Prepared for

The Boeing Company
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Seattle, Washington

FINAL PRE-DESIGN TECHNICAL MEMORANDUM: LONG-TERM STORMWATER TREATMENT

NORTH BOEING FIELD

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TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

EXECUTIVE SUMMARY

North Boeing Field (NBF) is an active aircraft research, testing, finishing, and delivery facility located adjacent to the King County International Airport (KCIA) in Seattle, Washington. A portion of NBF discharges stormwater and base flows to the Slip 4 Early Action Area of the Lower Duwamish Waterway (LDW) Superfund site. Sediments in Slip 4 are contaminated with polychlorinated biphenyls (PCBs), among other potential pollutants of concern, and studies conducted by the Boeing Company (Boeing), Washington Department of Ecology (Ecology), and the City of Seattle have found elevated concentrations of PCBs in water and solids within the storm drain system at NBF. On September 29, 2010 Boeing entered into an Administrative Settlement Agreement and Order on Consent for Removal Action (ASAOC) with the Environmental Protection Agency (EPA) (CERCLA-10-2010-0242). The ASAOC requires Boeing to address PCBs by implementing short-term and long-term stormwater treatment systems. The Short-Term Stormwater Treatment (STST) system is currently installed and operational. The Long-Term Stormwater Treatment (LTST) system is required to be installed and operating by September 30, 2011.

This Pre-Design Technical Memorandum (PDTM) follows the LTST Removal Action Work Plan (RAWP) (Geosyntec, 2011b), approved by EPA on January 31, 2011, and the Addendum to the LTST RAWP (Geosyntec, 2011c), approved by EPA on March 7, 2011. As described in the Addendum, the proposed LTST system will be a chitosan enhanced sand filter (CESF) system similar to the STST system. The LTST CESF system will be designed to achieve a minimum of 91% capture[1] and treatment of *onsite* storm flows from North lateral MH130A (see Section 4 of the LTST RAWP [Geosyntec, 2011b] for design storm methods), a drainage area that has been shown to contribute the greatest PCB concentrations and loads to the lift station. To achieve preferential treatment of the on-site flows it will be necessary to 1) reroute the runoff from off-site/upstream areas of the North lateral (from upstream of MH178) to the lift station and 2) direct runoff pumped from MH130A directly to the CESF system. Furthermore, the proposed flow routing scheme will maximize treatment capacity utilization by pumping additional base and storm flows from the lift station to the LTST system for treatment as capacity is available. With this routing configuration and the

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[1] 91% is not a performance standard set in the EPA order

proposed system capacity (described below), the LTST system will also achieve 100% treatment of dry weather base flows at the lift station in addition to 91% capture of stormwater flows from the onsite North lateral and some treatment of additional runoff flows from other areas. The parking lot area (6.8 acres) is the only portion of the NBF on-site and off-site drainage area that is not routed through the lift station and thus there will be no opportunity to treat runoff from this area with this system.

As described in the Addendum, a range of 750 to 1,500 gpm LTST design flow for the CESF at the lift station[2] was identified to be within the "knee of the curve" (or the point of diminishing returns) range for both the average annual runoff volume capture and PCB load reduction curves. Based on information provided in the Addendum, the EPA indicated that a 1,500 gpm system appeared to be preferred as it is predicted to achieve approximately 90% wet weather compliance with both the freshwater and marine water Interim Goals. A 1,500 gpm CESF system is also anticipated to achieve a long-term average volume capture at LS431 of 81% of runoff from on-site drainage only, and 59% of runoff from combined on and off-site drainage areas. This sized system is expected to fit within the available foot print adjacent to the lift station. Therefore, Boeing plans to proceed with the design of a 1,500 gpm CESF treatment system located adjacent to the lift station.

The planned equipment for the CESF system includes one inlet weir/settling tank (approximately 18,000 gallons), three storage tanks (each approximately 20,000 gallons), three sand filter systems each consisting of four individual 54-inch diameter sand filter pods, and a control system housed within a movable container (e.g., rail container box). The preliminary design plan is to have three independent sand filter systems that are optimally sized to each treat a 500 gpm flow rate. The purpose of three independent sand filter systems is to allow the treatment system to operate more continuously during low-flow conditions (e.g., base flows would only require up to one third of this capacity), to keep the size of the system components to within a range that avoids larger special-order equipment, to provide the ability to conduct maintenance on one of the units as needed while the others can still be functioning, and to allow for potential down-sizing of the system in the future if monitoring data indicate PCB source

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[2] As noted in the Addendum, the CESF treatment rates evaluated all assumed the existing pump at MH130A (currently in use for the STST system) was operating at a capacity of 500gpm to divert on-site runoff from the North lateral and that the off-site North lateral was rerouted to the lift station.

loadings are being reduced sufficiently. The CESF system is anticipated to fit within a 5,100 sq-ft area west of the lift station[3].

Submersible pumps will be installed in the oil water separator vault (OWS421) of the lift station to pump water to the CESF system. The pumps will be sized such that the total flow being pumped to the LTST CESF treatment system at any one time would be capable of achieving up to 1,500 gpm (i.e., sizing will consider the pump rate from the North lateral, which will be able to pump approximately 500 gpm directly from MH130A). It is anticipated that the lift station pumps will be designed with a 1000 to 1400 gpm capacity, pending further refinement. Pump size selection will be included in the 60 percent design documents. The lift station pumps will be set to activate (using either float switches or by programmable logic controllers (PLC) based on pressure transducer level reading) at a level below that which any of the four 50-hp King County pumps activate.

Operations and maintenance (O&M) practices for the LTST CESF system are expected to be similar to that of the current STST system. LTST CESF annual costs are projected to be roughly $170,000. This estimate includes CESF contractor labor, chitosan and other materials costs, power, and removal/disposal of filtered solids. It is estimated that there could also be an additional $50,000 in system O&M costs in the first year of operation for system startup and shakeout activities, control system adjustments, and troubleshooting/repairs, for a total year one estimated annual O&M cost of $220,000. This estimated annual O&M cost excludes costs for Boeing or consultant oversight, stormwater sampling/monitoring, EPA reporting, or extra contingency costs. As the system design proceeds, Boeing and the design team will evaluate options to reduce the overall environmental footprint of the selected treatment system by investigating methods to conserve energy, reduce residual waste production, and incorporate the use of renewable energy sources while maintaining the desired system performance.

Boeing plans to begin procurement of the major treatment system equipment in April 2011.

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[3] The LTST RAWP Addendum (Geosyntec, 2011c) states, “Approximately 2,500 square feet could be made available with the removal of an existing nitrogen storage tank and associated equipment.” Since the submittal of that document, additional available space has been identified.

1 INTRODUCTION

The Boeing Company (Boeing) has conducted operations at North Boeing Field (NBF) since the 1940s. NBF is located at 7500 East Marginal Way South in Seattle, Washington, and is used for research, flight testing, aircraft finishing, and delivery facilities. Stormwater from NBF is collected and conveyed by storm drains to Slip 4 of the Lower Duwamish Waterway (LDW), which was placed on the National Priorities List (NPL) for polychlorinated biphenyls (PCBs) sediment contamination in 2001 pursuant to the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA), or Superfund, with oversight by the United States Environmental Protection Agency (USEPA). In 2003 the sediments and portions of the banks of Slip 4 were identified as an Early Action Area. In 2007 the Washington State Department of Ecology (Ecology), the lead for source control at the LDW Superfund Site, identified NBF as a significant continuing source of PCBs to the LDW.

USEPA and Ecology have been working with Boeing, the City of Seattle, and King County, to eliminate sources of PCBs in stormwater discharges to Slip 4. On September 29, 2010 Boeing entered into an Administrative Settlement Agreement and Order on Consent for Removal Action (ASAOC) with the USEPA. The ASAOC requires that Boeing address the discharge of PCBs to Slip 4 Early Action Area through short-term and long-term stormwater treatment (STST and LTST, respectively) removal actions. The STST system is currently installed and operational. The LTST is required to be installed and operating by September 30, 2011. In addition, source control actions will continue to be performed to reduce PCB concentrations in storm drain solids.

As defined in the ASAOC, “stormwater” shall mean all liquids, including any particles dissolved therein, in the form of base flow, storm water runoff, snow melt runoff, and surface runoff and drainage, as well as all solids which enter the storm drainage system. “System” shall mean the combination of all man-holes, catch basins, pipes, and other drainage devices and conveyances designed, constructed and utilized for the purpose of carrying stormwater from NBF to Slip 4 of the LDW, and the drainage basin associated with these devices and conveyances.

1.1 Project Goals

Boeing is committed to minimizing the potential of post-remediation recontamination of the Slip 4 Early Action Area. As feasible, the LTST system and source controls will be designed to meet the Interim Goals for PCBs. System effectiveness will be assessed through long-term monitoring at the compliance point. The current Interim Goals for

PCBs in water and solids, the point of compliance, and sizing requirements for the LTST system are discussed below.

1.1.1 PCBs in Water and Solids Interim Goals

The goal of the LTST removal action is to treat stormwater runoff to remove polychlorinated biphenyls (PCBs), the chemical of concern driving the need for time critical removal action, prior to discharge from the NBF via the King County International Airport (KCIA) Storm Drain #3/PS44 Emergency Overflow (EOF) to Slip 4 (SAIC, 2010 and USEPA, 2010a). As feasible, the LTST system and source controls will be designed to meet the long-term Interim Goals outlined in the ASAOC SOW for PCBs in solids and water at the point of compliance (Table 1).

Table 1:Long-Term Interim Goals for PCBs in Water and Solids Discharged to Slip 4

Matrix	Description	Reference	Value
Water	Aquatic Life – Fresh/Chronic current Interim Goal	USEPA, 2010a	0.014 µg/L
	Aquatic Life - Marine/Chronic Interim Goal; pending results of Salinity Study	USEPA, 2010a	0.030 µg/L
Solids	Total dry weight current Interim Goal – pending EPA review	USEPA, 2010a	0.1 ppm (mg/kg)
	Sediment Quality Standard adjusted for site specific TOC (recommended by Landau as an alternative to the 0.1 ppm Interim Goal)	Landau Associates, 2010e	0.42 ppm

The Lower Duwamish Waterway is a tidally-influenced water body with variable salinity depending on location, tidal conditions, flows, and storm water influences. Applicable water quality criteria (marine or freshwater) for Slip 4 are dependent upon the salinity levels within the slip. As specified in the ASAOC SOW, the freshwater chronic aquatic life Interim Goal for PCBs in water discharged to Slip 4 is 0.014 micrograms per liter (µg/L) total PCBs. The marine chronic aquatic life standard is 0.030 µg/L total PCBs. In the absence of site-specific salinity data, the more stringent freshwater quality criteria currently apply. A slip salinity study is currently being planned and is scheduled to begin within the next several months to determine the appropriate applicable goal based upon observed salinity.

The ASAOC Interim Goal for PCBs in storm drain solids discharged to Slip 4 is 0.1 parts per million (ppm) dry weight total PCBs. Based on correspondence from SAIC to

USEPA dated January 29, 2010, Appendix C of the ASAOC states that "the current derivation of the Slip 4 sedimentation model predicts that a maximum bulk storm drain solids concentration of 0.1 ppm PCBs will not recontaminate Slip 4 sediments above 0.13 ppm PCBs…". The 0.13 ppm is based on the Washington State Department of Ecology (Ecology) Sediment Quality Standard (SQS) of 12 ppm organic carbon (Washington Administrative Code [WAC] 173-204-320), translated to a dry weight of sediment using an assumed percent Total Organic Carbon (TOC) content for the sediments. The current Interim Goal has no loading rate limitation (i.e., a PCB mass load-based threshold, below which the solids Interim Goal would not be used for compliance assessment purposes), which would also be important for assessing the potential for sediment recontamination (i.e., it is PCB mass loading to the Slip that ultimately dictates potential Slip sediment recontamination, combined with other factors like solids particle size distribution/settling velocities and PCB fractionation by particle size). This Interim Goal may change pending the collection and analysis of additional post-STST system implementation solids data at LS431, at which point a long-term Interim Goal for solids that can be feasibly met will be selected by USEPA. Boeing has also proposed using a remediation level of 0.42 parts per million (ppm) dry weight total PCBs which is based on the 12 ppm organic carbon SQS screening level normalized by a site-specific TOC of 3.5 percent (Landau, 2010).

1.1.2 Point of Compliance

The King County lift station (LS431) is identified by USEPA as the point of compliance since storm drain discharges here represents 94% of the NBF on-site drainage area. The remaining 6% of the area is known to have relatively lower PCB solids concentrations (Landau, 2011a). The lift station is also the furthest downstream location in the storm drain system that is not impacted by tidal flushing and PCB-containing sediments from Slip 4. Downstream of the lift station, such as CB433 or at the outfall, water and solids samples would not be representative of pure NBF storm drain discharges (note that the lift station also does currently include significant upgradient offsite contributions). As will be discussed in further detail in the 60% design documents, it is proposed that the LTST point of compliance remain in its current location downstream of the lift station pumps, which will also be just downstream of the point at which the CESF effluent is discharged.

