Prepared for

The Boeing Company
7500 East Marginal Way South
Seattle, Washington

FINAL SLIP 4 SALINITY MONITORING PLAN

NORTH BOEING FIELD

Prepared by

Geosyntec consultants

engineers | scientists | innovators

55 SW Yamhill St, Ste 200
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Project Number PW0250

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LIST OF ABBREVIATIONS

ASAOC	-	Administrative Settlement Agreement and Order on Consent
CERCLA	-	Comprehensive Environmental Response, Compensation, and Liability Act
CFR	-	Code of Federal Regulations
cfs	-	cubic feet per second
DMVA	-	Daily Maximum Vertical Average
DPS	-	Discrete Profiling Station
EOF	-	emergency overflow
EPA	-	Environmental Protection Agency
FSP	-	Field Sampling Plan
GTSP	-	Georgetown Steam Plant
HASP	-	Health and Safety Plan
KCIA	-	King County International Airport
LTST	-	Long-term Stormwater Treatment
LDW	-	Lower Duwamish Waterway
MLLW	-	mean lower low water
NBF	-	North Boeing Field
NPL	-	National Priorities List
QAPP	-	Quality Assurance Project Plan
µg/L	-	micrograms per liter
PCBs	-	polychlorinated biphenyls
ppt	-	parts per thousand
PSS	-	pratical salinity scale
RM	-	River Mile
SD	-	storm drain
SOPs	-	standard operating procedures
SOW	-	Statement of Work
USGS	-	United States Geological Survey
WAC	-	Washington Administrative Code

1.0 INTRODUCTION

This Slip 4 Salinity Monitoring Plan (Plan) was prepared by Geosyntec Consultants (Geosyntec) as part of the development of long-term stormwater treatment (LTST) for The Boeing Company's (Boeing) North Boeing Field (NBF) in Seattle, Washington. The primary authors of this work plan were Randy Crawford, Chris Walker, Ph.D., and David Carani under the direction of Eric Strecker, P.E., and Brandon Steets, P.E.. This report was peer reviewed by Megan Patterson, P.E. in accordance with Geosyntec's quality assurance protocols.

1.1 Background Summary

Slip 4 is located within the Lower Duwamish Waterway (LDW) Superfund Site located in Seattle, Washington (Figure 1-1). The LDW is a major shipping route, with most of the adjacent upland area developed for industrial and commercial operations. The lower reach of the Duwamish Waterway is a saltwater wedge estuary with a lower layer of nearly undiluted seawater moving upstream from Puget Sound and overlaid with a surface layer of riverine fresh water mixed with saltwater. The saltwater wedge is believed present in the vicinity of Slip throughout the year.

Slip 4 is approximately 2.8 miles from the southern end of Harbor Island, on the east bank of the LDW. The slip is approximately 1,400 feet long, with an average width of 200 feet, encompassing approximately 6.4 acres (Integral, 2006). Five landowners retain property within and immediately adjacent to Slip 4:

1. Boeing,
2. Crowley Marine Services,
3. City of Seattle (owner of the head of Slip 4),
4. First South Properties, and
5. King County.

The Slip 4 bed elevations range from approximately +5.0 feet mean lower low water (MLLW) at the slip head to -20 feet MLLW at the mouth. Bottom sediments are generally exposed at low tide along the head and eastern shoreline. Portions of the slip, particularly along the western shoreline, underwent historical dredging operations.

In 2001, the LDW Site was added to the United States Environmental Protection Agency's (EPA's) National Priorities List (NPL) pursuant to the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA), or Superfund, because of chemical contaminants in sediments. In 2003, the sediments and portions of the banks of Slip 4 were identified as an Early Action Area within the LDW Superfund site, primarily based on elevated concentrations of polychlorinated biphenyls (PCBs) in sediments. In 2006, EPA signed an Action Memorandum for a removal action to be performed in Slip 4 to address approximately 3.6 acres of contaminated sediments and banks. In 2007, the Washington Department of Ecology (Ecology), the lead for source control within the LDW Superfund site, identified stormwater originating from NBF as a significant source of PCBs into Slip 4. The Slip 4 sediment cleanup project, which had been put on hold while PCB sources were investigated, is currently scheduled to be constructed starting in October 2011.

Contaminated sediments within Slip 4 contain elevated PCB concentrations from numerous historical and potentially on-going sources. As shown in Figure 1-2, there are 17 outfalls that discharge into Slip 4. At the head of the Slip, there are five discharges:

1. 60-inch King County International Airport (KCIA) Storm Drain #3/PS44 Emergency Overflow (KCIA SD#3/PS44 EOF) (approximately 290-acre drainage area) – Drains parts of KCIA and majority of NBF;
2. 72-inch I-5 Storm Drain (approximately 120-acre drainage area) – Drains approximately 1.5 miles of I-5 between South Dawson Street and South Myrtle Street, 40 acres of primarily residential land east of I-5, and a mix of industrial, commercial and residential properties within the surrounding neighborhood;
3. 60-inch Georgetown Flume (unknown drainage area) – Formerly drained stormwater entering the open flume and from the Georgetown Steam Plant (GTSP), currently receives drainage from the roof of the GTSP;
4. 36-inch East Marginal Way Pump Station Emergency Overflow (EOF) Drain (approximately 318-acre drainage area) – King County emergency sewer overflow pump station; and
5. 24-inch North Boeing Field Storm Drain (NBF-SD) (currently inactive) – Formerly active storm drain for approximately 78-acres of NBF.

1.2 Objectives and Organization

An Administrative Settlement Agreement and Order on Consent (ASAOC) for a Removal Action was entered into by EPA and Boeing on 29 September 2010. The Statement of Work (SOW), Appendix C of the ASAOC, specifies that pending the outcome of a salinity study, the aquatic life chronic marine water quality criterion of 0.03 micrograms per liter (μg/L) total PCBs may be justified in place of the specified interim goal of 0.014 μg/L total PCBs based on the aquatic life chronic freshwater quality criterion. The purpose of this plan is to describe the scope of the intended salinity study in order to determine whether the marine or freshwater chronic aquatic life criteria for PCBs in water should be used as the long-term interim goal for discharges from the NBF storm drain system to Slip 4.

