decreasing OSI values between Year 2 and Year 10 sampling. BR-33 has consistently had an OSI value of +6 in all monitoring events.

In Year 7, it was noted that the OSI value of BR-23 decreased significantly between Year 2 and Year 4, from +7 to -3, but then improved to an OSI value of +7. In Year 10, BR-23 has maintained the median OSI value of +7.

The lowest OSI value of 0 was measured in one replicate of BR-16. However, the other two replicates had OSI values of +7. This one low value was due to more advanced signs of organically-enriched sediments and the presence of methane bubbles observed in the replicate with an OSI value of 0. However, other parameters used to assess benthic health such as aRPD and successional stage are not significantly different between the replicates. All three replicates show signs of a relatively high sediment oxygen demand with darker reduced sediment below the aRPD.

The median OSI values for all remedial areas are greater than +6 with the exception of the channel sand cap area that has a media OSI value of +6.

4.5 Summary of Year 10 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 findings from the Year 10 SPI survey:

- While the benthic habitat classifications were similar for the entire area in Year 2, there were observed differences in sediment type at certain locations in Year 4 and Year 7. For example, BR-18 showed evidence of the surface layer being eroded (most likely from propwash effects). However, this pattern was not observed in Year 10. Instead, the primary difference in sediment types in Year 10 was the observation of very fine to fine sand and no silt/clay in the profile images for BR-26 and BR-29.

- All of the remedial areas sampled show evidence of mature infaunal communities present and evidence of benthic ecosystem recovery. There was observed stability in the habitat conditions at monitoring BR-23, adjacent to a City outfall (OF230), where a positive change in the habitat conditions from Year 4 to Year 7 (from an OSI of -3 to an OSI of +7) had previously been observed. The Year 10 OSI value at this location was consistent with Year 7, with a value of +7.
- Consistent with the Year 7 SPI survey, there were no indications of quantum sediment input that formed distinct depositional layers during the Year 10 survey.
- In Year 7, conditions improved noticeably from Year 4, with BR-33 being the only location that continued to show retrograde successional conditions and high sediment oxygen demand. In Year 10, this location had improved to a Stage 2→3 community.

- While the results from Year 2 indicated that the completed remedial actions had a positive effect on benthic habitat quality, the Year 4 results indicated there were degraded conditions at three locations in particular (BR-18, BR-23, and BR-33). The Year 7 results showed improved benthic habitat quality at all locations with the exception of BR-33, described above. Although the Year 10 survey showed some evidence of organic loading and high sediment oxygen demand (locations with aRPDs < 1 cm), the benthic communities present appear to be able to balance these demands and persist in all remediation areas in the Thea Foss and Wheeler-Osgood Waterways, as indicated by the continued presence of mature infaunal communities with Stage 3 taxa and a waterway average OSI of +7.

- No further action is warranted based on the results of benthic recolonization monitoring performed in Year 10. Because SPI results do not require verification, analysis of the archived sediment and benthic samples does not appear to be warranted.

4.6 Conclusions and Future Long-Term Monitoring

No additional benthic monitoring activities are required to characterize the Year 10 conditions.

It is anticipated that the Long-Term Monitoring Plan for the Thea Foss and Wheeler-Osgood Waterways Remediation Project will be prepared by the City in coordination with EPA in 2017. The Long-Term Monitoring Plan will identify the future type and frequency of monitoring activities to be conducted through the waterway. If additional benthic recolonization monitoring is deemed a necessary part of the long-term monitoring, it may be appropriate to focus only on areas of organic loading and disturbance, and conducted using consistent methods and quantitative indices for long-term evaluation.

TABLES

4-1 – Summary of Sediment Profile Imaging Results

FIGURES

4-1 – Year 10 Benthic Recolonization Monitoring Locations

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)			
	Year 2 (2008)	Year 4 (2010)	Year 7 (2013)	Year 10 (2016)	Year 2 (2008)	Year 4 (2010)	Year 7 (2013)	Year 10 (2016)	Year 2 (2008)	Year 4 (2010)	Year 7 (2013)	Year 10 (2016)	Year 2 (2008)	Year 4 (2010)	Year 7 (2013)	Year 10 (2016)	Year 2 (2008)	Year 4 (2010)	Year 7 (2013)	Year 10 (2016)
Background/ No Action	1.07	0.75	0.90	1.02	2.77	2.49	2.98	1.59	2 1 on 3	3 1 on 3	1 to 2 2 to 3 1 on 3 2 on 3	3 1 on 3 2 on 3	13.57	13.43	13.23	13.06	+8	+9	+9	+8
Natural Recovery	0.91	0.88	0.73	0.83	2.50	2.38	1.85	1.04	1 on 3 2 to 3	3 2 to 3	1 to 2 2 to 3 1 on 3	3 1 on 3 2 on 3	14.88	16.33	14.56	18.25	+8	+8	+8	+7
Enhanced Natural Recovery	1.16	0.48	0.79	1.01	2.27	1.20	1.49	0.79	1 on 3 2 to 3	1 on 3	1 on 3	1 on 3 2 on 3	10.02	13.54	13.14	15.04	+9	+7	+7	+7
Dredge to Clean	1.00	1.22	0.98	1.32	2.20	2.43	1.92	2.45	1 on 3	3 1 on 3	2 to 3 1 on 3 2 on 3	3 1 on 3 2 on 3	18.15	17.66	15.59	16.89	+9	+9	+8	+8.5
Channel Sand Cap	1.59	1.16	1.10	1.33	1.78	1.69	1.41	1.11	1 on 3 2 to 3	3 1 to 3	1 1 to 2 3 1 on 3	2 2 to 3 3 1 on 3 2 on 3	18.86	15.26	20.05	15.69	+7.5	+8	+7	+6

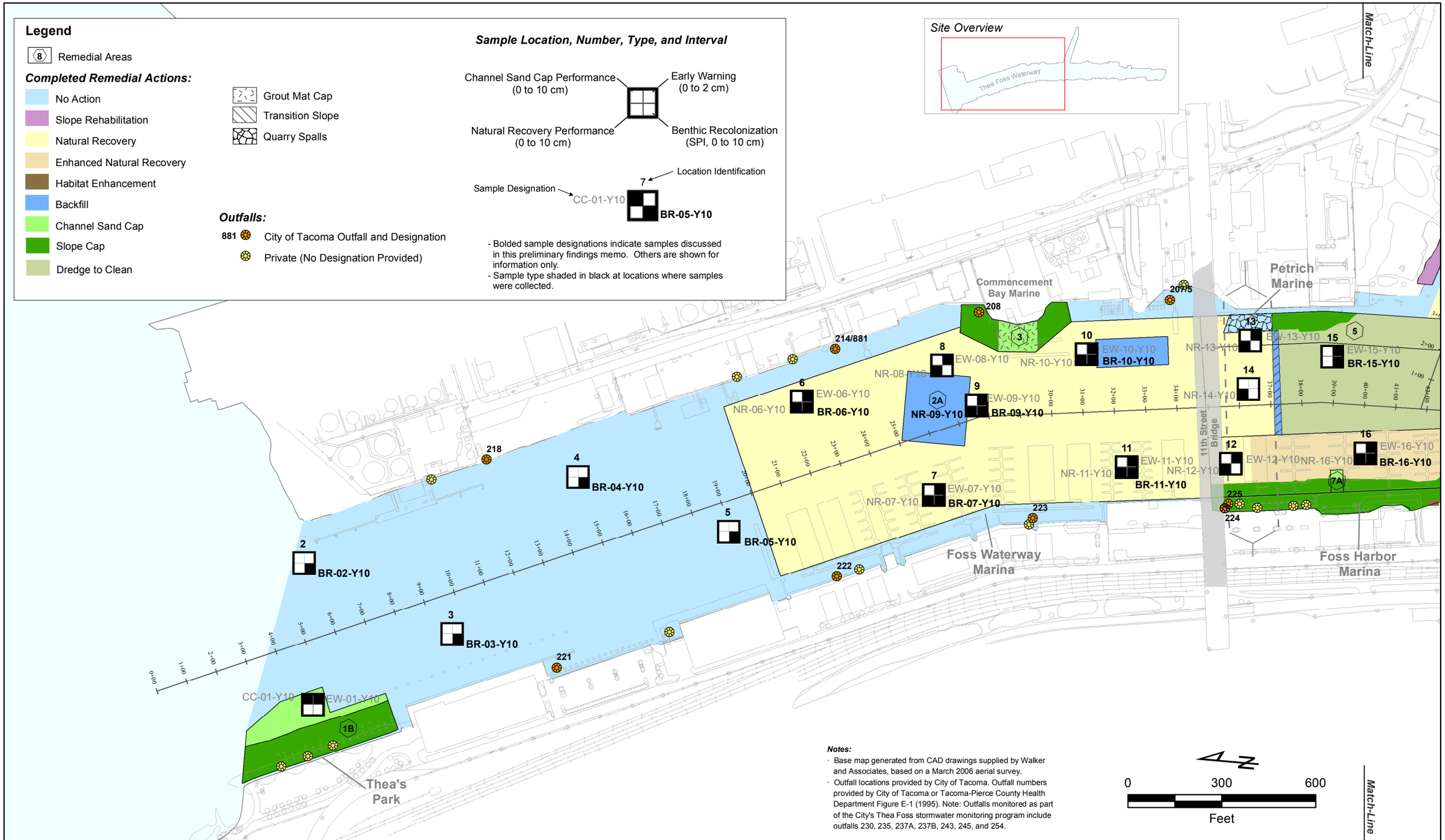

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Figure 4-1 (Page 1 of 2) Year 10 Benthic Recolonization Monitoring Locations

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

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5.0 CONFINED DISPOSAL FACILITY PERFORMANCE MONITORING

5.1 Introduction

The third CDF performance monitoring event of the St. Paul Waterway confined disposal facility (CDF) was conducted in Year 10 (2016). The first CDF monitoring event was previously conducted in Year 4 (2010), and the second CDF monitoring event was conducted in Year 7 (2013). Performance monitoring includes surface water and groundwater sampling and analysis as well as CDF berm and cap inspections. The results of the third performance monitoring event were documented in the Year 10 (2016) Performance Monitoring Memorandum that was submitted to the U.S. Environmental Protection Agency (EPA) on September 12, 2016 (see Attachment D-1). CDF performance monitoring was performed in accordance with the CDF monitoring requirements specified in the Operations, Maintenance, and Monitoring Plan (OMMP) for the Thea Foss and Wheeler-Osgood Waterways Remediation Project (City of Tacoma 2006) and the St. Paul Waterway Confined Disposal Facility Performance Monitoring Plan (City of Tacoma 2009a).

As part of the OMMP, both baseline monitoring and performance monitoring of the groundwater quality at the St. Paul Waterway CDF are required. Baseline and performance monitoring of the St. Paul Waterway CDF are performed to characterize post-construction groundwater quality and flow conditions to ensure the protection of adjacent surface water. Baseline monitoring of the St. Paul Waterway CDF was completed in December 2008, after being performed for eight quarters in March, June, September and December of 2007 and 2008. Quarterly baseline CDF monitoring included surface water and groundwater sampling and analysis, as well as CDF berm and cap inspections. The findings of baseline monitoring and an assessment of groundwater quality baseline conditions are summarized in the Baseline Water Quality Conditions Report (City of Tacoma 2009b).

The objective of performance monitoring is to compare long-term post-construction groundwater quality with baseline conditions established in the first two years following construction, to determine if constituents are being transported in groundwater from the CDF at concentrations that could pose a potential threat to surface water quality at the point of compliance. This comparison allows for the evaluation of the effectiveness of the remedy to ensure that the selected remedy remains protective, and an assurance that baseline concentrations are not exceeded in the surface water outside of the CDF. The performance standard for the performance monitoring program is to evaluate whether statistically significant increases in contaminant concentrations relative to the established groundwater baseline concentrations are observed.

The following sections summarize CDF performance monitoring requirements and the findings from the CDF performance monitoring activities performed in Year 10. The Year 10 CDF Performance Monitoring Memorandum is included as Attachment D-1. In addition, monitoring of erosion identified at the containment berm is performed coincident with the CDF performance monitoring, and a summary of the results of this year's monitoring is included below.

5.2 Summary of CDF Monitoring Requirements

CDF monitoring activities 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;
- Reporting of baseline groundwater conditions in the Baseline Groundwater Monitoring Report that was submitted to EPA on March 16, 2009;
- Performance of Year 4 performance CDF monitoring activities for surface water and groundwater sampling and analysis and berm and cap inspections between June 2-9, 2010;
- Reporting of performance monitoring results in the Year 4 2010 CDF Performance Monitoring Memorandum that was submitted to EPA on November 4, 2010;
- Performance of Year 7 performance CDF monitoring activities for surface water and groundwater sampling and analysis and berm and cap inspections between June 4 and July 16, 2013;
- Reporting of performance monitoring results in the Year 7 2013 CDF Performance Monitoring Memorandum that was submitted to EPA on October 9, 2013;
- Performance of Year 10 performance CDF monitoring activities for surface water and groundwater sampling and analysis and berm and cap inspections between June 13 and July 6, 2016; and
- Reporting of performance monitoring results in the Year 10 2016 CDF Performance Monitoring Memorandum that was submitted to EPA on September 12, 2016.

The performance monitoring program included the collection, analysis, and interpretation of groundwater data from six monitoring wells (four shallow and two deep) located around the perimeter of the St. Paul Waterway CDF (Figure 5-1). A groundwater monitoring sample was also collected from MW-04, the shallow well located within the contaminated sediments in the CDF during Year 4 and Year 7 sampling events. MW-04 and adjacent monitoring well MW-05 were not located as part of Year 10 sampling and both are believed to have been destroyed. Therefore, no groundwater samples were collected from MW-04 as part of the Year 10 sampling event. Groundwater samples from MW-04 were collected in previous events for informational purposes only and not included in any statistical comparisons to performance criteria (i.e., groundwater baseline concentrations). EPA was notified of this change via email on June 8, 2016 and acknowledged the information on June 9, 2016. Photographs of remaining wells were taken, and will be re-marked to ensure that they are visible to site operators.

An ambient surface water quality sample was also collected to establish background conditions in the adjacent surface water, and visual observations of the CDF containment and offset berms and surface of the CDF cap were made to document the condition of the berms and the cap.

In order to determine if statistically significant increases in contaminant concentrations relative to the established groundwater baseline concentrations were observed, the performance monitoring results for this CDF performance monitoring event were compared to the 95th percentile upper tolerance limit (UTL) for each analyte in each individual monitoring well for the baseline data set.

5.3 Summary of Field Activities, Analyses, and Reporting

Field activities for the CDF performance monitoring of the St. Paul Waterway CDF performed as part of Year 10 OMMP activities were conducted between June 13, 2016 and July 6, 2016. Groundwater performance monitoring was completed June 13-14, 2016. Surface water samples were collected from the City of Tacoma boat on June 13, 2016. CDF cap and berm inspections were performed on July 6, 2016.

Surface water monitoring was conducted at the station adjacent to the end of the St. Paul / Middle Waterway Peninsula and included the collection of one surface water sample and one sample duplicate (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 the City of Tacoma Laboratory for salinity, total mercury, and dissolved metals analyses. Conductivity was measured in the field.

Groundwater samples were collected from all six performance monitoring wells (Figure 5-1). Groundwater samples were submitted to the City of Tacoma Laboratory under chain of custody for total mercury, dissolved metals, polycyclic aromatic hydrocarbons (PAHs), salinity, total organic carbon (TOC), and total suspended solids (TSS) analyses. Conductivity was measured in the field.

Both surface and groundwater sampling was performed in general accordance with the procedures specified in the OMMP and the CDF Performance Monitoring Plan (City of Tacoma 2006 and 2009a). A summary of information regarding the purging of groundwater wells and the stabilization of field parameters, and the results of dedicated equipment inspections are discussed in detail in the Year 10 CDF Performance Monitoring Memorandum (Appendix D). 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 performed on July 6, 2016, and photographs were taken from a total of five photo points (Figure 5-2). Field forms were completed documenting observations during each monitoring event.

A Performance Monitoring Memorandum was prepared for the Year 10 CDF monitoring that documented field activities, presented the results of water quality parameter measurements and surface water and groundwater sample analyses, and observations from berm and cap inspections (Attachment D-1). The memorandum includes 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 following sections summarize the findings from the CDF performance monitoring that occurred during Year 10.

5.4 Summary of CDF Performance Monitoring Results

The results from the CDF performance monitoring completed during Year 10 are summarized in the following sections. Tables 5-1 through 5-3 provide a tabulated summary of the analytical results for surface water and groundwater samples for the CDF performance monitoring that occurred during Year 10 and a comparison of the groundwater data to the baseline 95th percentile UTL criteria at each location.

5.4.1 Surface Water Monitoring

Salinity was detected at 28.2 parts per thousand (ppt) in both the surface water and duplicate sample collected at the ambient surface water sampling location. Conductivity was measured at 42,600 umhos/cm in both the surface water and duplicate sample collected at the ambient surface water sampling location.

The only metal detected in surface water samples during Year 10 performance monitoring was dissolved zinc (Table 5-1). Total mercury and dissolved copper, lead, mercury, and nickel were not detected in the Year 10 surface water samples. Dissolved zinc was detected in the parent surface water sample collected from the ambient surface water sampling location at a concentration of 2.84 µg/L, and in the duplicate surface water sample at a concentration of 1.53 µg/L. The variation in the field duplicate result versus the parent is within the natural inherent variability of sampling in the surface water environment. Dissolved zinc was also the only metal detected in surface water monitoring during the Year 7 performance monitoring at concentrations comparable to the Year 10 duplicate sample and just less than two times the Year 7 concentration in the parent sample.

5.4.2 Groundwater Monitoring

Salinity ranged from 10.4 to 23.6 ppt in monitoring wells adjacent to the CDF (Tables 5-2 and 5-3). Conductivity in groundwater samples collected from monitoring wells adjacent to the CDF ranged from 17,400 to 35,400 umhos/cm. The lowest salinities and conductivities measured in the monitoring wells adjacent to the CDF were measured in MW-02 located northwest of the CDF. Consistent with the baseline monitoring, the highest salinity and conductivity measurements were found at deep monitoring well MW-08, located west of the CDF.

TOC measurements in wells adjacent to the CDF ranged from less than a detection limit of 10 mg/L to 31.8 mg/L in Year 10. TOC was measured below detection in shallow wells MW-01, MW-06, and MW-10. The highest TOC measured in wells adjacent to the CDF was in the groundwater sample collected from deep well MW-08, at 31.8 mg/L.

TSS measured in the wells adjacent to the CDF ranged from less than a detection limit of 2.35 mg/L to 107 mg/L, at wells MW-01 and MW-08, respectively.

Dissolved zinc, dissolved nickel, and dissolved copper were detected at one or more performance monitoring wells during Year 10 performance monitoring. Similar to baseline monitoring, dissolved mercury, total mercury, and dissolved lead were not detected in any of the Year 10 groundwater samples collected from monitoring wells adjacent to the CDF. Refer to the

Year 10 CDF Performance Monitoring Memorandum (Appendix D) for dissolved mercury, total mercury, and dissolved lead results.

Dissolved copper was detected in groundwater from three of the six performance monitoring wells located adjacent to the CDF: shallow wells MW-01 (2.17 µg/L) and MW-06 (109 µg/L) and deep well MW-08 (2.0 µg/L). The concentration at MW-01 is less than concentrations detected in this well during baseline monitoring, Year 4 and Year 7 performance monitoring. The concentration at MW-08 is less than the concentration detected in this well during baseline monitoring, and less than the reporting limit in Year 4 performance monitoring. Dissolved copper was not detected in MW-08 in Year 4 or Year 7 monitoring. The concentration at MW-06 is slightly greater than the maximum concentration measured in baseline monitoring (100 µg/L) and in Year 4 and Year 7 performance monitoring (56 µg/L and 87 µg/L, respectively).

Dissolved nickel was detected in groundwater collected from all performance monitoring wells, except for MW-08. The lowest detected concentration was 1.83 µg/L in groundwater collected from deep monitoring well MW-12, and the highest concentration was 12.6 µg/L detected in groundwater collected from shallow monitoring well MW-02. These detected concentrations are generally within the range of concentrations detected in these wells during baseline monitoring and Year 4 and Year 7 performance monitoring. Nickel was detected in groundwater samples collected from all monitoring wells located both adjacent to and within the CDF during baseline monitoring.

During baseline monitoring, dissolved zinc was only detected in groundwater collected from shallow monitoring well MW-06. During the baseline monitoring, the analytical reporting limit for zinc was 20 or 40 µg/L, depending on the sampling round. However, during performance monitoring using EPA Method 6020A, the reporting limit for zinc is substantially lower at 5 µg/L. During the Year 10 monitoring event dissolved zinc was detected in all monitoring wells adjacent to the CDF at concentrations ranging from 1.81 µg/L at MW-10 to 522 µg/L at MW-06. These detected concentrations for monitoring wells other than MW-06 are all below the reporting limits achieved at these same wells during baseline monitoring, therefore, it is not expected that there has been an increase in zinc detections in groundwater since baseline monitoring, but that lower concentrations of zinc are detected with the lower reporting limit. In Year 10 the dissolved zinc concentration detected in MW-06 was 522 µg/L. Consistent with baseline, Year 4, and Year 7 monitoring, dissolved zinc was detected in MW-06 during Year 10 at a substantially higher concentration than that of any other monitoring well. The Year 10 dissolved zinc concentration of 522 µg/L, is within the range of concentrations detected during baseline monitoring, and less than concentrations of 894 µg/L detected during the Year 4 performance monitoring and 580 µg/L detected during the Year 7 performance monitoring

In general, samples collected from shallow and deep wells adjacent to the CDF had similar or lower metals results during Year 10 performance monitoring as compared to the results of the quarterly baseline monitoring and Years 4 and 7 performance monitoring, with the exception of the slight increase in the dissolved copper concentration detected in MW-06 that is just outside the previously observed range. The results of quarterly baseline monitoring indicated that the metal concentrations detected in MW-06 were likely associated with a localized source, as copper and zinc were not detected or were detected at significantly 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). The comparison of the metals concentrations detected in MW-06 in performance monitoring to the baseline 95th percentile UTL performance criteria is discussed below in Section 5.4.3.

