*L*ower *D*uwamish *W*aterway *G*roup

Port of Seattle / City of Seattle / King County / The Boeing Company

Appendix K
Lower Duwamish Waterway Conceptual Monitoring Program

Draft Final Feasibility Study

Lower Duwamish Waterway
Seattle, Washington

FOR SUBMITTAL TO:

The U.S. Environmental Protection Agency
Region 10
Seattle, WA

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K.1 Introduction

This appendix presents the rationale and conceptual structure for a multi-component Lower Duwamish Waterway (LDW) monitoring program that serves as the basis for the monitoring portion of feasibility study (FS) cost estimates (Appendix I). The program relies on several simplifying assumptions and is not intended to specifically represent the scope and duration of monitoring that will eventually occur in the LDW. The monitoring requirements for determining compliance and success of remedial alternatives will be determined in post-FS decision documents and during remedial design.[1]

The monitoring program described herein is sufficiently broad, detailed, and consistent with guidance to fulfill FS-level scope and cost-estimation objectives. The scope of this appendix is limited to sediment chemistry, sediment toxicity, water quality, tissue chemistry, and physical inspections. Physical maintenance, repairs, and potential adaptive management contingency measures for each of the remedy components are discussed separately in Sections 9, 10, and 11 of the FS. The temporal elements of this monitoring program (as described in the following sections) include:

- Baseline monitoring
- Construction monitoring
- Post-construction performance monitoring
- Long-term operation and maintenance (O&M) monitoring
- Long-term remedial action objective (RAO) monitoring.

This appendix sets forth assumptions regarding quantities and frequencies of sampling and reporting that form the basis for cost estimation. Remedial design-level data collection does not fall within the types of monitoring discussed in this appendix. Remedial design and sampling costs are included as a line item under capital costs (Appendix I). Remedial design is applied as a percentage (20%) of the capital costs, and includes pre-design sampling and analysis costs. Verification monitoring will be conducted during remedial design; associated scope and costs are not addressed in this appendix.

Data collection and frequency assumptions for the five monitoring components described in this appendix are summarized in Table K-1. Table K-1 illustrates the scale of application for each monitoring element. Baseline and long-term RAO monitoring have LDW-wide applications common to all remedial alternatives. They are used to

[1] This appendix does not consider monitoring associated with near-shore or upland source control. Near-shore source control (e.g., identifying, remediating or stabilizing erodible banks) is a presumed component of remedial design. The scope of upland source control work, which will involve numerous parties other than those performing the LDW remedy, is beyond the scope of the FS.

assess the overall condition of the LDW in relation to achievement of the RAOs and cleanup levels set forth in the final decision document. The other three monitoring categories apply at the area- or project-specific level.

For cost estimation, the FS adopts this framework as the cleanup moves from construction to long-term monitoring. It is important to recognize that while the various monitoring types have different objectives, and their costs are estimated separately, they are not mutually exclusive. Project-specific and LDW-wide sampling will overlap in certain areas, allowing application of the data to multiple uses (e.g., for achieving both project-specific and LDW-wide monitoring objectives).

The five types of monitoring defined in Table K-1 are consistent with the three types of compliance monitoring requirements described in the Washington State Model Toxics Control Act (MTCA) (WAC 173-340-410):

- Protection monitoring confirms that human health and the environment are adequately protected during construction (corresponds to construction monitoring).
- Performance monitoring confirms that remedial actions have achieved the cleanup standards or other performance standards (corresponds to post-construction performance monitoring).
- Confirmational monitoring confirms the long-term effectiveness of a remedial action after the performance standards and/or remediation levels have been achieved. This would include monitoring of disposal, isolation, or containment sites to ensure protection (corresponds to long-term O&M monitoring, and long-term RAO monitoring).

Table K-2 cross-references MTCA compliance monitoring requirements with the five types of monitoring identified and described in this appendix.

