Removal Action Work Plan
Short-Term Stormwater Treatment
North Boeing Field
Seattle, Washington

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Prepared for

The Boeing Company
Seattle, Washington

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LIST OF ABBREVIATIONS AND ACRONYMS

µg/L	Micrograms per Liter
µg/kg	Micrograms per kilogram
ASAOC	Administrative Settlement Agreement and Order on Consent
AST	Aboveground Storage Tank
BMPs	Best Management Practices
Boeing	The Boeing Company
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CESF	Chitosan-Enhanced Sand Filtration
cfs	Cubic Feet per Second
EAA	Early Action Area
Ecology	Washington State Department of Ecology
EOF	Emergency Overflow
EPA	U.S. Environmental Protection Agency
GAC	Granular Activated Carbon
gpm	Gallons per Minute
GTSP	Georgetown Steam Plant
HASP	Health and Safety Plan
HSPF	Hydrologic Simulation Program – Fortran
KC	King County
KCIA	King County International Airport
KCRTS	King County Runoff Time Series
LDW	Lower Duwamish Waterway
mg/kg	Milligrams per Kilogram
mg/L	Milligrams per Liter
MTCA	Model Toxics Control Act
NBF	North Boeing Field
NPL	National Priorities List
NTU	Nephelometric Turbidity Unit
O&M	Operation and Maintenance
PCBs	Polychlorinated Biphenyls
PEL	Propulsion Engineering Labs
ppb	Parts per Billion
ppm	Parts per Million
RI/FS	Remedial Investigation/Feasibility Study
SAP	Sampling and Analysis Plan
SQS	Sediment Quality Standard
STST	Short-Term Stormwater Treatment
TSS	Total Suspended Solids
WAC	Washington Administrative Code
WWHM	Western Washington Hydrograph Model

1.0 INTRODUCTION

This work plan presents the plans for installation, operation, and maintenance of a short-term stormwater treatment (STST) facility for removal of polychlorinated biphenyls (PCBs) from stormwater in the storm drain system at North Boeing Field (NBF). Based on discussions between The Boeing Company (Boeing) and the U.S. Environmental Protection Agency (EPA) since the preliminary stormwater treatment evaluation technical memorandum was submitted to EPA (Landau Associates 2010a) and the Administrative Settlement Agreement and Order on Consent (ASAOC) for Removal Action, North Boeing Field Stormwater Treatment (EPA/Boeing 2010) was signed, the objective of the short-term treatment is to design, install, and operate a system that can be implemented quickly and that will remove PCBs and other hazardous substances prior to the discharge of stormwater from NBF via the King County International Airport (KCIA) Storm Drain #3/PS44 Emergency Overflow (EOF) to the Slip 4 Early Action Area (EAA) of the Lower Duwamish Waterway (LDW) Superfund Site in Seattle, Washington. Work will be performed in accordance with the EPA Action Memorandum for a Time-Critical Removal Action (EPA 2010).

As defined in the ASAOC, "'Stormwater' shall mean all liquids, including any particles dissolved therein, in the form of base flow, stormwater runoff, snow melt runoff, and surface runoff and drainage, as well as all solids which enter the System" (EPA 2010). "'System' shall mean the combination of all manholes, catch basins, pipes, and other drainage devices and conveyances designed, constructed, and utilized for the purpose of carrying stormwater from NBF to the LDW, and the drainage basin associated with these devices and conveyances" (EPA 2010).

The ASAOC Statement of Work identifies the objective of having a STST system installed and operational by September 15, 2010. Boeing designed the initial STST system with EPA oversight during negotiations of the ASAOC, and the system began operating on September 15. The STST system will continue operation until a long-term stormwater treatment remedy is in place or until it is otherwise deemed unnecessary to continue operation. These actions are intended to minimize the potential for recontamination of sediment in Slip 4, which is currently scheduled for remediation starting in October 2011, pursuant to a separate EPA settlement agreement with the city of Seattle and King County, dated September 28, 2006.

1.1 SITE LOCATION

NBF is located east of East Marginal Way South, adjacent to the KCIA and the city of Seattle Georgetown Steam Plant (GTSP). The approximate street address is 7370 East Marginal Way South, Seattle, Washington. NBF occupies approximately 112 acres, primarily within the Seattle and Tukwila city limits. Approximately 98 percent of the NBF facility is impervious. The location of the facility is shown on Figure 1.

1.2 BACKGROUND AND SOURCE CONTROL ACTIVITIES

Storm drains at NBF discharge stormwater from a portion of NBF and upstream areas to Slip 4 of the LDW. The LDW was added to the EPA's National Priorities List (NPL) under the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA), also known as Superfund, on September 13, 2001. The LDW was added to the Washington State Department of Ecology (Ecology) Hazardous Sites List on February 26, 2002. The EPA is planning to remove contaminated sediments in Slip 4 beginning in the fall of 2011. However, prior to performing the cleanup, the EPA is requiring Boeing to provide source control measures to reduce the release of PCBs and prevent the recontamination of sediments in Slip 4. Therefore, the EPA has been working with Ecology and the upstream parties (Boeing, the city of Seattle, and King County) to eliminate the discharge of PCBs into the associated stormwater conveyance systems.

Over the past few years, Boeing has been working to eliminate sources of PCBs from the storm drain system. Numerous investigations and studies have been completed to identify PCB source locations. As sources have been identified, Boeing has implemented removal and cleanup activities to reduce or eliminate those sources. Source control activities already completed or in progress include concrete joint material removal; replacing or relining sections of storm drain piping; cleaning storm drain structures and piping; sealing storm drain structures with grout; placing filters in storm drain structures to collect PCB-contaminated solids that enter into the storm drain system from ground surfaces; and removing PCB-contaminated soil, asphalt, solids, and debris within the Building 3-322 area of NBF. Additional source control activities that are planned for this fall include excavation and offsite disposal of PCB-contaminated soil near the fence line area adjoining the GTSP property; replacement of a storm drain line near the 3-302 building; abatement of materials (e.g., paint, caulk) identified as PCB-containing during the Propulsion Engineering Labs (PEL) area source evaluation investigation; and evaluation of additional potential sources in other parts of the NBF property.

Actions that Boeing has completed, that are in progress, or are planned, are presented in the following documents:

Landau Associates. 2010. *Revised Work Plan, Storm Drain System Catch Basin, Manhole, and Oil/Water Separator Sampling and Storm Drain System Cleaning, North Boeing Field, Seattle, Washington.* Prepared for The Boeing Company. March 26.

Landau Associates. 2010. *Work Plan, Concrete Joint Removal, North Boeing Field, Seattle, Washington.* Prepared for The Boeing Company. June 29

Landau Associates. 2007. Technical Memorandum re: *2006 Removal of Concrete Joint Material, North Boeing Field, Seattle, Washington.* January 22.

Landau Associates. 2010. *Work Plan, North Lateral Storm Drain System Evaluation of Potential Sources, North Boeing Field, Seattle, Washington.* Prepared for The Boeing Company. July 2.

Landau Associates. 2010. *Work Plan, Interim Action, 2010 Focused Soil Excavation, North Boeing Field, Seattle, Washington.* Prepared for The Boeing Company. August 20.

Landau Associates. 2010. *Work Plan, Focused Soil Investigation 2010, North Boeing Field, Seattle, Washington*. Prepared for The Boeing Company. June 25.

Landau Associates. 2010. *Work Plan Addendum No. 1, Focused Soil Investigation 2010, North Boeing Field, Seattle, Washington*. Prepared for The Boeing Company. July 9.

Landau Associates. 2010. *Work Plan, Human Health Risk Assessment and Transport Evaluation of Polychlorinated Biphenyls in Concrete Joint Material, North Boeing Field, Seattle, Washington*. Prepared for The Boeing Company. August 12.

Landau Associates. 2010. *Report, Storm Drain Structure and Surface Cleanup, North Boeing Field, Seattle, Washington.* Prepared for The Boeing Company. June 18.

Landau Associates. 2010. *Work Plan, Soil and Groundwater Investigation, North Boeing Field, Seattle, Washington*. Prepared for The Boeing Company. August 17.

Landau Associates. 2010. Technical Memorandum to Carl Bach, The Boeing Company, re: *Addendum No. 1, North Boeing Field Soil and Groundwater Work Plan, Groundwater Monitoring Well Installation and Sampling, North Boeing Field, Seattle.* Kris Hendrickson, Chip Halbert, and Chris Burke, Landau Associates. August 18.

Landau Associates. 2007. Technical Memorandum to Carl Bach, The Boeing Company, re: *Stormwater System Line Replacement, North Boeing Field, June to September 2007.* Kris Hendrickson and Mario Lopez, Landau Associates. November 14.

Landau Associates. 2009. *Report: Storm Drain System Source Investigation, North Boeing Field, Seattle, WA.* Prepared for The Boeing Company. September 8.

SAIC. 2010. *North Boeing Field/Georgetown Steam Plant Site Remedial Investigation/Feasibility Study: Assessment of Infiltration and Inflow to North Boeing Field Storm Drain System, DRAFT.* Prepared for Ecology by Science Applications International Corporation. July 14.

SAIC. 2010. *NBF-GTSP RI/FS Stormwater Contaminant Loadings to Slip 4 Draft Technical Memorandum.* Prepared for the Washington State Department of Ecology by Science Applications International Corporation. September 15.

More recent source control status updates have also been provided to EPA by Boeing (Landau Associates 2010b,c). Additional actions to prevent PCB-containing material from entering the storm drain system may be implemented based on the results from investigations currently in progress or planned for later this year. NBF, together with the GTSP, is subject to an Ecology Model Toxics Control Act (MTCA) agreed order for a Remedial Investigation/Feasibility Study (RI/FS).

Best management practices (BMPs) employed by Boeing to reduce the amount of solids that enter the storm drain system include sweeping of paved areas; the frequency of sweeping varies depending on need and accessibility.

1.3 NBF STORM DRAIN SYSTEM

As reported by SAIC (2010a), most areas of NBF drain to one of four lateral storm drain lines (the north, north-central, south-central, and south lateral storm drain lines), which are directed to a trunk line that passes through a King County lift station, under East Marginal Way S, and to the 60-inch KCIA SD#3/PS44 EOF outfall at Slip 4. The lift station prevents tidal backwash from flowing into the storm drain system, according to KCIA maintenance engineers. Stormwater from a smaller area near Building 3-380 (which previously discharged to Slip 4 via a separate storm drain line) is also routed through the lift station. Also within NBF, an automobile parking lot area downstream of the lift station drains to Slip 4 via the same SD#3/PS44 EOF outfall. Previous observations during periods of dry weather and inflow and infiltration studies (discussed below in Section 2.7) have shown that groundwater infiltrates into the storm drain system piping and is discharged to Slip 4.

Storm drains from outside of the NBF property also connect into the NBF storm drain system. These drains are primarily from KCIA. A map showing both NBF and offsite drainage basins that contribute flow to the lift station (LS431) is provided on Figure 2.

Estimates of the NBF drainage basin areas vary slightly, depending on the maps and other information used for the estimate. SAIC has estimated drainage basin boundaries using different methods than Boeing. Boeing has estimated the drainage areas based on review of previous survey work conducted for Boeing and associated CAD files containing the storm drain system and drainage basin boundaries. The storm drain system structures on NBF property drain an area of approximately 112 acres. This estimate excludes the area of the GTSP property that (other than the roof drain) is not connected to a storm drain system and where stormwater either infiltrates into the ground or drains onto NBF property. This estimate also excludes a small area (less than 0.1 acre) within the South Lateral drainage basin where collected drainage is discharged to the sanitary sewer. The small differences in drainage basin boundaries between current Boeing and SAIC drainage maps are not expected to significantly affect STST system design evaluation. The current best estimate by Boeing of onsite drainage basin areas and percentages of flow from each lateral are shown below.

Storm Drain Line	Area (acres)	Percent of Total
North Lateral (Excluding GTSP Area)	18.1	16.1
North-Central Lateral	14.7	13.1
South-Central Lateral	21.9	19.5
South Lateral	46.3	41.2
Bldg 3-380 area	4.6	4.1
Parking lot area (downstream of King County lift station)	6.8	6.0
Total NBF stormwater drainage area	112.4	100

These NBF drainage basins are shown on Figure 2. The offsite drainage basins that connect into the NBF storm drain lines are also shown on Figure 2, along with an inset table that includes estimated areas of the offsite drainage basins.

1.4 PROJECT GOALS

The goal of the STST removal action is to implement treatment for stormwater in the North Lateral of the NBF storm drain system to remove PCBs and other hazardous substances from stormwater prior to discharge to Slip 4, as required by the ASAOC. The treatment facility will be operated during storm events and base flow conditions. The STST described in this work plan will be implemented only at the North Lateral. Concentrations of PCBs in storm drain solids and water samples are greatest in the North Lateral. PCBs were also present in base flow water and solids samples that were collected (SAIC 2010b). As described later in this section, treatment of stormwater from the North Lateral, together with the source control activities that are being implemented in other parts of the NBF stormwater system, are anticipated to be sufficient to protect Slip 4 sediments and meet the interim goals for PCBs in water and solids in stormwater.

As set forth in EPA's Action Memorandum (EPA 2010), 0.014 micrograms per liter (µg/L) is the appropriate interim goal for PCBs in whole water discharged to Slip 4. The basis for the interim goal for water is the Aquatic Life-Fresh/Chronic water quality standard for total PCBs. Also, for the STST system, in-line storm drain solids discharged to Slip 4 must be below 10 milligrams per liter (mg/L) total suspended solids (TSS) as a daily maximum concentration and 5 mg/L TSS as an average monthly concentration, and must be below 420 parts per billion (ppb) dry weight total PCBs. The compliance point for the interim goals is at Lift Station LS431. The basis for these interim goals is provided in the Action Memorandum (EPA 2010).

As set forth in the Action Memorandum (EPA 2010), the short-term stormwater treatment facility for the NBF storm drain system shall meet the following interim goals for PCBs in solids and water:

- Water discharged to Slip 4 must be below the Aquatic Life - Fresh/Chronic water quality standard of 0.014 µg/L total PCBs.
- In-line storm drain solids discharged to Slip 4 must be below 10 mg/L TSS as a daily maximum concentration and 5 mg/L TSS as an average monthly concentration, and must be below 420 ppb dry weight total PCBs.

The basis for EPA establishing a TSS interim goal is that suspended solids "are viewed as a surrogate for hydrophobic compounds, such as PCBs. Based on the relationship between PCBs and TSS, the concentration of 10 mg/L TSS would result in the water quality standard of 0.014 µg/L total PCBs being consistently met (as cited in Geosyntec, August 24, 2010)". Further, EPA notes that "the interim goals for the short-term treatment facility have been established in recognition of the need for additional analysis of whole water and filtered solid samples from the NBF storm drains system, as well as the need for consideration of performance data from the 2010/2011 operation of the short-term treatment system. These data collection efforts will include, at a minimum, PCB analyses of influent and effluent associated with the short-term treatment system; PCB fractionation studies; flow measurements; mass balance monitoring; and, evaluation of results from compliance assessment evaluations of the short-term treatment system, including demonstration of effectiveness of treatment under a variety of stormwater flows and characteristics, particularly as it relates to the removal of smaller particle sizes. In order to allow for the time that may be necessary to develop the most effective treatment facility(s), EPA has established the short-term interim goal of 420 ppb dry weight total PCBs in solids (as cited in Landau Associates 2010d), but fully expects the more stringent interim treatment goal of 100 ppb dry weight total PCBs in solids to be attained as soon as possible" (EPA 2010).

The Washington State Sediment Management Standards [Washington Administrative Code (WAC) 173-204] Sediment Quality Standard (SQS) for PCBs of 12 milligrams per kilogram (mg/kg) is normalized for organic carbon content. As described in a July 23, 2010 technical memorandum (Landau Associates 2010d), Boeing proposed using a PCB concentration of 0.42 mg/kg dry weight (or 420 µg/kg dry weight) as a remediation level for evaluation of storm drain solids to determine samples that would exceed the SQS. Figure 3 shows the locations where PCBs were previously detected in storm drain solids samples above a concentration of 0.42 mg/kg dry weight. As can be seen on Figure 3, the north portion of the North Lateral contains the highest concentration of locations exceeding 0.42 mg/kg PCBs in storm drain solids.

Recently, SAIC (2010c) estimated that PCB mass loading from the North Lateral storm drain line made up nearly 75 percent of total filtered suspended solids PCB loading at the lift station (LS431). At both LS431 and Manhole 180, there were significant PCB contributions from base flow.

Significant PCBs source control activities were recently conducted at NBF and included grout sealing of 13 catch basin structures and surface solids removal along with new pavement installation near Building 3-322. These activities occurred in March and April 2010. Boeing has now completed nearly all cleaning of all storm drain structures at NBF, pressure wash cleaning of all accessible storm drain pipe segments, and inspecting storm drain systems with video cameras. In the absence of more recent storm drain solids PCB testing data designed to assess the effectiveness of these source control activities in removing sources of PCBs to the storm drain system, the North Lateral storm drain is targeted for the STST system installation.

Sediment trap samples collected at storm drain line laterals other than the North Lateral indicate lower concentrations of PCBs than the North Lateral. As shown on Figure 3, those results at times have been below the proposed 0.42 mg/kg dry weight remediation level. It is expected that, with additional planned source control actions and storm drain cleaning, stormwater treatment may not be necessary in areas outside of the North Lateral in order to protect Slip 4 sediment from recontamination. Table 1 was created to examine the possible reductions in PCBs concentrations following the current active PCBs source control work and the implementation of the planned STST system at the North Lateral. Two scenarios are evaluated in Table 1: the first assumes treatment of stormwater in the North Lateral that is generated at NBF with bypass of King County stormwater generated offsite, upstream of NBF, and the second includes treatment of the offsite input. Both scenarios use the "NBF-only"-sized treatment system. As shown in this table, PCB concentrations at the lift station are estimated to range from 0.12 to 0.43 mg/kg for solids and 0.006 to 0.020 µg/L for whole water if offsite flow is bypassed, and to range from 0.28 to 0.47 mg/kg for solids and 0.007 to 0.023 µg/L for whole water if offsite flow is routed through the treatment system. These ranges show that, generally, both the interim goal of 0.014 µg/L PCBs for whole water and the short-term interim goal of 0.42 mg/kg dry weight PCBs for solids at the lift station would be achieved.

1.5 STORMWATER TREATMENT SYSTEM LOCATION

Boeing and Landau Associates' personnel examined the NBF facility at the MH108 location and upstream along the North Lateral storm drain line for potential locations to stage a short-term stormwater treatment facility. The location identified as the best alternative to maximize capture of stormwater from the north portion of the North Lateral drain line, while allowing adequate space and access for treatment system equipment, was the area south of structure MH130, northeast of Building 3-350, north of the blast fence, and west of the existing sweeper decant treatment facility. The location of MH130 is shown on Figure 4. It was initially planned that the existing MH130 structure would be modified to allow stormwater capture, pump-out, and reintroduction of treated stormwater, as this location avoids interference with the aircraft activities in the Concourse A area. It was later determined that there would be access limitations and other structural concerns with converting MH130 into a lift station.

It was determined that installation of a new series of manholes, located approximately 40 ft south of MH130, would be preferable. [Note: a single vault was also considered; however, the project schedule did not allow sufficient time to fabricate a suitable custom vault.] The new manholes allow better personnel access for inspections and pump maintenance, potential future installation of a larger pump, and a more securely anchored overflow weir. The location of the new manholes also allows optional collection of stormwater from the 10-inch diameter storm drain branch line that enters the North Lateral approximately 40 ft south and downstream from MH130. Specifically, this is the branch of the storm drain line that comes from MH133D. The locations of MH133D and the new stormwater pumpout structure, MH130A, are shown on Figure 4.

As shown on Figure 4, there are portions of the North Lateral that are located downstream of MH130A and bypass the STST system location. Portions of the North Lateral not captured by the treatment system include Building 3-350 and surrounding area, a parking and storage area west of Building 3-350, and an area north of Building 3-380 that includes MH108 and CB363.

2.0 STORMWATER MODELING AND BASIS OF DESIGN

Stormwater modeling was performed and relevant water quality treatment design standards were considered in order to determine the basis of design for STST system sizing. The details of the determination of the basis of design for the treatment system are provided below.

2.1 DESIGN MANUAL

Ecology's *Stormwater Management Manual for Western Washington* (Stormwater Manual) (Ecology 2005) was determined to be the most applicable stormwater treatment design manual for this project. The Stormwater Manual has five volumes covering separate stormwater design topics. Applicable sections of Volume III (Hydrologic Analysis and Flow Control Design BMPs) and Volume V (Runoff Treatment BMPs) were used to assist with selection of the most relevant stormwater modeling program and determination of the design stormwater treatment flow rate.

2.2 HYDROLOGIC MODELING SOFTWARE

The Stormwater Manual, Volume III, Section 2, states a requirement for the use of one of three continuous simulation hydrologic model-based programs for the modeling of stormwater runoff. The programs are the Western Washington Hydrograph Model (WWHM), MGS Flood, and King County Runoff Time Series (KCRTS). The WWHM program is developed for the Puget Sound region and uses the EPA Hydrologic Simulation Program-Fortran (HSPF) program to perform the rainfall-runoff and routing computations.

Therefore, the WWHM program was determined to be the most applicable model to calculate the stormwater runoff design treatment flow. The most recent update of the WWHM, version 3.0 (WWHMv3; Ecology 2010), was used to perform the stormwater runoff modeling.

2.3 TREATMENT FLOW RATE

The Stormwater Manual, Volume V, Section 4, defines the water quality design flow rate to be a flow rate "at or below which 91% of the runoff volume, as estimated by an approved continuous runoff model, will be treated" when detention facilities are not required, and states that "all Best Management Practices (BMPs) should use the 15-minute time series." The flow rate that achieves 91 percent treatment of the total volume produced is calculated using WWHMv3 within the period of record (local precipitation records collected over approximately the past 64 years) and the flow is adjusted to represent the 15-minute time step. Based on base flow (i.e., infiltrating groundwater) sampling data collected in 2010 (some results shown on Figure 5), it appears that the higher concentrations of PCBs are encountered during base flow relative to stormwater flow. It is, therefore, possible that the 91 percent of flow capture would correspond to greater than 91 percent capture of PCBs. A program for monitoring and sampling the STST system to confirm that compliance goals are attained is described in Section 5.0.

2.4 TREATMENT SYSTEM CLASSIFICATION

WWHMv3 calculates design treatment flow rates for both “on-line” and “off-line” treatment systems. On-line treatment systems are configured such that all stormwater flow is routed through the system. Off-line treatment systems are configured to have only the design treatment flow rate pass through the treatment system and flows in excess of the design treatment rate bypass the treatment system. Calculated on-line treatment flow rates are larger than off-line flow rates because the treatment effectiveness is greatly reduced (assumed to have no effectiveness by WWHMv3) when the treatment system is forced to operate above its design capacity. The treatment system design for NBF is an off-line system that will pump stormwater using a submersible pump at a controlled maximum flow rate, not to exceed the design flow rate, and that will allow excess flow from extreme precipitation events to overflow the weir (to be located in a new manhole, MH130B) and bypass treatment. Bypass events will be observed and documented as described in the operation and maintenance (O&M) manual included as Appendix A of this work plan.

2.5 SOIL CLASSIFICATION

The WWHMv3 requires basin information for unpaved areas, such as landscaping and lawns, according to the underlying soil group classification (Hydrologic Soil Group A, B, or C soil). The NBF property is almost entirely paved; however, a significant amount of the off-property basin area is unpaved. Therefore, Hydrologic Soil Group Classification is needed to model the unpaved areas.

Various reports [*Subsurface Site Investigation, Proposed NBF Bldg 3-353* (Groundwater Technology, Inc. 1990); *Soil and Groundwater Investigation, NBF Former Building 3-360* (Landau Associates 2002); and *Subsurface Site Investigation, NBF Proposed Location Building 3-380* (Groundwater Technology, Inc. 1989)] were examined for drill log data and soil classifications. Information in these reports indicates that the underlying soil consists of medium-grained sand with interbedded sand, silt, gravel, and peat [mostly clayey silts (ML) and silty sand (SM) soil]. ML and SM soil are usually classified in Hydrologic Soil Groups “B” and “C”. In Appendix A of the *Additional Subsurface Assessment Investigation 3-360 Building NBF* report (Secor 1996), onsite soil is referred to as “Klinker Till”, which is similar to Beacon Hill Till (till soil is usually classified as Hydrologic Soil Group “C” soil). Soil types identified in the *Georgetown Steam Plant Low-Lying Area Data Report* (Integral 2010) are variable and generally range from poorly-graded gravels (GM) to ML. Therefore, to be conservative, soil in unpaved areas is assumed to be classified as Hydrologic Soil Group “C” soil.

2.6 BASIN AREAS

The upstream drainage basin for MH130 was estimated using an available Lidar map (with a collection date of 2000); Boeing storm drain system drawings; a city of Seattle map “Lower Duwamish

Waterway Areas Drainage to Slip 4"; Figure 2-1 "Storm Drain Lines in the Vicinity of NBF-GTSP Site" (SAIC 2009); and aerial photographs from Google Earth Pro. Lidar maps and aerial photos provided topographic and surface information to better analyze possible drainage basin boundary limits. Boeing AutoCAD drawing files of their storm drain system provided catch basin locations, estimated catch basin drainage boundaries, and conveyance pipe system information. The city of Seattle and SAIC figures cited above provided offsite catch basin locations, conveyance pipe system information, and estimated catch basin drainage boundaries.

Two different drainage basins were modeled as part of this evaluation. The first drainage basin is referred to as "NBF-Only" and includes only the drainage area that is estimated to flow into catch basins on Boeing-leased property and that drains to MH130. This drainage basin, used for the original design, is shown on Figure 6, and the actual final drainage basin (including the drainage area of the storm drain branch line coming from MH133D) is shown on Figure 7. The GTSP roof area is conveyed directly to Slip 4 via a dedicated storm drain pipe buried along the old flume alignment. Therefore, that roof area is not included in the drainage basin. Other than for the roof, no separate storm drain system is present for the GTSP property so it is included within the NBF-Only Basin. However, observations and modeling suggest that this mostly unpaved area does not contribute a significant amount of stormwater runoff onto NBF property.

The second drainage basin is referred to as the Full Drainage Basin, which contains the NBF-Only Basin that drains to MH130 plus all offsite areas contributing stormwater runoff to the NBF North Lateral storm drain via King County conveyance pipes. The Full Drainage Basin for the original design is shown on Figure 8. The estimated drainage basin areas used for the original design, including estimates of the specific areas that are considered to be pervious or impervious to infiltration, are summarized in the table below.

Land Cover	**Original Estimate of NBF-Only Basin Draining to MH 130 (acres)**	**Original Estimate of Full Drainage Basin Draining to MH130 (acres)**
Pervious	3.66	13.00
Impervious	10.58	34.85
Total	14.24	47.85

2.7 GROUNDWATER INFILTRATION

Stormwater runoff flow rate readings at MH108 were collected during the period from November 15, 2009 to March 11, 2010 at 15-minute intervals (data gathered by SAIC). Rain gauge information from the KCIA (KBFI station) is available from the same time period at 1-hour intervals. These data were imported into Excel and a graph was made overlaying the measured stormwater flows with that of the rain gauge. During the period between November 28, 2009 and December 14, 2009, the rain gauge data indicated the lowest amount of measurable rainfall, and the average recorded stormwater flow rate was approximately 62 gallons per minute (gpm) [0.14 cubic feet per second (cfs)]. Grout sealing was performed at catch basins in the North Lateral after that measurement time period in order to reduce and eliminate sources of groundwater infiltration; however, a significant volume of base flow originating from the upgradient King County property continues to flow into the North Lateral line. To be conservative, it is assumed that the base flow rate at MH108 is still at 62 gpm. It is also assumed that there would be the same base flow rate at MH130 and at the new manhole from which stormwater will be pumped for treatment.

2.8 WWHMV3 OUTPUT

After entering the NBF-Only Basin data and the Full Drainage Basin data into WWHMv3, the program generated the output results for water quality flow rates that are listed in the table below. WWHMv3 modeled drainage basin input and output data are included in Appendix B.

	Water Quality On-Line BMP			Water Quality Off-Line BMP	
Basin	24-hour Volume (acre-ft)	Standard Flow Rate (cfs)	15-Minute Flow Rate (cfs)	Standard Flow Rate (cfs)	15-Minute Flow Rate (cfs)
NBF-Only Basin	1.37	1.51	1.65	0.86	0.94
Full Drainage Basin	4.50	4.98	5.45	2.82	3.09

As discussed above, the treatment system is designed as an “off-line” system, and Ecology guidance indicates that the 15-minute time step design flow rate should be used. Therefore, the design water quality treatment flow rate for the Boeing-leased property is approximately 0.94 cfs (equivalent to approximately 420 gpm). This design flow rate meets the 2005 Ecology Manual’s requirement of treating 91% of the total runoff volume produced from the NBF-Only Basin.

During a larger storm event, when the design stormwater flow rate is occurring, the groundwater infiltration base flow discussed above may not occur. At that time, the storm drain pipes may be too full of water to allow infiltration. However, to be conservative, the estimated groundwater infiltration rate of 0.14 cfs was added to the water quality treatment flow rate of 0.94 cfs to come up with a design water quality treatment flow rate of approximately 1.08 cfs (approximately 485 gpm).

3.0 STORMWATER TREATMENT SYSTEM DESIGN

Based on the established interim goals for PCBs in water and solids and recent past PCBs analytical results (Section 1.2) and logistical considerations (Section 1.3) of installing a STST system by September 15, the treatment system was sized to treat the runoff from the Boeing-leased property that drains to MH130. Boeing is pursuing options for re-routing the King County storm drain lines that enter into the NBF North Lateral storm drain. Until such time as the King County lines can be rerouted and bypassed from treatment, stormwater from offsite King County property will contribute flow into the STST system. WWHMv3 was used to estimate the percentage of runoff volume that would be captured and treated by the NBF-Only treatment system before bypass of the King County stormwater can be accomplished. The model result was that approximately 61 percent of the total volume produced from the Full Drainage Basin would be treated by the system sized for the NBF-Only Basin area. Considering that the PCBs in stormwater are known to be associated with suspended solids due to their extremely low solubility, and that the majority of suspended solids are typically expected to be generated during the "first flush" portion of the storm events rather than during the later duration high-flow periods (although no NBF-specific data have yet been collected in this regard), it is possible that the treatment system will adequately achieve criteria protective against Slip 4 sediment recontamination.

Boeing intends to monitor the treatment effectiveness of the STST system during both low-flow and high-flow storm events to determine if the treatment system is achieving applicable water quality and solids interim goals. Boeing also has contingent plans to expand the size of the treatment system to the Full Drainage Basin design flow rate if that is determined to be necessary. Figure 9 illustrates how the design of this contingent expanded system was originally planned and shows how adequate space has been reserved for its potential installation. The actual layout of the STST system equipment varies slightly from that shown on Figure 9; the 4-vessel sand filter system is located east of the holding tanks and the pre-treatment tank is the northernmost of the three tanks, not the southernmost as had been originally planned.

Contractor suppliers of the selected stormwater treatment technology [chitosan-enhanced sand filtration (CESF) as described in Section 3.2] have indicated that expansion of the treatment system to the Full Drainage Basin design flow rate could be accomplished within 3 weeks, if necessary, and the rental pumps could be available within the same timeframe. Power requirements of an expanded treatment system may necessitate the use of a generator to supply power until such time as a more permanent utility can be provided. Boeing has a contract with the STST system contractor that includes a condition requiring that granular activated carbon (GAC) be installed within 3 weeks of notification, if it is determined that carbon is necessary to meet compliance monitoring requirements. Any other changes to the design will be submitted to EPA for review and approval to ensure that changes conform to performance standards and requirements of the ASAOC and are consistent with the objectives of this Removal Action, as required by the ASAOC.

From treatment system startup on September 15 through November 30, 2010, there was measured rainfall of approximately 12.8 inches and the total volume of stormwater treated by the system was approximately 5.15 million gallons. Based on those data and an average annual rainfall in Seattle of approximately 37 inches, the system would be expected to treat approximately 15 million gallons during a full year with average annual rainfall. The actual amount treated in a one-year period would depend on the size and duration of storm events and the amount of base flow that is present. Descriptions of the storm drain system modifications, short-term stormwater treatment system design, and treatment system installation are provided below in this section.

3.1 NEW STORMWATER MANHOLES

Stormwater will be pumped from the existing North Lateral drain line near MH130 to the STST system. A new stormwater vault was originally considered to provide the necessary space for: 1) the planned and potential future pumps, 2) a weir to create a detention volume for efficient pump operation, and 3) the return flow of treated water. Due to the unavailability of a suitable vault in the time required to meet the treatment system completion schedule, a series of three manholes were installed instead, one to provide space for each purpose identified above. The new manholes were installed to allow collection and pump-out of stormwater at the design treatment flow rate. The new manholes were named MH130A, B, and C, due to their proximity to existing manhole MH130, which was not altered. The locations of the new structures are shown on Figure 10. The new structures were constructed with a sump and a 10-horsepower submersible pump (located in MH130A) and a weir (located in MH130B) designed to detain stormwater in the structures (and in upstream piping) to establish a reservoir from which to pump and to allow overflow of extreme storm events. The weir elevation was constructed to provide adequate storage capacity to reduce the cycling time of the submersible pump to within manufacturer guidelines, in order to maximize pump motor life. Conversely, the weir elevation was constructed low enough and with an adequate overflow cross-sectional area to avoid flooding of upstream areas during an extreme precipitation event (e.g., the 100-year storm). A pressure transducer was installed upstream of the weir in MH130B on September 22, 2010 to record water levels. The transducer is set to collect a water level reading every 30 seconds. The water level readings can be compared to the weir elevation to determine the time and duration of overflow events and to estimate the volume of stormwater bypassing the treatment system. The third structure, MH130C, was constructed to receive discharge from the treatment system. The manhole design and weir construction details are shown on Figure 11. Excavation and dewatering during installation of these storm drain improvements have been documented (Landau Associates 2010e).

Trenched pipe was installed to convey the pumped stormwater from MH130A to aboveground storage tanks (ASTs) and to convey treated stormwater to MH130C and on into the 24-inch diameter North Lateral storm drain pipe, as shown on Figure 10. The conveyance of water within the treatment system area can be accomplished with aboveground piping and hose because it will be outside of vehicle traffic and pedestrian access areas.

3.2 SELECTED STORMWATER TREATMENT TECHNOLOGY

A preliminary evaluation of stormwater treatment technologies expected to be effective at removal of suspended solids and PCBs was previously performed (Landau Associates 2010a). After further review of the treatment technologies that are expected to be effective and that could be mobilized quickly, it was determined that CESF is the preferred treatment technology for the STST system. Chitosan is a natural polymer that can be extracted from shrimp and crab shells. For stormwater treatment applications, chitosan is produced as a liquid solution of chitosan acetate that is dosed into the stormwater prior to a filtration step (e.g., sand filter). The chitosan helps agglomerate suspended solids including even small colloidal suspended solids that are otherwise resistant to settling and filtration. The use of a polymer or coagulant can be particularly advantageous for removal of suspended solids where there is a significant percent by mass of suspended solids with a nominal diameter less than 5 microns. The data for NBF have been variable, but have suggested that there is a significant percentage of the suspended solids mass in the less than 5 micron particle size fraction. The dosage of chitosan acetate into stormwater has been, and for future operation is expected to remain, less than one part per million (ppm). The most recent dosage of chitosan has been 0.2 ppm as the pretreatment step and 0.47 ppm as the second and final dosage prior to the sand filter system, for a total dosage of 0.67 ppm. The liquid chitosan acetate is stored in a 275-gallon tote located inside the treatment system trailer and is dosed into the stormwater using an automated metering pump.

CESF systems have been used extensively at construction sites to reduce turbidity in stormwater runoff, and these systems are typically capable of removing suspended solids to the extent that turbidity is reduced to 1 Nephelometric turbidity unit (NTU) or below. CESF systems have also been used, although less often, at industrial sites for stormwater treatment projects. Ecology requires periodic testing for residual chitosan to ensure that the chitosan has been properly removed in the filtration step. An O&M manual has been prepared to describe the planned system monitoring and testing procedures and frequency. The O&M manual is provided as Appendix A to this work plan.

The treatment system design includes one 18,000-gallon capacity aboveground pretreatment tank with a weir and two 21,000-gallon capacity aboveground holding tanks to provide storage capacity and initial settling of heavy solids. One of the storage tanks could also be reconfigured to be a post-treatment holding/testing tank if found to be necessary. As indicated by the area shown on Figure 9, there is additional space available to accommodate additional storage tanks and treatment system equipment if determined to be necessary to meet interim PCBs goals. The system includes skid-mounted sand filter vessels with an automatic-backwash system. The pretreatment tank doubles as a backflush tank. An automatic flow-proportional chitosan pump dosing system with inline static mixers is another component of the treatment equipment. The sand filter system is a 4-pod or 4-vessel system where the treated effluent from three of the sand filter vessels can be used to backflush the fourth vessel. The 18,000-gallon weir pretreatment tank also acts as the backwash receiving/settling tank. A schematic diagram of the STST facility is shown on Figure 12. Additional detail of the treatment system equipment is provided in the O&M Manual (Appendix A).

GAC is effective at removing dissolved organic compounds from water. As was stated above, PCBs are extremely insoluble and are found in stormwater almost entirely adsorbed to suspended particles. However, if it is determined through testing of the STST system effluent that PCBs are not adequately removed through the CESF system, then contingent use of GAC has been considered in the allotment of space for the treatment system, as described in the following section. Boeing has made contractual arrangements with the stormwater treatment contractor (Clear Water Compliance Services) to have carbon vessels available, installed, and operational within 3 weeks of determination that the CESF system is inadequate to meet the whole water PCBs standard.

3.3 TREATMENT SYSTEM LAYOUT

The original design layout of the STST system is shown on Figure 9. The 18,000-gallon pretreatment tank is shown receiving pumped stormwater from MH130A, and the two 21,000-gallon storage tanks are shown directly north of the pretreatment tank. The actual configuration of the equipment was adjusted slightly. For clarity, no piping is shown between the pretreatment tank and the storage tanks. The skid-mounted 4-vessel sand filter system allows automated sequential backwashing of each sand filter vessel (using treated/filtered stormwater) while allowing continued stormwater treatment operation. To show that space is also available for expansion of the system, the additional sand filter equipment that would be needed to process the Full Drainage Basin design flow rate of 3.09 cfs (approximately 1,390 gpm) is shown in a different color on Figure 9. In addition, if secondary treatment is found to be needed, the number and approximate size of GAC vessels that could process the Full Drainage Basin design flow rate are also shown in a different color on Figure 9. Sampling taps and solids filters have been installed to allow testing of the influent and effluent of the treatment system. A nominal 5-micron polypropylene felt filter has been used for the inlet and effluent filter. Currently, a nominal 1-micron felt filter is being used on the effluent filter in an attempt to capture more and smaller suspended solids from the low-TSS effluent stream. A schematic diagram of the treatment system shows the locations of the two particulate filters (Figure 12), and additional details of the sampling collection devices are provided in the Operation and Maintenance Manual (Appendix A).

3.4 CONTRACTOR SELECTION

A request for bid document was issued to local stormwater treatment contractors that are experienced in providing and maintaining CESF systems. The bid request was provided to Clear Creek Systems, Inc. and to Clear Water Compliance Services, Inc. (Clear Water). Contractor selection was based on qualifications (i.e., demonstrated experience on similar projects), submitted bid cost, and ability to provide the equipment within the established schedule. Based on the evaluation of the bids, Clear Water was selected and a contract for installing the short-term treatment CESF system was executed with Clear Water on August 12, 2010.

4.0 TREATMENT SYSTEM OPERATION AND MAINTENANCE

The procedures for operating and maintaining the STST system (the CESF system) are provided in a separate O&M Manual. The O&M Manual is provided in Appendix A of this work plan.

In addition to describing the O&M procedures, the O&M Manual contains 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 percentage and effluent concentrations for both TSS and PCBs, and contingency measures to be taken if inadequate performance is demonstrated. Boeing reports operational data (e.g., total gallons of stormwater treated, rainfall, calculated volume of treatment system bypass by weir overflow) on a monthly basis in the progress reports that are submitted to EPA by the fifth day of each month.

Beyond the use in assessing the achievement of interim goals for TSS and PCBs (whole water and solids), the treatment system monitoring data will also be evaluated as part of the design of the long-term stormwater treatment system.

The treatment system is operated in accordance with applicable local, state, and federal regulations and standards. Residual chitosan testing is performed at least weekly to verify that no liquid chitosan is making it past the sand filter system. There is very high confidence that there will not be a problem with detection of residual chitosan in the discharge from the sand filter. In an e-mail from Neil Doherty of Clear Water, he states “In the eleven years that Clear Water has been performing Chitosan Enhanced Sand Filtration (CESF), with billions of gallons discharged and thousands of residual chitosan tests performed, we have never seen a true positive result of a residual chitosan test” (Doherty 2010).