PAHs were detected in MW-02, and were not detected in MW-01, MW-06, MW-08, MW-10, or MW-12 during Year 10 performance monitoring. Two LPAHs were detected at low levels in the groundwater sample collected from shallow well MW-02; anthracene at a concentration of 0.020 µg/L and naphthalene at 0.011 µg/L, both near the detection limit. Three HPAHs were detected at low levels in the groundwater samples collected from MW-02: benzo(a)anthracene at 0.011 µg/L, fluoranthene at 0.026 µg/L, and pyrene at 0.025 µg/L. During Year 7 monitoring of MW-02, one LPAH was detected (anthracene at 0.011 µg/L), and a total of five HPAHs were detected; benzo(g,h,i)perylene, dibenzo(a,h)anthracene, fluoranthene, indeno(1,2,3-cd)pyrene, and pyrene, at concentrations slightly above the reporting limit, ranging from 0.012 µg/L to 0.019 µg/L. The Year 10 detected concentrations of PAHs in MW-02 are within the range of concentrations detected during quarterly baseline monitoring and during Year 4 and Year 7 performance monitoring.

5.4.3 Comparison of Performance Monitoring Results to Performance Criteria

Analytical results of the samples collected during the Year 10 performance monitoring were compared to the distributions observed for each analyte at each well during the two-year baseline monitoring program. The data collected from the performance monitoring well were compared to the baseline analyte arithmetic or Kaplan-Meier mean (as determined in the baseline statistical evaluation) and the baseline 95th percentile UTL for each analyte in each monitoring well (refer to Tables 5-2 and 5-3).

As was the case with Year 7 performance monitoring, all of the groundwater PAH and metal concentrations detected during the Year 10 performance monitoring were less than the baseline 95th percentile UTL values, where values were available for comparison (Tables 5-2 and 5-3). Results are further discussed below.

During Year 4 performance monitoring, dissolved zinc was the only analyte that exceeded a baseline 95th percentile UTL, based on results from MW-06. The Year 10 performance monitoring zinc concentration of 522 µg/L is less than the baseline 95th percentile UTL and the Year 4 and Year 7 performance monitoring detected concentrations.

During Year 10 performance monitoring there were no conventional parameters that exceeded the baseline 95th percentile UTLs (Tables 5-2 and 5-3).

Baseline 95th percentile UTL performance criteria are available for two of the five PAHs detected in Year 10 performance monitoring, and there were no exceedances of the baseline 95th percentile UTL performance criteria for either of these PAHs detected at MW-02, the only monitoring well where PAHs were detected during Year 10 performance monitoring. LPAHs anthracene and naphthalene were detected at concentrations of 0.020 µg/L and 0.011 µg/L, respectively, in the groundwater collected from MW-02 during Year 10 performance monitoring. The HPAHs benzo(a)anthracene, fluoranthene, and pyrene were also detected in MW-02 groundwater, as concentrations of 0.011 µg/L, 0.026 µg/L, and 0.025 µg/L, respectively. As shown in Table 5-2, the baseline 95th percentile UTLs for anthracene, naphthalene, and benzo(a)anthracene were not able to be statistically calculated following the completion of the baseline monitoring program because there were insufficient detections to calculate a baseline 95th percentile UTL. Anthracene was not detected in Year 4 sampling at MW-02, and was detected at 0.011 µg/L in Year 7 performance monitoring. Napthalene was detected at 0.020 µg/L in Year 4 sampling at MW-02, and was not detected in Year 7 performance monitoring.

Benzo(a)anthracene was not detected in groundwater from MW-02 in either Year 4 or Year 7 performance monitoring. Fluoranthene and pyrene were detected during all three performance monitoring events at MW-02, but results for all were considerably less than the baseline 95th percentile UTL.

All detected metals and PAH concentrations were below the baseline 95th percentile UTL performance criteria, where comparisons are able to be performed.

5.4.4 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 the performance monitoring performed in Year 10. Additionally, no indications of erosion or material loss were observed on the cap or in the offset berm. With changes in operation at the site, the area is no longer used for log storage. There were no areas of ponded water observed on the cap surface or in the CDF cap drainage system during this inspection.

The erosion on the north face of the containment berm was inspected at the same time as the overall CDF inspection. Some of the rip rap from the surface of the containment berm is exposed and is continuing to spread in the upper area of the beach. There appears to have been some increase in the amount of exposed rip rap in the upper area of the beach in front of the containment berm relative to previous inspections. However, the berm continues to appear generally stable from a containment perspective at this time.

Within the habitat area on the surface of the containment berm, the maximum observed erosion of topsoil was a height of approximately 52 inches in the central portion of the containment berm. Measured depths of erosion appeared generally similar in most areas to measurements from previous monitoring events, but there appeared to be some increase in the amount of riprap present at the beach surface at the toe of the slope relative to the past inspections. The exposed material appears to be helping the upper shoreline reach a more stable angle of repose. Plants are continuing to become established on the upper beach and in the riparian area. There are several areas on both the east and west ends of the berm where portions of the bank with dune grass have become undercut and fallen. In these areas, the dune grass is generally continuing to grow and spread at the new, lower elevation on the upper portion of the beach. To accelerate the establishment of dune grass, additional plants have been placed over time in several areas along the slope. This is expected to help stabilize the bank as it continues to spread.

Overall, the CDF cap and both the offset and the containment berms appeared to be in good condition, and there were no concerns identified during the inspection.

5.5 Summary of Findings for the CDF Performance Monitoring

The following summarizes the findings from the CDF performance monitoring conducted in Year 10:

- Surface Water Monitoring
  - Copper, lead, nickel, and mercury were not detected in the ambient surface water sample and duplicate.

- Dissolved zinc was detected in the ambient surface water sample and duplicate at concentrations slightly above the reporting limit.

- Groundwater Monitoring
  - Dissolved lead, dissolved mercury, and total mercury were not detected in any groundwater samples collected from performance monitoring wells.
  - Dissolved nickel was detected in all performance monitoring wells except for MW-08, and dissolved zinc was detected in all performance monitoring wells.
  - Dissolved copper was detected in three performance monitoring wells; MW-01, MW-06, and MW-08.
  - Consistent with baseline monitoring, the highest concentrations of dissolved copper and dissolved zinc were detected in MW-06. The highest concentration of dissolved nickel was detected in MW-02.
  - All detected metals concentrations except dissolved copper at MW-06 are within the range of those observed during baseline monitoring. The dissolved copper concentration measured at MW-06 is less than the baseline 95th percentile UTL, though slightly higher than the maximum concentration measured in baseline monitoring and in Year 4 and Year 7 performance monitoring events.
  - MW-06 is an outlier for metals indicating that detections are likely associated with a localized source and not groundwater transport from the CDF.
  - PAHs were not detected in performance monitoring wells MW-01, MW-06, MW-08, MW-10 and MW-12.
  - Five PAHs were detected in MW-02 during Year 10 performance monitoring. Six PAHs were detected in MW-02 as part of Year 7 performance monitoring,
  - All detected PAHs and detected concentrations are within the range of those observed during baseline monitoring.
  - There were no PAH or metal exceedances of baseline 95th percentile UTL performance criteria during this performance monitoring event.

- CDF Berm and Cap Inspections
  - No seeps, sheens, or other indications of contamination were identified during berm and cap inspections.
  - Log storage is not currently occurring on the CDF cap due to a change in site operations by the property owner.
  - There was no ponded water observed on the surface of the CDF cap or in the CDF cap drainage system.
  - The maximum observed loss of topsoil/riprap at the containment berm due to erosion was a height of approximately 52 inches and appears somewhat more than previous observations.
  - Some rip rap is exposed on the upper slope of the beach, and appears to be somewhat more than previous observations; however, the containment berm does not appear to be compromised.

- No deficiencies were identified upon inspection of the offset berm and CDF cap.

5.6 Conclusions and Future Long-Term Monitoring

Data of acceptable quality were collected from all performance monitoring wells and the adjacent surface water location during the Year 10 performance monitoring event to achieve the objectives of CDF performance monitoring. Analyte concentrations detected in wells during performance monitoring were compared to the baseline mean and baseline 95th percentile UTL performance criteria. This allowed for the evaluation of the effectiveness and protectiveness of the CDF remedy during Year 10 performance monitoring. As described in detail in the previous results sections, and summarized below, there were no PAH or metal exceedances of the baseline 95th percentile UTL.

The results of baseline monitoring indicated that the metal concentrations detected in MW-06 are likely associated with a localized source, as dissolved copper and dissolved zinc were not detected or were detected at significantly lower concentrations in other shallow groundwater wells (MW-01, MW-02, and MW-10). Performance monitoring results indicate that the elevated zinc concentration detected in MW-06, remains localized and is not associated with statistically significant increases in chemical concentrations in groundwater flowing from the CDF. Consistent with baseline monitoring, elevated zinc concentrations were not detected in other shallow performance monitoring wells, or in previous monitoring of upgradient CDF well MW-04.

In Year 10, in shallow performance monitoring well MW-02, five PAHs were detected at low level concentrations that were close to the reporting limits and within the range of concentrations detected during baseline monitoring and Year 4 and Year 7 performance monitoring. The detected concentrations of PAHs in MW-02 were less than the baseline 95th percentile UTL performance criteria for all PAHs.

This comparison of long-term post-construction groundwater quality to the established baseline conditions indicates that no constituents are being transported in groundwater from the CDF at concentrations that could pose a potential threat to surface water quality at the point of compliance. No statistically significant increases in contaminant concentrations relative to the established groundwater baseline concentrations have been observed. This evaluation indicates that baseline concentrations are not exceeded in the surface water outside of the CDF, confirming the continued effectiveness and protectiveness of the remedy.

It is anticipated that the Long-Term Monitoring Plan for the Thea Foss and Wheeler-Osgood Waterways Remediation Project will be prepared by the City in coordination with EPA in 2017. The Long-Term Monitoring Plan will identify the future scope and frequency of groundwater and surface monitoring activities to be conducted to assess the performance of the CDF.

TABLES

5-1 – Summary of Surface Water Analytical Results from the Year 10 (2016) Performance Monitoring

5-2 – Summary of Shallow Groundwater Analytical Results and Baseline Criteria Comparison for Year 4, (2010), Year 7 (2013), and Year 10 (2016) Performance Monitoring

5-3 – Summary of Deep Groundwater Analytical Results and Baseline Criteria Comparison for Year 4 (2010), Year 7 (2013), and Year 10 (2016) Performance Monitoring

FIGURES

5-1 – Performance CDF Surface Water and Groundwater Monitoring Locations

5-2 – Performance CDF Berm and Cap Photo Point and Observation Locations

5-3 – North Beach Habitat Photo Point Locations

Table 5-1
Summary of Surface Water Analytical Results
from the Year 10 (2016) Performance Monitoring

	Station	SWM-01	
	Sample ID	SWM-01-Y10	SWM-DUP-Y10[1]
	Sample Date	6/13/2016	6/13/2016
Parameter	**Units**		
Conventionals			
Conductivity	umhos/cm	42,600	42,600
Salinity	ppt	28.2	28.2
Metals Dissolved			
Copper	µg/L	1.50 U	1.50 U
Lead	µg/L	1.50 U	1.50 U
Nickel	µg/L	1.50 U	1.50 U
Zinc	µg/L	**2.84**	**1.53**
Mercury	µg/L	0.250 U	0.250 U
Metals Total			
Mercury	µg/L	0.250 U	0.250 U

Note:

1. Sample SWM-DUP-Y10 is a duplicate of sample SWM-01-Y10.

Qualifiers:

U - Undetected

Bolded results indicate detected concentrations.

Table 5-2
Summary of Shallow Groundwater Analytical Results and Baseline Criteria Comparison for Year 4 (2010), Year 7 (2013), and Year 10 (2016) Performance Monitoring

Analytes for Each Performance Well	Units	Baseline Mean	Baseline 95 UTL	2010 Performance Monitoring Results		2013 Performance Monitoring Results		2016 Performance Monitoring Results	
MW-01									
pH[1]	pH units	6.78	7.4	6.57		6.62		6.66	
Dissolved Oxygen (DO)[1]	mg/L	5.066	11.15	4.10		1.30		0.00	
Conductivity	umhos/cm	27,683	42,397	25,540		21,700		24,000	
Salinity	ppt	17.1	27.7	21		12		15	
Total Organic Carbon (TOC)	mg/L	17.3	102	6.0		13		10	U
Total Suspended Soilds (TSS)	mg/L	16	35	3.8		1.4		2.35	U
Copper Dissolved	µg/L	8.4	14	5.7		2.5		2.17	
Nickel Dissolved	µg/L	60.5	396	5.0	U	9.5		10.3	
Zinc Dissolved	µg/L	NA	NA	5.0	U	29		3.19	
Naphthalene	µg/L	0.023	NA	0.010	U	0.010	U	0.010	UJ
Benzo(g,h,i)perylene[6]	µg/L	NA	NA	0.010	U	0.010		0.010	UJ
Dibenzo(a,h)anthracene[6]	µg/L	NA	NA	0.010	U	0.012		0.010	UJ
MW-02									
pH[1]	pH units	6.139	6.751	6.15		6.55		6.15	
Dissolved Oxygen (DO)[1]	mg/L	0.949	3.34	1.04		4.46		0.91	
Conductivity	umhos/cm	14,278	28,224	16,200		14,200		17,400	
Salinity	ppt	7.8	15	9.4		7.4		10.4	
Total Organic Carbon (TOC)	mg/L	48	195	24		41		19	
Total Suspended Soilds (TSS)	mg/L	108	191	176		22		28	
Copper Dissolved	µg/L	4	NA	5.0	U	1.0	U	1.0	U
Nickel Dissolved	µg/L	10	22	5.0		6.0		12.6	
Zinc Dissolved	µg/L	NA	NA	22.2		7.4		6.75	
Acenaphthene	µg/L	0.025	0.052	0.011	J	0.010	U	0.010	UJ
Anthracene	µg/L	0.019	NA	0.010	UJ	0.011		0.020	
Fluorene	µg/L	0.019	NA	0.010	U	0.010	U	0.010	UJ
Naphthalene[2]	µg/L	0.013	NA	0.020	J	0.010	U	0.011	J
Phenanthrene[3]	µg/L	0.028	NA	0.012		0.010	U	0.010	UJ
Benzo(a)anthracene	µg/L	0.031	NA	0.010	U	0.010	U	0.011	J
Benzo(a)pyrene	µg/L	0.023	NA	0.010	U	0.010	U	0.010	UJ
Benzofluoranthenes (total)	µg/L	0.032	NA	0.020	U	0.020	U	0.021	UJ
Benzo(g,h,i)perylene[4]	µg/L	0.014	NA	0.010	U	0.017		0.010	UJ
Chrysene	µg/L	0.023	NA	0.010	U	0.010	U	0.010	UJ
Dibenzo(a,h)anthracene[6]	µg/L	NA	NA	0.010	U	0.019		0.010	UJ
Fluoranthene	µg/L	0.051	0.305	0.025		0.013		0.026	
Indeno(1,2,3-cd)pyrene[5]	µg/L	0.011	NA	0.010	U	0.016		0.010	UJ
Pyrene	µg/L	0.040	0.222	0.021		0.012		0.025	

Analytes for Each Performance Well	Units	Baseline Mean	Baseline 95 UTL	2010 Performance Monitoring Results	2013 Performance Monitoring Results	2016 Performance Monitoring Results
MW-06						
pH[1]	pH units	6.757	8.426	6.46	6.76	6.62
Dissolved Oxygen (DO)[1]	mg/L	2.821	8.238	6.10	3.41	0.67
Conductivity	umhos/cm	30,673	44,392	29,300	31,620	29,100
Salinity	ppt	19.4	28.3	24	19	18.5
Total Organic Carbon (TOC)	mg/L	21.0	206	13	10	10 U
Total Suspended Solids (TSS)	mg/L	23	121	4.8	3.3	7.69
Copper Dissolved	µg/L	60	120	87	56	109
Nickel Dissolved	µg/L	54	121	19	24	8.2
Zinc Dissolved	µg/L	446	789	**894**	580	522
2-Methylnaphthalene	µg/L	0.133	NA	0.010 UJ	0.010 U	0.010 UJ
Acenaphthene	µg/L	0.845	NA	0.010 UJ	0.010 U	0.010 UJ
Anthracene	µg/L	0.122	NA	0.010 UJ	0.010 U	0.010 UJ
Fluorene	µg/L	0.399	NA	0.010 U	0.010 U	0.010 UJ
Naphthalene	µg/L	2.19	NA	0.010 UJ	0.010 U	0.010 UJ
Phenanthrene	µg/L	0.39	NA	0.010 U	0.010 U	0.010 UJ
Benzo(a)anthracene	µg/L	0.102	NA	0.010 U	0.010 U	0.010 UJ
Benzo(a)pyrene	µg/L	0.067	NA	0.010 U	0.010 U	0.010 UJ
Benzofluoranthenes (total)	µg/L	0.131	NA	0.020 U	0.010 U	0.020 UJ
Benzo(g,h,i)perylene	µg/L	0.046	NA	0.010 U	0.010 U	0.010 UJ
Chrysene	µg/L	0.118	NA	0.010 U	0.010 U	0.010 UJ
Dibenzo(a,h)anthracene	µg/L	0.011	NA	0.010 U	0.010 U	0.010 UJ
Fluoranthene	µg/L	0.63	NA	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 UJ
Pyrene	µg/L	0.383	NA	0.010 U	0.010 U	0.010 U
MW-10						
pH[1]	pH units	6.507	7.62	6.28	7.16	6.74
Dissolved Oxygen (DO)[1]	mg/L	0.541	1.177	0.63	**2.02**	0.35
Conductivity	umhos/cm	30,011	45,429	27,660	25,460	21,000
Salinity	ppt	19.3	30.4	23	16	13
Total Organic Carbon (TOC)	mg/L	11	38	7.0	14	10 U
Total Suspended Soilds (TSS)	mg/L	40.6	73.6	32	18	20.3
Copper Dissolved	µg/L	7	9	5.0 U	1.0 U	1.0 U
Nickel Dissolved	µg/L	12	23	5.0 U	1.9	3.8
Zinc Dissolved	µg/L	NA	NA	26.8	4.8	1.81
Acenaphthene	µg/L	0.014	0.017	0.010 UJ	0.010 U	0.010 UJ
Naphthalene	µg/L	0.02	NA	0.010 UJ	0.010 U	0.010 UJ
Fluoranthene	µg/L	0.019	0.030	0.012	0.010 U	0.010 UJ
Pyrene	µg/L	0.014	0.021	0.010 U	0.010 U	0.010 UJ

Notes:

MW Monitoring Well

NA Analyte is presented in the table as it was detected at least once during baseline monitoring or performance monitoring, however, there were insufficient detections during baseline monitoring to calculate a baseline 95th UTL.

UTL Upper Tolerance Level

1 pH and dissolved oxygen measurements were conducted in the field during sampling using a multi-parameter field meter.

2 The maximum naphthalene concentration detected in MW-02 during baseline monitoring was 0.019 ug/L.

3 The maximum phenanthrene concentration detected in MW-02 during baseline monitoring was 0.048 ug/L.

4 The maximum benzo(g,h,i)perylene concentration detected in MW-02 during baseline monitoring was 0.014 ug/L.

5 The maximum indeno(1,2,3-cd)pyrene concentration detected in MW-02 during baseline monitoring was 0.011 ug/L.

6 The analyte was not detected during baseline monitoring.

Bolded results indicate detected concentrations above the baseline 95th UTL.

Qualifiers:

U - Undetected

UJ - Undetected and the associated numerical value is an estimated quantity.

Table 5-3
Summary of Deep Groundwater Analytical Results and Baseline Criteria Comparison for Year 4 (2010), Year 7 (2013), and Year 10 (2016) Performance Monitoring

Analytes for Each Performance Well	Units	Baseline Mean	Baseline 95 UTL	2010 Performance Monitoring Results	2013 Performance Monitoring Results	2016 Performance Monitoring Results
MW-08						
pH[1]	pH units	7.077	8.17	6.83	7.04	6.82
Dissolved Oxygen (DO)[1]	mg/L	0.716	1.7	0.34	0.59	0.0
Conductivity	umhos/cm	37,303	46,064	34,770	38,280	35,400
Salinity	ppt	22.7	30.7	29	23	23.6
Total Organic Carbon (TOC)	mg/L	80.4	269	25	110	31.8
Total Suspended Solids (TSS)	mg/L	88.3	218.8	54	79	107
Copper Dissolved	µg/L	4	NA	5.0 U	1.0 U	2.0
Nickel Dissolved	µg/L	10	15	5.0 U	1.0 U	1.5 U
Zinc Dissolved	µg/L	NA	NA	9.5	4.3	2.09
Naphthalene	µg/L	0.018	NA	0.010 UJ	0.010 U	0.011 UJ
MW-12						
pH[1]	pH units	7.537	9.159	7.02	7.38	7.15
Dissolved Oxygen (DO)[1]	mg/L	0.41	1.17	0.13	0.64	0.05
Conductivity	umhos/cm	27,673	34,424	28,250	**74,950**	32,300
Salinity	ppt	18.0	23.0	23	19	19.5
Total Organic Carbon (TOC)	mg/L	82	272	23	89	24.2
Total Suspended Soilds (TSS)	mg/L	61.7	132	12	44	84.8
Nickel Dissolved	µg/L	10	18	5.0 U	1.0	1.83
Zinc Dissolved	µg/L	NA	NA	5.0 U	3.9	1.90
Naphthalene[2]	µg/L	0.018	NA	0.015 J	0.010 U	0.010 UJ

Notes:

MW Monitoring Well

NA Analyte is presented in the table as it was detected at least once during baseline monitoring or performance monitoring, however, there were insufficient detections during baseline monitoring to calculate a baseline 95th UTL.