K.2 Baseline Monitoring

Baseline monitoring establishes a site-wide basis for comparing pre- and post-remediation conditions. Baseline monitoring occurs before remediation commences and is distinct from project-specific remedial design sampling and data collection.[2]

The FS sediment dataset includes a large body of data spanning almost 20 years (1991 to 2009) that will inform the scope for baseline monitoring. However, the data are skewed (i.e., unevenly distributed) both geospatially and temporally. The pronounced rates at which sediment from the Green/Duwamish River system accumulates in the LDW (as estimated by the Sediment Transport Model [STM] and discussed in Section 5.1)

[2] Baseline monitoring will occur once shortly after the remedy decision documents are issued. Remedial design sampling will occur before active remediation in specific project areas and will therefore occur later than and at a smaller spatial scale than baseline sampling. Verification monitoring will be concurrent with remedial design sampling.

suggest that conditions may be improved through natural recovery by the time the final decision document is issued. This argues for a new temporally and spatially consistent LDW-wide dataset. Newer data are needed at appropriate scales (project-based and LDW-wide) to establish a baseline condition and provide a basis for comparisons with post-remediation data.

The sampling design for baseline monitoring should facilitate evaluation of the aggregate benefits derived from remedial actions over time and over relevant spatial scales (e.g., site-wide, potential clamming areas, and assumed beach play areas). A site-wide bathymetric survey and sampling/analysis of sediment, surface water, and fish and shellfish tissue are assumed. In addition, placeholder scope and costs are assumed for additional yet to be defined baseline and long-term RAO monitoring surveys (Table K-1 and Appendix I).

K.3 Construction Monitoring

Construction monitoring during remediation is area-specific, is short-term, and is used to evaluate whether the project is being constructed in accordance with plans and specifications (i.e., performance of contractor, equipment, and environmental controls). For dredging and capping operations, construction monitoring evaluates water quality near the operations to determine whether the resuspension of contaminated sediments and their downgradient movement are being adequately controlled.

Construction monitoring occurs during active portions of a given remedy (i.e., dredging, capping, and ENR) and is assumed to be project-specific and to consist of:

- Daily field-based water quality monitoring in the immediate vicinity of the active remediation to demonstrate compliance with water quality certification requirements (e.g., physical measures such as turbidity).
- Intermittent collection of downcurrent water column samples for chemical analyses. The need for chemical testing will be based on the screening results from the daily field-based water quality monitoring.
- Construction quality control to verify achievement of design specifications (e.g., cap area coverage and thickness). Bathymetric surveys are used to determine whether target sediments are removed in dredging operations and whether cap materials are being placed in the design location and at the specified design thickness. For capping and ENR technologies, other methods (e.g., sediment cores, staking, diver surveys, and settling plates; Anchor 2007) are often employed post-construction and are included in Section K.4 below.

Construction monitoring will be developed on a case-by-case basis by the performing parties. For FS purposes, construction monitoring is assumed to occur during the full duration of each construction season, which in turn, is based on the construction period estimates developed in Section 8 of the FS. FS cost assumptions are outlined in Table K-1.

K.4 Post-construction Performance Monitoring

Post-construction performance monitoring demonstrates whether, after construction, specific cleanup projects comply with project requirements and design specifications (e.g., surface sediment chemical concentrations are below the remediation action levels [RALs]; minimum average ENR thickness must be 6 inches of spatial coverage). This monitoring focuses on acquisition of sediment chemistry (chemicals of concern [COCs]) data in the actively remediated footprint (i.e., dredging, capping, ENR).[3] However, sampling is also assumed for areas peripheral to dredge footprints to support dredge residuals management decisions (e.g., need for and extent of thin-layer sand placement). Post-construction monitoring is slightly different for different remedial technologies and consists of:

- **Dredging:** Surface sediment sampling and analysis for COCs, grain size, and TOC
- **ENR and Capping:** Surface sediment sampling and analysis for COCs, grain size, and TOC; ENR/cap thickness verification using a combination of tools including bathymetry soundings, sediment cores, diver surveys, staking, and/or settlement plates.