This document is organized into four sections:

1. Regulatory Standards – Describes the current applicable State regulatory standards for determining salinity and summarizes available relevant historical data; and

2. Monitoring Approach – Describes the proposed monitoring location, methods, frequency, duration and analytes, as well as data quality objectives.

3. Data Analysis – Describes the methodology for data analysis; and

4. Quality Assurance – Describes the components involved in quality assurance of data generation and analysis.

A Quality Assurance Project Plan (QAPP) for this study is also included as Attachment A.

2.0 REGULATORY STANDARDS

This section provides a summary of the applicable Washington state regulatory standards for determining salinity in surface water bodies, and compares this with Part 131 – Water Quality Standards of Title 40 of the Code of Federal Regulations (40 CFR). Additionally, the results of previous salinity measurements in the main LDW channel near Slip 4 are provided.

2.1 Regulations Summary

Currently, the Washington Administrative Code (WAC) Chapter 173-201A provides the water quality standards for surface waters. WAC 173-201A-260 (3)e states that for brackish waters (typically defined as waters in which salinity is between 1 ppt and 10 ppt), such as Slip 4, the use of fresh or marine waters criteria is determined as follows:

1. Fresh water criteria – applied if 95% of the salinity values for the vertically averaged daily maximum salinity are less than or equal to 1 part per thousand (ppt); and
2. Marine water criteria – applied at all other locations where 95% of the salinity values for the vertically averaged daily maximum salinity are greater than 1 ppt.

The State currently does not designate specific methods or sampling approaches for determining salinity, although Ecology provisionally approved a *Standard Operating Procedure (SOP) for Field Measurements of Conductivity/Salinity with a Conductivity Meter and Probe* (Ecology, 2006).

The Federal standard, as laid out in 40 CFR 131.36(c)(3), provides for three distinctions for water quality criteria:

1. Fresh water – waters in which the salinity is equal to or less than 1 ppt 95% or more of the time;
2. Marine water – waters in which salinity is equal to or greater than 10 ppt 95% or more of the time; and
3. Brackish water – waters in which the salinity is between 1 ppt and 10 ppt for 95% or more of the time.

In cases for waters in which the salinity is between 1 ppt and 10 ppt (i.e., brackish waters) as defined in paragraph (c)(3) (i) and (ii) of CFR 131.36, the applicable criteria are the more stringent fresh or marine water criteria. However, the EPA Regional Administrator may approve the use of the alternative fresh water or marine criteria if scientifically defensible information and data demonstrate that on a site-specific basis the biology of the waterbody is dominated by freshwater aquatic life and that freshwater criteria are more appropriate; or conversely, the biology of the waterbody is dominated by saltwater aquatic life and that saltwater criteria are more appropriate. No provisions for vertically averaging salinity data are provided under the federal standard, and no measurement depths (i.e., surface or bottom) are specified.

2.2 Available Data Summary

Sediment and surface water in Slip 4 and nearby areas of the LDW have undergone several investigations. Numerous areas within Slip 4 have been subject to several routine maintenance dredging events as a result of ship traffic. Despite considerable salinity work that has been done within the LDW (Windward 2010), limited salinity data exists within Slip 4 and no vertical salinity profiles of the Slip were found. The *Slip 4 Summary of Information and Identification of Data Gaps Report*, prepared by Striplin Environmental Associates in 2004, cited data in Table 4-2 collected at two monitoring stations located within the main channel of the LDW:

1. Approximately three river miles downstream of Slip 4 at the Spokane Street bridge; and
2. Approximately 0.5 river miles upstream of Slip 4 at the 16th Avenue bridge.

Figure 1-1 illustrates the approximate location of the two monitoring stations. Surface and bottom practical salinity scale (PSS) measurements[1] were collected over approximately a four-year period. Table 2-1 provides a summary of the results from this survey. No vertical average values were computed.

Table 2 - 1: Historical Salinity Measurements in the Lower Duwamish Waterway

Monitoring Locations	Depth	Lowest Observed PSS* Value	Greatest Observed PSS* Value
Spokane Street Bridge	Upper	4.75	29.22
	Lower	8.42	30.63
16th Avenue Bridge	Upper	2.01	27.70
	Lower	23.13	29.83

***PSS – Practical Salinity Scale roughly corresponds to parts per thousand (ppt)**

In addition, a limited salinity monitoring study was previously performed by Boeing as part of the Duwamish Sediment Other Area Additional Characterization Investigation.

[1] PSS (Lewis 1980) is a unitless value that roughly corresponds to parts per thousand (ppt). The current definition for Practical Salinity states that a seawater of Practical Salinity 35 has a conductivity equal to a potassium chloride (KCl) solution containing a mass of 32.4356 grams of KCl per kilogram of solution at 15^0 C (APHA 2005).

This study collected salinity data during an outgoing tide on 25 July 2008 from a single mid-channel location just upstream of the 16th Avenue Bridge (AMEC Geomatrix, 2008). The downcast vertical average (i.e., the average of the data collected during the vertical descent of the instrument) of this single salinity profile was approximately 18 ppt.

3.0 MONITORING APPROACH

Although considerable salinity data exists within the LDW, insufficient data specific to Slip 4 is available to address the question of whether marine criteria or fresh water criteria should apply to waters within the Slip. The answer to this question has significant implications to the stormwater treatment technologies that will be required for stormwater leaving the NBF site. Therefore, the primary objective of this monitoring approach is to provide sufficient data of known and acceptable quality to establish whether marine or fresh water criteria should apply. The following sections describe the monitoring strategy that will be applied unless the presence of physical and legal limitations associated with monitoring Slip 4 dictate otherwise. This approach will provide data in sufficient quality and quantity to achieve the objectives of this monitoring plan. Data will be evaluated following the initial three discrete manual collection events of the study to determine if sufficient information is obtained to make a determination of the most applicable water quality criteria. If it is determined that sufficient data has been obtained, monitoring will conclude. If not, additional monitoring will be recommended to Boeing as an extension of the project.