In a few site-specific instances, positive field tests have occurred, yet, after laboratory analysis, these results were proven to be false positives due to organic interference in the effluent water. These events were also correlated to the over application of source control BMP’s such as straw, hydro-seeding tackifier (guar), and soil tackifier (i.e., polyacrylamide and bonded-fiber matrix). Dissolved concentrations of these organics in the treatment system effluent, when reacting with iodine in the final step of the residual chitosan procedure, produced a bluish hue, therefore, yielding a false-positive result.

The chemical composition of chitosan is such that it binds to the anionic solids as well as other chitosan molecules within the top layers of the sand filter media rather than go through the filter in a dissolved form, making the presence of residual chitosan (>1 mg/L) in treatment system effluent nearly impossible. It should be noted that Clear Water has performed controlled pilot tests and experiments in which influent dose rates of up to 50 mg/L have not yielded a positive residual chitosan test.

Any wastes from O&M of the STST facility will be tested and profiled to determine contaminant concentrations and disposal requirements. Based on relatively low TSS concentrations in NBF stormwater, the inlet weir tank may not accumulate a significant amount of solids within just a few months of system operation to require cleanout of solids. The solids level in the inlet weir tank is inspected at least once per month and, if the solids level at the bottom of the tank is greater than 12 inches, a sample of the solids will be collected for waste profiling purposes and the solids will be cleaned out from the tank. The O&M Manual in Appendix A provides more detailed procedures for measuring the amount of accumulated solids and for removal and disposal of those solids.

Prior to any shipment of wastes from the treatment facility exceeding 10 cubic yards in any calendar year to an out-of-state waste management facility, written notification of such shipment will be provided to the appropriate state environmental official in the receiving facility's state and to the EPA on-scene coordinator. Written notification will include the following information: 1) the name and location of the facility to which the Waste Material is to be shipped, 2) the type and quantity of the Waste Material to be shipped, 3) the expected schedule for the shipment of the Waste Material, and 4) the method of transportation. Notification of major changes in the shipment plan, such as a decision to ship the Waste Material to another facility within the same state, or to a facility in another state, will be provided to the state in which the planned receiving facility is located. The identity of the receiving facility and state will be determined by Boeing, and the information required above will be provided at least twenty (20) days prior to the date the waste material is to be shipped. Before shipping any hazardous substances, pollutants, or contaminants from the site that are generated pursuant to the ASAOC, Boeing will obtain EPA's certification that the proposed receiving facility is operating in compliance with the requirements of Section 121(d)(3) of CERCLA, 42 U.S.C. § 9621(d)(3), and 40 C.F.R. § 300.440.

5.0 COMPLIANCE MONITORING

Compliance monitoring will include monitoring to evaluate the performance and effectiveness of the STST facility, and monitoring of water and solids from the entire NBF stormwater system, including the point of compliance at the lift station (LS431). Monitoring of the STST facility is described in the O&M Manual, which is provided in Appendix A. Monitoring of the treatment facility will include analysis of influent and effluent whole water, filtered solids samples, and measurements of TSS. The goal to demonstrate general effectiveness of the treatment system is 95 percent removal of TSS from stormwater or, if the influent TSS is less than 20 mg/L, a TSS concentration of not more than 1 mg/L.

Additionally, as set forth in the Action Memorandum for the Time-Critical Removal Action issued by EPA and dated September 23, 2010, the STST facility for the NBF storm drain system shall meet the following interim goals for PCBs in solids and water:

- Water discharged to Slip 4 must be below the Aquatic Life-Fresh/Chronic water quality standard of 0.014 µg/L total PCBs.
- In-line storm drain solids discharged to Slip 4 must be below 10 mg/L TSS as a daily maximum concentration and 5 mg/L TSS as an average monthly concentration, and must be below 420 ppb dry weight total PCBs.

The compliance point for the interim goals will be Lift Station LS431. Samples will be collected at LS431 to demonstrate that the interim goals are being met.

Monitoring of the entire NBF stormwater system (site-wide monitoring) is fully described in the Sampling and Analysis Plan (SAP) that is provided in conjunction with this work plan (Appendix C). In summary, the site-wide monitoring of the NBF system will include evaluation of both filtered solids and flow-weighted composite whole water samples at lift station LS431 and MH108 for TSS and PCBs, as well as particle size distribution of filtered solids. Sampling will be conducted for 10 events at LS431 and 5 events at MH108 between November 2010 and April 2011, including two base flow events at LS431. The sediment trap monitoring program begun in 2005 will be continued, with samples collected on a semi-annual basis. Flow-weighted whole water samples and filtered solids samples will continue to be collected from the lift station after April 2011 on either a monthly or quarterly frequency, depending on the evaluation of results from the first 10 sampling events. A sampling and analysis summary is provided in Table 2.

Sample results for whole water samples from the lift station will be compared to performance criteria listed above. Results from the site-wide monitoring will be used to evaluate the effectiveness of source control actions and whether treatment of stormwater from portions of the storm drain system other than the North Lateral is necessary to protect Slip 4.

Boeing also previously prepared for EPA a Short-term Treatment Compliance Assessment memorandum (Landau Associates 2010f) that presented the treatment system sampling results, an assessment of treatment system performance, and any system modifications completed in order to meet the conditions of the Compliance Schedule. Boeing also continues to provide monthly progress reports to EPA by the fifth day of the following month, in which compliance with the interim goals is addressed.

In each monthly progress report to EPA, when validated analytical data are available from the Lift Station or other sampling locations, Boeing will compare the results to the criteria discussed above. If it is found that any particular criteria are not met, then Boeing will evaluate the adequacy of the site sampling program and will describe any additional sampling procedures (e.g., new sampling locations, increased sampling frequency, or modified sampling/analytical methods) that are recommended to address the issue. In that situation, Boeing will also consider potential additional source control actions and will present any recommendations to EPA in the progress report.

6.0 PROJECT SCHEDULE

The established schedule was for a general contractor to install MH130A, B, and C, and for Clear Water to install the treatment equipment by September 13 with full, steady operation on September 15, 2010. This schedule for system startup was met.

Treatment system performance monitoring began on September 20, 2010. The full NBF site PCB monitoring program began on November 17, 2010, after completion of the majority of the storm drain system cleaning. The complete schedule for sampling is provided in the SAP that is being provided to EPA in conjunction with this Work Plan (Appendix C).

7.0 REMOVAL ACTION TEAM

The removal action team includes personnel from Boeing; their consultants Landau Associates and Geosyntec; their contracted analytical laboratory Analytical Resources, Inc. (ARI); and their construction contractors Glacier Environmental Services, Inc. (Glacier) and Clear Water Compliance Services (Clear Water). Glacier is responsible for constructing structures and providing equipment needed to convey stormwater from the storm drain system to the STST facility and back to the storm drain system. Clear Water is responsible for installing a CESF system to filter out suspended solids and their associated PCBs. An organization chart showing personnel and their roles and responsibilities is provided as Figure 13.

8.0 HEALTH AND SAFETY PLANS

Several health and safety plans (HASPs) will cover the activities described in this work plan. For Landau Associates' employees, a HASP for NBF activities was generated on September 8, 2008 and updated on August 28, 2010. The updated HASP covers the work areas and types of work that will occur in this removal action and will be used for this project. Glacier and Clear Water each have HASPs that apply to their employees' activities related to this work plan. The three HASPs are provided in Appendix D.

No exposure of offsite personnel or Boeing facility employees to contaminants due to activities described in this work plan is anticipated. The NBF facility is completely fenced and access to the facility is limited, with full-time security personnel on duty at all gates. No area residents are anticipated to be able to access the NBF facility. The construction work areas will be designated and access limited to necessary personnel. Dust control will be implemented, as needed, to prevent potentially contaminated soil from being blown out of the construction work area.

9.0 USE OF REPORT

This work plan has been prepared for the exclusive use of The Boeing Company and applicable regulatory agencies for specific application to the installation of a STST facility for removal of PCBs from stormwater in the storm drain system at NBF. No other party is entitled to rely on the information and recommendations included in this document without the express written consent of Landau Associates. Further, the reuse of information and recommendations provided herein for extensions of the project or for any other project, without review and authorization by Landau Associates, shall be at the user's sole risk. Landau Associates warrants that within the limitations of scope, schedule, and budget, our services have been provided in a manner consistent with that level of care and skill ordinarily exercised by members of the profession currently practicing in the same locality under similar conditions as this project. We make no other warranty, either express or implied.

This document has been prepared under the supervision and direction of the following key staff.

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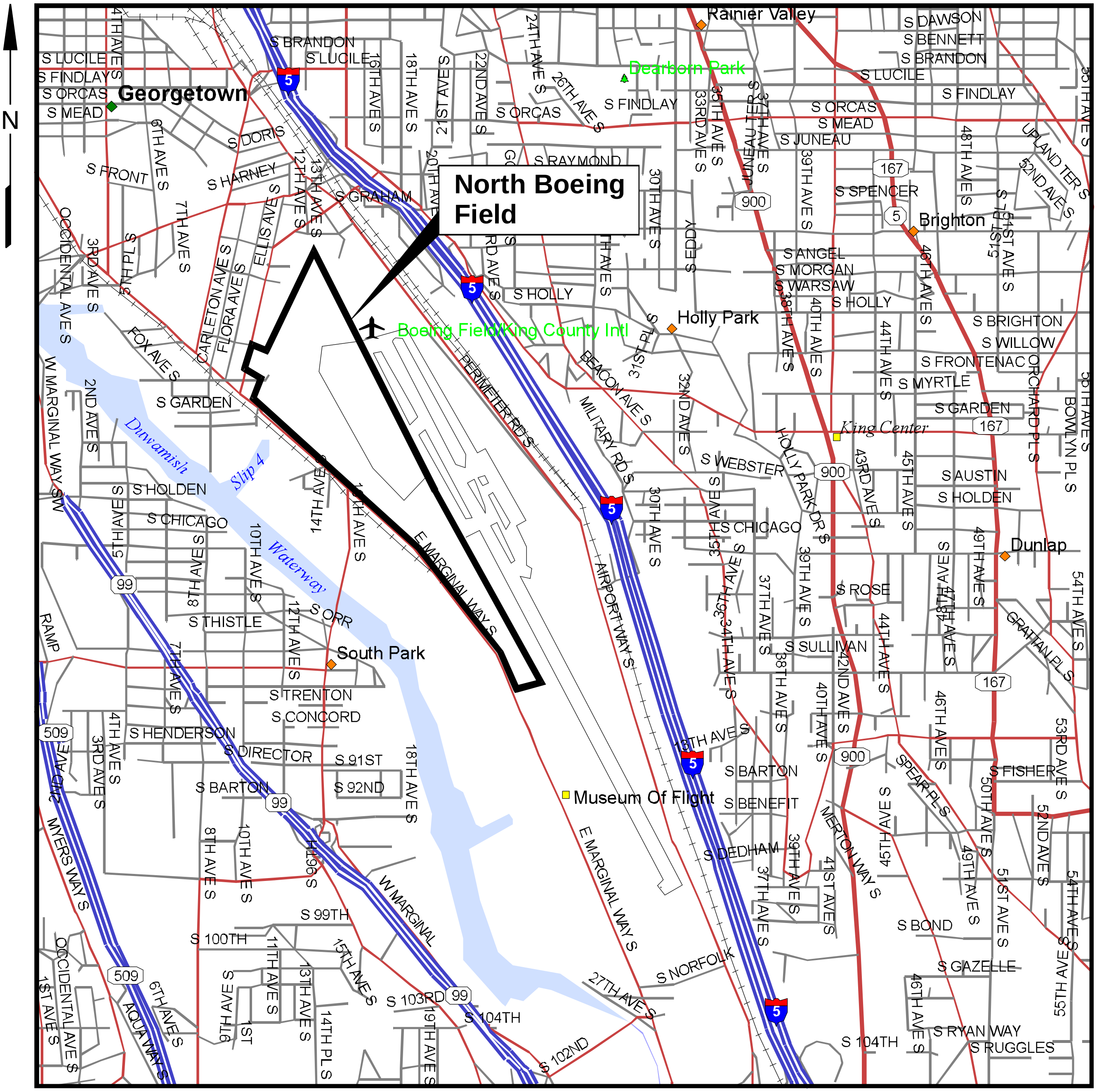

Map from DeLorme Street Atlas USA, 2002

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Scale in Miles

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LANDAU ASSOCIATES

North Boeing Field Seattle, Washington	**Vicinity Map**	Figure 1

Y:\Projects\025082\MapDocs\On_Offsite_Basins.mxd NAD 1983 StatePlane Washington North FIPS 4601 Feet

North Boeing Field Stormwater Drainage Basin Areas	Onsite Area (Acres)	Offsite Area (Acres)	Total Area (Acres)
North Lateral (Excluding Steam Plant Area)	18.1	37.0	55.1
North Lateral Steam Plant Only - No Roof	0.0	4.1	4.1
North-Central Lateral	14.7	42.6	57.3
South-Central Lateral	21.9	42.7	64.6
South Lateral	46.3	64.3	110.6
Bldg 3-380 Area	4.6	0.0	4.6
Parking Lot Area (Downstream of KC Lift Station)	6.8	0.0	6.8
Total Area	112.4	190.7	303.1
Sanitary Sewer <0.1 Acres			
Georgetown Steam Plant Roof = 0.5 Acres			

Legend

- Off-site
- Drainage to Sanitary Sewer
- Building 3-380 Area
- North-Central Lateral
- North Lateral
- Parking Lot Area (Downstream of King County Lift Station, LS431)
- South-Central Lateral
- South Lateral

0 450 900

Scale in Feet

Data Source: Aerial - SAIC 2009; Conveyance System - The Boeing Company (On-site) and SAIC 2009 (Off-site); Basin Boundaries - The Boeing Company (On-site), SAIC 2009 (Off-site) Figure 2-1 "Storm Drain Lines in the Vicinity of NBF-GTSP Site", and City of Seattle Map "Lower Duwamish Waterway Areas Draining to Slip 4"

Note
1. Black and white reproduction of this color original may reduce its effectiveness and lead to incorrect interpretation.

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North Boeing Field
Seattle, Washington

North Boeing Field Stormwater Drainage Basins

Figure 2

Y:\Projects\025082\MapDocs\2010StormDrainAnalytical ResultsRevised201055.mxd 12/13/2010 NAD 1983 StatePlane Washington North FIPS 4601 Feet

Notes

1. Black and white reproduction of this color original may reduce its effectiveness and lead to incorrect interpretation.
2. PCB analytical results shown are from samples that were collected prior to the 2010 Storm Drain Jet Cleaning.

0 160 320

Scale in Feet

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North Boeing Field
Seattle, Washington

North Lateral Storm Drain Structure PCB Sampling Analytical Results

Figure 3

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Legend

- Catch Basin Type II
- Lift Station
- Storm Drain Manhole
- North Lateral Untreated
- North Lateral Treated
- South-Central Lateral
- North-Central Lateral
- Lift Station Discharge Plus Drainage from Parking Lot Area
- North Boeing Field Property Boundary
- Basin Boundary

North Boeing Field Stormwater Drainage Basin Areas	Onsite Area (Acres)	Offsite Area (Acres)	Total Area (Acres)
North Lateral (Excluding GTSP Area)	18.1	37.0	55.1
North Lateral - GTSP (Excluding Roof)	0.0	4.1	4.1
Short Term Stormwater Treatment System Basin	12.8	41.1	53.9

Note
1. Black and white reproduction of this color original may reduce its effectiveness and lead to incorrect interpretation.

Data Source: Boeing

0 300 600
Scale in Feet

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North Boeing Field
Seattle, Washington

North Lateral Storm Drainage Area and Site Features

Figure
4

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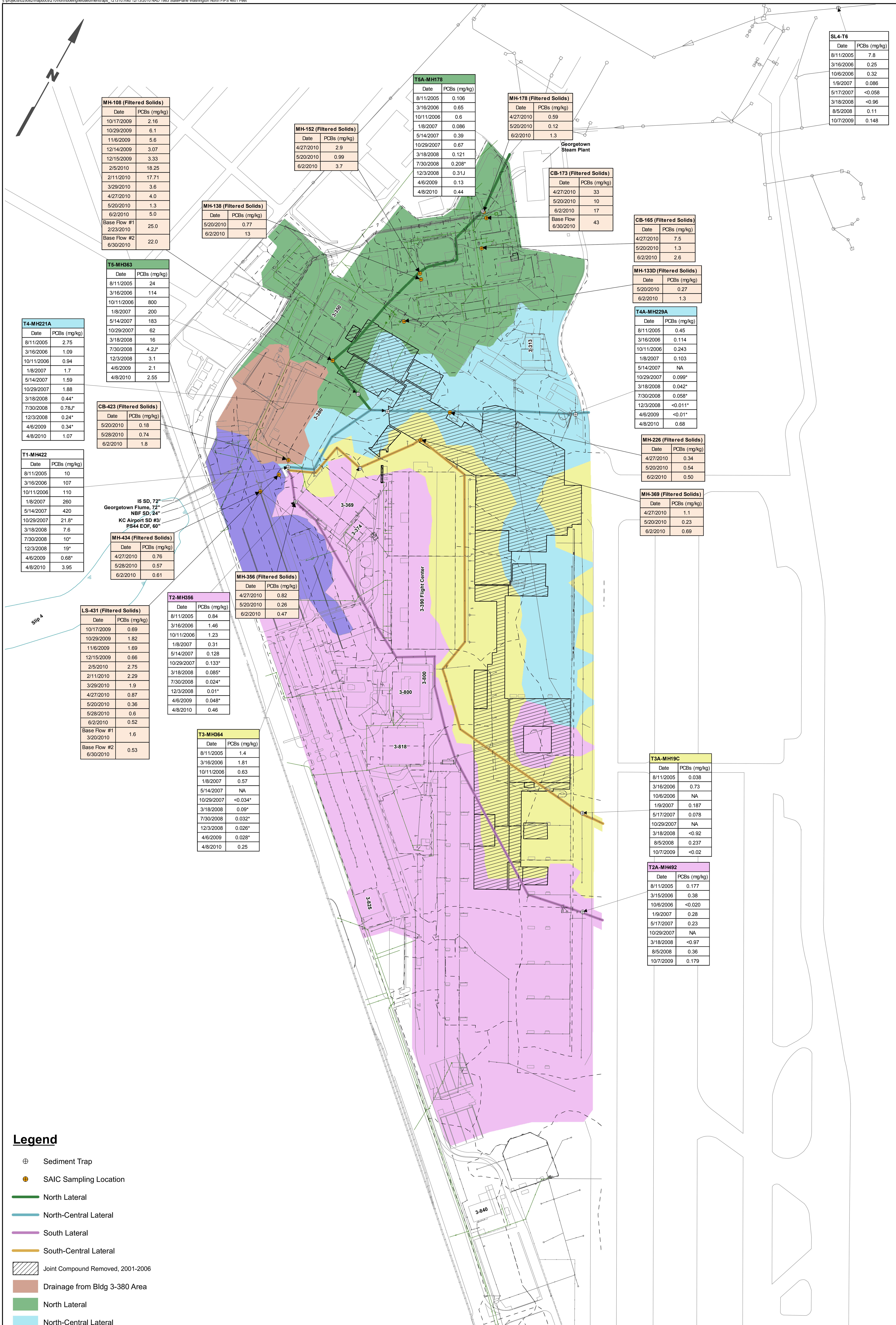

MH-108 (Filtered Solids)

Date	PCBs (mg/kg)
10/17/2009	2.16
10/29/2009	6.1
11/6/2009	5.6
12/14/2009	3.07
12/15/2009	3.33
2/5/2010	18.25
2/11/2010	17.71
3/29/2010	3.6
4/27/2010	4.0
5/20/2010	1.3
6/2/2010	5.0
Base Flow #1 2/23/2010	25.0
Base Flow #2 6/30/2010	22.0

MH-152 (Filtered Solids)

Date	PCBs (mg/kg)
4/27/2010	2.9
5/20/2010	0.99
6/2/2010	3.7

T5A-MH178

Date	PCBs (mg/kg)
8/11/2005	0.106
3/16/2006	0.65
10/11/2006	0.6
1/8/2007	0.086
5/14/2007	0.39
10/29/2007	0.67
3/18/2008	0.121
7/30/2008	0.208*
12/3/2008	0.31J
4/6/2009	0.13
4/8/2010	0.44

MH-178 (Filtered Solids)

Date	PCBs (mg/kg)
4/27/2010	0.59
5/20/2010	0.12
6/2/2010	1.3

SL4-T6

Date	PCBs (mg/kg)
8/11/2005	7.8
3/16/2006	0.25
10/6/2006	0.32
1/9/2007	0.086
5/17/2007	<0.058
3/18/2008	<0.96
8/5/2008	0.11
10/7/2009	0.148

CB-173 (Filtered Solids)

Date	PCBs (mg/kg)
4/27/2010	33
5/20/2010	10
6/2/2010	17
Base Flow 6/30/2010	43

MH-138 (Filtered Solids)

Date	PCBs (mg/kg)
5/20/2010	0.77
6/2/2010	13

CB-165 (Filtered Solids)

Date	PCBs (mg/kg)
4/27/2010	7.5
5/20/2010	1.3
6/2/2010	2.6

MH-133D (Filtered Solids)

Date	PCBs (mg/kg)
5/20/2010	0.27
6/2/2010	1.3

T5-MH363

Date	PCBs (mg/kg)
8/11/2005	24
3/16/2006	114
10/11/2006	800
1/8/2007	200
5/14/2007	183
10/29/2007	62
3/18/2008	16
7/30/2008	4.2J*
12/3/2008	3.1
4/6/2009	2.1
4/8/2010	2.55

T4-MH221A

Date	PCBs (mg/kg)
8/11/2005	2.75
3/16/2006	1.09
10/11/2006	0.94
1/8/2007	1.7
5/14/2007	1.59
10/29/2007	1.88
3/18/2008	0.44*
7/30/2008	0.78J*
12/3/2008	0.24*
4/6/2009	0.34*
4/8/2010	1.07

T4A-MH229A

Date	PCBs (mg/kg)
8/11/2005	0.45
3/16/2006	0.114
10/11/2006	0.243
1/8/2007	0.103
5/14/2007	NA
10/29/2007	0.099*
3/18/2008	0.042*
7/30/2008	0.058*
12/3/2008	<0.011*
4/6/2009	<0.01*
4/8/2010	0.68

CB-423 (Filtered Solids)

Date	PCBs (mg/kg)
5/20/2010	0.18
5/28/2010	0.74
6/2/2010	1.8

MH-226 (Filtered Solids)

Date	PCBs (mg/kg)
4/27/2010	0.34
5/20/2010	0.54
6/2/2010	0.50

T1-MH422

Date	PCBs (mg/kg)
8/11/2005	10
3/16/2006	107
10/11/2006	110
1/8/2007	260
5/14/2007	420
10/29/2007	21.8*
3/18/2008	7.6
7/30/2008	10*
12/3/2008	19*
4/6/2009	0.68*
4/8/2010	3.95

MH-369 (Filtered Solids)

Date	PCBs (mg/kg)
4/27/2010	1.1
5/20/2010	0.23
6/2/2010	0.69

MH-434 (Filtered Solids)

Date	PCBs (mg/kg)
4/27/2010	0.76
5/28/2010	0.57
6/2/2010	0.61

MH-356 (Filtered Solids)

Date	PCBs (mg/kg)
4/27/2010	0.82
5/20/2010	0.26
6/2/2010	0.47

T2-MH356

Date	PCBs (mg/kg)
8/11/2005	0.84
3/16/2006	1.46
10/11/2006	1.23
1/8/2007	0.31
5/14/2007	0.128
10/29/2007	0.133*
3/18/2008	0.085*
7/30/2008	0.024*
12/3/2008	0.01*
4/6/2009	0.048*
4/8/2010	0.46

LS-431 (Filtered Solids)

Date	PCBs (mg/kg)
10/17/2009	0.69
10/29/2009	1.82
11/6/2009	1.69
12/15/2009	0.66
2/5/2010	2.75
2/11/2010	2.29
3/29/2010	1.9
4/27/2010	0.87
5/20/2010	0.36
5/28/2010	0.6
6/2/2010	0.52
Base Flow #1 3/20/2010	1.6
Base Flow #2 6/30/2010	0.53

T3-MH364

Date	PCBs (mg/kg)
8/11/2005	1.4
3/16/2006	1.81
10/11/2006	0.63
1/8/2007	0.57
5/14/2007	NA
10/29/2007	<0.034*
3/18/2008	0.09*
7/30/2008	0.032*
12/3/2008	0.026*
4/6/2009	0.028*
4/8/2010	0.25

T3A-MH19C

Date	PCBs (mg/kg)
8/11/2005	0.038
3/16/2006	0.73
10/6/2006	NA
1/9/2007	0.187
5/17/2007	0.078
10/29/2007	NA
3/18/2008	<0.92
8/5/2008	0.237
10/7/2009	<0.02

T2A-MH492

Date	PCBs (mg/kg)
8/11/2005	0.177
3/15/2006	0.38
10/6/2006	<0.020
1/9/2007	0.28
5/17/2007	0.23
10/29/2007	NA
3/18/2008	<0.97
8/5/2008	0.36
10/7/2009	0.179

Legend

- Sediment Trap
- SAIC Sampling Location
- North Lateral
- North-Central Lateral
- South Lateral
- South-Central Lateral
- Joint Compound Removed, 2001-2006
- Drainage from Bldg 3-380 Area
- North Lateral
- North-Central Lateral
- Parking Lot Area
- South Lateral
- South-Central Lateral

Note
1. Drainage areas based on information from SAIC from 4/5/10.
2. * indicates sample analyzed on as-recieved basis due to limited sample quantity.

0 200 400
Scale in Feet

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North Boeing Field Seattle, Washington	PCBs in Suspended Solids	Figure 5

Notes

1. Basin boundaries are estimated using Lidar (obtained from the Puget Sound Lidar Consortium with a collection date of 2000) and aerial photographs (from Google Earth Pro) for better analysis of possible basin boundary limits; Boeing storm drain system drawings for catch basin locations, conveyance pipe information, and estimated catch basin drainage boundaries; and the City of Seattle map "Lower Duwamish Waterway Areas Draining to Slip 4" and Figure 2-1 "Storm Drain Lines in the Vicinity of NBF-GTSP Site" from SAIC 2009 for off site catch basin locations, conveyance pipe information, and estimated catch basin drainage boundaries.

2. Black and white reproduction of this color original may reduce its effectiveness and lead to incorrect interpretation.

Base map source: The Boeing Company 2009, Aerial Photo: SAIC 2009

0 100 200

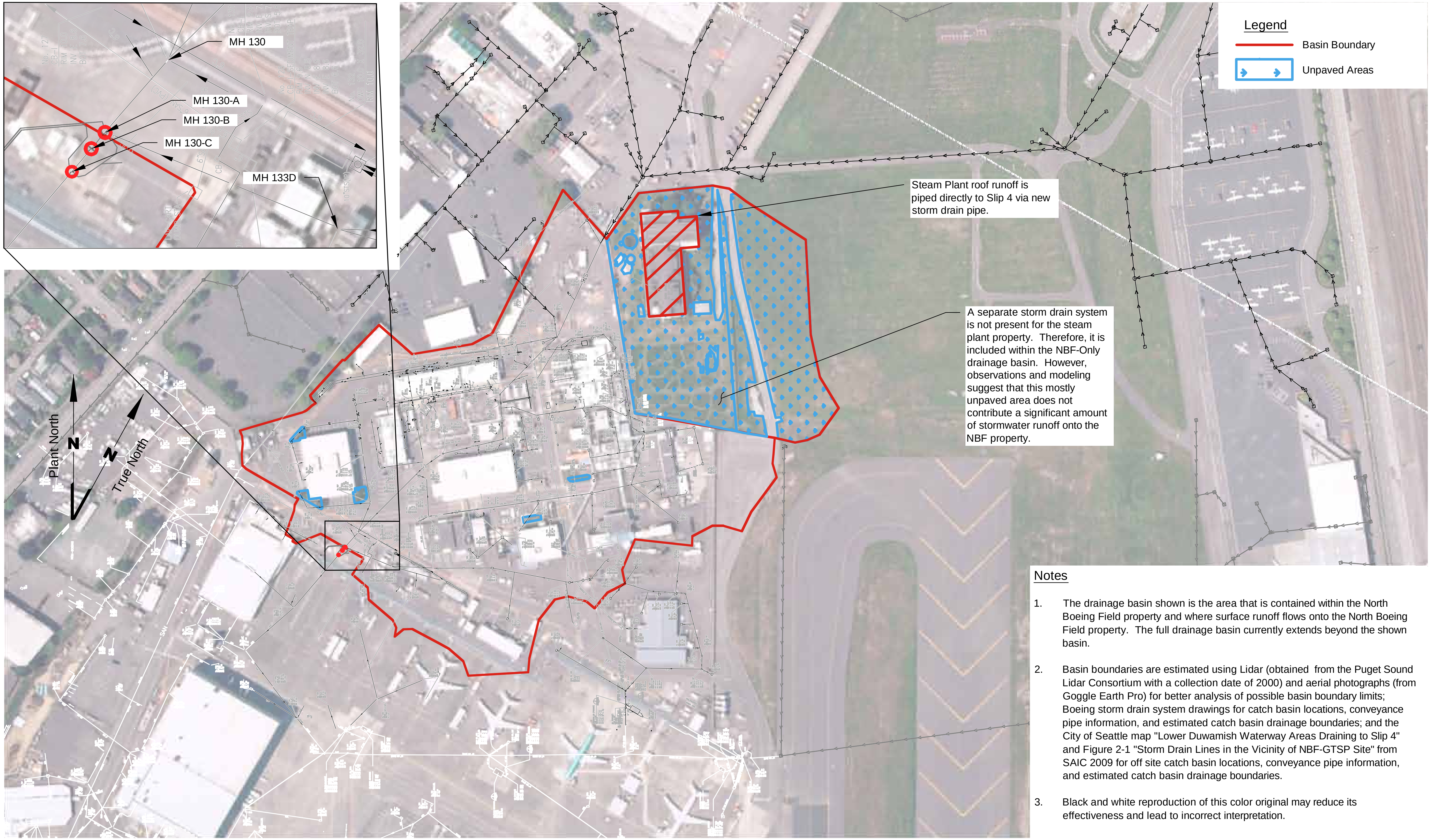
Scale in Feet

LANDAU ASSOCIATES

North Boeing Field
Seattle, Washington

NBF - Onsite Drainage Basin for MH 130

Figure 6



Notes

1. The drainage basin shown is the area that is contained within the North Boeing Field property and where surface runoff flows onto the North Boeing Field property. The full drainage basin currently extends beyond the shown basin.

2. Basin boundaries are estimated using Lidar (obtained from the Puget Sound Lidar Consortium with a collection date of 2000) and aerial photographs (from Goggle Earth Pro) for better analysis of possible basin boundary limits; Boeing storm drain system drawings for catch basin locations, conveyance pipe information, and estimated catch basin drainage boundaries; and the City of Seattle map "Lower Duwamish Waterway Areas Draining to Slip 4" and Figure 2-1 "Storm Drain Lines in the Vicinity of NBF-GTSP Site" from SAIC 2009 for off site catch basin locations, conveyance pipe information, and estimated catch basin drainage boundaries.

3. Black and white reproduction of this color original may reduce its effectiveness and lead to incorrect interpretation.

Base map source: The Boeing Company 2009, Aerial Photo: SAIC 2009

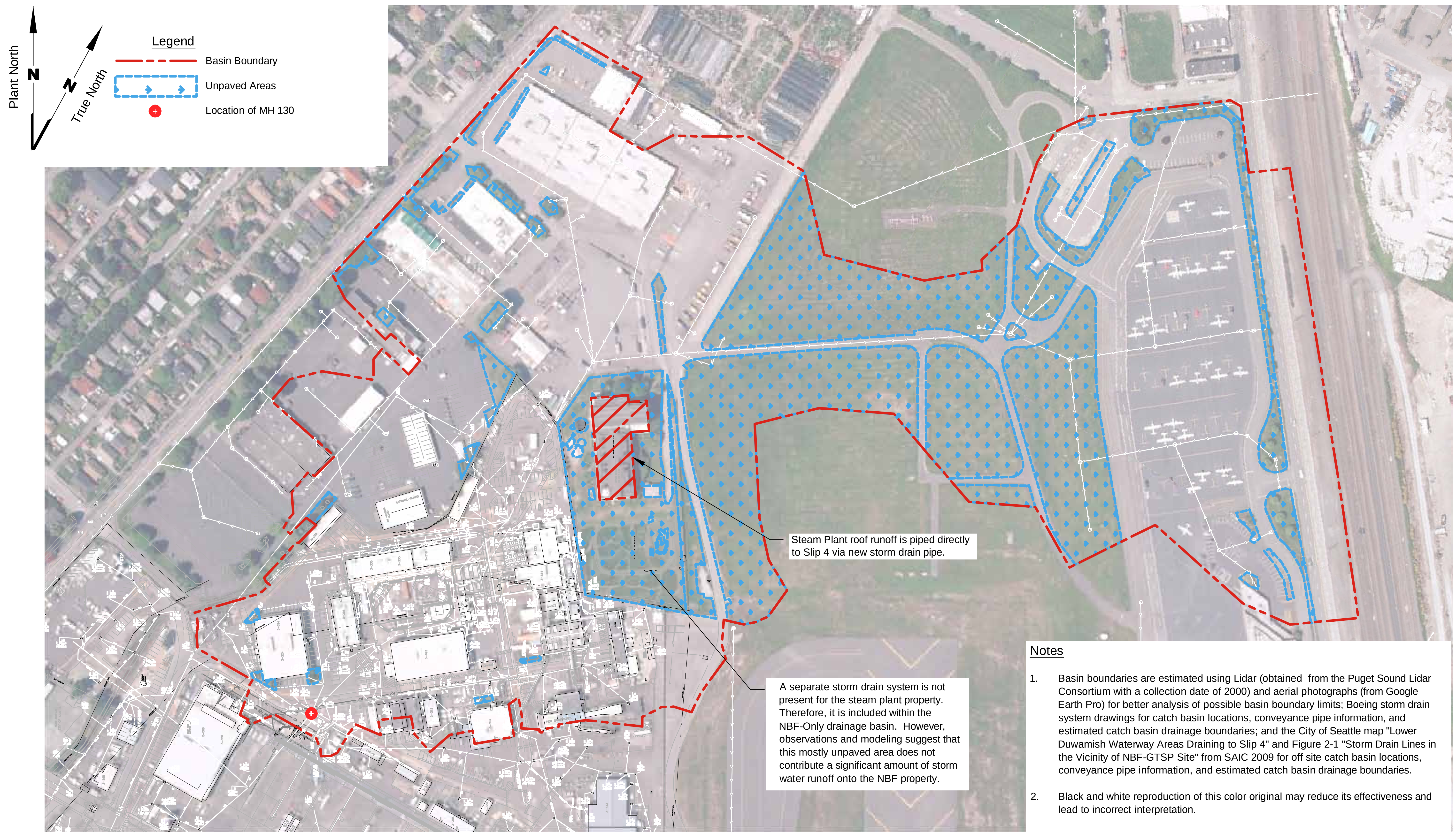
0 200 400
Scale in Feet

LANDAU ASSOCIATES

North Boeing Field
Seattle, Washington

NBF- Onsite Drainage Basin for MH 130A

Figure
7



Notes

1. Basin boundaries are estimated using Lidar (obtained from the Puget Sound Lidar Consortium with a collection date of 2000) and aerial photographs (from Google Earth Pro) for better analysis of possible basin boundary limits; Boeing storm drain system drawings for catch basin locations, conveyance pipe information, and estimated catch basin drainage boundaries; and the City of Seattle map "Lower Duwamish Waterway Areas Draining to Slip 4" and Figure 2-1 "Storm Drain Lines in the Vicinity of NBF-GTSP Site" from SAIC 2009 for off site catch basin locations, conveyance pipe information, and estimated catch basin drainage boundaries.

2. Black and white reproduction of this color original may reduce its effectiveness and lead to incorrect interpretation.

Base map source: The Boeing Company 2009, Aerial Photo: SAIC 2009

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North Boeing Field
Seattle, Washington

Full Drainage Basin for MH 130

Figure 8

Legend

Tank — Pre-Treatment or Storage/Settling Tank.

SF — Chitosan Enhanced Sand Filtration Unit.

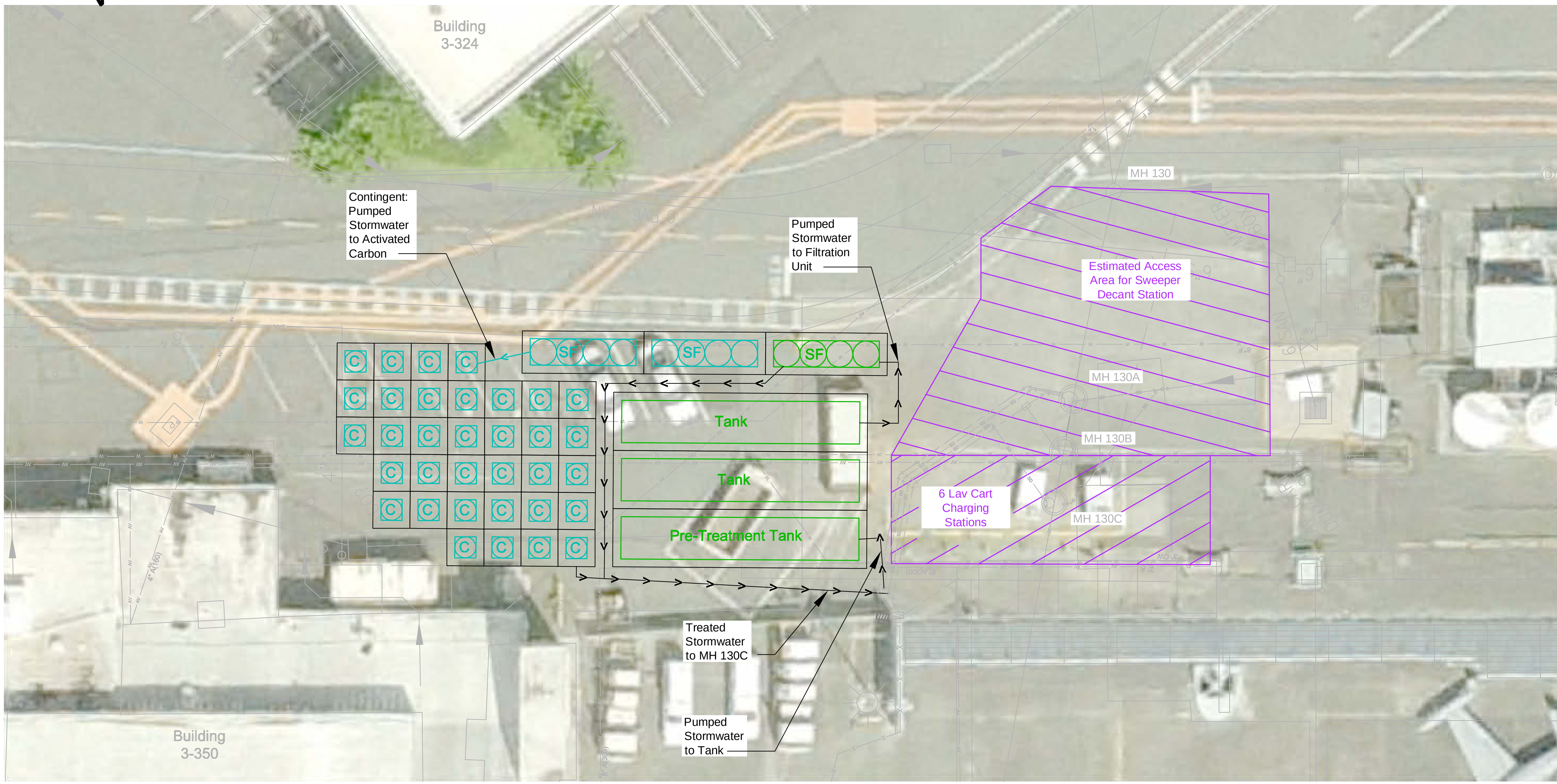
C / SF — Contingent Sand Filtration (SF) Treatment for Full Drainage Basin Flow and Contingent Secondary Treatment Using Granular Activated Carbon (C).

Note

1. Black and white reproduction of this color original may reduce its effectiveness and lead to incorrect interpretation.