Performance monitoring occurs at the end of construction in a specific project area and at the conclusion of each construction season for projects that are only partially completed. A single project-area specific bathymetric survey is assumed at the conclusion of construction. FS cost assumptions are outlined in Table K-1.

K.5 Long-term Operation and Maintenance (O&M) Monitoring

Long-term operation and maintenance monitoring verifies that areas requiring management (i.e., dredging, capping, ENR, or MNR) remain protective. Cap and ENR areas are physically inspected (e.g., diver surveys) to check for evidence of instability and scour. Chemical analyses of surface sediments in all managed areas are used to evaluate recovery status and whether recontamination is occurring. The scope of long-term O&M monitoring depends on the remedial action undertaken. The spatial density of samples, frequency, and duration of monitoring are expected to vary. For example, a more intensive program (longer duration and greater sample density) is anticipated for areas undergoing ENR and MNR than for areas remediated by dredging or capping. Detailed long-term O&M monitoring requirements will be defined during remedial

[3] Other project requirements such as cap or ENR application thicknesses are verified as part of Construction Monitoring (Section K.3).

design. For FS cost estimation purposes, the assumed rationale for long-term O&M monitoring is as follows (see Table K-1 for data requirements and collection frequencies):

- **Dredging**– Surface sediment grabs and chemical analyses for COCs are collected to assess whether recontamination is occurring.
- **Capping** – Inspections and chemical analyses for COCs in the surface and subsurface are conducted to assess cap conditions and identify potential concerns with cap surface chemistry, including erosion, settlement/compaction, recontamination, and contaminant flux through the cap. In the event that monitoring indicates recontamination beyond acceptable levels, continued monitoring is needed to verify the extent of recontamination or to establish temporal trends. Physical inspections assess any changes in the cap from erosion or settlement. Potential adaptive management contingency actions based on monitoring and inspection include continued monitoring to establish trends and repair by placement of additional granular material. The FS cost estimate assumes a fixed percentage of the total cap area of each alternative will need supplemental sand placement to ensure cap protectiveness based on monitoring results (Appendix I).
- **ENR** –Surface sediment grabs with chemical analyses for COCs are obtained to assess conditions over time. In the event that monitoring indicates recontamination beyond acceptable levels, continued monitoring is needed to verify the extent of recontamination, establish temporal trends, or to inform planning for repairs or contingency actions. The FS cost estimates assume a fixed percentage of the total ENR area of each alternative fails to achieve project-specific goals and reverts to dredging based on monitoring results (Appendix I).
- **MNR** –MNR requires the most O&M sampling because performance depends solely on natural processes and is thus subject to greater uncertainty compared to dredging, capping, and ENR. Surface sediment grabs with chemical analyses for COCs and toxicity testing are obtained to assess conditions over time. Where monitoring indicates that recovery is progressing adequately toward goals, O&M monitoring continues until recovery is documented and is then discontinued. If monitoring demonstrates an unacceptable rate of recovery, adaptive management contingency actions may be warranted. The FS cost estimates assume a fixed percentage of the total MNR area of each alternative fails to achieve project-specific goals and reverts to dredging based on monitoring results (Appendix I).

K.6 Long-term RAO Monitoring

Long-term RAO monitoring evaluates sediment, surface water, and tissue quality at the site during and following completion of all remedial actions and achievement of RAOs has been demonstrated. The scope of a long-term RAO monitoring program is similar and complementary to baseline monitoring, and is largely independent of the specific remedial action although data from other elements of the monitoring program (described in the previous sections) will complement and contribute to the long-term RAO monitoring datasets. Sample numbers and collection frequency will vary by exposure area and media (Table K-1) to:

- Evaluate sediment quality site-wide and in the potential clamming areas and assumed beach play areas.
- Evaluate surface water quality and compliance with surface water quality ARARs.
- Evaluate fish and shellfish tissue quality.

Long-term RAO monitoring is expected to include pre-established reviews (typically a minimum of every 5 years) to allow EPA and Ecology to assess the effectiveness of the remedial actions. These periodic reviews can inform adaptive management decisions that may be required to achieve the RAOs.