UTL Upper Tolerance Level

1 pH and dissolved oxygen measurements were conducted in the field during sampling using a multi-parameter field meter.

2 The maximum naphthalene concentration detected in MW-12 during baseline monitoring was 0.018 ug/L.

Bolded results indicate detected concentrations above the baseline 95th UTL.

Qualifiers:

U - Undetected

UJ - Undetected and the associated numerical value is an estimated quantity.

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Thea Foss and Wheeler-Osgood Waterways
Performance Monitoring Memorandum

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

I:\GIS\Projects\COT_ON_CALL\MXD\2016 Yr 10 Performance Monitoring Memorandum\Figure 5-1 Performance CDF Surface Water and GW Mon Locations.mxd
10/19/2016

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Performance Monitoring Memorandum

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

I:\GIS\Projects\COT_ON_CALL\MXD\2016 Yr 10 Performance Monitoring Memorandum\Figure 5-2 Performance CDF Berm and Cap Photo Point Locations.mxd
10/19/2016

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Thea Foss and Wheeler-Osgood Waterways OMMP

Figure 5-3
North Beach Habitat Photo Point Locations

F:\projects\COT-Oncall\GIS\Baseline OMMP CDF Monitoring\2nd Qrt June 07 Monitoring\MXD\Figure 3 (North Beach Habitat Photo Point Locations).mxd
Printing Date: 8/23/2007

6.0 HABITAT MITIGATION AREA MONITORING

6.1 Introduction

This section presents a summary of the Year 10 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. With completion of this tenth year of monitoring, the City of Tacoma (City) and U.S. Environmental Protection Agency (EPA) will be meeting to evaluate the need for and scope of any additional required 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 10 Monitoring Habitat Mitigation Area Monitoring Preliminary Findings Memorandum (Habitat PFM) (City of Tacoma 2016e) which summarized the work performed and the initial findings. This memorandum was submitted to the agencies on September 27, 2016. A copy of this Preliminary Findings Memorandum is included as Attachment E-1.

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 identified 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 10 mitigation area performance monitoring consists of three components: habitat mitigation area monitoring, habitat mitigation area maintenance, and contingency planning and response actions.

Year 10 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, waters vegetation, tightens large woody debris (LWD) cables, pulls or cuts weeds, and replants on an as needed basis. A summary of their work performed during each quarter of the past year has been provided in the quarterly progress reports. A summary of their work completed since the time of the qualitative inspections at each site is provided in Section 6.3. In addition, the City contracts with NRC as needed to clean up homeless encampments on the habitat sites when they are discovered. “No Trespassing” signs have been posted with the intent of discouraging settlement in these sensitive locations.

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. At this time there are no issues that are being addressed in accordance with these formal procedures.

6.2 Habitat Mitigation Area Monitoring

6.2.1 Summary of Habitat Mitigation Area Monitoring

Year 10 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 specified 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 10 Habitat PFM. A summary is also provided below.

6.2.2 Summary of Field Activities

Year 10 habitat monitoring activities were initiated on July 5, 2016, and continued per scheduled staff availability at the various sites until August 30, 2016. Copies of the completed inspection forms and photographs for these monitoring activities are included in the Habitat PFM. For reference purposes, survey information for photo point locations and elevation stakes is included in Table 6-3. 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 5, 2016. Photographs were also taken on July 5, 2016, 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 -0.37 feet MLLW to -0.64 feet MLLW.

The quantitative vegetation survey of the marsh area was completed on July 20, 2016, and was completed in the riparian area on July 21-22, 2016. Quantitative monitoring locations are shown on Figure 6-9 and Figure 6-9A. Note that where monitoring points could not be located, survey was used to restake the monitoring location. Locations where this occurred are noted on the field forms and in Attachment E-2.

Initial elevation monitoring was performed on July 5, 2016, during the qualitative ground survey. Measurements were taken at two of the five elevation stakes established during baseline monitoring that were located during the inspection. The other three stakes, E-1, E-3 and E-4 were missing and elevations were determined by survey after the inspection as discussed further below. Elevation monitoring results are included on Table 6-5.

The GPS delineation of the vegetation in the brackish marsh area was performed on July 22, 2016.

Middle Waterway Tideflat Habitat – The qualitative ground survey of the site was completed on July 5, 2016. Photographs were also taken on July 5, 2016, 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 -0.21 feet MLLW to -0.42 feet MLLW.

The quantitative vegetation survey of both the brackish salt marsh area was conducted on July 21, 2016, and was performed in the riparian area on July 22, 2016. Quantitative monitoring locations are shown on Figure 6-10.

Elevation monitoring was performed on July 5, 2016, during the qualitative ground survey. Measurements were taken at the six elevation stakes established at the site during baseline monitoring. Elevation monitoring results are included on Table 6-5.

The GPS delineation of the vegetation in the brackish marsh area was performed on July 22, 2016.

Puyallup River Side Channel – The qualitative ground survey of the site was completed on July 6, 2016. Photographs were also taken on July 6, 2016 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 -2.66 feet MLLW to -2.80 feet MLLW.

The quantitative vegetation survey of the riparian area was completed on July 19, 2016 at the monitoring locations shown on Figure 6-11. Where monitoring points could not be located, wayfinding with GPS and past data clues (i.e., types of vegetation present previously and other notes) were used to approximate the monitoring location. Points were chosen to most accurately represent the area. Locations where this occurred are noted on the field forms and in Attachment E-2.

Initial elevation monitoring was performed on July 6, 2016, during the qualitative ground survey. Measurements were taken at three of the six elevation stakes established during baseline monitoring that were located during the inspection. For one of these three stakes, staff was unable to determine the specific location (i.e., either E-5 or E-6) at the time of the inspection. On July 19, 2016, it was confirmed by GPS that the one measured during the qualitative inspection was E-6. In addition, E-1 was located by GPS and the elevation measured and recorded on July 19, 2016. Two other stakes, E-4 and E-5 were unable to be located by GPS and are thought to be buried. These stakes were not reset because elevation monitoring at this site does not have an associated performance standard. Elevation monitoring results are included on Table 6-5.

Hylebos Creek Mitigation Site – The qualitative ground survey of the site was completed on July 5, 2016. Photographs were also taken on July 5, 2016 at six of the seven permanent photo points established at the locations shown on Figure 6-4. One of the photos was inaccessible during the inspection due to transient activity, and was subsequently taken on July 19, 2016. A total of 20 photographs were taken at these points at tidal elevations ranging from approximately -0.63 feet MLLW to -2.46 feet MLLW. Four additional photographs were taken during high tide on the evening August 30, 2016, at a tide of approximately 11.75 feet MLLW to show site conditions during periods of inundation. Photographs were not taken at all photopoints during the high tide because of safety concerns including the presence of unidentified people on the site and difficulty in accessing the different points due to the dense vegetation coverage. Additional photos of the site under inundation conditions can be taken upon request of the agencies.

A centerline transect survey of each channel was performed on August 29, 2016. During the transect survey, elevation data was gathered at all six of the site elevation stakes due to the fact that they were difficult to access during the qualitative survey, and to provide the most accurate data for evaluation. Elevation monitoring results for these elevation stakes are included on Table 6-5.

The quantitative vegetation survey of the riparian area was completed on July 20, 2016. Quantitative monitoring locations are shown on Figure 6-12. Where monitoring points could not be located, wayfinding with GPS and past data clues were used to approximate the monitoring location. Point locations were matched to most accurately represent the monitoring area. Locations where this occurred are noted on the field forms and in Attachment E-2.

Johnny's Dock Habitat Enhancement – The qualitative ground survey of the site was completed on July 5, 2016. Photographs were also taken on July 5, 2016 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 elevations ranging from approximately -2.25 feet MLLW to -2.40 feet MLLW.

Head of Thea Foss Shoreline Habitat – The qualitative ground survey of the site was completed on July 5, 2016. Photographs were also taken on July 5, 2016 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 -0.97 feet MLLW to -1.41 feet MLLW.

SR 509 Esplanade Riparian Habitat – The qualitative ground survey of the site was completed on July 5, 2016. Photographs were also taken on July 5, 2016 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 tidal elevations ranging from approximately -0.25 feet MLLW to 0.84 feet MLLW.

Log Step Habitat Enhancement – The qualitative ground survey of the site was completed on July 5, 2013. One photograph was also taken on July 5, 2016 at the permanent photo point established at the location shown on Figure 6-8. The photograph was taken at this point at a tidal elevation of 1.73 feet MLLW. While the photo was taken at a tide higher than the 0 feet MLLW specification for photo documentation identified in the OMMP, all of the developed habitat at this site is well above 0 feet MLLW.

6.2.3 Summary of Findings from Habitat Mitigation Area Monitoring

As described above, 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 to achieve their specific site objectives. Initial results of the monitoring performed at each of the sites are described in detail in the Habitat PFM, and are summarized in the sections below.

North Beach Habitat – The qualitative ground survey confirmed that the site is in fair to excellent condition, and continuing to become more established in the riparian areas, particularly with the growth and development of the more recently planted area on top of the berm. The marsh area is well established at this time, although the dynamic conditions of the beach and shifting gravels affects the area of plant establishment from year to year. The pickleweed is continuing to spread well throughout the potential marsh portion of the site and is the dominant species in most of this area. Some small areas of salt grass are present, but it is much less prevalent than the pickleweed. Dunegrass is also present and spreading at the upper beach elevations in the transition zone between the marsh and riparian areas. The original pilot nodes were not particularly successful, as they were located in beach areas where the gravel movement was significant. However, the plants are very well developed higher on the shoreline and amongst the large woody debris where conditions are more conducive to survival.

The new riparian area planted in the fall of 2009 includes a variety of planted trees and shrubs, and the field notes for this area include the top five species identified within each established quadrat, as well as the percentage of the area covered by invasive species. In most cases the quadrats include a combination of native and invasive species. In many quadrats, hydroseed is the dominant species, although a good mix of native trees and shrubs are present and dominating other quadrats and the area is developing nicely. The maximum presence of invasives noted at the time of the inspection was 30% within two of the selected quadrats, but the majority of quadrats had 2% invasives or less present. As expected, the greater the coverage of the quadrat by native trees and shrubs, the fewer invasives were noted, and it is anticipated that this will continue. Removal of invasives from the sites is performed on a routine basis by the WCC. Invasive presence/coverage is correlated with the length of time elapsed between maintenance visits.

In the original riparian area, the site continues to be dominated by hydroseed and willow (19 of the 25 monitoring locations), with other monitoring locations dominated by species including ocean spray, red flowering currant, and snowberry. In the field notes, the top five species identified within

each quadrat in this area were determined, as well as the percentage of the area covered by invasive species. In most cases the quadrat included a combination of both native and invasive species. The maximum presence of invasives noted at the time of the inspection was 10%, but the vast majority of quadrats had less than 5% invasives present. As noted above, removal of invasives from the sites is performed on a routine basis by the WCC. Invasive presence/coverage is correlated with the length of time elapsed between maintenance visits.

Ongoing erosion along the lower face of the containment berm continues to be monitored on a regular basis as described in more detail in the Year 10 (2016) CDF Performance Monitoring Memorandum and Section 5.0 of this report. The percentage of eroded area in each original riparian vegetation monitoring quadrat is estimated on the field form and ranges up to 30%. Dunegrass is continuing to spread at the toe of the slope which is helping to provide some soil retention and wave energy dissipation. Additional dune grass plugs have been placed by the WCC in some areas in past years to enhance vegetation along the slope and to provide for accelerated establishment. It was noted that habitat mix/fine-grained material was present at the surface in this area. Minor weeding of the area is needed, along with checking and tightening of the anchors on the large woody debris as needed, and removal of trash and other debris. In addition, the bollards that are located around the adjacent CDF monitoring wells need to be straightened and re-painted to increase visibility. 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 more detail in the Preliminary Findings Memorandum. For both the old and new riparian areas, Total Percent Cover was analyzed, and for the salt marsh area, the Area-Weighted Percent Cover (AWPC), Percent of Potential Marsh with Some Vegetation (PPMV), 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. Results of these analyses are shown on Table 6-7 along with a comparison to the performance criteria.

As shown on Table 6-8, for both the existing and new riparian areas, there was decrease in all but one of the metrics at this site between Year 7 and Year 10. The one metric that increased between monitoring events was shrub cover in the new riparian area. While there were decreases in two of the three metrics for the new riparian area, this portion of the site met all of its applicable performance standards. In the original riparian area, the site performance standards were not achieved for shrub or ground cover and fell just short of the total cover goal. For the shrub cover metric, review of the monitoring data shows that the area along the central and eastern portion of the containment berm has been the most difficult to establish. While total cover for this area is generally good, this is primarily due to the presence of hydroseed. This area is affected by the erosion along the face of the containment berm with 5-30% of each quadrat gone. The soils are very dry, regardless of regularly scheduled watering in this area. If monitoring data for this area are excluded from the averaging, the area comes much closer to achieving this performance standard. In contrast, evaluation of the data relative to the groundcover metric shows that the amount of groundcover present decreases coincidentally, as expected, as the amount of tree and shrub cover increases in the portion of the riparian area above the potential marsh. Shade cover from the trees and shrubs reduces the amount of groundcover present in this area. Total cover, which was estimated at 77.9% relative to the performance standard of 80%, would seem to be the most relevant performance standard for comparison. As the new riparian area becomes more established over time, it is expected to contribute to the overall success of this combined riparian area.

For the salt marsh area, while the site met the performance criteria for PPMV and density, it fell short of the performance criteria for AWPC. Due to the exposure of this area and beach dynamics in general, the sediments at the site move around and plant material appears to be smothered by the shifting beach sands and gravels. In addition, it appears that the plants are surviving best on the upper shoreline and in the protected areas between the LWD. Therefore, this data should be considered in conjunction with the GPS delineation of the plant growth in the marsh (see Figure 6-14). It appears that, while the AWPC criteria were not met using the cover class midpoints at the randomly selected quadrat locations, the overall area of salt marsh growth as measured by GPS delineation has increased approximately 30% since the Year 7 survey. Therefore, the site appears to be establishing as expected and is meeting the objectives for function.

As indicated above, three of the elevation stakes were found to be missing during the qualitative monitoring event and elevations were subsequently determined by survey. Based on an evaluation of measurements from all five monitoring stakes, the average of the absolute value of change in elevation from Year 7 to Year 10 of 1.8 inches meets the performance criteria for the site (see Table 6-5).

Middle Waterway Tideflat Habitat – The qualitative ground survey confirmed that the site was continuing to develop well. The vast majority of the upper intertidal area is filled with vegetation and the site was noted as being in good condition overall. As described previously in the Year 7 Habitat PFM, a break in the sprinkler header line just south of mid-site was noted in 2013 during the Year 7 inspection. Water flowing from the break caused an area of erosion on the slope. Upon identification of the issue, the City turned off the sprinkler system and the end of the header pipe was capped. Following placement of the cap, the system was turned back on in the southern portion of the site. As a result of this break, the northern portion of the marsh has not been irrigated for the past several years. During the Year 10 inspection, it was found that the power for the remainder of the irrigation system had been inadvertently cut by a contractor working on demolition at the adjacent Interfor site. In the portion of the marsh where the sprinkler has been off for several years, the vegetation has transitioned to more salt tolerant species and coverage is quite dense and continuing to spread. In the portion of the site where the sprinkler system was more recently disconnected, the brackish marsh plants are showing some stress but pickleweed and saltgrass are present and are expected to begin to spread as they have in the northern area. Based on the results of the northern marsh, it is fully anticipated that this southern area will fully transition to coverage by more salt tolerant intertidal marsh vegetation in the next few years.

The City notified EPA of both of these issues upon discovery and requested determination as to whether or not repair of the sprinkler system would be required. The City has received an initial verbal response from EPA indicating that the Trustees have agreed that the irrigation system can be shut down at this time. The City has requested and is currently awaiting the final written determination.

Vegetation within the riparian area is also doing relatively well in most areas. There are some limited areas of erosion, particularly at the north end of the site. In the central and southern portions of the site, the presence of transients has had some impact on the vegetation by either removal, damage to limbs or soil compaction. Many of the trees are showing some signs of drought stress noted as yellowing, early leaf loss, etc., including red alder, cottonwood and Douglas fir. In the riparian area, the site is primarily dominated by willow, hydroseed and trees including cottonwood, Douglas fir and shore pine. Many other native species are also well established, including ocean spray, red flowering currant, lupine, as well as gumweed and orache on the lower slope. In the field notes, the top five species identified within each quadrat were

determined, and in most cases included a majority, and a variety of native species. The presence of invasives at the time of the inspection was estimated at 2% or less in most quadrats. Five quadrats had greater amounts of invasives present with coverage estimated between 5 and 20%. As noted above, removal of invasives from the sites is performed on a routine basis by the WCC. Invasive presence/coverage is correlated with the length of time elapsed between maintenance visits.

As indicated above, continued discussion with EPA regarding maintenance of the sprinkler system is needed, along with some limited weeding and debris removal, and tightening of the anchors on the LWD. Maintenance tasks are summarized in Table 6-4.

Overall, the marsh area is very well established, currently with a combination of brackish marsh, and intertidal marsh vegetation. Lyngby's sedge (Carex lyngbei) and Seacoast bulrush (scirpus maritimus) are present throughout the area at the southern end that was still being sprinkled until recently, however they are not as vigorous and the scirpus is not blooming. Throughout the area, pickleweed is spreading along the lower elevations of the marsh and salt tolerant species are becoming more prevalent and diverse. There is more orache present, and the salt grass is spreading in the northern area, and now stretching into the southern area as well. Throughout both of these areas, sand spurry, and brass buttons were also observed, and fleshy jaumea was present in some locations as well.

Quantitative vegetation monitoring was performed and the data were analyzed as outlined in the OMMP and summarized in Table 6-6. Quantitative monitoring activities are described in the Habitat PFM. For the riparian area, Total Percent Cover was analyzed, and for the brackish marsh area, the AWPC, PPMV 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. Results of these analyses are shown on Table 6-7 along with a comparison to the performance criteria. As shown on Table 6-8, the marsh portion of the site appears to have remained generally stable between Year 7 and Year 10 with a slight increase in the AWPC, no change in the PPMV, and a decrease in the density, however it still well exceeds the performance criteria. In the riparian portion of the site, there were decreases in each of the metrics as discussed further below.

Based on the analyses performed, the marsh area of the site meets all of the performance criteria for vegetation establishment with the exception of AWPC, which fell short of the performance criteria. The performance criteria for AWPC is 80%. Thirteen of the twenty-five quadrats monitored have a cover class midpoint of 85% or higher, which would average well above the performance criteria of 80%. Most of the quadrats where the cover class midpoint was estimated less than 85% were located in the southern half of the site where the sprinkler system was recently disconnected as described above, and the brackish marsh plants in this area are showing some stress from the sudden change in salinity. Several of the other quadrats with lower cover class midpoints were located at either the upper or lower edges of the vegetated area. At this site, the lower edges of the marsh vegetation are subject to predation by geese and also experience more tidal shifting of substrate materials. A few of the monitoring points are located at these lower elevations and have little or no vegetation present which brings down the averages. Quadrats at the upper elevations are shaded by the riparian vegetation, which also impacts development of vegetative coverage. Therefore, this AWPC data should be considered in conjunction with the GPS delineation of the plant growth in the marsh (see Figure 6-15). As shown on the figure, the vast majority of the upper intertidal area is vegetated. While the AWPC criteria were not met using the cover class midpoints at the randomly selected quadrat locations, the overall area of new growth as measured during the GPS delineation has remained relatively stable since Year 7

(42,630 sq ft coverage in Year 7, and 41,394 sq ft coverage in Year 10). As the site completes its transition from a brackish marsh to an intertidal marsh over the next few years, the vegetative coverage in this band is expected to stabilize and no response actions are warranted at this time.

Based on the analyses performed, the riparian area of the site meets the performance criteria for tree coverage (32.2% relative to a performance standard of 30%) and total coverage (84.5% relative to a performance standard of 80%). Both of these coverage estimates were slightly lower than the estimated coverage for these sub-strata in Year 7. Shrub coverage in the riparian area also decreased slightly relative to Year 7 estimates, and fell short of the performance standard (37.2% relative to a performance standard of 60%). Groundcover in the riparian area decreased fairly significantly between Year 7 and Year 10 and failed to meet the Year 10 performance standard (30.1% relative to a performance standard of 60%). It was noted during the inspection that the groundcover coverage numbers varied greatly with the location of the monitoring point, and the amount of shade present. Where it was located by a large tree or shrub, the shade element made the coverage measurement less representative of the site. Overall, in areas where there is shade to heavy shade, groundcover is much decreased as compared to open areas with full sun exposure. With regard to shrub coverage, there was no apparent pattern seen for the change in coverage between Year 7 and Year 10 with areas of increased, decreased and stable shrub coverage generally distributed throughout the site. The decrease in shrub coverage was just over 4% between Year 7 and Year 10. It is likely a combination of factors that led to this sub-strata not meeting the Year 10 performance criteria including: limited areas of slope erosion, willow die-off or disease, transient encampments, dry summers, etc. While the site did not meet the performance criteria for the shrub or groundcover coverage, it did meet the total coverage criteria, and is expected to continue to develop over time.

Very small amounts of bark were present at the site during the inspection, likely due to the fact that the log haul out facility located north of the habitat area is not currently operational. It was estimated that the bark covered less than 1% 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. This bark does not appear to be affecting plant development in any way.