3.1 Salinity Monitoring

The extent and magnitude of salinity within the LDW is influenced by several factors including tidal cycles, rainfall events, and upstream discharge of the Green River. The greatest likelihood of freshwater influence within Slip 4 is during high flows within the LDW as measured at the upstream Green River United States Geological Survey (USGS) stream gage #12113000 located in Auburn, Washington (Cliff Whitmus, AMEC/Geomatrix, personal communication). Salinity monitoring at Slip 4 is being recommended to target those conditions having the greatest potential quantity of freshwater present, thereby creating conditions with the lowest likely salinity. This represents the most conservative approach for sampling, since the freshwater chronic aquatic life criteria for PCBs is more stringent (i.e., lower) than the marine water criterion. If conditions during this low salinity period are determined to be sufficiently saline to permit use of the marine criterion, then this determination should be acceptable during other seasons when reduced freshwater discharges occur and the effect of marine waters is greater.

Monitoring events will be triggered when the National Weather Service predictions for Green River discharges range above approximately 1,900 cubic feet per second (cfs). Discharges will be confirmed by real-time monitoring at USGS gage # 12113000 (Auburn, WA) a minimum of 24 hours prior to sampling. As shown in Figure 3-1, this discharge represents the 75th percentile of the Green River average daily discharge, and corresponds roughly with approximately a 53-foot stage. This stage condition is mostly expected to occur during the months of December through February based on historic gage data (Figure 3-1).

Monitoring within the slip will consist of three separate discrete manual vertical profiling events (i.e., sampling events) at one transect located midway along Slip 4 (Figure 3-2). Each of the three sampling events will collect data throughout a 12-hour period designed to be inclusive of a single high tide and low tide event, thereby collecting data throughout a period of maximum (high tide) and minimum (low tide) intrusion by the saltwater wedge. The selection of three sampling events was designed to capture the variability exhibited during high flow events on the LDW occurring during winter and early spring.

Salinity measurements will be collected manually, by boat, from multiple discrete profiling stations (DPS) along the transect. Eight equally spaced DPSs will be located along a transverse (as opposed to longitudinal) transect in Slip 4. The exact location of this transect will ultimately depend on potential physical and legal limitations (i.e., property access, safety) but will generally be located near the middle of Slip 4 in such an area that is not directly adjacent to stormwater (i.e., freshwater) discharges and in sufficient water depth capable of being sampled throughout a tidal cycle (Figure 3-2). Additionally, the use of a transverse (as compared to longitudinal) transect of Slip 4 provides the greatest likelihood of capturing potential short-circuiting of a freshwater lens from the NBF/KCIA storm drain outfall. The initial transect selection will be performed during low tide to reduce the likelihood that the DPS locations will not be regularly exposed during tide cycles. GPS coordinates will be documented for each DPS and will be used for subsequent profile visits. If commercial traffic within the Slip prevents the safe and successful performance of work at the initially selected locations, the boat captain is authorized to adjust the transect or DPS locations accordingly, provided the EPA project manager is notified by phone within 1 hour. A description, including GPS coordinates, of deviation from the initially selected locations will be documented. Vertical profile measurements, at 0.5-meter depth intervals, will be collected at each DPS location at approximately 2 hour intervals throughout a twelve-hour period that will be inclusive of both a high and low tide. Thus, each sampling event will be composed of six profiling events. Sampling will not be conducted when vessels or tugs are actively moving within the slip. Field personnel will record detailed observations during the sampling event regarding events that may be relevant to data interpretation.

3.1.1 Methods, Frequency, Duration, Analytes

Conductivity and water temperature profiles will be collected at each DPS location, with the downcast data used for primary analysis, and upcast data used for quality assurance purposes (Table 3-1). Additionally, precipitation will be monitored using the

NBF gauge. During site visits, field staff will collect vertical profiles at 0.5-meter depths until the bottom sediments are reached at each DPS location (with a minimum of one sample taken from each DPS). Monitoring will be triggered by a predicted river discharge of at least approximately 1,900 cfs, as forecasted by the National Weather Service and verified by real-time data at USGS gage # 12113000 (Auburn, WA) a minimum of 24 hours prior to sampling. This discharge represents approximately the 75th percentile for the average daily discharge at the USGS Auburn gage station and represents a river stage of approximately 53 feet.

Table 3-1: Sampling Methods, Parameters, Frequency, and Duration

Monitoring Methods	Parameters	Measurement Frequency	Number of Locations	Assessment Period	Site Visit Frequency
Discrete	Conductivity, Water Temperature	6 Vertical Profiles (at 0.5 meter depth intervals) per DPS over 12 hours (~ 2 hours apart)	8 DPSs	Minimum of three events	Once per sampling event

Table 3-2 summarizes the relevant analytical parameters and monitoring equipment used for obtaining the data. The accuracy of the measurement data will be assessed and controlled as described in Table 3-2, unless otherwise documented with alternative numeric criteria. These results will be used to control accuracy within acceptable limits by requiring that they meet specific criteria.

Table 3-2: Analytes and Probable Monitoring Equipment

Parameter	Meter	Accuracy
Conductivity*	YSI Model 600 XLM Meter or equivalent	+/-0.5% of reading + 0.001mS/cm
Water Temperature		+/- 0.15°C

***Conductivity is converted to parts per thousand (ppt) internally by equipment and is dependent on the specific instrument's reference standard.**

The three sampling events are anticipated to occur between late December and early March, the period corresponding with higher daily discharges in the Duwamish River. The higher daily discharges observed during this period should represent the largest contribution of freshwater into Slip 4, and subsequently the lowest potential contribution of marine water from the saltwater wedge. If the sampling results indicate salinity values greater than 10 ppt under these conditions, then additional sampling would not be warranted during the lower freshwater discharge conditions observed throughout the summer months.

4.0 DATA ANALYSIS

The following subsections describe how the salinity data will be analyzed.

4.1 Salinity Data

Data will be summarized such that spatial and temporal trends can be evaluated using a daily maximum vertical average (DMVA) from each sampling event. The DMVA will be calculated by averaging data from a given horizontal measurement row at each of the eight DPS locations (i.e., values would be individually calculated for rows A through F in Figure 3-3). A corresponding vertical average will then be calculated based on the horizontal averages for each of the six profiling events scheduled to occur during a single sampling event. The DMVA for a single sampling event transect will be the greatest value of the six profiling events. This process will be repeated for each of the three sampling events.