Table K-1 presents the scope, sample types, number of samples, and sample testing requirements for each of the different monitoring types (surface sediment, surface water, and tissue) assumed for cost purposes in this FS.

K.6.1 Surface Sediment Quality

Surface sediment sampling approaches for the different exposure areas are described below. In addition, a field study is an assumed component of baseline and long-term RAO monitoring to evaluate the relationship between sediment and clam tissue chemistry for arsenic and cPAHs in clamming areas. While no specific data quality objectives or experimental design are described herein, a lump sum cost for a field study is included in the cost estimates for the remedial alternatives (see Appendix I).

K.6.1.1 LDW-Wide Exposure Area

For FS cost estimation purposes, a random stratified design for sample collection is assumed. While a more sophisticated approach may ultimately be developed post-FS (e.g., stratified into reaches, exposure areas) to better manage data skewness and variance, a simple stratified random sampling approach is acceptable for FS purposes and for the following reasons:

- Remedial design data collected from contaminated areas designated for cleanup will complement site-wide randomly acquired baseline data and thereby further address data skewness.
- Remediation of the EAAs (Alternative 1) and other hot spots (e.g., those managed by Alternatives 2R and 2R-CAD) is expected to dramatically reduce data skewness. Also, project-specific data collected through other types of monitoring (e.g., O&M) will complement site-wide randomly acquired data.

Separating the site into strata acknowledges the skewed distribution of the LDW surface sediment concentration data (Kern 2010). The stratified design assumes two types of data with similar attributes: 1) monitoring data collected from remediated areas at moderate data density, frequency, and variance and 2) monitoring data collected from unremediated areas at lower data density, with lower variance expected in the range of concentrations observed. Thus, for site-wide baseline and long-term RAO monitoring, 100 surface sediment samples are assumed per sampling event[4], although the actual population for any given event may be much larger for the aforementioned reasons. Samples will be analyzed for chemical and physical testing parameters (Table K-1).

K.6.1.2 Potential Clamming Area

The potential clamming area occupies approximately 105 acres of the LDW. For this FS, it is assumed that the potential clamming area will be represented by 25 randomly collected samples[5] per event. All surface sediment samples (45 cm depth for point of compliance) will be analyzed for the parameters shown in Table K-1. This FS assumes collection of discrete or composite samples; various compositing schemes could be considered during design.

Additionally, a field study will be conducted to evaluate the relationship between sediment and clam tissue concentrations of arsenic and cPAHs in the potential clamming areas. Results will be used to evaluate seafood consumption risks for arsenic and cPAHs. The specifics of this field study will be developed subsequent to the FS; costs are currently approximated as a lump sum in Appendix I.

K.6.1.3 Assumed Beach Play Areas

The eight assumed beach play areas individually range from 1 to 10 acres. For cost estimation purposes, the FS assumes that baseline and long-term RAO monitoring utilize composite samples; one from each assumed beach play area collected to depths of 45 cm as the point of compliance. All composite samples will be analyzed for the parameters shown in Table K-1. A multi-increment composite sampling scheme may be

[4] 100 site-wide samples (supplemented with area-specific samples) should have the ability to measure a minimum detectable difference of 25% between the mean of trend data, with a beta = 0.1 and alpha = 0.05, and 95%UCL.

[5] Samples may be discrete and/or composite. Assume roughly one sample per four acres.

considered during design as an alternate way of evaluating "average" concentrations over large spatial areas, but this type of design is beyond the scope of this FS.

K.6.2 Surface Water and Tissue Quality

Surface water sampling is site-wide at a few select stations to assess ambient conditions over time relative to surface water quality ARARs. Samples may be collected as discrete or depth-integrated composite samples; the scope will be determined during remedial design.