1.1.3 Sizing Requirements

As described in the LTST RAWP (Section 4; Geosyntec, 2011b), the proposed LTST system will be designed to achieve, at minimum, approximately 91% capture and treatment of onsite storm flows from North lateral MH130A, a drainage area that has been shown to contribute the greatest PCB concentrations and loads to the lift station. Furthermore, the proposed flow routing scheme will maximize treatment capacity utilization by pumping additional base and storm flows from the lift station as system capacity is available. This will result in 100% treatment of base flows at the lift station. A 1,500 gpm CESF system, in combination with a 500 gpm pump capacity at MH130A, is also anticipated to achieve a long-term average volume capture at LS431 of 81% of runoff from on-site drainage only, and 59% of runoff from combined on and off-site drainage areas. A portion of storm flows from other laterals, all of which are routed to the lift station and comingled, will also be treated based on available capacity in the LTST system. The CESF system will be operated at full capacity (1,500 gpm) whenever sufficient stormwater is present.

As described in the Addendum to the LTST RAWP (Geosyntec, 2011c), the size of the system beyond the minimum requirements was evaluated based on the system's ability to maximize, to the extent practicable, the long-term average volume capture, annual PCB load reduction, and frequency of meeting the water Interim Goals, while also taking into consideration land availability, power availability, impacts to the design, procurement, and construction schedule for each evaluated design flow rate.

1.2 Scope of Work

This Pre-Design Technical Memorandum follows the LTST Removal Action Work Plan (RAWP) and Addendum (Geosyntec, 2011b and 2011c, respectively) and includes design performance specifications and project goals to verify the project concept and direction for the long-term treatment facility. As required by the ASAOC (USEPA, 2010), this memorandum addresses the:

- Proposed long-term treatment facility(s) and the use of contractors;
- Preliminary design including size and alignment of infrastructure and improvements;

- Proposed treatment processes and devices (e.g., treatment units, filters, storage tanks), including a discussion of drainage basins, environmental conditions, rainfall amounts and intensities, system efficiency and discharge water quality;

- Process and instrumentation drawing for the system showing all flows and including any regeneration and/or backwash;

- Bypass or overflow event configurations;

- Management/maintenance plan to operate the facility, with an estimate of annual maintenance costs; and

- Monitoring and contingency planning, including how data will be recorded and reported to USEPA.

1.3 Terms of Reference

The work described in this report was conducted by Geosyntec Consultants and Landau Associates for The Boeing Company (Boeing) North Boeing Field (NBF) (7500 East Marginal Way South, Seattle, Washington) to be submitted to the USEPA. The primary authors of this Pre-Design Technical Memorandum were Megan Patterson, P.E., Marc Leisenring, P.E., and Dan Pankani, P.E. under the direction of Brandon Steets, P.E. and Eric Strecker, P.E. Landau Associates contributors include Joe Kalmar, P.E., Robert Ludwig, P.E., and Martin Valeri. This report was senior reviewed by Brandon Steets, P.E. and Eric Strecker, P.E. in accordance with Geosyntec's quality assurance protocols.

2 BACKGROUND

NBF occupies approximately 112 acres and is located approximately 4 miles south of downtown Seattle (Figures 1 and 2). NBF is adjacent to the Georgetown Steam Plant (GTSP) to the north and the King County International Airport (KCIA) to the east. Slip 4 Early Action Area of the LDW is located across Marginal Way, approximately 150 feet southwest of the NBF site boundary. The following describes the NBF regulatory setting, watershed description, climate and hydrology, receiving waters, and subsurface conditions as they relate to the LTST system.

2.1 Regulatory Setting

The relevance of CERCLA and EPA's Green Remediation Policy to the LTST system are discussed below. Stormwater discharges from NBF are also authorized by the Industrial Stormwater General Permit (ISWGP) issued by the Washington State Department of Ecology, which became effective on January 1, 2010. While this Permit does not affect the LTST design, it is expected to increase compliance with the Permit.

2.1.1 CERCLA

Pursuant to the ASAOC, the Boeing Company, an identified Potentially Responsible Party (PRP), voluntarily and with no admission of liability has consented to conduct PCB source control activities and implement a system for treating PCB-laden stormwater prior to discharging to the Slip 4 Early Action Area of the LDW. The ASAOC was issued by the USEPA Region 10 under the authority vested in the President of the United States by Sections 104, 106(a), 107, and 122 of the Comprehensive Environmental Response, Compensation, and Liability Act of 1980, as amended ("CERCLA"), 42 U.S.C. §§ 9604, 9606(a), 9607, and 9622. CERCLA, commonly known as Superfund, provides broad Federal authority to respond directly to releases or threatened releases of hazardous substances or pollutants, such as PCBs, that may endanger public health or the environment. The ASAOC establishes that Boeing is responsible for the performance and costs of removal actions conducted to reduce surface water discharges of PCBs from the North Boeing Field property to Slip 4.

2.1.2 Green Remediation Policy

USEPA Region 10 has a "Clean and Green Policy" to enhance the environmental benefits of Federal remediation programs at Superfund sites by encouraging sustainable technologies and practices. The goal of the Policy is to achieve remedial action goals while supporting sustainable use and reuse of remediated land, minimizing impacts to water quality and water resources, reducing toxic air and greenhouse gas emissions, minimizing material use and waste production, and conserving natural resources and energy. The Policy applies to all Superfund cleanup activities including those performed by PRPs, States or Tribes through Cooperative Agreements, USEPA and/or the Army Corps of Engineer contractors. The Policy encourages cleanup practices that:

- Employ 100% use of renewable energy, and energy conservation and efficiency approaches including EnergyStar equipment;
- Use cleaner fuels, diesel emissions controls and retrofits, and emission reduction strategies;
- Utilize water conservation and efficiency approaches including WaterSense products;
- Incorporate sustainable site design;
- Utilize reused or recycled industrial materials within regulatory requirements;
- Require recycling or reuse of materials generated at or removed from the site;
- Use environmentally preferable purchasing;
- Use "green concrete" (coal combustion products in place of Portland Cement);
- Ensure methane recovery from landfills;
- Support greenhouse gas emission reduction technologies; and
- Use Environmental Management System (EMS) practices such as reducing the use of paper by moving to fully electronic transmittal of project documents and implementation of waste reduction and recycling programs at all work sites.

This Policy is in alignment with USEPA's Principles for Greener Cleanups[5] and USEPA's Superfund Green Remediation Strategy[6], which seek to minimize the environmental footprint of remedial activities by considering five core elements: (1) energy, (2) air and atmosphere, (3) water, (4) land and ecosystems, and (5) materials and waste. In summary, efforts should be made to utilize techniques and technologies to maximize the overall environmental benefit of Superfund cleanup activities without

[5] http://www.epa.gov/oswer/greencleanups/principles.html
[6] http://www.epa.gov/superfund/greenremediation/sf-gr-strategy.pdf

"compromising cleanup objectives, community interests, the reasonableness of cleanup timeframes, or the protectiveness of the cleanup actions."

As the system design proceeds, Boeing and the design team will evaluate options to reduce the overall environmental footprint of the selected treatment system by investigating methods to conserve energy, reduce residual waste production, and incorporate the use of renewable energy sources while maintaining the desired system performance, as well as other elements listed above.

2.1.3 Industrial Stormwater General Permit

The ISWGP limits the discharge of pollutants from industrial facilities to surface and ground waters in conformance with the State of Washington Water Pollution Control Law (RCW 90.48) and the Federal Water Pollution Control Act (33 USC § 1251 et seq.). All Permittees must develop a Stormwater Pollution Prevention Plan (SWPPP), which specifies the Best Management Practices (BMPs) necessary to comply with State water quality standards and applicable Federal technology-based treatment requirements under 40 CFR 125.3.

For the NBF, the BMPs selected and described in the SWPPP must provide levels of pollution prevention that are comparable to the BMPs listed in the Stormwater Management Manual for Western Washington (Ecology, 2005). The Manual lists various source control and treatment control BMPs that can be implemented to reduce the discharge of pollutants. Treatment control BMPs are structural facilities that remove pollutants from stormwater through sedimentation/settling, filtration, plant uptake, ion exchange, adsorption, and bacterial decomposition. While treatment control BMPs implemented as part of new development or significant redevelopment projects must meet specific sizing requirements (e.g., flow rate necessary to capture and treat 91% of the total stormwater runoff volume), there are no such requirements for industrial or retrofit situations, such as the LTST system currently being designed to remove PCBs from stormwater at NBF.

2.2 <u>Watershed Description</u>

2.2.1 Land Ownership and Uses

NBF facilities are primarily used for research, flight testing, aircraft finishing, and delivery facilities. Land uses within the areas tributary to LS431 are predominantly industrial (e.g., KCIA) with some residential to the northwest along Ellis Avenue South.

2.2.2 Drainage Basins

There are six main drainage basins at NBF, five of which contain laterals which discharge to the lift station (Table 2). For the purpose of this pre-design technical memorandum, runoff from the GTSP and the KCIA is considered "off-site" runoff (Figure 2). Runoff from NBF includes that from the Building 3-380 area, four major storm drain laterals (North, South-Central, North-Central, and South laterals), and the parking lot area (Figure 3). The parking lot area (6.8 acres) is the only portion of the NBF on-site and off-site drainage area that is not routed through the lift station and thus there will be no opportunity to treat runoff from this area with the proposed system. The major storm drain laterals are directed to the King County Lift Station (LS431 in Figure 4), which directs flows to the 60-inch KCIA Storm Drain #3/PS44 (SD#3/PS44) outfall at the Slip 4 Early Action Area. Several NBF parking lots (approximately 6 acres) drain to SD#3/PS44 downstream of the Lift Station.

Table 2. Summary of On- and Off-Site Drainage Areas and Imperviousness

Sub-Area	Acreage (Estimated % Impervious)		
	On-Site	**Off-Site**	**Combined On+Off-Site**
Parking Lot	6.8 (100%)	-- (--)	6.8 (100%)
Building 3-380	4.6 (100%)	-- (--)	4.6 (100%)
North Lateral	18.1 (90%)	41.1 (62%)	59.2 (71%)
North-Central Lateral	14.7 (100%)	42.6 (52%)	57.3 (64%)
South Lateral	46.3 (100%)	64.3 (79%)	110.6 (88%)
South-Central Lateral	21.9 (100%)	42.7 (50%)	64.6 (67%)
Total to Slip 4	112.4 (98%)	190.7 (63%)	303.1 (76%)
Total to LS431 (excludes Parking Lot)	105.6 (98%)	190.7 (63%)	296.3 (75%)

Note: Acreages and imperviousness based on Landau (2011a).

The lift station at LS431 prevents tidal flow into the onsite storm drains upstream of LS431 and pumps water from the storm drain system to the Slip 4 outfall (Landau, 2010). LS431 is approximately 480 feet away from the outlet at Slip 4; it is assumed that the combination of the distance of the outfall to the lift station, and design of the lift station itself would minimize any tidal influences on ground water levels and base flows upstream of LS431.

2.2.3 Topography and Imperviousness

The NBF property is only a fraction of the total area that contributes storm water and base flow to LS431. Approximately 190 acres of offsite areas to the east of the NBF property consisting mostly of pervious areas and runways within KCIA property drains through NBF to LS431. Table 2 shows a breakdown of estimated site imperviousness by drainage basin. The NBF property is well connected hydraulically with a system of storm drain inlets, manholes and pipes. The slopes across the project site are generally mild to flat. Off-site areas that drain through the Project site are assumed to have mild slopes as well based on previous work from Landau, site photos and site visits.

2.3 Climate and Hydrology

The climate at NBF can be described as Oceanic or Marine, with mild wet winters and mild dry summers. Average annual precipitation for the site is approximately 36 inches based on an analysis of precipitation data from the National Climatic Data Center (NCDC) rain gage at the Seattle-Tacoma International Airport (SeaTac) (Figure 5). Average monthly precipitation over the period of record is shown in Figure 6. Monthly rainfall ranges from approximately 0.7 inches in the driest month, July, to approximately 5.9 inches in the wettest month, November. Summary statistics for the SeaTac gage are shown in Table 3.

Table 3: Rainfall Statistics based on Seattle-Tacoma International Airport Rainfall Gage (1968-2008)

Station[1]	Period of Record	Average annual rainfall (inches)	Average number of events per year[2]	Average storm duration (hrs)	Average storm intensity (in/hr)	Average storm depth (in)
SEATAC	10/01/1968 to 10/01/2008	36	62	9.4 hours	0.05	0.50

1 – NCDC Hourly Precipitation data from Hydrosphere Data Products, Boulder, CO (1999)

2 – Storms defined as cumulative daily rainfall greater than 0.15 inches over a 5-hour period. While not assessed for general hydrologic site characterization, Ecology's definition of a storm event for monitoring purposes (SAIC, 2009) is defined as an event with cumulative daily rainfall greater than 0.15 inches over a 5-hour period and preceded by 24-hours of no greater than a trace (0.04 inches) of precipitation.

2.4 Receiving Waters

Runoff from NBF discharges into the Slip 4 Early Action Area which is connected to the LDW. The LDW flows into Elliott Bay approximately 4 miles northwest of the outfall and eventually merges with Puget Sound.

2.5 Subsurface Setting

2.5.1 Site Soils

The NBF project site is highly impervious as shown in Table 2 and as discussed in the next section; however, off-site areas that drain through the NBF property have a higher percentage of unpaved areas (airfield grass areas). To adequately predict storm water runoff quantities from the pervious areas, knowledge of the site soils is helpful. According to investigations conducted by Landau Associates (2010), the NBF soils consist of medium-grained sand with interbedded sand, silt gravel and peat. The soils are classified as Hydrologic Soil Groups “B” and “C”. To be conservative (or allow for runoff estimates to be biased high, if any) in the storm water modeling efforts, site soils have been modeled as Hydrologic Group “C” which is less permeable than Group “B” soils and therefore predict more runoff than might actually occur.