If at least one of the three transect DMVA salinity values, as measured by conductivity and computed for the transect as the average of the DMVAs for each station, is less than 1 ppt, the freshwater criteria will apply. If the three DMVA salinity values are greater than 10 ppt, the marine criteria will apply. If neither of the above conditions are met, then the salinity data will be assessed spatially based on the horizontal and vertical calculations to determine the percentage of marine and fresh water components within the transect.

4.2 Data Evaluation and Reporting

The study is designed to extend for a period ending when three separate monitoring events are completed. Dependent upon initial findings, the study may be concluded after these three events if data collected are sufficient to adequately characterize the salinity within Slip 4 during this critical high Green River discharge condition. A report will be prepared and submitted to EPA after results from these three monitoring events are compiled. The report will summarize results, provide a preliminary determination of the salinity within the Slip, and make recommendations as to whether marine or fresh water criteria are most applicable and/or whether monitoring should continue. If monitoring is not sufficient to render a conclusion regarding the salinity within Slip 4, the study may be extended, after which a second report will be submitted.

5.0 QUALITY ASSURANCE

As required by the ASAOC SOW, a QAPP was developed to specify the procedures that will be used to maximize the likelihood that data results are defensible and of high quality. Attachment A provides a summary of the QAPP that will be implemented upon initiation of the Salinity Monitoring Plan. The QAPP will outline the data quality criteria necessary for a successful project and the system of quality control checks that will be used to achieve compliance with those criteria.

5.1 Data Quality Objectives

The primary Data Quality Objective (DQO) for this project is to provide data of known, acceptable and defensible quality that will provide confidence in decision-making relative to the project. Quality control checks will be implemented with respect to data collection methods, laboratory analysis, and data reporting for all components of the study including discrete salinity monitoring. Measurements of data quality will include acceptable limits for precision, accuracy, representativeness, completeness, and comparability.

5.2 Salinity Monitoring

Proper maintenance, calibration, and operation of each instrument will be the responsibility of the contractor's field personnel and the instrument technicians assigned to the project. All instruments and equipment used during the field activities will be maintained, calibrated, and operated according to the manufacturer's guidelines and recommendations. Contractor-specific SOPs for the following activities will be provided as part of a separately prepared Field Sampling Plan (FSP):

- Field Analysis of Water Temperature;
- Field Analysis of Specific Conductance;
- Quality Control for Field Instruments; and
- Operation, Deployment, and Maintenance of YSI 6-Series Sondes (or equivalent).

The SOPs contained in the FSP should contain a level-of-detail consistent with the Ecology prepared *Standard Operating Procedure for Field Measurements of Conductivity/Salinity with a Conductivity Meter and Probe* (Ecology, 2006).

Field equipment will be calibrated in accordance with the equipment operating manuals prior to use in the field as appropriate and/or a change in calibration response. Copies of the instrument manuals will be maintained by field staff. A record of field calibration of analytical instruments will be maintained by field personnel on the appropriate field logs. Examples of the contractor's data calibration log sheets, data record sheets and daily field sheets for each relevant instrument will be provided in advance of commencing field operations. Additionally, a field logbook will include notes on unusual results, changing of standards, battery charging, and operation and maintenance.

In order to preserve equipment accuracy, the instruments will be stored, transported, and handled with care in accordance with the handling instructions in SOPs associated with this Monitoring Plan and the individual operating manuals. Damaged instruments will be taken out of service immediately and not used again until a qualified technician repairs and recalibrates the instruments.

5.3 Health and Safety

A Health and Safety Plan (HASP) will be developed by the contractor prior to project initiation to identify potential health and safety hazards during monitoring operations within the LDW and specifically within Slip 4. The HASP will describe preventive measures to minimize health and safety hazards and provides procedures for responding to a health and safety incident should one occur. The HASP will be provided to EPA for review.

6.0 REFERENCES

AMEC Geomatrix, 2008. DSOA Additional Characterization Water Sample Collection, Boeing Plant 2 Duwamish Sediment Other Area. December 18, 2008.

AMEC Geomatrix, 2010. Cliff Whitmus, personal communication. November 2010.

American Public Health Association (APHA), 2005. Standard Methods for the Examination of Water and Wastewater. 21st Edition. Washington DC.

Code of Federal Regulations, Title 40, Part 131, Section 36(c) 3

Integral, 2006. Lower Duwamish Waterway Slip 4 Early Action Area, Engineering Evaluation/Cost Analysis. February 10, 2006.

Lewis, E.L. 1980. The Practical Salinity Scale 1978 and its antecedents. IEEEJ. Oceanic Eng. OE-5:3.

Striplin Environmental Associates (SEA), 2004. Lower Duwamish Waterway Slip 4 Early Action Area, Summary of Existing Information and Identification of Data Gaps. January 15, 2004.

USEPA, 2010. *Administrative Settlement and Order on Consent for Removal Action*. USEPA Region 10, Docket No. CERCLA-10-2010-0242. Effective September 29.

Washington Administrative Code, Chapter 173-201A, Section 260 3(e).

Washington Department of Ecology, 2006. Standard Operating Procedure for Field Measurements of Conductivity/Salinity with a Conductivity Meter and Probe, Version 1.0. Provisionally Approved July 10, 2006.

Windward Environmental, 2010. Lower Duwamish Waterway Remedial Investigation Final Report. July 9, 2010.