Fish and shellfish tissue sampling are assumed to be of similar scope and magnitude to work conducted in 2005 and 2007 as part of the RI (Windward 2006; Windward 2009). Based on the scope of these previous surveys, the FS assumes about 75 tissue composite samples per event from various species and tissue types (e.g., whole-body and fillet).[6] Results will be used to assess achievement of RAO 1 (human health seafood consumption) and RAO 4 (ecological seafood consumption by river otter).

K.7 References

Anchor 2007. *Duwamish/Diagonal Sediment Remediation Project. 2005 Monitoring Report*. Elliott Bay/Duwamish Restoration Program Panel. Prepared for King County Department of Natural Resources. Prepared by Anchor Environmental, Seattle, WA. May 2007.

Ecology 1991. Sediment Cleanup Standards User Manual. First Edition. Management Standards. Chapter 173-204 Washington Administrative Code (WAC). Washington State Department of Ecology, Sediment Management Unit, Olympia, Washington. December, 1991.

Environmental Protection Agency (EPA) 2005. *Contaminated Sediment Remediation Guidance For Hazardous Waste Sites*. Office of Solid Waste and Emergency Response. EPA-540-R-05-012, OSWER 9355.0-85. December 2005. Available online at http://www.epa.gov/superfund/resources/sediment/guidance.htm.

Kern 2010. Coverage Rates for Selected Upper Confidence Limit Methods for Mean of Total PCBs in Sediments. Prepared for Assessment and Restoration Division Office of Response and Restoration, National Oceanic and Atmospheric Administration. Seattle, Washington. March 30, 2010.

EPA 2004. Guidance for Monitoring at Hazardous Waste Sites: Framework for Monitoring Plan Development and Implementation. Office of Solid Waste and Emergency Response, OSWER Directive No. 9355.4-28. U.S. Environmental Protection Agency. January 2004

[6] The tissue samples will be composite samples collected from fish trawls and crab traps in several subareas for a total of 75 composite samples.

Windward 2006. Lower Duwamish Waterway Remedial Investigation. *Data report: Chemical Analysis of Fish and Crab Tissue Samples Collected in 2005.* Final. Prepared for Lower Duwamish Waterway Group. Windward Environmental LLC, Seattle, WA. April 19, 2006.

Windward 2009. Lower Duwamish Waterway Remedial Investigation. *Data report: Chemical Analyses of Fish, Crab, and Clam Tissue Samples and Co-located Sediment Samples Collected in 2007*. Final. Prepared for Lower Duwamish Waterway Group. Windward Environmental LLC, Seattle, WA. March 5, 2009.

Table K-1 Conceptual LDW Monitoring Program, Used for Cost Estimation

Monitoring Category[a]	Parameters	Sample Collection, Analysis and Frequency Assumptions
Baseline and Long-term RAO[b]	Bathymetry	Two bank-to-bank and site-wide multi-beam bathymetric surveys. One for baseline and one 5 to 10 years into remedy construction as a check on net sedimentation rates and scour areas.
	Sediment Chemistry and Toxicity	LDW-wide: 100 randomly collected samples analyzed for the following parameters: • Group A[c] – 100% of samples • Group B[d] – 25% of samples Potential Clamming Area: 25 randomly collected samples (discrete and/or composites) analyzed for total PCBs, arsenic, cPAHs, and dioxins/furans. Assumed Beach Play Areas: Single composite samples from each of 8 assumed beach play areas analyzed for total PCBs, arsenic, cPAHs, and dioxins/furans. Baseline monitoring to occur before construction. Long-term RAO monitoring at intervals of 5, 10, and 15 years after the active portion of remedy is completed for alternatives that take 10 years or less to construct (Alternatives 2, 3, 4C, and 5C). Assume one additional sample round for Alternatives 4R, 5R, 5R-Treatment, and 6C. Assume two additional sample rounds for alternatives that take more than 20 years to complete (Alternative 6R).
	Surface Water Quality	Surface water samples collected for the analyses of priority pollutant metals, cPAHs, and PCB congeners at four stations in the LDW at baseline and 5, 10, 15 years after active portion of remedy is completed for alternatives that take 10 years or less to construct (Alternatives 2, 3, 4C, and 5C). Assume one additional sample round for Alternatives 4R, 5R, 5R-T and 6C. Assume two additional sample rounds for alternatives that take more than 20 years to complete (Alternative 6R).
	Tissue	Collect 75 fish and shellfish tissue samples (discrete and/or composite) from selected areas consistent with 2007 RI sampling design and scope. Analyzed as follows: • PCBs as Aroclors, lipids, solids – 100% of all tissue samples • Arsenic, cPAHs – 100% of clam tissue samples (30% of sample count) • PCBs as congeners, other chemicals[e] – 33% of samples Long-term RAO monitoring at intervals of 5, 10, and 15 years after the active portion of remedy is completed for all alternatives. Assume one additional sample round for Alternatives 4R, 5R, 5R-Treatment, and 6C. Assume two additional sample rounds for Alternative 6R.[f]
	Other Surveys	Assume undefined scope for additional misc. surveys yet to be determined during remedial design. These may include benthic infauna surveys, SPI camera surveys, sediment cores, or physical assessments. One event for baseline and one additional event at 5 to 10 years into remedy construction.

