Lower Duwamish Waterway
Slip 4

Interim Source Control Status Report

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Table of Contents

Page

Introduction 1
Summary of Source Control Status 2
Source Control Action Plan and Updates 4
Source Control Action Items 6
Sediment Trap Sampling 7
Source Tracing and Controls at KCIA 8
Source Control Activities at NBF-GTSP Site 9
Stormwater Treatment 11
Potential for Slip 4 Sediment Recontamination 14
Summary of Potential Risks for Slip 4 Sediment Recontamination 17
References 19

Tables

Table 1. Status of Source Control at Facilities within the Slip 4 Source Control Area 4
Table 2. PCB Concentrations in Sediment Traps in the Slip 4 Source Control Area 8
Table 3. Source Control Activities at the NBF-GTSP Site since July 2009 9
Table 4. Average PCB Concentrations in Untreated Stormwater Filtered Solids (October 2009 – June 2010) 12
Table 5. Predicted Post-Treatment PCB Concentrations in SD Solids 13
Table 6. Concentrations of Other COPCs in Stormwater and Solids at the King County Lift Station (LS431) 14

Figures

Figure 1. Early Action Area 3 (Slip 4)
Figure 2. Slip 4 Drainage Basin
Figure 3. Storm Drain System at North Boeing Field
Figure 4. Total PCBs in Storm Drain Solids at NBF-GTSP Site
Figure 5. Predicted Reduction in PCB Concentrations in SD Solids at the KC Lift Station
Figure 6. Predicted Slip 4 Surface Sediment Concentrations of PCBs

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Introduction

This report summarizes the current status of source control for the River Mile (RM) 2.8 East (Slip 4) source control area, also referred to as the Slip 4 Early Action Area (EAA) or EAA-3. This is considered an interim report because some high priority source control actions have not yet been fully implemented per the 2004 Source Control Strategy (Ecology, 2004). This report has been prepared by the Washington State Department of Ecology (Ecology) with review and input from the U.S. Environmental Protection Agency (EPA).

Slip 4 is located on the east bank of the Lower Duwamish Waterway (LDW), approximately 2.8 miles from the southern end of Harbor Island. The slip is approximately 1,400 feet long, with an average width of 200 feet, and encompasses about 6.4 acres. Properties immediately adjacent to Slip 4 are currently owned by 8th Avenue Terminals (formerly Crowley Marine Services), City of Seattle, First South Properties, King County, and the Boeing Company (Figure 1).

In 2001, the LDW was placed on the EPA's National Priority List (NPL) pursuant to the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA). In 2003, the sediments and portions of the bank in Slip 4 were identified as an Early Action Area (EAA) for the LDW Superfund Site. PCB concentrations measured in Slip 4 surface sediments during a 2004 sediment investigation ranged from 0.2 to 5.1 mg/kg dry weight (DW), while subsurface sediment concentrations ranged up to 17 mg/kg DW (USEPA 2006).

In 2006, EPA issued a non-time-critical removal Action Memorandum for the Slip 4 EAA (USEPA 2006). The removal action addresses approximately 3.6 acres of estuarine sediments and adjacent bank areas near the head of Slip 4 that are contaminated with polychlorinated biphenyls (PCBs). Removal will be conducted by the City of Seattle and King County pursuant to an EPA Settlement Agreement. The EPA Action Memorandum defines PCBs as the COC for the Slip 4 EAA; however, other contaminants have been detected in Slip 4 sediments at concentrations above the Washington State Sediment Management Standards (SMS). Contaminated sediments with the highest PCB concentrations will be removed through dredging and excavation, and remaining sediments, which have lower concentrations, will be capped. Contaminated sediments and soils from adjacent bank areas along the eastern portion of the slip will be excavated, and these bank areas will be sloped to accommodate placement of engineered slope caps.

The primary removal action objective for sediments in the Slip 4 EAA, as stated in the EPA Action Memorandum (USEPA 2006), is:

> "…to reduce the concentrations of contaminants in post-cleanup surface sediments [biologically active zone (0-10 cm)] to below the Washington Sediment Quality Standards (SQS) for PCBs and other chemicals of interest."

The current plan for cleanup of Slip 4 establishes October 1, 2011 as the date that construction work will begin. Ecology and EPA will issue a Slip 4 source control update prior to commencing construction activities.

Summary of Source Control Status

The goal of the 2004 Source Control Strategy (Ecology, 2004) is to minimize the potential for chemicals in sediment to exceed Ecology's Sediment Management Standards and cleanup goals for the Lower Duwamish Waterway. The strategy to achieve this goal is by using administrative and legal authorities to perform inspections and require necessary source control actions. As discussed in this report, some high priority source control actions have been taken to minimize releases of contaminants into Slip 4. These include:

- Closed connections, removed contaminated sediment, demolished and replaced the Georgetown Steam Plant Flume;
- Cleaned out catch basins and lines at King County International Airport (KCIA);
- Completed business source control inspections and continued re-inspections to verify that tenant facilities at KCIA comply with applicable regulations and best management practices.
- Cleaned storm drains at NBF (99% completed in 2010)
- Began short term stormwater treatment on the North Lateral Storm Drain (Short-term treatment began on September 15, 2010; long-term treatment planned for 2011)

Six remaining high priority action items are being addressed. They include:

- Continue sediment trap sampling at NBF, KCIA, and the I-5 Storm Drain (ongoing; will continue concurrent with Slip 4 sediment cleanup);
- Complete source tracing at KCIA in conjunction with investigations and actions taking place at the NBF-GTSP Site under the Ecology Agreed Order (see below);
- Property-wide characterization at GTSP property to assess the need for additional remediation (field work completed; report scheduled for March 2011);
- Characterization of extent of PCBs in concrete joint material at NBF (material removal completed in Propulsion Engineering Laboratory area in 2010; other property areas to be evaluated in 2011);
- Characterization of contaminated soil and groundwater in the Propulsion Engineering Laboratory area of NBF (soil characterization completed in 2010; groundwater characterization to continue in 2011);
- Continued source tracing in the north lateral storm drain line at NBF to identify and/or eliminate transport of PCBs to Slip 4 (cleaning, inspection, and some damaged piping repaired/replaced in 2010; work to continue in 2011); and
- Conduct RI/FS at NBF-GTSP Site and implement interim actions as needed (RI/FS ongoing; interim actions at GTSP and Propulsion Engineering Laboratory area of NBF scheduled for 2011 construction season).

In addition to these actions, under an Administrative Settlement Agreement and Order on Consent with EPA, the Boeing Company has begun short-term treatment of stormwater in the north lateral storm drain at NBF to remove PCBs. The north lateral was identified as the primary source of PCBs into Slip 4 as a result of sediment trap, stormwater, and storm drain solids sampling and testing at NBF. EPA and Boeing are reviewing data from the short-term treatment system to determine the needs for long-term stormwater treatment at NBF.

With these additional source control actions, the most significant risks for recontamination of Slip 4 from currently identified contaminant sources will be minimized. There are some potential uncertainties that have been identified that will need to be addressed. These include:

- Re-routing of the King County SD line from upstream of the NBF north lateral to a location downstream of the King County Lift Station creates a new source control data gap. Sampling and testing of stormwater and storm drain solids will be completed during the 2010-2011 wet season to evaluate the recontamination potential from rerouting the King County SD line.
- 8th Avenue Terminals/Crowley has proposed installation of a new stormwater line that would discharge to the head of Slip 4. The site owner will be required to meet City of Seattle and Ecology discharge requirements and to demonstrate that the discharge will not recontaminate Slip 4 sediments.
- Contaminants are present in bank soils at Slip 4; however the soils will be managed as part of the Slip 4 remediation and capped to prevent future releases. The cap has also been designed to prevent releases of PCB-contaminated pore water or groundwater to Slip 4. Groundwater up gradient from the Slip 4 bank on the 8th Avenue Terminals site will be characterized under a MTCA Agreed Order by Ecology to determine if groundwater from this site could represent an ongoing source of Slip 4 sediment recontamination.
- Insufficient information is currently available to assess the potential for Slip 4 sediment recontamination with chemicals other than PCBs (i.e., metals, PAHs, phthalates). Additional data will be collected during the 2010-2011 wet season to estimate loading of these additional chemicals to Slip 4 sediments and to determine the effectiveness of short-term stormwater treatment in removing these chemicals from stormwater.