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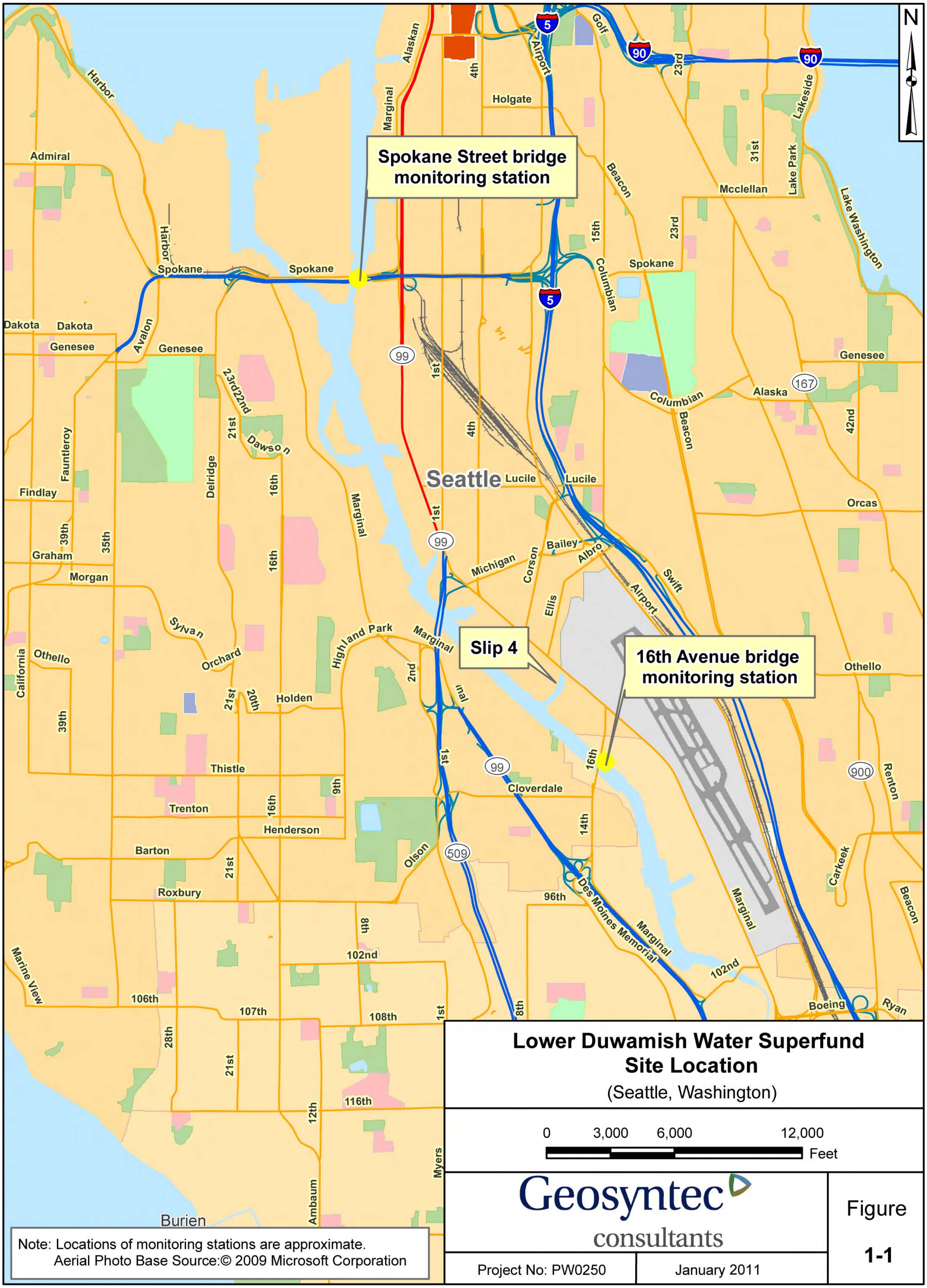
FIGURES



Lower Duwamish Water Superfund Site Location

(Seattle, Washington)

0 3,000 6,000 12,000 Feet

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Figure 1-1

Project No: PW0250

January 2011

Note: Locations of monitoring stations are approximate.
Aerial Photo Base Source:© 2009 Microsoft Corporation

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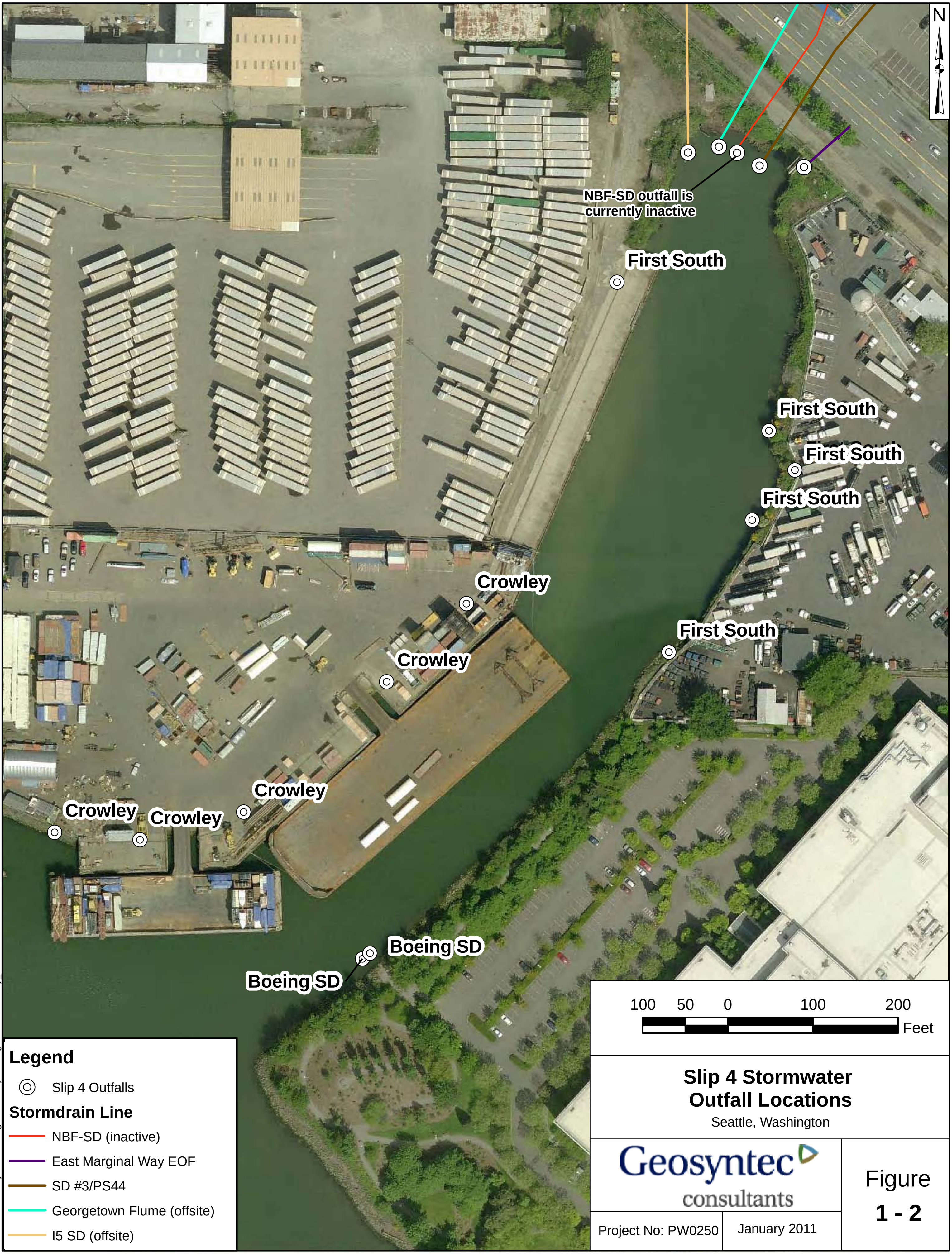