Plant North N

True North N



Base map source: The Boeing Company 2009, Aerial Photo: SAIC 2009

0 20 40
Scale in Feet

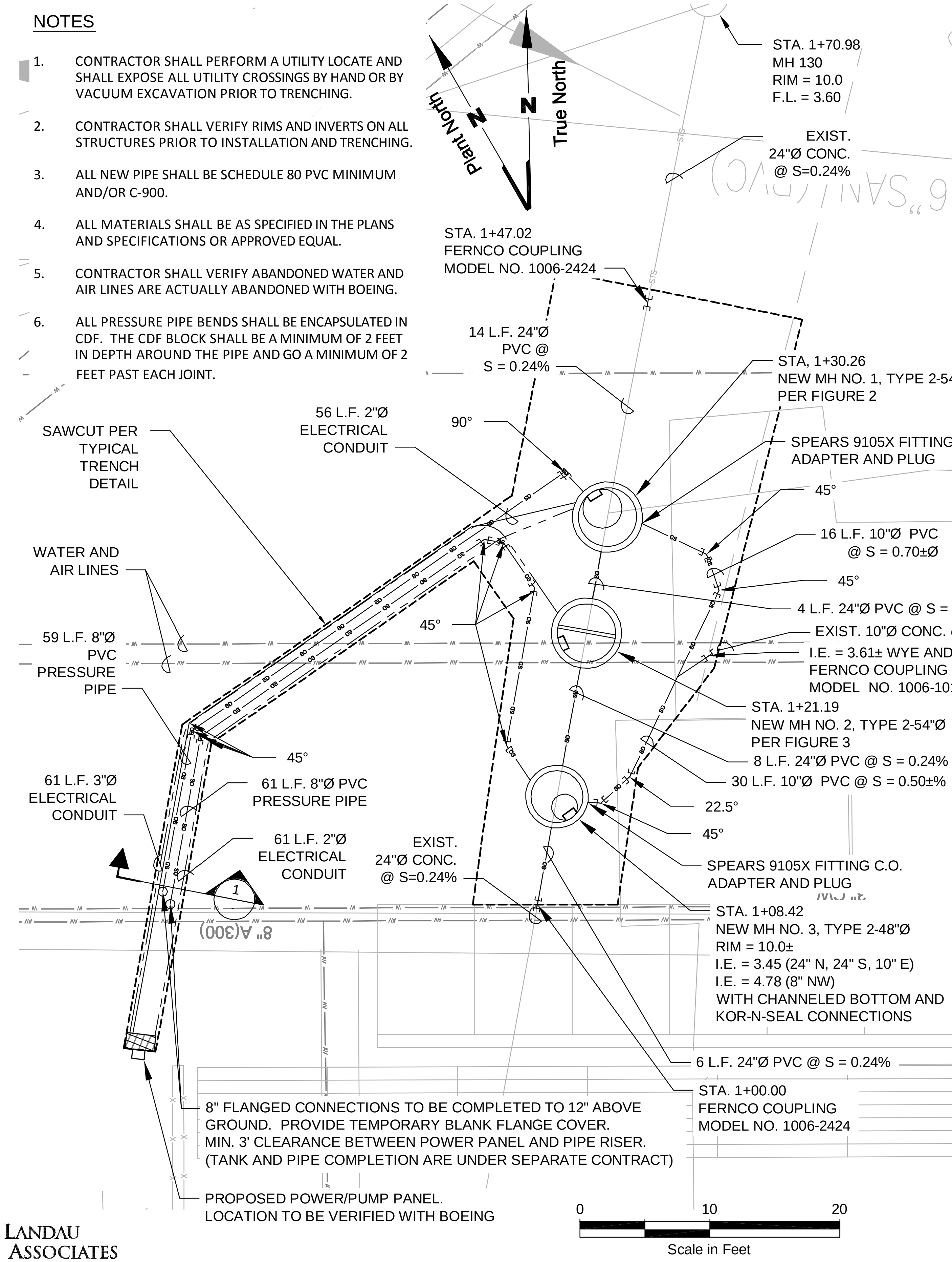
North Boeing Field
Seattle, Washington

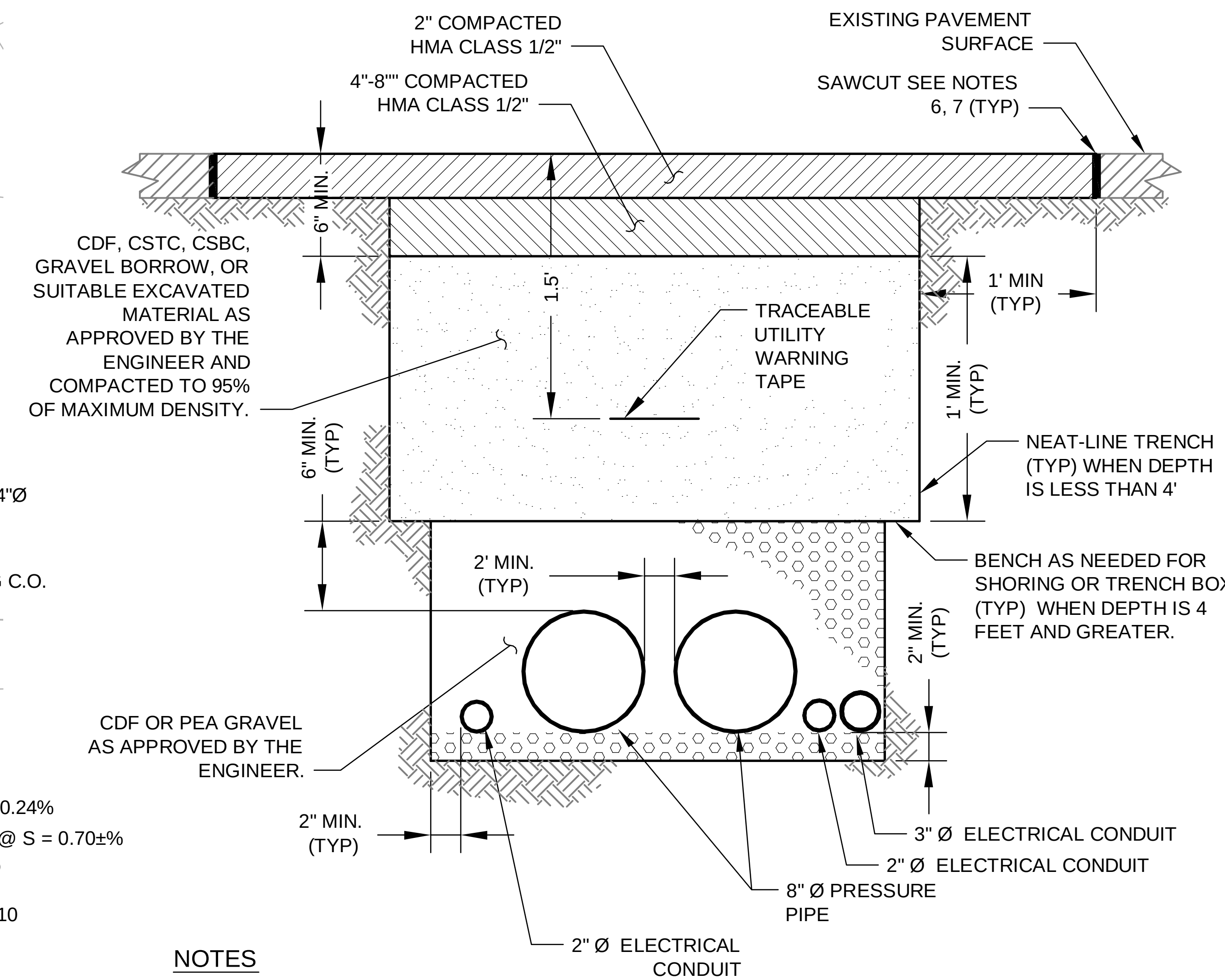
Stormwater Treatment System Layout

Figure 9

NOTES

1. CONTRACTOR SHALL PERFORM A UTILITY LOCATE AND SHALL EXPOSE ALL UTILITY CROSSINGS BY HAND OR BY VACUUM EXCAVATION PRIOR TO TRENCHING.
2. CONTRACTOR SHALL VERIFY RIMS AND INVERTS ON ALL STRUCTURES PRIOR TO INSTALLATION AND TRENCHING.
3. ALL NEW PIPE SHALL BE SCHEDULE 80 PVC MINIMUM AND/OR C-900.
4. ALL MATERIALS SHALL BE AS SPECIFIED IN THE PLANS AND SPECIFICATIONS OR APPROVED EQUAL.
5. CONTRACTOR SHALL VERIFY ABANDONED WATER AND AIR LINES ARE ACTUALLY ABANDONED WITH BOEING.
6. ALL PRESSURE PIPE BENDS SHALL BE ENCAPSULATED IN CDF. THE CDF BLOCK SHALL BE A MINIMUM OF 2 FEET IN DEPTH AROUND THE PIPE AND GO A MINIMUM OF 2 FEET PAST EACH JOINT.





NOTES

1. ALL STANDARD SPECIFICATION SECTION REFERENCES ARE REFERRING TO THE LATEST WSDOT AND APWA STANDARD SPECIFICATIONS FOR ROAD, BRIDGE, AND MUNICIPAL CONSTRUCTION (M 41-01).
2. HMA CLASS 1/2" PG 64-22 MIX SHALL BE PER STD SPEC 5.04.
3. CSTC AND CSBC SHALL BE PER STD SPEC 9-03.9(3) .
4. CDF SHALL BE PER STD SPEC 2-09.3(1) E.
5. PEA GRAVEL SHALL BE PER STD SPEC
6. ALL SAW CUTS SHALL BE VERTICAL AND IN STRAIGHT LINES.
7. TACK ASPHALT FACES OF SAWCUTS AND SEAL SAWCUTS WITH PG 64-22 OIL.
8. EXCAVATIONS OVER 4' DEEP SHALL COMPLY WITH THE SAFETY STANDARD DESCRIBED IN CHAPTER 296-155-PART N OF THE WAC.

1 TYPICAL TRENCH DETAIL

SCALE: N.T.S.

BASE MAP SOURCE: THE BOEING COMPANY 2009

2010-08-22

North Boeing Field Seattle, Washington	**TRENCHED UTILITIES FROM NEW MANHOLES TO STORMWATER TREATMENT SYSTEM**	FIGURE 10

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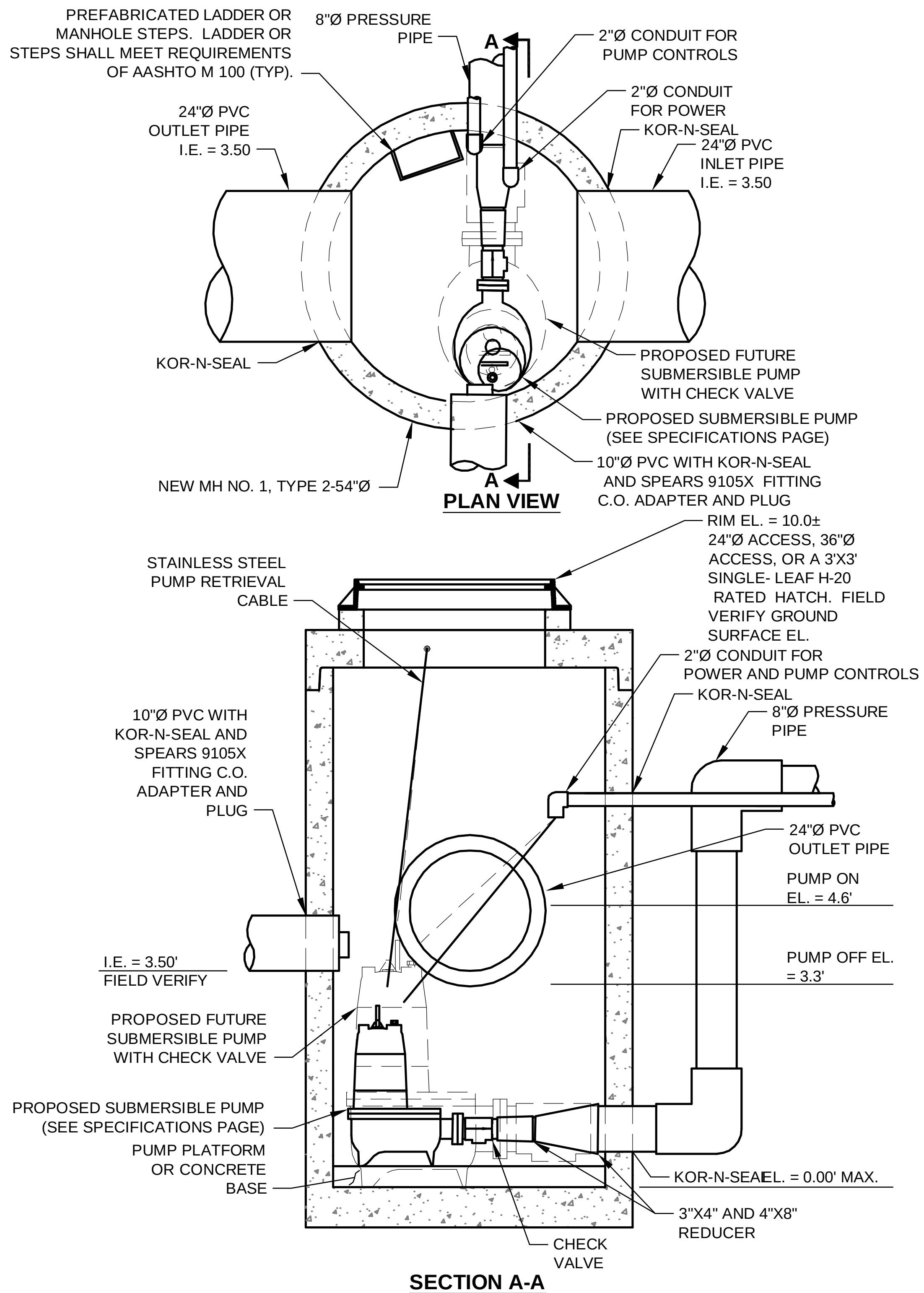
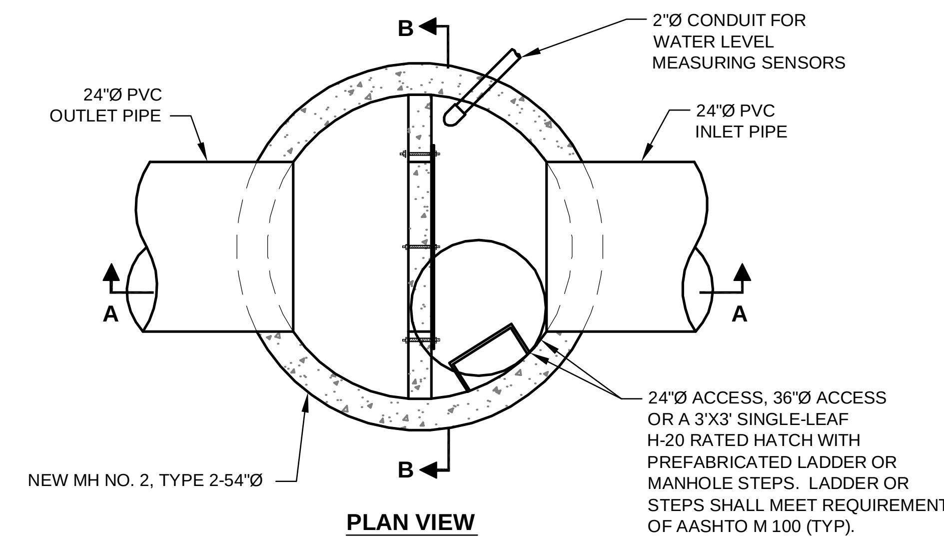


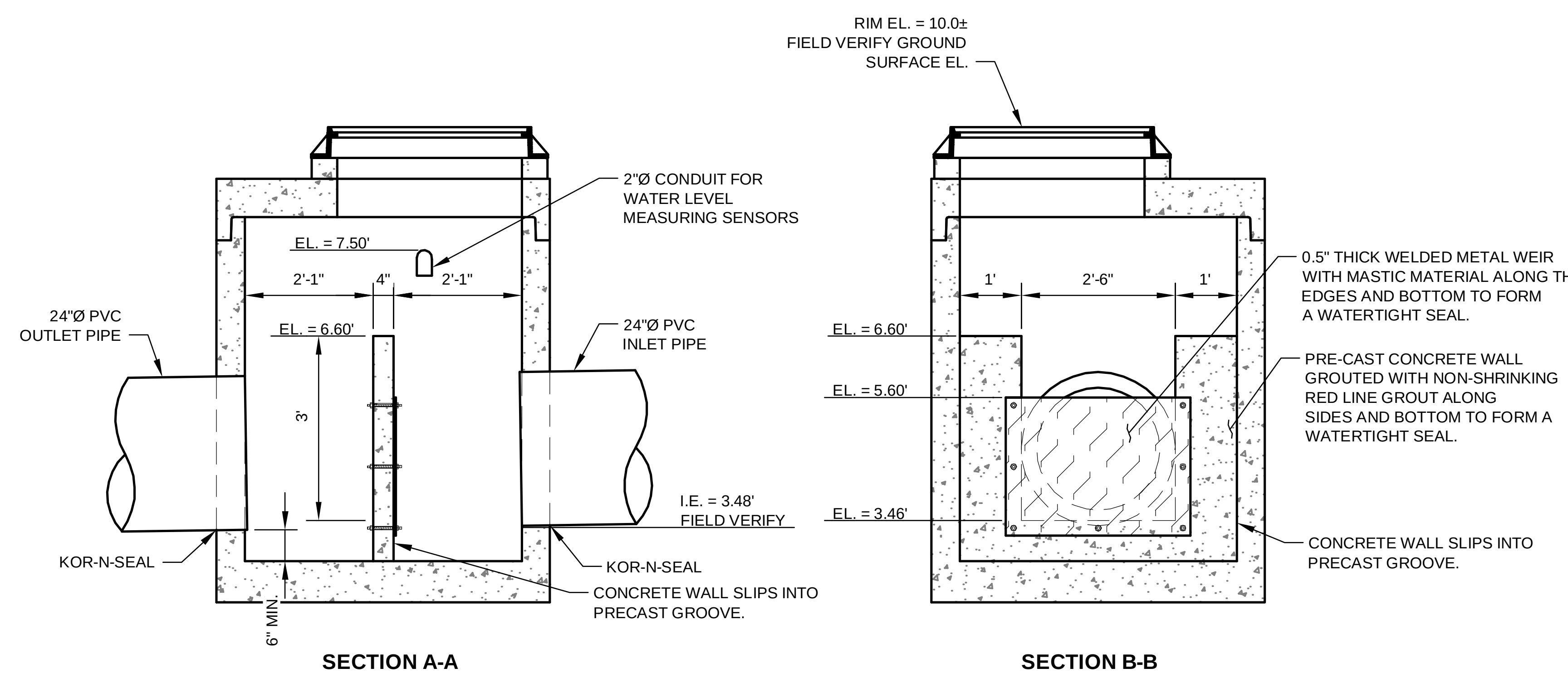
2 NEW MANHOLE NO. 1 (MH130A) DETAIL

SCALE: N.T.S.

NOTES

1. GROUT ALL MANHOLE PIPE PENETRATIONS AND THEN APPLY WATER-SEALING POLYURETHANE GROUT.
2. CONTRACTOR SHALL SUBMIT FOR APPROVAL, DETAILS AND SPECIFICATIONS OF SUPPORT ANCHORING OF PIPE.
3. CONTRACTOR SHALL SUBMIT FOR APPROVAL, DETAILS AND SPECIFICATIONS FOR "L" BRACKETS AND CONCRETE WALL ANCHORING.
4. CONTRACTOR SHALL SUBMIT FOR APPROVAL DETAILS AND SPECIFICATIONS FOR PUMP ANCHORING SYSTEMS.
5. ALL NEW PIPE SHALL BE SCHEDULE 80 PVC MINIMUM AND/OR C-900.
6. ALL MATERIALS SHALL BE AS SPECIFIED IN THE PLANS AND SPECIFICATIONS OR APPROVED EQUAL.





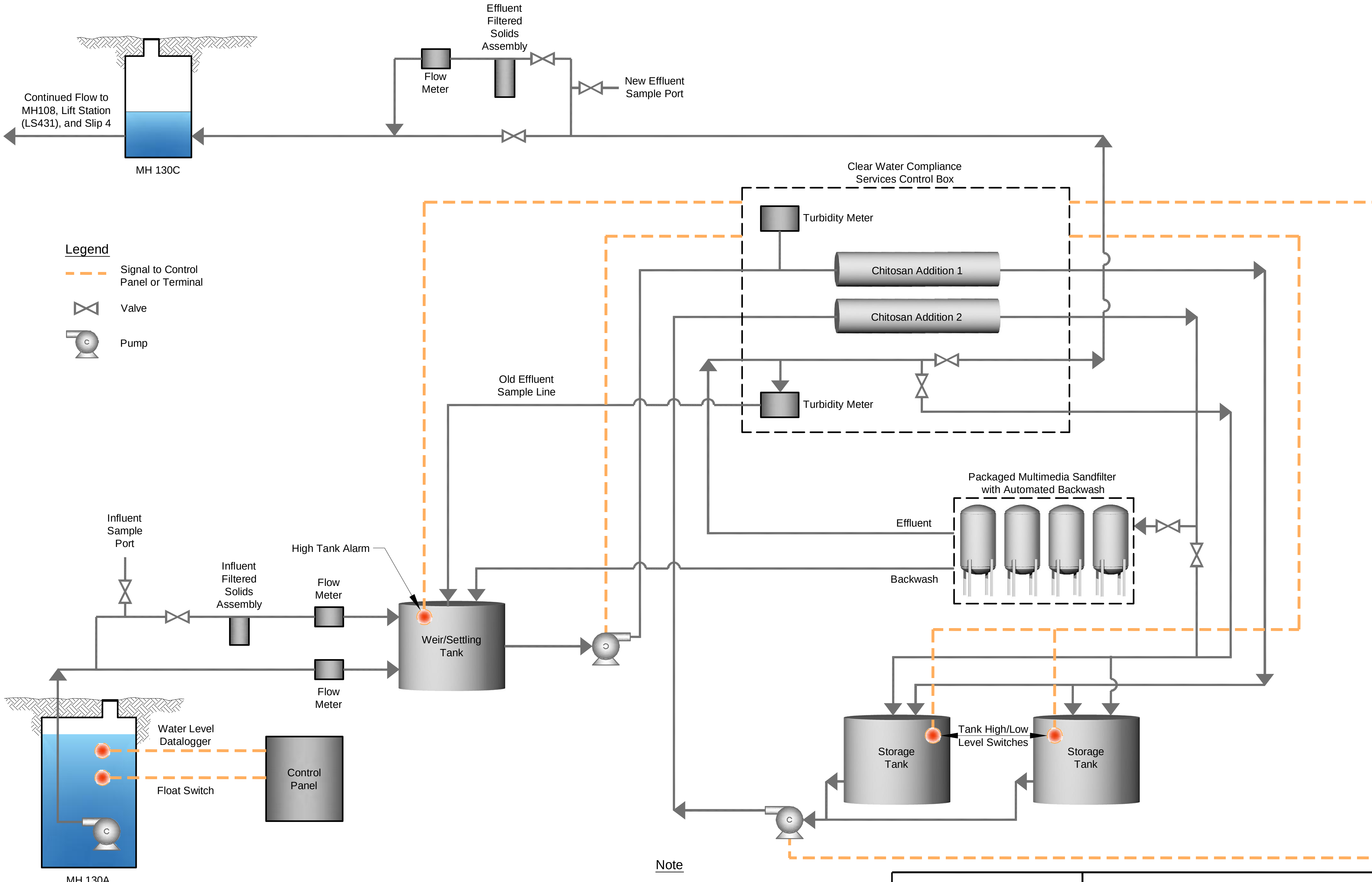
3 NEW MANHOLE NO. 2 (MH 103B) DETAIL

SCALE: N.T.S.

LANDAU ASSOCIATES, INC. | V:\025\082\210\004 design\F-WP-FINAL-FIG11-MH NEW.dwg (A) "Figure 10" 12/13/2010

LANDAU ASSOCIATES

North Boeing Field Seattle, Washington	**NEW STORMWATER LIFT STATION AND OVERFLOW WEIR**	Figure 11



Note

1. Black and white reproduction of this color original may reduce its effectiveness and lead to incorrect interpretation.

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North Boeing Filed
Seattle, Washington

Short-Term Stormwater Treatment Facility Schematic

Figure 12

U.S. Environmental Protection Agency

Karen Keeley/Project Manager - Overall project management
206-553-2141

Washington State Department of Ecology

Mark Edens/Project Manager - Overall project management
for MTCA NBF/GTSP RI/FS - 425-649-7070

The Boeing Company

Carl Bach/Environmental Remediation Project Manager -
Responsible for technical issues - 206-898-0438
Brian Anderson/Environmental Remediation Project Manager -
Responsible for EPA coordination - 425-373-8825
Ray Power/BCA Remediation Focal -
Responsible for NBF stormwater compliance - 425-965-2297
Jennifer Parsons/Environmental Remediation -
Coordination of field activities - 206-715-7981
Fred Wallace/Environmental Remediation -
Coordination of field activities - 206-930-0461

SAIC

Iris Winstanley, Ecology Contract Manager
Glen Vedera, Field Lead for Stormwater Sampling

Analytical Resources, Inc.

Kelly Bottem/Client Services Manager
-Responsible for sample analysis
206-695-6200

Landau Associates, Inc.
425-778-0907

Kris Hendrickson, PE/Project Manager - Overall project management
Joe Kalmar, PE/Stormwater Lead - Lead engineer for project design and monitoring
Robert Ludwig, PE/Engineer - Design support
Chris Kimmel/Health and Safety Officer - Overall project health and safety
Martin Valeri/Field Lead - Field lead for performance and site-wide monitoring
Ken Brown/Field Technician - Field monitoring and support
Anne Halvorsen/Data Manager - Data validation and management

Geosyntec

Eric Strecker, PE/Principal
-Additional stormwater treatment support
503-222-9518
Brandon Steets, PE/Senior Engineer
-Additional stormwater treatment support
805-897-3800 x9122

Clear Water Compliance Services
425-412-5700

Neil Doherty/Project Manager -Treatment system installation, O&M, reporting,
and field management - 425-754-5265
Nate Holloway/Sr. Project Manager - Treatment system project support
Tyrone Clager/QA/QC, Safety Officer, CPESC - Treatment system QA/QC and safety
Todd Toland/Superintendent - Treatment system maintenance
Chris Augustine/President - Treatment system administration and contract

Glacier Environmental Services, Inc.

Steve Miles/Project Manager
Management of storm drain system
improvements/installation
425-355-2826

LANDAU ASSOCIATES

North Boeing Field
Seattle, Washington

Removal Action Team - Project Organization Chart

Figure 13

TABLE 1
MASS BALANCE TO ESTIMATE PCBs CONCENTRATIONS FOLLOWING SHORT-TERM TREATMENT
NORTH BOEING FIELD
SEATTLE, WASHINGTON

	Solids (PCBs in mg/kg)												Whole Water (PCBs in µg/L)	
Storm Drain Lateral	South	Offsite	S.Central	Offsite	N. Central	Offsite	North	Offsite	3-380	Lift Station	Park Lot	**Site**	North	Lift Station
Sediment Trap ID	SL4-T2	SL4-T2A	SL4-T3	SL4-T3A	SL4-T4	SL4-T4A	SL4-T5	SL4-T5A		SL4-T1				
Structure ID	MH356	MH492	MH364	MH19C	MH221A	MH299A	MH363	MH178	Average	MH422	Average		MH108	LS431
PCBs [recent monitoring result(s)][1]	0.46	0.18	0.25	0.02	1.1	0.68	2.6	0.44	0.32	4.0	0.55		0.092	0.027
% of Lift Station Load[2]	44%		21%		14%		17%		4%	100%			17%	100%
PCBs - weighted	0.20	0.08	0.05	0.004	0.15	0.09	0.44	0.08	0.01					
Source Control and SD Cleaning Load Reduction[3]														
80%	0.04		0.01		0.03		0.09		0.00		0.11		0.018	0.005
30%	0.14		0.04		0.10		0.31		0.01		0.39		0.064	0.019
Post-Treatment[4]														
NBF Only (offsite bypassed)														
PCBs - Estimated Low Range	0.04		0.01		0.03		0.04		0.00	**0.13**	0.11	**0.13**	0.009	**0.006**
PCBs - Estimated High Range	0.14		0.04		0.10		0.15		0.01	**0.44**	0.39	**0.44**	0.032	**0.021**
Including Offsite Drainage[5]														
PCBs - Estimated Low Range	N/A	0.08	0.01		N/A	0.09	N/A	0.08	0.00	**0.26**	0.11	**0.25**	0.014	**0.007**
PCBs - Estimated High Range	0.14		0.04		0.10		0.17		0.01	**0.46**	0.39	**0.46**	0.047	**0.024**

Routed through Lift Station LS431	Area (acres)	% of Total
North Lateral through MH130	10.2	9.7%
North Lateral not through MH130	7.9	7.5%
North-central lateral	14.7	13.9%
South-central lateral	21.9	20.7%
South lateral	46.3	43.8%
Bldg 3-380 area	4.6	4.4%
Total drainage area (through LS431)	105.6	100%

Entire Site		
From Lift Station	105.6	94%
Parking Lot Area	6.8	6%
Area Going to Sanitary Sewer	0.1	0%
Total drainage area	112.4	100%

Notes:

1. PCB solids loading for storm laterals estimated from most recent sediment trap data (April 2010 for MH356, MH364, MH221A, MH299A, MH363, MH178, MH422, and October 2009 for MH492 and MH19C) and from an average of PCB concentrations from all storm drain structures sampled in April 2010 for laterals without sediment trap data (3-380 and Parking Lot areas only). PCB whole water loading is estimated using an average of whole water sample data from October 2009 through June 2010.

2. Based on drainage area of lateral compared to total NBF drainage area routed through LS431. The Parking Lot Area is downstream of the Lift Station, and PCB loading for this area is weighted and accounted for after estimating loading at the Lift Station. All area data is from SAIC (SAIC 2010).

3. In 2010, many source control/storm drain cleaning actions were or are currently being conducted. Activities include vactoring all solids from every storm drain structure accessible on NBF property and jet-rodding every accessible storm drain line on NBF property. Work in the North Lateral also includes removal of concrete joint material, grouting storm drain structures where groundwater infiltration was observed, and excavating near the 3-322 building.

4. Post treatment calculations assume a 90% reduction in PCB concentration for the NBF-Only (offsite bypassed) scenario, and a 60% reduction in PCB concentration for the Including Offsite Drainage scenario. These reductions were applied only to the portion of North Lateral drainage area that is routed through MH130, and are based on the percent of flow treated as calculated by WWHMv3.

5. In this scenario, if the post-treatment load reduction calculation reduced the PCB concentration below that being contributed from offsite, the weighted offsite concentration (shown in blue text), was used instead.

TABLE 2
SHORT-TERM REMOVAL ACTION SAMPLING AND ANALYSIS SUMMARY
NORTH BOEING FIELD - SEATTLE, WASHINGTON

Location	Sample Type	Sample Media	Frequency (a)	Parameters (q)	Analytical Methods
Lift Station (LS 431)	Whole Water (b, c, p) (flow-weighted composite)	Stormwater (d)	10 Initial Events (5 storm events and 2 base flow under the ASAOC and 3 additional storm events to provide data for Ecology NBF/GTSP RI/FS), Nov 2010 - April 2011	PCBs	EPA Method 8082
				TSS	SM 2540
			To be Determined (e), starting May 2011	PCBs	EPA Method 8082
				TSS	SM 2540
	Filtered Solids (b, p, q) (in-line stormwater filtration)	Stormwater Solids	10 Initial Events (5 storm events and 2 base flow under the ASAOC and 3 additional storm events to provide data for Ecology NBF/GTSP RI/FS), Nov 2010 - April 2011	PCBs	EPA Method 8082
				TSS	Calculated (f)
				Particle Size Distribution	PSEP-PS
				PCB Concentrations by particle size (m)	EPA Method 8082
			To be Determined (e), starting May 2011	PCBs	EPA Method 8082
				TSS	Calculated (f)
				Particle Size Distribution	PSEP-PS (r)
				PCB Concentrations by particle size (m)	EPA Method 8082
	Bed Load (g)	Residual Solids	5 Storm Events and 2 Base Flow Events	PCBs	EPA Method 8082
Short-Term Stormwater Treatment System	Whole Water Influent (grab)	Stormwater (d)	Weekly (h)	PCBs	EPA Method 8082
				TSS	SM 2540
	Whole Water Effluent (grab)	Stormwater (d)	Weekly (h)	PCBs	EPA Method 8082
				TSS	SM 2540
	Whole Water Effluent (grab) (i)	Stormwater (d)	Weekly (j)	Residual Chitosan	Ecology approved procedure (k)
	Filtered Solids Influent	Stormwater Suspended Solids	Twice monthly (l)	PCBs	EPA Method 8082
				TSS	Calculated (f)
	Filtered Solids Effluent	Stormwater Suspended Solids	Twice monthly (l)	PCBs	EPA Method 8082
				TSS	Calculated (f)
Manhole 108 (MH108) (p)	Whole Water Effluent (b, p) (flow-weighted composite)	Stormwater (d)	5 Storm Events Nov 2010 - February 2011 (h)	PCBs	EPA Method 8082
				TSS	SM 2540
	Filtered Solids (b, p, q) (in-line stormwater filtration)	Stormwater Solids	5 Storm Events Nov 2010 - February 2011 (h)	PCBs	EPA Method 8082
				TSS	Calculated (f)
				Particle Size Distribution	PSEP-PS (r)
				PCB Concentrations by particle size (m)	EPA Method 8082
Sediment Traps (SL4-T1, SL4-T2, SL4-T3, SL4-T4, SL4-T4A, SL4-T5, SL4-T5A)	Grab	Stormwater Solids	Semi-Annually (n)	PCBs	EPA Method 8082
				Semivolatiles	PSDDA SVOCS SW8270D
				Total Metals	Method 6000-7000
				NWTPH-Dx	NWTPH-Dx
				Total Organic Carbon	Plumb, 1981
				Grain Size	PSEP-PS
Weir tank (filter backwash tank)	Grab	Settled Solids	As Needed (o)	PCBs	EPA Method 8082
				PAHs	SW8270D
				metals	TCLP and/or Method 6000-7000
				Petroleum Hydrocarbons	NWTPH-Dx and NWTPH-Gx

TABLE 2
SHORT-TERM REMOVAL ACTION SAMPLING AND ANALYSIS SUMMARY
NORTH BOEING FIELD - SEATTLE, WASHINGTON

Location	Sample Type	Sample Media	Frequency (a)	Parameters (q)	Analytical Methods

(a) Monitoring plan beginning November 2010. All sampling and analysis will be performed by Boeing/Landau Associates and Boeing's contract laboratory, unless otherwise noted.
(b) Boeing is coordinating with the Washington State Department of Ecology and their consultant SAIC for sampling at the lift station and Manhole 108. Samples may be collected by either Boeing/Landau Associates or Ecology/SAIC.
(c) During three events, Ecology/SAIC will collect whole water samples at the lift station using centrifuge method (Green River) and submit the samples for PCB analysis .
(d) Stormwater is defined as all liquids, including any particles dissolved therein, in the form of base flow, storm water runoff, snow melt runoff, and drainage, as well as all solids which enter the storm drain system.
(e) Boeing will propose to EPA a sampling frequency of monthly or quarterly based on the results from the initial 10 sampling events.
(f) Calculated based on mass of filtered solids and volume of stormwater filtered.
(g) The feasible location(s) for installation and specific type of bed load sampling unit is still being determined.
(h) The five Manhole 108 stormwater and solids sampling events and at least five of the weekly influent/ effluent sampling events will be performed concurrent with the lift station storm sampling events. Whether or not weir overflow occurred (i.e., treatment system bybass) during the sampling period will be recorded.
(i) Whole water effluent grab samples for Residual Chitosan testing will be collected from the treatment facility effluent sample port by Clear Water Compliance Services.
(j) Because of the uniform low turbidity of the NBF stormwater relative to the typical chitosan effluent sand filtration (CESF) construction site projects, the fact that residual chitosan has never been detected in sand filter effluent from this project, and because of the extremely low probability of chitosan passing through the sand filters, residual chitosan is proposed to be conducted weekly.
(k) Per Clear Water O&M Manual, Ecology approves procedures for residual chitosan testing for each distributor of chitosan acetate. Testing will be conducted in accordance with the distributors approved procedures.
(l) The influent and effluent flow rate will be checked twice monthly. If the flow rate is low enough to suggest adequate amount of solids have collected on the filter, a filtered solids sample will be collected and analyzed.
(m) It is expected that there will be adequate quantity of solids for particle size distribution analysis, but there may not be an adequate amount of solids for the laboratory to analyze PCBs within selected particle size fractions.
(n) Sediment traps were installed November 12, 2010. The traps will be collected and replaced in April 2011. Depending on the quantity of solids collected, the laboratory may not be able to analyze all parameters. Analysis of parameters will be prioritized in the order listed.
(o) The thickness of accumulated solids (sludge) in the weir tank will be checked monthly by Clear Water Compliance Services. If more than an average of 12 inches of solids have accumulated a grab sample of the solids will be collected by Boeing/Landau Associates and analyzed for waste characterization purposes. Similar testing would be done of filter sand prior to disposal.
(p) Lift station and Manhole 108 whole water samples will also be analyzed for metals (arsenic, cadmium, chromium, copper, lead, mercury, silver, and zinc), SVOCs, and TOC and other conventionals in accordance with the Ecology/SAIC storm system sampling work plan and addenda (SAIC 2009, 2010b, 2010c) if sufficient volume is available.
Lift station and Manhole 108 solids samples will also be analyzed for metals (arsenic, cadmium, chromium, copper, lead, mercury, silver, and zinc), PAHs, and dioxins/furans in accordance with the Ecology/SAIC storm system sampling work plan and addenda (SAIC 2009, 2010b, 2010c) if sufficient volume is available.
(q) Analyses will be performed if sufficient sample volume is collected. The priority for analysis of samples if insufficient sample volume is collected is summarized in Table 4.
(r) Grain size fractionation/particle size distribution will be conducted using Puget Sound Estuary Protocols (PSEP) method. When low volumes of sample are collected, grain size fractionation will be accomplished using sedigraph for material less than 62.5 µm.

APPENDIX A

Operation and Maintenance Manual

APPENDIX A
Operation and Maintenance Manual
Short-Term Stormwater Treatment Facility
North Boeing Field
Seattle, Washington

January 7, 2011

Prepared for

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ATTACHMENTS

1.0 INTRODUCTION

This operation and maintenance (O&M) manual has been prepared to present recommended operation, maintenance, monitoring, and testing procedures related to the short-term stormwater treatment (STST) system at North Boeing Field (NBF). The STST system is designed to remove polychlorinated biphenyls (PCBs) from stormwater in the storm drain system at NBF; the system became operational on September 15, 2010. The STST system is expected to operate until a long-term stormwater treatment remedy is in place or until it is otherwise deemed unnecessary to continue operation.

This manual is an Appendix of the *Removal Action Work Plan for the Short-Term Stormwater Treatment System, North Boeing Field* (Landau Associates, December 13, 2010; Work Plan; revision in process). All figures referenced in this document are presented in the Work Plan.

1.1 SITE LOCATION

NBF is located east of East Marginal Way South, adjacent to the King County International Airport (KCIA) and the city of Seattle Georgetown Steam Plant (GTSP). The approximate street address is 7370 East Marginal Way South, Seattle, Washington. The location of the facility is shown on Figure 1 of the Work Plan.

1.2 TREATMENT SYSTEM LOCATION AND DESCRIPTION

The STST is located southwest of storm drain structure (manhole) MH130, northeast of Building 3-350, north of the blast fence, and west of the existing sweeper decant treatment facility, as shown on Figure 3 of the Work Plan. A new series of manholes (MH130A, B, and C) were installed approximately 40 ft downstream of MH130. The new structures are designed to allow stormwater capture, pump-out, and re-introduction of treated stormwater; their location is shown on Figure 7 of the Work Plan. Components include a sump and submersible pump located in MH130A, and a weir located in MH130B that is designed to detain stormwater in the structures (and in upstream piping) to establish a reservoir from which to pump and to allow overflow of extreme storm events. The weir elevation is constructed to provide adequate storage capacity to reduce the cycling frequency of the submersible pump to within manufacturer guidelines, in order to maximize pump motor life. Conversely, the weir elevation is constructed low enough and with an adequate overflow cross-sectional area to avoid flooding of upstream areas during an extreme precipitation event (e.g., the 100-year storm). The third structure, MH130C, is constructed to receive discharge from the STST.

The STST consists of a chitosan-enhanced sand filtration (CESF) system. Attachment 1 of this manual shows a process flow diagram of the STST. The design includes one 18,000-gallon capacity aboveground pretreatment tank with a weir (which also doubles as a backflush tank) and two 21,000-gallon capacity aboveground holding tanks to provide additional storage and pretreatment capacity. One of the storage tanks could also be reconfigured to be a post-treatment holding/testing tank, if found to be necessary. As indicated by the area shown on Figure 9 of the Work Plan, additional space is available to accommodate additional storage tanks and treatment system equipment, if determined to be necessary to meet interim PCB removal goals. The system also includes skid-mounted sand filter vessels with an automatic backwash system, and an automatic flow-proportional chitosan pump dosing system with inline static mixers. The specific sizing and number of transfer pumps, sand filters, and chitosan metering pumps was determined by Clear Water Compliance Services (Clear Water), the stormwater treatment contractor that installed and operates the system. Additional specifications of the STST system equipment are provided below in Section 2.1.1.