Addressing the remaining high priority source control actions, implementing long-term stormwater treatment, and addressing the remaining uncertainties will minimize the potential for recontamination of the head of Slip 4 following cleanup. Ecology, in collaboration with USEPA, has determined that source control activities implemented to date are sufficient to allow sediment cleanup at the head of Slip 4 to be initiated in 2011.

Source Control Action Plan and Updates

Ecology, as the lead for source control at the LDW Superfund Site, prepared a Source Control Action Plan (SCAP) for the Slip 4 EAA (Ecology 2006). The SCAP identified potential sources of sediment recontamination and identified and prioritized source control action items.

In January 2007, Ecology determined that cleanup of the Slip 4 EAA should not proceed due to ongoing PCB discharges to the slip, and the corresponding likelihood of recontamination of sediments following the removal action. Ecology also concluded that North Boeing Field (NBF) was the most significant source of contamination, based on PCBs found in solids in the storm drain system at NBF (USEPA 2010b). Areas with stormwater drainage to Slip 4 and the storm drain system at NBF are shown in Figures 2 and 3, respectively. Since 2007, actions have been taken to control PCB discharges from NBF.

An update to the SCAP was prepared in 2007; the *Technical Memorandum: Status of Slip 4 Source Control* (SAIC 2007a) summarized actions conducted since publication of the SCAP and updated the action item list. Additional source control updates have been prepared as part of the LDW Source Control Status Reports published in July 2007, May 2008, October 2008, and August 2009 (Ecology 2007, 2008a, 2008b, 2009).

The SCAP and subsequent source control status reports identified potential adjacent and upland sources of contaminants to Slip 4. Progress and status of the source control work that has been identified in the various reports has been somewhat reorganized in Table 1 below, but all of the high and medium priority tasks are included in this update.

Table 1. Status of Source Control at Facilities within the Slip 4 Source Control Area

Facility Name	Source Control Activities	Source Control Status
8th Avenue Terminals/ Crowley Marine Services	Polycyclic aromatic hydrocarbons (PAHs) are present in soil and groundwater in the southern portion of the Crowley Marine Services/8th Avenue Terminals. Under an Agreed Order with Ecology, 8th Avenue Terminals is conducting a Remedial Investigation/Feasibility Study (RI/FS). Storm drain (SD) catch basin samples collected in 2008 contained PAHs and phthalates above SD screening levels. Several source control action items are incomplete (Ecology 2009).	In Progress: Crowley Agreed Order tasks (1) Soil & groundwater sampling at west & southern portions of property to be characterized. (2) Storm flow and solids to be analyzed to determine if current system is source of other COCs in Slip. (3) Design & install appropriately sized storm water collection system to meet City storm water codes, City and State permit requirements.
Georgetown Flume	Seattle City Light (SCL) removed the Georgetown Flume and associated PCB-contaminated sediments in 2009/2010, and installed a new pipe to transport storm drainage from the Georgetown Steam Plant (GTSP) to Slip 4.	Complete

Facility Name	Source Control Activities	Source Control Status
Slip 4 Bank Soils	SCL owns sediments at the head of Slip 4 and the adjacent bank. The extent of soil contamination in bank soils at the head of Slip 4 has not been fully characterized and is considered a potential source of PAHs & metals based on available information about past use and limited sampling. City's proposed plans for recently purchased bank and sediments raise concerns about potential for exposing contamination via soils or groundwater/seeps that may be discovered. This work will be done under EPA oversight and should additional concerns be discovered during excavation, the plans will be changed to address these contingencies (USEPA, 2011). This work is proposed as facilitation of remedial design of the Slip 4 cleanup and will also serve as habitat improvement.	Pending: The extent of contamination in this area must be characterized.
I-5 Storm Drain	Sediment trap data indicate historical PCB concentrations as high as 7.8 mg/kg dry weight (DW) in this SD. Most recent data, however, show much lower levels (0.061 mg/kg DW). No further source control actions have been identified.	Complete: Monitoring is ongoing.
First South Properties	The potential for sediment recontamination associated with this property is considered low. Two source control action items are incomplete (Ecology 2009). These include a facility inspection and review of the response to EPA's 104(e) request for information.	In Progress: Outstanding work here is inspection for new drainage planned in 2009 and reviewing responses to EPA 104(e) request for information when they are complete - neither of which are likely to affect certainty about recontamination potential.
Boeing Plant 2 (northern portion)	Cleanup is being conducted as a RCRA Corrective Action under EPA oversight. Cleanup is currently in progress. Boeing has proposed a complete redesign of storm water collection, management and treatment as part of the overall RCRA Corrective Action for Plant 2. Current proposal monitors storm water and provides treatment as needed for discharge to Slip 4.	In Progress: No PCBs discharge from Plant 2 to Slip 4. EPA RCRA documents indicate there less PCB contamination at north end of site. As of late 2010, EPA oversight focus is on PCB investigation of non-caulk materials as related to storm water inflow and remedial activities at south end of Plant 2.
Arco Station 5218	No chemicals of concern (COCs) have been identified at this property; the potential for sediment recontamination is considered low.	Complete
Washington Air National Guard	Ecology's Integrated Site Information System (ISIS) lists an independent cleanup at this property for total petroleum hydrocarbons (TPH) and beryllium in soil, plus gross alpha and beta radiation in soil and groundwater. Cleanup was completed and a No Further Action (NFA) determination was issued on October 18, 2005.	Complete
Aviation Fuel Storage/ Schultz Distributing	Past activities indicate the potential for releases to the environment; however, no sampling has been conducted. Seattle Public Utilities (SPU) planned to conduct dye testing in SD lines at this location in 2007. A property summary prepared for Ecology in January 2007 concluded that this site is not a potential source of slip 4 sediment recontamination (SAIC 2007b).	Complete
Marine Vacuum Service	Documented releases to the environment have occurred at this property; PAHs remain in soil. A property summary prepared for Ecology in October 2006 identified several data gaps; however, it concluded that sediment recontamination associated with this facility is unlikely (SAIC 2006b).	Complete

Facility Name	Source Control Activities	Source Control Status
North Coast Chemical Company	Volatile organic compounds (VOCs) and petroleum hydrocarbons have been confirmed in soil and groundwater at this property. A property summary prepared for Ecology in February 2007 concluded that this property is not a potential source of Slip 4 sediment recontamination (SAIC 2007c). The current site operator, Ultrablock, Inc., planned to re-route stormwater to the sanitary sewer in 2007.	Complete
American Avionics	Voluntary cleanup of TPH-contaminated soil was conducted between 1997 and 2000. Residual hydrocarbon contamination above Model Toxics Control Act (MTCA) Method A cleanup levels remain in soil and groundwater. No samples were analyzed for PCBs, PAHs, or phthalates. Stormwater from this site drains to the south-central lateral SD at NBF, which shows Sediment Quality Standard (SQS) exceedances for total high molecular weight PAHs and phthalates. A property summary prepared for Ecology in December 2006 indicated a low potential for Slip 4 sediment recontamination (SAIC 2006c). Source tracing at KCIA is ongoing.	Complete (monitoring continues as part of NBF stormwater and storm drain solids sampling and testing)
King County International Airport (KCIA)/King County Airport Maintenance Facility	A property summary prepared for Ecology in December 2006 for the King County (KC) Airport Maintenance Facility identified several data gaps and recommended follow-up (SAIC 2006a). Soil and groundwater sampling in the area is planned to support the RI/FS for the NBF-GTSP property. Elevated concentrations of sediment COCs have been detected in sediment traps in the KCIA storm drain system upstream of NBF. Source tracing is ongoing.	In Progress
King County Stormwater Separation Project	Since the 2009 Status Report a relatively small area of KCIA (non-Boeing leased property) drainage has been found to contribute significant flow to the NBF north lateral storm drain. A stormwater separation project is currently proposed route flows from KCIA around the north lateral storm drain on NBF. This is proposed to allow source investigations to locate where contaminants are entering the north lateral storm drain on NBF and to make treatment and design decisions easier for the separated flows.	Pending: Separation will cause KCIA (non-Boeing) flows to effectively bypass CERCLA stormwater treatment on the north lateral drain line of NBF. Flow from NBF drainage will continue treatment and monitoring per EPA's CERCLA stormwater treatment order.
North Boeing Field/ Georgetown Steam Plant (NBF-GTSP)	Historical and ongoing PCB contamination has been documented in the NBF storm drain system, concrete joint material, and other media. Under Agreed Order No. DE-5685 between Ecology, Boeing, the City of Seattle, and King County, Ecology is conducting an RI/FS at the Site. SCL and Boeing have undertaken site characterization activities and several interim actions are in progress.	In Progress

Source Control Action Items

As of the last LDW Source Control Status Report (published in August 2009), a total of 52 source control action items had been identified for the Slip 4 EAA; 35 of these action items had been completed at that time. Of the remaining 17 action items, nine were identified as high priority actions that should be completed prior to sediment cleanup, seven were identified as medium priority actions that may be completed prior to or concurrent with sediment cleanup, and one was identified as low priority. The incomplete high priority source control actions all pertain to the NBF-GTSP and northern KCIA area. Potential sources of contaminants to Slip 4

sediments for which medium or low priority action items have been identified include 8th Avenue Terminals and Boeing Plant 2; source control activities associated with these properties will be discussed in more detail in the next LDW Source Control Status Report.