2.5.2 Groundwater

There is evidence of groundwater intrusion into the on-site storm drain system. This groundwater intrusion is assumed to be responsible for both wet and dry weather base flows observed at NBF. Landau Associates estimated groundwater base flow rates at MH108 to be approximately 0.14 cfs or 62 gpm (Landau Associates, 2010) during the period between November 28, 2009 and December 14, 2009. This number is based on Landau’s analysis of runoff flow rate measurements collected at MH108 and hourly rainfall data from KCIA used to eliminate flow records that likely represent runoff. Since base flow analysis was initially performed, grout sealing of a number of the catch basins has been completed and is expected to reduce groundwater intrusion in the North. To be conservative, the original estimate will be retained for pre-design, and base flows are assumed to be approximately 0.14 cfs at MH108. As additional flow data are collected at the STST system influent, this assumption may change. However, these North lateral base flow rates should not significantly influence the design of the LTST system.

To estimate base flows at LS431, we have assumed that base flows are seasonal, dependent on antecedent rainfall patterns and minimally tidally influenced. Pump flow rates collected at LS431 are available for the periods between October 2009 and June 2010 and from November 2010 to January 2011. These data were obtained and analyzed, and average daily flow rates were calculated to smooth the data and eliminate noise introduced by the pumps cycling on and off. These daily average flow rates are plotted and presented as Figure 7. Based on the figure, base flows at LS431 appear to range from 0.5 cfs during the dry season to approximately 1.0 cfs during the wet season.

2.5.3 Other Geotechnical Considerations

A geotechnical and structural evaluation at the proposed LTST site should be conducted to evaluate the load bearing capacity of the soils and identify equipment foundation requirements. Boring logs near the site indicate that the soils in the area are primarily fine to medium sands overlain with fill material (GeoMapNW, 2011). These soil conditions along with a high water table could cause liquefaction in the event of an earthquake or during construction. Liquefaction can cause foundations and other structures to settle and/or crack and can cause underground tanks and pipes to rise buoyantly.

3 SIZING METHODOLOGY

As described in the LTST RAWP Addendum (Geosyntec, 2011c) the Western Washington Hydrology Model (WWHM) was initially used as the primary tool for modeling stormwater runoff volumes and flow rates. WWHM comes with a built-in precipitation time series consisting of 30 years of SeaTac rainfall data from 1968 to 1998 (the WWHM time series has not been updated in recent years). Primarily due to limitations of WWHM's routing capabilities and to some extent the data limitations, USEPA's Stormwater Management Model (SWMM) was used for subsequent analyses. SWMM provides a straight forward means of simulating the lift station pumps with its built-in support for pump control logic. The more recent and complete precipitation record from the NBF-KCIA gage (Figure 5) was used as input to the SWMM model. SeaTac is approximately 9 miles from both the project site and NBF-KCIA; both sites (SeaTac and NBF) share similar rainfall patterns. The SWMM model was calibrated against measured flows at the lift station and SWMM results were compared with WWHM predicted flows and volumes.

4 PROPOSED LONGTERM STORMWATER TREATMENT FACILITY

The LTST will consist of a CESF system very similar in configuration and operation to the current STST system (Landau, 2011), with the main differences being that the LTST system will be located at the Lift Station (allowing for 100% base flow treatment and significant increase in volume capture and load reduction compared with the STST [Geosyntec, 2011c]) and it will be sized to treat a much larger flow rate of 1,500 gpm. In addition, the offsite North lateral drainage area will be rerouted (to allow for isolated treatment of MH130A flows) by the time the LTST system is implemented. Figure 8 illustrates the NBF areas proposed to be treated by the LTST system under storm and base flow conditions.

4.1 Stormwater Treatment Design Basis

The LTST system will preferentially capture and treat the majority of storm flows from MH130A, all of the dry weather base flow to the Lift Station (LS431), and a portion of the storm flow to the Lift Station. It is anticipated that this plan will require at least two conveyance pipes to be installed (Figures 9 and 10). The first will divert offsite stormwater that currently flows through the North lateral from just upstream of MH178 directly to LS431 to separate offsite North lateral stormwater from onsite North lateral stormwater. The second will convey the stormwater pumped from MH130A (runoff from the onsite portion of North lateral stormwater) to the LTST CESF. Boeing will provide design details on the conveyance infrastructure in the Pre-Final (60%) Design Document. It should be noted that runoff from all laterals, with the exception of flows diverted at MH130A, will be routed to the lift station vault and comingled prior to pumping to the CESF for treatment. As shown in Figure 9, portions of both the North off-site reroute and the force main from MH130 will be on property owned by or leased from the City of Seattle.

As described in the LTST RAWP Addendum (Geosyntec, 2011c), a range of 750 to 1,500 gpm LTST design flow for the CESF at the lift station was identified to be within the “knee of the curve” (or the point of diminishing returns) range for both the volume capture and PCB load reduction curves. It is predicted that a 750 gpm design basis would comply with the freshwater Interim Goal for water quality approximately 88% of the time during a “typical” year, and would achieve a 70% total annual PCB load reduction, which is nearly twice the reduction the STST is currently achieving. A 1,500 gpm system is predicted to achieve approximately 90% wet weather compliance with both the freshwater and marine water Interim Goals. One of USEPA’s comments (USEPA, 2011) in response to the Addendum was that “it appears that 1,500 gpm may represent a "knee" of the curve for compliance with the freshwater Interim Goal during the wet-weather season."

Therefore, based on the capture and load reduction analysis and based on USEPA review comments, Boeing plans to proceed with design of a 1,500 gpm CESF treatment system located at the Lift Station. The following sections provide additional detail of the LTST system design.

4.2 Treatment Processes and Equipment

As stated above, the CESF system will be similar in configuration and operation to the current STST system although significantly larger in footprint and capacity. As outlined in the RAWP for STST (Landau, 2011a), the treatment processes include coarse solids settling in aboveground settling/storage tanks, solids coagulation via chitosan acetate dosage (less than one part per million of chitosan acetate solution containing the natural biopolymer chitin), sand filtration through a bank of sand filter units to remove the coagulated solids, and automated sequential backflushing of the sand filter units to maintain the necessary system treatment capacity and associated TSS and PCB removal efficiency. This approach has proven effective for removing PCBs in water by the NBF STST system.

For a 1,500 gpm sized system, the current conceptual design system calls for one inlet weir/settling tank (approximately 18,000 gallons), three storage tanks (each approximately 20,000 gallons), three sand filter systems each consisting of four individual 54-inch diameter sand filter pods, and a control system housed within a container or structure (e.g., rail container box, shed, trailer, etc.).

The preliminary design plan is to have three independent sand filter systems that are optimally sized to each treat an approximate 500 gpm flow rate. The purpose of three independent sand filter systems is to allow portions of the treatment system to operate more continuously during low-flow conditions, to keep the size of the system components to within a range that avoids larger special-order equipment, to allow more flexibility in maintenance (ability to take one of the systems off-line for periodic maintenance), and to allow for potential down-sizing of the system in the future. Each of the three sand filter systems is anticipated to be the same 4-pod (each a 54-inch diameter vessel) unit that is currently used for the STST.

Given the available filtration surface area of approximately 64 sf for a 4-pod sand filter unit, a 500 gpm flow results in a sand filter loading of approximately 7.9 gpm per square foot (sf). This design loading is well within the Washington Department of Ecology general use designation for CESF at 15 gpm/sf, and that use designation is for construction stormwater projects with much higher total suspended solids (TSS) loading compared to the NBF site. Even during backflush cycles (under higher back-pressure and reduced flow rate) when flow is routed through only 3 of the 4 sand filter pods the filter loading is not expected to exceed 10 gpm/sf. This planned moderate hydraulic loading rate is equivalent to current STST operation and will allow for continued effective filtration of TSS and PCBs, will result in lower pressure drop across the sand filters, and will thereby reduce the size of pumps required and minimize power consumption.

It is currently planned that sand filter backwash water will be discharged to the inlet weir tank. It is further anticipated that backflushing would be automated and sequenced with backwashing occurring at one vessel at a time. This will minimize backwash flow rates. One potential benefit of discharging backwash water to the inlet settling tank is that any excess chitosan associated with the backwash solids may be available to interact with suspended solids in the inlet stormwater, improving initial settling in this tank. The design sizing basis for tanks and other equipment will be presented in the Pre-Final (60%) Design Document, as described below. Special design considerations will be made to ensure that adequate volume is provided or other scour protection in the inlet weir tank(s) such that backwash solids in the weir/settling tank will not be scoured and re-suspended by the 1,500 gpm of incoming stormwater.

4.2.1 LTST System Location and Layout

Boeing has worked to identify and set aside space near the Lift Station for the LTST system. A 1,500 gpm size CESF system is expected to fit within a 5,100 sf area just west of the Lift Station[7]. That area and a preliminary plan view layout of system equipment are provided on Figure 11A. The same preliminary layout of the system shown over an aerial photo of the site is provided on Figure 11B. An additional area of approximately 1,400 sf was identified for possible LTST use, but an existing idle nitrogen tank and its protective bollards would first need to be removed and the pavement restored.

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[7] Since the submittal of the LTST RAWP Addendum (Geosyntec, 2011c) an additional 2,600 sf of available space has been identified.

4.2.2 Stormwater Collection Pump Operation & Control

Stormwater will continue to be pumped from the North lateral out of MH130A and treated. The existing submersible pump at this location produces approximately 540 gallons per minute. A new buried stormwater conveyance pipe will be installed from MH130A to the Lift Station and untreated stormwater pumped from MH130A will be pumped directly into the weir tank at the new Lift Station CESF system. It is possible that with the additional piping length and friction losses associated with the longer piping length to the Lift Station that the submersible pump will produce somewhat less than 540 gpm. The friction loss and ultimate flow rate produced will depend on pipe diameter, pipe material, and number of bends in the pipe. The existing pump in MH130A may need to be replaced with a larger pump to compensate for the additional piping length required to discharge to the new LTST system location at the Lift Station. Pump and pipe sizing will be designed and installed as required to achieve the flow rate determined necessary from earlier evaluations (i.e., at least 500 gpm, the existing pump capacity for the STST, designed for 91% capture and treatment of onsite storm flows from North lateral MH130A).

Any spare treatment capacity that remains at the 1,500 gpm CESF system will be taken up by pumping base flow and/or stormwater from the Lift Station. The CESF system will be operated at full capacity (1,500 gpm) whenever sufficient stormwater is present. Submersible pumps would be installed in the inlet vault of the Lift Station (referenced as OWS421 per Boeing storm drain drawings; note that the vault structure is not a baffled oil water separator as indicated by the reference number). Typically, sludge does not collect in OWS421 due to the turbulence generated by incoming stormwater and the activation of the large 50 hp King County lift station pumps; however, heavier sand particles may accumulate in the corners and sides of the lift station sump where turbulence is lower. While the proposed pump plan is not anticipated to alter the accumulation of sludge in OWS421, this can be monitored upon LTST system startup. The inlet weir tank on the LTST system will contain both an overflow and underflow baffle to trap settled solids and any floating fuel/oil.

Currently, there are no plans to pump out of the Lift Station OWS421 with a preference for collecting stormwater from one storm drain lateral pipe over another, meaning that all stormwater (other than the water pumped from MH130A) will mix together in OWS421 and will be pumped out without regard to specific lateral. However, if future

Lift Station discharge compliance sampling indicates that applicable PCB criteria are not being met, contingent actions may be implemented as described in Section 6.3. .

The aboveground inlet weir tank and three storage tanks will have high level switches and will be able to temporarily deactivate one or both OWS421 submersible pumps in the event that more than 1,500 gpm is pumped for a period of time and exceeds the CESF system storage and treatment capacity. As design develops, it is possible that the use of automated controls in combination with the use of variable frequency drives (VFD) will be utilized to regulate the pumped stormwater flow rate to the 1,500 gpm design basis. For both submersible pumps and aboveground CESF system transfer pumps, Boeing will seek to purchase high-efficiency pumps/motors.

During STST system operation there have been occasions where the submersible pump was impacted by rocks and gravel generated by a water main break at the facility and where the inlet flow meter was impacted by string and other debris. Consideration will be given in the preliminary design to install screens or strainers upstream of these elements to prevent operational impacts, install pumps that can pass high solids, or install pumps such that cleaning of pump intakes can be performed without the need to perform confined space entry into the storm drain structures.

The submersible pumps in OWS421 will be set to activate (using either float switches or by programmable logic controllers (PLC) based on pressure transducer level reading) at a level below that which any of the four 50-hp King County pumps activate. As design progresses, we may request that King County adjust the on level setpoint for their first pump to ensure that their pumps do not interfere with the recovery of the first full 1,500 gpm stormwater flow rate, but currently it does not appear that that will be required. The two new submersible pumps would also be set to turn off at a level that is above their minimum manufacturer’s recommended submergence depth in order to avoid motor overheating or dry run conditions.

Note that with the use of the submersible pumps, the frequency of the King County pumps being activated will decrease significantly (almost never during base flows and less often during storm events) and therefore the overall energy use of the LTST system will be partially offset by power saved with the decreased use of the lift station pumps.