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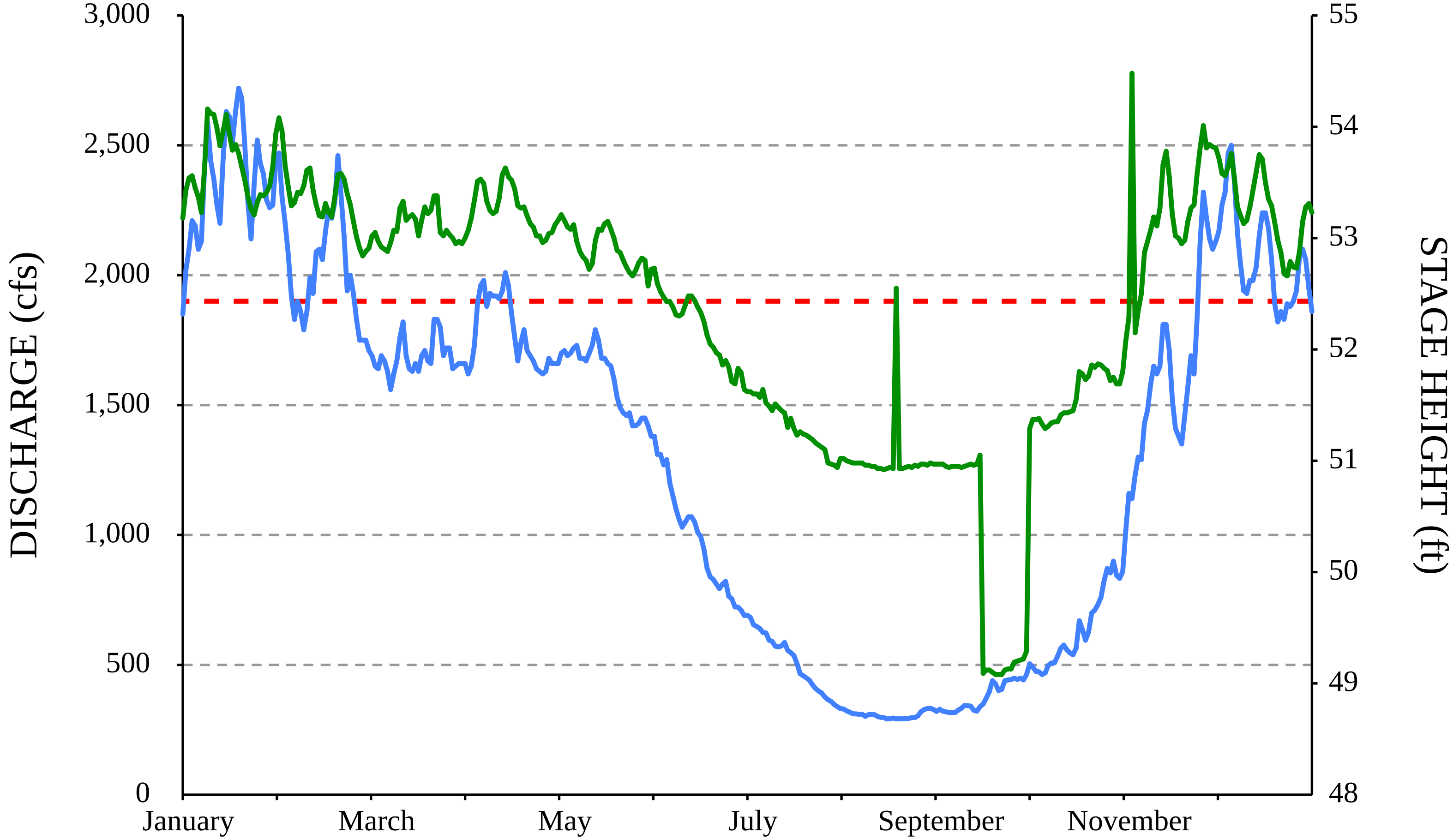

Legend

- Green River discharge (cfs)
- Green River stage height (ft)
- 75th percentile of discharge (approximately 1,900 cfs)

Notes

Values represent the mean of daily mean values for each day from 01 October 1961 through 30 September 2009.
Values from USGS National Water Information System: Web Interface.
USGS - United States Geologic Survey   cfs - cubic feet per second   ft - feet

Green River Average Daily Discharge and Stage Height
USGS Gage Station # 12113000 (Auburn, Washington)
Seattle, Washington