Three of the nine high priority action items have been completed since August 2009:

- Closed connections, removed contaminated sediment, demolished and replaced the Georgetown Steam Plant Flume;
- Cleaned out catch basins and lines at KCIA;
- Completed business source control inspections and continued re-inspections to verify that tenant facilities at KCIA comply with applicable regulations and best management practices.

The six remaining high priority actions items identified as of the 2009 Source Control Status Report are being addressed as follows:

- Continue sediment trap sampling at NBF, KCIA, and the I-5 Storm Drain (ongoing; will continue concurrent with Slip 4 sediment cleanup);
- Complete source tracing at KCIA in conjunction with investigations and actions taking place at the NBF-GTSP Site under the Ecology Agreed Order (see below);
- Fill data gaps identified by characterization of the GTSP property to assess the need for additional remediation (field work completed; report scheduled for March 2011);
- Characterization of extent of PCBs in concrete joint material at NBF (material removal completed in Propulsion Engineering Laboratory area in 2010; other property areas to be evaluated in 2011);
- Characterization of contaminated soil and groundwater in the Propulsion Engineering Laboratory area of NBF (soil characterization completed in 2010; groundwater characterization to continue in 2011);
- Continued source tracing in the north lateral storm drain line at NBF to identify and/or eliminate transport of PCBs to Slip 4 (cleaning, inspection, and some damaged piping repaired/replaced in 2010; work to continue in 2011); and
- Conduct RI/FS at NBF-GTSP Site and implement interim actions as needed (RI/FS ongoing; interim actions at GTSP and Propulsion Engineering Laboratory area of NBF scheduled for 2011 construction season).

These are described in more detail below.

Sediment Trap Sampling

Eleven rounds of sediment trap sampling have been conducted by SPU and Boeing since 2005; the most recent data available are for samples collected in April 2010. Sediment trap sampling is an ongoing source control evaluation activity, and will continue subject to staff and budget limitations. Sediment traps are installed at 10 locations including upstream and downstream

locations at NBF's north, north-central, south-central, and south lateral SD lines; one location downstream of the combined north and north-central SD lines (near the King County Lift Station), and one location in the I-5 SD. Sediment trap locations are shown in the Supplemental Data Gaps Report (SAIC 2009).

While generally decreasing over time, PCB concentrations in all but sediment trap T3A remain at concentrations above the Lowest Apparent Effects Threshold (LAET) for impacts to sediment (0.13 mg/kg DW).

Table 2. PCB Concentrations in Sediment Traps in the Slip 4 Source Control Area

Sediment Trap Location	Range of PCB Conc'ns (2005-2010) mg/kg DW	Most Recent PCB Conc'n (April 2010) mg/kg DW
T1 (Downstream end of north and north-central lateral SD)	0.68 – 420	3.95
T2 (Downstream end of south lateral SD)	0.010 – 1.46	0.46
T2A (Upstream of NBF on the south lateral SD)	<0.02 – 0.38	0.45
T3 (Downstream end of south-central lateral SD)	0.026 – 1.81	0.25
T3A (Upstream of NBF on the south-central lateral SD)	<0.02 – 0.73	<0.02
T4 (Downstream end of north-central lateral SD)	0.24 – 2.75	1.07
T4A (Upstream of NBF on the north-central lateral SD)	<0.011 – 5.60	0.68
T5 (Downstream end of north lateral SD)	2.1 – 800	2.55
T5A (Upstream of NBF on the north lateral SD)	0.086 – 0.67	0.44
T6 (I-5 SD)	<0.019 – 7.8	0.061

Source Tracing and Controls at KCIA

Source tracing activities at KCIA since publication of the last LDW Source Control Status Report (August 2009) include:

- Cleanout of storm drain structures (catch basins/manholes) in the central portion of KCIA, in the area that drains to Slip 4, was conducted in June 2010. (Structures in the eastern and western portions of KCIA were cleaned in late 2008.) Structures in the south-central portion will be cleaned in 2011.
- Weekly inspections of oil/water separators in 2009 for oil boom maintenance; no measureable accumulations of sediment were found.
- Continued regular sweeping of paved surfaces including runways, taxiways, roads, and ramps, per Federal Aviation Administration (FAA) requirements.
- Continued stormwater and storm drain solids monitoring as needed.

King County will be preparing a report summarizing source tracing activities in early summer 2011.

Source Control Activities at NBF-GTSP Site

Under Agreed Order No. DE-5685 between Ecology, Boeing, the City of Seattle, and King County, Ecology is conducting a Remedial Investigation/Feasibility Study (RI/FS) at the NBF-GTSP Site. Under the Agreed Order, the potentially liable parties (PLPs) are given first opportunity to perform any interim actions that may be required under the order. Several interim actions by Boeing and SCL have been completed or are currently in progress.

Source control activities conducted at the NBF-GTSP Site since publication of the August 2009 LDW Source Control Status Report are listed below.

Table 3. Source Control Activities at the NBF-GTSP Site since July 2009

Dates	Activity	Description
Feb-Sep 2009	Removal/Replacement of GTSP Flume	The City of Seattle completed removal and replacement of the GTSP Flume in September 2009 (Herrera 2010). Specific activities included removal of sediment/water in the flume; removal of PCB and cPAH contaminated soil immediately surrounding the flume; and replacement of the flume with a new pipe and bioswale that provides stormwater conveyance for the GTSP and S Myrtle Street right-of-way.
May-Sep 2009	SD Investigation and Cleanout	Based on results of SD structure sampling throughout NBF, Boeing conducted cleanout of selected manhole, catch basin, and oil/water separator structures.
Aug 2009	Supplemental Data Gaps Report	Ecology compiled sampling data and other new information obtained since publication of the original Data Gaps Report in April 2007 in a comprehensive Supplemental Summary of Existing Information and Identification of Data Gaps report (SAIC 2009).
Oct 2009-Feb 2010	Preliminary Stormwater Sampling	Ecology conducted sampling of whole water and filtered suspended solids during five storm events at two locations: the King County Lift Station, and a manhole near the downstream end of the north lateral storm drain line (MH108) (SAIC 2010a).
Mar-Apr 2010	Surface Cleaning, SD Structure Cleaning, and Soil Removal	Boeing conducted pressure cleaning of surface areas around Buildings 3-323, 3-302, and 3-322 to remove residual PCBs from surface debris; in addition, Boeing removed asphalt and underlying soil along the north side of Building 3-322 and on the west side of Building 3-302. Catch basin filters were installed in SD structures in the vicinity of these buildings. Seven catch basins with PCB concentrations greater than 50 mg/kg were cleaned.
Mar-Apr 2010	SD Structure Grouting	Boeing identified 13 catch basin and/or manhole locations with observed or potential for groundwater infiltration. These were sealed with polyurethane grout.
Mar-May 2010	SD Structure Sampling	Boeing collected samples from all storm drain structures (containing sufficient material to sample) in the north lateral drainage area for metals and PCB analysis. In addition, Boeing collected samples from storm drain structures in the north-central lateral drainage area and from selected storm drain structures in the south and south-central lateral drainage areas.