4.2.3 CESF System Instrumentation and Controls

The preliminary design of the CESF system includes plans for monitoring, recording, and/or controlling the following parameters, including (but not limited to) those listed below:

- Monitor inlet stormwater flow rate and total flow from both MH130A and from the Lift Station, both real-time monitoring and data recording.
- Monitor both recirculation (re-treated) flow volume and effluent discharge stormwater flow rate and total flow, both real-time monitoring and data recording.
- PLC-based control of sand filter backflushing, to be triggered based on maximum time interval and/or based on differential pressure rise.
- Continuous monitoring and recording of influent and effluent turbidity (which correlates to TSS and thereby also to PCB concentration) and pH.
- Four independent and PLC-controlled chitosan metering pumps. Static mixers will be provided in the lines just downstream of the chitosan injection points in order to thoroughly mix the chitosan into the stormwater.
- Storage tank water level controls with temporary lift station submersible pump shutoff in the event of high storage tank water level, with automatic restart of pump following continued stormwater treatment and storage tank drawdown.
- Remote calling/texting to operations personnel of any abnormal conditions (e.g., long periods in recirculation mode, abnormally high influent or effluent turbidity, pH outside the range of 5.5 – 8.5, high tank water level that is not corrected within an allowable time).
- Solids filter assemblies (e.g., bag or cartridge filter) with 1-micron filter elements at the MH130A influent line, the Lift Station influent line, and the CESF system effluent line. Each filter would also be installed with a downstream flow totalizer to record volume filtered.

A preliminary process schematic diagram showing the major treatment system components and instrumentation/controls is provided on Figure 12. Some problems were encountered during STST system operation and were due to system control features (e.g., pH control, valve adjustment during backwashing events, recirculation times, etc.). Specifications for LTST system controls will address those issues and will be described in the 60% Design Documents.

4.2.4 Implementation Schedule

In order to ensure that the CESF system equipment can be manufactured, delivered, installed, and the full LTST system operational by the September 2011 date established in the ASAOC, Boeing plans to start the procurement process for ordering the major treatment system equipment in April 2011.

4.3 System Performance

LTST system performance can be evaluated through the quality of discharge water (i.e., are the Interim Goals for water met) and system efficiency (i.e., how often are these goals met).

4.3.1 Discharge Water Quality

As discussed in the LTST RAWP Addendum, the 1,500 gpm LTST system is predicted to achieve a total load reduction of approximately 73% annually (or 96% in dry weather [reduced from 6.7 to 0.24 g/yr] and 68% in wet weather [reduced from 32 to 3.4 g/yr]). It is also anticipated that the LTST system will comply with the freshwater and marine Interim Goals for water approximately 96% of the time during a "typical" year (or 100% of dry days and 90% of wet days per year) based on rough estimates using limited available water and filtered solids dry wet weather monitoring data.

As described in the AKART Analysis (Geosyntec, 2011a), the LTST is not expected to meet the PCB Interim Goal for solids (0.1 ppm) because any (very fine) solids that bypass or break through the filter would be expected to have roughly the same PCB solids concentration (or perhaps higher if the PCB solids concentrations are higher on smaller particles) as the influent. Recent STST system effluent filtered solids PCB results support this finding. However, there is uncertainty in the representativeness of the collected solids data. The mass of filtered solids may be underestimated due to a loss of filter bag material, which would result in solids PCB concentrations that are biased high (Landau, 2011b)[8]. It is anticipated that the current solids Interim Goal will be modified by USEPA pending analysis and review of additional solids data collected at the STST system effluent and at the lift station.

4.3.2 System Efficiency

As discussed in the LTST RAWP Addendum, a 1,500 gpm CESF system is anticipated to achieve a long-term average volume capture at LS431 of 81% of runoff from on-site drainage only, and 59% of runoff from combined on and off-site drainage areas. This system would also achieve a long-term average volume capture at MH130A of roughly 91% of storm runoff from on-site North lateral drainage into that structure (as described in the LTST RAWP and Addendum [Geosyntec, 2011b and 2011c].

4.4 System Reliability

As has been the case for the STST CESF system operation, the LTST CESF system is expected to be very reliable and to have minimal downtime. With automated remote notification of alarm conditions it is expected that any problems can be quickly addressed. It is also expected that during the first number of months of the LTST CESF system operation that there will be some minor startup and operational issues to be worked out as has been the case with the STST system (e.g., debris entanglement in the inlet flow meter, pH range operational control adjustment, draining and manual operation during freezing conditions). However, some of the lessons learned during STST start-up can be utilized to minimize start-up issues.

Out of 21 weekly STST CESF system effluent grab samples, none of the samples have exceeded a TSS concentration of 1.5 mg/L (typically non-detect at less than 1 mg/L) and none of the discharge samples have had a concentration of total PCBs that has

[8] Filtered solids PCB concentrations may be biased high as a result of possible filter bag mass loss (which would result in an underestimate of filtered solids mass, and therefore an overestimate of PCB solids concentrations). However, even if filter bag mass loss is as much as 10% (a likely high value), the overestimate of solids PCB concentrations would be only 5-31%. This is relatively small in comparison to the difference between the STST effluent filtered solids PCB concentrations (typically 1-2 ppm) and the solids Interim Goal (0.1 ppm), or 90-95%.

exceeded the 0.014 µg/L freshwater criterion. The intent is to design the LTST CESF system to achieve a similar level of performance reliability for all treated effluent.

4.5 Design Steps

Design milestones for LTST system include:

- The Pre-Final (60%) Design Document including a Sampling and Analysis Plan (due the week of May 2, 2011 per the LTST RAWP Addendum). Design work will include the selection and placement of specific treatment system equipment, conveyance infrastructure design, transfer system design (e.g., pumps), electrical and control system design, procedures and plans for the decontamination of equipment and disposal of contaminated materials, technical specifications, monitoring and sampling access and equipment, a data analysis to verify the design will meet performance requirements, description of the connection to the CESF system effluent to the storm drain upstream of the point of compliance, and a determination of a preliminary construction schedule and activities.

- 90% Design Document including draft O&M manual (due the week of May 23, 2011). In addition to refining the LTST system design, a preliminary cost estimate will be developed.

- Draft Monitoring Plan (to be completed June 1, 2011). Methods and procedures for sampling and analysis will be selected, to ensure that appropriate data will be collected and appropriate analysis will be conducted to accurately measure the efficacy of the LTST system in treating stormwater to required performance standards.

- 100% Design Document including final O&M Manual (due the week of June 20, 2011). Final design will be completed, including a final cost estimate and a final construction schedule.

Three CESF system suppliers/contractors have been identified that can potentially provide systems of the type and size specified in the design within the timeframe necessary: Clear Water Compliance Services (who have provided the rented equipment and operate the STST system), Clear Creek Systems, and OSW Equipment & Repair. Boeing may request competitive bids from these contractors. Alternatively, given the limited time in which to design and procure the equipment, Boeing may (after initial design planning) choose to work directly with a preferred CESF system supplier/contractor.

5 OPERATIONS AND MAINTENANCE

The operation and maintenance (O&M) of the LTST CESF system will be similar to that of the current STST system. Appendix A of the STST Removal Action Work Plan (Landau, 2011a) includes a detailed description of operation, maintenance, and monitoring of the STST system, and this manual is anticipated to be applicable to the LTST system. An O&M Manual will be prepared for the LTST and a draft of that manual is scheduled to be submitted to USEPA with the 90% design submittal. A summary of the prominent O&M tasks and description of LTST specific tasks is given below.

5.1 System Management and Maintenance

CESF systems are most frequently operated at construction sites where very turbid water (on the order of 1000s of NTUs) is being treated, are operated intermittently, and are actively operated by trained personnel. Operation at NBF will differ in that treatment will take place 24 hours a day to treat base flow (although this may only use one third of the sand filters allowing the others to rest or be maintained), treating water with turbidity typically less than 25 NTU. Therefore, similar to the STST system, once the system is determined to be operating properly, operation and monitoring will be automated, leaving only weekly calibration and a routine inspection to be conducted by trained CESF operators. A remote messaging alarm system will alert personnel if additional unscheduled/immediate maintenance is needed.

Operation of the CESF system will be automated by float switches in MH130A, the OWS421 Lift Station inlet vault, and in the weir and storage tanks, and will be placed to pump and treat stormwater preferentially according to the facility design, up to the design flow rate. Alarms will notify CESF system personnel of any conditions of concern, as discussed above.

Monitoring of the CESF system will include residual chitosan testing, routine inspections, and sensor and chitosan metering pump calibrations. Once the CESF system is optimized and operating smoothly, the chitosan dosing rate is anticipated to be constant, and a weekly residual chitosan testing frequency is anticipated to be adequate to verify that no chitosan is being discharged to Slip 4, as discussed in the STST RAWP O&M Manual (Landau 2011).

5.2 Annual Maintenance Costs

As listed in the LTST RAWP Addendum, annual costs for operation and maintenance of a 1,500 gpm system are projected to be roughly $170,000. This estimate includes CESF contractor labor, chitosan and other materials costs, power, and removal/disposal of filtered solids. It is estimated that there could be an additional $50,000 in system O&M costs in the first year of system operation for system startup and shakeout activities, control system adjustments, and troubleshooting/repairs, for a total year one estimated annual O&M cost of $220,000. This estimated annual O&M cost does not include costs for Boeing or consultant oversight, stormwater sampling/monitoring, USEPA reporting, or extra contingency costs.

6 MONITORING AND CONTINGENCY PLANNING

The following outlines how the LTST system will be monitored, how the data will be reported to USEPA, and what steps have been taken for contingency planning.

6.1 Monitoring

The LTST system is designed to meet the Interim Goal for water at the point of compliance, defined as LS431 in the LTST RAWP. Compliance with the Interim Goal and verification of adequate CESF system performance will be evaluated through the collection of water and solids samples downstream of the LTST confluence. The performance and effectiveness of the LTST system will be evaluated through the collection and analysis of influent and effluent samples. Performance data will be used for system optimization (i.e., modifications to backflushing frequency, recirculation criteria, etc.) when necessary. Background data will also continue to be collected to build upon existing datasets and to provide information critical to any potential rerouting of other off-site laterals.

6.1.1 Compliance with Interim Goals

Consistent with ASAOC, whole water and filtered solids samples will be collected at LS431 to demonstrate compliance with the interim goals. Flow-weighted auto-composite water samples will be analyzed for PCBs and TSS (for use in the LTST performance assessment) and solids samples collected via in-line filtration will be analyzed for PCBs.

6.1.2 Background Data

Continued storm drain monitoring will likely be necessary not only to fill data gaps to support LTST system planning and design, but also to characterize runoff in areas not proposed for water treatment (such as off-site storm flows from other than the North lateral). Previous monitoring by SAIC and Landau Associates has focused on sampling at locations MH108 (North lateral) and LS431. Monitoring will continue at LS431 to allow for compliance assessment at the lift station, however monitoring at MH108 may be reduced or discontinued depending on the need for additional monitoring downstream of MH130A. Additionally, sampling near the point at which offsite stormwater from King County enters the NBF North lateral storm drain (immediately upstream of MH178), has recently been conducted for PCBs in both whole water and filtered solids. Preliminary results indicate that stormwater entering into NBF at this location contains PCBs at concentrations greater than the current EPA interim goals for whole water. Additional testing is being conducted at MH178 to further characterize water quality at this location. The sediment trap monitoring program, begun in 2005, will be continued with samples collected on a semi-annual basis.

6.1.3 LTST Performance

Upon LTST system start-up, whole water and filtered solids influent and effluent grab samples will be analyzed for PCBs and TSS. Whole water samples will be collected weekly and filtered solids influent and effluent samples will be collected twice monthly or as possible, based on an accumulation of sufficient solids mass on a 1µm filter bag.

Additional detail related to monitoring will be provided in future documents to be developed specific to the LTST System. A Draft Sampling and Analysis Plan (SAP) meeting the requirements of the ASAOC SOW Section III will be developed and submitted to USEPA as part of 60% Design Documents in the week of May 2, 2011. The SAP will also include a Field Sampling Plan (FSP) and Quality Assurance Project Plan (QAPP). A Draft Monitoring Plan will also be prepared, consistent with the SAP, FSP, and QAPP, and Attachment C-1 of the ASAOC SOW, and submitted to USEPA on June 1, 2011.

6.2 Reporting

Until such time that USEPA approves of alternate reporting requirements, Boeing will continue to prepare monthly progress reports and submit those reports to USEPA by the fifth day of the following month (or the first subsequent work day if the fifth day of the month falls on a weekend or holiday). Monthly progress reports will continue to include information related to stormwater treatment system operation (e.g., total gallons of stormwater treated, rainfall data, any significant operational problems, any system shutdowns) and will contain summary data tables of all validated stormwater analytical testing results that were received from the laboratory by the 24th of the month.

6.3 Contingency Planning

As is the case with the STST O&M Manual, the LTST O&M Manual will contain the procedures for monitoring the performance of the CESF system including sampling locations, sampling frequency, laboratory analytical procedures, procedures and criteria for evaluating adequate system performance for removal of both TSS and PCBs, and contingency measures to be taken if inadequate performance is demonstrated.

If despite full and proper operation of the 1,500 gpm CESF system at the lift station the applicable PCB water criteria are still not met at an acceptable frequency at the compliance point, then potential contingency actions include proceeding with design and installation of an additional media filtration system to treat storm flows separately at the North Lateral in order to increase the percentage of site stormwater treated from the other laterals or rerouting and bypassing King County storm drain lines (i.e., North, North Central, Central, and/or South laterals) around the Lift Station, or to install additional or larger storage tanks at the lift station to increase the percentage of site stormwater runoff able to be treated by the 1,500 gpm CESF system. An evaluation of stormwater retention options may also be considered.