As indicated in the PFM, elevation monitoring was performed during the site monitoring event, and the average of the absolute value of change in elevation from Year 7 to Year 10 of 1.4 inches meets the performance criteria for the site (see Table 6-5).

Puyallup River Side Channel – The qualitative ground survey confirmed that the site was well developed and the plants are filling in very nicely in the riparian areas along the old levee section. Overall the site was noted to be in very good condition. The primary issue noted at the site in the past was the fairly extensive use of the site by transients. While this has decreased to a large extent in the vegetated area on the old levee, the impact caused by past use is still evident. Identification and removal of these campsites and the associated trash is an ongoing issue that will be coordinated with the Tacoma Police Department and the City's Homeless Services Manager.

It was noted that habitat mix/fine-grained material was present at the surface in the intertidal area as required. The spit of sedimentation remains inside of the side channel off of the downstream remnant levee section but the opening to side channel area remains open due to the daily tidal exchange. Minor weeding of the area was the only other maintenance activity identified at this time.

Overall, the riparian area on the cutdown berm portion (old levee) of the site is dominated by a variety of shrubs and trees, primarily willows, red alder and ocean spray which are continuing to become more established. There are compacted and established trails that remain through the vegetation on both ends of the old levee, despite efforts to re-plant. In addition, many of the quadrats were noted to be heavily shaded. In the field notes, the top five species identified within each quadrat were determined, and included a variety of native species. Invasive species within each quadrat were also noted, and minor amounts were present throughout the area. As noted above, removal of invasives from the sites is performed on a routine basis by the WCC. Invasive presence/coverage is correlated with the length of time elapsed between maintenance visits.

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 Habitat PFM. 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. Results of this analysis are shown on Table 6-7 along with a comparison to the performance criteria.

As shown on Table 6-8, there was an increase in each metric at this site between Year 7 and Year 10 with the exception of groundcover which decreased by approximately 6%. The site meets the performance criteria for shrubs (65.6% relative to a performance standard of 60%) as well as the performance standard for tree coverage (49.5% relative to a performance standard of 30%). The successful establishment of trees and shrubs and the resultant shading, combined with the presence of the trail created by transients compacting the soil, has attributed to the decrease in groundcover coverage. The site therefore does not meet the groundcover performance criteria (36.8% relative to the performance standard of 60%). Total coverage measured in Year 10 was slightly higher than the Year 7 total coverage, and fell just short of the performance criteria (88.6% relative to the performance criteria of 90%). Overall the site appears healthy and is functioning well and no response actions appear warranted at this time.

Hylebos Creek Mitigation Site – The qualitative ground survey confirmed that the site was continuing to flourish with vegetation in both the riparian and marsh areas thriving and spreading, and many volunteer plants noted. Many evergreen trees on the slope area are also growing nicely. There is minimal presence of invasives with the exception of some Himalayan blackberry and reed canary grass which is extremely difficult to control with upstream seed sources present. No obstruction to fish passage was observed in the channel areas. Overall, this site appeared to be in excellent condition with only minor weeding and tightening of the LWD anchors needed at this time.

The upper area of the forested wetland portion of the site is dominated by a variety of shrubs and trees which are becoming more established, dense and diverse as time goes on. A high functioning plant community has developed with large areas dominated by red alder and willow, and several other native trees and shrubs, including ninebark, cascara, hazelnut, big leaf maple, twinberry and others. In the field notes, the top five species identified within each quadrat were determined, and in most cases included a nice variety of native species. Minor amounts of invasive species were also noted in just over half of the quadrats, however at the time of the inspection their coverage was less than 1% in all but two of the quadrats, which had an estimated 30% cover of reed canary grass, Himalayan blackberry and morning glory noted. As noted previously, removal of invasives from the sites is performed on a routine basis by the WCC. Invasive presence/coverage is correlated with the length of time elapsed between maintenance visits.

Quantitative vegetation monitoring was performed and the data were analyzed as outlined in the OMMP and summarized in Table 6-6. Quantitative monitoring activities are described in the Habitat PFM. 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. Results of these analyses are shown on Table 6-7 along with a comparison to the performance criteria. Based on the analyses performed, the site far exceeds all of the performance criteria for vegetation establishment (see Table 6-7).

A transect survey of the centerlines of both the north and south nodes was performed on August 29, 2016 (see Figure 6-12). Table 6-9 presents Year 10 survey data, along with the elevations measured during previous surveys, 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. Figure 6-13 provides the cross sections of the nodes showing the design, as-built and Year 10 elevations.

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 0.55 feet and in the north lobe was 0.31 feet) as measured during Year 10.

As indicated in previous reports, the depth of the nodes at the Hylebos Creek Mitigation Site has been the subject of ongoing discussion since the completion of construction. The Biological Opinion (BO) prepared for the project was finalized before plans for this mitigation project were developed, so no specific performance criteria for this site are included in that document. Because of this, performance criteria for this site were instead determined in the project description and the design plans. The project objectives as a whole for the Thea Foss remediation project were identified in the Design Analysis Report, and the overall project mitigation plan proposed by the City used the Simenstad Report (2000) as a reference for guiding the selection and design of habitat mitigation projects. One of the top priorities for habitat restoration identified by Simenstad was to restore off-channel, or blind-slough, habitat types in the lower river and estuary in order to improve habitat for migrating juvenile salmon. The Hylebos Creek Mitigation Site was developed with this as a consideration, and is providing function as a blind slough. Unfortunately, the agencies' expectations of the site features based upon their review of the plans and specifications, was not consistent with the actual approved design.

The project was constructed in accordance with the approved plans. During construction, at the contractor's discretion and as approved in the field, the channels were actually built deeper than the approved plans. 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. Due to the established bottom elevation of the adjacent creek and the hydrodynamics of the site, 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 channel depths had equalized to that of the creek bottom 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). Since that time, the site appears to have reached equilibrium, because elevations within the channels at most locations have remained fairly consistent since the baseline survey (see Table 6-9). However, as indicated above, the site does not meet the defined performance criteria of less than 0.2 feet of change from the as-built

conditions. Although, if the elevations are compared to the approved design elevations - the channels are deeper on average than envisioned in the design, or if elevations are compared to the Year 0 elevations, the performance criteria are met. Note that at all other mitigation sites for this project where elevation change is a performance standard, the performance criteria related to elevation change is based upon comparisons to baseline conditions.

Other habitat assessment parameters for this site should be considered in determining the need for and value of any response actions relative to the failure to achieve the elevation change performance criteria. Please note that when the performance criteria were written it was not anticipated that the channels would be constructed deeper than the design elevations. Quantitative vegetation monitoring shows that the site vegetation far exceeds the performance criteria, which provides shading, detritus, and refuge areas for juvenile salmonids. Invertebrate monitoring was performed during past monitoring events, which identified the presence of insects at the water surface, providing a food source for salmonid and other fish species. The site was monitored for the presence of juvenile salmonids during the migration period during Year 1 and Year 3. Salmon were observed utilizing the site during the late May monitoring event in Year 1. They were not observed during Year 3 monitoring, however, fewer salmonids were observed at other sites during this monitoring year as well, indicating that other regional factors likely resulted in the reduced frequency of observation in Year 3 (see Year 3 Annual Report). The site is stable at this time, and no obstruction to fish passage has been identified during any of the site monitoring events over time. Based upon consideration of all of these elements, the City believes that the site is achieving all of the functions outlined in the project description and design documents, which set forth the required functional elements for this site, and, therefore, no response actions are needed.

The City has recommended that the performance criteria for elevation monitoring at the Hylebos Creek Mitigation Site be modified to indicate that the average change along the centerline transect of the nodes will be less than 0.2 feet from the agency approved design elevation. EPA has indicated that it is willing to discuss this issue with the Adaptive Management Team, however, a final determination has not been made at this time.

Johnny's Dock Habitat Enhancement – The qualitative ground survey confirmed that the site is well established, although the plants are somewhat less lush than they had been in previous inspections. Salt grass is present but experiencing heavy goose grazing. No tufted hairgrass or pickleweed were observed during this inspection. Additional species were volunteering at the site including gumweed, orache, sea plantain and potentilla. No invasive species were present. Overall, the site appeared to be in excellent condition. Checking and tightening of LWD anchors were the only maintenance activities identified.

Head of Thea Foss Shoreline Habitat – The qualitative ground survey confirmed that the site is well established and the planted species are continuing to thrive and spread, and the site appears in excellent condition. The plants are generally very dense, leaving little room for significant invasives. Potentilla is doing notably well and continues to dominate the site, although significant amounts of saltgrass and some tufted hairgrass are also present. Volunteer gumweed is spreading very well along the high tide line. In addition, volunteer beach roses were observed as well as fleshy jaumea and carex at the south end. Phragmites and pepperweed continue to be present at the site, and require removal along with other invasive species. Minor weeding and tightening of LWD anchors were the only maintenance activities identified.

SR 509 Esplanade Riparian Habitat – The qualitative ground survey confirmed that the site was generally continuing to establish well, although it is impacted to some extent by the persistent

presence of a transient population. The pathway along the shoreline of the site constructed by unknown parties has been discussed in previous reports. It remains and at this point has been extended to the south through the majority of the site. It appears to be maintained by consistent usage as well as weeding. It does not appear, however, that its presence is impacting the habitat or the remediation to any significant extent since it is generally located below the elevation of the planted species. Overall, the site appeared to be in fair to good condition, although plant establishment under the bridge continues to be problematic. Weeding and trash removal are needed, along with continued sprinkler system checks and maintenance to ensure proper function. In addition, vegetation will be thinned/limbed up to discourage transient camping and increase the lines of sight through the area.

Log Step Habitat Enhancement – The qualitative ground survey confirmed that the site is well established and the plants are continuing to thrive. Volunteer pickleweed is continuing to spread at the site, and the planted dunegrass appears very healthy. Overall, the site appeared to be in excellent condition. Minor weeding in the adjacent area and checking and tightening the anchors on the LWD are the only maintenance activities required at this time. A large log was found during the inspection to be tied up to the other LWD on the site, likely to keep it from damaging the adjacent marina, but it does not appear to be negatively impacting the habitat site.

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 6-10.

6.2.4 Schedule of Habitat Mitigation Area Monitoring Activities

With completion of work under the OMMP, there are currently no further habitat mitigation area monitoring activities scheduled. The scope and schedule of any additional monitoring activities at these sites will be discussed with EPA in the context of the Long Term Monitoring Plan for the project.

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 2016, the WCC has followed up on the following maintenance issues identified in Table 6-4:

- Limbed up the vegetation and removed invasives at the SR 509 Esplanade enhancement area;
- Removed trash and invasives from all sites;
- Removed encampment debris (NRC);

- Installed “No Trespassing” signs;
- Continued with scheduled watering of plants and placement of mulch rings at North Beach; and
- Straightened and repainted bollards adjacent to the confined disposal facility.

6.3.3 Vegetation Performance Standards Evaluation

Under the approved OMMP, replanting of the sites will generally be performed as a contingency action if, upon completion of quantitative evaluations, it is determined that plant coverage is less than the performance standards. Based upon the Year 10 quantitative vegetation survey and as discussed above, the vegetation performance standards for several metrics were not achieved in Year 10:

- Total cover of native or naturalized plants is at least 80 percent; groundcover layer and shrub layer cover each at least 60 percent in the original riparian area at the North Beach Habitat;
- Area Weighted Percent Cover for the salt marsh at the North Beach Habitat;
- Cover of ground layer cover and shrub layer cover each at least 60 percent in the riparian area at the Middle Waterway Tideflat Habitat;
- Area Weighted Percent Cover for the salt marsh at the Middle Waterway Tideflat Habitat; and
- Total cover of native or naturalized plants is at least 90 percent; ground layer cover at least 60 percent on the old levee section at the Puyallup River Side Channel.

For the original riparian area at the North Beach Habitat, the total cover goals for native or naturalized plants is at least 80 percent; ground layer cover and shrub layer cover each at least 60%. As shown on Table 6-7, the shrub coverage was measured at 33.8% relative to the performance standard of 60%, the ground vegetation cover was measured at 43.6% relative to the performance criteria of 60%, and the total cover fell just short of the performance criteria measured at 77.9% relative to the performance standard of 80%. For the shrub cover metric, review of the monitoring data shows that the area along the central and eastern portion of the containment berm has been the most difficult to establish. This area is affected by the erosion along the face of the containment berm, and quick drainage through the berm substrate materials causing very dry soil conditions, despite regularly scheduled watering in this area. If monitoring data for this area are excluded from the averaging, the area comes much closer to achieving this performance standard. In contrast, evaluation of the data relative to the groundcover metric shows that the amount of groundcover present decreases coincidentally and as expected, as the amount of tree and shrub cover increases in the portion of the riparian area above the potential marsh. Shade cover from the trees and shrubs reduces the amount of groundcover present in this area. In addition, large mulch rings had recently been placed around the shrubs and trees in an effort to control weeds and retain moisture. These mulch areas that fell with quadrats were not counted as either vegetated or bare ground in the estimation of cover class midpoints. Total cover, which fell just short of its performance standard would seem to be the most relevant standard for evaluation of the site. As the adjacent newer riparian area continues to develop, it is expected to contribute to the overall success of the combined area.

For the salt marsh area at the North Beach Habitat, the measured AWPC of 41.52% was below the performance criteria of 50%. As noted above, this data should be considered in conjunction with

the GPS delineation of the plant growth in the marsh at this site as shown on Figure 6-14. While the performance criteria were not met using the cover class midpoints at the randomly selected quadrat locations, the overall area of new growth as measured during the GPS delineation has increased by 30% since the Year 7 survey. Vegetation is present and spreading in the areas of the site that are protected from storm/wave action by the gravel berm or large woody debris. Therefore, the site appears to be establishing as expected and is providing good habitat function in this area.

For the riparian area at the Middle Waterway Tideflat Habitat, the ground layer cover and shrub layer cover each fell short of the performance criteria of 60 percent coverage. Shrub coverage was estimated at 37.2% and groundcover at 30.1%. It was noted during the inspection that the groundcover coverage numbers varied greatly with the specific location of the monitoring point, and where it was located by a large tree, the shading made the measurement less representative of the area as a whole. The locations of quadrats with increased, decreased and equal shrub coverage between Year 7 and Year 10 are generally distributed throughout the site. The decrease in shrub coverage was just over 4% between Year 7 and Year 10. It is likely a combination of factors that led to this sub-strata not meeting the Year 10 performance criteria including erosion of the slope in some limited areas, die-off of some of the willows due to willow gall or other disease, and potentially other factors. While the site did not meet the performance criteria for the shrub or groundcover coverage, it did meet the total coverage criteria, and is expected to continue to develop over time.

For the salt marsh area at the Middle Waterway Tideflat Habitat, the measured AWPC of 57.15% was below the performance criteria of 80%. Most of the quadrats where the cover class midpoint was estimated less than 85% were located in the southern half of the site where the sprinkler system was recently disconnected as described above, and the brackish marsh plants in this area are showing some stress due to the change in pore salinity. Several of the other quadrats with lower cover class midpoints were located at either the upper or lower edges of the vegetated area where they are subject to predation by geese, experience more tidal shifting of substrate materials, or are shaded by the riparian vegetation which impacts vegetative coverage development and brings down the averages. Therefore, this AWPC data should be considered in conjunction with the GPS delineation of the plant growth in the marsh (see Figure 6-15). As shown on the figure, the vast majority of the upper intertidal area is vegetated. While the AWPC criteria were not met using the cover class midpoints at the randomly selected quadrat locations, the overall area of new growth as measured during the GPS delineation has remained relatively stable since Year 7 (42,630 sq ft coverage in Year 7, and 41,394 sq ft coverage in Year 10). With agency concurrence allowing discontinuation of the marsh irrigation, and with the significant seed source in the area, the site is expected to complete its transition to a self-sustaining, continuous intertidal marsh over the next few years.

In the riparian area on the old levee section at the Puyallup River Side Channel, the performance criteria for total cover of native or naturalized plants of at least 90 percent and ground layer cover of at least 60 percent were not achieved during Year 10 monitoring. The groundcover coverage was estimated at 36.8% relative to the performance standard of 60%, and the total coverage was estimated at 88.6% relative to the performance criteria of 90%. The success for the tree and shrub coverage at this site and the resultant shading, combined with the presence of the trail created by transients which has compacted the ground along the top of the old levee, is expected to have caused the decrease in groundcover coverage. With the total cover estimate falling just below the 90% performance criteria, the site appears healthy and is functioning well and no response actions appear warranted at this time.

It is the City's recommendation that no additional plantings be installed at any of the habitat sites at this time. The mitigation sites are generally well established and providing good habitat function. Over time these sites will continue to mature and develop as self-sustaining natural areas. While the City will continue to maintain these sites in the coming years, the need for and scope of any formal monitoring and maintenance at these sites will be discussed with the agencies in the context of the Long Term Monitoring Plan for the project.

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 are no ongoing or new issues identified at this time that are being actively considered in the adaptive management and contingency planning processes. In a letter to EPA dated May 22, 2013, the City identified several habitat related issues which required resolution. In their June 27, 2013 response, EPA indicated that it would like to have these issues considered by the Adaptive Management Team (AMT). Since then EPA has asked the Trustees for an evaluation of these issues, and the City is currently awaiting response.

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Table 6-1
Year 10 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	TC	TC	n/a
Elevation Monitoring	x	x	x	x[1]	n/a
Surface Water Elevation Sampling	n/a	n/a	n/a	TC	n/a
Brackish Marsh Salinity Monitoring	n/a	TC	n/a	n/a	n/a
Juvenile Salmonid Monitoring	TC	TC	TC	TC	n/a

[1] Includes monitoring of both elevation stakes and transect monitoring
TC Task completed

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

Site	Corrective Action Tasks
North Beach Habitat	- minor weeding - minor trash removal - check and tighten anchors on large woody debris, as needed - straighten and paint bollards around adjacent monitoring wells
Middle Waterway Tideflat Habitat	- await EPA/Trustee direction on maintenance of sprinkler system - minor weeding - straighten and paint bollards around adjacent monitoring wells - check and tighten anchors on large woody debris, as needed
Puyallup River Side Channel	- minor weeding - coordinate with TPD on transient/trash removal
Hylebos Creek Mitigation Site	- minor weeding - check and tighten anchors on large woody debris, as needed
Johnny's Dock Habitat Enhancement	- check and tighten anchors on large woody debris, as needed
Head of Thea Foss Shoreline Habitat	- minor weeding - check and tighten anchors on logs, as needed
SR 509 Esplanade Riparian Habitat	- weeding throughout site including removal of debris. Weedeat around plants - minor trash removal - check sprinkler system to ensure proper function - continue limb up cottonwood and thin other riparian vegetation as needed for public safety
Log Step Habitat Enhancement	- minor weeding in adjacent area - check and tighten anchors on logs as needed

Table 6-5
Year 10 Elevation Monitoring Results

Site	Year	Stake 1	Stake 2	Stake 3	Stake 4	Stake 5	Stake 6	Average Change from Baseline (in.)	Average Change between Years 7 and 10
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	+3.5	+1.5	-1.0	0.0	+2.0	n/a	+1.2	n/a
	5	+8.0	+2.0	-2.5	+10.0	+1.5	n/a	+3.8	n/a
	7	+11.0	+2.0	+10.0	+10.0	+2.0	n/a	+7.0	n/a
	10	+11.3	+1.0	+13.4	+6.2	+1.5	n/a	+6.7	n/a
	Year 10 – Year 7	+0.3	-1.0	+3.4	-3.8	-0.5	n/a	n/a	1.8
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	+0.5	*	+0.5	-10.0	0.0	+1.0	-1.6*	n/a
	5	+1.25	-0.5	+1.0	+25.5	-0.5	0.0	+4.5	n/a
	7	+4.5	+1.0	+2.0	-13.5	-1.5	-1.5	-1.5	n/a
	10	+6.0	+1.0	+2.0	-8.0	-0.5	-2.0	3.25	n/a
	Year 10 – Year 7	+1.5	0	0	+5.5	+1.0	-0.5	n/a	1.4
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	+3.5	-2.5	-0.5	+6.5	+4.25	+7.0	+3.042	n/a
	5	+3.0	+1.0	0.0	+10.5	+2.5	+7.0	+4.0	n/a
	7	+3.0	+1.5	0.0	*	+3.5	+8.0	+3.2	n/a
	10	+8.5	+2.5	+6.0	*	*	+9.0	+6.5	n/a
	Year 10 – Year 7	+5.5	+1.0	+6.0	*	*	+1.0	n/a	3.4
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	-0.75	+1.25	+2.0	0.0	+1.5	-1.5	+0.417	n/a
	5	+1.5	0.0	+1.5	-1.0	+1.5	+0.5	+0.667	n/a
	7	+2.0	+6.5	+2.0	-1.0	+1.5	+0.5	+1.917	n/a
	10	+1.2	+7.5	+2.2	-1.1	+0.7	-1.0	+2.3	n/a
	Year 10 – Year 7	-0.8	+1.0	+0.2	-0.1	-0.8	-1.5	n/a	0.7

* Erosion stake missing. Average change based on remaining stakes.