Dates	Activity	Description
Mar-Jun 2010	Expanded Stormwater Sampling	Ecology collected whole water and filtered solids samples during five additional storm events and two base flow events at the King County Lift Station and MH108 locations. In addition, Ecology collected filtered solids samples from the north-central, south-central, and south lateral storm drain lines, as well as the Building 3-380 and parking lot drainage areas and from six additional locations in the north lateral drainage area during three storm events and one base flow event (SAIC 2010b).
Apr-Jul 2010	Infiltration and Inflow Assessment	Ecology prepared a draft assessment of potential sources and pathways for infiltration of contaminated groundwater and inflow of contaminated surface runoff to the SD system at NBF (SAIC 2010c).
May-Sep2010	Slip 4 Sediment Recontamination Modeling	Ecology collected Slip 4 surface sediment samples and filtered stormwater solids for particle size fractionation in support of sediment recontamination modeling. The model was calibrated using site-specific data and the maximum allowable concentration of PCBs in SD solids that will not cause recontamination of sediments was estimated (SAIC 2010d).
May-Jul 2010	SD Structure and Line Cleaning	Boeing completed jet cleaning of SD structures and lines in the north lateral; jet cleaning of structures and lines in the other SD lines is currently in progress.
Jun 2010	Soil and Groundwater Sampling at GTSP	The City of Seattle conducted soil and groundwater sampling to support an interim soil and groundwater cleanup action at the Low-Lying Area at the GTSP property.
Jul-Oct 2010	Source Evaluation, North Lateral SD Area	Boeing conducted a source evaluation in the north lateral drainage area to identify potential contaminant sources in areas where PCBs and metals in SD structures were identified at concentrations above screening levels. Sampling included paint from building and equipment surfaces, caulk from windows or door jams, surface debris, concrete, asphalt, and roofing materials.
Jul-Oct 2010	Focused Soil Investigation – PEL Area	Boeing conducted a focused soil investigation in the Propulsion Engineering Laboratory (PEL) area, located in the northern portion of NBF. Sampling was conducted to provide additional characterization of PCBs in soil in the area southeast and southwest of the GTSP property (fence line area) and in the area near Building 3-302 where Boeing plans to replace a SD line.
Jul-Oct 2010	Concrete Joint Material Removal in the PEL Area	Boeing removed approximately 3,900 linear feet of concrete joint material (CJM) (Landau 2010b).
Aug 2010	Video-Inspection of North Lateral SD Line	Boeing conducted a video inspection of the north lateral SD lines following jet cleaning of structures and lines to confirm that jet cleaning activities had adequately removed solids and debris, and to inspect for cracks, fractures, or breaks in the SD line segments that could allow soil intrusion or groundwater infiltration. Numerous cracks and other damage to pipes were observed, as well as 83 tap connections. Repairs to be made as needed.
Sep-Oct 2010	Removal and Replacement of Storm Drain Lines	Boeing removed and replaced storm drain lines in the vicinity of Building 3-302 in the north lateral drainage area.

Additional activities currently in progress include:

- GTSP continuing site characterization (field work completed; report scheduled for March 2011);
- Cleanout of all accessible lines, catch basins, manholes, and oil/water separators in the north-central, south-central, and south lateral storm drain lines (99% completed in 2010; remaining work scheduled for completion in early 2011);
- Soil and groundwater investigation for the PEL area — soil results are completed, and are being used to identify appropriate groundwater sampling locations (scheduled for completion in early 2011);
- A human health risk assessment and transport evaluation for concrete joint material in the flight line area (a voluntary activity by Boeing scheduled for completion in early 2011);
- Video inspection of storm drain lines in the north-central, south-central, and south lateral storm drain lines (all but approximately 350 feet completed in late 2010; remaining to be completed in early 2011 subject to weather conditions);
- Source removal in the north lateral SD area, including removal of paint from bollards, and removal of building caulk and other materials at Building 3-326 (removal of paint from bollards completed in October 2010; removal of other source material to be scheduled); and
- Planning for an interim remedial action near the fence line between GTSP and NBF (scheduled for the 2011 construction season).

While the completed actions in Table 4 and the partially completed actions described above have reduced PCB concentrations in stormwater, PCBs continue to be detected in the storm drain system. The most recent PCB concentrations in storm drain solids, through May 2010, are shown in Figure 4.

Stormwater Treatment

In late September 2010, USEPA and Boeing entered into an Administrative Settlement Agreement and Order on Consent (ASAOC) (USEPA 2010a). Under this agreement, Boeing agreed to implement short-term and long-term treatment of stormwater in the north lateral storm drain. EPA's interim goals for the short-term stormwater treatment system are PCB concentrations below 0.014 µg/L in water and below 0.42 mg/kg DW in solids, with total suspended solids (TSS) below a daily maximum of 10 mg/L and a monthly average of 5 mg/L. For the long-term stormwater treatment system, EPA interim goals are PCB concentrations below 0.014 µg/L in water and below 0.10 mg/kg DW in solids.

Current and post-treatment PCB concentrations in stormwater discharged from the NBF-GTSP Site to Slip 4 have been estimated by Ecology's contractor based on sampling results for 10 storm events between October 2009 and June 2010 at the King County Lift Station (LS431) and a manhole near the downstream end of the north lateral storm drain line (MH108). These are summarized below in Tables 4 and 5. It should be noted that these estimates are based on averages of limited data. Monitoring data collected during the 2010-2011 wet season will provide more definitive analysis of the effectiveness of the short-term treatment system. This additional data will be used to evaluate the needs for long-term stormwater treatment.

Table 4. Average PCB Concentrations in Untreated Stormwater Filtered Solids (October 2009 – June 2010)

Storm Event	Date	Stormwater Flow (millions of Liters)			PCB Concentration (mg/kg DW)		
		North Lateral	Other SD Lines*	All Lines	North Lateral	Other SD Lines**	All Lines
1	10/17/2009	2.65	13.55	16.20	2.2	0.41	0.7
2	10/29/2009	1.11	2.71	3.82	6.1	0.031	1.8
3	11/6/2009	2.92	10.31	13.23	5.5	0.62	1.7
4	12/15/2009	1.37	5.39	6.76	3.4	-0.047	0.65
5	2/5/2010	0.50	2.87	3.37	18.0	0.14	2.8
6	2/11/2010	0.50	2.73	3.23	17.7	-0.51	2.3
7	3/29/2010	2.54	13.72	16.26	3.6	1.7	2.0
8	4/27/2010	1.17	4.70	5.87	4.1	0.067	0.87
9	5/20/2010	0.76	4.14	4.90	1.3	0.20	0.37
10	6/2/2010	0.96	5.40	6.35	5.0	-0.27	0.52
	Average	**1.45**	**6.55**	**8.00**	**6.7**	**0.20**	**1.4**
	% of Total Flow	**18%**	**82%**	**100%**			

	Indicates a calculated value
	Indicates a measured value

* Flow in other SD lines = Flow in all lines - Flow in north lateral SD line

** PCB conc'n in other SD lines = ((Flow in all lines x Conc'n in all lines)-(Flow in north lateral SD x Conc'n in north lateral SD))/(Flow in other SD lines)

NOTE: Negative PCB concentrations are an artifact of the calculation algorithm. For storm events where a negative PCB concentration is shown for 'Other SD Line', dilution of PCB concentrations in the north lateral SD with flow from other SD lines does not adequately account for the much lower concentrations at the KC Lift Station.

Table 5 below provides estimates of PCB concentrations in storm drain solids at the KC Lift Station that vary according to the percentage reduction of PCBs in storm drain solids in the north lateral storm drain line. No reduction in PCBs in solids was assumed for other storm drain lines since they are not affected by the short-term stormwater treatment system. PCB concentrations at the KC Lift Station were calculated by multiplying average concentrations by the average percent of total flow provided in Table 4. For example, the calculation for a 20 percent PCB reduction in the north lateral storm drain line is as follows:

(North Lateral SD)		(Other SD Lines)		(Lift Station)
5.4 mg/kg PCB x 0.18	+	0.20 mg/kg PCB x 0.82	=	1.1 mg/kg PCB

Table 5. Predicted Post-Treatment PCB Concentrations in SD Solids

	PCB Concentration (mg/kg DW)		
	North Lateral SD (MH108)	Other SD Lines	All Lines (Lift Station)
No Stormwater Treatment	**6.7**	**0.20**	**1.4**
10% Reduction in Conc'n	**6.0**	**0.20**	**1.3**
20% Reduction in Conc'n	**5.4**	**0.20**	**1.1**
30% Reduction in Conc'n	**4.7**	**0.20**	**1.0**
40% Reduction in Conc'n	**4.0**	**0.20**	**0.89**
50% Reduction in Conc'n	**3.4**	**0.20**	**0.77**
60% Reduction in Conc'n	**2.7**	**0.20**	**0.65**
70% Reduction in Conc'n	**2.0**	**0.20**	**0.53**
Short-Term SW Treatment Goal			**0.42**
80% Reduction in Conc'n	**1.3**	**0.20**	**0.41**
90% Reduction in Conc'n	**0.7**	**0.20**	**0.29**
100% Reduction in Conc'n	**0.0**	**0.20**	**0.16**
Interim SW Treatment Goal			**0.10**

Estimated PCB concentrations in stormwater solids are shown in Figure 5. The Slip 4 recontamination model, as presented in the Slip 4 Recontamination Modeling Report (SAIC 2010d), was used to predict Slip 4 surface sediment concentrations for the estimated PCB concentrations in stormwater (Figure 6), assuming average sediment total organic carbon (TOC) concentrations content between 2 and 4 percent.[1]

These predicted concentrations should be used with caution, as they are based on numerous simplifying assumptions and limited available data, and are therefore associated with a significant level of uncertainty.