7 CONCLUSIONS

In compliance with USEPA's 2010 ASAOC, Boeing is moving ahead on the design of the LTST system to reduce PCB loading to Slip 4 of the Lower Duwamish Waterway and to meet the Interim Goals for water at the point of compliance. The Addendum to the LTST RAWP evaluated the benefits of various pumping rates from the lift station vault to a CESF treatment system located adjacent to the lift station. A 750-1,500 gpm flow range was identified as the "knee of the curve" (or the point of diminishing returns) for both the PCB load removal and average annual runoff volume capture. Boeing has conservatively selected 1,500 gpm as the recommended LTST design flow rate. A 1500 gpm system is predicted to achieve compliance with the freshwater and marine Interim Goals for water approximately 96% of the time during a "typical" year (or 100% of dry days and 90% of wet days per year). The total PCB load reduction is predicted to be approximately 73% annually (or 96% in dry weather [reduced from 6.7 to 0.24 g/yr] and 68% in wet weather [reduced from 32 to 3.4 g/yr]). A 1,500 gpm CESF system is also anticipated to achieve a long-term average volume capture at LS431 of 81% of runoff from on-site drainage only, and 59% of runoff from combined on and off-site drainage areas.

The LTST CESF system will designed to achieve, at minimum, 91% capture and treatment of *onsite* storm flows from North lateral MH130A, a drainage area that has been shown to contribute the greatest PCB concentrations and loads to the lift station. To achieve preferential treatment of the on-site flows, it will be necessary to 1) reroute the off-site North lateral from upstream of MH178 to the lift station and 2) direct runoff pumped from MH130A directly to the CESF system (preferentially treating runoff from the North lateral). Furthermore, the proposed flow routing scheme will maximize treatment capacity utilization by pumping additional base and storm flows from the lift station to the LTST system for treatment as capacity is available. This routing configuration and system size will also achieve 100% treatment of dry weather base flows at the lift station.

The LTST will require one inlet weir/settling tank (approximately 18,000 gallons), three storage tanks (each approximately 20,000 gallons), three sand filter systems each consisting of four individual 54-inch diameter sand filter pods, and a control system. Three independent sand filter systems sized to each treat a 500 gpm flow rate will allow the treatment system to operate more continuously during low-flow conditions (e.g., base flows would only require up to one third of this capacity), to keep the size of the system components to within a range that avoids larger special-order equipment, and to allow for potential down-sizing of the system in the future (in the case that the implementation of source controls reduces the PCB loading). Each of the three sand filter systems is anticipated to be equivalent to the 4-pod unit that is currently used for the STST. The CESF system is anticipated to fit within a 5,100 sq-ft area west of the lift station.

The submersible pumps to be installed in the oil water separator vault (OWS421) of the lift station to pump water to the CESF system will be sized such that the total flow being pumped to the LTST CESF treatment system is 1,500 gpm (i.e., this will take into account the 500 gpm pump rate from the North lateral MH130A directly to the LTST CESF). The lift station pump design capacity is anticipated to be between 1000 and 1400 gpm, pending further refinement. Final pump sizing will be included in the 60 percent design documents. The lift station pumps will be set to activate (using either float switches or by programmable logic controllers (PLC) based on pressure transducer level reading) at a level below that which any of the four 50-hp King County pumps activate.

O&M activities for the LTST CESF system are expected to be similar to those of the current STST system. Annual O&M costs for the LTST CESF are projected to be roughly $170,000. This estimate includes CESF contractor labor, chitosan and other materials costs, power, and removal/disposal of filtered solids. It is estimated that there could also be an additional $50,000 in system O&M costs in the first year of operation for system startup and shakeout activities, control system adjustments, and troubleshooting/repairs, for a total year one estimated annual O&M cost of $220,000. This estimated annual O&M cost excludes costs for Boeing or consultant oversight, stormwater sampling/monitoring, USEPA reporting, or extra contingency costs.

Three CESF system suppliers/contractors have been identified that can potentially provide systems of the type and size specified in the design within the timeframe necessary: Clear Water Compliance Services (who have provided the rented equipment and operate the STST system), Clear Creek Systems, and OSW Equipment & Repair. Boeing may request competitive bids from these contractors. Alternatively, given the limited time in which to design and procure the equipment, Boeing may (after initial design planning) choose to work directly with the preferred CESF system supplier/contractor.

Boeing plans to start the procurement process for ordering the major treatment system equipment in April 2011.

The Pre-Final (60%) Design Document, due the week of May 2, 2011 (as proposed in the LTST RAWP Addendum) will include the selection and placement of specific treatment system equipment, a data analysis to verify the design will meet performance requirements, identification of a specific point of compliance, and a determination of a preliminary construction schedule. Boeing and the design team will also evaluate options to reduce the overall environmental footprint of the selected treatment system by investigating methods to conserve energy, reduce residual waste production, and incorporate the use of renewable energy sources while maintaining the desired system performance.

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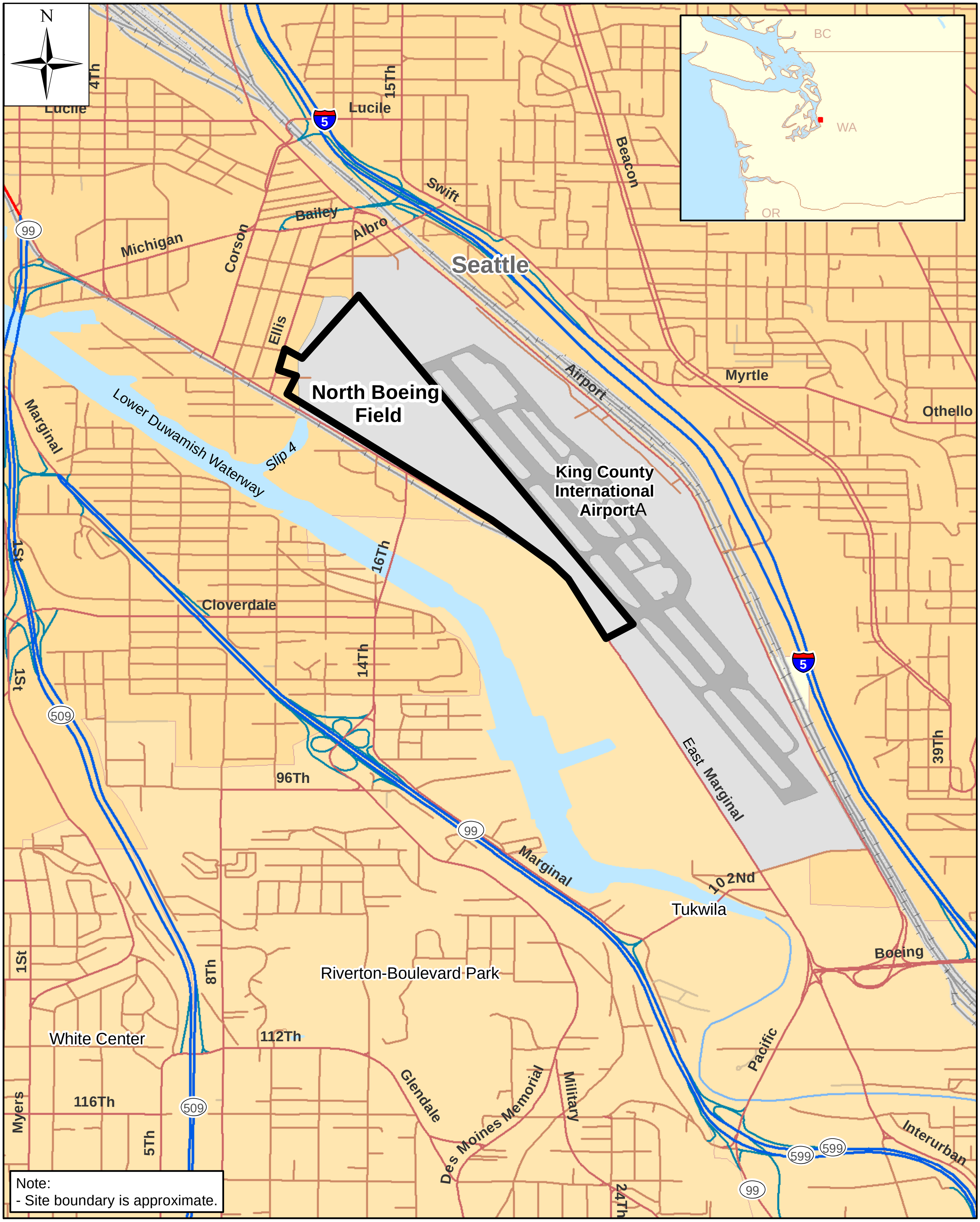
FIGURES



0 0.25 0.5 1 Miles

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PW0250

Figure 1
Vicinity Map
North Boeing Field
Seattle, Washington

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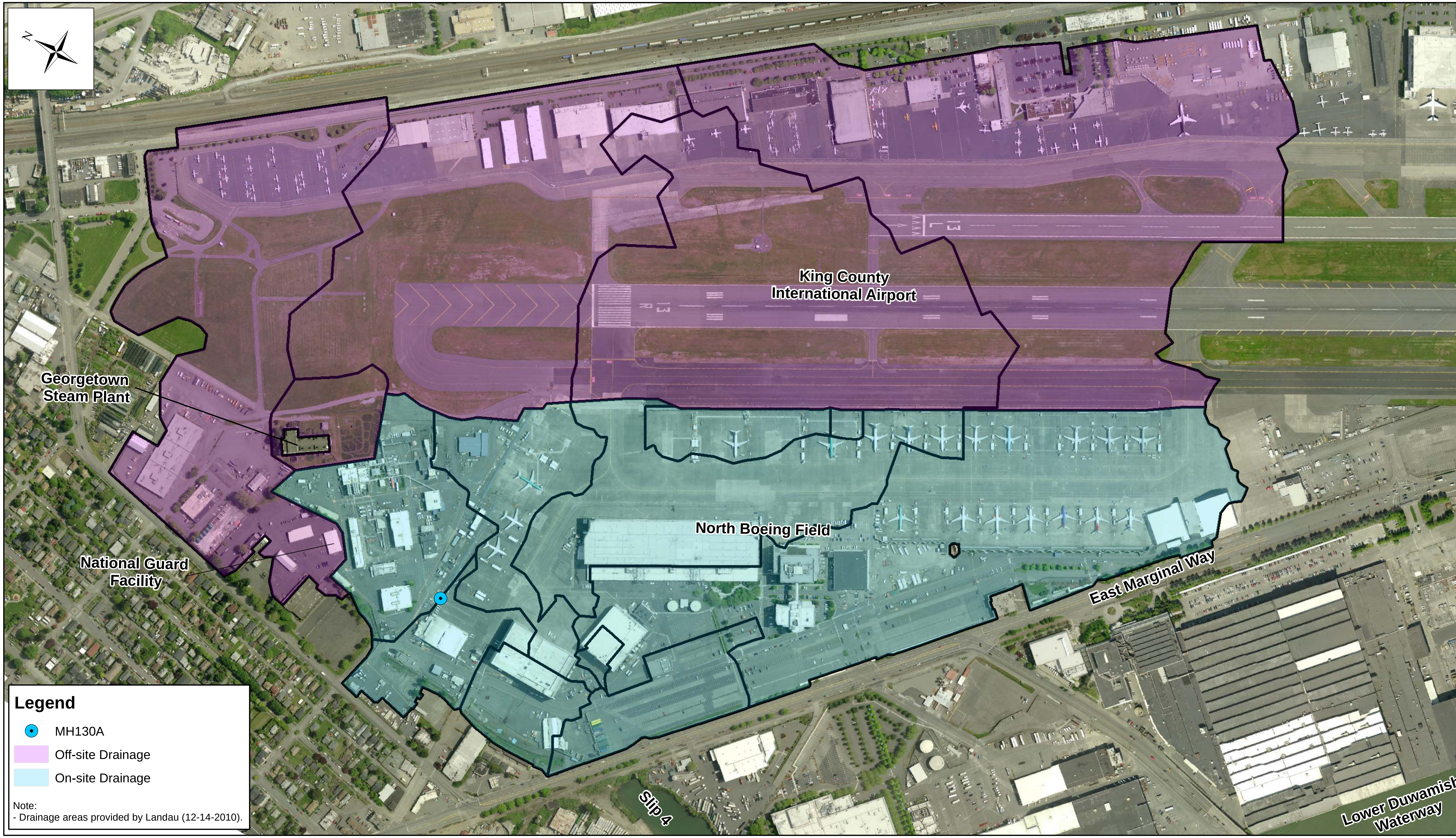