Geosyntec consultants

Project No: PW0250   November 2010

Figure 3-1

Anticipated Salinity Monitoring Locations in Slip 4

Seattle, Washington

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Project No: PW0250

January 2011

Figure **3 - 2**

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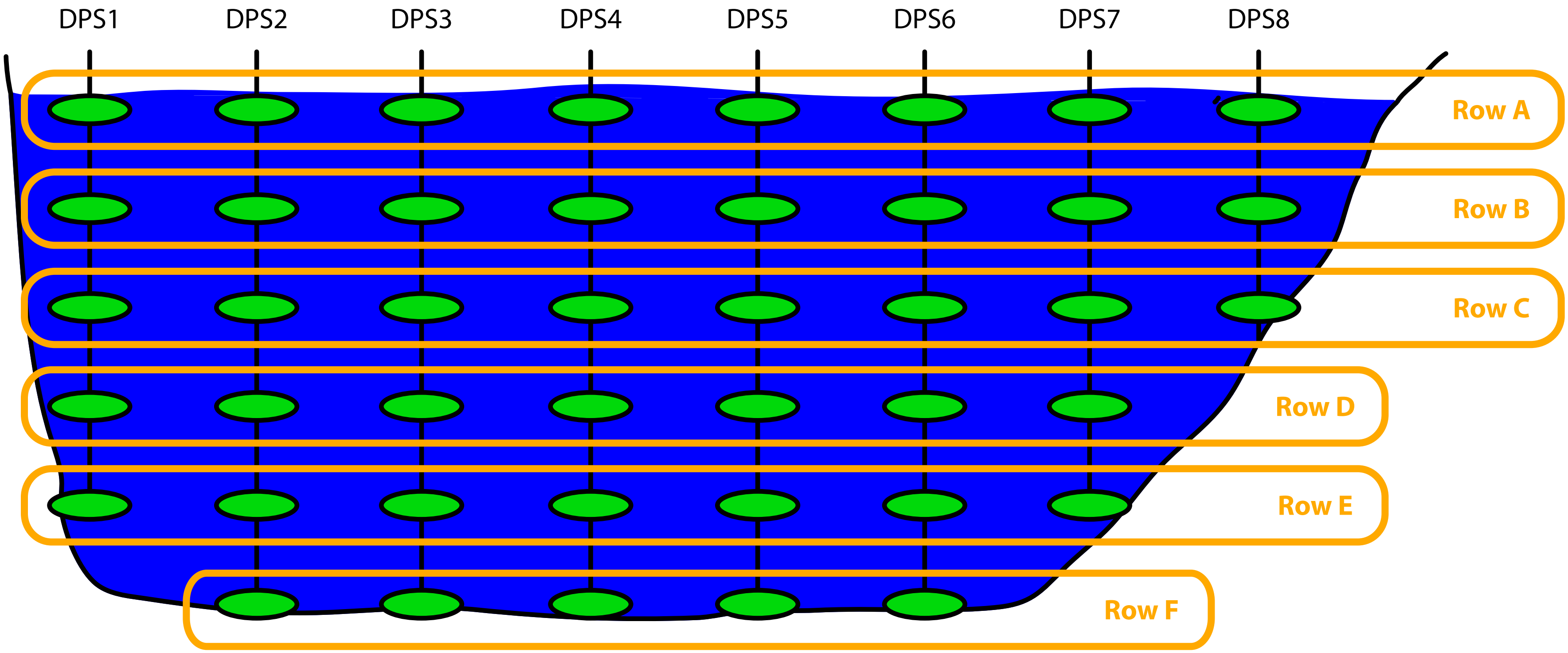

Legend

Salinity measurement location

Notes

Vertical profile measurements will be collected at 0.5-meter depths until the bottom sediments are reached at each discrete profiling station (DPS) location. A minimum of one sample will be taken at each DPS. The number of vertical measurements depicted here may vary based on the actual bed geometry.

Horizontal and vertical lengths are not to scale.

This cross-sectional view of Slip 4 is idealized and may not represent the actual observed conditions during sampling.

Cross-Sectional Representation of Sampling Profile

Slip 4, Lower Duwamish River
Seattle, Washington

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Figure 3-3

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ATTACHMENT A:

QUALITY ASSURANCE PROJECT PLAN

ATTACHMENT A
QUALITY ASSURANCE PROJECT PLAN

SLIP 4 SALINITY MONITORING PLAN
NORTH BOEING FIELD
SEATTLE, WASHINGTON

A.1. INTRODUCTION

A.1.1 Terms of Reference

This attachment to the Slip 4 Salinity Monitoring Plan presents the description of quality assurance/quality control (QA/QC) procedures for use within the Slip 4 Salinity Investigation.

This attachment includes the following sections:

- Section A.2, Quality Objectives and Criteria for Measurement of Data, describes the data quality objectives (DQOs) of the project and establishes the performance criteria for use in data generation; and
- Section A.3, Data Validation, describes the appropriate data validation procedures.

A.1.2 Project Scope

The project scope involves the collection of salinity data within Slip 4, North Boeing Field, Seattle Washington to determine whether marine or freshwater water quality criteria should apply within waters of the slip.

Discrete salinity monitoring will be performed manually by the project team along one transect near the middle of Slip 4 during three events. This sampling will target high flow events within the Green River as determined by USGS gage 12113000 (Tukwila, WA) in order to capture greatest likelihood of freshwater influence during a tidal cycle.

A.1.3 Project Schedule

Sampling activities will begin following approval of the QAPP by Boeing and will continue until three separate high flow events have been monitored. The three sampling events are anticipated to occur between late December 2010 and early March 2011. If data collected within these three events is sufficient to make a determination as to the applicability of marine or fresh water criteria the project will be concluded and validated data will be provided to Boeing in a final report. If the project is continued, at the discretion of Boeing, a final report will be prepared upon completion of the project.

A.2. QUALITY OBJECTIVES AND CRITERIA FOR MEASUREMENT OF DATA

A.2.1 Purpose & Background

The following sections document the DQOs of the project and establish performance criteria for the planning process and measurement systems to be used in generating the data. The DQOs are based on the project objectives and should ensure that the data from this project are useful for assessing water quality criteria compliance.

A.2.2 Quality Objectives and Criteria for Measurement Data

A.2.2.1 Introduction

DQOs are qualitative and quantitative statements developed by data users to specify the quality of data from field and laboratory data collection activities to support specific decisions or regulatory actions. The DQOs describe what data are needed, why the data are needed, and how the data will be used. DQOs also establish numeric limits for the data to allow the data user (or reviewers) to determine whether data collected are of sufficient quality for use in their intended application.