Based on the predicted PCB concentrations in stormwater solids and Slip 4 sediments, as shown in Figures 5 and 6, it is uncertain at this time if stormwater discharged from NBF after implementation of the short-term stormwater treatment system will meet EPA's interim stormwater treatment goal of 0.10 mg/kg DW but is likely to meet EPA's short-term stormwater treatment goal of 0.42 mg/kg DW, assuming at least 80% treatment efficiency can be achieved.

As stated above, monitoring data collected during the 2010-2011 wet season will provide more definitive analysis of the effectiveness of the short-term treatment system. EPA, Ecology, and The Boeing Company will be evaluating these data to determine what long-term stormwater treatment will be needed to meet EPA's interim stormwater treatment goal per the requirements of EPA's ASAOC with Boeing

In addition to PCBs, recent surface sediment sampling in Slip 4, conducted in May 2010, identified lead, mercury, zinc, total high molecular weight polycyclic aromatic hydrocarbons (HPAH), and bis(2-ethylhexyl)phthalate (BEHP) at concentrations above the Washington Sediment Management Standards (SMS) Sediment Quality Standard (SQS) value (organic-carbon normalized) or the Lowest Apparent Effects Threshold (LAET) value (dry weight) (SAIC

[1] TOC concentrations measured in Slip 4 surface sediment samples ranged from 2.3 to 5.7 percent; the average TOC in the segment of highest predicted PCB concentrations (100 to 200 feet from the head of Slip 4) was 4.1 percent (SAIC 2010d).

2010d). In addition, cadmium, copper, and various PAHs were detected above the marine or freshwater chronic water quality criteria (WQC) in whole water stormwater samples collected at the King County lift station between October 2009 and June 2010. These are considered chemicals of potential concern (COPCs) with respect to sediment recontamination (SAIC 2010c).

Storm drain concentrations of these COPCs are summarized in the following table.

Table 6. Concentrations of Other COPCs in Stormwater and Solids at the King County Lift Station (LS431)

COPC	Water Quality Criterion (ug/L)	Conc'n in Whole Water (October 2009 – June 2010) (ug/L)	SQS/ LAET (mg/kg DW)	Conc'n in Filtered Suspended Solids (October 2009 – June 2010) (mg/kg DW)
Cadmium	9.3	<0.2 – 16.5	5.1	3.0 – 11.1
Copper	3.1	0.85 – 17.4	390	26 - 261
Lead	8.1	<1 – 13.0	450	60 -265
Mercury	0.012	< 0.10	0.41	0.06 – 2.0***
Zinc	81	13.0 – 98.0	410	220 – 1,200
Total HPAH	*	0.056 – 3.4	12	15 - 30
BEHP	2.2**	<1 – 1.8	NA	NA

*WQC exceedances were reported for individual HPAH compounds; there is no WQC for total HPAH. The WQC for most individual HPAH compounds is 0.018 ug/L, based on human health risk (consumption of organisms only).

**The WQC for BEHP is based on human health risk (consumption of organisms only). BEHP was detected in whole water in the north lateral storm drain line at a concentration of 3.2 ug/L in December 2009 (SAIC 2010a).

***Mercury was detected in filtered suspended solids in the north lateral storm drain line (MH108) at concentrations of 0.20 – 2.67 mg/kg.

NA – Not analyzed

Source: SAIC 2010a, SAIC 2010b

While exceedances of WQC and/or SQS/LAET values in whole water and filtered suspended solids have been measured at the King County Lift Station for these sediment COPCs, modeling of contaminant transport to Slip 4 has not been performed, and an assessment of the potential for recontamination of Slip 4 sediments for these contaminants has not been completed. Insufficient data are currently available to adequately assess the potential for recontamination of Slip 4 sediment by other contaminants including metals, PAHs, and phthalates. In addition, dioxins/furans have been detected in Slip 4 sediments (7.9 to 41.1 ng/kg in May 2010 surface sediment samples) and in the NBF storm drain system (as high as 167 ng/kg in filtered suspended solids in December 2009), and are therefore also considered COPCs. Additional stormwater sampling and testing are currently being performed to determine if short-term stormwater treatment is effective in controlling releases of these contaminants.

Potential for Slip 4 Sediment Recontamination

Crowley Marine Services/8th Avenue Terminals

An Agreed Order to conduct an RI/FS and prepare a Draft Cleanup Action Plan was completed on October 12, 2009. 8th Avenue Terminals is presently working on an RI/FS Work Plan, Sampling and Analysis Plan, and Quality Assurance Project Plan, as required by the Order. Collection of samples for the RI is expected to commence in March 2011. The RI is tentatively

scheduled for completion in March 2012; however ongoing sampling results will be available prior to RI completion.

The following action items are not yet complete:

- Collect stormwater and/or solids samples from storm drain system to determine if onsite system is source of COCs found in waterway sediment.
- In conjunction with an Agreed Order for the Crowley Marine Services site, perform additional investigations that include collection of data on chemical concentrations in soil and groundwater at the western and southern portions of the property.

A stormwater compliance inspection by Seattle Public Utilities (SPU) was conducted at the site on May 5, 2010. The stormwater system on the northern portion of the site was determined to require maintenance to make it functional. Crowley is in the process of determining the proper design for the system and installation of new stormwater lines and catch basins is planned.

During work to address the compliance issues, 8th Avenue Terminals determined that it may be necessary to install a new outfall line into the head of Slip 4. A collapsed line appears to exist in this area, which formerly drained the northern portion of the property. 8th Avenue Terminals is in discussions with the City of Seattle to determine if a new line can be installed, and to design it to fit within the upcoming Slip 4 sediment removal action. At this time, Crowley has not yet completed the new design for the system. The City will require 8th Avenue Terminals to locate the former outfall line by July 1, 2011 and demonstrate that the old outfalls are isolated and there are no unpermitted connections. The final design will be required to meet City of Seattle and Washington State discharge requirements and to demonstrate that the discharge will not recontaminate Slip 4 sediments.

Site investigations conducted in 1989 included sampling and testing of soils and groundwater on the site. PAHs, PCBs, phthalates, zinc, and copper were detected in soils above MTCA cleanup levels. PAHs and phthalates were detected in groundwater at concentrations above MTCA cleanup levels.

A site investigation conducted in 1994 found petroleum hydrocarbons above MTCA cleanup levels in the groundwater adjacent to the boundary of the City property. The contamination is the result of leaking underground storage tanks removed in 1988.

A soil sample taken adjacent to the boundary with the City property in 2010 contained PAHs and TPH above MTCA cleanup levels. PCBs were not detected in this sample.

The site is considered a potential source for Slip 4 sediment recontamination because of the contaminants that have been detected in soil and groundwater, and the unknown condition of the stormwater system. Additional site characterization will be conducted under a MTCA Agreed Order with Ecology to define the extent of contamination and to determine if there are pathways for these contaminants to reach Slip 4.

Slip 4 Bank

Seattle City Light (SCL) purchased property from Crowley Marine Services that consisted of sediments at the head of Slip 4 and the adjacent bank around the head of the Slip. Just prior to the purchase, the City hired HWA Geosciences (HWA) to perform a Phase II Environmental Site

Assessment on the upland area to further characterize upland soil and groundwater conditions (HWA 2006). HWA collected subsurface soil samples at the soil ground water interface (typically at 12 to 16 ft bgs) from seven borings near the head of Slip 4.