0 500 1,000 2,000 Feet

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Figure 2

On-Site and Off-Site Drainage Areas

North Boeing Field
Seattle, Washington

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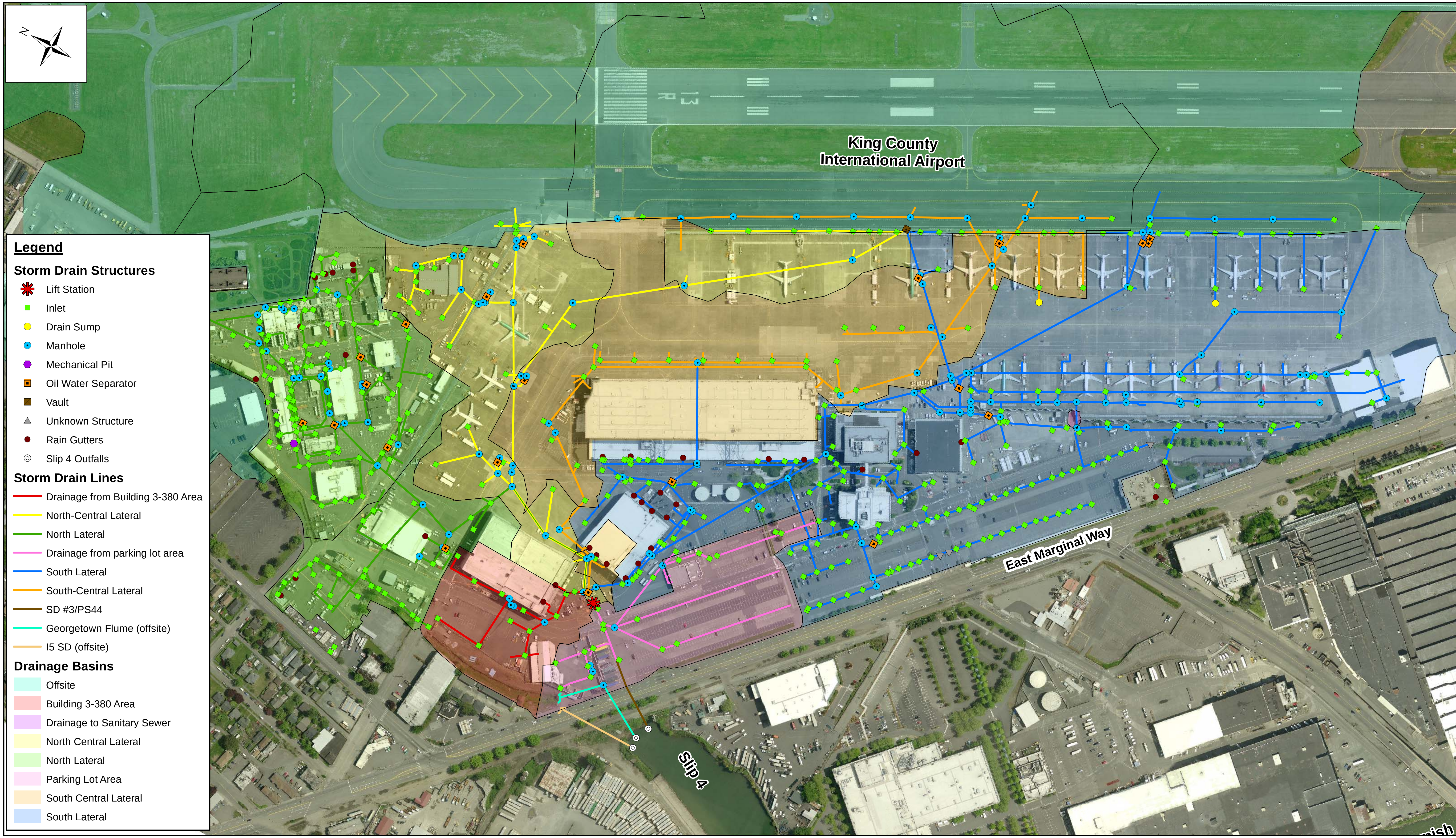

Notes:
- Storm drain infrastructure and aerial imagery provided by SAIC (2010)

0 375 750 1,500 Feet

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Figure 3
Storm Drain Structures and Drainage Basins
North Boeing Field
Seattle, Washington

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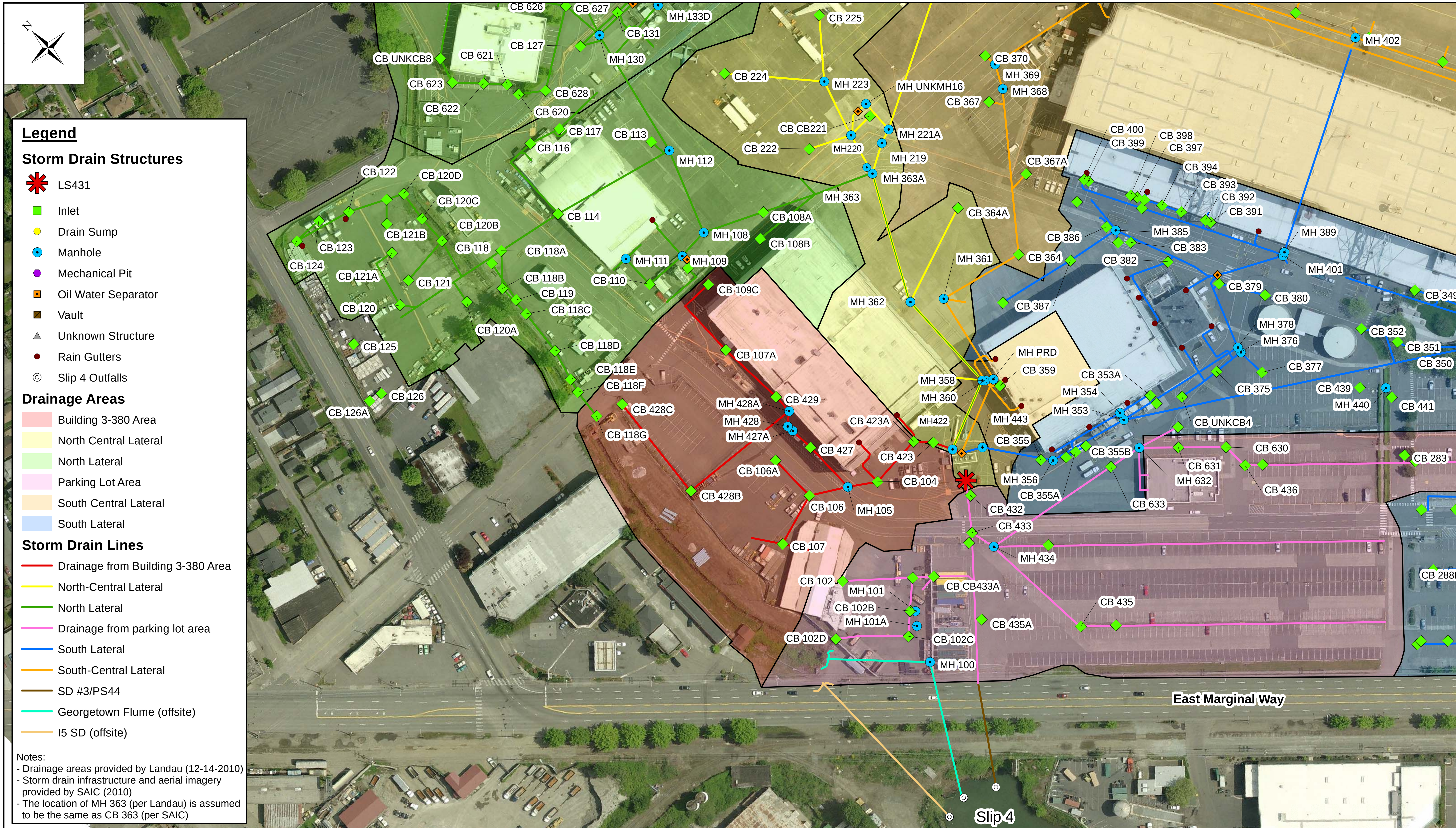

0 150 300 600 Feet

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Figure 4
Storm Drain Structures Near LS431 and Slip 4
North Boeing Field
Seattle, Washington

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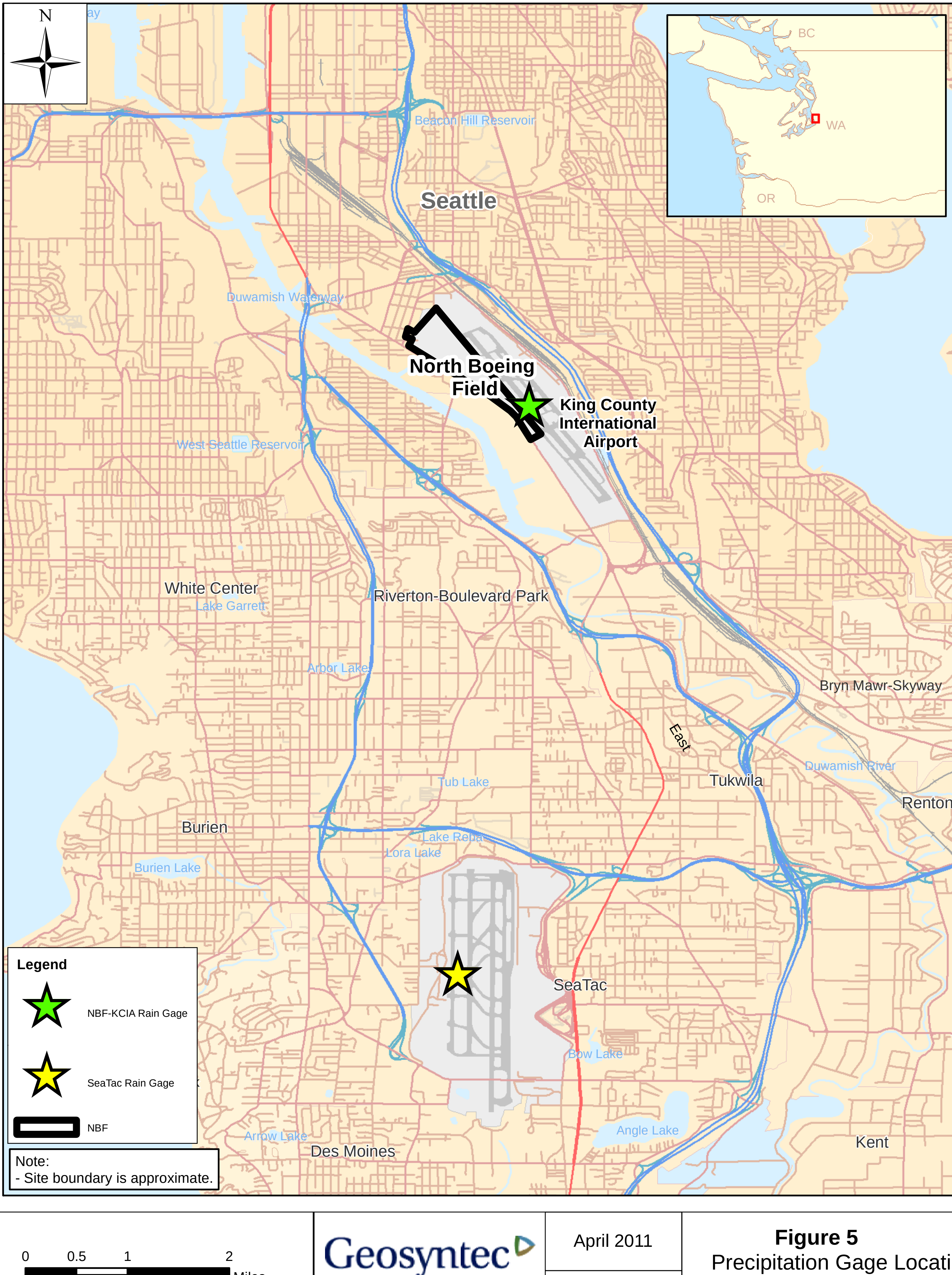