Table 6-6
Quantitative Vegetation Analyses by Site

Site	Strata	Sub-Strata	Metrics
North Beach Habitat	Riparian Existing	Shrub	TPC
		Ground Cover	TPC
		Total	TPC
	Riparian New	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	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 Existing	Shrub	TPC	33.8%	60%	No
		Ground Cover	TPC	43.6%	60%	No
		Total	TPC	77.9%	80%	No
	Riparian New	Shrub	TPC	26.2%	25%	Yes
		Ground Cover	TPC	54.1%	25%	Yes
		Total	TPC	86.0%	50%	Yes
	Saltmarsh	n/a	AWPC	41.52%	50%	No
			PPMV	96%	70%	Yes
			D	423%	200%*	Yes
	Saltmarsh, pilot area	n/a	TPC	0.0%	n/a	n/a
Middle Waterway Tideflat Habitat	Riparian	Tree	TPC	32.2%	30%	Yes
		Shrub	TPC	37.2%	60%	No
		Ground Cover	TPC	30.1%	60%	No
		Total	TPC	84.5%	80%	Yes
	Brackish marsh	n/a	AWPC	57.15%	80%	No
			PPMV	88%	70%	Yes
			D	5324%	200%*	Yes
Puyallup River Side Channel	Riparian	Tree	TPC	49.5%	30%	Yes
		Shrub	TPC	65.6%	60%	Yes
		Ground Cover	TPC	36.8%	60%	No
		Total	TPC	88.6%	90%	No
Hylebos Creek Mitigation Site	Forested Wetland	Tree	TPC	72.6%	30%	Yes
		Shrub	TPC	78.2%	60%	Yes
		Total	TPC	96.5%	80%	Yes

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

Table 6-8
Inter-Annual Quantitative Vegetation Results

Site	Strata	Sub-Strata	Metric	Year 1	Year 2	Year 4	Year 7	Year 10
North Beach Habitat	Riparian Existing	Shrub	TPC	11.2%	13.9%	28.4%	35.1%	33.8%
		Ground Cover	TPC	13.1%	40.5%	50.6%	82.1%	43.6%
		Total	TPC	20.8%	49.7%	60.2%	91.3%	77.9%
	Riparian New	Shrub	TPC	--	--	9.4%	16.9%	26.2%
		Ground Cover	TPC	--	--	2.9%	97.5%	54.1%
		Total	TPC	--	--	12.3%	97.5%	86.0%
	Saltmarsh	n/a	AWPC	5.25%	10.78%	19.06%	20.86%	41.52%
			PPMV	32%	60%	76%	64%	96%
			D	132%	449%	555%	251%	423%
	Saltmarsh pilot area	n/a	TPC	0.667%	0.0%	n/a	n/a	n/a
Middle Waterway Tideflat Habitat	Riparian	Tree	TPC	5.7%	8.1%	24.2%	36.7%	32.2%
		Shrub	TPC	6.9%	8.3%	26.0%	41.5%	37.2%
		Ground Cover	TPC	32%	51.3%	75.6%	77.0%	30.1%
		Total	TPC	35.7%	66.0%	86.8%	91.2%	84.5%
	Brackish marsh	n/a	AWPC	15.14%	34.71%	50.46%	56.83%	57.15%
			PPMV	80%	96%	96%	88%	88%
			D	6947%	10336%	6872%	6986%	5324%
Puyallup River Side Channel	Riparian	Tree	TPC	2.0%	4.4%	11.9%	31.5%	49.5%
		Shrub	TPC	6.3%	13.8%	35.2%	58.3%	65.6%
		Ground Cover	TPC	2.7%	8.4%	28.2%	43.0%	36.8%
		Total	TPC	8.5%	24.3%	60.2%	86.1%	88.6%
Hylebos Creek Mitigation Site	Forested Wetland	Tree	TPC	--[1]	--[1]	57.0%	75.6%	72.6%
		Shrub	TPC	--[1]	--[1]	58.5%	64.4%	78.2%
		Total	TPC	65.7%	78.1%	92.1%	97.5%	96.5%

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

[1] Prior to Year 4, there was not a Performance Standard for Trees and Shrub coverage.

Table 6-9
Hylebos Creek Transect Elevations

South Lobe Elevations													
Point	**Northing**	**Easting**	**Design Elevation**	**Post Construction Elevations**	**Year 0 Elevations**	**Year 1 Elevations**	**Year 2 Elevations**	**Year 3 Elevations**	**Year 4 Elevations**	**Year 5 Elevations**	**Year 6 Elevations**	**Year 7 Elevations**	**Year 10 Elevations**
S-1	705914.01	1181063.36	1.7	1.05	--	1.30	1.23	1.75	1.09	0.25	-0.07	0.31	0.20
S-2	705904.40	1181079.00	1.7	0.53	1.42	1.53	1.44	1.17	1.01	1.26	1.50	1.54	1.56
S-3	705880.46	1181098.72	1.7	0.67	--	1.32	1.23	1.36	1.26	1.28	1.53	1.53	1.67
S-4	705855.87	1181095.14	1.7	0.73	--	1.39	1.36	1.31	1.39	1.34	1.46	1.47	1.51
S-5	705826.47	1181088.39	1.8	0.66	--	1.27	1.26	1.30	1.26	1.16	1.29	1.28	1.33
S-6	705804.98	1181082.76	1.8	0.64	--	0.66	0.71	0.81	0.79	0.68	0.84	0.81	0.92
S-7	705783.57	1181075.84	1.8	0.61	--	1.22	1.18	1.19	1.18	1.11	1.21	1.21	1.26
S-8	705763.37	1181064.01	1.9	0.67	--	1.09	1.04	1.05	1.01	0.98	1.07	1.02	1.18
S-9	705743.90	1181053.00	2.3	0.62	1.41	1.33	1.35	1.34	1.28	1.37	1.42	1.65	1.51

North Lobe Elevations													
Point	**Northing**	**Easting**	**Design Elevation**	**Post Construction Elevations**	**Year 0 Elevations**	**Year 1 Elevations**	**Year 2 Elevations**	**Year 3 Elevations**	**Year 4 Elevations**	**Year 5 Elevations**	**Year 6 Elevations**	**Year 7 Elevations**	**Year 10 Elevations**
N-1	705988.18	1181015.70	1.2	1.48	--	1.44	1.43	1.43	1.30	1.53	1.40	1.47	1.18
N-2	705999.00	1181026.00	1.5	1.41	1.73	1.61	1.68	1.71	1.47	1.69	1.56	1.62	1.65
N-3	705987.66	1181055.16	2.1	1.74	--	2.08	2.07	1.88	1.86	1.85	1.74	1.89	1.76
N-4	705975.21	1181076.61	2.4	1.52	--	1.93	1.91	1.87	1.73	1.76	1.72	1.82	1.91
N-5	705961.87	1181097.96	2.7	1.92	--	2.00	2.05	2.17	1.95	1.91	1.92	1.99	2.03
N-6	705949.49	1181119.73	2.7	1.55	--	2.00	1.93	1.51	1.88	1.90	1.81	1.99	2.00
N-7	705936.30	1181140.86	2.8	1.17	--	1.95	1.90	1.84	1.86	1.84	1.80	1.90	1.89
N-8	705908.34	1181150.64	3.0	1.40	--	2.06	1.97	1.92	1.93	1.92	1.87	2.05	2.08
N-9	705869.60	1181162.00	3.5	2.15	2.76	2.64	2.69	2.54	2.50	2.51	2.36	2.66	2.67

Table 6-10
Performance Standard Schedule by Site

Performance Standard	Year 10 2016	Performance Standard Achieved?
1.0 North Beach		
Elevation		
1.1.2 Average change is less than 8 inches (average absolute value of change between Yr 7 and Yr 10)	X	Yes
1.1.3 Presence of habitat mix at the surface.	X	Yes
Riparian Vegetation		
1.2.5 Total cover of native or naturalized plants is at least 80 percent; ground layer cover and shrub layer cover each at least 60 percent.	X	No
1.2.6 Non-native/invasive vegetation cover is not more than 10 percent.	X	Yes*
Riparian Vegetation – top of containment berm (planted fall 2009)		
1.2.4 Total cover of native or naturalized plants is at least 50 percent; ground layer cover and shrub layer cover each at least 25 percent.	X	Yes
1.2.5 Non-native/invasive vegetation cover is not more than 10 percent.	X	Yes*
Saltmarsh Vegetation		
1.3.5 Proportion of potential marsh area with some vascular marsh vegetation will be at least 70 percent; area-weighted average cover of native or naturalized plants is at least 50 percent.	X	PPMV - Yes AWPC - No
1.3.9 In planted areas, marsh vegetation density will be at least 200% 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. Middle Waterway Tideflat		
Elevation		
2.1.2 Average change is less than 8 inches (average absolute value of change between Yr 7 and Yr 10)	X	Yes
Riparian Vegetation		
2.2.5 Total cover of native or naturalized plants is at least 80 percent; ground layer cover and shrub layer cover each at least 60 percent; tree cover at least 30 percent.	X	Total - Yes GC/Shrub - No Trees - Yes
2.2.6 Non-native/invasive vegetation cover is not more than 10 percent.	X	Yes*

Performance Standard	Year 10 2016	Performance Standard Achieved?
Brackish Marsh Vegetation		
2.3.5 Proportion of potential marsh area with some vascular marsh vegetation will be at least 70 percent; area-weighted average cover of native or naturalized plants is at least 80 percent.	X	PPMV - Yes AWPC - No
2.3.8 In planted areas, marsh vegetation density will be at least 200% 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*
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 effects on biological function; there is no performance standard associated with it.	X	n/a
3.1.2 Presence of fine-grained material in interstices of riprap between elevation 13 feet MLLW and 9 feet MLLW.	X	Yes
Riparian Vegetation (old levee section – enhanced fall 2009)		
3.2.5 Total cover of native or naturalized plants is at least 90 percent; ground layer cover and shrub layer cover each at least 60 percent; tree cover at least 30 percent.	X	Total/GC - No Trees/Shrubs - Yes
3.2.6 Non-native/invasive vegetation cover is not more than 10 percent.	X	Yes*
4. Hylebos Creek		
Elevation		
4.1.1 Average change along centerline transect of channels is less than 0.2 feet from as-built elevation.	X	No
4.1.2 No obstruction to fish passage in channels.	X	Yes
Forested Wetland Vegetation		
4.2.5 Total cover of native or naturalized plants is at least 80 percent; shrub cover at least 60 percent; tree cover at least 30 percent.	X	Yes
4.2.6 Non-native/invasive vegetation cover is not more than 10 percent.	X	Yes*
Surface Water Elevation		
4.5 Water level is greater than 2 ft during 30% of the monitoring period.	X	n/a

*Control of invasives in the riparian areas of the sites is an ongoing maintenance function. The percentage of invasives present is dependent on how recent the last maintenance work took place.

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Figure 6-1
North Beach Habitat

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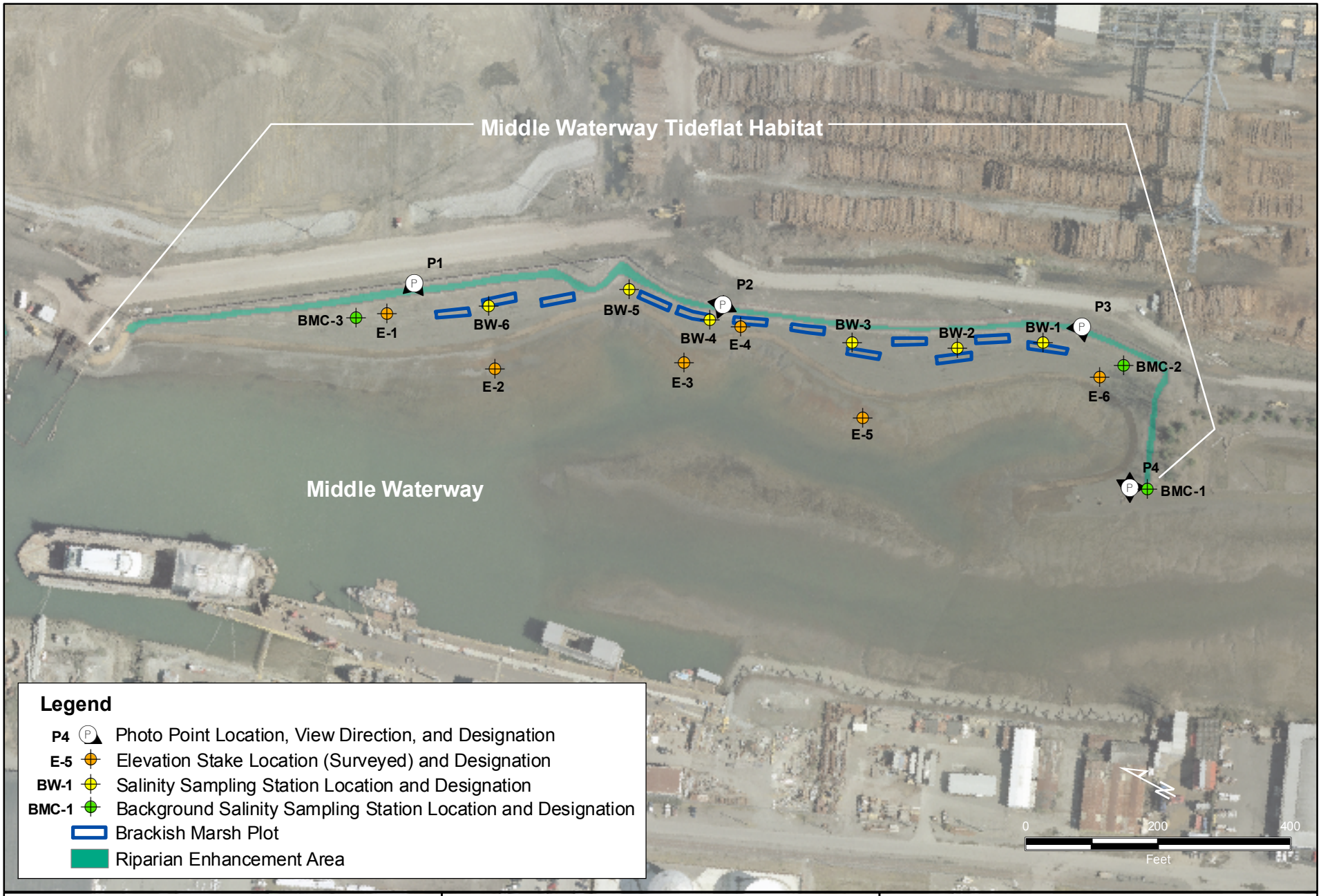

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Figure 6-2
Middle Waterway Tideflat Habitat

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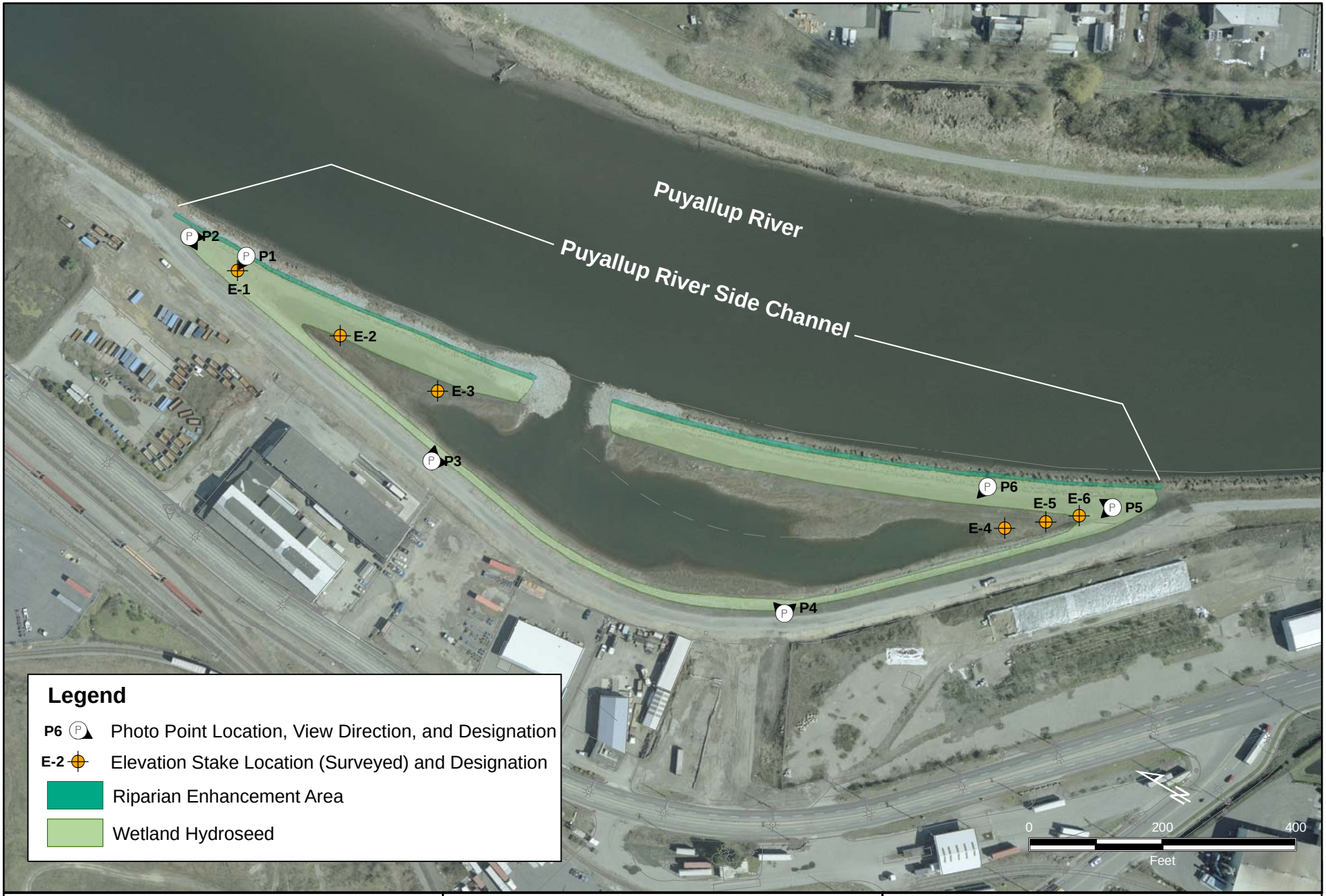

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Figure 6-3
Puyallup River Side Channel

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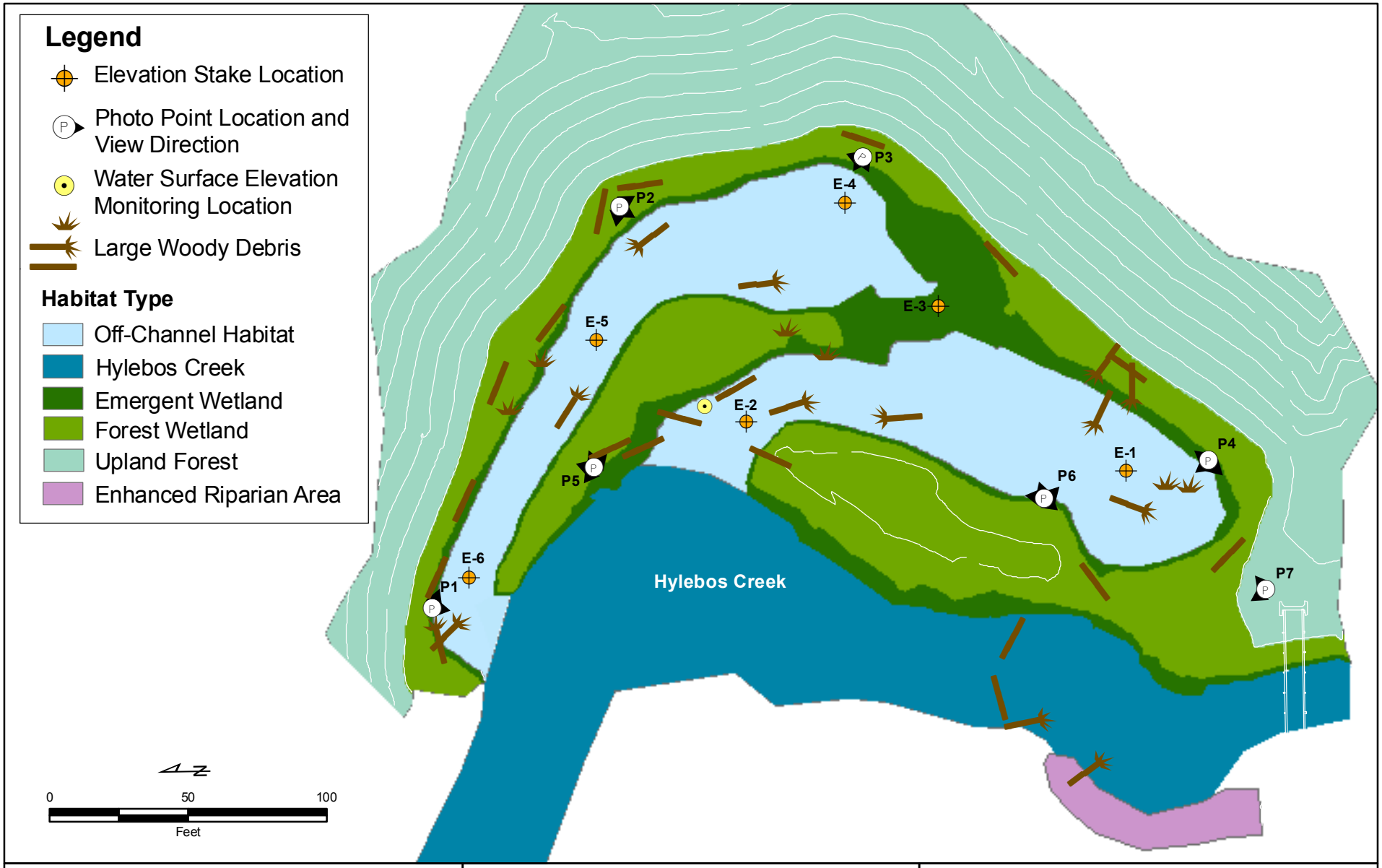

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Figure 6-4
Hylebos Creek Mitigation Site