Chitosan is a natural polymer that can be extracted from shrimp and crab shells. For stormwater treatment applications, chitosan is produced into a liquid solution of chitosan acetate that is dosed into the stormwater prior to a filtration step (e.g., sand filter). The chitosan is able to help agglomerate suspended solids including even small colloidal suspended solids that are otherwise resistant to settling and filtration. The dosage of chitosan acetate into stormwater has been and is expected to continue to be less than one part per million (ppm). CESF systems have been used extensively at construction sites to reduce turbidity in stormwater runoff, and these systems are typically capable of removing suspended solids to the extent that turbidity is reduced to 1 Nephelometric turbidity unit (NTU) or below. CESF systems have also been used, although less often, at industrial sites for stormwater treatment projects. The Washington State Department of Ecology (Ecology) does require periodic testing for residual chitosan to ensure that the chitosan has been properly removed in the filtration step.

PCBs are extremely insoluble and are found in stormwater almost entirely bound to suspended particles. However, if it is determined through testing of the STST system that PCBs are not adequately removed through the CESF system, then contingent use of granular activated carbon (GAC), effective at removing dissolved organic compounds from water, will be considered. If GAC were to be added to the STST due to the presence of dissolved PCBs, then water treated by GAC and discharged to the storm sewer would be tested for PCBs to confirm adequate PCB removal. Space within the treatment system area has been allotted for the contingent GAC system. Boeing will make the necessary arrangements to have carbon vessels available, installed, and operational within 3 weeks of determination that the CESF system is inadequate to meet the whole water PCB standard (described in the Work Plan).

Two different drainage basins were evaluated for potential treatment in the Work Plan. The treatment system installed was sized for the “NBF-Only” drainage basin, which encompasses only the area that drains to MH130 that is leased by Boeing. However, the design included provisions for possible expansion of the treatment system to be sized to treat the "Full Drainage Basin", which encompasses all of the area that drains to MH130, including the offsite area.

The original design layout of the STST system is shown on Figure 9 of the Work Plan. Each of the skid-mounted sand filter systems is shown as a multiple pressure vessel system (e.g., shown as 4-vessel systems) to allow automated sequential backwashing of each sand filter vessel without loss of the full design treatment flow rate. To show that space is also available for expansion of the system, the additional sand filter equipment that would be needed to process the Full Drainage Basin design flow rate of 3.09 cubic feet per second [cfs; approximately 1,390 gallons per minute (gpm)] is shown in a separate color on Figure 9 of the Work Plan. In addition, if secondary treatment is needed, the number and approximate size of GAC vessels that could process the Full Drainage Basin design flow rate are also shown in a separate color on Figure 9 of the Work Plan.

2.0 TREATMENT SYSTEM OPERATION, MAINTENANCE, AND MONITORING

This section describes the operation, maintenance, and monitoring of the STST system. Performance monitoring of the system is discussed in Section 3.0, and monitoring at other NBF locations to characterize site-wide stormwater discharge is described in the Work Plan and the Sampling and Analysis Plan (SAP) that is provided in Appendix C of the Work Plan.

2.1 OPERATION AND MAINTENANCE

Many of the standard procedures and guidelines for CESF systems are written for construction sites, where the system is only run during regular business hours, can be constantly monitored, and where a retention structure can detain stormwater during hours of system shutdown. At NBF, treatment will take place 24 hours a day due to base flow. System pumps were designed to automatically cycle on and off depending on the incoming flow rate of stormwater. Additionally, CESF systems at construction sites receive water of greatly varying turbidity, often very turbid, whereas the influent stormwater at NBF is much less turbid, and of a more consistent quality.

For these reasons, system startup and initial monitoring at NBF was much the same as at a construction site, but, now that the system is running smoothly, constant monitoring is not necessary. After initial optimization (conducted during the first week of operation), only weekly calibration and a routine site and system inspection to ensure proper operation require direct operator supervision. A remote alert messaging system will notify the operator of potential problems when the system is unmanned. Table 1 summarizes the monitoring tasks associated with the treatment system and their frequency.

The following sections describe startup procedures, monitoring procedures, and frequency of monitoring for the CESF system at NBF.

2.1.1 SYSTEM COMPONENTS

Although there are variations between individual CESF systems, many of the basic components are similar. The following is a list of the individual components associated with the CESF system at NBF.

Stormwater Retention Structure(s): Stormwater retention structures can include ponds, tanks, or vaults. At NBF, stormwater is retained in the sump of the 54-inch diameter manhole structure MH130A, in the portion of MH130B upstream of the weir, and in piping upstream of MH130A and in between MH130A and MH130B.

Stormwater Collection Pump: The stormwater collection pump is a 10 horsepower (hp) submersible electric pump. For the STST system, the submersible pump is located in MH130A. The pump is controlled by float activation with pump on at approximately elevation 4.45 ft and pump off at elevation 3.3 ft. The weir downstream in MH130B is at approximately 5.23 ft elevation.

Pretreatment Tank: For the STST system, the submersible pump in MH130A discharges to an 18,000-gallon pretreatment tank with a weir, to allow settling of large particles and retention of any spilled floating oil prior to chitosan dosing.

Chitosan Injection System: The chitosan injection system consists of a chitosan storage tank (a 275-gallon tote, located inside the control trailer), a variable speed chemical metering pump, graduated cylinders for calibration, inline static mixers, and assorted tubing and control valves. For the STST system, Chitosan dosing occurs both in between the pretreatment tank and the storage tanks, and in between the storage tanks and the sand filtration unit.

Storage Tanks: For the STST system, two 21,000-gallon steel aboveground storage tanks (ASTs) provide storage capacity and allow for further settling of heavy solids prior to sand filtration.

Transfer Pumps: The main pump, which pumps water from the storage tanks through the sand filter, is equipped with a 30 hp electric motor. Another smaller pump transfers water from the inlet weir tank to the two storage tanks. The transfer pumps are controlled by float activation to provide automation of the system.

Sand Filtration Unit: The sand pod unit has four 54-inch-diameter steel sand filter vessel pods (54x4) with automatic backflush capabilities. Sand filters are the primary cleaning mechanism of the CESF system. In order to rejuvenate the filter media in a given pod/vessel, water for backflushing is taken directly from the filtered effluent from the other pods/vessels; no potable water connection is necessary. Backflush water is conveyed to a backflush tank.

Backflush Tank: At NBF, the first chamber (prior to the weir) of the 18,000-gallon pretreatment tank will double as a backflush tank. In addition to conserving footprint, this will improve settling in the pretreatment tank from addition of some chitosan present in the backflush water.

Programmable Logic Controller (PLC): The PLC is used to operate the treatment system. All automated controls, alarm settings, and recent system data are stored in the PLC.

Interconnecting Piping: Interconnecting piping integrates all the components in the STST and conveys the water to the discharge point. The STST system includes primarily polyvinyl chloride (PVC) piping with some polyethylene tubing for sampling conveyance (i.e., for the turbidity and pH meters). For the STST system, piping is trenched between MH130A and the pretreatment tank, and between the sand filter unit and MH130C, but is aboveground in the treatment area, because the treatment area is outside of vehicle traffic and pedestrian access areas.

Pipe Fittings: PVC pipes are typically connected with couplers and glue. Some flanges are used and are bolted together with a rubber sealing gasket. Some cam lock connectors (quick-disconnect fittings) are also used and are sealed with rubber gaskets.

Effluent Water Quality Monitoring Equipment: The CESF system continuously samples the treated effluent water for pH and turbidity. The system includes pH meters, turbidimeters, flow meters, an instrument display panel, and sample lines. Data collected are recorded by the PLC. Water that does not meet setpoint tolerances for pH and turbidity is recirculated (using automated valves discussed below) back to the two 21,000-gallon storage tanks for additional treatment.

Manual Valves: Manual valves are used by the operator to control flow rates and internal system pressures. There are manual valves located on the influent and effluent side of the sand filter, as well as on the backflush line. To control flow to the pretreatment tank, a throttle valve is located in between the submersible pump and the pretreatment tank. Additionally, a manual throttle valve is located on the system pump.

Automatic Valves: Automated pneumatic valves are located on the effluent line in the system container. These valves divert flow between the discharge and recirculation lines based on the water quality readings of the in-line sensors.

Laboratory Equipment: Components for bench scale testing and monitoring include hand-held meters, beakers, droppers, filters, standard solutions, chemicals, monitoring forms, and other miscellaneous items.

Air Compressor: The air compressor provides pressurized air to operate pneumatic control valves on the CESF effluent line and backflush valves on the sand filter.

Backflush Controls: Backflushing is controlled both by a differential pressure setpoint (pressure differential increases as the filter accumulates filtered solids) and by an operational timer (to ensure a minimum backflushing frequency). The current differential pressure setpoint to trigger backflushing is 12 pounds per square inch (psi), and the operational time that will trigger backflushing is 3 hours. Backflushing will occur if either of these setpoints is triggered.

2.1.2 SYSTEM START UP

The typical operational sequences for starting and stopping the CESF system are given in Section 3.2 of the *Operation and Maintenance Manual for Chitosan-Enhanced Sand Filtration System* provided by Clear Water Compliance Services, included as Attachment 2 to this manual for reference. These procedures are written assuming the system is shut down at the end of every shift, which does not apply to the NBF STST system. Since the NBF system will be automated, these procedures will only be required on initial startup, and after an unexpected shutdown. A revised procedure for startup is provided below:

1. Perform site and system inspection procedures (Section 2.1.5). Unlock container and power up the system. Orient all valves for operation in recirculation mode.

2. Turn on the sensors. Read and record system volume totalizers in the Daily System Operation and Maintenance log. Record any other relevant system information.

3. Calibrate hand-held pH, turbidity and conductivity meters.

4. If water quality or system changes have been made, take a grab sample from the influent to the pretreatment tank and perform a bench scale treatability test to determine likely chitosan dosage.

5. Calibrate inline pH and turbidity meters.

6. Switch PLC to recirculation mode. Recheck manual valve orientation.

7. Start the filtration system pumps using the system PLC screen and watch for proper system functioning.

8. Start chitosan metering (also known by pump manufacturer name, LMI) pumps.

9. Calibrate LMI pumps to deliver proper chitosan dosage.

10. Once LMI pumps are calibrated and all discharge conditions are met, switch system to automatic mode by touching the “valves auto” button on the main screen of the system PLC.

11. Collect samples of sand filter effluent and perform the residual chitosan test.

12. Treatment technicians will remain onsite during startup to monitor overall system performance. System pressure and inline water quality results are to be recorded manually every 15 minutes in the appropriate field log, until the system has stabilized. When unmanned, the control system will automatically record water quality data every 15 minutes.

13. Residual chitosan tests are to be performed twice during the first 2 hours of system startup, and as needed afterwards, but no less than once per week for the duration of system operation. Chitosan dosage pump calibrations are to be performed within the first 4 hours during initial startup, and as needed afterwards, but no less than once per week for the duration of system operation.

2.1.3 SYSTEM SHUT DOWN

The NBF system will not be shut down regularly during its operational lifetime, but only for troubleshooting due to an unexpected problem, or in anticipation of a freeze event (see Section 2.1.4). The shut down procedures can be found in Clear Water's Manual (Attachment 2).

2.1.4 FREEZE PROTECTION

During cold weather conditions, certain precautions need to be taken to protect against freeze events. A freeze event could result in system component damage and/or operations loss. These procedures can be found in Clear Water's Manual (Attachment 2).

2.1.5 ROUTINE SITE AND SYSTEM INSPECTION

Following the startup and frequent inspections during the first few weeks of CESF system operation, routine inspections will be conducted on a weekly basis during operation of the system. A preliminary assessment will be made of the overall integrity of a job site upon arrival. Conditions may have changed at the site in such a way that affects treatment operations. The following procedures have been adapted from Clear Water's Manual (Attachment 2):

MH130A, B, and C: Check the structures for signs of proper system operation. Stormwater should not be overtopping the weir in MH130B except during significant precipitation events. Check that the system is pumping properly out of MH130A and discharging properly into MH130C.

Float Switches: Check the floats in MH130A, in the pretreatment tank, and in the storage tanks for proper operation and activation levels.

Pipe Integrity: Check to see if all the conveyance lines are in working order. Surface pipes at industrial sites are vulnerable to vehicle impact and environmental wear. Small stress cracks can become significant safety or operational problems when operating under pressure.

Hose/Pipe Connections: Ensure all necessary conveyance piping and hoses are attached to appropriate system equipment.

Generator Fluid Levels: If a generator is used (e.g., during a power outage), check the fluid levels (fuel, oil, water) on the system power generator to see if the equipment needs to be serviced. If any fluids are low or warning signals lit, contact the project manager.

Unlock Container: All Clear Water treatment containers are kept locked when Clear Water or other trained personnel are not present. Keys for all treatment containers will be provided by the project manager.

Chitosan Injection System Valves: Ensure that the chitosan storage tank valve is open for proper chitosan injection.

Sand Filter Bleeder and Drain Valves: Ensure small bleeder valves at the top of the sand filter pods and drain valves are closed.

Sample Port Valves: Ensure the water quality sampling valves are open.

Air Compressor: Make sure the compressor breaker switch is on. Check to make sure the drain valve is closed.

Chitosan Volume: Assess the quantity of chitosan in the storage tanks. Site project managers need to be kept aware of chitosan levels so they can schedule a timely resupply.

2.1.6 FIELD DOCUMENTATION

A series of triplicate forms are provided in all the system containers for Clear Water technicians to log the results of operational activities. All the forms have a field to record the project title, project number, project location, and date in the header block. System operators should print and sign their name at the bottom of the sheet. If multiple operators are working in a single system container, the forms should be signed by the most senior operator. All fields on each form are to be completed. Fields that do not apply to a particular site or system should be completed with the letters NA (not applicable). Blank copies of each of the following forms can be found in Attachment 3 of this manual:

CESF – Daily System Operations and Maintenance: This is the primary form used by Clear Water operators. The pre- and post-treatment flow totalizer numbers, as well as the total volume treated and the total volume discharged, are recorded here. This form is intended to summarize system activities and productivity. Regulatory agencies require an evaluation of system performance and water quality monitoring for all discharge periods. Other relevant operational information should be recorded here for reference by Clear Water staff.

Bench Scale Treatability Form: This form is used to record water quality data and the observed results associated with the startup bench scale treatability test. The procedure for this test is described in Section 2.1.8. Visual observations shall be recorded in conjunction with each dose adjustment. Additionally, a general assessment of the entire test shall be recorded upon completion of the test.

Receiving Water Quality Monitoring Form: The receiving water quality form would be used to record the results of upstream and downstream conditions in the receiving water body. The observations recorded on this form would then be used to assess any impacts CESF discharges may impose on the receiving water. This form is not considered to be applicable to NBF or to discharge to MH130C and on to Slip 4.

Chemical Metering Pump Calibration Form: This form is used to record the chemical delivery pump rate and calculate the treatment system chitosan dose rate. The chitosan calibration procedure is described in Section 2.1.10.

Residual Chitosan Test Form: This form is used to record the results and sample data associated with residual chitosan tests. The procedure for this test is described in Section 2.2.1.1. Operating conditions that necessitate elevated chitosan dose rates may increase the residual chitosan testing requirements.

Manual Data Collection Form: This form is used to record inline water quality data (pH, turbidity) as well as system pressure. Influent and effluent data will be recorded for each of these categories. These data will be recorded every 15 minutes when checking the system, until stabilization of parameters is observed. This data should be read from the "water" page of the PLC. In addition, meter confidence checks will be recorded on this form.

Instrument Calibration Report Form: Clear Water's CESF systems have multiple water quality meters that need to be calibrated regularly. There are separate forms associated with inline pH meters, inline turbidity meters, and all the hand-held meters. There are fields to record the strength of the calibration standard used, the initial meter reading, and the calibrated meter reading.

2.1.7 SENSOR CALIBRATION AND CARE

The system's internal water quality sensors, as well as the hand-held sensors, will be calibrated weekly. Calibration information for each instrument will be logged on the accompanying calibration form. Regular calibration of the sensors will help ensure accuracy of water quality monitoring.

Confidence Checks must be performed to confirm sensor accuracy. Hand-held meter readings will be checked against inline readings during the residual chitosan tests. Confidence Checks are to be recorded on the Manual Data Collection Form.

The manufacturer-provided calibration procedures for each meter are included in Clear Water's Manual (Attachment 2). Additionally, the entire owner's manual for the hand-held meters are included inside each treatment system. Calibration standards for the inline and hand-held turbidimeters are included in the corresponding meter kits. Calibration standards for the inline and hand-held pH meters are supplied within the treatment system containers. The calibration standard for the conductivity meter is supplied within the treatment system container.

Hand-Held pH Meter: It is important to properly care for the pH meter probe. Irreparable damage to the probe commonly occurs due to simple neglect. The pH probe storage solution and cleaning solution is included in the treatment system containers. Use the cleaning solution periodically or whenever its use appears necessary. Store the probe in probe storage solution whenever the meter is not in use. The tip of the probe should never be allowed to dry out. The probe will be rinsed with water between insertions into different standards or samples to avoid contamination.

Hand-Held Turbidimeter: The included cuvettes for calibration standards and sample measurements need to be handled carefully. The readability of the glass cuvettes will be compromised if they get scratched. Avoid touching the cuvettes with your bare fingers and carefully remove smudges with laboratory wipes. The cuvettes can become stained if dirty samples are allowed to sit inside for an extended period. Always promptly empty samples and rinse the cuvettes with distilled water after use. Clean stained cuvettes with a gentle solvent. Make sure the outside of the cuvettes are dry before inserting them into the meters. Introducing moisture into the meters will compromise the sample reading and damage the meter. Record the Initial Reading before calibrating the meter. Record the Final Reading after calibrating the meter.

Inline pH Meter: Follow the probe care and usage instructions previously stated for the hand-held meter. Calibrate the pH meter using the EASYCAL method identified by the manufacturer. Choose a calibration slope appropriate to the stormwater that will be treated (7 to 4 if water is under a pH of 7; 7 to 10 if water is over a pH of 7). Finish the calibration procedure by measuring the calibrated reading of the pH 7 buffer. This will ensure the meter is reading within the range of the stormwater being treated. Record the initial reading when the meter is in calibration mode and record the final reading when the meter is back in normal operation mode.

Carefully remove and replace probe from probe seat. Probe-amplifier lock points can be damaged if not removed gently. Cross threading is a common problem with the pH seats. Be aware of the O-ring gasket falling out when removing probe from pH seat.

Inline Turbidimeter: Follow the cuvette care and usage instructions previously stated for the hand-held meter. Be aware of condensation on the flow through cuvette. Cold water in the cuvette and the warm air inside the treatment container will often promote condensation, which would need to be wiped off before returning the cuvette to the measurement chamber. Record the initial reading and final reading when in calibration mode.

2.1.8 BENCH SCALE TREATABILITY TEST

After the water quality sensors have been calibrated, the system operator can perform the bench scale treatability test at system startup. This test was conducted during the first couple of days of system startup testing and was used to assess the conditions of the stormwater to be treated and to determine the proper chitosan dosage rate. Unlike a construction site, the water quality conditions of the stormwater at NBF are relatively constant. Therefore, future bench scale treatability testing will only be performed if there is reason to believe the influent stormwater quality has changed significantly. The following description of the treatability test has been adapted from Clear Water's Manual (Attachment 2).

The bench scale treatability test lets the operator know of possible treatment problems prior to introducing water to the CESF system. Several factors can influence treatability, including concentration of suspended solids, pH, detergents, the presence of soil tackifiers such as polyacrylamides (PAMs) and guar in the runoff.

The samples procured for this test should be representative samples from recent runoff, and should not contain sediment that would settle naturally (sand and rocks).

Required Equipment: In order to perform this testing sequence, the following items are required:

- Properly calibrated pH meter
- Properly calibrated turbidimeter
- Properly calibrated conductivity meter
- One 1-liter sample glass beaker
- One 1-liter sample plastic beaker
- Chitosan acetate
- Pipette
- Stir rod.

Perform the Screening Test:

1. Retrieve a one-liter grab sample of stormwater from the influent with a plastic beaker.
2. Transfer the sample into a one-liter glass beaker.
3. Measure and record initial pH, conductivity, and turbidity of sample in the appropriate field log.
4. If the sample does not have a pH reading conducive to treatment (6.5 to 8.0), carefully adjust the pH of the sample by adding small amounts of sodium bicarbonate or acetic acid until the sample reads a pH close to 7. Record the adjusted pH and note treatment method.
5. Add one drop of a known quantity chitosan to the sample.
6. Stir sample vigorously for one minute to assure dissolution.
7. Allow sufficient settling time and observe solution for the formation of small floc particles called pinfloc.
8. Grab a sample from the surface of the sample jar and record the turbidity.

9. Repeat steps 5 through 8, recording observations and dosage related to the appearance of floc and settling.

Interpreting the Screening Test: Visible sediment settling indicates that chitosan has coagulated the particles. The beaker may contain clear water on top, or be slightly cloudy, and there should be variation in coagulation amount between dose rates. The object of this test is not to produce completely clean, clear water in the beaker. Rather, it is to determine the most suitable dose rate for CESF treatment. For planning purposes, the smallest effective dosage will be used as the initial dose rate. If there is no change in sample appearance (i.e., reduction in turbidity) between doses it is assumed that there are treatability problems. This is rare, and may occur for different reasons that need to be investigated.

2.1.9 pH ADJUSTMENT

Although pH adjustment is not included in all CESF treatment regimens, it is not unusual. Many of the sites that require pH treatment require it on a consistent basis while at other sites it may be sporadic or short term. Adjustment of pH is required based on some site conditions for regulatory and operational purposes. Many aquatic species are very sensitive to pH alterations and even a small alteration can have a significant effect on a natural system. Information on pH adjustment, based on observed NBF site conditions and adapted from Clear Water's Manual (Attachment 2), is provided below for reference.

Relatively low pH stormwater (6.0 to 6.5 standard units) has been observed onsite at NBF during heavy rainfall events. In accordance with the Industrial Stormwater General Permit issued to the facility by Ecology, water from the facility can be discharged within a pH range of 5.0 to 9.0. The CESF treatment system has been set to automatically go into recirculation mode and not discharge treated stormwater if pH goes outside of the operational control range of 5.5 to 8.5 standard units. This control will help to ensure that treated and discharged stormwater is well inside the pH benchmark range of the permit.

Although chitosan is expected to be most effective within a pH range of 6.5 to 8.5 standard units, the CESF system is expected to continue to meet its treatment goal of 95 percent or greater removal of suspended solids [or a maximum concentration of 1 milligram per liter (mg/L) when influent total suspended solids (TSS) is less than 20 mg/L] over a wider pH range. Because of that expectation and the observation that stormwater pH is rarely outside the pH range of 6.5 to 8.5, adjustment of pH is not planned for normal operation at NBF. If it is found that the treatment performance for removal of suspended solids is not met due to pH issues (which is not expected), pH adjustment will be performed. The adjustment of pH for CESF systems is generally done with one of two chemicals: sodium bicarbonate or carbon dioxide (CO_2). Sodium bicarbonate raises low pH and CO_2 lowers high pH. Care must be taken during addition of bicarbonate or carbon dioxide in order to prevent over-correction of pH.

2.1.10 CHITOSAN METERING PUMP CALIBRATION

The following information has been adapted from Clear Water's Manual (Attachment 2). Clear Water technicians will operate and calibrate the chemical metering system. Metering pumps are often referred to as LMI pumps because of the common use of metering pumps produced by the manufacturer of that name. Calibrations are to be performed every 4 hours during initial startup, and as needed afterwards, but no less than once per week for the duration of system operation, to ensure that the dose rate is at or below 1.0 ppm. Additionally, the metering pump shall be recalibrated when a significant change occurs in either the influent flow or turbidity. Calibration results and flow rates will be recorded on the CESF system monitoring forms and the calibration records will be kept onsite.

OPERATIONAL NOTE: Metering pump dials should **ONLY** be adjusted when pumps are **OPERATIONAL.** Adjusting pump dials while pump is not running will likely result in pump damage and/or failure.

When adjusting the metering pump to obtain proper dose rate, there are two primary adjustments: stroke frequency and stroke length. Experience has shown that the stroke frequency should be set as high as possible for a consistent rate of delivery, and then the stroke length adjusted to deliver the desired dose rate.

The CESF chemical injection system for the STST system has two chitosan metering pumps with a dedicated delivery line for each pump; one metering pump is used for the pretreatment dose prior to stormwater entering the two 21,000-gallon settling tanks and the other metering pump is used for the final chitosan dose prior to the sand filters.

Calibration Procedure:

1. Fill the calibration cylinder by opening the valve on the bottom of the cylinder. Fill the cylinder as close to full as the static head pressure on the storage tank will allow without over filling.

2. Close the valve on the chitosan storage tank.

3. Allow the LMI pump to drain the cylinder to a desired volume and then begin timing the pump for one minute.

4. Close the cylinder valve at exactly one minute.

5. Immediately open the valve on the chitosan storage tank.

6. Read and record the volume of chitosan consumed.

7. Calculate the dose rate using the calculation table below. Pair the chitosan consumption rate with the corresponding stormwater flow rate.

8. Convert delivery rate from milliliters per minute (mL/min) to milligrams per minute (mg/min) (multiply result by 10 for 1% chitosan) and flow rate from gallons per minute

(gallons/min) to liters per minute (L/min) (multiply by 3.78). Divide chitosan delivery rate by flow rate to get dose rate (ppm). Refer to formulas presented below.

9. Adjust delivery rate toward desired dose rate* if necessary and repeat procedure until proper dosage is achieved.

10. Record the final results on the Chemical Metering Pump Calibration Form.

11. Repeat procedure for next LMI pump.

* The desired dose rate depends on many variables including site and system history, turbidity levels, use level designation limits, water chemistry, flow rate, and pre-treatment activity. Typically, an operator should dose the minimum amount necessary to achieve the desired result:

Formulas:

- Liqui-Floc delivery rate (mL/min) x 0.01 (chitosan concentration) x 1 gram per milliliter (g/ml) (weight of Liquid-Floc) = absolute weight of chitosan in grams per minute (g/min)
- Chitosan delivery (g/min) x 1000 milligrams per gram (mg/g) = delivery rate (mg/min)
- System influent flow (gpm) x 3.78 liters per gallon (L/gal) = flow rate (L/min)
- Delivery rate (mg/min) / flow rate (L/min) = dose rate in milligrams per liter (mg/L) = ppm.

When the LMI calibrations are complete, verify the valve on the chitosan storage tank is open and the valve on the calibration cylinder is closed. Verify that all LMI pumps are on. Record the dose rate of the pretreatment pump and the sand filter pump separately. Add these two dose rates together to get the overall system dose rate. The overall system dose rate shall not exceed the maximum allowable chitosan dose rate (1 ppm).

2.1.11 BACKFLUSH

Backflushing is the process by which water flow is reversed through the sand filter beds to expel the accumulated sediment on the top of the beds. Each sand pod is flushed one at a time while the rest of the pods in the filter continue to operate normally. The stormwater that was filtered from the active pods will fill the bottom header and a portion of it will be forced upward through the pod that is being backflushed.

Although backflush cycles are automated, the process needs to be understood by the system operator, and periodically monitored (at least once per week) to ensure optimal backflush flows and pressures. Monitoring includes testing of the backflush mechanism and pressure differential switch. The backflush parameters were initially set from the control box, which is fixed to the side of the sand filter. Flush duration, delay between switching pods, and manual start and stop, as well as power and breaker switches, are all on the control box. However, during freezing conditions in November the control box on the sand filter malfunctioned so now the PLC is used to control backflushing based on differential pressure readings. The setpoint for backflushing based on differential pressure is currently 12 psi. The cycle timer knob should be set to zero as backflush cycle initiation is typically controlled through the pressure differential switch on the bottom of the control box. Currently, a backflushing cycle frequency of once per 3 hours of operation is set in the PLC to ensure a minimum frequency of backflushing.

As the filter beds become clogged with floc particles, the pressures between the top and bottom headers begin to deviate. The top header will gain pressure and the bottom header will lose pressure due to decreased water passage. When this pressure differential reaches the setpoint of 12 psi, the system will initiate the backflush cycle to remove the captured floc from the media bed.

The system requires a minimum of 20 psi effluent pressure for adequate backflush. Pressures below this will generally not be high enough to fluidize the sand beds, which is necessary for proper backflush. System pressures and flow rates will differ between operation and backflush cycles. Operators can monitor flows and pressures during transition to backflush to assure they remain optimal. Valve adjustments may need to be made accordingly. In addition to the influent and effluent control valves, there is a valve at the end of the backflush header. This valve is set during system startup to optimize backflush flow without discharging filter media. This backflush valve generally does not need adjusting and should only be adjusted by experienced operators who are familiar with the system.

A sight glass is installed at the top of the backflush header to monitor backflush efficiency. The water in the sight glass should appear turbid during the initial stage of each pod flush. Toward the end of the flush, the water should appear clearer as all of the floc is expelled from the sand bed. A backflush sample line can also be used to monitor the effectiveness of the backflush. Flush duration is set at 2 minutes. To increase backflush intensity, operators should increase the frequency instead of duration of the cycle.

The consequence of insufficient backflushing is impacted sand beds. Failure to backflush will cause excess floc accumulation in the filter. Excess floc under operating pressures will cause the beds to compact, limiting water movement through the beds. This is commonly called impaction. Impaction will force a system shutdown. The water in the filter must be evacuated, the filters will need to be opened, and the sand in the filter must be broken up with a shovel. In extreme cases, the filter medium may be so compromised that it will need to be discarded and replaced. With the low TSS concentrations at NBF, this condition has not been experienced at the STST system and is not expected to occur in the future.

Backflush water is discharged to the inlet of the weir settling tank where the solids can settle out at the bottom of the tank. Procedures for monitoring and removal of accumulated solids are discussed in the following section.

2.1.12 MONITORING AND REMOVAL OF ACCUMULATED SOLIDS

Any wastes from operation and maintenance of the STST facility will be tested and profiled to determine contaminant concentrations and disposal requirements. Based on relatively low TSS concentrations in NBF stormwater, the inlet weir tank may not accumulate a significant amount of solids within just a few months of system operation to require cleanout of solids. The solids level in the inlet weir tank is inspected at least once per month. If the solids level at the bottom of the tank is greater than 12 inches, a sample of the solids will be collected for waste profiling purposes and the solids will be cleaned out from the tank.

Monitoring of accumulated solids involves use of a probe rod and flashlight from the top of the inlet weir tank, on the inlet side of the tank. The probe rod is used to feel for solids level, and a flashlight is used to assist the visual observation of the top of solids level. The rod is then pushed through the bed of accumulated solids until it reaches the metal bottom of the tank and that measurement in inches is recorded. This measurement is repeated at four or more locations reachable from the access port at the top of the tank and is conducted at equal-spaced intervals between the inlet side of the tank and the weir side of the tank. The average of these four or more readings will be used to determine if the solids level exceeds a 12-inch depth and requires solids testing and tank cleanout.

2.2 SYSTEM MONITORING

This section describes the residual chitosan sampling procedure, the remote alert messaging system, and system bypass observation and documentation procedures.

2.2.1 CHITOSAN

High doses of chitosan in the aquatic environment have exhibited toxic effects on fish in laboratory tests. In the CESF process, the majority of the chitosan introduced into stormwater is consumed during the coagulation/flocculation process. The residual chitosan test was developed to confirm the concentration of chitosan in the treated effluent is below the 0.2 mg/L environmental threshold. Based on system startup treatability testing and on performance monitoring results from the first 2 months of CESF system operation, the chitosan pretreatment dosage is currently set at 0.2 ppm and the final dosage is currently set at 0.47 ppm, for a current total chitosan dosage of approximately 0.67 ppm. This is a relatively low dosage of chitosan based on the relatively low concentration of TSS in NBF stormwater. In addition to the low chitosan dosage rate, other reasons that residual chitosan at the effluent of the sand filter is not expected to ever occur are described in detail in Section 4.0 of the STST Work Plan.

The residual chitosan test is used as a precautionary measure to alert technicians of potential treatment problems before significant impacts can occur. Boeing has discussed the use of CESF for temporary stormwater treatment at NBF with Ecology. Ecology has stated that CESF is an approved water treatment process for construction projects and, although the NBF site is not a construction project, they do not object to the use of CESF at NBF for this application. Ecology has issued a General Use Level Designation (GULD) for the use of CESF systems for stormwater discharges at construction sites (*Use Designations for Erosion and Sediment Control for Chitosan-Enhanced Sand Filtration using 1%*

ChitoVan™/SeaVan™ Chitosan Acetate Solution, Washington State Department of Ecology, July 2009). Although NBF is not a construction site, many of the conditions applicable to CESF under this designation apply to the treatment system at NBF, unless otherwise noted:

- Formal written approval from Ecology is required for the use of chemical treatment at each site. Written approval must be obtained from the appropriate Ecology regional office. This approval only applies to discharges to surface waters.
  - For the NBF project, Ecology has yielded management of the STST project and the CESF system operation to EPA.
- This use level designation applies only to ChitoVan™/SeaVan™ (1 percent chitosan acetate solution).
- The chitosan dose rate for water entering the filters shall not exceed 1 mg/L ChitoVan™/SeaVan™ (as chitosan by weight). All calibration results must be recorded simultaneously with the flow rates and kept onsite.
- Source control procedures shall be implemented to the maximum extent feasible to minimize the need for the use of additional chitosan acetate for the pretreatment of stormwater. Additional ChitoVan™/SeaVan™ (amounts greater than 1 mg/L chitosan by weight) may be used to pretreat water that exceeds 600 NTU. A portion of the 1 mg/L ChitoVan™/SeaVan™ may be used to pretreat water less than or equal to 600 NTU. Pretreatment must occur in a tank or basin dedicated to pretreatment. All pretreated water must enter the sand filters. Pretreated water must have no less than 50 NTU and no more than 600 NTU before final dosing. This will help ensure that free chitosan does not enter the CESF system. Also, 1 mg/L ChitoVan™/SeaVan™ (chitosan by weight) is sufficient to treat water in this range. Water exiting the pretreatment tanks must be continuously monitored for turbidity. An automatic integrated turbidity sensor shall be located on the output from the pretreatment tanks or basins. This sensor will alert the operator when turbidity values fall outside of the 50 to 600 NTU range. If this occurs, operators can reroute the out-of-spec water to the untreated stormwater pond, shut the system down, or conduct additional residual chitosan tests. One of these actions must occur each time the alarm goes off. Jar tests must be used to determine proper pretreatment dosing and proper treatment dosing.
  - Stormwater at NBF has a much lower turbidity than stormwater at construction sites, and has consistently been measured to be less than 50 NTU. In addition, the NBF project has a much lower effluent TSS/turbidity requirement than for a typical construction site. Therefore, the procedures outlined above are not considered applicable for the NBF project, but other adequate precautions are taken to ensure that chitosan is not overdosed and that there is no detectable residual chitosan in the sand filter effluent.
- Jar tests are to be conducted at startup to determine the dosage level of chitosan acetate solution. Jar test results are to be recorded in the daily operating log. If the results of the jar test indicate that the dose needs to be adjusted, the jar testing results and the indicated dose rate change shall be documented in the daily operating log.
  - Jar tests were conducted at startup to determine the dosage level of chitosan acetate solution, and those results were recorded in the operating log. The bench scale treatability test will be conducted in the future, if necessary, based on significant changes in site stormwater conditions or based on detections of turbidity, TSS, or PCBs above effluent criteria.

- During CESF operation, water quality influent and effluent shall be continuously monitored for pH, turbidity, and flow. For batch treatment systems, only water discharged from the batch treatment basins or tanks must be continuously monitored for pH, turbidity, and flow during discharge.

- The discharge flow rate shall be continuously metered and recorded. For batch treatment systems only, water discharged from the batch treatment basins or tanks must be continuously monitored for flow rate.

- The effluent shall be monitored for residual chitosan or aquatic toxicity. If effluent will be monitored for aquatic toxicity, the most sensitive test reported in the intended use plan must be used. If the effluent will be monitored for residual chitosan, a discrete grab sample of homogeneous sand filter discharge must be collected and analyzed within 30 minutes of the onset of operation and 2 hours after startup to confirm a discharge concentration below 0.2 ppm. The test is to be repeated whenever there is a change in dosage, or a significant change in influent turbidity or flow rate. For batch treatment systems, only water discharged from the batch treatment basins or tanks must be monitored. For batch treatment systems, an additional grab sample of the potential batch treatment discharge must be collected and analyzed for aquatic toxicity or residual chitosan before any discharge from treatment basins or tanks can occur.

  - The NBF system will be operated on a continuous basis and, therefore, will not have periodic startup similar to construction sites. When the system is started up, two grab samples will be collected and analyzed as described above. After the system is automated, it will be monitored for residual chitosan weekly, and also when there is a significant change in influent turbidity or whenever there is a change in the chitosan dose rate. See Section 2.2.1.1 below for more detail on residual chitosan testing.

- Discharges from the CESF shall be maintained below 0.2 ppm residual chitosan at all times. Discharges must be monitored for residual chitosan or aquatic toxicity. In the event that the chitosan residual in the discharge is greater than 0.2 ppm, the discharge exhibits aquatic toxicity, or when the CESF system fails to meet discharge quality requirements, a contingency plan must be included in every SWPPP that immediately corrects the situation. The operation and maintenance manual must include contingency plan measures and must be available on-site.

  - Residual chitosan testing procedures are provided in this manual, in Section 2.2.1.1 below, along with a discussion of contingency actions if residual chitosan is detected and confirmed.

- Discharges from the CESF system shall not cause or contribute to receiving water quality violations and shall comply with all known, available, and reasonable treatments (AKART) and local government requirements for turbidity and other applicable pollutants.

  - Stormwater discharge at NBF is permitted through the Industrial Stormwater General Permit. As described in Section 5.0 of the Work Plan, the interim goal for PCBs in treated stormwater is 0.014 micrograms per liter (µg/L).

- Discharges from the CESF system under these designations shall achieve performance goals of a maximum instantaneous discharge of 10 NTU turbidity and a discharge pH within a range of 6.5 to 8.5. These limits reduce interferences associated with the residual chitosan test.

- Discharges from the CESF system at NBF will be controlled to below 10 NTU and are generally within the pH range of 6.5 to 8.5. See Section 2.1.9 above for a discussion of the expanded pH range applicable during the limited period of extreme rainfall events.

- The CESF facility contractor shall guarantee that the CESF system, when used as directed, will not produce treated water that exhibits aquatic toxicity caused by chitosan added as a treatment agent.

- The CESF system shall only be operated by a trained technician certified through an Ecology-approved training program that includes classroom and field instruction. The technician must have the following minimum training requirements:

  - Prerequisites:
    - Fundamental knowledge of high-pressure sand filter systems
    - Fundamental knowledge of water pumping and piping systems
    - Fundamental knowledge of stormwater discharge regulations for applicable region/locale
    - Fundamental knowledge of stormwater quality testing procedures and methods for parameters applicable to the region/locale.

  - Classroom (8 hours)
    - Stormwater regulatory framework and requirements
    - Stormwater treatment chemistry (chitosan, pH, coagulation, filtration, etc.)
    - Stormwater treatability (how to do jar testing)
    - Treatment system components and their operation
    - Treatment system operation
    - Troubleshooting.

  - In the field (32 hours)
    - Operating the treatment system
    - Entering data in the system operations log
    - Testing turbidity and pH
    - Optimizing chitosan dose rate
    - Water quality sampling and testing (turbidity and pH)
    - Residual Chitosan Test.

- The SWPPP is to include a field procedure, accepted by Ecology, for *detecting residual chitosan in stormwater discharges sensitive to 0.2 ppm.*

  - Procedures for residual chitosan detection are provided in this manual, in Section 2.2.1.1 below.

2.2.1.1 Residual Chitosan Test

The treatment system is operated in accordance with applicable local, state, and federal regulations and standards. Residual chitosan testing was initially performed daily during routine STST system monitoring. Based on discussions with EPA and per the current STST SAP, residual chitosan testing is currently performed weekly to verify that no dissolved chitosan is making it past the sand filter system. As discussed in the STST Work Plan, there is very high confidence that there will not be a problem with detection of residual chitosan in the discharge from the sand filter. In an e-mail from Neil Doherty of Clear Water, he states "In the eleven years that Clear Water has been performing Chitosan Enhanced Sand Filtration (CESF), with billions of gallons discharged and thousands of residual chitosan tests performed, we have never seen a true positive result of a residual chitosan test" (E-mail message from Neil Doherty, Clear Water Compliance Services, Inc., to Joe Kalmar, Landau Associates. Re: *Residual Chitosan Test Frequency Statement*. November 18, 2010).

In a few site-specific instances, positive field tests have occurred, yet, after laboratory analysis, these results were proven to be false positives due to organic interference in the effluent water. These events were also correlated to the over application of source control BMP's such as straw, hydro-seeding tackifier (guar), and soil tackifier (i.e., polyacrylamide and bonded-fiber matrix). Dissolved concentrations of these organics in the treatment system effluent, when reacted with iodine in the final step of the residual chitosan procedure, produced a bluish hue, therefore, yielding a false-positive result.

The chemical composition of chitosan is such that it binds to the anionic solids as well as other chitosan molecules within the top layers of the sand filter media rather than going through the filter in a dissolved form, making the presence of residual chitosan (>1 mg/L) in treatment system effluent nearly impossible. It should be noted that Clear Water has performed controlled pilot tests and experiments in which influent dose rates of up to 50 mg/L have not yielded a positive residual chitosan test.