Table K-1 Conceptual LDW Monitoring Program, Used for Cost Estimation

Monitoring Category[a]	Parameters	Sample Collection, Analysis and Frequency Assumptions
Construction	Water Quality	Monitor field parameters (e.g., turbidity, pH) in the field daily at each of three locations; mixing zone boundary, halfway between mixing zone boundary and operating area, and reference area during construction for each dredge operation (the FS assumes the two operations are spatially separated so that separate points of compliance are needed). Field costs listed on a per-day basis, totaling 88 days per season (see Appendix I) Collect composite water column samples for chemical analyses at downstream mixing zone boundary and upstream reference area. There will be a total of four monitoring stations, three for the dredge that operates in deep water and one for the dredge operating in shallow water closer to the banks. Assuming that there will be one sampling event for every station each day during the field season, the total number of field screening samples will be 352 (88 x 4 = 352). The number of samples that will require chemical analysis for PCBs, arsenic, and cPAHs are based on the assumption that 30% of field screening samples will have field screening parameters (e.g., turbidity, pH) that indicate that chemical analysis will be necessary (30% of 352 = 106). Monitoring costs are prorated on a per-day basis (see Appendix I).
Post-Construction	Sediment Chemistry and Bathymetry	The total number of surface sediment samples varies by alternative and is determined by the size of the active remedial footprint (four samples per acre). Immediate post-construction performance testing as follows: : • Group A[c] – 100% of samples • Group B[d] – 25% of samples One sampling event at the end of each construction season (i.e., for partially completed projects) and at the end of each individual construction project. One project area bathymetric survey at the end of construction.
Long-Term Operation and Maintenance (O&M)	Diver Inspection and Sediment Chemistry	• Dredge: Two samples per acre; Years 2 and 5 • Cap: Diver inspection and two surface samples per acre; Years 2, 5 and 10. One sediment core per acre; Years 5 and 10 based on surface sediment results • ENR: Diver inspection and four surface sediment samples per acre; Years 2, 5, and 10 • MNR(10): Four surface samples per acre; Years 2, 3, 5, 7, and 10; periodic physical inspection if deemed necessary based on chemistry and grain size results • MNR(20): Four surface samples per acre, Years 2, 3, 5, 7, 10, 15, and 20; periodic physical inspection if deemed necessary based on chemistry and grain size results. Note: Same sample Group A and B parameter groups as for post-construction monitoring (see above).