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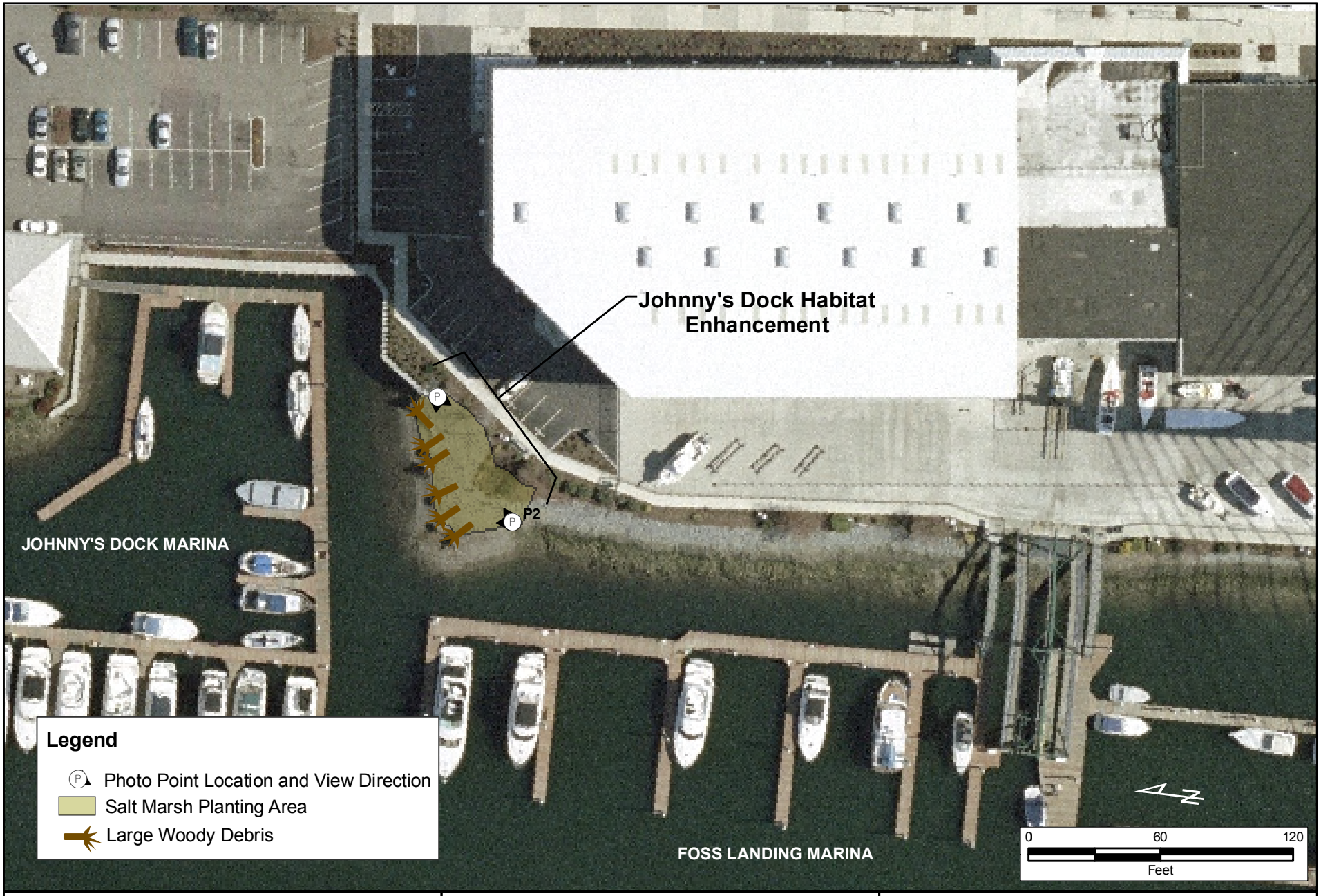

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Figure 6-5
Johnny's Dock Habitat Enhancement

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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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
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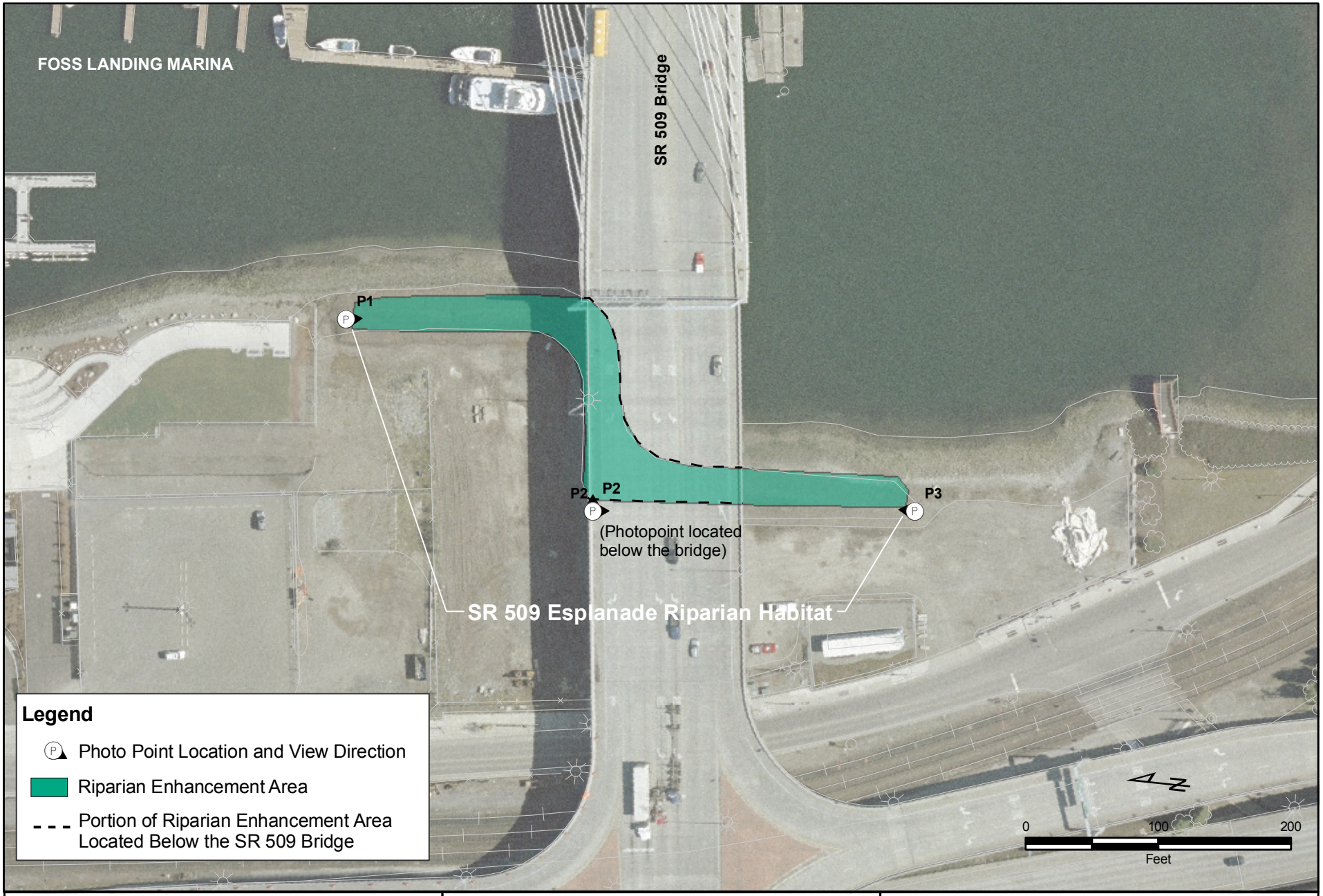

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Figure 6-7
SR 509 Esplanade Riparian Habitat

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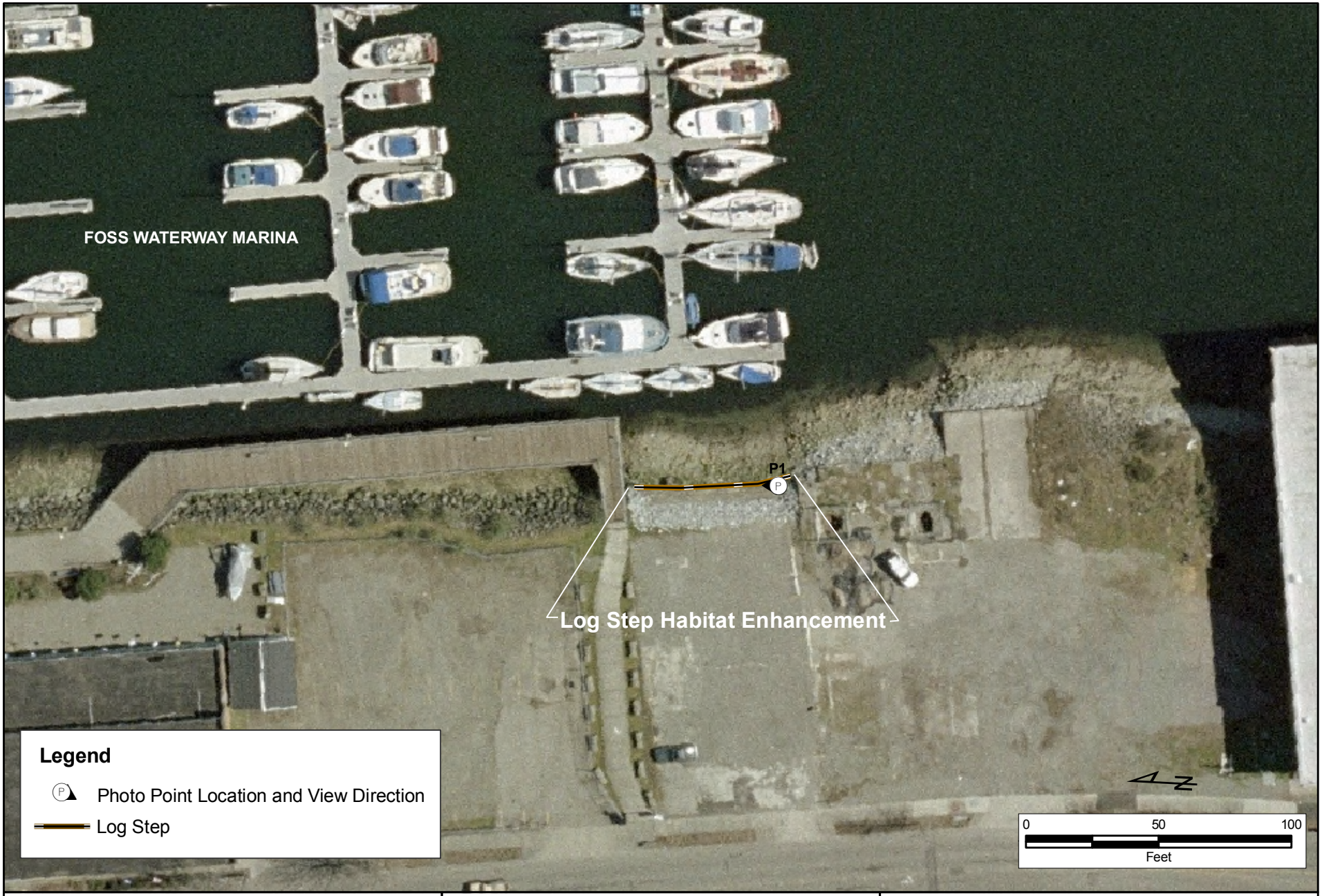

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Figure 6-8
Log Step Habitat Enhancement

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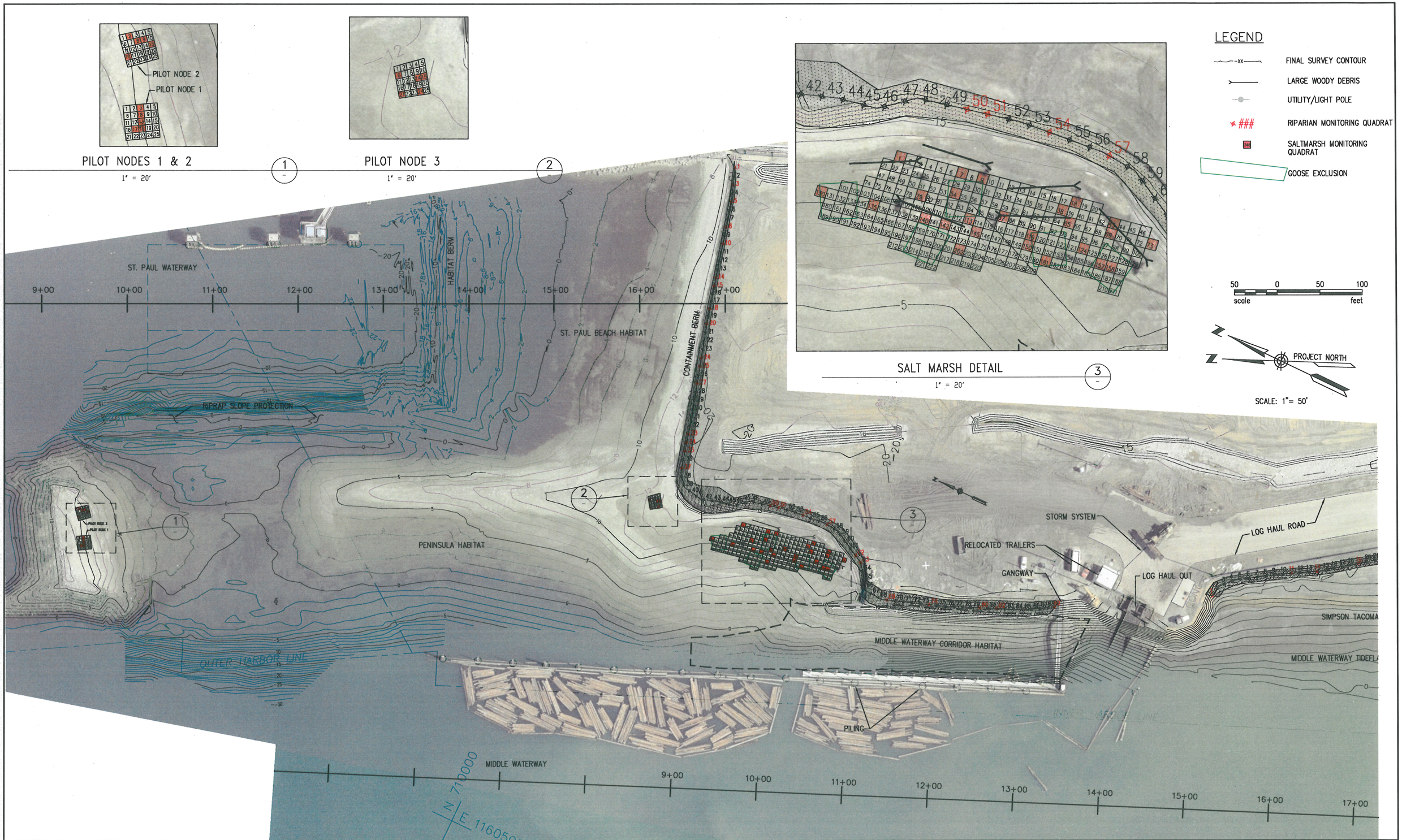

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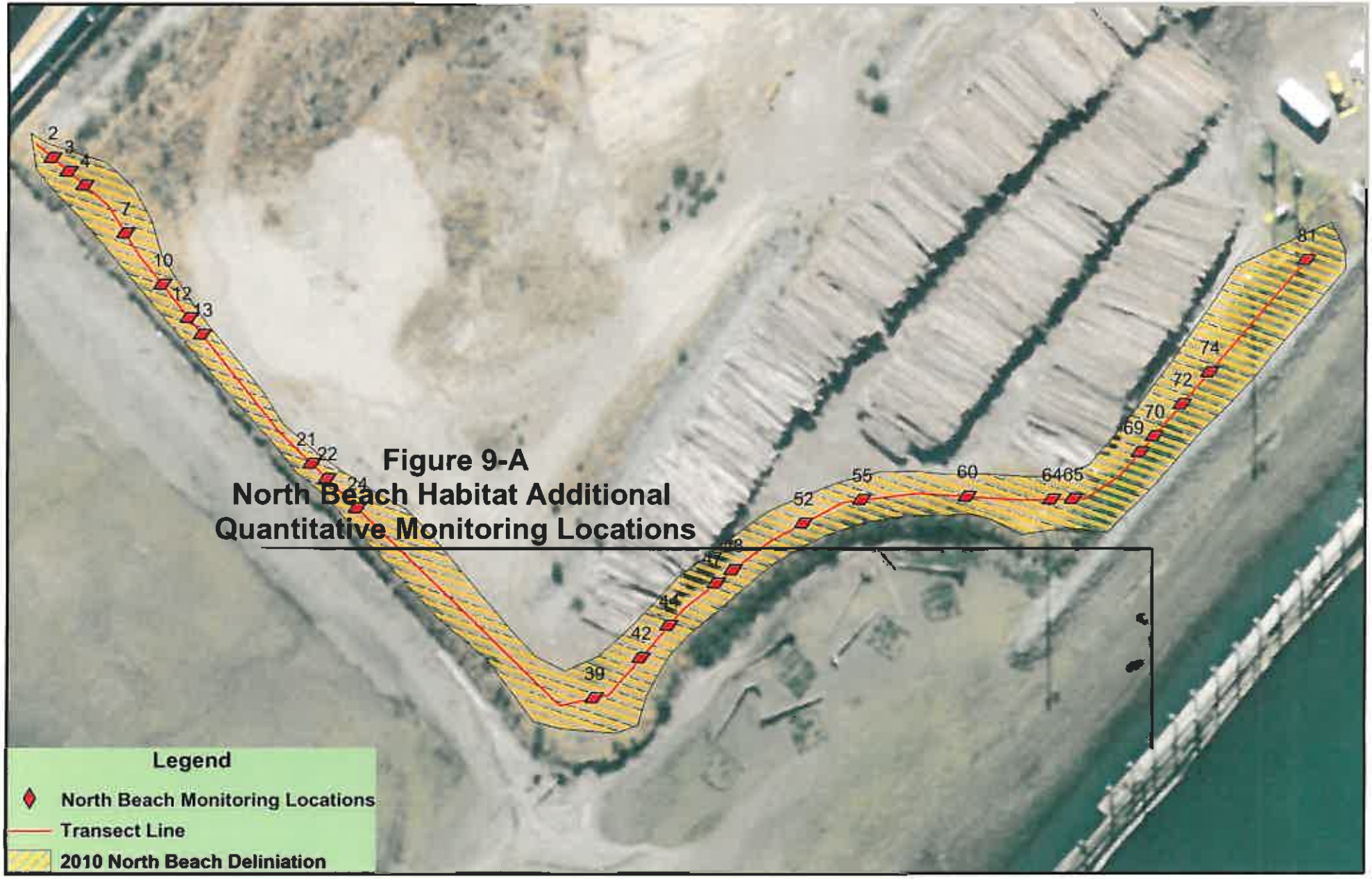
FIGURE 6-9
NORTH BEACH HABITAT
QUANTITATIVE MONITORING LOCATIONS

Figure 6-9A
North Beach Habitat Additional Quantitative Monitoring Locations



0 12.5 25 50 75 100 125 150 Feet

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FIGURE 6-10
MIDDLE WATERWAY TIDEFLAT HABITAT QUANTITATIVE MONITORING LOCATIONS