Since the NBF system is anticipated to have a constant dosing rate throughout system operation, and since stormwater influent is expected to be of a consistent quality, testing for residual chitosan as designated by Ecology for construction sites is not necessary.

The following procedure, taken from Clear Water's Manual (Attachment 2), was produced as a quick reference for Clear Water technicians with considerations given to company-specific equipment.

Required Equipment: There should be two separate, clearly marked, sets of equipment. One set will be used for the sample analysis and should be marked "sample". The second set will be for the matrix spike used for a color comparison. The second set should be marked "spike". Equipment includes:

- Two stir rods
- Two 140 mL capacity plastic syringes with threaded tip
- Two threaded plastic Swinnex filter seats
- Two plastic 1L beakers
- One pair of forceps
- Plastic disposable droppers
- Fiberglass micro filters
- Chemicals: 1 percent chitosan acetate, 0.1N solution Iodine, Sodium Bicarbonate (with scoop).

Procedure: Make sure all equipment is washed thoroughly and proper laboratory procedures are followed. Most "hits" produced in this test are actually false positives that are due to contaminated equipment.

1. Take two separate 1-liter samples from the sand filter effluent sample line.
2. Measure and record pH, turbidity, and conductivity on the Residual Chitosan Test Monitoring Form. Transfer all relevant data from the LMI calibration to this form.
3. Add two drops of 1 percent chitosan acetate to the beaker marked "spike". Stir vigorously for 1 minute to assure dissolution. This beaker now has a chitosan concentration of approximately 0.2 ppm.
4. Add one scoop (approximately 5 grams) each of sodium bicarbonate to the sample and the 0.1 ppm spike sample. Stir vigorously for one minute. Read and record the adjusted pH. The new pH level must be at 8 or above to cause the chitosan to come out of solution.
5. Open the Swinnex filter seats and carefully place clean filter papers in each one with a pair of forceps. Carefully thread the seats back together. Avoid cross threading the seats for proper filter dosing.
6. Draw 100 mL of the treated sample water from the "sample" beaker into the "sample" syringe. Thread the "sample" filter seat onto the syringe. Slowly push the sample water through the filter. Repeat with another 100 mL (200 mL total). Repeat procedure with "spike" sample.
7. Remove the filter seat from the syringe and then remove the filter from the seat with forceps. Remove the sample first and the spike second to avoid contamination.
8. Place each filter on a clean, inverted glass beaker to dry. Place the beaker a reasonable distance in front of a space heater to facilitate drying. Dry completely for optimum results.
9. After the filters are dry, add one drop of iodine to each filter. Wait 15 minutes to interpret results.
10. A light yellow rust color indicates the absence of chitosan. This is how the sample should appear. A dark brown or blue/black color indicates the presence of chitosan. This is how the spike sample should appear.

If an operator gets a positive test, the system will immediately be shut down and investigated to determine if any of the operating parameters are out of specification. The system can then be corrected and the filtrate retested to confirm the absence of chitosan in the treated filtrate. If chitosan above 0.2 ppm in the treated filtrate is confirmed, the sand filter media will be replaced.

2.2.2 Remote Alert Messaging System

In addition to daily monitoring conducted onsite by a technician as described in Section 2.1, the treatment system at NBF will incorporate a remote alert messaging system that will send text messages to Clear Water staff, enabling them to remotely monitor the status of the treatment system. These messages can alert a technician to situations that may require an unanticipated site visit to investigate the potential problem. The situations that will send a text message to Clear Water staff include:

- High "Pond" Alarm – indicates a high level in the pretreatment weir tank
- High Tank Alarm – indicates a high level in the storage tanks
- Backflush – indicates a backflush cycle is taking place
- Recirculation – indicates a recirculation event is taking place.

2.2.3 TREATMENT BYPASS

In order to assess the performance of the treatment system, it is necessary to document any system bypasses. As discussed in the Work Plan, the treatment system was designed to treat the flow equivalent to 91 percent of the runoff produced from the NBF-Only Basin, and which was estimated to be approximately 61 percent of the flow from the full MH130 drainage basin that includes offsite areas.

A water level datalogger (pressure transducer) was installed upstream of the weir in MH130B on September 22, 2010 to record water levels. The transducer is set to collect a water level reading every 30 seconds. The water level readings can be compared to the weir elevation to determine the time and duration of overflow events and to estimate the volume of stormwater bypassing the STST system. The pressure transducer will be calibrated quarterly to ensure continued accuracy and replacement of the desiccant on the vent tubing will be performed approximately every 4 months (based on visual color change of the desiccant media) to prevent moisture damage to the transducer.

Boeing reports operational data (e.g., total gallons of stormwater treated, rainfall data, and any unusual events) on a monthly basis in the progress reports that are submitted to EPA by the fifth day of each month. Those monthly progress reports also include the calculated estimate of the volume of stormwater that bypassed the CESF system in the previous month.

3.0 PERFORMANCE MONITORING

This section describes the procedures and criteria used to evaluate the direct performance of the STST system.

3.1 SAMPLING PROCEDURES

Performance monitoring of the STST system includes monitoring both the performance of the CESF system in removing PCBs and TSS and monitoring of NBF full-site stormwater discharges at the lift station (LS431).

Initial monitoring of the STST system was performed by sampling just the influent and effluent of the CESF system following the procedures in the prior draft O&M Manual, which was prepared by Landau Associates and was issued to EPA on September 2, 2010. Monitoring of the STST is now expanded to include full-site discharges at LS431, and the full details of the current performance monitoring procedures are included in the SAP, which can be found in Appendix C of the STST Work Plan.

3.2 EVALUATION AND REPORTING

The PCB-removal effectiveness of the STST system will be evaluated by analyzing sample results to compare influent versus effluent concentrations, and to compare effluent concentrations to applicable water quality and sediment criteria. Also, to ensure general effectiveness of the treatment system, whole water sample data shall consistently show ninety-five percent (95 percent) removal of TSS from stormwater, or, if the influent TSS is less than 20 mg/L, the system shall achieve a treated effluent TSS not to exceed 1 mg/L. If sample analysis shows this requirement is not being met, Clear Water will immediately make adjustments to the treatment system based on observed performance and sample data, and will conduct a round of influent and effluent sampling on an accelerated turnaround to confirm the adjustments have brought the system back within compliance of the TSS performance requirement.

Boeing has contingent plans to expand the size of the treatment system to the Full Drainage Basin design flow rate, if determined to be necessary based on sample results. Figure 9 of the Work Plan illustrates how the design of this contingent expanded system has been evaluated and shows how adequate space has been reserved for its potential installation. Clear Water Compliance Services has indicated that expansion of the treatment system to the Full Drainage Basin design flow rate could be accomplished within 3 weeks, if necessary, and the rental pumps could be available within the same timeframe. If it is determined that carbon is necessary, Clear Water Compliance Services has agreed to a condition that carbon be installed within 3 weeks of notification.

Landau Associates will evaluate the sampling data as it is received and will make recommendations for any changes to the operation or monitoring of the STST system in writing to Boeing and Clear Water. A technical memorandum regarding the STST Compliance Assessment was prepared after start up and initial operation of the system to present the STST system sampling results thus far and an initial evaluation of the STST system performance. That STST Compliance Assessment was dated November 17, 2010 and was provided to EPA. The assessment concluded that the STST system is operating well and meeting the applicable TSS and PCB removal criteria at the CESF system effluent.

4.0 USE OF REPORT

This Operation and Maintenance Manual has been prepared for the exclusive use of The Boeing Company and applicable regulatory agencies for the North Boeing Field property area. No other party is entitled to rely on the information and recommendations included in this document without the express written consent of Landau Associates. Further, the reuse of information and recommendations, without review and authorization by Landau Associates, shall be at the user's sole risk. Landau Associates warrants that within the limitations of scope, schedule, and budget, our services have been provided in a manner consistent with that level of care and skill ordinarily exercised by members of the profession currently practicing in the same locality under similar conditions as this project. We make no other warranty, either express or implied.

This document has been prepared under the supervision and direction of the following key staff.

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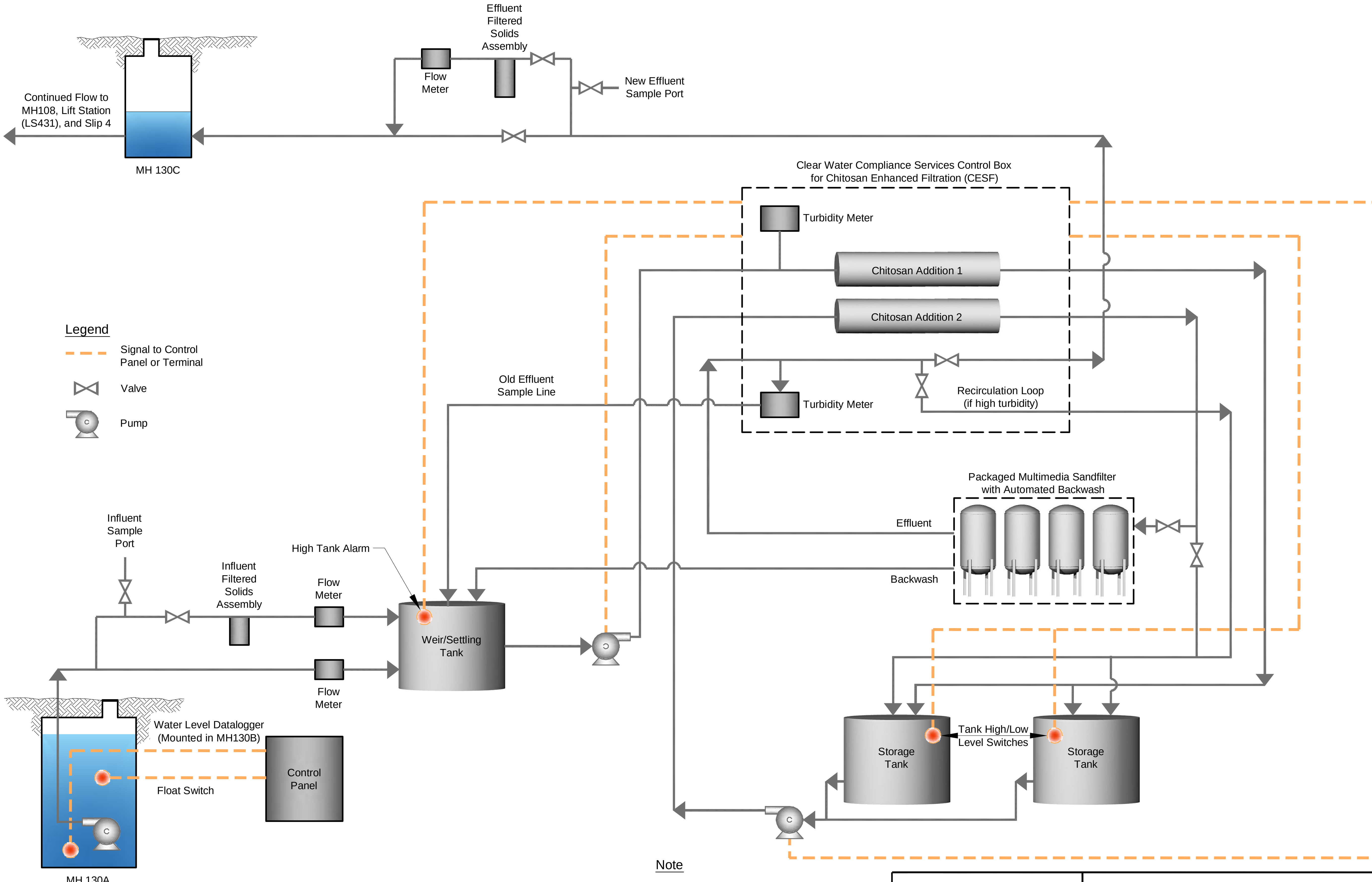
TABLE A-1
SUMMARY OF MONITORING TASKS
CHITOSAN-ENHANCED SAND FILTRATION SYSTEM - NORTH BOEING FIELD

Task	Section of O&M Manual	Frequency Required
Routine Site and System Inspection	Section 2.1.5	Minimum Once Per Week, Daily During any Non-Routine Activities
Sensor Calibration	Section 2.1.7	Weekly
Bench Scale Treatability Test	Section 2.1.8	Conducted during first week of initial startup. Also to be conducted if influent water quality changes significantly.
Chitosan Metering Pump Calibration	Section 2.1.10	Every 4 hours during initial startup, then minimum of once per week. Also whenever chitosan dosage rate is changed.
Backflush System Monitoring	Section 2.1.11	Weekly
Residual Chitosan Test	Section 2.2.1	Twice during startup, then daily during monitoring for first 2 months of operation. Residual testing now conducted weekly. Also whenever the dose rate changes or when turbidity or flow rate changes significantly.
Whole Water Sampling of System Influent/Effluent for Total PCBs and TSS	Section 3.1.1	See Sampling and Analysis Plan (Appendix C of STST Work Plan)
Filtered Solids Sampling of System Influent/Effluent for Total PCBs and TSS	Section 3.1.1	See Sampling and Analysis Plan (Appendix C of STST Work Plan)
Sampling at Compliance Point (Lift Station LS431)	Section 3.1.1	See Sampling and Analysis Plan (Appendix C of STST Work Plan)

ATTACHMENT 1

Short-Term Stormwater Treatment Facility Schematic



Note

1. Black and white reproduction of this color original may reduce its effectiveness and lead to incorrect interpretation.

LANDAU ASSOCIATES

North Boeing Filed
Seattle, Washington

Short-Term Stormwater Treatment Facility Schematic

Figure
A-1

ATTACHMENT 2

Clear Water Compliance Services Operation and Maintenance Manual

Clear Water Compliance Services®

OPERATION AND MAINTENANCE MANUAL

FOR

CHITOSAN-ENHANSED SAND FILTRATION SYSTEM

Clear Water Compliance Services
12314 Beverly Park Rd., Unit 134
Lynnwood, WA 98037

TABLE OF CONTENTS

INTRODUCTION

1.1 CHITOSAN-ENHANCED STORMWATER TREATMENT

This Operation and Maintenance Manual (O&M Manual) has been written to describe the elements involved in the deployment, operation and maintenance of chitosan-enhanced sand filtration systems for treating stormwater on typical construction sites.

Chitosan enhanced sand filtration (CESF) is a safe and effective method for removing sediment from stormwater runoff. Proper stormwater management protects our natural waterways and enables site development. Flow-through CESF systems can treat far greater quantities of stormwater runoff than traditional settling processes. CESF is not a substitute for traditional stormwater management techniques. This technology is to be used in conjunction with standard erosion and sediment control measures.

1.2 INTRODUCTION TO CHITOSAN

Chitosan is extracted from chitin and is nature's second most abundant natural biopolymer next to cellulose. Chitin is the structural material found in crustacean shells such as shrimp, crabs, and lobsters. Chitin is also found in fungi cell walls and the exoskeletons of insects. Chitin and chitosan are natural components of biochemical degradation processes occurring naturally in the earth's soil and water. Like chitin, chitosan is found to exist naturally in the environment (water and soil) because it is a biodegradation product of chitin.

Chitosan acetate has been used in water treatment for more then three decades. It has the unique ability to absorb dissolved oil and grease from water, chelate (bond with) heavy metals, and flocculate suspended sediment. Chitosan-based water treatment has been used for decades in various industrial and municipal applications and commercial aquarium clarification. The U.S. Environmental Protection Agency has approved chitosan for use in drinking water treatment and in the agriculture industry.

There are different chitosan acetate solutions formulated specifically to treat construction stormwater. In the State of Washington, the use designation for chitosan acetate depends on the product manufacturer, concentration, and treatment method. The body of this text will explain treatment operations for General Use Level Designation of 1% chitosan for direct discharge.

Stormwater treatment with Chitosan, at proper dose rates, is highly effective in reducing turbidity levels by greater than 95% when used with sand filtration systems. Chitosan's effectiveness lies in its ability to make small suspended soil particles larger and denser. The larger and denser floc particles can be easily removed through forced settling or sand filtration. The cationic nature of chitosan molecules interact with the predominately anionic sediment particles in stormwater. As these opposite charges attract, the chitosan molecules can bind with numerous soil particles. This process of flocculation creates larger, denser particles in solution, allowing them to settle via gravity or be removed by filtration systems. Over dosing can cause the opposite of the intended effect. An excess of cationic material can cause the floc that initially formed at a lower dose to break apart.

1.3 CESF TREATMENT OVERVIEW

Chitosan-enhanced sand filtration is a flow-through stormwater treatment technology that utilizes chitosan in conjunction with pressurized sand filtration to remove suspended sediment from stormwater runoff. These systems are designed to be deployed on construction sites for the duration of a particular development project and then removed after the successful stabilization of all disturbed areas. Construction companies are compelled by law to prevent the discharge of polluted stormwater runoff from active construction sites. Clear Water Compliance Services works in conjunction with its clients to develop and implement a comprehensive Stormwater Pollution Prevention Plan (SWPPP).

After a careful study of site hydrology and local precipitation patterns, the contractor will install appropriate erosion and sediment control measures called Best Management Practices (BMPs). The BMPs will help reduce the turbidity of the site runoff conveyed to a retention pond for treatment. Each treatment system is designed and installed to be operated on an as need basis, pumping water from the retention basin through the CESF system on demand. Retention ponds have a site specific capacity designed to give Clear Water treatment technicians time to operate on regular schedules or respond to heavy storm events.

Upon arrival at a treatment site, Clear Water operators will complete a list of required tasks before operating the treatment system. A site inspection, meter calibrations, water quality tests, manual valve operation and paperwork initiation all must be completed before system start up can commence. The purpose of these tasks is to assure operator safety and proper system operation. After all preliminary procedures are completed the operator will start up the system by turning on the system pump(s). Operations will proceed by calibrating the chitosan delivery system, performing residual chitosan tests, manually logging water quality data, and monitoring the system for pressure and flow optimization.

When stormwater is transferred through the CESF system, chitosan is introduced to the water to coagulate suspended solids, which then will settle out via gravity or be removed within the sand filter. The sand filters are equipped with automatic backflush systems, which will backflush the filtered sediment from the individual filter pods as necessary to maintain the hydraulic capacity of the filtration media. This feature allows the treatment system to operate on a continuous flow-through basis. The treatment systems are also equipped with in line pH and turbidity sensors capable of monitoring and recording the effectiveness of the treatment. Automated valves direct treated stormwater to recirculate or discharge based on the water quality readings of the in line sensors.

After the operation period is complete the treatment technician will exercise standard and site specific shut down procedures. Familiarization with current site and weather conditions, pond water level, project manager (PM) and contractor concerns, and operation schedules are the responsibility of the technician. Good team work will ensure operational success and personal safety.

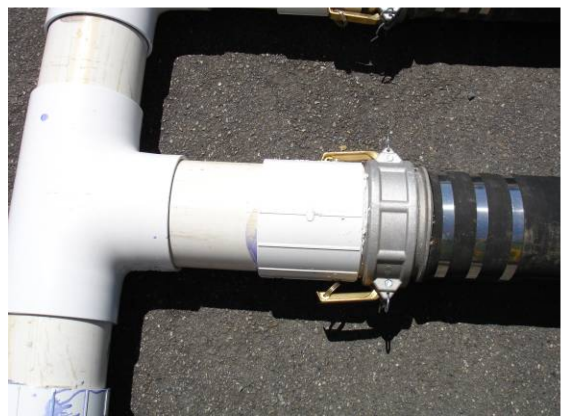
1.4 TREATMENT SYSTEM COMPONENTS

Although there are variations between individual CESF systems, many of the basic components are similar. The following is a list of the individual segments that one would expect to see associated with a CESF system.

1) Stormwater retention structure[s] — Stormwater retention structures include ponds, tanks or vaults. Ponds can either be lined or unlined; permanent or temporary. Tanks are rental units and frequently have weirs inside to facilitate settling. Vaults are permanent underground structures built for long term stormwater management.

2) Interconnecting piping — Water may be conveyed via swales, ditches or pipes to the retention structure. Interconnecting piping integrates all the components in the treatment system and conveys the water to the discharge point. Pipe types may include PVC, Bauer, flex hose and polyethylene tubes for sampling.

3) Pipe fittings – PVC pipes are typically connected with couplers and glue. Flanges are bolted together with a rubber sealing gasket. Bauer and cam lock connectors are quick disconnect fittings.



4) Primary influent and pretreat pump — The pretreatment pump is typically submersible and is attached to a float. The main pump, which pushes water through the sand filter, is shore based. Pumps are typically electric.

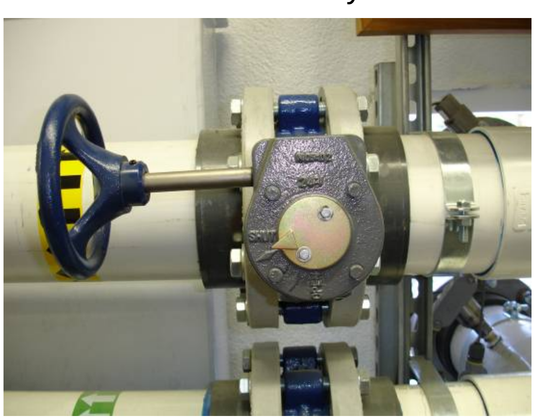
5) Chitosan injection system — The chitosan injection system consists of a storage tank, LMI delivery pump, graduated cylinders for calibration, a static mixer, and assorted tubing and control valves.

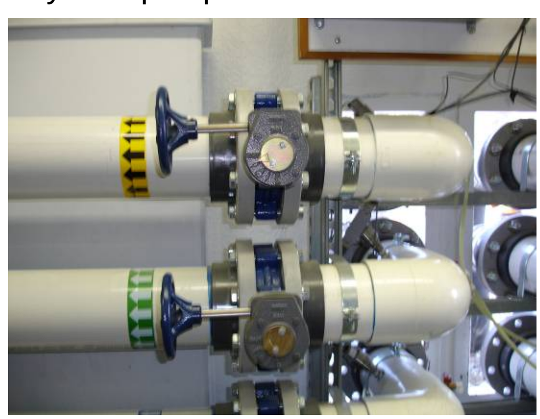



6) Sand Filtration Unit — The 54X4 sand pod unit with back flush capabilities is most commonly used. Three pod units or units with different diameters may also be encountered. Sand pods are the primary cleaning mechanism of the CESF system.


7) Effluent water quality monitoring equipment — This equipment continuously samples the effluent water for pH and turbidity. The system includes pH meters, turbidimeters, flow meters, an instrument display panel, and sample lines. Data collected here is recorded by the PLC.

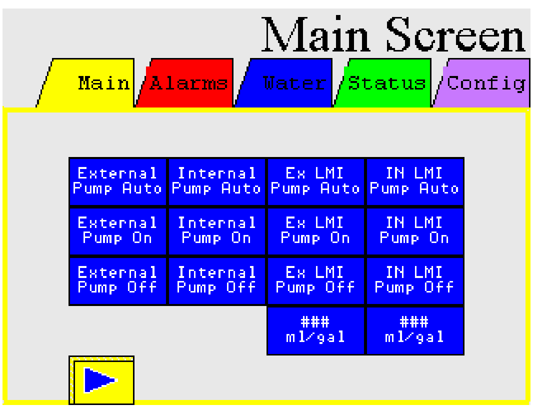
8) Manual valves — Manual valves are used by the operator to control flow rates and internal system pressures. There are manual valves located on the influent and effluent side of the sand filter, as well as on the backflush line. Additionally, a manual throttle valve may be located on the system pump.





9) Automatic valves — Automated pneumatic valves are located on the effluent line in the system container. These valves divert flow between the discharge and recirculation lines based on the water quality readings of the in-line sensors.

10) Programmable Logic Controller (PLC) — Primary control panel used to operate the treatment system. All automated controls, alarm settings, and recent system data are stored in the PLC.



11) Power Generator— These are rented units which provide electric power for CESF equipment and operations. These units are typically fueled and maintained by the contractor.

12) Laboratory Equipment — Components for bench scale testing and monitoring include handheld meters, beakers, droppers, filters, standard solutions, chemicals, monitoring forms and other miscellaneous items.

13) Air Compressor — Provides pressurized air to operate pneumatic control valves on the CESF effluent line and backflush valves on the sand filter

14) Backflush Control Box — Sets parameters for sand filter back flush cycles. Activates automatically based on differential pressure in the filter.

TREATMENT CONCEPTS AND SYSTEM DESIGN

2.1 CONSTRUCTION SITE OPERATIONS

The majority of Clear Water treatment operations take place on active construction sites. Construction sites are particularly dangerous locations and Clear Water employees should remain vigilant about health and safety issues. Constantly changing conditions, unstable surfaces, heavy equipment operations, as well as other issues all contribute to site hazards.

Health and safety precautions are extensive and beyond the scope of this manual. Clear Water technicians should refer to the site specific Health And Safety Plan (HASP) for safety issues pertaining to each job site. The weekly checklist included in the HASP needs to be read and signed by every Clear Water employee that visits a site for that particular week.

2.2 STORMWATER REGULATIONS

Construction stormwater runoff has been identified as a major source of pollution in our nation's natural waters. The physical, biological and chemical integrity of a natural water body receiving discharge from a construction site can be greatly impacted.

The two major laws that most stormwater regulations emanate from are the Federal Clean Water Act and Endangered Species Act. The Environmental Protection Agency is ultimately responsible for enforcement of these laws, but may delegate enforcement to a state agency. The Department of Ecology (DOE) is the regulatory authority for these laws in the state of Washington. (Note: many Clear Water treatment procedures are based on DOE regulations. Always consult local regulations before operating CESF systems.)

Whenever Clear Water intends to treat runoff from a particular construction site a Stormwater Treatment Plan (STP) must be produced as mandated by DOE. This STP explains exactly how the CESF system will be used on a specific site as part of an integrated Stormwater Pollution Prevention Plan (SWPPP). An STP will be included inside every active CESF system container. All operators should read the STP for any site they are working on to become familiar with site specific and general operational information.

There are many other stormwater regulations that are beyond the scope of this text. Increased knowledge of stormwater regulations will improve an operator's effectiveness. Additional information is available through other Clear Water resources, as well as the DOE website.

2.3 WATER CHEMISTRY

Effective implementation of a treatment system requires a thorough understanding of site stormwater characteristics and the potential impact on chitosan flocculation. Potential contaminants such as VOCs, PCBs, heavy metals, etc., must be identified and remediated prior discharge. Other compounds such as naturally occurring lignins and tannins can impact the CESF treatment process but do not pose a concern for discharge.

CESF systems are designed to treat turbid stormwater impacted with suspended sediments. Many environmental contaminants can be adsorbed to soil particles and become suspended in stormwater runoff. Many of these contaminants can be removed from solution by removing the sediment. Although this can be a beneficial side reaction in CESF treatment, Clear Water makes no treatment claims for stormwater runoff other than turbidity.

Prior to full-scale deployment, it is essential to conduct a series of bench scale treatability tests to ensure the stormwater sediment is conducive to treatment with chitosan. These tests should be focused on determining stormwater turbidity and pH, treatability, proper chitosan dose rate, and potential settling times if required.

Aside from harmful contaminates, the water chemistry variables of primary concern are pH, turbidity and conductivity. pH must be in the range of 6.5 — 8.5. Values outside this range will require pH adjustment prior to flocculent addition. Typical pH adjustment involves either adding Sodium Bicarbonate to adjust the pH upward or adding dry ice (CO_2) to adjust down. The use level designations require pretreatment for stormwater greater than 600 NTU.

Although CESF systems are capable of continuous operation when turbidity approach 600 NTUs, experience has shown that optimal system function is typically limited to influent turbidities less than 200 NTU. Generally, typical pre-treatment activity will bring NTU levels well within range of sand filter use. High turbidity (in excess of 600 NTU for an extended period of time) may require reevaluation of existing site Best Management Practices (BMPs).

2.4 SCREENING AND TREATABILITY TESTS

It is essential to confirm early on that site stormwater is conducive to treatment with chitosan. A simple bench scale treatability test enables Clear Water technicians to assess the treatability of site stormwater quickly in the field.

Bench scale treatability testing allows PMs and system operators to determine a likely chitosan dose range. On large sites, it is strongly recommended that Clear Water technicians perform treatability tests using samples from several different areas of the site.

Several factors can influence treatability, including pH (typically from concrete work onsite or natural limestone), detergents, the presence of soil tackifiers such as polyacrylamides (PAMs) and guar in the runoff.

Bench scale treatability tests should be done multiple times prior to system deployment to identify and address treatability issues early on. Treatability tests are also to be preformed daily before system start-up and whenever conditions on the site warrant reevaluation.

The procedure for this test is described in the section 3.6 of this manual

2.5 RETENTION STRUCTURES AND SEDIMENT MANAGEMENT

Stormwater retention ponds and traditional erosion control devices are the first line of defense in sediment management. CESF systems are more effective when properly integrated into a SWPPP that uses traditional erosion and sediment control techniques. Actual sizing and placement of retention structures and BMPs is beyond the scope of this document. Regardless of the type and size of structure, the following components are necessary for implementation:

1) **Traditional BMPs** — Traditional BMPs are essential to proper stormwater management. These surface stabilization measures help prevent significant erosion and sediment movement. CESF is intended to aid, not to substitute, standard stormwater management techniques.

2) **Primary retention structure** — The water reservoir in which all untreated stormwater is directed and stored. This is typically an excavated pond prepared by the contractor to store site runoff. The storage capacity of these structures varies depending on the size of the disturbed area and site limitations.

3) **Pretreat retention structure** — Secondary retention structure in which pretreated, unfiltered stormwater is allowed to settle prior to sand filtration. These structures can be ponds or above ground tanks. Ideally these structures will contain weirs to reduce and dissipate energy in the flowing water and aid in sediment settling.

4) **Backflush (from the sand filtration system)** — Backflush water will contain floc particles accumulated on the surface of the sand filter beds. These floc particles will settle rapidly in the retention structure due to their large size and density. The rate of settlement will depend on sediment load, water chemistry and flow rate. Backflush water should never be directly released into the receiving water body.

Every effort should be made to avoid routing backflush water to the primary retention structure. Ideally, the backflush outflow should be directed to a dedicated backflush tank which overflows into the pre-treat cells. At minimum, the backflush outflow should be directed to the opposite end of the retention structure from the intake pump.

- If there is any possibility that the coagulated/flocculated sediment (sludge) contains hazardous materials, then the retention structure should be lined to facilitate proper handling and disposal of contaminated sediments. Lining the retention structure will also prevent unwanted infiltration of untreated water.

- Disposal — Sludge may be dewatered and disposed of onsite. Contaminated sediment should be handled in accordance with applicable regulations and permit stipulations.

2.6 INTERCONNECTING TREATMENT SYSTEM PIPING

The filtration system requires interconnecting piping capable of transferring desired flow rates without significant friction head losses. Typically, schedule 40 polyvinylchloride (PVC) pipe and flexible hose is used to interconnect the system components. Sizing should be in accordance with system requirements, and will generally be as follows:

PIPING SIZES AND FLOW RATES

FLOW RATE	*PIPE SIZE*
Up to 350 gpm	**4”**
350-750 gpm	**6”**
+750 gpm	**8”**

The headers on the sand filter and the internal piping of the treatment system container are 6 inches in diameter. The ideal diameter of the external system piping is 6 inches which will maintain consistent pressures and flow rates. Reducing the diameter of a conveyance line (pipe) will increase the pressure the water exerts within that line. Conversely, increasing the diameter down a conveyance line will relieve the pressure in that line.

The treatment system container has hand operated flow control valves located on the influent and effluent lines for the sand filter. These valves control pressure and flow rates in and through the sand filter. In addition, the sand filter has a flow control valve located on the back flush line. Flow control throttle valves may also be located on the system pumps.

2.7 PLUMBING

As the treatment system container and sand filter is equipped with 6" pipe, it is recommended that 6" pipe be used to connect the system components. There are many factors that influence the type and size of pipe used for a CESF system which are beyond the scope of this manual. PVC or Bauer pipe are most commonly used for field mobilization but different types of flexible hose may also prove necessary in certain configurations.

Most CESF systems are equipped with pretreatment and backflush capabilities. The backflush line from the sand filter is a 4" header and will require 4" pipe. The pretreat line will require a pump separate from the main system pump and will typically be assembled using 6" pipe and fittings.

Before plumbing the system, make sure all required system components are in place and as level as possible. This includes the system operation container, water pumps, electrical generator, sand filter and any tanks.

CAUTION: BE SURE TO LEAVE ACCESS TO THE TREATMENT CONTAINER AND GENERATOR FOR ANY VEHICLES NEEDED TO RESUPPLY CHITOSAN AND DIESEL!

If the pump being used is submersible it should be connected to a flotation device prior to placement in a pond. Many types of flotation devices are used. The decision on which type to use needs to be made based on the size of the pump. If the pump being used is not a submersible pump, the intake line should be connected to a suction float with a debris screen. Flotation devices and screens prevent the introduction of rocks, sticks, mud and other debris to the pump. This can prevent costly maintenance, repairs, replacements and operational time loss.

The order in which the system is plumbed will depend on the physical configuration of the site. For the purpose of this manual the mobilization procedure will be described in the chronological order of the system water flow. The following list is generalized and site specific adjustments may apply.

- **Connect the pretreat pump.** Any flotation devices should be connected to influent before placement in the water. Run the line from the water to the pump, then from the pump to the bottom header at the front of the treatment container. Tape on the headers in the system container indicates direction of flow.

- **Connect pretreat line between system container and pretreat retention structure.** A distance of at least 50 feet is desired to maximize the mixing of the chitosan and the stormwater. Water should be released into the retention structure above the surface.

- **Connect line from pretreat retention structure to sand filter pump.** The water intake line from the pretreat retention structure should be as far as possible from the point where the pretreated water is introduced to the structure. This placement will take advantage of the maximum possible settling time of the sediment.

- **Connect line from system pump to treatment container.** This line will go from the pump discharge to the middle header at the front of the treatment container. Tape on the header in the container indicates flow direction.

- **Connect line from middle header effluent to the sand filter.** A distance of at least 50 feet is desired to maximize the mixing of the chitosan and the stormwater. This line will run to the top 6" header of the sand filter.

- **Connect line from bottom header of sand filter to treatment container.** This line will go to the top header at the front of the treatment container. Tape on the header in the container indicates direction of flow. This line will branch in to two effluent lines, each with an automated valve. The lower of these lines is the discharge effluent line. The top line is the recirculation line.

- **Connect discharge line.** This line will run from the container to the discharge location.

- **Connect recirculation line.** This line will run from the top effluent pipe and typically run into the primary retention structure consultant the PM for site specific modifications.

- **Connect backflush line.** This line will run from the 4" header on the top of the sand filter to the primary retention structure or separate backflush cell. This line should introduce water to the retention structure as far as possible from the pretreatment influent line to minimize uptake of suspended solids.

2.8 CHITOSAN DELIVERY SYSTEM

The chitosan deliver system consists of a chitosan storage container, secondary spill containment structure, metering pump, graduated cylinder(s) for calibration, static mixer, interconnecting tubing and valves. A secondary spill contaminant structure is required by regulatory agencies to provide containment in case of accidental spills. Consideration should be given to regular chitosan supplying procedures when installing the treatment system on site.

The metering pumps for the sand filtration systems are LMI Model C77 variable speed chemical metering pumps with high viscosity head assemblies. This pump is a variable-output, positive displacement metering pump with a flow rate range of 0-10 gallons per hour at 80 psi. These pumps are explicitly specified in the use level designations. Individual pumps are typically installed for the pretreatment and filter influent dosing.

PISTON SPEED AND DISPLACEMENT RATE SHOULD ONLY BE ADJUSTED WHILE PUMP IS IN OPERATION!

The capacity of a chitosan storage container can range from 150 to 275 gallons. The operational time frame of a storage container can last from several days to several months, depending on dose rate and the volume of water treated. Ball valves are installed on the chitosan delivery lines for meter calibration purposes. The static mixers installed on the pretreat and sand filter influent lines increases the mixing rate within the pipes. Incorporation of static mixers into Clear Water's CESF systems has reduced the required chitosan contact time, the overall system footprint, and decreased chitosan utilization by 25 to 50%.

The dose rate will depend on influent turbidities, water chemistry, and local regulatory agencies. The use level designation specifies a maximum allowable dose rate of 1ppm. Under certain conditions DOE will increase maximum allowable dose rate to accommodate specific site conditions. Follow the bench scale treatability protocol to determine the likely dosage range.

2.9 WATER QUALITY MONITORING

Local, Regional, State (use level designation), and Federal regulations will determine the scope of water quality testing that must be performed on the site. Construction permit and SWPPP approvals from applicable environmental jurisdictions will typically state what testing must be performed, how often, and who should receive the results. These regulations will often effect system discharge location and volume.

The treatment system is designed to monitor effluent turbidity and pH, and to automatically divert flow from discharge to recirculation should these values exceed permit limits. Influent water quality parameters are also monitored by the system PLC but do not trigger any flow diversions.

Clear Water treatment technicians must calibrate system sensors on a daily basis to ensure reliability of the automated process. Additionally, technicians must perform multiple manual water quality tests as dictated by the use level designation. Hand held meters must be checked and compared to the in-line meters on a daily basis. This procedure is referred to as a Confidence Check.

Other water quality parameters governed by local regulatory agencies must be monitored and addressed by the system operator. Sample ports are provided in the system to take water samples for bench scale monitoring. The filter influent and effluent headers each have one sample port feeding into the system's flow-through water quality sensors. The influent port samples pure runoff or pre-treat water before it gets dosed for the sand filter. The effluent port samples water after if has been filtered but before it is discharged. Water sampled for residual chitosan tests should be drawn from the effluent port to prove the absence of residual chitosan.

TREATMENT SYSTEM OPERATIONS

3.1 SYSTEM OPERATOR

The stormwater filtration system shall be operated, monitored and maintained by experienced water filtration personnel as required by the use level designation. The system operator should have previous training or should be trained during the first several days of operation under the guidance of an individual experienced in chitosan-enhanced water treatment systems.

3.1.1 Required Operator Qualifications

1) Minimum 1 year experience with, and sound working knowledge of, pressurized sand filtration systems.

2) Experience deploying and troubleshooting pressurized water pumping and piping systems.

3) Fundamental knowledge of stormwater discharge regulations for applicable region/locale.

4) Fundamental knowledge of water quality testing procedures for parameters applicable to the region/locale.

3.1.2 Required Operator Training

Classroom training (8 hours)

1) Stormwater regulatory framework and requirements

2) Stormwater treatment chemistry (chitosan, pH, coagulation, filtration,

etc.)

3) Stormwater treatability (how to do jar testing)

4) Treatment system components and their operation

5) Troubleshooting

Field Training (40 hours)

1) Operating a treatment system

2) Entering data in the system operation log

3) Testing turbidity and pH

4) Optimizing chitosan dose rate

5) Water quality sampling and testing (turbidity and pH)

3.2 SYSTEM OPERATION SEQUENCE

The typical operational sequence for starting and stopping systems is given below. System, site, and regulatory variations must always be considered. The following sequence is intended to be a general outline for CESF operations, not a comprehensive protocol.

3.2.1 System Start Up

1) Perform site and system inspection procedures (section 3.3). Examine system for obvious damage or malfunction. Unlock container and power up the system. Orient all valves for operation in recirculation mode.

2) Turn on the sensors. Read and record system volume totalizers in the Daily System Operation and Maintenance log. Record any other relevant system information.

3) Calibrate hand held pH, turbidity and conductivity meters.

4) Take a grab sample from primary retention structure and perform bench scale treatability test to determine likely chitosan dosage.

5) Perform water quality background check. This includes taking grab samples from the receiving water body and recording pH, turbidity and conductivity in the appropriate field log.

6) Calibrate inline pH and turbidity meters.

7) Switch PLC to recirculation mode. Recheck manual valve orientation.

8) Start the filtration system pumps using system PLC screen and watch for proper system functioning.

9) Start LMI pumps

10) Calibrate LMI pumps to deliver proper chitosan dosage

11) Once LMI pumps are calibrated and all discharge conditions are met, switch system to automatic mode by touching the "valves auto" button on the main screen of the system PLC.

12) Collect samples of sand filter effluent and perform the residual chitosan test.

13) Treatment technicians will remain on site while the system is in operation to monitor overall system performance. System pressure and inline water quality results are to be recorded every fifteen minutes in the appropriate field log.

14) Residual chitosan tests are to be performed twice during the first two hours of system operation. LMI calibrations are to be performed every four hours after start up calibration, or when a significant change occurs in the dose rate or influent turbidity

3.2.2 System Shut Down

1) Begin system shut down by switching system back into recirculation mode.

2) Turn off main system pumps and LMI pumps.

3) Open sand filter bleeder and/or drain valves and let water drain from the recirculation line.

4) Record flow meter totalizer readings in the appropriate field log. Note any operational anomalies and certify operations.

5) Follow shut down procedures for inline pH and turbidity meters (Section 3.15).

6) Drain air compressor using manufacturer installed drain plug.

7) Clean and organize the treatment system container.

8) Close all applicable system valves (inline sample; chitosan storage tank; water storage tank; pneumatic valves).

9) Turn off all extraneous power in the system and lock the container.