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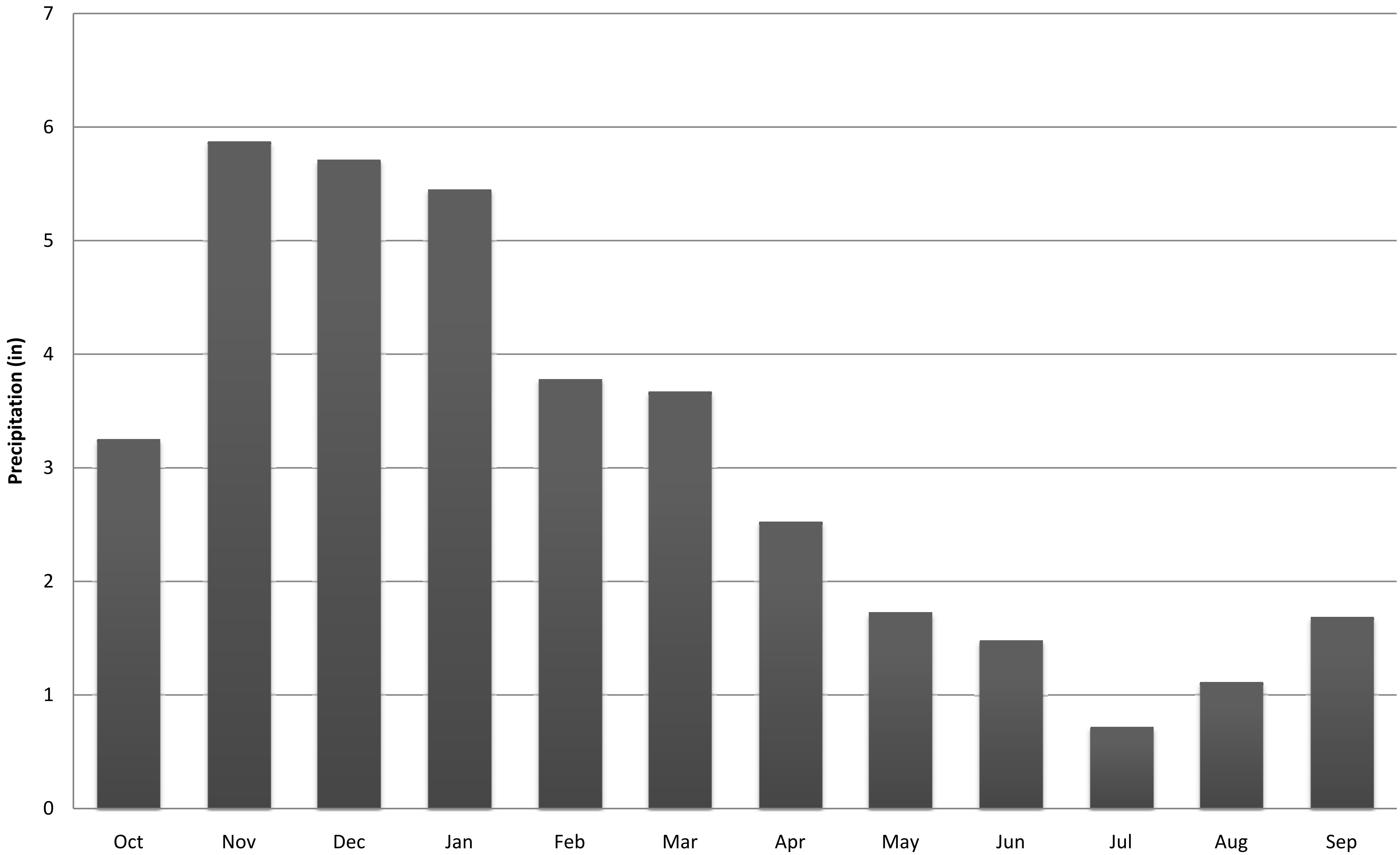
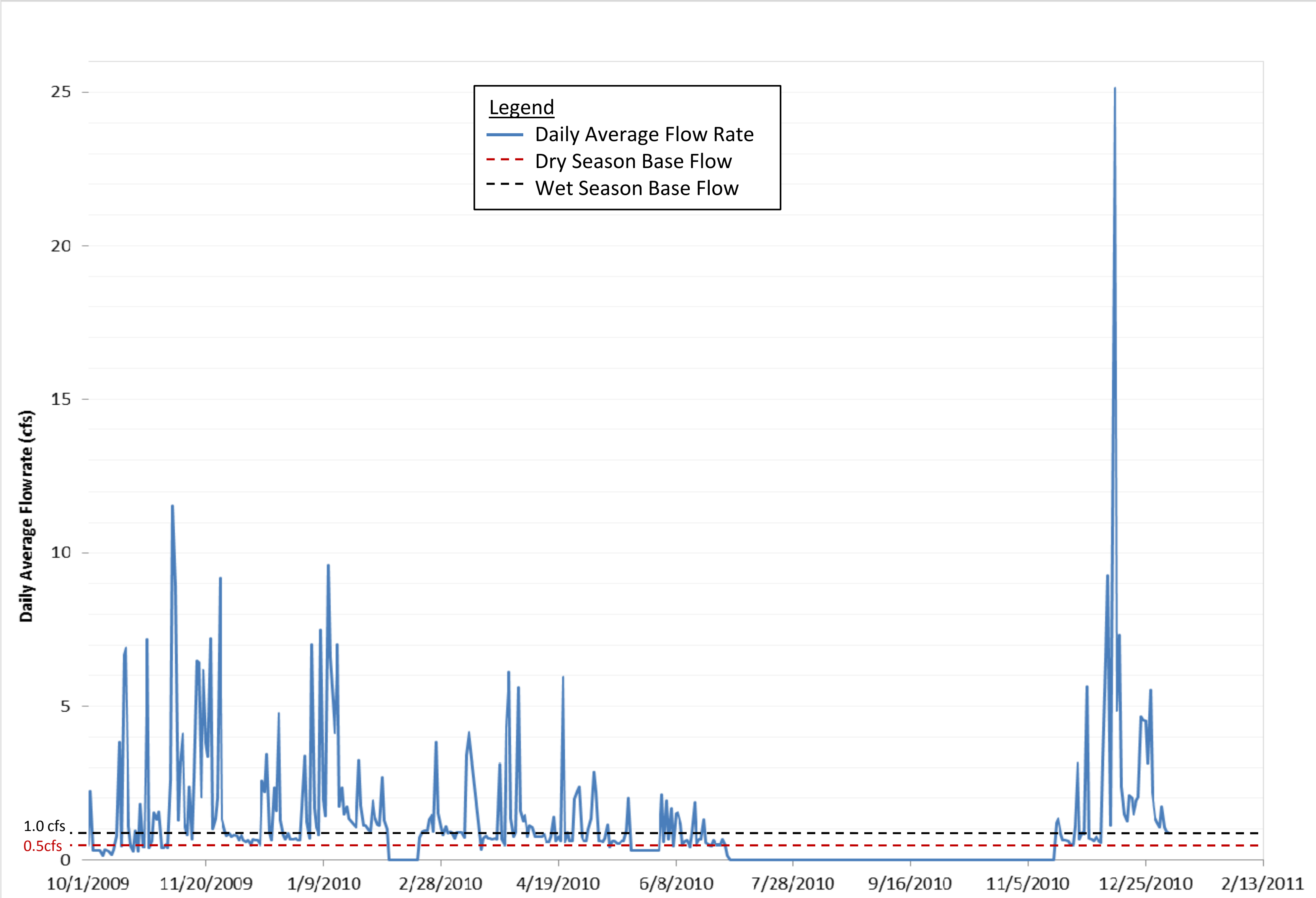
Figure 5
Precipitation Gage Location
North Boeing Field
Seattle, Washington

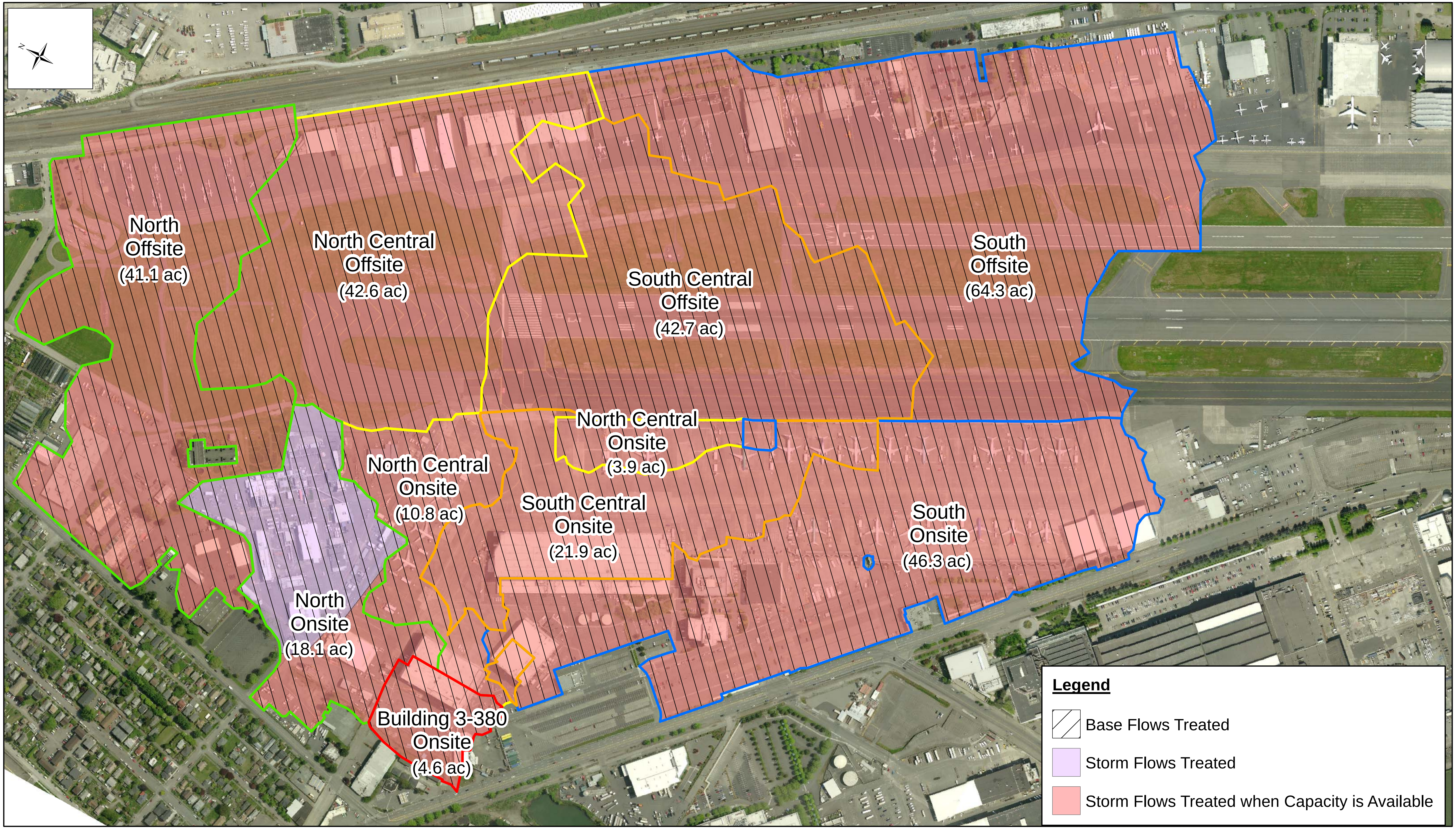


1 – Precipitation at SEATAC, Seattle-Tacoma International Airport
2 – Period of record 10/01/1968 to 10/01/2008
3 – NCDC Hourly Precipitation data from Hydrosphere Data Products, Boulder, CO. 1999

Geosyntec consultants	April 2011	**Figure 6** SeaTac :Avg. Monthly Precipitation North Boeing Field Seattle, WA
	PW0250	



Geosyntec consultants	April 2011	**Figure 7** Average Daily Flow Rate at LS431 North Boeing Field Seattle, WA
	PW0250	



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Note: Drainage areas provided by Landau (12-14-2010)

0 500 1,000 2,000 Feet

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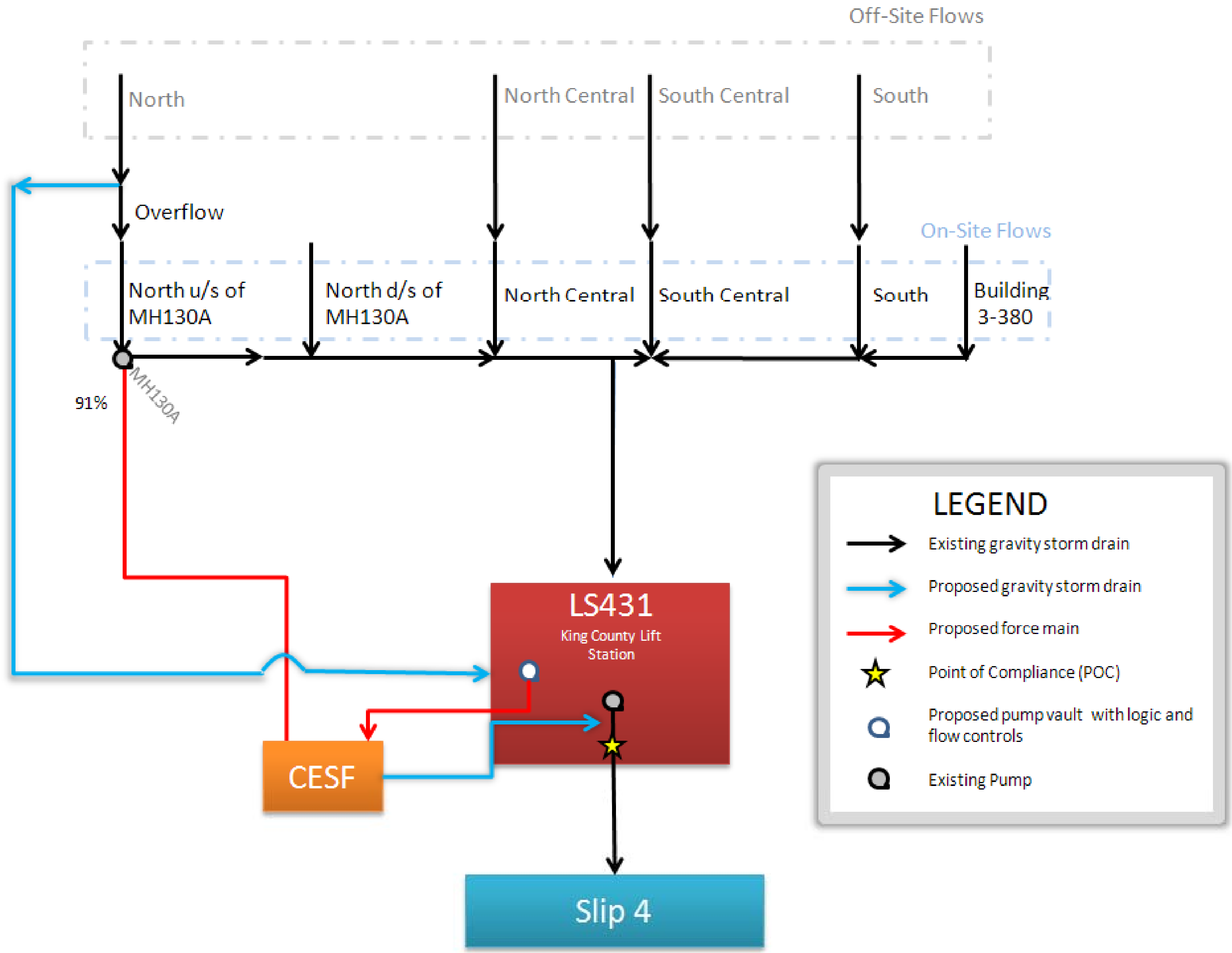
Figure 8