The 100% Design Analysis Report for the removal action (Integral 2007a) states the following on Page 1-6:

> "A total of 10 subsurface soil samples and five groundwater samples were analyzed for chemical constituents. One of 10 soil samples analyzed contained petroleum hydrocarbon concentrations exceeding MTCA cleanup levels. Six soil samples contained total carcinogenic polycyclic aromatic hydrocarbons (cPAHs) exceeding the MTCA Method A cleanup levels. Two soil samples contained PCB concentrations exceeding MTCA cleanup levels. One soil sample contained an arsenic concentration at the cleanup level. Two groundwater samples from HWA B6 and HWA B7 contained lube oil range petroleum hydrocarbon concentrations above MTCA cleanup levels. Based on these results, there is a potential that PCBs, PAHs, and petroleum hydrocarbons in existing subsurface soils may exceed MTCA cleanup levels and/or SMS criteria on the excavated banks of shoreline zones 2 and 3 (shoreline zones 1 through 5 are shown on Figure 1-6). The design includes engineered caps on these banks to contain these chemicals should the affected soils be exposed in bank excavations."

Groundwater was not sampled in HWA B4 and B5, located nearest Slip 4 on the west side. Semivolatile analysis was attempted in HWA B3 and B6; however, no data was obtained due to a laboratory error during the initial extraction process. Therefore, no data on semivolatile contaminants is available for the City property groundwater adjacent to the Crowley site. Phthalate was detected in groundwater immediately up gradient from the west side of the head of Slip 4 during investigations of the Crowley site. In response to finding contamination on the banks near the head of Slip 4, Section V of the USEPA's Action Memorandum for the Slip 4 Removal Action (USEPA 2006) requires placement of engineered slope caps on the eastern shore of Slip 4.

Design drawings for construction in the uplands area at the head of Slip 4 (Integral 2007b) indicate that excavations in this area will be as deep as 8 - 12 feet. The plans provide for access to the area by the engineer during construction for documentation sampling; however there are no plans for additional excavation based on the documentation sampling. This work will be done under EPA oversight and should additional concerns be discovered during excavation, the plans will be changed to address these contingencies (USEPA, 2011). The design drawings indicate that the slopes will be capped with a minimum of 12 inches of filter material covered by a minimum of 18 inches of cap armor. The filter material will be amended with granulated activated carbon at minimum 0.5% by weight. The carbon amended filter material has been designed to adsorb PCBs from contaminated pore water or groundwater to prevent potential recontamination of Slip 4.

The extent of contamination on the slopes at the head of Slip 4 has not been fully characterized. Slope excavation and bulkhead removal during construction might result in temporary releases of contaminants to Slip 4; however the engineered cap has been designed to prevent direct contact with contaminated soils and flow of PCBs in pore water or groundwater through the cap. Therefore long-term releases of contaminated soil or PCB-contaminated pore water or groundwater to Slip 4 are not anticipated. Phthalate has been detected above cleanup levels in groundwater on the Crowley Marine Services site directly up gradient from the northwest bank of Slip 4. Since groundwater has not been sampled and tested for phthalates on the northwest bank of Slip 4, it is unknown if groundwater flow or seeps from the area could be a potential

source of Slip 4 recontamination. The nature and extent of groundwater contamination on the Crowley Marine Services site will be investigated under a MTCA Agreed Order with Ecology.

KCIA/NBF Stormwater Separation

To reduce the volume of stormwater that needs to be treated, Boeing has recently proposed to re-route the King County SD line that feeds into the NBF north lateral SD line. Stormwater from north of the NBF property currently enters the site on the northern boundary at Manhole # 178 (MH178). The preliminary plan is to redirect the stormwater discharging into Manhole # 178 into a new storm drain that will generally follow the route of the GTSP flume and discharge into the KCIA SD#3/PS44 EOF line downstream of the KC Lift Station. The most recent sediment trap data for T5A (Table 2), at the proposed re-route location, shows that PCBs are present in storm drain solids at this location at 0.44 mg/kg DW. Further analysis of the storm drains discharging into MH 178 and additional sampling and testing of stormwater and storm drain solids in the vicinity of MH178 will occur during the 2010-2011 wet season to evaluate the potential contaminant loading that might result from this new stormwater discharge to Slip 4.

Summary of Potential Risks for Slip 4 Sediment Recontamination

Based on current information, there remains a potential for Slip 4 sediment recontamination following EPA's non-time critical removal action of contaminated sediment at the head of Slip 4.

Depending on the organic carbon content of the receiving sediments, and the efficiency of the NBF stormwater treatment system, PCB concentrations in Slip 4 sediments may or may not exceed Ecology's SMS Sediment Quality Standard (SQS) of 12 mg/kg OC, but concentrations will likely be less than the Contaminant Screening Level (CSL) of 65 mg/kg OC.

Data gaps and uncertainties remain regarding other potential sources of contaminants to Slip 4 sediments. These include:

- Re-routing of the King County SD line from upstream of the NBF north lateral to a location downstream of the KC Lift Station creates a new source control data gap. On the basis of available data, PCBs are present in storm drain solids from upstream of the NBF north lateral. Sampling and testing of stormwater and storm drain solids will be completed during the 2010-2011 wet season to evaluate the recontamination potential from rerouting the King County SD line.
- 8th Avenue Terminals has proposed installation of a new stormwater line that would discharge to the head of Slip 4. This could potentially introduce new contaminants to Slip 4 sediments. The site owner will be required to meet City of Seattle and Ecology discharge requirements and to demonstrate that the discharge will not recontaminate Slip 4 sediments.
- Contaminants are present in bank soils at Slip 4; however the soils will be managed as part of the Slip 4 remediation and capped to prevent future releases. The cap has also been designed to prevent releases of PCB-contaminated pore water or groundwater to Slip 4. Groundwater up gradient from the Slip 4 bank on the 8th Avenue Terminals site will be characterized under a MTCA Agreed Order by Ecology to determine if

groundwater from this site could represent an ongoing source of Slip 4 sediment recontamination.

- The efficiency of the short-term stormwater treatment system at NBF has not been determined. Data are currently being collected by Boeing to assess the degree of treatment that will be achieved. These data will provide a more definitive analysis of the effectiveness of short-term treatment. Analysis of short-term treatment will be used to design a long-term stormwater treatment system that will meet EPA's interim stormwater treatment goal.
- Insufficient information is currently available to assess the potential for Slip 4 sediment recontamination with chemicals other than PCBs (i.e., metals, PAHs, phthalates, dioxins/furans). Additional data is currently being collected to determine the effectiveness of short-term stormwater treatment in removing these chemicals from stormwater.

Addressing the remaining high priority source control actions, implementing long-term stormwater treatment, and addressing the remaining uncertainties will minimize the potential for recontamination of the head of Slip 4 following cleanup. Ecology, in collaboration with USEPA, has determined that source control activities implemented to date are sufficient to allow sediment cleanup at the head of Slip 4 to be initiated in 2011.