3.2.3 Freeze Protection

During cold weather conditions, certain precautions need to be taken to protect against freeze events. A freeze event could result in system component damage and/or operations loss.

1) All conveyance lines should be drained. Frozen pipes could result in flow blockage and/or pipe fracture. Ball valves are likely installed on conveyance

lines to drain water for freeze protection. Disconnect low end cam-locks or Bauer fittings for drainage if necessary.

2) Sand filters should be drained. Bleeder valves on the top of the sand pods should be open to aid in filter drainage. Drain valves may be installed on the bottom header for more direct filter evacuation.
3) System Container should be kept heated at all times. Generator, system, and heater should all be left in “auto”. Extreme cold conditions can cause instrument damage, plumbing damage and will affect the hydraulic performance of the chitosan. The properties of some of the chemicals may be compromised if they freeze.

3.3 SITE AND SYSTEM INSPECTION

A preliminary assessment should be made of the overall integrity of a job site upon arrival. Conditions may have changed at the site in such a way that affects treatment operations. In addition, standard operating procedures must be performed prior to system start up.

Overall site integrity: Construction sites are in a constant state of change. Be aware of major physical changes such as road additions or removal, vegetation removal, sanitary facility location, site access points, excavations and heavy equipment operation.

Pond Level: Check pond level upon arrival. Report excessive pond levels immediately. Observe pond level prior to system startup and monitor level frequently during operation. Note both increases and decreases in pond level to assure efficient staffing and operation.

Pipe Integrity: Check to see if all the conveyance lines are in working order. Surface pipes on construction sites are vulnerable to vehicle impact, vandalism, and environmental damage. Small stress cracks can become significant safety or operational problems when operating under pressure

Freeze Protection: Close all drain valves that may be affixed to water conveyance lines or the sand filter. These valves are left open to drain excess water from the lines in cold weather. Water expands as it freezes and PVC pipe becomes more brittle in cold weather. This combination can render a system inoperable.

Manually Operated Valves: Switch any manual valves to the proper position for site specific operations. Some valves associated with system operation are automatically controlled by the PLC. However, some systems may incorporate manual valves for pretreatment cells, multiple retention ponds, or multiple discharge locations. If you are unsure about proper valve positions, contact the project manager.

Hose/Pipe Connections: Shut down protocols on some sites require operators to disconnect specific conveyance lines to drain the system. Assure all necessary conveyance piping and hoses are attached to appropriate system equipment.

Generator Fluid Levels: Check the fluid levels (fuel, oil, water) on the system power generator to see if the equipment needs to be serviced. If any fluids are low or warning signals lit, contact the project manager.

Equipment Theft: Power cables, generators and hand tools are a frequent target of theft. Check to see if any operational equipment appears to be missing or tampered with.

Unlock Container: All Clear Water treatment containers are kept locked when company personnel are not present. Keys for all treatment containers will be provided by the PM.

Power Up System: A treatment system will likely be in AUTO or OFF upon arrival. CESF system key switch and generator should be set to ON during system operation.

Chitosan Injection System Valves: The chitosan storage tank valve should be shut at the end of every shift to protect against chitosan leaks. Open any valves necessary for proper chitosan injection.

Sand Filter Bleeder and Drain Valves: Small bleeder valves at the top of the sand filter pods are typically left open at the end of system operations to aid in the drainage of the sand filter. Make sure these valves and drain valves are closed before introducing water to the filter.

Sample Port Valves: Water quality sampling lines should be closed at the end of system operations. Keep these valves closed until the inline water quality meters have been calibrated. Open the valves before system operations.

Air Compressor: Turn on air compressor if it is turned off. Make sure the compressor breaker switch is on. Check to make sure the previous operator drained the compressor of water and the drain valve is closed.

Chitosan Volume: Asses the quantity of chitosan in the storage tanks. Site PMs need to be kept aware of chitosan levels so they can schedule a timely resupply.

3.4 FIELD DOCUMENTATION

A series of triplicate forms are provided in all the system containers for technicians to log the results of operational activities. Completion of these forms is necessary for compliance with Clear Water and regulatory procedures. The complete set of forms is to be used during every operational period.

All the forms have a field to record the project title, project number, project location and date in the header block. System operators should print and sign their name at the bottom of the sheet. If multiple operators are working in a single system container, the forms should be signed by the most senior operator. All fields on each form are to be completed. Fields are never to be left blank. Fields which do not apply to a particular site or system should be completed with the letters NA (not applicable).

CESF – Daily System Operations and Maintenance: This is the primary form used by Clear Water operators. The pre and post treatment flow totalizer numbers as well as the total volume treated and the total volume discharged are recorded here. This form is intended to summarize system activities and productivity. Regulatory agencies require an evaluation of system performance and water quality monitoring for all discharge periods. Other relevant operational information should be recorded here for reference by Clear Water staff.

Bench Scale Treatability Form: This form is used to record water quality data and the observed results associated with the bench scale treatability test. The procedure for this test is described within this manual. Visual observations should be recorded in conjunction with each dose adjustment. Additionally, a general assessment of the entire test should be recorded upon completion of the test.

Receiving Water Quality Monitoring Form: The receiving water quality form is used to record the results of upstream and downstream conditions in the receiving water body. The observations recorded on this form are used to assess any impacts CESF discharges may impose on the receiving water. This form has limited usability on some sites because of the location of the discharge or type of receiving body.

Chemical Metering Pump Calibration Form: This form is used to record the LMI chemical delivery rate and calculate the treatment system dose rate. The chitosan calibration procedure is described within this manual. Chitosan injection pumps are to be calibrated upon system start up and every four hours thereafter.

Residual Chitosan Test Form: This form is used to record the results and sample data associated with residual chitosan tests. The procedure for this test is described within this manual. This residual chitosan is to be performed twice during the first two hours of CESF operation. Operating conditions that necessitate elevated chitosan dose rates may increase the residual chitosan testing requirements.

Manual Data Collection Form: This form is used to record inline water quality data (pH, Turbidity) as well as system pressure. Influent and effluent data should be recorded for each of these three categories. This data should be recorded every 15 minutes and logged in military time. This data should be read from the "water" page of the PLC. In addition, daily meter confidence checks should be recorded on this form.

Instrument Calibration Report Form: Clear Water's CESF systems have multiple water quality meters which need to be calibrated daily. There are separate forms associated with inline pH meters, inline turbidity meters, and all the hand held meters. There are fields to record the strength of the calibration standard used, the initial meter reading, and the calibrated meter reading.

3.5 SENSOR CALIBRATION

The systems internal water quality sensors, as well as the hand held sensors, should be calibrated daily before operations begin. Log the calibration information for each instrument in the accompanying calibration form. Daily calibration of the sensors is directed in the use level designation and will help ensure accuracy of water quality monitoring.

Confidence Checks must be performed to confirm sensor accuracy. Hand held readings should be checked against inline readings during the residual chitosan tests. An additional Confidence Check is to be performed and recorded six hours after system start up. Confidence Checks are to be recorded in the Manual Data Collection Form.

The manufacturer provided calibration procedures for each meter are included as an attachment in this manual. Additionally, the entire owner's manual for the hand held meters are included inside each treatment system. Calibration standards for the inline and hand held turbidimeters are included in the corresponding meter kits. Calibration standards for the inline and hand held pH meters are supplied within the treatment system containers. The calibration standard for the conductivity meter is supplied within the treatment system container.

3.5.1 Hand Held Meter Calibration

Hand held meters are to be calibrated at the beginning of each operational shift. A separate set of forms are included specifically for calibrating the hand held meters.

These meters must be calibrated prior to the preliminary water quality tests. Follow the included manufacturer's instructions for proper calibration procedure.

3.5.1.1 Hand Held pH Meter

It is important to properly care for the pH meter probe. Irreparable damage to the probe commonly occurs due to simple neglect. pH probe storage solution and cleaning solution is included in the treatment system containers. Use the cleaning solution periodically or whenever its use appears necessary. Store the probe in probe storage solution whenever the meter is not in use. The tip of the probe should never be allowed to dry out. The probe should be rinsed with water between insertions of different standards or samples to avoid contamination.

3.5.1.2 Hand Held Turbidimeter

The included cuvettes for calibration standards and sample measurements need to be handled carefully. The readability of the glass cuvettes will be compromised if they get scratched. Avoid touching the cuvettes with your bare fingers and carefully remove smudges with laboratory wipes. The cuvettes can become stained if dirty samples are allowed to sit inside for an extended period. Always promptly empty samples and rinse the cuvettes with distilled water after use. Clean stained cuvettes with a gentle solvent.

Make sure the outside of the cuvettes are dry before inserting them into the meters. Introducing moisture into the meters will compromise sample reading and damage the meter.

Record the Initial Reading before calibrating the meter. Record the Final Reading after calibrating the meter.

3.5.2 Inline Meter Calibration

Inline meters are to be calibrated at the beginning of each operational shift before stormwater treatment begins. Record calibration data in the appropriate forms. Follow the included manufacturer's instructions for proper calibration procedure.

3.5.2.1 Inline pH Meter

Follow the probe care and usage instructions previously stated for the hand held meter.

Calibrate the pH meter using the EASYCAL method identified by the manufacturer. Choose a calibration slope appropriate to the stormwater that will be treated for that shift (7 to 4 if water is under 7; 7 to 10 if water is over 7). Finish the calibration procedure by measuring the calibrated reading of the pH 7 buffer. This will ensure the meter is reading within the range of the stormwater being treated. Record the Initial Reading when the meter is in calibration mode and record the Final Reading when the meter is back in normal operation mode.

Carefully remove and replace probe from probe seat. Probe-amplifier lock points can be damaged if not removed gently. Cross threading is a common problem with the pH seats. Be aware of the O-ring gasket falling out when removing probe from pH seat.

3.5.2.2 Inline Turbidimeter

Follow the cuvette care and usage instructions previously stated for the hand held meter.

Be aware of condensation on the flow through cuvette when calibrating between 24 hour operational periods. Cold water in the cuvette and the warm air inside the treatment container will often promote condensation which would need to be wiped off before returning the cuvette to the measurement chamber.

Record the Initial Reading and Final Reading when in calibration mode.

3.6 PRELIMINARY WATER QUALITY TESTS

After the water quality sensors have been calibrated the system operator can perform the bench scale treatability and receiving water quality tests. These tests are used to assess the conditions of the stormwater to be treated and the receiving waters. The technician may have to adjust treatment system operations based on the water chemistry results of these tests

3.6.1 Bench Scale Treatability Test

The bench scale treatability test lets the operator know of possible treatment problems prior to introducing water to the CESF system. Several factors can influence treatability, including pH (typically from concrete work onsite, or natural limestone), detergents, the presence of soil tackifiers such as polyacrylamides (PAMs) and guar in the runoff.

Conditions in the bench scale test are different than conditions inside the treatment system. For this reason different treatment outcomes may occur between bench scale tests and system operations.

The samples procured for this test should be representative samples from recent runoff, and should not contain sediment that would settle naturally (sand and rocks). On large sites it may be prudent to collect multiple samples from different points on the site and perform separate tests.

3.6.1.1 Required Equipment

In order to perform this testing sequence, the following items are required:

- Properly calibrated pH meter
- Properly calibrated turbidimeter
- Properly calibrated conductivity meter
- One 1-liter sample glass beaker
- One 1-liter sample plastic beaker
- Chitosan acetate
- Pipette
- Stir rod

3.6.1.2 Perform the Screening Test

1) Retrieve a one liter grab sample of stormwater from the site retention pond with a plastic beaker.

2) Transfer the sample into a one liter glass beaker

3) Measure and record initial pH, conductivity and turbidity of sample in the appropriate field log.

4) If the sample does not have a pH reading conducive to treatment (6.5 – 8.0), carefully adjust the pH of the sample by adding small amounts of sodium bicarbonate or acetic acid until the sample reads a pH close to 7. Record the adjusted pH and note treatment method.

5) Add one drop of a known quantity chitosan to the sample.

6) Stir sample vigorously for one minute to assure dissolution.

7) Allow sufficient settling time and observe solution for the formation of small floc particles called pinfloc.

8) Grab a sample from the surface of the sample jar and record the turbidity.

9) Repeat steps 3 through 4, recording observations and dosage related to the appearance of floc and settling.

3.6.1.3 Interpreting the Screening Test

Visible sediment settling indicates that chitosan has coagulated the particles. The beaker may contain clear water on top, or be slightly cloudy, and there should be variation in coagulation amount between dose rates. The object of this test is not to produce completely clean, clear water in the beaker. Rather, it is to determine the most suitable dose rate for CESF treatment.

For planning purposes, the smallest effective dosage should be used as the initial dose rate.

If there is no change in sample appearance between doses it is assumed that there are treatability problems. This is rare, and may occur for different reasons which need to be investigated.

3.6.2 RECEIVING WATER QUALITY TEST

Receiving water quality tests are designed to measure if discharge from CESF operations is negatively impacting the receiving water body. Site specific conditions may force the system operator to amend or even abandon this test all together. Certain discharge points, such as municipal storm sewers or overland infiltration, make it physically impossible to obtain a sample for this test.

This test is designed for a linear flow water body such as a river or stream. The procedure for this test will be described for such a water body. PMs and treatment technicians may need to improvise sample collection procedures if site conditions are inconsistent with this assumption.

1) Before system start-up, take two 1-liter beakers to the discharge point to obtain grab samples. Take one sample several yards upstream and one sample several yards downstream of the discharge. Always wear nitrile laboratory gloves when taking grab samples. Operators must not place themselves in precarious situations to obtain a sample. NO JOB IS TOO IMPORTANT TO NEGLECT SAFETY CONCERNS!

2) Return samples to the system container to measure the water quality. Measure pH, turbidity and conductivity of each sample with hand held meters. Record the sample location, time and water quality data for the two samples in the top two columns of the Receiving Water Quality Form.

3) After several hours of operation, return to the system discharge point and take one sample from each of the previously identified locations. Return these samples to the system container to measure water quality. Record the water quality data along with the location(s) and time(s) on the bottom two columns of the form.

4) Compare the two data sets. Ideally there will be a negligible difference between the data sets. If there is a significant difference between the two data sets, it should be recognized as evidence that system operations are impacting the receiving water body. Operators should notify their project managers in such a case.

3.7 PUMP ACTIVATION

After meter calibration and preliminary water quality tests are completed, the operator is ready to introduce water to the CESF system. Operators should always verify all manual valve positions to ensure the pressurized water has a clear and proper path of entry and exit through the treatment system. Closed pathways will dead head the pump which can lead to equipment damage and/or safety concerns.

Attention should be paid to the water levels of the primary and (if applicable) secondary retention ponds. Pretreatment should be momentarily delayed if the secondary cell is full. Filter treatment should be delayed if the secondary cell is empty. Overflowing retention structures can result in stormwater runoff violations. Pumping of a dry retention structure can cause pump damage. Pretreatment and primary pumps often do not deliver water at the same rate. Treatment technicians should continually check pond levels and pump flow rates and adjust pump operation accordingly.

3.7.1 Pump Activation Procedure

1) Open the automated recirculation valve by pressing the “Recirc Valve On” button on the Main Screen window of the PLC. Visually confirm that the valve has opened.
2) Toggle over to the secondary Main Screen window by pressing the yellow and blue arrow on the bottom of the screen. All the buttons on this screen supply power to individual pumps.
3) Switch on pretreat and/or main pumps, based on retention structure(s) water level by pressing the “External Pump On”/”Internal Pump On” button(s) accordingly.
4) Switch on the corresponding pretreat and/or main LMI pumps by pressing the “Ex LMI Pump On”/”In LMI Pump On” button(s).
5) Check associated components as water begins to run through the treatment system including, air compressor, backflush control box, flow meters, and flow through sample lines.

6) Observe pressure gauges to assure the CESF system reaches an acceptable operating pressure.

3.8 SYSTEM OPTIMIZATION

CESF systems usually take several minutes to reach full operating pressure after pump activation. Clear Water technicians should take this time to confirm proper system operation. Systems which have been operated recently and frequently will generally reach optimum operating conditions soon after pump activation. Systems which are starting up for the first time or have not been operated for a long time will require some adjustments to reach optimum operating conditions.

3.8.1 System Optimization Procedure

1) After pump activation, confirm that the air compressor is receiving power and delivering the proper pressures. Compression chamber pressure should be 100+ psi and line pressure should be 60+ psi
2) Visually confirm water discharge. Walk over to the discharge (recirculation) point to observe this. No water or decreased water flow indicates possible system breach.
3) Confirm that the flow sensors are working. There are different types of flow sensors and the reason for failure may differ. If the flow meter is not registering flow but system flow is evident, the sensor may need to be inspected. This process involves system shut down, water main evacuation and removing the meter for inspection.
4) Confirm backflush control box is powered. The backflush control box automates all backflush operations. Loss of backflush will result in filter sand bed impaction. Check main power, breaker switch and power cord if box is not powered.
5) Confirm sample line flow. Polyethylene tubes which convey the water quality samples should dispel water through one of the penetrations in the container. No outflow from these tubes indicates the water quality readings are not representative of the treated stormwater. Check for proper valve orientation and/or clogged lines.
6) Optimize flow rates. The maximum discharge flow rate for a specific site will be specified in the Stormwater Treatment Plan. Adjust manual valves to achieve desired flow rate.
7) Optimize system pressure. Optimal system pressure depends on the specific system and will vary from site to site. Variables such as pump capacity, plumbing configuration, filter size, discharge rate and water treatability will all affect system pressure. Typical system pressure should range between 30 and 50 psi. System pressures can be as low as 20 and as high as 50 with no operational impediments. Opening the influent valve will increase system

pressure and increase system flow. Opening the effluent valve will decrease system pressure and increase system flow.

3.9 pH TREATMENT

Although pH treatment is not included in all CESF treatment regimens, it is not unusual. Many of the sites that require pH treatment require it on a consistent basis while other times it may be sporadic or short term.

pH treatment is required for regulatory and operational purposes. These two requirements are not necessarily unrelated.

Regulatory requirements dictate runoff from construction sites that discharge to non-marine surface waters must have a pH between 6.5 and 8.5. Most natural waters are well within that range. Many aquatic species are very sensitive to pH alterations and even a small alteration can have a significant effect on a natural system.

Stormwater pH must stay in the same range of 6.5 to 8.5 for CESF treatment. The chemical reaction which facilitates chitosan flocculation is optimized within this range. Outside of this range, the effectiveness of chitosan as a flocculent is severely compromised.

pH treatment for CESF systems is generally done with one of two chemicals. Sodium Bicarbonate raises low pH and CO_2 lowers high pH. Beware of over correction. Adding too much chemistry for pH correction will render water untreatable.

SODIUM BICARBONATE: Adding Sodium Bicarbonate to acidic water (pH below 7) will raise the pH to a treatable level. Sodium bicarbonate is typically supplied to CESF system operators in 50 lb bags. It is most effective to add the chemical to a point in the system where it can be physically disturbed and dissolved. The point where pressurized water is discharged into a settling pond would be an ideal location.

CO_2: Adding CO_2 to caustic water (pH above 7) will lower the pH to a treatable level. CO_2 is supplied to CESF system operators in the form of dry ice or in a compressed gas or cryogenic tank. Dry ice is most effective when introduced to a retention structure near the region of pump uptake, right before chitosan is injected. Cryogenic tanks are normally supplied when pH treatment will be a regular process and there will be a dedicated “sparge” tank for gas injection.

3.10 LMI CALIBRATION

Clear Water technicians will operate and calibrate the chemical metering system consistent with the use level designation requirements. Technicians will calibrate the chemical metering system at system startup and every four hours thereafter during system operation to ensure that the dose rate is at or below 1.0 ppm at all times. Additionally, the metering pump shall be recalibrated when a significant change occurs in either the flow or influent turbidity. Calibration results and flow rates will be recorded on the CESF system monitoring forms and the calibration records will be kept onsite.

OPERATIONAL NOTE: LMI pump dials should **ONLY** be adjusted when pumps are **OPERATIONAL.** Adjusting pump dials while pump is not running will likely result in pump damage and/or failure.

When adjusting the metering pump to obtain proper dose rate, there are two primary adjustments: stroke frequency and stroke length. Experience has shown that the stroke frequency should be set as high as possible for a consistent rate of delivery, and then the stroke length adjusted to deliver the desired dose rate.

Some CESF chemical injection systems have a dedicated delivery line for each pump, while other systems have multiple pumps connected to the same line. Operators should consider the design of the injection system being calibrated when executing this procedure. Systems that have multiple pumps plumbed to the same line will require the operator to isolate the unmeasured pump from the system during calibration.

Upon initiation of this procedure, the valve on the chitosan storage tank should be open and both system pumps and chitosan delivery pumps should be operating.

Calibration Procedure:

1) Fill the calibration cylinder by opening the valve on the bottom of the cylinder. Fill the cylinder as close to full as the static head pressure on the storage tank will allow without over filling.
2) Close the valve on the chitosan storage tank.
3) Allow the LMI pump to drain the cylinder to a desired volume and then begin timing the pump for one minute.
4) Close the cylinder valve at exactly one minute.
5) Immediately open the valve on the chitosan storage tank
6) Read and record the volume of chitosan consumed
7) Calculate the dose rate using the calculation table below. Pair the chitosan consumption rate with the corresponding stormwater flow rate.
8) Convert delivery rate from ml/min to mg/min (multiply result by 10 for 1% chitosan) and flow rate from gal/min to L/min (multiply by 3.78). Divide chitosan delivery rate by flow rate to get does rate (ppm). Refer to formulas presented below.

9) Adjust delivery rate toward desired dose rate* if necessary and repeat procedure until proper dosage is achieved.
10) Record the final results in the Chemical Metering Pump Calibration Form.
11) Repeat procedure for next LMI pump.

1. Liqui-Floc delivery rate (ml/min) x 0.01 (chitosan concentration) x 1g/ml (weight of Liquid-Floc) = absolute weight of chitosan in g/min
2. Chitosan delivery (g/min) x 1000 (mg/g) = delivery rate (mg/min)
3. System influent flow (gpm) x 3.78 L/gal. = flow rate (L/min)
4. Delivery rate (mg/min) / flow rate (L/min) = dose rate in mg/L = ppm

When the LMI calibrations are complete, verify the valve on the chitosan storage tank is open and the valve on the calibration cylinder is closed. Verify that all LMI pumps are on.

Record the dose rate of the pretreat pump and the sand filter pump separately. Add these two dose rates together to get the overall system dose rate. The overall system dose rate should not exceed the maximum allowable chitosan dose rate (1 ppm).

***** The desired dose rate depends on many variables including site and system history, turbidity levels, use level designation limits, water chemistry, flow rate and pre-treatment activity. Typically an operator should dose the minimum amount necessary to achieve the desired result.

3.11 RESIDUAL CHITOSAN TEST

High doses of chitosan in the aquatic environment have exhibited toxic effects on fish in laboratory tests. In the CESF process, the majority of the chitosan introduced into stormwater is consumed during the coagulation/flocculation process. The residual chitosan test was developed to confirm the concentration of chitosan in the treated effluent is below the 0.2mg/L environmental threshold. The residual chitosan test is used as a precautionary measure to alert technicians of potential treatment problems before significant impacts can occur.

The Dept. of Ecology approves procedures for residual chitosan testing for each distributor of chitosan acetate. One example, “Colorimetric Determination of Residual Chitosan in Treated Stormwater”, is included as an attachment to this manual. The following procedure was produced as a quick reference for Clear Water technicians with considerations given to company specific equipment.

The use level designation require at least two discrete grab samples of CESF system discharge be analyzed for residual chitosan during each operating period. An operating period shall not exceed 24 hours. The samples must be collected one and two hours after the onset of each operating period.

3.11.1 Required Equipment

There should be two separate, clearly marked, sets of equipment. One set will be used for the sample analysis and should be marked “sample”. The second set will be for the matrix spike used for a color comparison. The second set should be marked “spike”.

- Two stir rods
- Two 140 mL capacity plastic syringes with threaded tip
- Two threaded plastic Swinnex filter seats
- Two plastic 1L beakers
- 1 pair of forceps
- plastic disposable droppers
- fiberglass micro filters
- Chemicals: 1% chitosan acetate, 0.1N solution Iodine, Sodium Bicarbonate (with scoop)

3.11.2 Procedure

Make sure all equipment is washed thoroughly and proper laboratory procedures are followed. Most “hits” produced in this test are actually false positives that are due to contaminated equipment.

1) Take 2 separate 1 liter samples from the sand filter effluent sample line.

2) Measure and record pH, turbidity and conductivity in the Residual Chitosan Test Monitoring Form. Transfer all relevant data from the LMI calibration to this form.

3) Add two drops of 1% chitosan acetate to the beaker marked “spike”. Stir vigorously for 1 minute to assure dissolution. This beaker now has a chitosan concentration of approximately 0.2 ppm.

4) Add one scoop (approximately 5 grams) each of Sodium Bicarbonate to the sample and the 0.1 ppm spike sample. Stir vigorously for one minute. Read and record the adjusted pH. The new pH level must be at 8 or above to cause the chitosan to come out of solution.

5) Open the Swinnex filter seats and carefully place clean filter papers in each one with a pair of forceps. Carefully thread the seats back together. Avoid cross threading the seats for proper filter dosing.

6) Draw 100 mL of the treated sample water from the “sample” beaker into the “sample” syringe. Thread the “sample” filter seat on to the syringe. Slowly push the sample water through the filter. Repeat with another 100 mL (200 mL total). Repeat procedure with “spike” sample.

7) Remove the filter seat from the syringe and then remove the filter from the seat with forceps. Remove the sample first and the spike second to avoid contamination.

8) Place each filter on a clean, inverted glass beaker to dry. Place the beaker a reasonable distance in front of a space heater to facilitate drying. Dry completely for optimum results.

9) After the filters are dry, add one drop of iodine to each filter. Wait 15 minutes to interpret results.

10) A light yellow rust color indicates the absence of chitosan. This is how the sample should appear. A dark brown or blue/black color indicates the presence of chitosan. This is how the spike sample should appear.

If an operator gets a positive test the system will immediately be shut down and investigated to determine if any of the operating parameters are out of specification. The system can then be corrected and the filtrate retested to confirm the absence of chitosan in the treated filtrate.

3.12 SYSTEM DISCHARGE

After the inline water quality readings are within discharge limits and initial LMI pump calibrations have been performed, the CESF system is ready for stormwater discharge. Access the Main Screen on the PLC and press the “Valves Auto” button. This will prompt the system to open the discharge valve and close the automated recirculation valve. The system will continue to direct all water through the discharge line as long as the pH and turbidity readings are within the programmed discharge limits.

The automated valves should be visually inspected periodically to confirm proper operation. Valves that do not fully actuate pose potential safety and/or equipment damage concerns. The discharge point should be visually inspected periodically for possible erosion, especially during the initial periods of operation.

3.13 MANUAL DATA COLLECTION

Water quality and system operational data are automatically logged through the PLC during periods of operation. In addition, operators should manually record system data every 15 minutes during operation. The Manual Data Collection Monitoring Forms are provided for this purpose.

These forms are designed to record influent and effluent data for pH, turbidity and sand filter pressures. Each sample recorded should be initialed by the operator logged in military time. An extra column is provided to make any relevant notes associated with each sample recorded.

As previously noted in section 3.5 Sensor Calibration, the Confidence Checks should be recorded in this form. This needs to be performed two times during every operational period. Immediately after a manual data record is taken, the system operator will obtain a grab sample from the sample influent and effluent lines. Turbidity and pH data is to be taken with the hand held meters and logged immediately below the inline meter data for comparison. Readings taken from the mechanical pressure gauges on the sand filter will recorded and compared with the readings on the PLC. An asterisk should be placed in the “Notes” field to indicate Confidence Check as described on the form.

3.14 BACKFLUSH

Backflushing is the process by which water flow is reversed through the sand beds to expel the accumulated sediment on the top of the beds. Each sand pod is flushed one at a time while the rest of the pods in the filter continue to operate normally. The stormwater which was filtered from the active pods will fill the bottom header and a portion of it is forced upward through the pod that is being backflushed.

Although backflush cycles are automated, the process needs to be understood and controlled by the system operator. The backflush parameters are set from the control box which is fixed to the side of the sand filter. Flush duration, delay between switching pods, manual start and stop as well as power and breaker switches are all on the control box. The cycle timer knob should be set to zero as backflush cycle initiation is typically controlled through the pressure differential switch on the bottom of the control box.

Typically, at a pre-set pressure differential, the controller will initiate a backflush cycle to remove the captured floc from the media bed. As the filter beds become clogged with floc particles the pressures between the top and bottom headers begin to deviate. The top header will gain pressure and the bottom header will lose pressure due to decreased water passage. When this pressure differential reaches a set level, the system will initiate the backflush cycle. The differential is generally set around 8 psi but will vary from system to system.

The system requires a minimum of 20 psi effluent pressure for adequate backflush. Pressures below this will generally not be high enough to fluidize the sand beds, which is necessary for proper backflush. System pressures and flow rates will differ between operation and backflush cycles. Operators must monitor flows and pressures during transition to backflush to assure they remain optimal. Valve adjustments may need to be made accordingly. In addition to the influent and effluent control valves there is a valve at the end of the backflush header. This valve is set during system start up to optimize backflush flow without discharging filter media. This backflush valve generally does not need adjusting and should only be adjusted by experienced operators who are familiar with that particular site.

A site glass is installed at the top of the backflush header to monitor backflush efficiency. The water in the site glass should appear turbid during the initial stage of each pod flush. Toward the end of the flush the water should appear clearer as all of the floc is expelled from the sand bed. Some systems are equipped with backflush sample lines which can also be used to monitor the effectiveness of the backflush. Flush duration should be set at two minutes. To increase backflush intensity, operators should increase the frequency instead of duration of the cycle.

The consequence of insufficient backflushing is impacted sand beds. Failure to backflush will cause excess floc accumulation in the filter. Excess floc under operating pressures will cause the beds to compact, limiting water movement through the beds. This is commonly called impaction. Impaction will force a system shut down. The water in the filter must be evacuated, the filters will need to be opened and the sand in the filter must be broken up with a shovel. In extreme cases the filter medium may be so compromised that it will need to be discarded and replaced.

3.15 SYSTEM SHUT DOWN

System operation is typically carried out during pre determined shifts. System operations may need to be abbreviated or extended based on retention pond levels or predicted rain events. Occasionally, shifts will be extended on an emergency basis if there is danger of potential site release.

Shut down procedures will vary from site to site. Project Managers should communicate site specific concerns directly to technicians or through site documents. The following checklist covers the range of typical tasks that need to be completed when shutting down a CESF system.

1) Switch pneumatic valve from “auto” to “recirc” by pressing “Recirc Valve On” on the PLC.

2) Switch LMI pumps off on the PLC.

3) Switch pretreat and main pump off on the PLC.

4) Visually and audibly confirm pump shut down.

5) Record final totalizer readings on the daily operations form. Record any operational anomalies your PM may be concerned about. Record system operation assessment and certify acceptability of operation. Communicate significant system upsets or concerns directly to the PM.

6) Finish all paper work. Remove the pink slips from the operations form and place in the appropriate folder. Return remaining copies to the PM.

7) Drain air compressor.

8) Clean laboratory bench top and system container.

9) Close chitosan tank valve. Close sample port valves. Open sand filter bleeder valves to aid the drainage of the sand filter.

10) Empty, rinse and replace inline cuvettes. Remove and clean inline pH probes. Immerse probes in proper storage solution.

11) Perform any necessary freeze protection procedures. Leave heaters, container and generator switches in "Auto"

12) Switch sensors off on the PLC. Close automatic valves on the PLC.

13) Turn off all lights and any extraneous power from the container.

14) Secure the site and lock the system. Any valuable equipment should be locked up to discourage theft.

Clear Water staff should leave all PPE on until they have entered their vehicle to leave the site. All Clear Water trucks are supplied with magnetic amber lights which should be attached to the top of the vehicle and activated until the vehicle has exited the construction site. Yield to all heavy equipment when driving on construction sites. Obey all traffic control instructions. Construction sites are inherently dangerous places and Clear Water employees should exercise extreme caution when present.

CONTROL SYSTEM OPERATION

This section is designed to teach Clear Water technicians how to use the control interface for the CESF systems. This is dedicated to the control system operations and does not include operating procedures for the mechanical parts of the system. The control system is commonly referred to as the programmable logic controller (PLC). The system is designed to simplify technician procedures while ensuring compliance with regulatory requirements for CESF operations

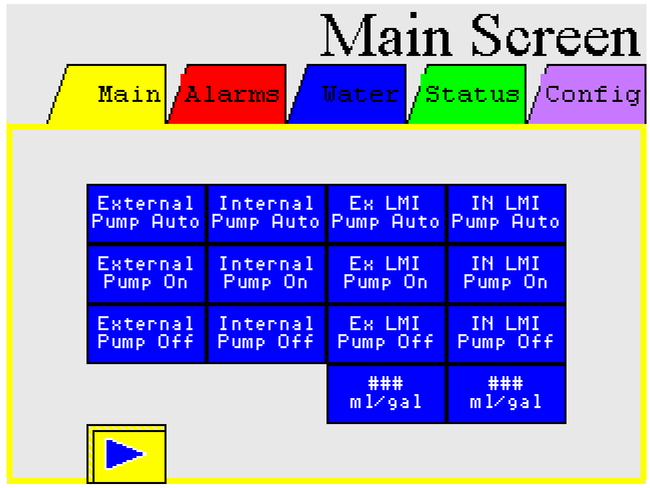
4.1 TOUCH SCREENS

When the touch screen first comes on it will display the alarm screen. Given that multiple alarms (of the same or different types) could have occurred since the last time the system was operational, a series of alarms may need to be acknowledged. Acknowledge alarms by pressing the “Ack All” button. Be sure to check the Alarm Screen before you begin operations.

Once all the alarms are acknowledged, the Logo (or Startup) screen will appear. This screen is for informational purposes only. Touch the “Main” button to access into the operational screens of the program.

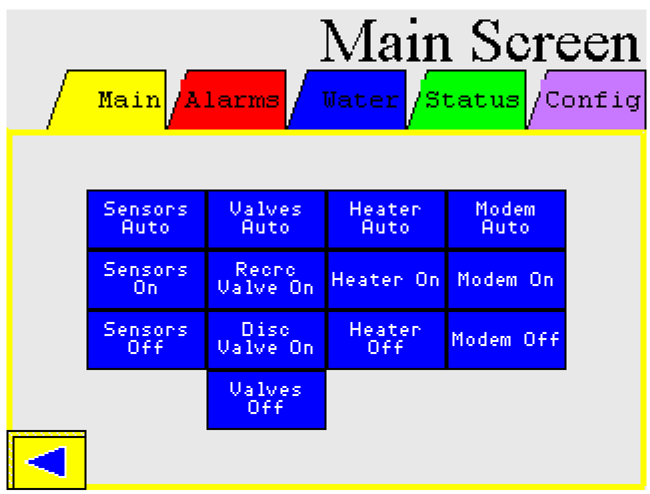
The screens are color coded and can be accessed by the file tabs at the top of the screen. The types of screen are; Main, Alarm, Water, Status, and Configuration.

“Main” screens are where system control takes place. There are two “Main” screens, for operations. The “Main” screens are laid out in a columnar fashion. The top button on each column puts that component into Automatic mode governed by the specific operational parameters that have been preset for it. The “On” button turns that component on with all safety and internal checks overridden for that particular component. The “Off” button disables that component. The primary main screen controls all system pumps.



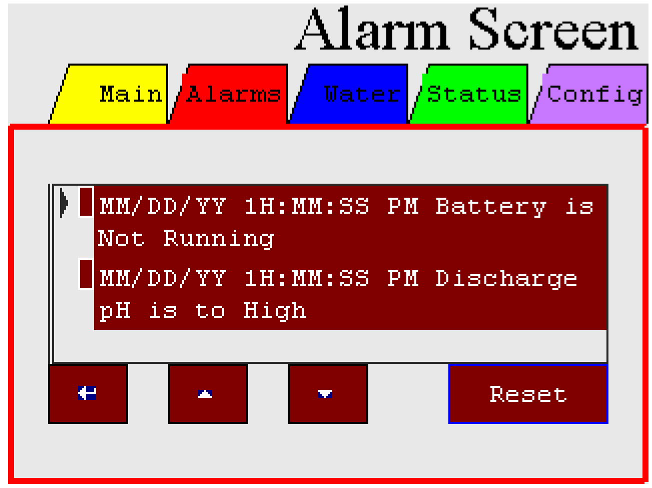
The yellow and blue arrow button at the bottom of the screen lets operators to toggle back and forth between the two main screens.

The secondary main screen controls system sensors, automated discharge valves, heaters and the system modem. In most situations the modem and heater controls should always be left in “Auto”. These buttons will change state based on what the PLC is trying to do not necessarily what the system is actually doing. *Example: You push the button to open the Discharge Valve but there is no air pressure. The PLC is trying to open the valve so the display will blink “Disc Open” yet the valve is still closed.*



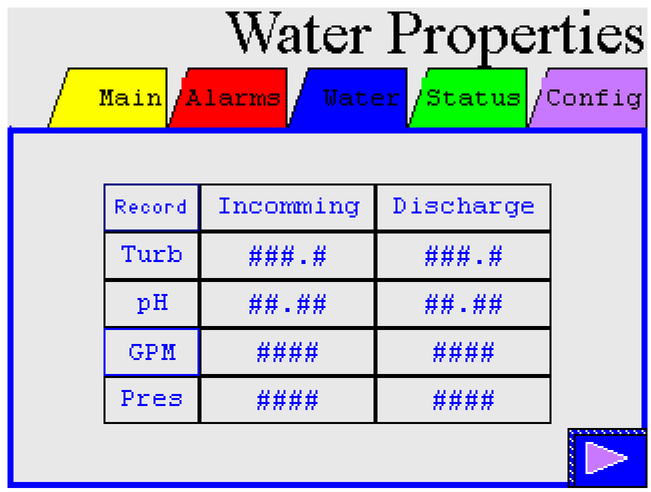
Some sites may not have some components. In such cases columns identifying unused components will be blank.

The "Alarm" screen displays emergency status information requiring immediate attention. All alarms on this screen that contain the word "Faulted" have to be cleared using the "Reset" button and are impeding operation of the system in some fashion. Alarms that do not contain "Faulted" warnings are for information only and do not require manual reset.

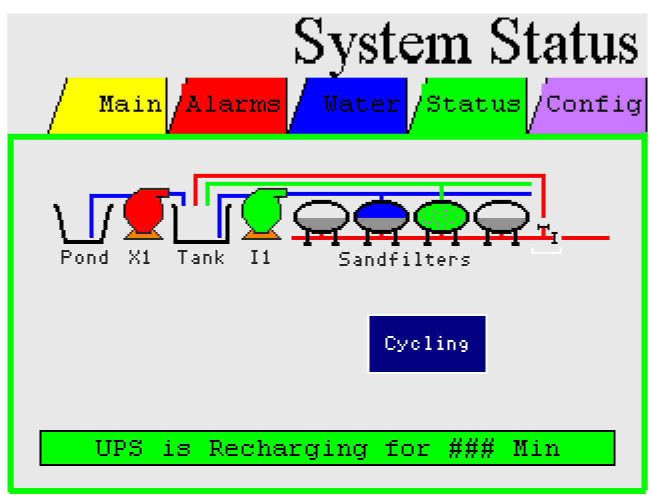


The "Water" screen is designed to display the water quality and system hydrology data. The data in the left hand column displays influent data and the column on the right displays effluent data. It alternates between current data and the running system recordable data. To know which you are looking at see the top left hand corner of the matrix.

The arrow button in the lower right hand corner will take you to the "Last Saved" screen.



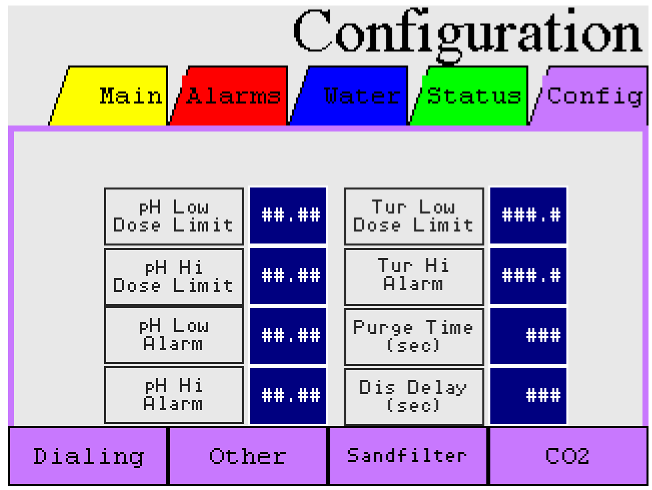
The "Status" screen is a graphical display that is designed to give the operator a real-time flow diagram of system operations.
The water level in the "Pond" and "Tank" corresponds to the actual levels in those facilities. Pumps are green for on and red for off, with a large X indicating a fault. The sand filter modules change from gray, off; to blue, on; to green, back flush. The valves will change direction based on the current status of the system.