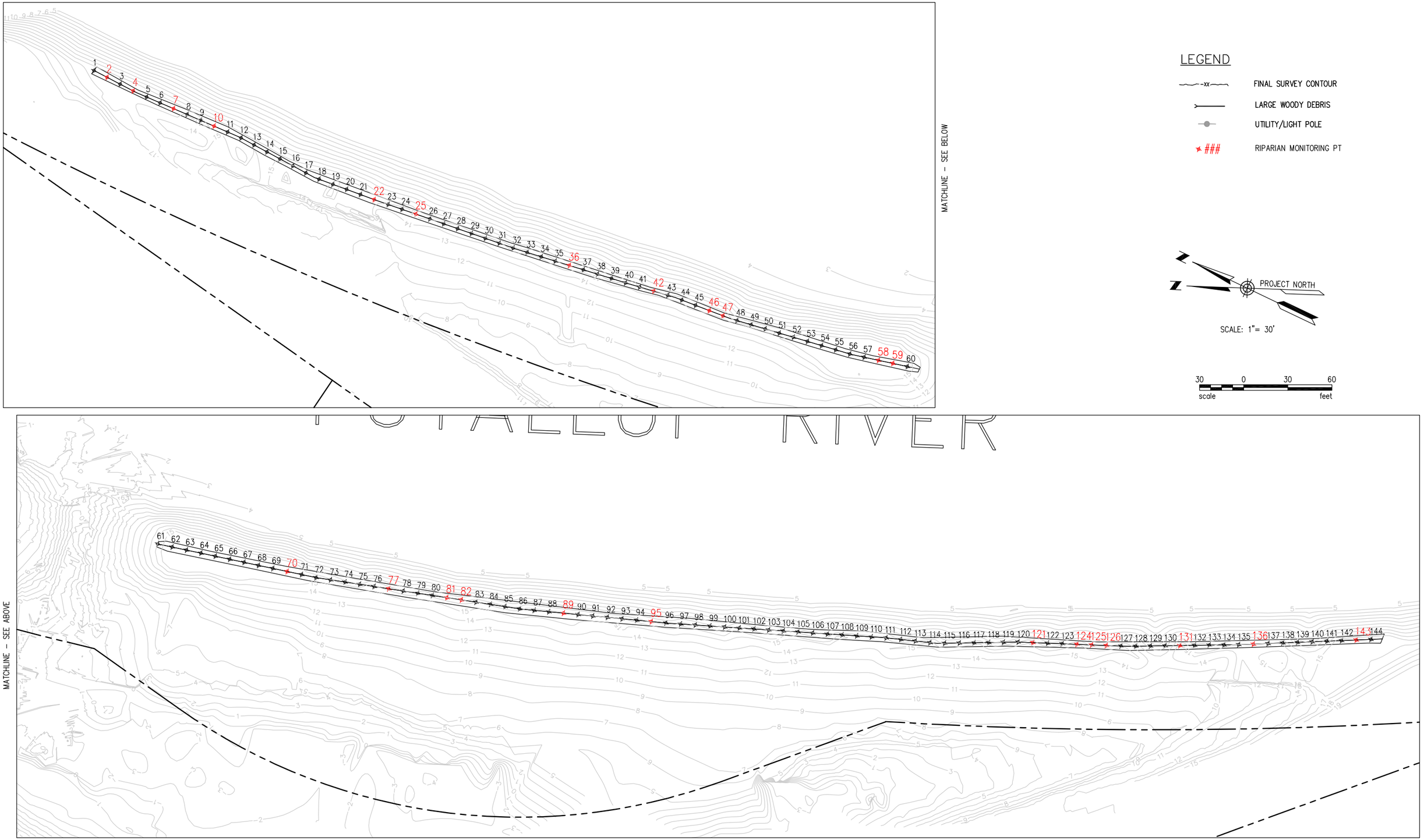

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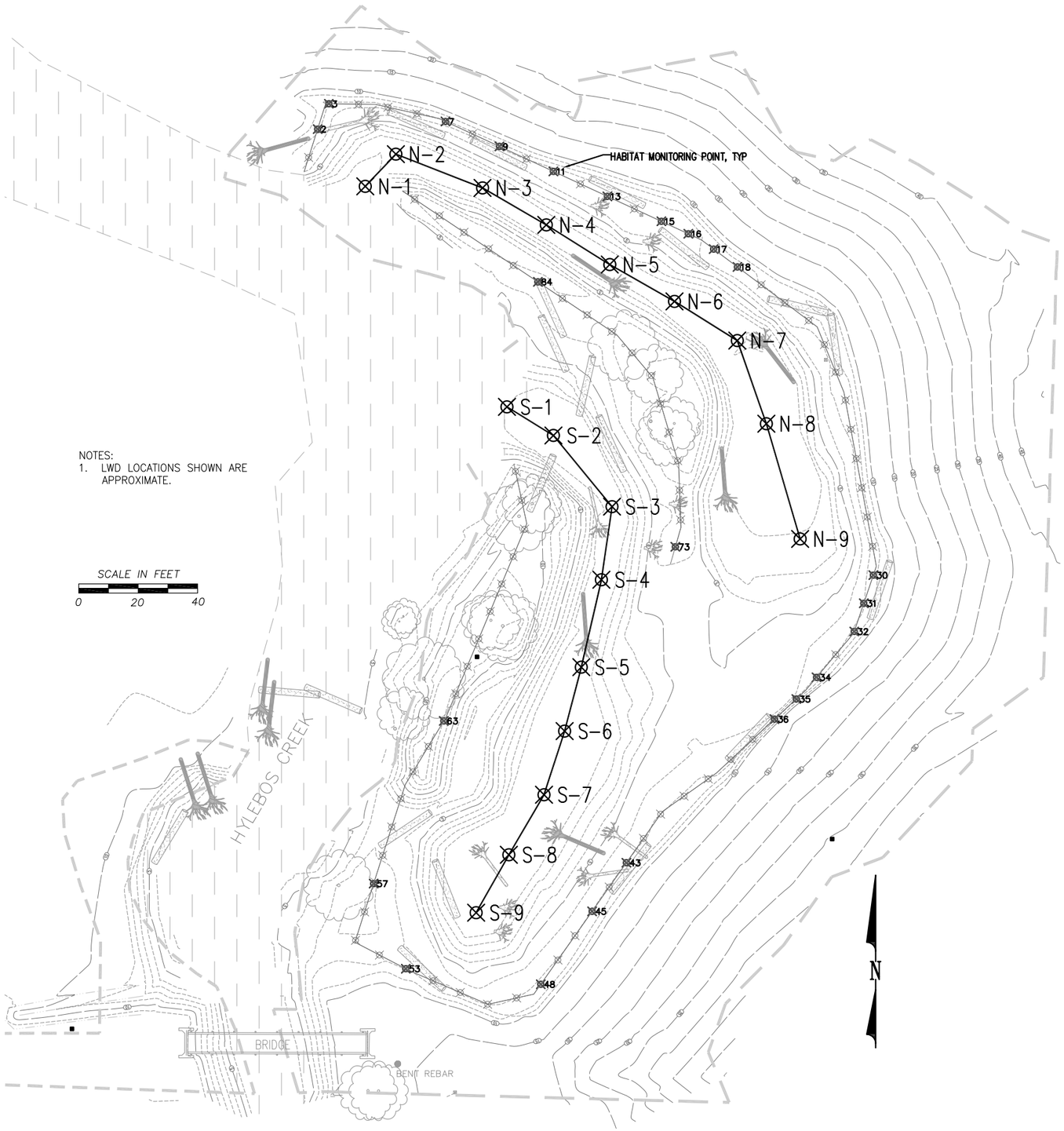
FIGURE 6-11
PUYALLUP RIVER SIDE CHANNEL
QUANTITATIVE MONITORING LOCATIONS



NOTES:
1. LWD LOCATIONS SHOWN ARE APPROXIMATE.

SOUTH LOBE CENTERLINE			
POINT	NORTHING	EASTING	YR 10 ELEV.
S-1	705914.01	1181063.36	0.20
S-2	705904.40	1181079.00	1.56
S-3	705880.46	1181098.72	1.67
S-4	705855.87	1181095.14	1.51
S-5	705826.47	1181088.39	1.33
S-6	705804.98	1181082.76	0.92
S-7	705783.57	1181075.84	1.26
S-8	705763.37	1181064.01	1.18
S-9 (E-1)	705743.90	1181053.00	1.51

NORTH LOBE CENTERLINE			
POINT	NORTHING	EASTING	YR 10 ELEV.
N-1	705988.18	1181015.70	1.18
N-2 (E-6)	705999.00	1181026.00	1.65
N-3	705987.66	1181055.16	1.76
N-4	705975.21	1181076.61	1.91
N-5	705961.87	1181097.96	2.03
N-6	705949.49	1181119.73	2.00
N-7	705936.30	1181140.86	1.89
N-8	705908.34	1181150.64	2.08
N-9 (E-4)	705869.60	1181162.00	2.67

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FIGURE 6-12
HYLEBOS CREEK HABITAT
QUANTITATIVE MONITORING LOCATIONS

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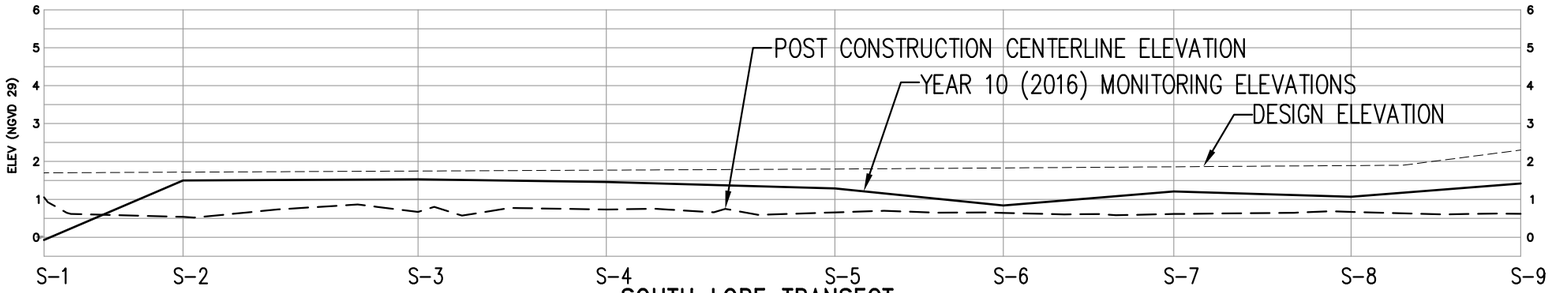
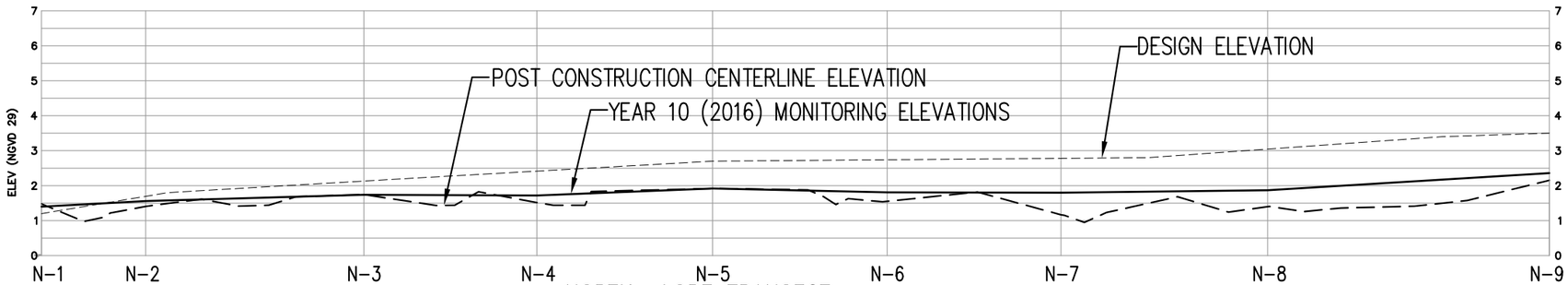


SOUTH LOBE TRANSECT

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



NORTH LOBE TRANSECT

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

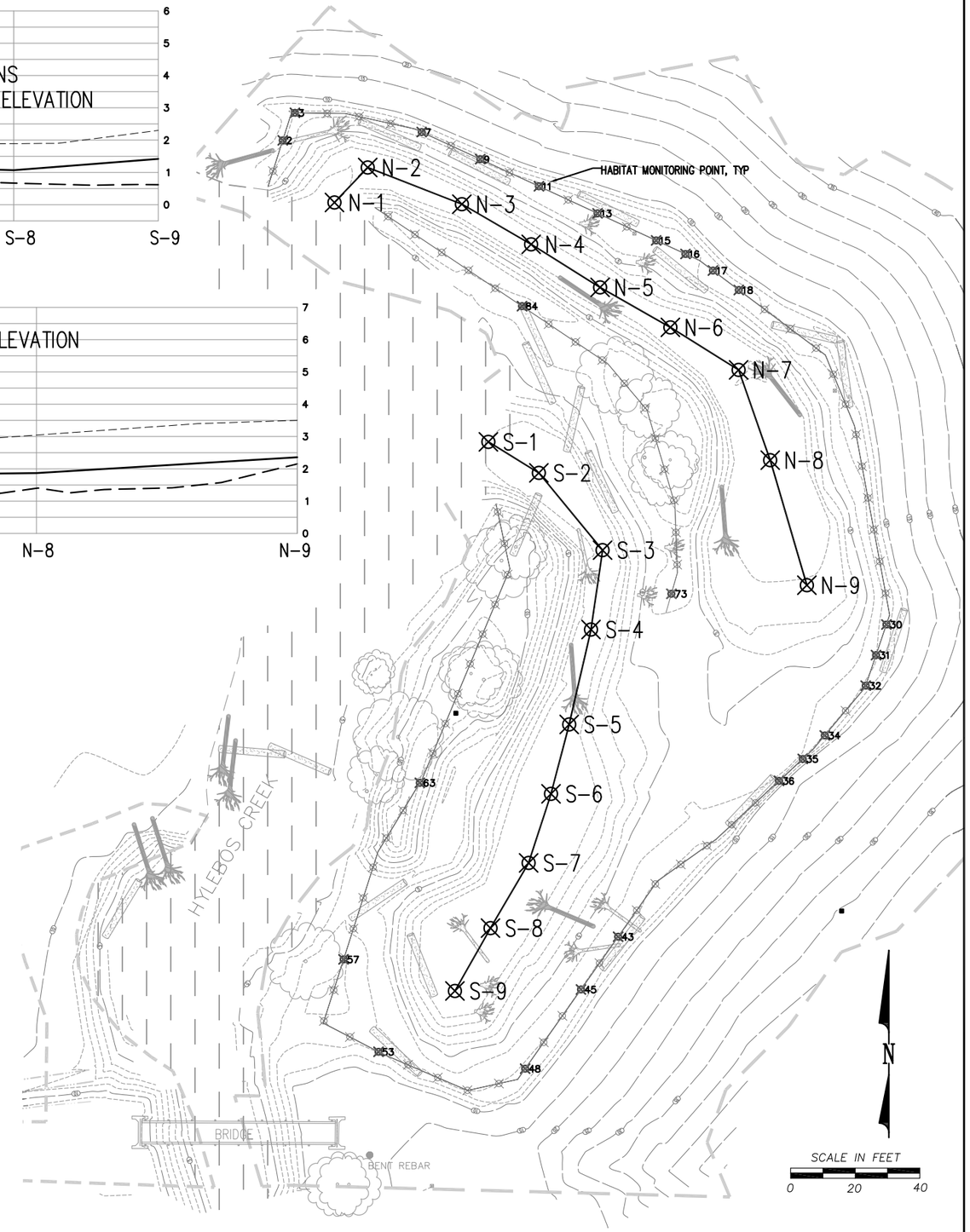


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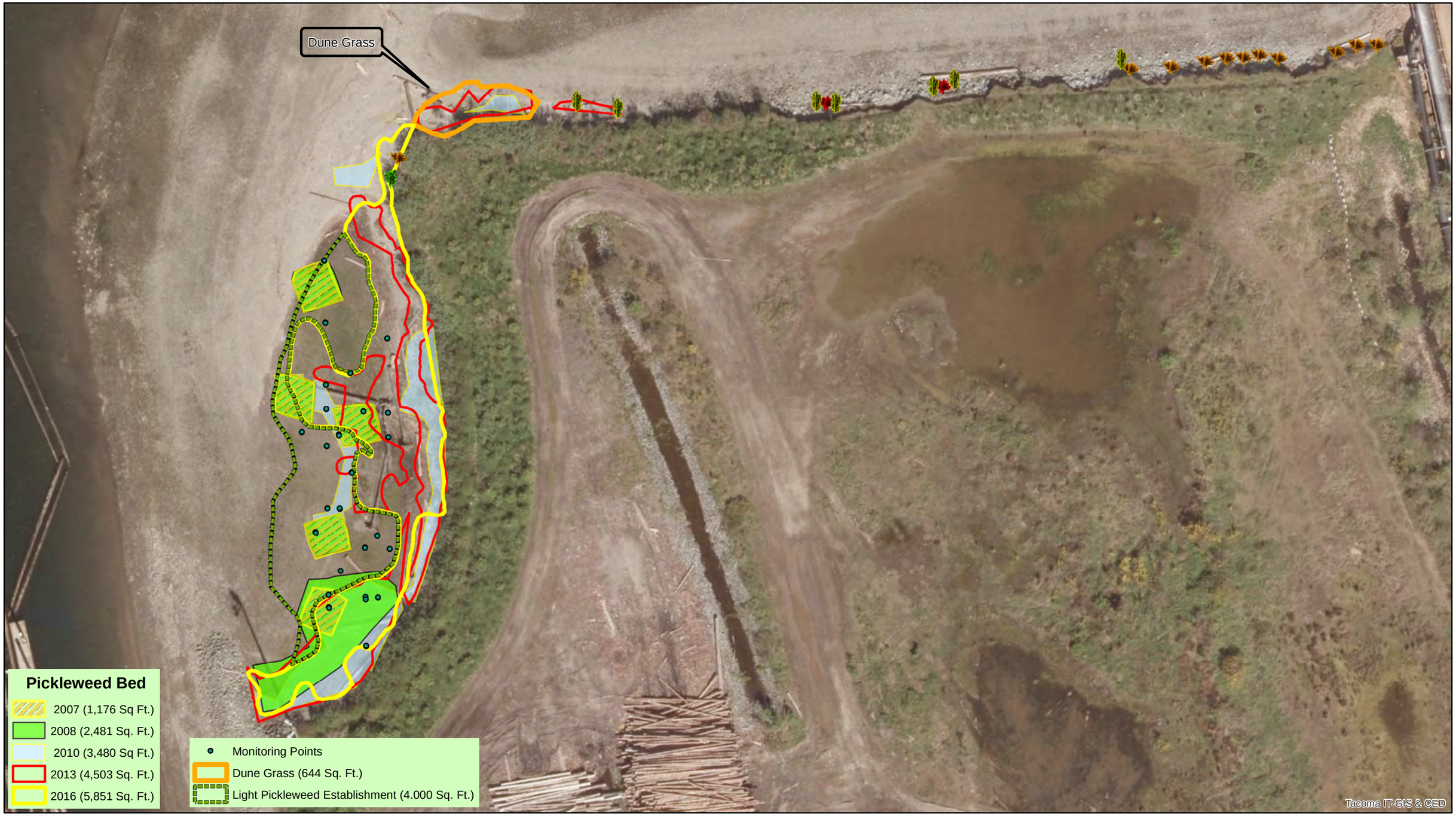
Figure 6-13
Hylebos Creek Centerline Transect Elevation Comparison

Figure 6-14
North Beach Habitat GPS Delineation of Plant Growth/Quantitative Monitoring Points



Plant growth is a total of original planting, new growth and additional planting

Dune Grass ((Beach Establishment 2016) | Dune Grass(Beach Establishment) | Dune Grass (Planted 8_13) | Pickleweed Spearscale

0 12.5 25 50 75 100 Feet

N

Figure 6-15
Middle Waterway Tideflat Habitat GPS Delineation of Plant Growth

Plant growth is a total of original planting, new growth and additional planting

Gumweed Salt Grass Pickle Weed

0 65 130 260 390 520 Feet

7.0 ADDITIONAL PROJECT RELATED ACTIVITIES

7.1 Introduction

Numerous other activities are ongoing during the implementation 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 effect on the project. Therefore, status updates on these various activities are 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.

Plan elements which have been implemented prior to this reporting period have been reported in the applicable Annual Operations, Maintenance, and Monitoring Reports. The following provides a status update on activities related to plan implementation which occurred during Year 10:

- Project representatives continued to work with the City's Planning and Development Services (PDS) division to implement steps 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 areas. Project representatives worked with PDS and EPA on a case by case basis to review development proposals as they were submitted. Several development plans are currently under construction or consideration and are being monitored relative to their potential impact on the cleanup areas. These proposals include the following:

    - **Waterway Park and Central Park** – The Foss Waterway Development Authority (FWDA) is planning to construct park developments in two locations on the Foss Waterway: on the east side of the head of the Thea Foss Waterway (Waterway Park) and in the central portion of the west side of the waterway (Central Park).

      The FWDA has partnered with the Metropolitan Park District (MPT) on development of these parks. The MPT and FWDA selected Site Works as the consultant to complete schematic design and public outreach for this next phase of park development. A Recreation and Conservation Office (RCO) grant request was submitted for the Central Park development. The MPT made a presentation to the RCO which subsequently ranked the project at number 44 out of the 77 that applied for funding. The Waterway Park project and the boat

launch float upgrade are currently in the design development phase, which will be followed by the fundraising phase. The City will continue to work with the FWDA and MPT as needed as the overall park development plans are finalized and construction is completed.

- **Public Esplanade** – The FWDA completed the design of the Site 9 public esplanade (immediately south of the Murray Morgan Bridge on the western shoreline) and has been working to secure funding for permitting. Permits are in place but funds have not been identified at this time. It is currently anticipated that the esplanade at the site will be replaced at a later date as part of a proposed real estate development project on the adjacent site.

  The design and permitting for the esplanade on Site 10 is complete and the City and FWDA are currently working cooperatively to assemble the funding package. The Site 11 Phase II public esplanade located immediately north of the Murray Morgan Bridge has been completed and is open to the public. The public esplanade has been well received and active use of this asset has been immediate.

- **Site 4 at 1543 Dock Street** – Business development for this site is underway and the FWDA is anticipating an announcement in Fall 2016 regarding a development timeline for the hotel.

- **Sites 8 & 9 at 1131 & 1119 Dock Street** – On March 23, 2016 the FWDA Board of Directors authorized the Executive Director to begin negotiations with Presbyterian Retirement Communities Northwest (PRCN) for development of a project on Site 8/9, located on the west side of the waterway, just south of the Murray Morgan Bridge. These development sites were added to the Department of Ecology (Ecology) Area Wide Consent Decree and construction will follow the requirements identified in the Consent Decree. The site specific clean-up action plans were finalized in early 2016, and issued for public comment. The City will continue to work with FWDA and the developer as the site is developed.

- **Site 10 at 921 Dock Street** – This site is currently being offered for redevelopment. Uses will be consistent with allowable uses under the S-8 zoning designation of the Tacoma Municipal Code. This site is not under the Area Wide Consent Decree. The Phase I Environmental Report done on the property did not indicate any historic uses known to generate heavy metals or other common contaminants of concern under the MTCA.

- **Municipal Dock Site at 1025 Dock Street** – This site is currently being offered for redevelopment. Uses will be consistent with allowable uses under the S-8 zoning designation of the Tacoma Municipal Code. The site has a No Further Action letter (NFA) from the State Department of Ecology.

- **Simpson Property** – The Simpson sawmill was sold to Canada-based Interfor Corporation on March 1, 2015, and operations at the mill subsequently ceased on May 22, 2015. On July 31, 2015, it was announced that the sawmill would not be coming back on line and the sawmill property is currently on the market. The future use of property is yet to be determined but it is not expected to remain a sawmill. The Foss Project team will continue coordination with the property owner on any projects in this area as additional information becomes available.

- **Tacoma Metals Site Remediation** – This site is located adjacent to the Puyallup River Side Channel habitat mitigation area. As of the date of this report, Ecology is continuing to work toward finalization of the Draft Cleanup Action Plan. Once the Draft CAP is completed, a new administrative order will likely be negotiated to implement the cleanup at the site.