Following the seven steps of the DQO process described in detail in EPA QA/G-4, Guidance for the Data Quality Objectives Process, the following quality objectives were developed:

- Data must be of sufficient quality and quantity to assess ambient water quality against established and anticipated water quality criteria in the selected reaches during study periods;
- Data must withstand scientific scrutiny;
- Data generated must be comparable with data collected from previous investigations conducted by Boeing and their contractors;
- Data must be generated using controlled, approved/accepted procedures for field sampling, sample documentation, and laboratory analysis; and
- Data generated must be of known precision and accuracy.

The selection of appropriate measurement parameters depends on the objectives of the measurement effort, types of constituents, expected concentrations, and the types of measurements to be performed. Measurements will be made as to yield results that are representative of the media sampled and the site conditions.

To meet objectives, the following quality control parameters will be evaluated: precision, accuracy, completeness, representativeness, and comparability. These parameters will be evaluated by field personnel for field measurements and by the laboratory personnel for laboratory analyses.

A.2.2.2 Precision

Precision is a measure of mutual agreement among individual measurements of the same monitoring location under prescribed and similar conditions. Precision of the measurement data for this project will be assessed by the analysis of duplicate vertical profiles. In order to verify and document that the accuracy of conductivity measurements were maintained, field instrument calibration checks will be performed at the end of each sampling event. Precision of the measurement data will be assessed and controlled as described in Table 3-2 for the Salinity Monitoring Plan, unless otherwise documented with alternative numeric criteria.

Laboratory analytical precision of salinity, if applicable, shall be evaluated by using laboratory control samples (LCS). Field measurements will be assessed using sample duplicate vertical profile measurements obtained during the upward retrieval of the water quality meter (i.e., the up-cast). Precision is calculated in terms of relative percent difference (RPD).

RPDs must be compared to the laboratory-established RPDs for the analysis. Precision of duplicates may depend on sample homogeneity. The field analyst or his supervisor must investigate the cause of data outside stated acceptance limits. Corrective action may include recalibration, reanalysis of QC samples, sample reanalysis, or flagging the data as suspect if problems cannot be resolved.

A.2.2.3 Accuracy

Accuracy is the degree of agreement of a measurement or average of measurements with an accepted reference or "true" value. Accuracy is a measure of observation confidence in a system. Accuracy of the measurement data will be assessed and controlled as described in Table 3-2 for the Salinity Monitoring Plan, unless otherwise documented with alternative numeric criteria. These results will be used to control accuracy within acceptable limits by requiring that they meet specific criteria.

A.2.2.4 Completeness

Completeness is a measure of the amount of valid data obtained from a measurement system compared to the amount expected to be obtained under controlled laboratory conditions. Data completeness is a measure of the extent to which the database resulting from a measurement effort fulfills objectives for the amount of data required. Completeness is defined as the valid data percentage of the total tests requested. Valid analyses are defined as those where the sample arrived at the laboratory intact, properly preserved, in sufficient quantity to perform the requested analyses, and accompanied by a completed chain-of-custody form. Furthermore, the sample must be analyzed within the specified holding time and in such a manner that analytical QC acceptance criteria are met. The completeness requirement for all events is 95%.

A.2.2.5 Representativeness

Representativeness expresses the degree to which data accurately and precisely represents a characteristic of a population, parameter variations at a sampling point, a process condition, or an environmental condition. The characteristics of representativeness are usually not quantifiable. Subjective factors to be taken into account are as follows:

- Degree of homogeneity of a site;
- Degree of homogeneity of a sample taken from one point in a site; and
- Available information on which a sampling plan is based.

Field duplicates are also used to assess representativeness. To maximize representativeness of results, sampling techniques, sample size, and sample locations will be carefully chosen so they provide laboratory samples representative of the site and the specific area.

A.2.2.6 Comparability

Comparability expresses the confidence with which one data set can be compared to another data set measuring the same property. Comparability is ensured through the use of established and approved sample collection techniques and analytical methods, consistency in the basis of analysis, consistency in reporting units, and analysis of standard reference materials.

The use of standard methods to collect (USGS 1998, USEPA 1997, SOPs) and analyze (40 CFR Part 136.3, and APHA 2005) samples, along with instruments calibrated against National Institute of Science and Technology (NIST) traceable standards, will also ensure comparability.

Comparability also depends on the other data quality characteristics. Only when data are judged to be representative of the environmental conditions, and when precision and accuracy are known, can data sets be compared with confidence.

A.3. DATA VALIDATION

Data are not considered final until validated. Valid data is defined as results that are generated when the instrument and quality controls are within the designated limits. Data validation procedures are designed to systematically review data quality and to assign qualifiers that indicate limited usability of data. The data validation process begins with the review and evaluation of data by the supervisor and QA personnel assigned to the project. The project QA/QC coordinator is responsible for ensuring that all analyses performed are correct, properly documented, and complete and must satisfy the project DQOs. Each discrepancy and/or corrected data requests will be discussed with the appropriate field or laboratory personnel prior to the completion of data validation.

A data validation section will be included in the final report that will summarize QC results, qualifiers, and any possible data limitations. The QA/QC coordinator will assess the validated data and determine whether DQOs were met. Specific usability limitations of the data will be determined by the QA/QC coordinator and documented within the appropriate final report section.

Raw data for conductivity and temperature will be provided electronically to EPA in standard flat file format capable of being read by programs utilizing comma or fixed-value delimitated files.

A.4. QAPP AUTHORIZATION

This is to certify I am an authorized representative who approves of the information contained within this QAPP.

Brandon Steets, P.E.

Senior Engineer
Geosyntec Consultants

REFERENCES

American Public Health Association. 2005. Standard Methods for the Examination of Water and Wastewater. 21st Edition. Washington DC.

USEPA 1997. EPA QA/R-5 EPA Requirements for Quality Assurance Project Plans for Environmental Data Operations, Draft Final – Electronic Version, October 1997.

USGS 1998. Techniques of Water Resources Investigations, National National Field Manual for the Collection of Water Quality Data, Book 9,

40 CFR 136.3, 2000, Code of Federal Regulations, Title 40, "Protection of Environment," Part 136.3, "Guidelines Establishing Test Procedures for the Analysis of Pollutants," Section .3, "Identification of Test Procedures," Office of the Federal Register.