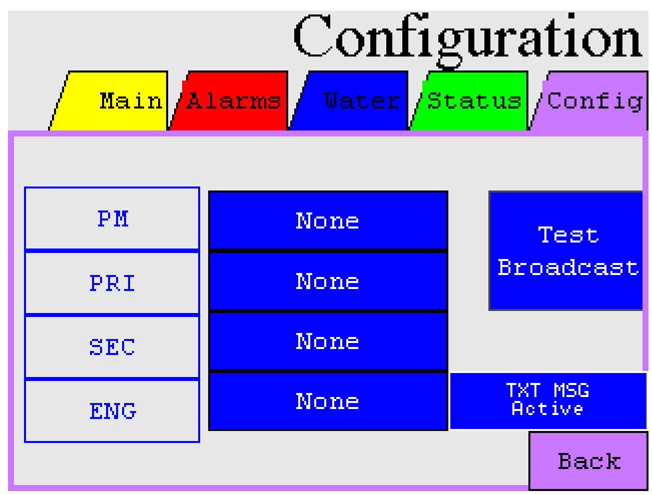
The main configuration screen sets the discharge limits for that particular site. These limits are preset and should not be changed by operators.

The pH and turbidity alarms identify the meter readings which will display visual alarms on the stop system discharge.

“Dis Delay” is the amount of time the treated water must be within spec before the PLC will allow discharge during automatic operation.



The second configuration screen is used to select emergency text message recipients. Each one allows you to cycle through the list of possible recipients just by touching the name multiple times. Four individuals can be selected Project Manager, Primary Responder, Secondary Responder, and Engineer. This screen also contains a test broadcast button. This allows you to test the text message system. If “None” is selected in a given box the PLC will skip that individual to call.



4.2 ALARM GLOSSARY

Discharge pH is too High: The discharge pH reading the PLC is receiving from the pH meter on the discharge header is greater than the pH Hi Alarm value set in the configuration screen.

Discharge pH is too Low: The discharge pH reading the PLC is receiving from the pH meter on the discharge header is lower than the pH Low Alarm value set in the configuration screen.

Discharge Turbidity is too High: The discharge Turbidity reading the PLC is receiving from the Turbidity meter on the discharge header is greater than the Turbidity Hi Alarm value set in the configuration screen.

Tank Level is too High: PLC is receiving a signal from the Tank High Level float switch, or the value from the Tank Level transducer is reading higher than the preset high limit.

Pond Level is too High: PLC is receiving a signal from the Pond High Level float switch, or the value from the pond Level transducer is reading higher than the preset high limit.

System in Recirculation Mode: PLC has actuated the recirculation valve to Open.

UPS Power is Low: Generator is operational for the purpose of recharging the UPS.

Generator Faulted Out: PLC sent a signal for the Generator to auto start but has not received a power on signal in 30 seconds.

Pond Operate Switch Faulted: High Level Pond switch is triggered but the Operate switch is not.

Pond Low Level Switch Faulted: Operate Level Pond switch is triggered but the Low Level switch is not.

Tank Operate Switch Faulted: High Level Tank switch is triggered but the Operate switch is not.

Tank Low Level Switch Faulted: Operate Level Tank switch is triggered but the Low Level switch is not.

Internal Pump Faulted: PLC sent a start signal to the Soft Started and has not received an Up to Speed signal back for 30 seconds.

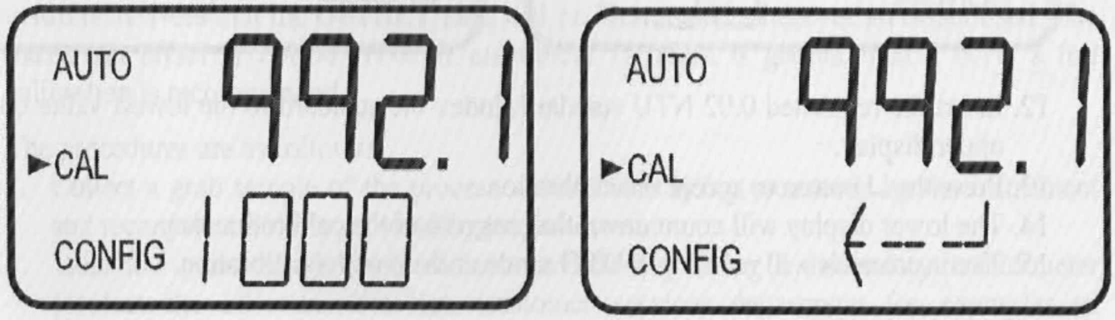
External Pump Faulted: PLC sent a start signal to the Motor Contactor and has not received an operational signal back for 30 seconds.

Max Pressure Exceeded: One of the Pressure Transducers sent a signal to the PLC that exceeded the 60 PSI Maximum Pressure Setting and shut down the Pumps.

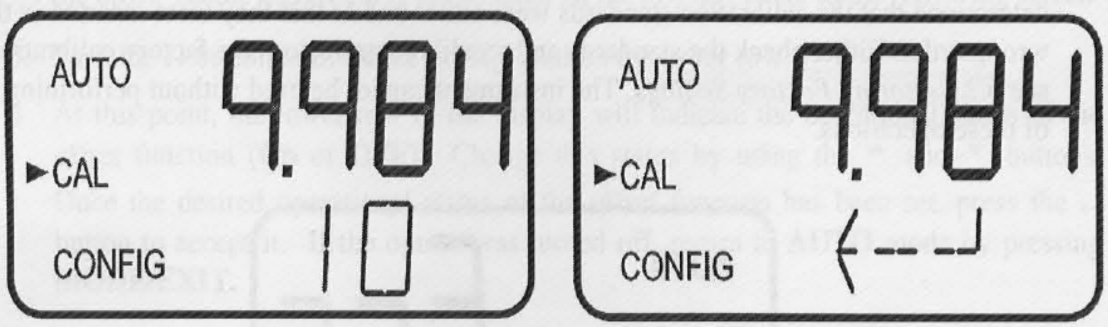
ATTACHMENTS

5.2 Calibration Procedures

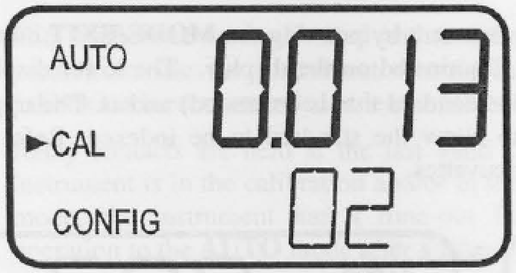
1. Select the calibration function of the instrument by pressing the **MODE/EXIT** button once. The arrow beside **CAL** will be illuminated on the display. The lower display shows alternating **1000** (the value of the standard that is requested) and ↵. The upper display shows the real-time reading to allow the standard to be indexed. Refer to section 6.1 for information on indexing cuvettes.

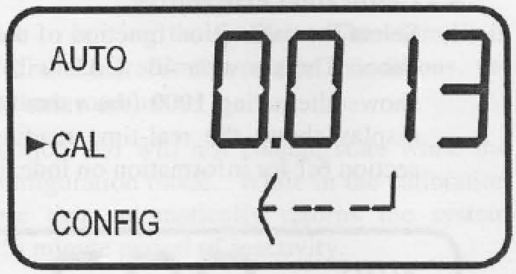


2. Remove the flow through unit.
3. Insert the requested 1000 NTU standard. Index the standard to the lowest value on the upper display.
4. Press the ↵ button to accept the calibration.
5. The lower display will count down the progress of the calibration step.
6. The lower display will now change to show alternating **10** and ↵, requesting the 10.0 NTU standard.



7. If the alternating **10** and ↵ is not displayed, push the ▲ or ▼ until this display is shown.
8. Insert the requested 10.0 NTU standard. Index the standard to the lowest value on the upper display.
9. Press the ↵ button to accept the calibration.
10. The lower display will count down the progress of the calibration step.
11. The lower display will now change to show **02** and ↵, requesting the 0.02 NTU standard.



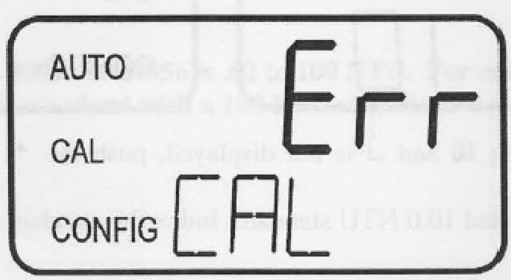


12. Insert the requested 0.02 NTU standard. Index the standard to the lowest value on the upper display.
13. Press the ↵ button to accept the calibration.
14. The lower display will count down the progress of the calibration step.
15. The instrument will return to **AUTO** mode at the end the calibration.

Note: During calibration, the fan inside the instrument is turned off to extend the life of the desiccant. The fan will be turned on during calibration countdowns and after returning to the AUTO mode or after five minutes, which ever comes first. It is recommended that the measurement chamber be kept covered during the calibration period and that the flow through cuvette be replaced immediately after the calibration to prevent premature saturation of the desiccant.

5.3 Calibration Error

If the screen shown below, is displayed after calibration, the internal diagnostics have determined that the calibration standards were either bad or that they were inserted in the wrong order. Either check the standards and recalibrate or restore the factory calibration see 6.2 *Restoring Factory Settings*. The instrument cannot be used without performing one of these operations.



To recalibrate press the MODE key and start the calibration sequence again. To restore the factory calibration, push and hold the ▲ button. Now push and release the ↵ then release the ▲ button.

EASY CAL Procedure - pH

- This procedure simplifies system calibration using standard 4.0, 7.0, 10.0 pH buffers only. If these pH buffers are not available, calibrate the system via the CALIBRATE menu, using the STANDARD and SLOPE settings.
- Access the CALIBRATE menu and set sensor temperature before performing EASY CAL for new electrode installations.
- Access EASY CAL menu from the view menu.

EASY CAL: ---- Enter Key Code	Press UP, UP, UP, DOWN buttons in sequence to enter menu. XXXX will appear during code entry.

To Calibrate:	Response:	To Accept:
Place Sensor in pH Buffer #1 Place electrode tip in first pH buffer pH 7.0 = 0 mV pH 4.0 = 177 pH 10 = -177 Limit ± 60 mV	6.90 pH -005 mV Allow for stabilization 30 seconds*	6.90 pH -005 mV ENTER to accept 7.00 pH -005 mV
Place Sensor in pH Buffer #2 Place electrode tip in second pH buffer.	3.93 pH +179 mV Allow for stabilization 30 seconds*	3.93 pH +179 mV Press ENTER to accept second buffer calibration. 4.00 pH +179 mV

To exit menus and return to VIEW press UP and DOWN button at the same time	Display returns to VIEW Menu in 10 minutes or when ENTER is pressed	Good Easy Cal Press <ENTER>

Theoretical mV values

pH @ 25°C	mV
2	+296
3	+237
4	+177
5	+118
6	+59
7	+0
8	-59
9	-118
10	-177
11	-237
12	-296

Colorimetric Determination of Residual Chitosan in Treated Stormwater[1]

Field Test

Background Chitosan-Enhanced Sand Filtration has proven to be a safe and effective treatment technology for the purification of construction stormwater. Chitosan has been tested extensively to determine its aquatic toxicity and stormwater treated with chitosan has also been tested and found to have no effect on fish and daphnia. Because concentrated chitosan does exhibit significant toxic effects on rainbow trout in clean laboratory water, it is important to know if there is chitosan in the stormwater after treatment and filtration. A review of the 15th edition of Standard Methods and EPA's test method manual (SW-846) revealed no test methods for low-level chitosan acetate analysis in water. 10 major analytical laboratories were consulted also and none were able to test for low-levels of chitosan acetate. Consequently, the following colorimetric iodine spot field test for the semi-quantitative analysis of chitosan has been developed.

It is important to note that this is a <u>screening field test</u> which is used to alert the treatment system operator in the event of a positive test result. This test is only designed to detect the presence of greater than 0.10 mg/L (100 µg/L) chitosan in the treated filtrate, not to quantify that presence. If an operator gets a positive test the system can then be investigated to determine if any of the operating parameters are out of specification. The system can then be corrected and the filtrate retested to confirm the absence of chitosan in the treated filtrate. This is the purpose of the test.

1. PRINCIPLE AND APPLICABILITY

Principle. This method is based on the well-known reaction between iodine and polysaccharides (chitosan is a natural polysaccharide). When iodine is added to a chitosan sample the original iodine yellow-rust color will change to a deep blue-black color indicating the presence of a polysaccharide (see Figures 1 and 2). The chitosan used for water treatment (Storm Klear Liqui-Floc) is fully water-soluble chitosan acetate (chitosan dissolved in a 5% solution of acetic acid). This test methodology requires the precipitation of residual chitosan acetate (in the sample) with sodium bicarbonate with subsequent filtration to capture the precipitated chitosan on a one-inch diameter glass fiber micro filter. Because the residual chitosan concentration is estimated to be less than 0.1 mg/L in treated filtrate, 200 mL of water must be filtered through the one-inch diameter glass fiber micro filter. Because the residual chitosan concentration is estimated to be less than 0.1 mg/L in treated filtrate, 200 mL of water must be filtered through the one-inch

diameter glass fiber micro filter in order to concentrate enough chitosan to react with the iodine (a minimum of 20 micrograms). The pH of the water sample is increased to > 8 to precipitate any chitosan present[2].

After filtration, the filter paper is used for the colorimetric test (one drop of iodine is placed on the filter paper). This test is semi-quantitative and is designed only to confirm the absence of chitosan in stormwater treated with chitosan. There is no way to determine

[1] Analytical test method developed by JW Macpherson, Natural Site Solutions LLC

[2] Chitosan acetate precipitates at pH 8 and above - Vanson HaloSource, Inc. 2004

the exact concentration of chitosan in the event of a positive reaction except to estimate >0.1 mg/L.

1.2 Applicability. This method is applicable for the semi-quantitative analysis of chitosan in stormwater treated with chitosan. It has been developed as a field test that can be quickly and easily performed in a contractor's trailer on a construction site.

2. RANGE AND SENSITIVITY

The lower limit of detection is approximately 0.1 mg/L (0.1 ppm) with a water sample volume of 200 mL. The maximum of the range is essentially unlimited.

3. INTERFERENCES

3.1 Polysaccharides other than chitosan (such as guar) have the potential to interfere by false positive. Interferences may be screened by testing the influent water for polysaccharides prior to treatment. Chitosan is the only polysaccharide introduced to the treatment system. Based on field experience, polysaccharides are not present in natural waters or stormwater detention basins at a concentration high enough to interfere with this test method.

3.2 Another potential interference is the accumulation of dirt particles on the glass fiber filter. To reduce this problem the water to be tested (treated filtrate) must be 10 NTU or less. Chitosan-enhanced sand filter systems typically produce treated filtrate less than 10 NTU.

4. PRECISION AND ACCURACY

See QA/QC section.

5. APPARATUS

5.1 Sampling Apparatus.

5.1.1 Sampling Containers. Clean 1,000 mL plastic containers.

5.2 Sample Filtration.

5.2.1 Glass Fiber Filter. (1) 140 mL capacity plastic syringe with threaded connector to attach *Swinnex* filter holder. (1) 25 mm filter holder (Swinnex plastic filter holder) http://www.wine-testing-supplies.com/cgi-bin/cp-app.cgi
(1) box of 100 Ahlstrom (or equivalent) glass microfiber filters
(See Figure 6)

6. REAGENTS

6.1 Sampling.

6.1.1 Sample Preservation. None required as water will be analyzed immediately.

6.3 Analysis.

6.3.2 Caustic Food-grade sodium bicarbonate powder

6.3.3 Iodine 0.10 N solution as I_2, CAS# 7553-56-2

6.3.4 Chitosan 1% solution of chitosan acetate as a standard (Vanson).

7. PROCEDURE

7.1 Sampling.

7.1.1 Collect (2) 1 Liter samples of the chitosan-treated filtrate directly from the effluent of the chitosan-enhanced sand filter system. Test with a turbidimeter to ensure the turbidity is less than 10 NTU.

7.2 Sample Filtration.

7.2.1 Adjust the pH of the prefiltered sample to > 8 with sodium bicarbonate (approx. 5 grams) and mix for 1 minute. Then filter 200 mL of the sample through the 25 mm glass fiber filter unit attached to the filtration syringe (see Figure 6).

7.3 Analysis.

7.3.1 Air-dry the 25mm glass fiber filter[3]. Put one drop of iodine on the dried filter paper, wait 15 minutes then interpret the results. A light yellow-rust color indicates the absence of chitosan (<0.1 mg/L). A dark brown or blue/black color indicates the presence of chitosan (>0.1 mg/L). See Figures 3 and 4 for color key. It is important to note that the iodine color associated with a negative result (or blank) will fade and disappear within about 20 minutes while the color associated with a positive test is permanent for a period of several hours at least. Figure 5 is a color comparison chart using actual treated filtrate with a turbidity of 9.05 NTU.

7.4 Field Matrix Spike. To the second 1-liter sample add chitosan acetate standard to a concentration of 0.10 mg/L and repeat the filtration procedure. Put one drop of iodine on the dried filter paper, wait one minute then interpret the results. This spike should be recovered as a dark stain on the filter paper (see Figures 3 and 4).

8. CALIBRATION – QA/QC

8.1 Method Calibration (Laboratory Spikes, blanks and duplicates).

8.1.1 To calibrate the test method run the test sequence using laboratory grade water with four different known concentrations of chitosan acetate as indicated below:

0 mg chitosan acetate in 1 liter water (0.0 mg/L) the blank
0.125 mg chitosan acetate in 1-liter water (0.125 mg/L)
0.25 mg chitosan acetate in 1-liter water (0.25 mg/L)

[3] The glass micro-fiber filter does not have to be completely dry but should be nearly dry or completely dry to obtain the best results.

0.5 mg chitosan acetate in 1-liter water (0.5 mg/L)

Adjust the pH of each test solution to 8.0 or greater with 5 grams sodium bicarbonate, mix and let stand for 5 minutes. Filter 200 mL of each solution, remove and dry the filter, then add one drop of the iodine solution to each filter and observe the result.

Wait 15 minutes then interpret the results[4]. The control blank should be colorless or nearly colorless while the 0.125 mg and 0.25 mg and 0.5 mg standards should turn dark brown, or nearly black (see Figures 3 and 4).

8.1.2 Re-run the tests using new standards – test duplicates.

9. Method QA/QC

9.1 Matrix Spikes.

Collect one liter of treated CESF effluent known to be free of residual chitosan. To each sample add:

0 mg chitosan acetate in 1 liter water (0.0 mg/L)
0.125 mg chitosan acetate in 1-liter water (0.125 mg/L)
0.25 mg chitosan acetate in 1-liter water (0.25 mg/L)
0.5 mg chitosan acetate in 1-liter water (0.5 mg/L)

Adjust the pH of each test solution to 8.0 or greater with 5 grams sodium bicarbonate, mix and let stand for 5 minutes. Filter 200 mL of each solution, remove and dry the filter, then add one drop of the iodine solution to each filter and observe. See Figure 5.

9.2 Matrix Spike Duplicates.

Collect one liter of treated CESF effluent known to have less than 0.1 mg/l residual chitosan. To each sample add:

0 mg chitosan acetate in 1 liter water (0.0 mg/L)
0.125 mg chitosan acetate in 1-liter water (0.125 mg/L)
0.25 mg chitosan acetate in 1-liter water (0.25 mg/L)
0.5 mg chitosan acetate in 1-liter water (0.5 mg/L)

Adjust the pH of each test solution to 8.0 or greater with 5 grams sodium bicarbonate, mix and let stand for 5 minutes. Filter 200 mL of each solution, remove and dry the filter, then add one drop of the iodine solution to each filter and observe.

[4] After approximately 20 minutes the yellow-rust color of the iodine without chitosan (blank) will disappear leaving no color (see Figures 3 &4). The dark color of iodine in the presence of chitosan will persist and become permanent.

9.3 Blanks.

Blanks should be run along with the treated water sample to ensure there is no inadvertent chitosan contamination in the equipment. To perform a blank analysis, adjust the pH of distilled water to > 8 with sodium bicarbonate and filter in exactly the same way the sample is filtered. Place one drop of the iodine solution on the dried filter element. The blank should be a yellow-rust color with no visible dark staining and the color should fade to colorless within approximately 15 to 20 minutes leaving a white filter.

The above QA/QC tests were run and the colorimetric results were photographed in Figures 2, 3, 4 and 5. The results indicate that:

- **Figure 2 demonstrates a definite chitosan/iodine colorimetric reaction.**
- **Blanks and blank duplicates showed no color response, as expected.**
- **Laboratory spikes (Figures 3 and 4) showed a good color response at the lowest concentration of 0.125 mg/L and the spike duplicates showed similar color intensities.**
- **Matrix spikes in treated filtrate (Figure 5) showed a good color response at the lowest concentration of 0.125 mg/L.**

ATTACHMENT 3

CESF Operation Forms

CLEAR WATER COMPLIANCE SERVICES, INC.

CESF – DAILY SYSTEM OPERATIONS AND MAINTENANCE

Project Title: ______________________________ Project No.: ____________

Project Location: ______________________________ Date: ____________

Weather Conditions: ______________________________

	Pretreatment Meter Reading		Influent Meter Reading		Effluent Meter Reading	
	Gallons	Time	Gallons	Time	Gallons	Time
Start:	______	______	______	______	______	______
Finish:	______	______	______	______	______	______
Total Volume:	______		______		______	

Operator's Evaluation of System Operations: ______________________________

____

____

____

____

____

____

____

____

Residual Chitosan Test: # of tests: ________ Results: # Passed ______ # Failed ______

Recent Hydroseeding/Hydromulching onsite: Yes No

First Shift	Second Shift	Third Shift
______________	______________	______________
Technician Name	Technician Name	Technician Name
______________	______________	______________
Technician Signature	Technician Signature	Technician Signature

CLEAR WATER COMPLIANCE SERVICES, INC.

CESF – EVALUATION OF SYSTEM OPERATIONS & MAINTENANCE

Project Title: ______________________________ Project No.: ______________

Project Location: ______________________________ Date: ______________

Operator's Evaluation of System Operations: ______________________________

____

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____

____

Other Monitoring: ______________________________

____

____

____

First Shift	**Second Shift**	**Third Shift**
______________	______________	______________
Technician Name	Technician Name	Technician Name
______________	______________	______________
Technician Signature	Technician Signature	Technician Signature

CLEAR WATER COMPLIANCE SERVICES, INC.

MANUAL DATA COLLECTION MONITORING FORM

Project Title: ______________________________ Project No.: ____________

Project Location: ______________________________ Date: ____________

Notes	Time	pH Influent / Effluent	NTU Influent / Effluent	Pressures Influent / Effluent	Initials
		/	/	/	
		/	/	/	
		/	/	/	
		/	/	/	
		/	/	/	
		/	/	/	
		/	/	/	
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		/	/	/	
		/	/	/	
		/	/	/	

* Indicates verification of in-line meters – samples measured with benchtop meters (required once per day).

First Shift	Second Shift	Third Shift
Technician Name	Technician Name	Technician Name
Technician Signature	Technician Signature	Technician Signature

CLEAR WATER COMPLIANCE SERVICES, INC.

CESF SYSTEM INSTRUMENT CALIBRATION REPORT FORM

Project Title: ______________________________ Project No.: ____________

Project Location: ______________________________ Date: ____________

Influent pH Meter Model: ______________________________

pH Standard: __________ Initial Reading: __________ Calibrated Reading: __________

pH Standard: __________ Initial Reading: __________ Calibrated Reading: __________

Effluent pH Meter Model: ______________________________

pH Standard: __________ Initial Reading: __________ Calibrated Reading: __________

pH Standard: __________ Initial Reading: __________ Calibrated Reading: __________

__________ pH Meter Model: ______________________________

pH Standard: __________ Initial Reading: __________ Calibrated Reading: __________

pH Standard: __________ Initial Reading: __________ Calibrated Reading: __________

__________ pH Meter Model: ______________________________

pH Standard: __________ Initial Reading: __________ Calibrated Reading: __________

pH Standard: __________ Initial Reading: __________ Calibrated Reading: __________

First Shift	**Second Shift**	**Third Shift**
Technician Name	Technician Name	Technician Name
Technician Signature	Technician Signature	Technician Signature

CLEAR WATER COMPLIANCE SERVICES, INC.

CESF SYSTEM INSTRUMENT CALIBRATION REPORT FORM

Project Title: ______________________________ Project No.: ____________

Project Location: ______________________________ Date: ____________

Pretreatment Turbidity Meter Model: ______________________________

Turbidity Standard: __________ Initial Reading: __________ Calibrated Reading: __________

Turbidity Standard: __________ Initial Reading: __________ Calibrated Reading: __________

Turbidity Standard: __________ Initial Reading: __________ Calibrated Reading: __________

Influent Turbidity Meter Model: ______________________________

Turbidity Standard: __________ Initial Reading: __________ Calibrated Reading: __________

Turbidity Standard: __________ Initial Reading: __________ Calibrated Reading: __________

Turbidity Standard: __________ Initial Reading: __________ Calibrated Reading: __________

Effluent Turbidity Meter Model: ______________________________

Turbidity Standard: __________ Initial Reading: __________ Calibrated Reading: __________

Turbidity Standard: __________ Initial Reading: __________ Calibrated Reading: __________

Turbidity Standard: __________ Initial Reading: __________ Calibrated Reading: __________

First Shift	**Second Shift**	**Third Shift**
Technician Name	Technician Name	Technician Name
Technician Signature	Technician Signature	Technician Signature

CLEAR WATER COMPLIANCE SERVICES, INC.

BENCHTOP INSTRUMENT CALIBRATION REPORT FORM

Project Title: ______________________________ Project No.: __________

Project Location: ______________________________ Date: __________

pH Meter Model: ______________________________

pH Standard: __________ Initial Reading: __________ Calibrated Reading: __________

pH Standard: __________ Initial Reading: __________ Calibrated Reading: __________

pH Standard: __________ Initial Reading: __________ Calibrated Reading: __________

Turbidity Meter Model: ______________________________

Turbidity Standard: __________ Initial Reading: __________ Calibrated Reading: __________

Turbidity Standard: __________ Initial Reading: __________ Calibrated Reading: __________

Turbidity Standard: __________ Initial Reading: __________ Calibrated Reading: __________

Turbidity Standard: __________ Initial Reading: __________ Calibrated Reading: __________

Conductivity Meter Model: ______________________________

Conductivity Standard: __________

Initial Reading: __________

Calibrated Reading: __________

First Shift	**Second Shift**	**Third Shift**
____________________	____________________	____________________
Technician Name	Technician Name	Technician Name
____________________	____________________	____________________
Technician Signature	Technician Signature	Technician Signature

CLEAR WATER COMPLIANCE SERVICES, INC.

CHEMICAL METERING PUMP CALIBRATION FORM

Project Title: ____________________ Project No.: __________

Project Location: ____________________ Date: __________

Note: Chemical metering pump calibrations are required at the start of treatment system operations and every 4 hours following treatment system startup.

Time	Pre-treat/ Sand Filter	Flow (gpm)	Chitosan 1% or 2%	Chitosan Delivery (ml/min)	Dose Rate (ppm)	Initials

CHITOSAN DELIVERY DOSE RATE CALCULATION

1. Liqui-Floc delivery rate (ml/min) x 0.01 (chitosan concentration) x 1 g/ml (weight of liqui-floc) = absolute weight of chitosan in g/min
2. Chitosan delivery (g/min) x 1000 mg/g = chitosan delivery rate (mg/min)
3. System influent flow (gpm) x 3.78 L/gal. = stormwater flow rate (L/min)
4. (Chitosan-mg/min) / (flow rate-L/min) = dose rate in mg/L = ppm

First Shift	**Second Shift**	**Third Shift**
Technician Name	Technician Name	Technician Name
Technician Signature	Technician Signature	Technician Signature

	CLEAR WATER COMPLIANCE SERVICES, INC.
	RESIDUAL CHITOSAN TEST MONITORING FORM

Project Title: ____________________ Project No.: __________

Project Location: ____________________ Date: __________

Note: Residual chitosan testing is required twice during the first two hours of each 8 hour operational period.

Sample Time	Turbidity NTU	pH	Specific Conductance µS/cm	Flow Rate gpm	Chitosan Delivery ml/min	Chitosan Dose Rate ppm

RESIDUAL CHITOSAN TEST No. 1 – ANALYSIS – Time

pH Start __________ Adjusted pH __________ Test Result: Positive Negative

RESIDUAL CHITOSAN TEST No. 1 – MATRIX SPIKE - Time

pH Start __________ Adjusted pH __________ Test Result: Positive Negative

Residual Chitosan Test Results: Pass Fail

RESIDUAL CHITOSAN TEST No. 2 – ANALYSIS - Time

pH Start __________ Adjusted pH __________ Test Result: Positive Negative

RESIDUAL CHITOSAN TEST No. 2 – MATRIX SPIKE – Time

pH Start __________ Adjusted pH __________ Test Result: Positive Negative

Residual Chitosan Test Results: Pass Fail

First Shift	**Second Shift**	**Third Shift**
Technician Name	Technician Name	Technician Name
Technician Signature	Technician Signature	Technician Signature

CLEAR WATER COMPLIANCE SERVICES, INC.

RECEIVING WATER QUALITY MONITORING FORM

Project Title: ______________________________ Project No.: ____________

Project Location: ______________________________ Date: ____________

Before Startup:

Sample Location: ______________________________

	Upstream	Downstream
Sample Time:	____________	____________
Turbidity (NTU):	____________	____________
pH (Standard Units):	____________	____________
Specific Conductance (uS/cm):	____________	____________

During Operations:

Sample Location: ______________________________

	Upstream	Downstream
Sample Time:	____________	____________
Turbidity (NTU):	____________	____________
pH (Standard Units):	____________	____________
Specific Conductance (uS/cm):	____________	____________

First Shift	**Second Shift**	**Third Shift**
____________	____________	____________
Technician Name	Technician Name	Technician Name
____________	____________	____________
Technician Signature	Technician Signature	Technician Signature

CLEAR WATER COMPLIANCE SERVICES, INC.

BENCH-SCALE TREATABILITY DOCUMENTATION FORM

Project Title: ______________________________ Project No.: ____________

Project Location: ______________________________ Date: ____________

Sample Identification: ______________________________

Sample Time: ____________ Sample Volume: ____________ Turbidity (NTU): ____________

pH initial (Std. units): ____________ pH (Std. units): ____________ Conductivity (µS/cm): ____________

(If normally adjusted using CO_2 or Sodium Bicarbonate)

Bench-Scale Treatability Results

Drops of 1% Liqui-floc	Estimated Dose Rate (ppm)	Observed Results (floc size and setting time)

1 drop of 1% Liqui-Floc using a 3-mL transfer pipette is approximately 0.5 ppm in a 1-liter sample

1 drop of Poly Alum 60 using a 3-mL transfer pipette is approximately 37 ppm in a 1 liter sample

Observations: ______________________________

____

____

____

First Shift	**Second Shift**	**Third Shift**
Technician Name	Technician Name	Technician Name
Technician Signature	Technician Signature	Technician Signature

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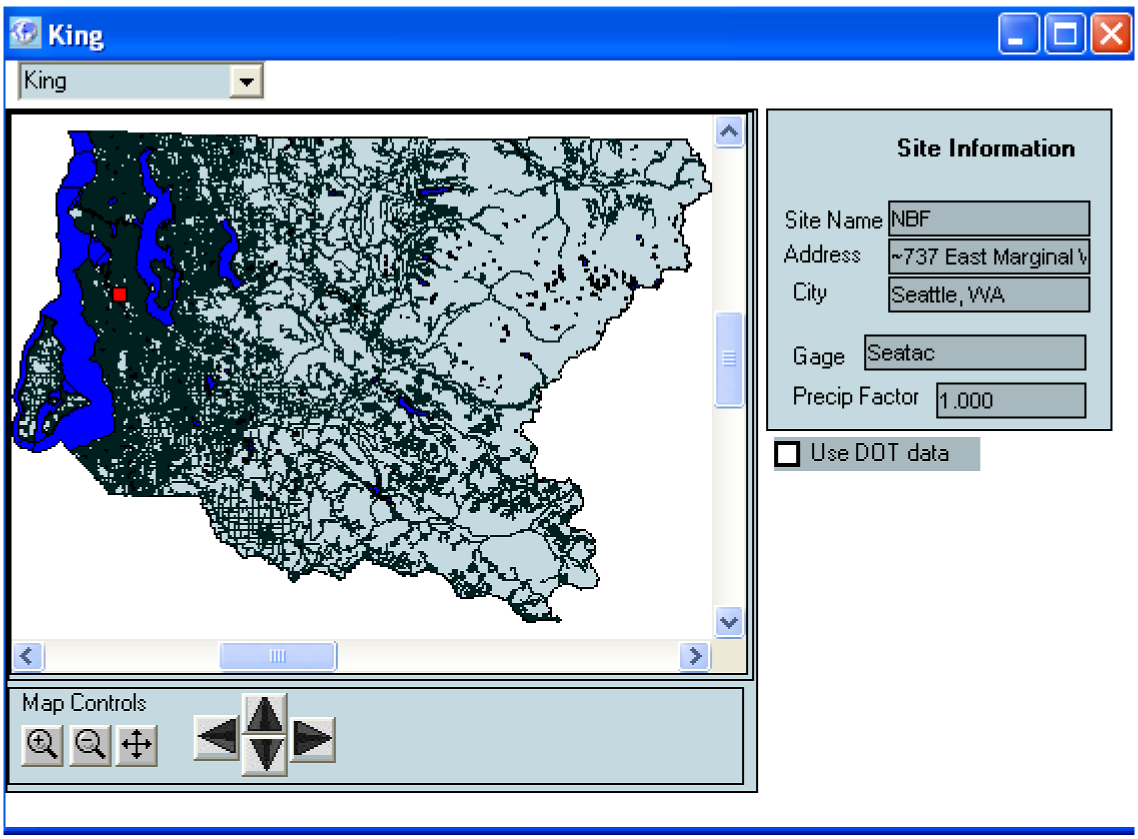
APPENDIX B

Stormwater Modeling (WWHMv3) Input and Output Files

STORMWATER MODELING (WWHMV3) INPUT AND OUTPUT FILES

Western Washington Hydrology Model
PROJECT REPORT

Project Name: NBF
Site Address: ~737 East Marginal Way South
City : Seattle, WA
Report Date : 9/2/2010
Gage : Seatac
Data Start : 1948/10/01
Data End : 1998/09/30
Precip Scale: 1.00
WWHM3 Version: 1.0 6/4/2010

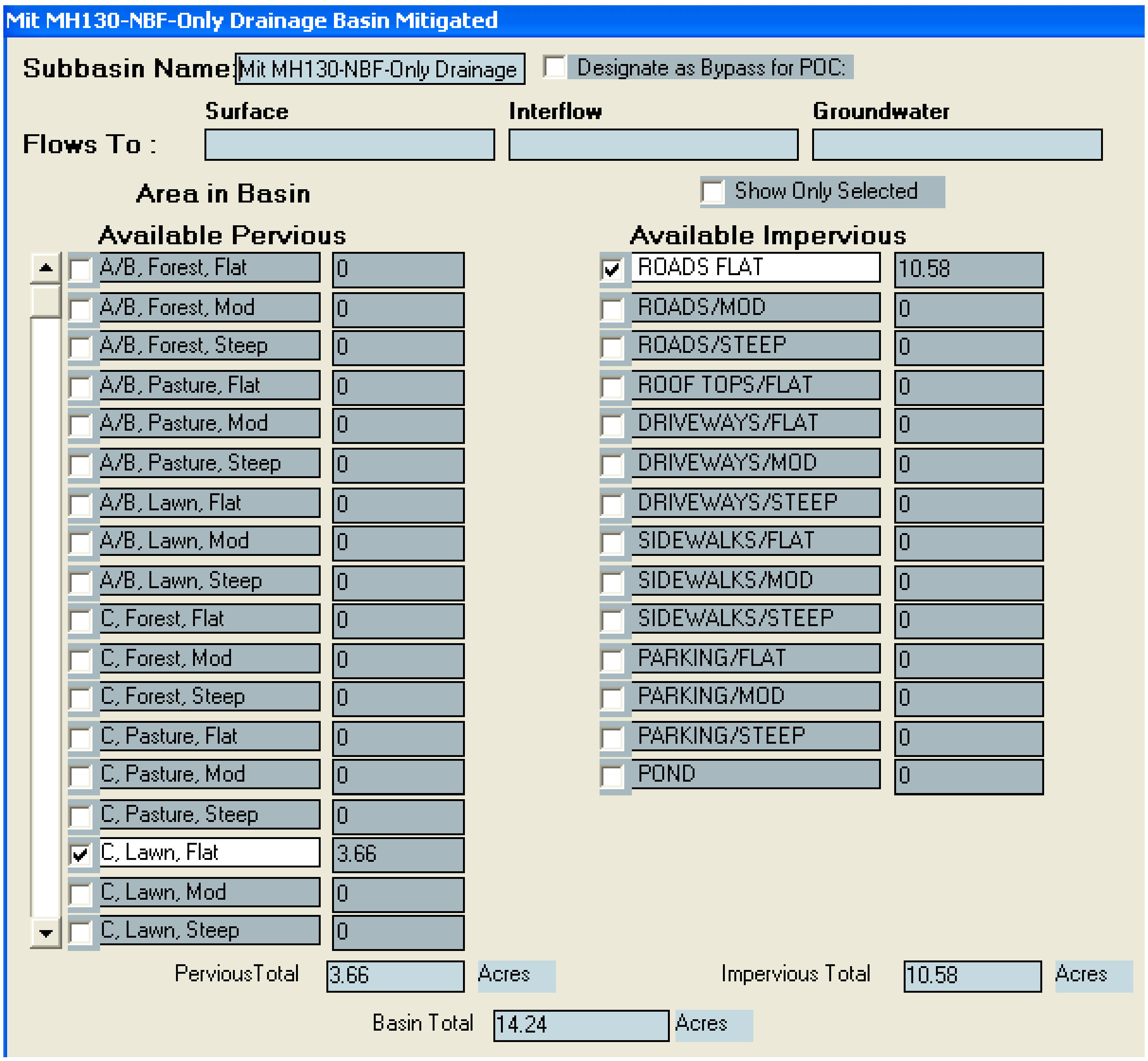


POC 1 Mitigated Flow
Name : Mit MH130-NBF-Only Drainage Basin
Bypass: No

GroundWater: No

Pervious Land Use	Acres
C, Lawn, Flat	3.66

Impervious Land Use	Acres
ROADS FLAT	10.58



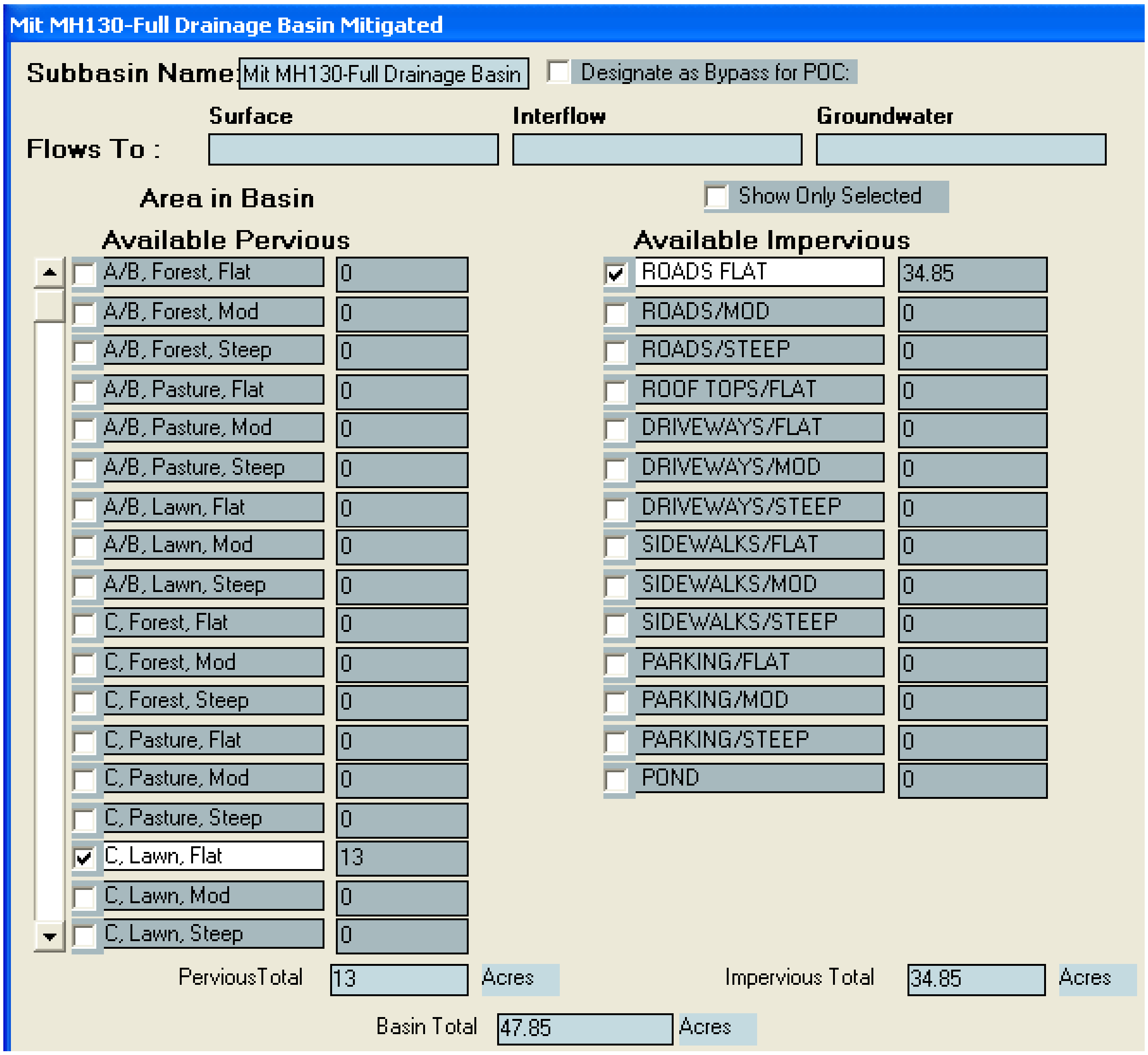
Element Flows To:
Surface **Interflow** **Groundwater**