The City will continue to review additional projects and design submittals as they are developed to ensure consistency with, and protection of the remedy.

7.3 Stormwater Source Control

7.3.1 Introduction

The Thea Foss and Wheeler-Osgood Waterways are located in a highly urbanized drainage basin with residential, commercial and industrial land uses and transportation corridors. Sources of Contaminants of Concern (COCs) continue to exist in the drainage basins and are conveyed to the waterways via stormwater (municipal and private), aerial deposition, marinas, and groundwater seeps. The contaminants identified as having the greatest potential to affect sediment quality following the cleanup action include PAHs and phthalates.

Under a Consent Decree with EPA dated May 9, 2003, the City of Tacoma is implementing a stormwater monitoring and source control strategy 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 Thea Foss Post-Remediation Source Control Strategy uses a multifaceted approach consisting of aggressive source control efforts, enhanced maintenance, a comprehensive monitoring program, a computer model to predict impacts, and a decision matrix to identify the need for additional source controls. The strategy's elements are integrated with the City's NPDES Phase I requirements, however, many of the elements performed in the Thea Foss basin exceed NPDES requirements.

The City prepared and submitted the Thea Foss and Wheeler-Osgood Waterways 2015 Source Control and Water Year 2015 Stormwater Monitoring Report (Stormwater Annual Report) in March 2016. This Stormwater Annual Report outlines the City's existing programs and studies completed in 2015 and includes a discussion of the need for additional source controls. Included are annual source control evaluations for the seven major outfalls discharging to the waterways; Outfalls 230, 235, 237A, 237B, 243, 245 and 254. The evaluations include a drain by drain assessment and incorporate the review of ongoing studies, source control investigations, water quality data and stormwater suspended particulate matter (SSPM) data for that outfall/basin.

In addition to the 2015 source control evaluations, the Stormwater Annual Report contained a review of the results from the first fourteen years of outfall monitoring conducted under the City's NPDES Program, source control actions completed in the Thea Foss drainage basins and computer model predictions. The history and trends emerging over the fourteen years of the program (2002-2015) are examined and presented in the report.

7.3.2 Stormwater Time Trend Analysis

Part of the evaluation included in the Stormwater Annual Report is an assessment of whether stormwater quality is improving over time. As described in the report, over a 14 year period (August 2001-September 2015), stormwater and SSPM have been sampled at the seven major outfalls that discharge into the Thea Foss and Wheeler-Osgood Waterways. In addition, baseflow was sampled at the same seven outfalls for the first 10 years of the program. Over the last 14 years, 1,635 samples have been collected with 322 baseflow and 954 stormwater samples collected at the outfalls, and 86 outfall and 273 upline SSPM samples collected in pipeline sediment traps deployed throughout the watershed. This depth of data provides the basis for meaningful statistical evaluation of the trends over the program period.

Forty-six statistically significant time trends (46 out of 49 tests or approximately 94% of the tests) were shown in Year 14 using simple linear regression. All trends were in the direction of decreasing concentrations. This is the same number of significant reductions than was observed In Year 13. In Year 12, 44 significant trends were detected; in Year 11, 41 significant trends were detected, in Year 10, 37 significant trends were detected; in Year 9, 26 significant trends were observed; in Year 8, 10 significant trends were observed; and in Year 7, only 4 significant trends were observed. It should be noted that some new statistical approaches were implemented beginning in WY2012 and for this reason, the results since then are not fully comparable to previous year's results. However, these changes have improved the statistical approach to the trend analysis, and the City's ability to discern trends. In addition to the 49 time trend tests that have been evaluated in past years, the 2014 QAPP requires the City to analyze and evaluate total copper. For three outfalls, OF235, OF237B and OF245, the data collected in WY2015 has been added to data previously collected under the NPDES program between 2009 and 2012, and more data is available to perform a cursory evaluation of time trends, although with less data, the statistical results are not fully comparable to data for the remaining constituents. Based on this cursory analysis, one of these three outfalls, OF237B, shows a significantly significant decrease in copper concentration. With these three tests added, there are 47 statistically significant time trends (47 out of 52 tests, or approximately 90% of the tests) shown in Year 14, with all trends in the direction of decreasing concentrations. Time trends for copper at all seven outfalls will continue to be evaluated as additional data becomes available.

The time trends were modeled with best-fit regression equations to estimate percent reductions over the 14 year monitoring period for these constituents and outfalls:

Total Suspended Solids (TSS): Approximately 47-68% reduction in OF230, OF235, OF237A, OF237B and OF245;

Copper: Approximately 39% reduction in OF237B (based on more limited data);

Lead: Approximately 53-78% reduction in OF230, OF235, OF237A, OF237B, OF245 and OF254;

Zinc: Approximately 43-61% reduction in all seven outfalls;

Polycyclic Aromatic Hydrocarbons (PAHs): Approximately 87-98% reduction in phenanthrene, pyrene and indeno(1,2,3-cd)pyrene in all seven outfalls; and

Bis(2-ethylhexyl)phthalate (DEHP): Approximately 76-91% reduction in all seven outfalls.

7.3.3 Municipal, State, and Federal Source Control Efforts

The cumulative effect of municipal, state, and federal source control efforts has likely contributed to these observed improvements in stormwater quality. The City has directed numerous source control efforts in this watershed focused on these COCs. The City implements aggressive source control activities that comply with or exceed the requirements of the NPDES permit. Many of these activities have been developed specifically to respond to sources of contaminants found during various investigations.

Stormwater Management Program. The NPDES Phase I Municipal Stormwater Permit (NDPES Phase I Permit), effective August 1, 2013 through July 31, 2018, requires a Stormwater Management Program which is divided into 10 components including stormwater outfall sampling, source control, maintenance, inspections, capital projects, and program development and implementation for the municipal separated storm sewer system (MS4). The City integrates these NPDES program elements with the ongoing Thea Foss Program.

In 2015, City staff performed numerous field activities within the Foss Waterway Watershed including the following:

- Responded to 197 spills/complaints including conducting investigations;
- Provided technical assistance on source control and best management practices;
- Conducted 552 total inspections (97 business inspections, 15 pre-treatment inspections and 440 asset inspections);
- Assessed an additional 80,013 feet of pipe under the STRAP program.

All of the business inspections, complaints and spills, and various source control field activities are documented and tracked using a web-based database. The web-based database is an effective tool for retrieving historical information and examining trends.

Municipal Stormwater Ordinance. The City's stormwater ordinance, during this reporting period through the 2012 Stormwater Management Manual and as of January 7, 2016 through the 2016 Stormwater Management Manual, requires stormwater treatment and control systems on new and redeveloped sites when certain thresholds are met, and provides a mechanism for enforcement of the stormwater management regulations. Through new development and redevelopment, stormwater runoff from industrial and commercial sites throughout the Thea Foss Basin is being converted from untreated to treated runoff (i.e., removal of solids from stormwater runoff).

Special Studies. The City has conducted a number of special studies to better understand the distribution of DEHP and PAHs in the urban environment and how those and other COCs might best be controlled.

Stormwater treatment studies. Stormwater treatment studies have been conducted to evaluate the ability of proprietary and public domain stormwater treatment systems to remove DEHP and PAHs from stormwater runoff. Systems tested to date include StormFilter, AquaFilter, pervious pavements, rain gardens and wet vaults. The City has evaluated each technology's effectiveness, applicability and reasonableness for use within the Foss Waterway Watershed.

Basin-wide sewer line cleaning. Basin-wide sewer line cleaning was conducted in the majority of the area of four drainage basins (OF254 in 2006; OF230 and OF235 in 2007; and OF237B in 2011) and part of a fifth basin (OF237A in 2008). The objective of the sewer line cleaning

program is to remove residual sediments in the storm drains and sediment-bound contaminants. Contaminants in sediments present in the system may not solely be from new sources, but may in part be from legacy contamination in the pipe that could be continuing to impact stormwater or baseflow quality through re-suspension and/or dissolution.

A statistical comparison of pre-cleaning versus post-cleaning data ("before" and "after" conditions) shows there are statistically significant reductions in the mean concentrations of all seven Thea Foss index chemicals in OF230, OF235, OF237A, and OF237B and in six of the seven index chemicals in OF254 (all but TSS). While this is representative of the results of combined source control efforts, sewer line cleaning appears to have been effective at accelerating removal of PAHs from stormwater, with 65-89% reductions in all five of these drains, including both light and heavy PAH fractions. DEHP also shows a significant reduction of approximately 18-79% in all five drainage basins.

Lead shows a significant reduction of 11-53% and zinc shows a significant reduction of 18-43% in response to line cleaning in all five of the basins. In 2015, reductions of 16-52% in TSS are statistically significant in four of the five basins (all except OF254). These statistical comparisons will continue to be updated as more post-cleaning data are collected. The statistical power of this test should increase over time, and quite possibly statistical differences that can't be resolved today may be distinguishable in the future.

Enhanced street sweeping program. In January 2007, the City's street sweeping program was enhanced in an attempt to reduce sediment buildup in the storm sewer system. Under the enhanced program, the sweeping frequency was increased, air regenerative sweepers replaced mechanical sweepers, and the City also increased communications with residents, which helped raise awareness of the importance of the street sweeping program.

A statistical comparison of data from before and after implementation of the enhanced sweeping program ("before" and "after" conditions) shows there are statistically significant reductions in the mean concentrations of the three index PAHs and DEHP in all seven outfalls. While this is representative of the results of combined source control efforts, enhanced street sweeping appears to have been effective at accelerating removal of PAHs and DEHP from stormwater, with 57-82% reductions of PAHs in all seven drains, including both light and heavy PAH fractions. DEHP reductions ranged from approximately 20-75% in the seven drains.

Zinc shows significant reductions of 21-38% in response to enhanced sweeping in all seven basins. In six of the seven basins (all but OF243) lead shows significant reductions of 8-49% and TSS shows significant reductions of 1-50% in five of the seven outfalls (OF230, OF235, OF237A, OF237B and OF245). These statistical comparisons will continue to be updated as more data are collected. The statistical power of this test should increase over time, and quite possibly statistical differences that can't be resolved today may be distinguishable in the future.

Stormwater pipe retrofit projects. In 2010, 13,500 linear feet of existing storm sewer main was structurally rehabilitated in the OF230 drainage basin. In 2013, an additional 13,807 linear feet of existing storm sewer main was structurally rehabilitated in the OF230 drainage basin, along with 5,479 linear feet in the OF235 drainage basin and 5,126 linear feet in the OF237A drainage basin. The rehabilitation projects were accomplished by means of Cured-In-Place Pipe (CIPP) construction technologies using resin impregnated liners which fixed defects (cracks, holes, etc.) in the pipe that could have allowed potentially contaminated groundwater and soil from historic "hot spots" to enter the storm sewer system

A statistical comparison of monitoring data from pre-construction and post-2013 lining project construction were reviewed and statistically significant reductions in OF230, OF235 and

OF237A were evident for TSS, lead, zinc, PAHs and DEHP (see Table 2-6). CIPP lining, along with other source control activities, resulted in reductions of TSS at 38-47%, lead at 55-71%, zinc at 19-41%, DEHP at 55-75% and PAHs (phenanthrene, pyrene, and indeno(1,2,3-cd)pyrene) at 59-92%. As additional post-lining monitoring data become available, the statistical power of the test should increase and quite possibly statistical differences that cannot currently be resolved may become distinguishable in the future.

GIS-based pollutant loading model. The City completed development of a GIS-based pollutant loading model to evaluate other stormwater best management practices (BMPs) that may be effective on a basin-wide scale (i.e., affecting tens, hundreds, or thousands of acres). The BMPs under consideration are street sweeping, low-impact development (LID), and engineered treatment devices such as filtration vaults. The goals of this study are: to evaluate the feasibility and cost-effectiveness of stormwater BMPs implemented on a basin-wide scale; to identify areas of concentrated pollutant runoff where source control efforts are best focused; and to assess the degree to which stormwater BMPs will cause a reduction of pollutant loadings, and thereby improvements in Thea Foss sediment quality. The model was calibrated to the City's stormwater monitoring record. The City is currently planning to use this model as a tool in evaluating the selection of stormwater BMPs in the future.

Other State Regulations. In July 2012, the Washington State Department of Ecology (Ecology) reissued the final modified Industrial Stormwater General Permit (ISWGP) which includes new requirements. It is anticipated that under Ecology's ISWGP and the existing Construction Stormwater Permit, contaminants in stormwater will be reduced over time from industrial facilities and construction sites. It is also anticipated that reductions of air pollution will occur through Ecology's Air Program. As reductions in air pollution are realized, the pollutant loads washed off upland surfaces and entrained in stormwater runoff will decrease.

7.3.4 Compliance with Sediment Quality Objectives in the Waterway

When the waterway sediment remediation projects were completed, the majority of the sediment surface had no, or very low concentrations of contaminants present since the surface was either dredged to clean sediments or covered with new, clean capping materials. It was anticipated that ongoing source contributions to the waterway would cause concentrations of contaminants to increase gradually. Over time, the goal is to have the contaminant concentrations equilibrate at a level below the sediment cleanup standards set by the EPA. The City developed a predictive model so that actual sediment monitoring results can be compared to model predictions to determine areas where additional source controls may be needed to remain in compliance.

The sediments in the waterway are the true barometer, however, of whether additional source controls are needed for compliance with regulatory requirements. As discussed throughout this report, sediment monitoring was performed by the City in 2016, in the portion of the waterway generally north of the SR 509 Bridge. In addition, in 2014 sediment monitoring was performed by the Utilities, in coordination with the City, in their work area located in the head of the waterway (see Section 7.4 below).

As described throughout this report, Year 10 sediment sampling in the waterway was conducted by the City in the area from just north of the SR509 Bridge to the mouth of the waterway. In general, past in-waterway sediment results indicate that the SQOs are generally not exceeded with the exception of relatively low levels of PAHs and DEHP in some localized areas. Generally similar results were found in Year 10. The one exception to this is the results for

benzoic acid, where there were significantly more detections of benzoic acid in both the performance monitoring samples and the early warning samples. However, as discussed in detail in Section 2 of this report, this is not believed to be associated with a new source of contamination to the waterway but rather is associated with improved analytical methods.

These Year 10 sediment data will be evaluated and compared to the WY2016 stormwater and storm sediment monitoring results to determine if additional source control actions are needed. This evaluation will be included in the Thea Foss and Wheeler-Osgood Waterways 2016 Source Control and Water Year 2016 Stormwater Monitoring Report to be submitted for agency review in March 2017.

7.3.5 2015 Source Control Work Plan

A considerable amount of source control work has taken place in the Foss Drainage Basin over the last 14 years. With the significant improvements realized, fewer major source control issues remain. The source control work plan for 2016 identified specific activities for the watershed and for each basin. Each activity was prioritized in order from highest to lowest with higher priorities given to eliminating/reducing point sources and activities that are based on best professional judgment to provide a measurable benefit in reducing chemical loadings to the waterway. Some highlights being completed in 2016 include:

- OF230: Continue source tracing investigation and track private property cleanups in area draining to FD3A, FD18 and FD18B for mercury and PCBs, with PAHs and phthalates analyzed as well.
- OF237A: Continue source tracing investigation to track potential sources of PAHs to FD13B-New from the Tacoma News Tribune site.
- OF243: Continue mercury source tracing investigations in the FD23 drainage area. Continue working with businesses in the BNSF yard to evaluate other potential sources.
- OF245: Continue joint inspection with TPCHD and Ecology and follow-up efforts at Quality Transport for evaluation and control of phthalate sources.
- OF230: Evaluate possible sources of PCBs to FD16.
- OF235: Continue to investigate sources of lead, PAHs and phthalates in stormwater. The area draining to FD6A is higher than other branches of OF235 in PAH concentrations in stormwater, and stormwater concentrations at the outfall rank highest overall.
- OF237A: Evaluate possible sources of PCBs to FD10C.
- OF237B: Track PCB removal activities associated with the road construction project in FD34/35.
- All: Review WY2015 SSPM data when available to evaluate the effectiveness of treatment systems installed and source control actions taken.

More information about these activities can be found in the Stormwater Annual Report.

7.3.6 Conclusion

Reduction of contaminant loads to the Thea Foss and Wheeler-Osgood Waterways over the years, through the City's implementation of its stormwater source control program, as well as through the control of other sources, has been substantial. The improvement in stormwater quality since the mid-1990s indicates that source control efforts by the City and others in the Foss Waterway Watershed have been effective in reducing chemical concentrations in stormwater. The City believes some minor additional improvements in stormwater quality may be realized in the future with ongoing NPDES Phase I Permit programs and continuing improvements in source control implementation. The City is moving forward with ongoing source tracing investigations, treatability studies, and other special investigations for evaluating and identifying cost-effective controls for metals, DEHP and PAHs in municipal stormwater. Ongoing control of sources which are outside the City's jurisdiction must also continue to be coordinated by other federal, state, and local authorities.

The improvements in stormwater quality since the mid-1990s indicate that source control efforts in the Foss Waterway Watershed have been effective in the reduction of chemical concentrations in stormwater. Tests performed show 94% statistically significant time trends, all in the direction of decreasing concentrations. This result is significant and a testament to the City's ongoing comprehensive source control program. Source control activities currently being implemented by the City include business inspections, response to spills and illicit discharges, mapping/maintenance/cleaning of the stormwater system, pollutant source tracing, and implementation of the City's Surface Water Management Manual through the stormwater ordinance.

It should be noted that while considerable improvements to stormwater quality have been made, the largest changes were realized in the earlier years of the program when major sources were identified and eliminated. Because the source control program has been so effective through the years, fewer major sources or maintenance actions are needed and the program is beginning to approach an equilibrium or maintenance mode. In other words, the concentrations of contaminants of concern in the stormwater in the Foss Waterway Watershed are reaching a level where the opportunities for large reductions are more limited. This may over time lead to the appearance of fewer additional decreasing trends in contaminant concentrations, lower percentages of reduction, and potentially even a few minor increasing trends, particularly if looking only at results from more recent years. However, data shows that the City's stormwater source control and monitoring program have been very effective in reducing contaminant levels in stormwater and SSPM and that the risk of recontamination of sediments over biological effects thresholds in the Thea Foss Waterway from stormwater is low.

7.4 Recontamination in the Head of the Thea Foss Waterway

As part of the Utilities' Operations, Maintenance, and Monitoring Plan (OMMP) for the Head of the Thea Foss Waterway (Tetra Tech 2003), sediment sampling and analysis was not required during this reporting period. The most recent compliance monitoring event conducted in the head of the waterway was the Utilities' Year 10 (2014) OMMP monitoring. The results of this Year 10 monitoring were summarized in the City's Year 8 OMMP Annual Report.

EPA is currently considering the next steps for continued monitoring in the head of the waterway. At this time the agencies have indicated that they plan to coordinate a comprehensive monitoring program for the whole waterway so that the head and the remainder

of the waterway are on the same monitoring schedule. It is anticipated that discussions of the next steps in the OMMP monitoring program will begin in late 2016.

7.5 Deauthorization of Navigation Channel in Encroachment Areas

In accordance with a Memorandum of Agreement between the Army Corps of Engineers (ACOE) 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 ACOE on September 25, 2007. A response from ACOE 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. This involved coordination with the congressional delegation to request language be included in the Water Resources Development Act. The ACOE did indicate that they could assist with legislative drafting services for this, if requested by a member of Congress. The City diligently coordinated with its Government Relations Office and the Congressional delegation on the shoreline deauthorization. The City provided the required locational information and legislative language to the Congressional representatives, but inclusion of the language in the bill was delayed because additional information including a cost estimate was required from ACOE. While Congressional representatives were hopeful that they would be able to include the Thea Foss deauthorization language, the final WRDA bill was signed by the President on June 10, 2014, without the Thea Foss deauthorization language included.

At that time, the Congressional delegation felt confident that the language would be included in the next WRDA bill and have indicated that they would make it a top priority. On September 27, 2016, the House of Representatives passed its version of WRDA and instead of listing deauthorization projects individually, they instructed the head of the Army Corps to submit a list of projects which are inactive and should be deauthorized to the House and Senate. If that provision is contained in the House-Senate conference which will hammer out the final bill, City representatives, along with Congressman Kilmer's office, will work with the Corps to ensure that the Thea Foss Waterway is on that list. The list would become effective after a standard comment period.

The House and Senate will be working over the next few weeks to hammer out a final WRDA bill with the idea of getting it passed in the lame duck session of congress which starts November 14.

If it turns out they are not going with the new deauthorization process, we'll go back to the strategy of trying to get it listed in the final bill.

APPENDICES

(on enclosed CD)

APPENDIX A – PHYSICAL CAP INTEGRITY MONITORING

A-1 Year 10 Monitoring Low Tide Slope Cap Inspection Preliminary Findings Memorandum

A-2 Year 10 Monitoring Subtidal Cap Hydrographic Survey Preliminary Findings Memorandum

APPENDIX B – SEDIMENT AND CAP PERFORMANCE MONITORING

B-1 Year 10 Sediment and Cap Performance and Early Warning Monitoring Preliminary Findings Memorandum

B-2 Discrete Samples Data Validation Report

APPENDIX C – BENTHIC RECOLONIZATION MONITORING

C-1 Year 10 Monitoring Benthic Recolonization Monitoring Preliminary Findings Memorandum

APPENDIX D – CONFINED DISPOSAL FACILITY MONITORING

D-1 St. Paul Waterway Confined Disposal Facility Year 10 (2016) CDF Performance Monitoring Memorandum

APPENDIX E – HABITAT MITIGATION AREA MONITORING

E-1 Year 10 Monitoring Habitat Mitigation Area Monitoring Preliminary Findings Memorandum

E-2 Quantitative Monitoring Calculations

APPENDIX F – HEALTH AND SAFETY PLAN

APPENDIX G – ADDITIONAL PROJECT RELATED ACTIVITIES