Notes:

a See Appendix I for details regarding frequency and duration of monitoring costs and assumptions. Baseline and long-term RAO monitoring assumptions and costs are the same across all remedial alternatives (except Alternative 1). Construction monitoring costs are determined by the number of work seasons. Post-construction and long-term O&M monitoring are area-specific and determined by the size of the remedial footprint. All monitoring assumptions and costs are for FS purposes only and are subject to refinement during remedial design and post-FS decision documents.

b A field study is also anticipated to evaluate the relationship between sediment and clam tissue concentrations of arsenic and cPAHs in clamming areas. No specific experimental design is assumed for the FS. Field-study costs are approximated as a lump sum value (see Appendix I).

c Group A parameters: total PCBs (as Aroclors), arsenic, cPAHs, all SMS chemicals, and associated conventional parameters (e.g., TOC, grain size, percent solids).

d Group B parameters: other COCs, dioxins/furans, and sediment toxicity tests, all of which are assumed to be monitored at a reduced percentage of the base sample group.

e Other chemicals include, but are not necessarily limited to, dioxins/furans.

f The purpose of tissue sampling is to assess cleanup effectiveness relative to RAO 1. Tissue sampling monitors concentrations of risk-driver chemicals in tissue, and thus monitors the reduction in human health risks, rather than calculating a prescribed percent reduction. Without a prescribed percent reduction, comparison to baseline is less important than whether future tissue concentrations are in line with predicted concentrations based on the food web model and changes in sediment concentrations. It is acknowledged that concentrations in tissues will have some year-to-year variability. A portion of the tissue samples will be analyzed as whole-body samples to evaluate RAO 4 (river otter, ecological seafood consumption risks)

COCs = chemicals of concern; cPAHs = carcinogenic polycyclic aromatic hydrocarbons; ENR = enhanced natural recovery; MNR = monitored natural recovery; O&M = operations and maintenance; PCB = polychlorinated biphenyl; RAO = remedial action objective.

Table K-2 Comparison of Monitoring Criteria and Terminologies Used in This FS Compared to MTCA

Monitoring Objective	Type of Monitoring Described in this FS In part, based on EPA contaminated sediment remediation guidance for hazardous wastes sites (EPA 2005) and EPA guidance for monitoring at hazardous waste sites: framework for monitoring plan development and implementation (OSWER 2004)	Type of MTCA Compliance Monitoring "shall be required until residual hazardous substances concentrations no longer exceed site cleanup levels established under WAC 173-340 through 173-340-760" [173-340-410][a]
Establish baseline conditions for future compliance monitoring	Baseline monitoring	n/a
Refine the nature and extent of contaminated areas and remedial action boundaries after the FS; confirm recovery processes	Remedial design sampling and verification monitoring[b]	n/a
Protect human health and the environment during construction	Construction monitoring (area-specific short-term monitoring during construction)	Protection monitoring
Verify that remedial action levels or remediation levels have been achieved before demobilizing from the site	Post-construction performance monitoring (area-specific performance immediately following active remediation)	Performance monitoring
Confirm that natural recovery processes are occurring as predicted to achieve cleanup goals	Long-term operations & maintenance monitoring	Performance monitoring
Monitor the stability of a cap area to ensure isolation and containment and of an ENR area to ensure recovery	Long-term operations & maintenance monitoring	Confirmational monitoring
Monitor surface sediments over time for potential recontamination	Long-term RAO monitoring	Confirmational monitoring
Monitor tissues over time to assess risk reduction	Long-term RAO monitoring	Confirmational monitoring
Determine how on-going sources at or near a site may affect the success of active cleanup and/or natural recovery	Source control evaluation within upland drainage basins – conducted by the Source Control Work Group in parallel to baseline, remedy design, and long-term monitoring; may include other responsible parties	Source control monitoring (but not a component of compliance monitoring) (Ecology 1991)

Notes:

a Demonstrating the ability to achieve cleanup standards involves the point of compliance, how long it takes to achieve cleanup levels (time to achieve RAOs or restoration time frame under MTCA), and monitoring to ensure that cleanup standards have been achieved and will continue to be achieved in the future [WAC 173-340-700] .

b Remedial design sampling and verification monitoring are not addressed in this appendix, but are included in the FS as a percentage of capital costs for each remedial alternative (Appendix I).

(shaded) Included in FS monitoring cost estimates and scope of Appendix K