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Key

- Property Boundary
- Road
- Outfall

Figure 1. Early Action Area 3 (Slip 4)

0 250 500 1,000 1,500 2,000 Feet

WA State Plane North, NAD83

N

SAIC From Science to Solutions

L. Delwiche SAIC, 2008

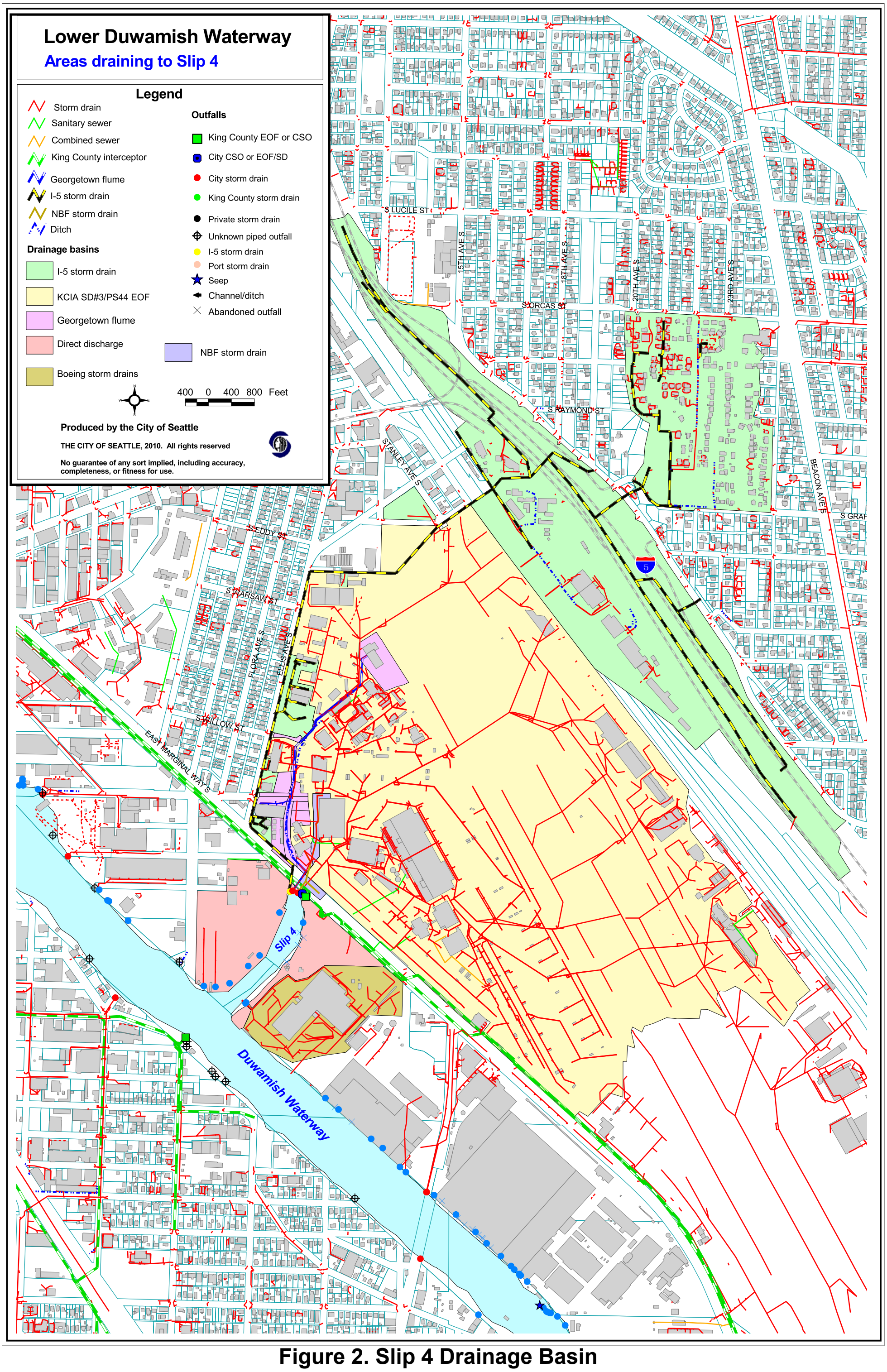


Figure 2. Slip 4 Drainage Basin

SAIC From Science to Solutions

Figure 3. Storm Drain System at North Boeing Field

0 300 600 1,200 Feet

DEPARTMENT OF ECOLOGY State of Washington

Figure 4. Total PCBs in Storm Drain Solids at NBF-GTSP Site

SAIC
From Science to Solutions

Total PCBs
SD Solids (mg/kg)

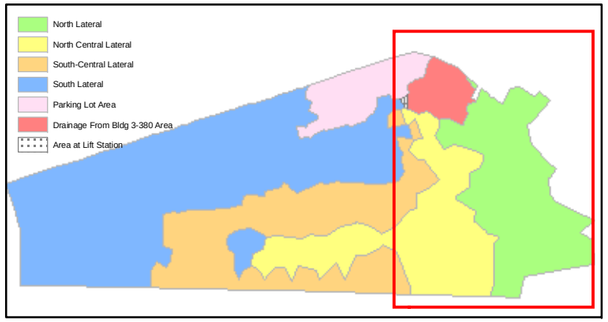
- 0 - 0.13
- > 0.13 - 1
- > 1 - 1.3
- > 1.3 - 13
- > 13 - 130
- > 130 - 180
- U Non Detect Values

- 0 - 0.13
- > 0.13 - 1
- > 1 - 1.3
- > 1.3 - 13
- > 13 - 130
- > 130 - 180
- Non Detect Values

- North Lateral
- North-Central Lateral
- South-Central Lateral
- South Lateral
- Drainage from Building 3-380 Area
- Drainage from parking lot area

Most recent result at each location shown.

Screening Levels: (mg/kg)
SD Solids:
LAET = 0.13
2LAET = 1.0



DEPARTMENT OF ECOLOGY
State of Washington

- SD structures
- Existing Boeing Buildings
- Non-Boeing Buildings

Coordinate System:
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Prepared By: apw
File: 2-8_PCBs_SD_Solids.mxd
Illustrative purposes only.