Areas Treated

North Boeing Field
Seattle, Washington

	Geosyntec consultants	April 2011	**Figure 9** Proposed LTST System Plan View North Boeing Field Seattle, WA
		PW0250	



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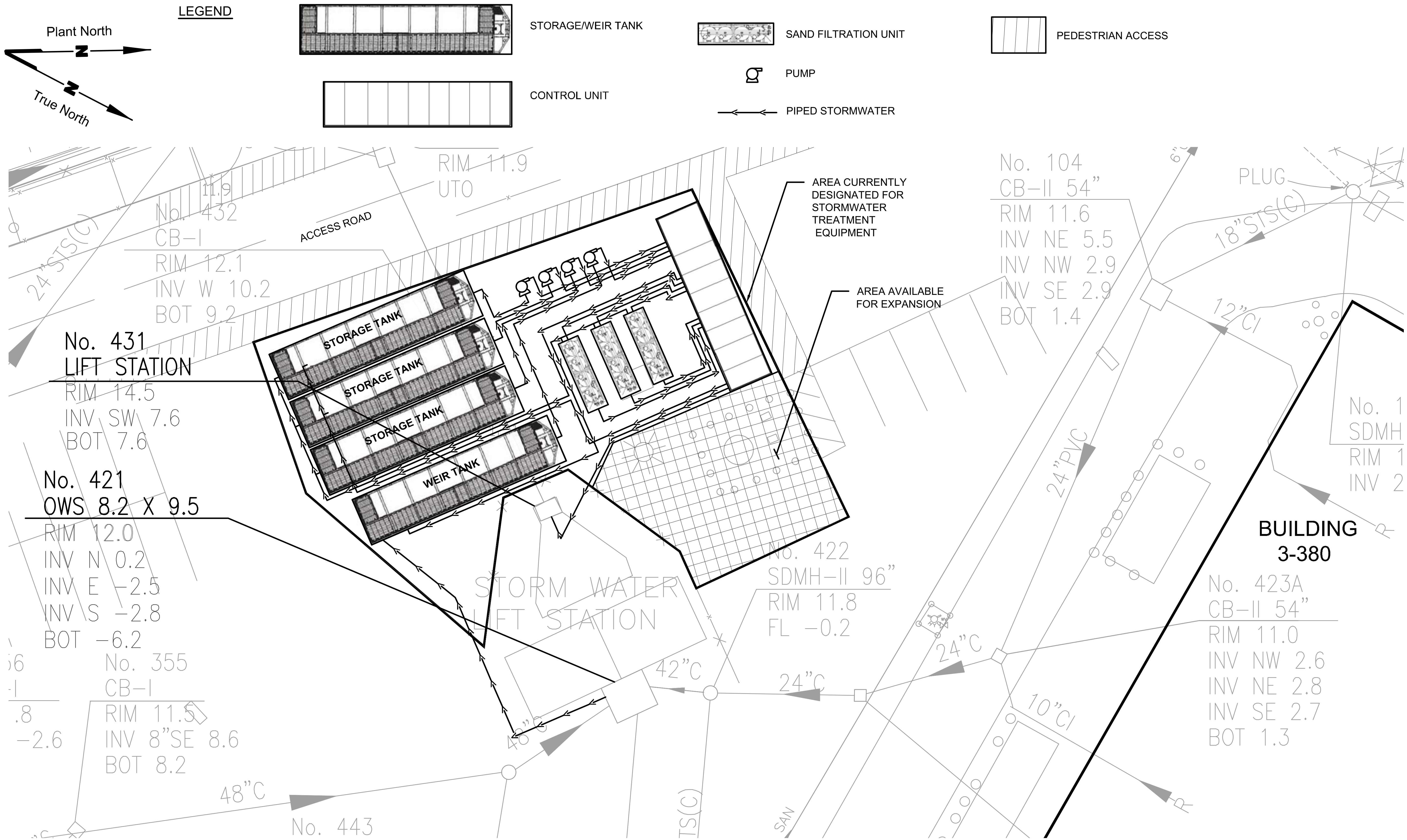
April 2011	**Figure 10** LTST Conceptual Design Approach North Boeing Field Seattle, WA
PW0250	



BASE MAP SOURCE: THE BOEING COMPANY 2009

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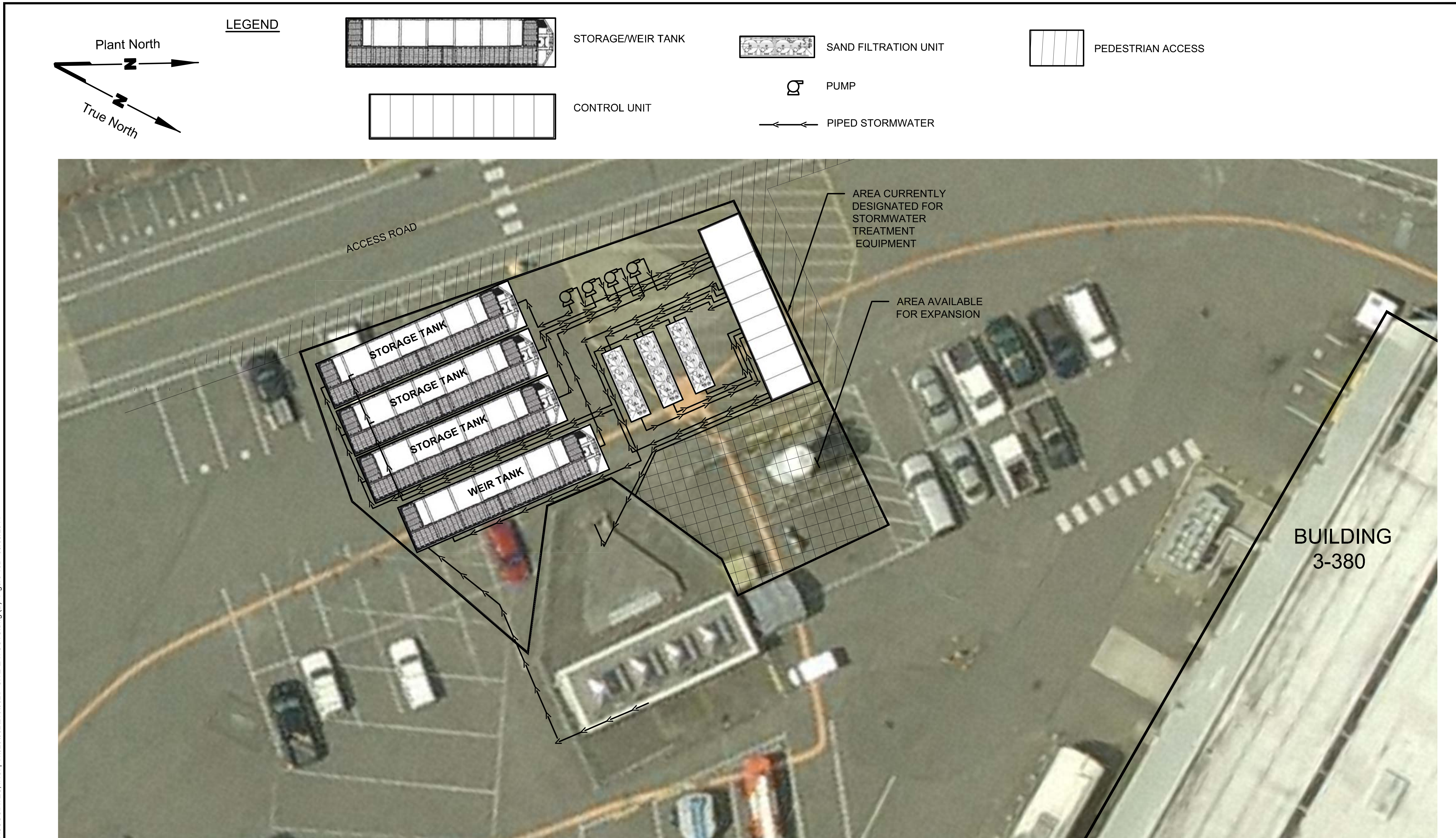
0 20 40
SCALE IN FEET

NORTH BOEING FIELD SEATTLE, WASHINGTON	LTST SYSTEM PRELIMINARY LAYOUT, PLAN VIEW	FIGURE 11A



BASE MAP SOURCE: THE BOEING COMPANY 2009; AERIAL PHOTO: SAIC 2009

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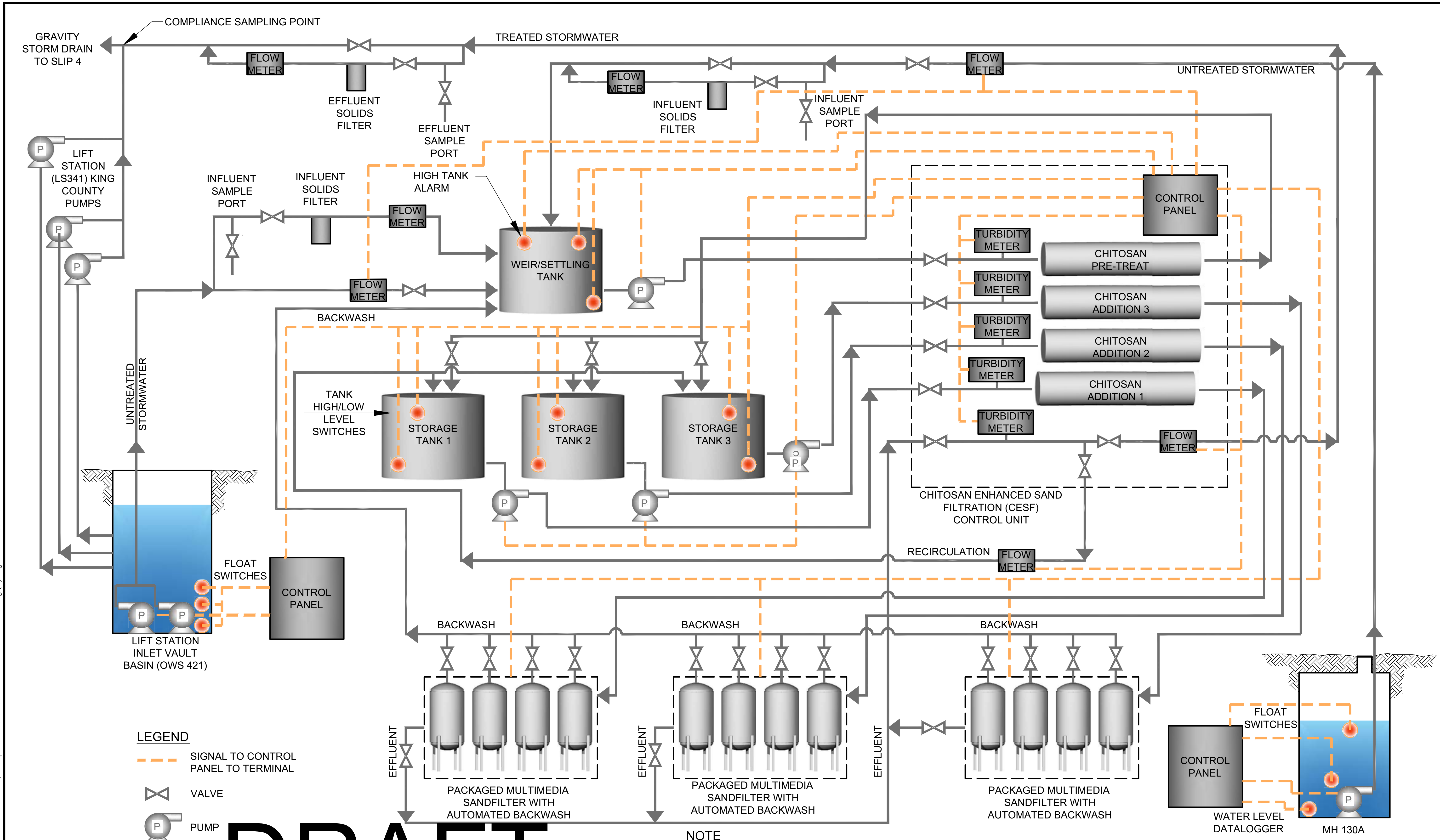
NORTH BOEING FIELD
SEATTLE, WASHINGTON

LTST SYSTEM PRELIMINARY LAYOUT, AERIAL VIEW

FIGURE 11B



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NOTE

1. BLACK AND WHITE REPRODUCTIONS OF THIS ORIGINAL MAY REDUCE ITS EFFECTIVES AND LEAD TO INCORRECT INTERPRETATION.

LANDAU ASSOCIATES

NORTH BOEING FIELD
SEATTLE, WASHINGTON

LTST SYSTEM PRELIMINARY PROCESS SCHEMATIC

FIGURE
12