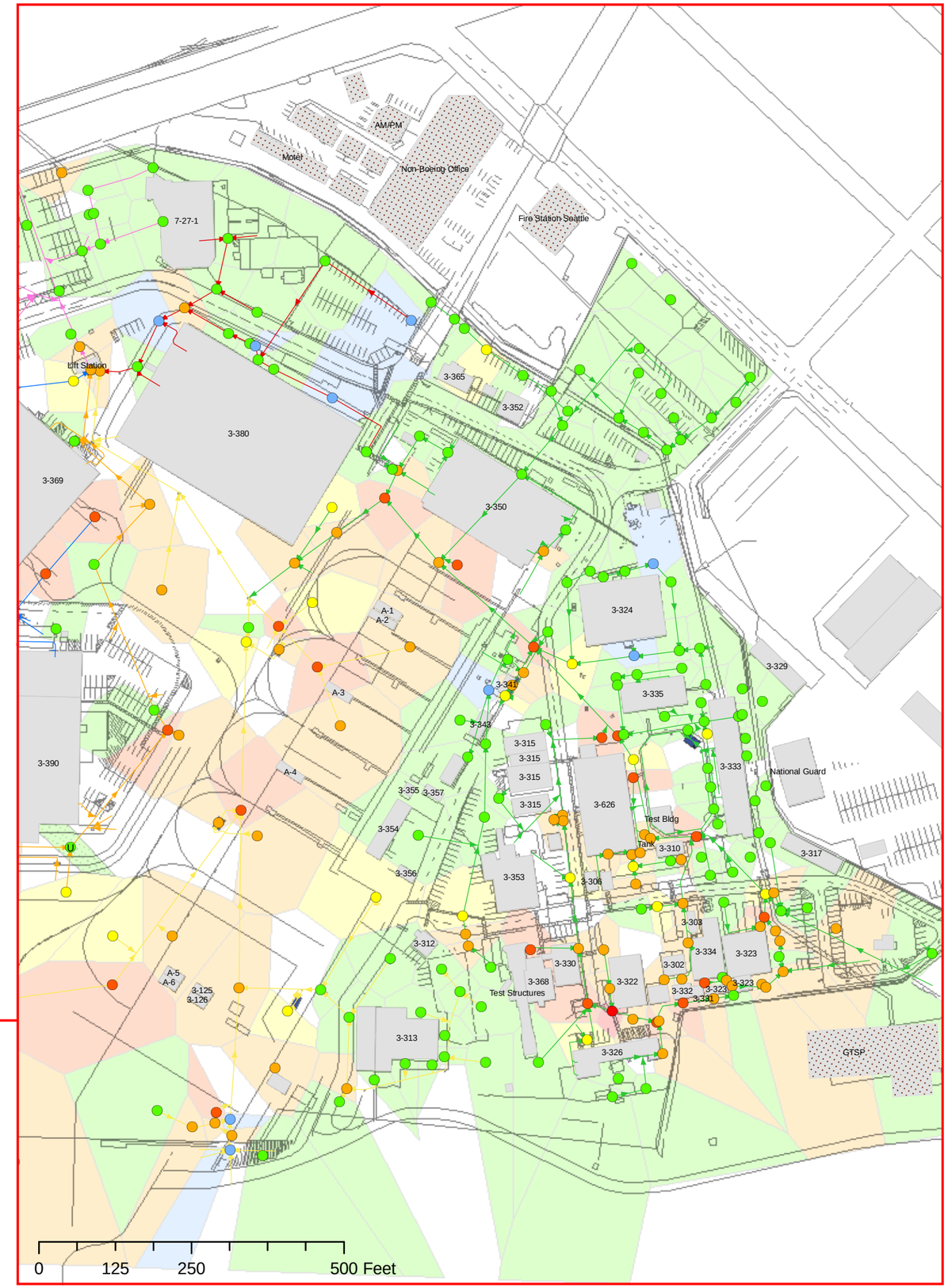

Figure 5
Predicted Reduction in PCB Conc'n in SD Solids at the KC Lift Station

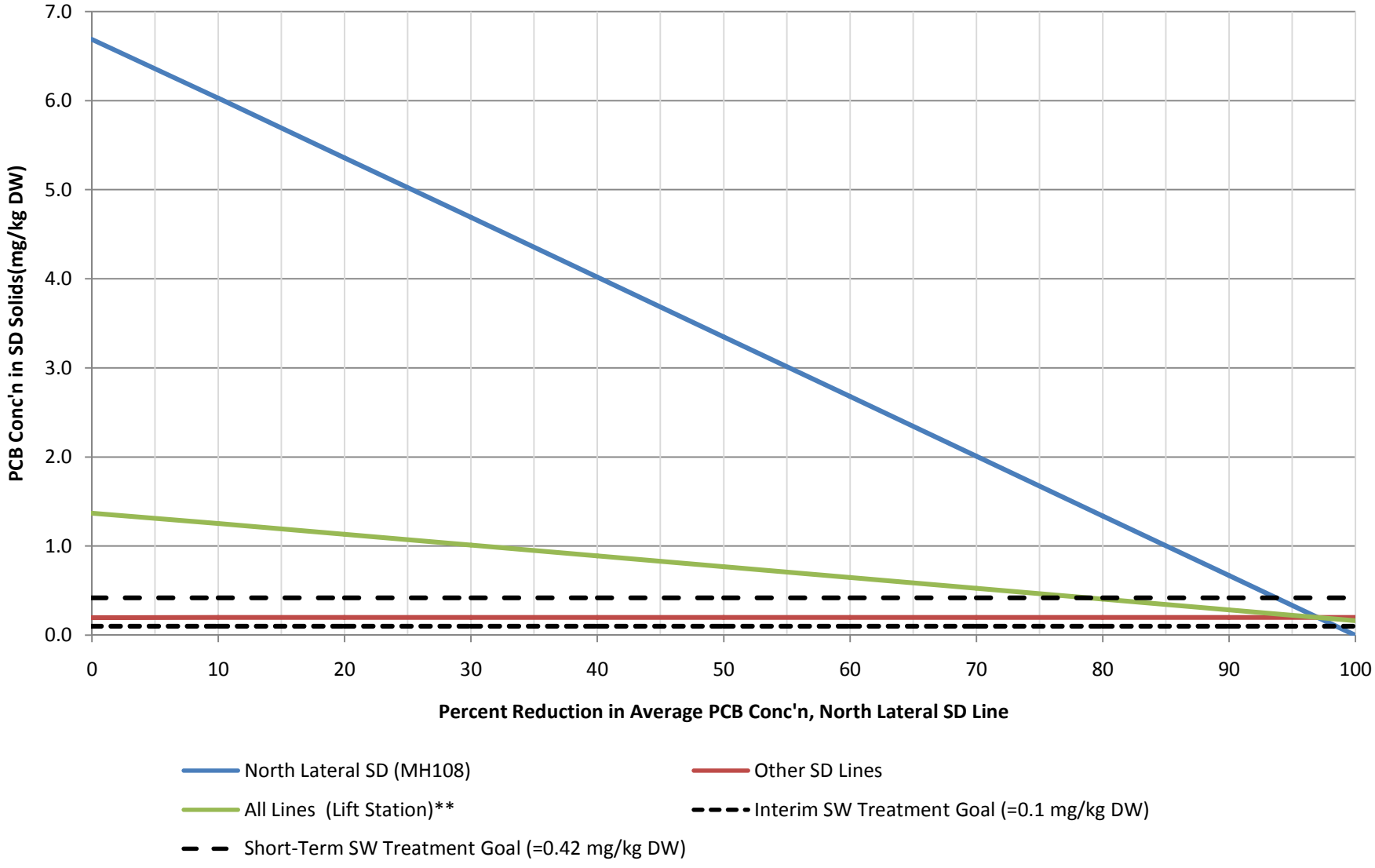
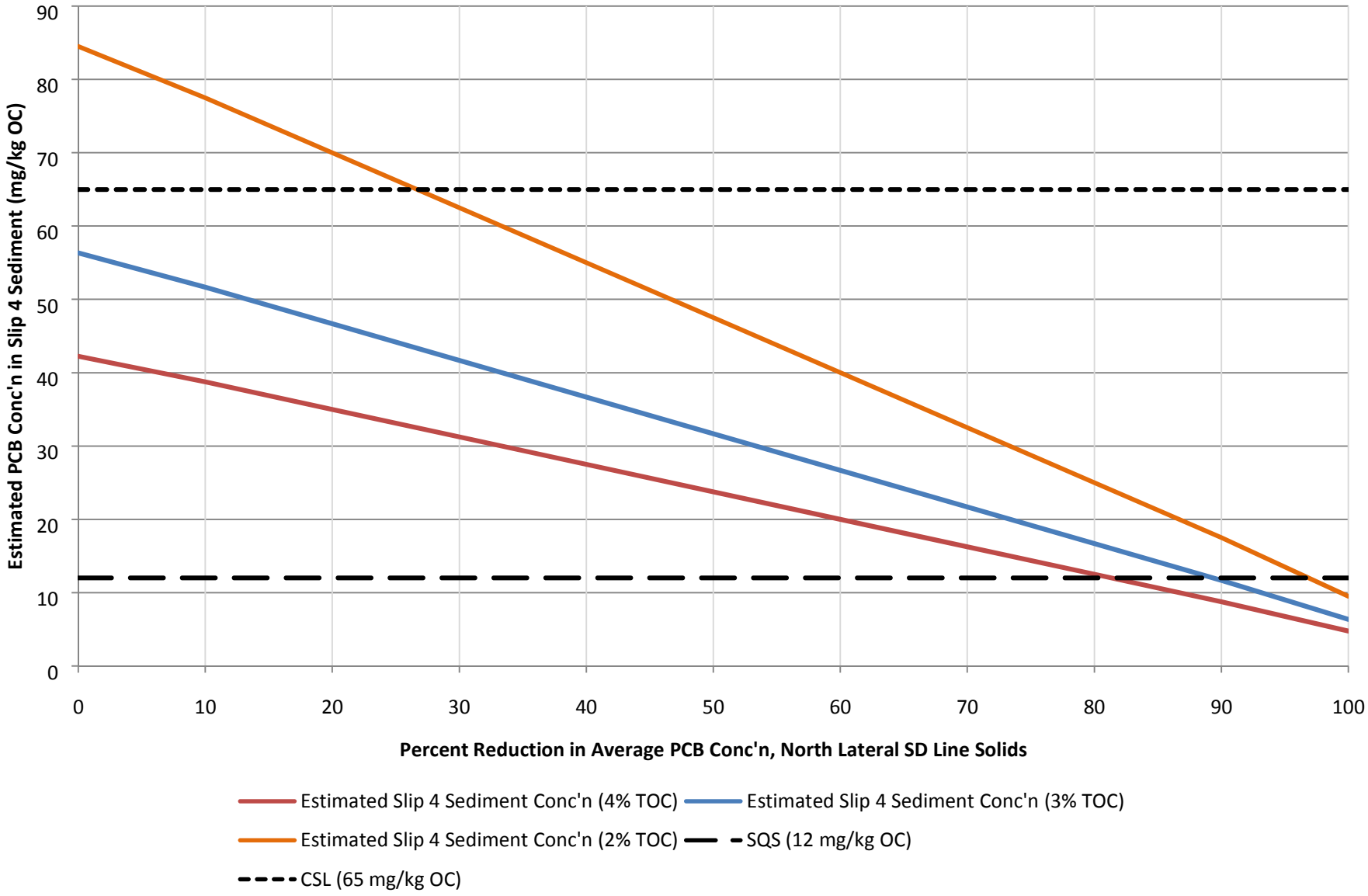
Figure 6
Predicted Slip 4 Surface Sediment Conc'n of PCBs