POC 2 Mitigated Flow
Name : Mit MH130-Full Drainage Basin
Bypass: No

GroundWater: No

Pervious Land Use	Acres
C, Lawn, Flat	13

Impervious Land Use	Acres
ROADS FLAT	34.85



Mit MH130-Full Drainage Basin Mitigated

Subbasin Name: Mit MH130-Full Drainage Basin   Designate as Bypass for POC:

Flows To : Surface | Interflow | Groundwater

Area in Basin   Show Only Selected

Available Pervious		Available Impervious	
A/B, Forest, Flat	0	ROADS FLAT	34.85
A/B, Forest, Mod	0	ROADS/MOD	0
A/B, Forest, Steep	0	ROADS/STEEP	0
A/B, Pasture, Flat	0	ROOF TOPS/FLAT	0
A/B, Pasture, Mod	0	DRIVEWAYS/FLAT	0
A/B, Pasture, Steep	0	DRIVEWAYS/MOD	0
A/B, Lawn, Flat	0	DRIVEWAYS/STEEP	0
A/B, Lawn, Mod	0	SIDEWALKS/FLAT	0
A/B, Lawn, Steep	0	SIDEWALKS/MOD	0
C, Forest, Flat	0	SIDEWALKS/STEEP	0
C, Forest, Mod	0	PARKING/FLAT	0
C, Forest, Steep	0	PARKING/MOD	0
C, Pasture, Flat	0	PARKING/STEEP	0
C, Pasture, Mod	0	POND	0
C, Pasture, Steep	0		
C, Lawn, Flat	13		
C, Lawn, Mod	0		
C, Lawn, Steep	0		

PerviousTotal 13 Acres   Impervious Total 34.85 Acres

Basin Total 47.85 Acres

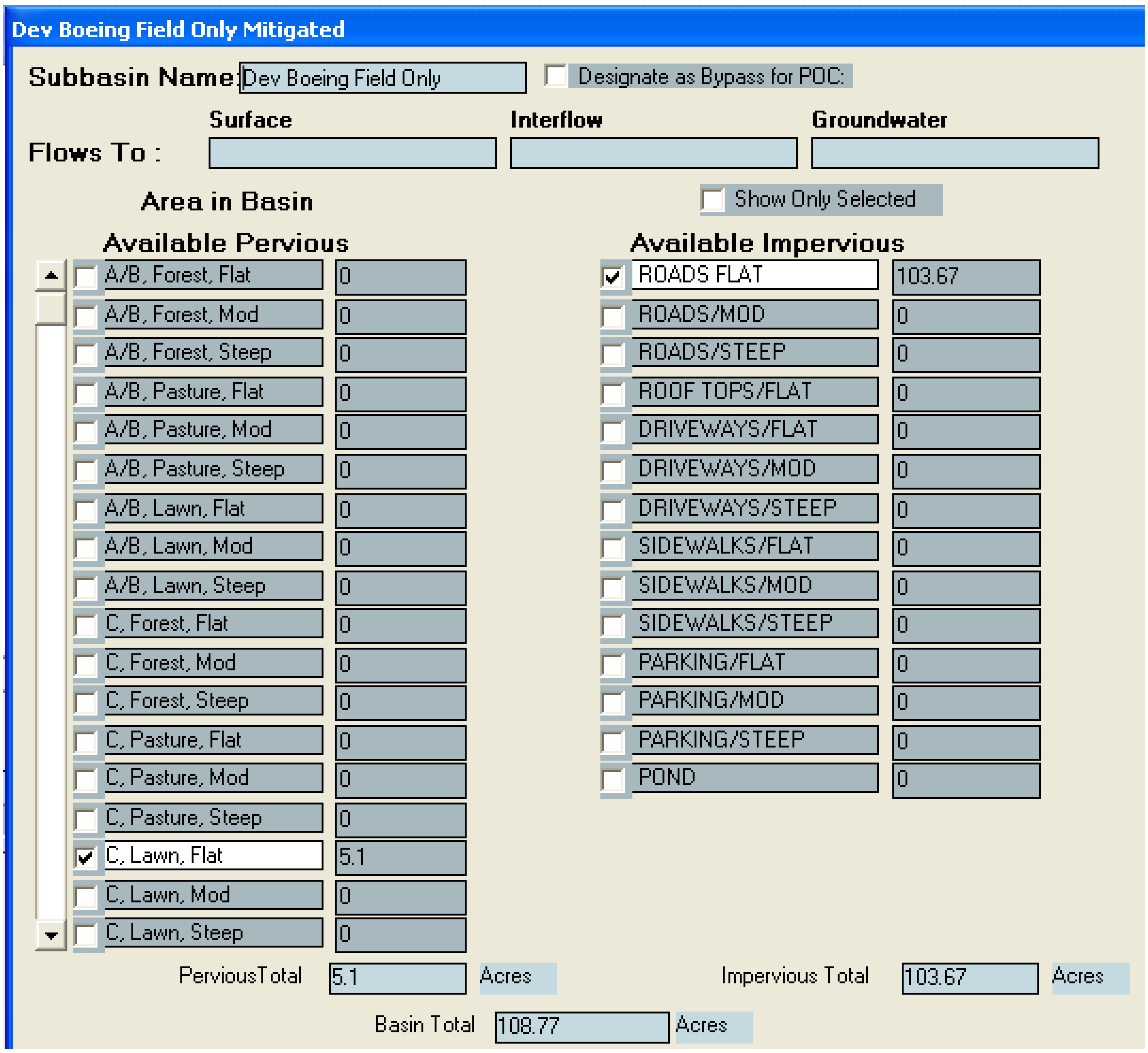
Element Flows To:
Surface **Interflow** **Groundwater**

POC 4 Mitigated Flow
Name : Dev Boeing Field Only
Bypass: No

GroundWater: No

Pervious Land Use	Acres
C, Lawn, Flat	5.1

Impervious Land Use	Acres
ROADS FLAT	103.67


Dev Boeing Field Only Mitigated

Subbasin Name: Dev Boeing Field Only — Designate as Bypass for POC:

Flows To : Surface / Interflow / Groundwater

Area in Basin — Show Only Selected

Available Pervious		Available Impervious	
A/B, Forest, Flat	0	ROADS FLAT (checked)	103.67
A/B, Forest, Mod	0	ROADS/MOD	0
A/B, Forest, Steep	0	ROADS/STEEP	0
A/B, Pasture, Flat	0	ROOF TOPS/FLAT	0
A/B, Pasture, Mod	0	DRIVEWAYS/FLAT	0
A/B, Pasture, Steep	0	DRIVEWAYS/MOD	0
A/B, Lawn, Flat	0	DRIVEWAYS/STEEP	0
A/B, Lawn, Mod	0	SIDEWALKS/FLAT	0
A/B, Lawn, Steep	0	SIDEWALKS/MOD	0
C, Forest, Flat	0	SIDEWALKS/STEEP	0
C, Forest, Mod	0	PARKING/FLAT	0
C, Forest, Steep	0	PARKING/MOD	0
C, Pasture, Flat	0	PARKING/STEEP	0
C, Pasture, Mod	0	POND	0
C, Pasture, Steep	0		
C, Lawn, Flat (checked)	5.1		
C, Lawn, Mod	0		
C, Lawn, Steep	0		

PerviousTotal 5.1 Acres — Impervious Total 103.67 Acres

Basin Total 108.77 Acres

Element Flows To:

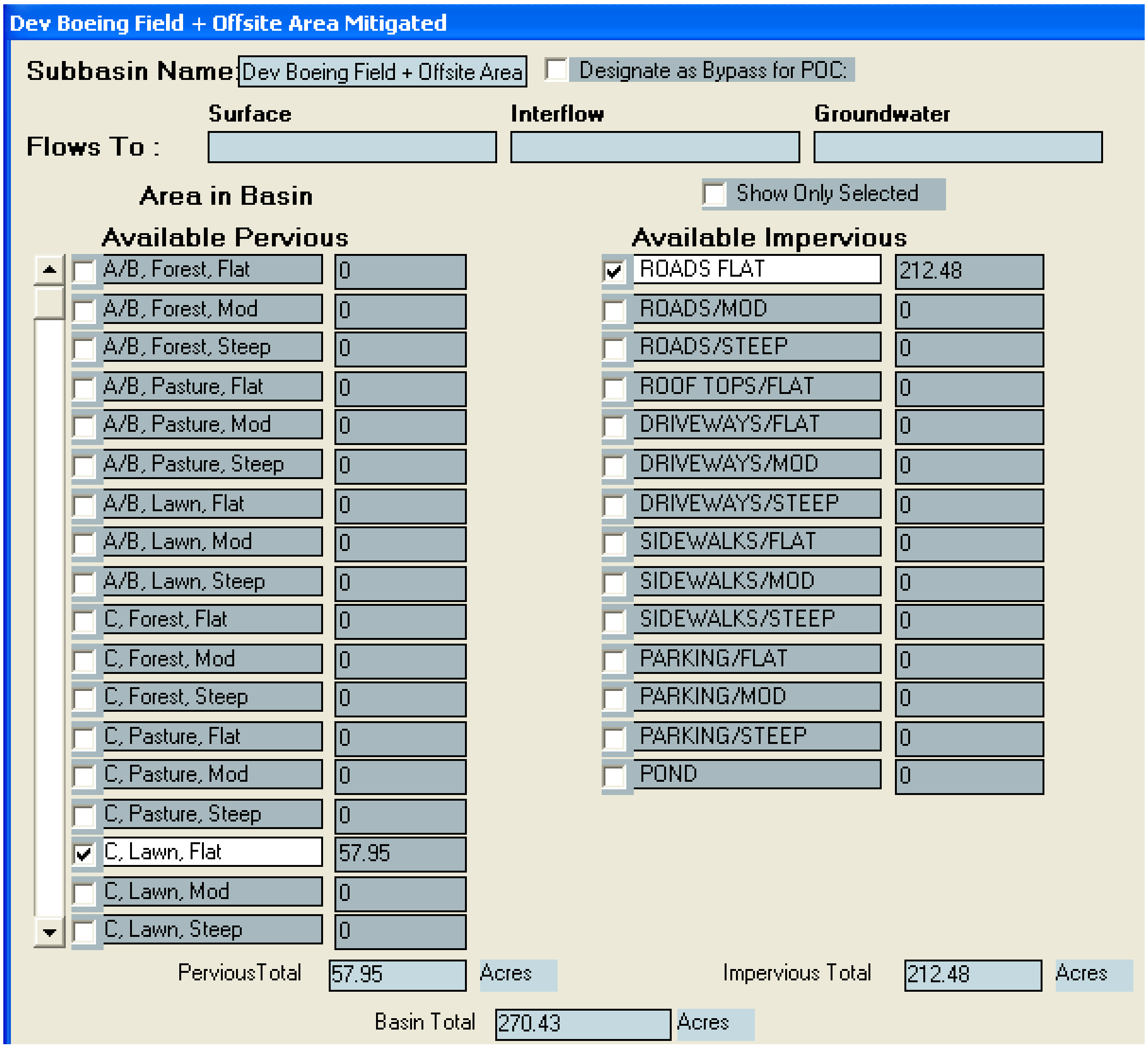
Surface	Interflow	Groundwater

POC 5 Mitigated Flow
Name : Dev Boeing Field + Offsite Area
Bypass: No

GroundWater: No

Pervious Land Use	Acres
C, Lawn, Flat	57.95

Impervious Land Use	Acres
ROADS FLAT	212.48



Element Flows To:
Surface **Interflow** **Groundwater**

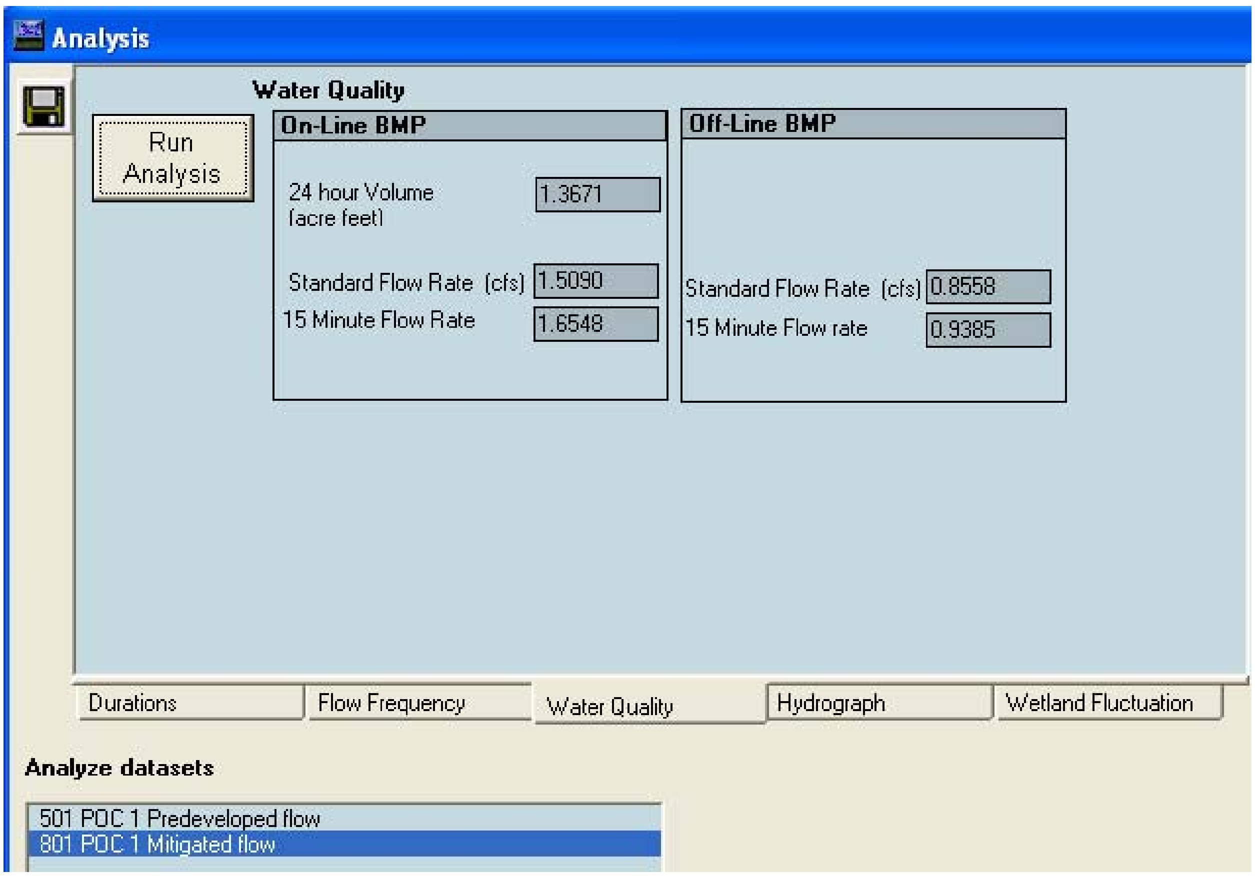
MITIGATED LAND USE

ANALYSIS RESULTS

Flow Frequency Return Periods for Mitigated. POC #1

Return Period	Flow(cfs)
2 year	2.811353
5 year	3.461116
10 year	3.885116
25 year	4.418031
50 year	4.814739
100 year	5.212321

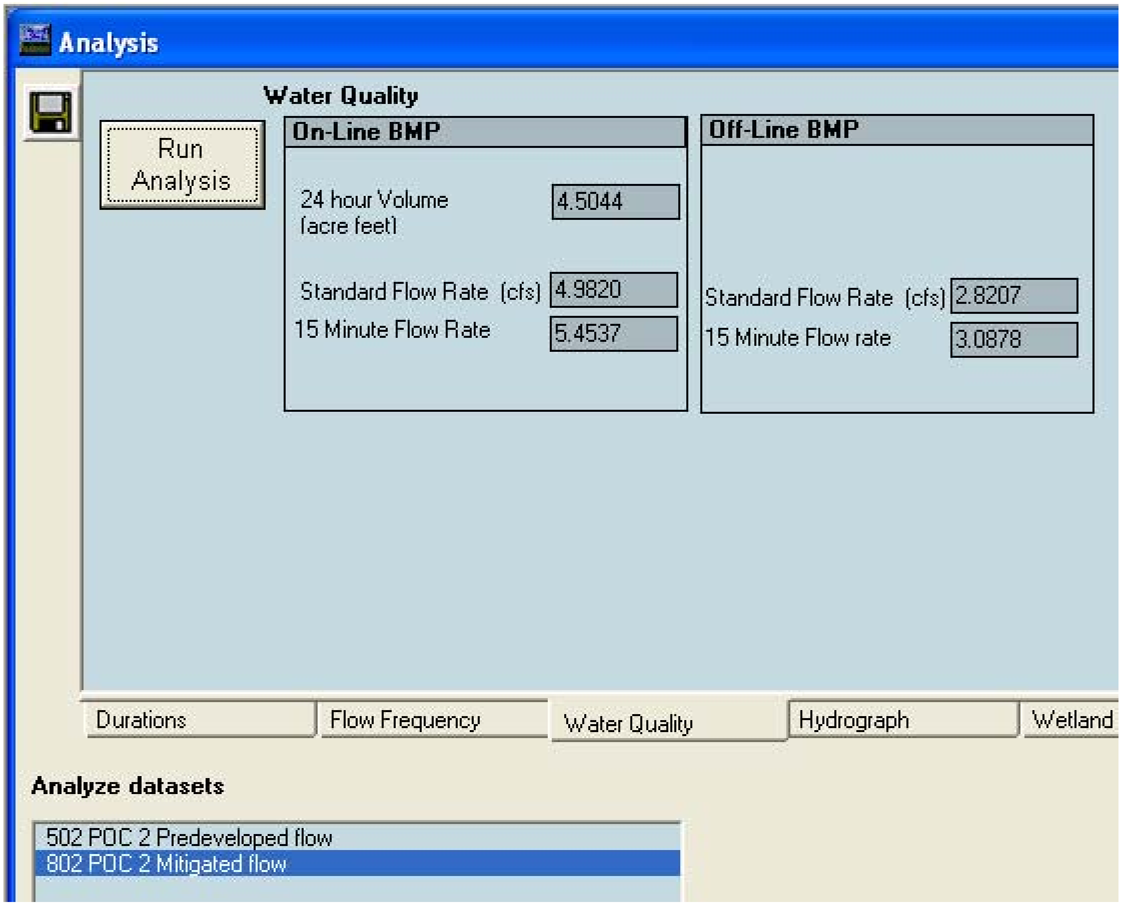
Water Quality BMP Flow and Volume for POC 1.
On-line facility volume: 1.3671 acre-feet
On-line facility target flow: 0.01 **cfs.**
Adjusted for 15 min: 1.6548 **cfs.**
Off-line facility target flow: 0.8558 **cfs.**
Adjusted for 15 min: 0.9385 **cfs.**



Flow Frequency Return Periods for Mitigated. POC #2

Return Period	**Flow(cfs)**
2 year	9.30416
5 year	11.466855
10 year	12.879276
25 year	14.655634
50 year	15.978703
100 year	17.30525

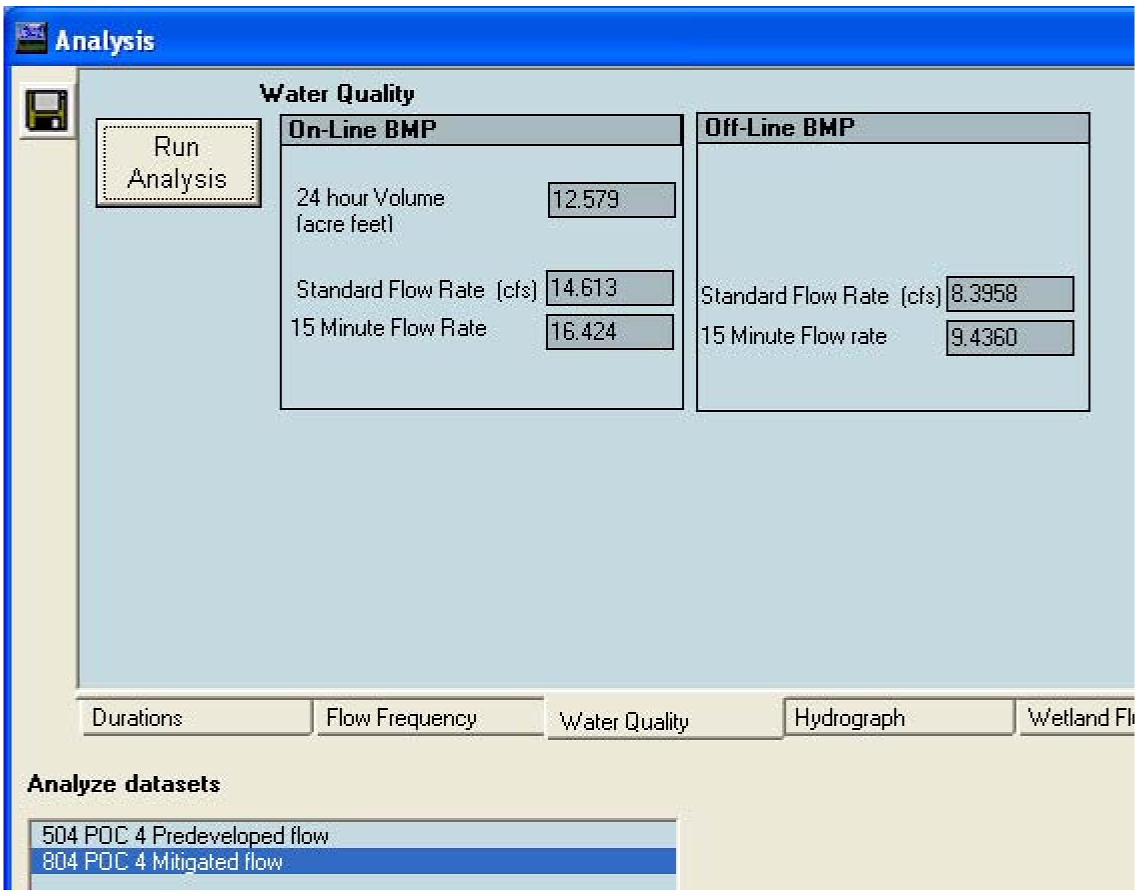
Water Quality BMP Flow and Volume for POC 2.
On-line facility volume: 4.5044 acre-feet
On-line facility target flow: 0.01 **cfs.**
Adjusted for 15 min: 5.4537 **cfs.**
Off-line facility target flow: 2.8207 **cfs.**
Adjusted for 15 min: 3.0878 **cfs.**



Flow Frequency Return Periods for Mitigated. POC #4

Return Period	Flow(cfs)
2 year	26.128798
5 year	31.821828
10 year	35.506146
25 year	40.107521
50 year	43.513918
100 year	46.913187

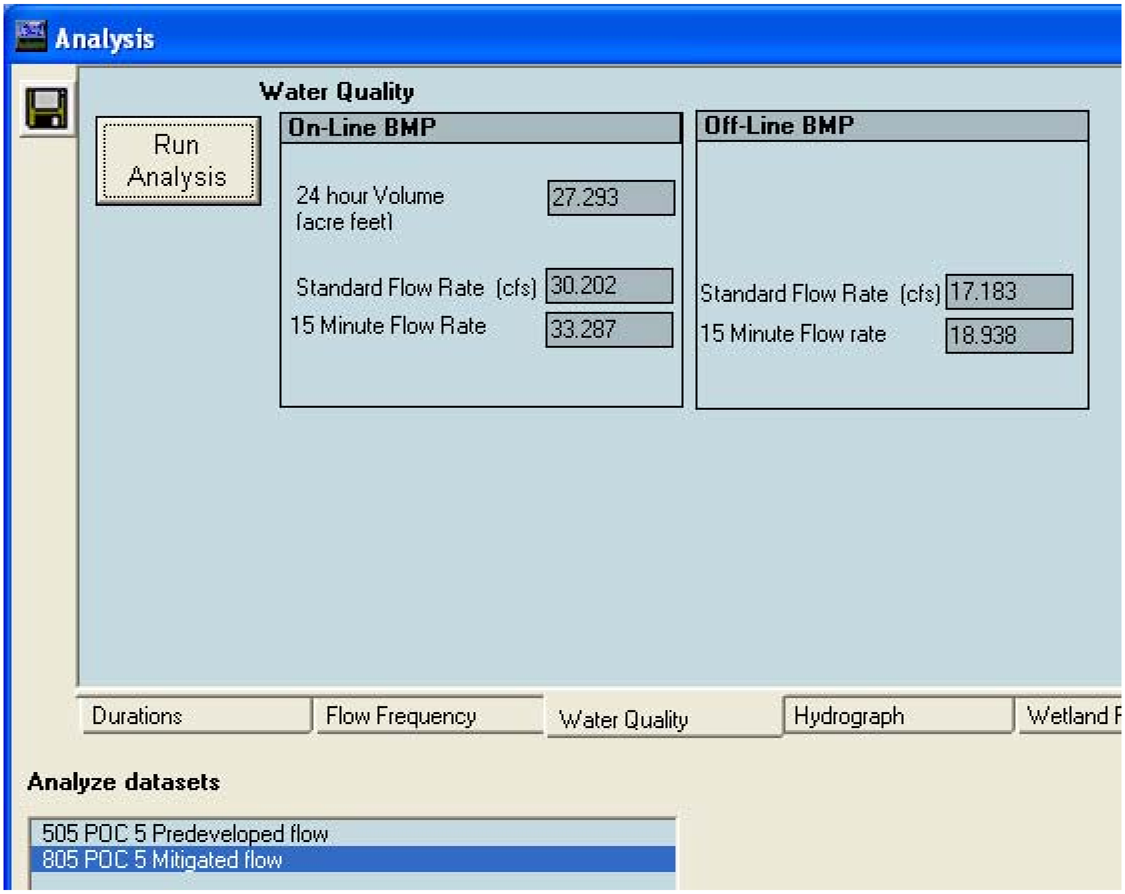
Water Quality BMP Flow and Volume for POC 4.
On-line facility volume: 12.579 acre-feet
On-line facility target flow: 0.01 **cfs.**
Adjusted for 15 min: 16.424 **cfs.**
Off-line facility target flow: 8.3958 **cfs.**
Adjusted for 15 min: 9.436 **cfs.**



Flow Frequency Return Periods for Mitigated. POC #5

Return Period	Flow(cfs)
2 year	55.744296
5 year	68.436202
10 year	76.700523
25 year	87.070662
50 year	94.779252
100 year	102.49623

Water Quality BMP Flow and Volume for POC 5.
On-line facility volume: 27.293 acre-feet
On-line facility target flow: 0.01 **cfs.**
Adjusted for 15 min: 33.287 **cfs.**
Off-line facility target flow: 17.183 **cfs.**
Adjusted for 15 min: 18.938 **cfs.**



Perlnd and Implnd Changes
Total of 1 changes have been made.

Implnd changes.

Name	Property	Original	Changed
ROADS FLAT	ENGL	61	27

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APPENDIX C

Sampling and Analysis Plan

APPENDIX C
Sampling and Analysis Plan
Removal Action
Short-Term Stormwater Treatment Facility
North Boeing Field
Seattle, Washington

January 7, 2011

Prepared for

The Boeing Company
Seattle, WA

LANDAU ASSOCIATES
130 2nd Avenue South
Edmonds, WA 98020
(425) 778-0907

TITLE AND APPROVAL SHEET

APPENDIX C – SAMPLING AND ANALYSIS PLAN
REMOVAL ACTION WORK PLAN
SHORT-TERM STORMWATER TREATMENT

NORTH BOEING FIELD, SEATTLE, WASHINGTON

Quality Assurance Project Plan Approvals

EPA Project Manager:	Karen Keeley	Karen Keeley	Date: Jan. 7, 2011
EPA QA Manager:	Ginna Grepo-Grove		Date: Jan. 7, 2011
Boeing Project Manager:	Carl Bach	Carl Bach. Digitally signed by 127180 DN: c=US, o=Boeing, ou=people, cn=127180, email=carl.m.bach@boeing.com Date: 2011.01.11 06:18:57 -08'00'	Date: Jan. 7, 2011
Landau Associates Project Manager:	Kristy Hendrickson	Digitally signed by Kristy J. Hendrickson DN: cn=Kristy J. Hendrickson, o, ou, email=khendrickson@landauinc.com, c=US Date: 2011.01.11 09:01:31 -08'00'	Date: Jan. 7, 2011
Landau Associates Task Manager:	Joe Kalmar	Joseph Kalmar. Digitally signed by Joe Kalmar DN: cn=Joe Kalmar, o, ou, email=jkalmar@landauinc.com, c=US Date: 2011.01.11 09:14:53 -08'00'	Date: Jan. 7, 2011
Landau Associates Project QA Coordinator:	Anne Halvorsen	Anne Halvorsen. Digitally signed by Anne Halvorsen DN: cn=Anne Halvorsen, o, ou, email=ahalvorsen@landauinc.com, c=US Date: 2011.01.11 09:20:22 -08'00'	Date: Jan. 7, 2011
ARI Project Manager:	Kelly Bottem	Kelly Bottem. Digitally signed by Kelly Bottem DN: cn=Kelly Bottem, o=ARI Labs, Inc., ou=Project Management, email=kellyb@arilabs.com, c=US Date: 2011.01.10 15:59:58 -08'00'	Date: Jan. 7, 2011
ARI QA Manager:	Dave Mitchell	Dave Mitchell. Digitally signed by Dave Mitchell DN: cn=Dave Mitchell, o=ARI Labs, Inc., ou=QA, email=davem@arilabs.com, c=US Date: 2011.01.10 16:09:48 -08'00'	Date: Jan. 7, 2011

TABLE OF CONTENTS

FIGURES

TABLES

LIST OF ACRONYMS

µg/L	micrograms per Liter
µg/kg	micrograms per kilogram
µm	micron
ASAOC	Administrative Settlement Agreement and Order on Consent
Boeing	The Boeing Company
C	Celsius
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CESF	Chitosan-Enhanced Sand Filtration
CFR	Code of Federal Regulations
CLP	Contract Laboratory Program
CPR	Cardiopulmonary Resuscitation
CSV	Comma Separated Value
DQOs	Data Quality Objectives
EAA	Early Action Area
Ecology	Washington State Department of Ecology
EDD	Electronic Data Deliverable
EOF	Emergency Overflow
EPA	U.S. Environmental Protection Agency
FSP	Field Sampling Plan
gpm	Gallons per Minute
GTSP	Georgetown Steam Plant
HASP	Health and Safety Plan
KBFI	Seattle Boeing Field-King County International Airport rain gauge
KCIA	King County International Airport
LDW	Lower Duwamish Waterway
mg/L	Milligrams per Liter
mL	Milliliter
MQOs	Measurement Quality Objectives
MS	Matrix Spike
MSD	Matrix Spike Duplicate
NBF	North Boeing Field
NELAC	National Environmental Lab Accreditation Conference
NOAA	National Oceanic and Atmospheric Agency

NPL	National Priorities List
OSHA	Occupational Safety and Health Administration
PAHs	Polycyclic Aromatic Hydrocarbons
PCBs	Polychlorinated Biphenyls
ppb	Parts per Billion
PSDDA	Puget Sound Dredged Disposal Analysis
PSEP	Puget Sound Estuary Program
psi	Pounds per Square Inch
PVC	Polyvinyl Chloride
QA	Quality Assurance
QAPP	Quality Assurance Project Plan
QC	Quality Control
RI/FS	Remedial Investigation and Feasibility Study
RPD	Relative Percent Difference
SAP	Sampling and Analysis Plan
SM	Standard Method
STST	Short-Term Stormwater Treatment
SVOCs	Semivolatile Organic Compounds
TCLP	Toxicity Characteristic Leaching Procedure
TOC	Total Organic Carbon
TSS	Total Suspended Solids
WAC	Washington Administrative Code
WISHA	Washington Industrial Safety and Health Act

1.0 INTRODUCTION

This document presents a sampling and analysis plan (SAP) for a removal action being conducted by The Boeing Company (Boeing) at the North Boeing Field (NBF) site in Seattle, Washington (Figure 1). The removal action includes the design, installation, and operation of a short-term stormwater treatment (STST) facility to control contaminant discharges from the NBF site to the Slip 4 Early Action Area (EAA) of the Lower Duwamish Waterway (LDW) Superfund Site. The removal action is being conducted under an Administrative Settlement Agreement and Order on Consent (ASAOC) for Removal Action [Docket No. Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA)-10-2010-0242] between Boeing and the U.S. Environmental Protection Agency (EPA). The ASAOC requires that a SAP be prepared for collection and analysis of stormwater compliance monitoring samples and any other samples related to the removal action; this SAP is an appendix to the *Removal Action Work Plan, Short-Term Stormwater Treatment, North Boeing Field, Seattle, Washington* dated January 4, 2011. As defined in the draft ASAOC, "'Stormwater' shall mean all liquids, including any particles dissolved therein, in the form of base flow, stormwater runoff, snow melt runoff, and surface runoff and drainage, as well as all solids that enter the System" (EPA 2010). "'System" shall mean the combination of all manholes, catch basins, pipes, and other drainage devices and conveyances that are designed, constructed, and utilized for the purpose of carrying stormwater from NBF to the LDW, and the drainage basins associated with these devices and conveyances" (EPA 2010).

This SAP is comprised of a Field Sampling Plan (FSP) and a project-specific Quality Assurance Project Plan (QAPP). The FSP (Section 2.0) identifies the sampling objectives and describes the sampling and analysis procedures and methodologies to achieve the sampling objectives. The QAPP (Section 3.0) identifies data quality objectives (DQOs) for the project and describes the quality assurance (QA) and quality control (QC) protocols necessary to achieve the DQOs.

1.1 PROJECT SITE DESCRIPTION

NBF is located east of East Marginal Way South, adjacent to the King County International Airport (KCIA) and the city of Seattle Georgetown Steam Plant (GTSP). The approximate street address is 7370 East Marginal Way South, Seattle, Washington. NBF is approximately 150 ft from the head of Slip 4, which is an EAA at approximately River Mile 2.8 on the Duwamish Waterway within the LDW Superfund Site. The location of the site is shown on Figure 1.

1.2 PROJECT BACKGROUND

In 2001, the LDW was placed on the National Priorities List (NPL) pursuant to CERCLA. In 2003, the sediments and portions of the bank in Slip 4 were identified as an EAA due to the presence of polychlorinated biphenyls (PCBs) in the sediment. Prior to cleanup of Slip 4, the Washington State

Department of Ecology (Ecology) determined that ongoing sources of PCB discharges to Slip 4 should be controlled to reduce the likelihood of recontamination of the sediment following cleanup. Previous investigations at the NBF site identified the presence of PCBs in solids in manholes, catch basins, and sediment traps, and in water in the NBF storm drain system, which discharges to Slip 4 via the KCIA Storm Drain #3 PS44 Emergency Overflow (EOF) (Figure 2). As reported by SAIC (SAIC 2010a), the majority of PCBs discharging from NBF to Slip 4 via the NBF storm drain system are from the north lateral portion of the storm drain. To remove the PCBs from the NBF storm drain system prior to discharge to Slip 4, a STST facility was installed and placed into operation on September 15, 2010. The facility will be operated on a continuous basis under the oversight and direction of EPA until a long-term stormwater treatment facility is installed and operating. Interim goals for the STST facility have been set by EPA and are as follows:

- Water discharged to Slip 4 must be below the Aquatic Life – Fresh/Chronic water quality standard of 0.014 micrograms per liter (µg/L) total PCBs. This goal is consistent with the long-term stormwater treatment facility interim goal; however, if a salinity study is conducted in Slip 4 and results document that waters are marine, then the long-term interim goal for PCBs may increase to 0.03 µg/L total PCBs, which is the Marine/Chronic water quality standard.
- In-line storm drain solids discharged to Slip 4 must be below 10 milligrams per liter (mg/L) total suspended solids (TSS) as a daily maximum concentration and 5 mg/L TSS as an average monthly concentration, and must be below 420 parts per billion (ppb) dry weight total PCBs.

During operation of the STST facility, samples of the storm drain system solids and stormwater will be collected to monitor compliance with the interim STST facility goals, to evaluate performance of the STST facility, and to support design of a long-term stormwater treatment facility.

1.3 PROJECT ORGANIZATION

The removal action team includes personnel from Boeing; their consultants Landau Associates, Inc. (Landau Associates) and Geosyntec Consultants (Geosyntec); their contracted analytical laboratory Analytical Resources, Inc. (ARI); and their construction contractors Glacier Environmental Services, Inc. (Glacier) and Clear Water Compliance Services (Clear Water). Glacier is responsible for constructing structures and providing equipment needed to convey stormwater from the storm drain system to the STST facility and back to the storm drain system. Clear Water is responsible for installing a chitosan-enhanced sand filtration (CESF) system to filter out suspended solids and the associated PCBs. An organization chart showing personnel and their roles and responsibilities is provided as Figure 3.

2.0 FIELD SAMPLING PLAN

This FSP presents the sampling objectives related to the STST removal action being conducted at the site; proposed sample locations; and the sample collection methodologies, frequency, and laboratory analyses. A monitoring plan for the long-term removal action will be prepared and submitted to EPA as required by the ASAOC. The sampling procedures are consistent with procedures used previously to collect stormwater and solids samples at the NBF site for Boeing and Ecology.

2.1 SAMPLING OBJECTIVES

The objectives of the field sampling are to gather data to accomplish the following:

- Monitor compliance with the interim STST goals
- Evaluate the performance of the STST facility
- Evaluate the effectiveness of treatment under a variety of storm flows and characteristics
- Support design of a long-term stormwater treatment facility(s).

2.2 SAMPLING LOCATIONS

To meet the sampling objectives identified in Section 2.1, stormwater and solids samples will be collected from the NBF storm drain system at the following locations:

- **Lift Station (LS431)**. In accordance with the ASAOC, the King County lift station has been identified as the point of compliance with the STST interim goals (described in Section 1.2). Compliance monitoring at this location will consist of collecting whole water samples of the stormwater and filtered solids entrained in the stormwater for laboratory analysis.
- **STST Facility**. To monitor the performance of the STST facility, whole water samples of the treatment facility influent and effluent, and filtered solids from the treatment facility influent and effluent, will be collected for laboratory analysis.
- **Manhole 108 (MH108).** MH108 is located downstream of the STST facility. MH108 receives both water that has been treated by, and water that bypassed, the STST facility, as well as a small amount of stormwater from downstream of the STST facility. Therefore, to further evaluate the effectiveness of the STST facility and compliance with the STST interim goals, Boeing will collect and analyze whole water samples of the stormwater and samples of the filtered solids in the stormwater at MH108.
- **Weir Tank.** Samples of solids retained in the 18,000-gallon weir tank associated with the STST facility will be collected periodically, as needed, to determine appropriate disposal options for the solids. The thickness of the solids in the tank will be checked monthly. If more than an average of 12 inches of solids has accumulated, a sample of the solids will be collected.
- **Sediment Traps.** To continue to evaluate stormwater discharged from the other three NBF lateral storm drains (north-central, south-central, and south), which is not treated at the STST facility prior to discharge to Slip 4, Boeing will continue the sediment trap monitoring program that began in 2005. This will consist of collecting solids from sediment traps (SL4-

T1, SL4-T2, SL4-T3, SL4-T4 and SL4-T5). Boeing and the city of Seattle will continue to monitor other sediment traps that are located on storm drain lines entering the NBF site.

The locations of the lift station, STST facility, MH108, and the sediment traps are shown on Figure 2. A schematic of the STST facility identifying the weir tank and the influent and effluent sample ports is provided on Figure 4.

2.3 LIFT STATION SAMPLING

Sampling at the lift station will consist of collecting flow-weighted composite whole water samples of the stormwater from the outflow of the lift station and collecting samples of the filtered solids entrained in the stormwater. This section describes the sampling devices, sample collection methods, frequency of sample collection, and laboratory analyses. Sampling devices and collection methodologies are consistent with those used previously by SAIC for Ecology to collect stormwater and solids samples from the lift station (SAIC 2009, 2010b, 2010c).

2.3.1 SAMPLING FREQUENCY

To evaluate compliance with the STST facility goals during a variety of storm flows, as required in the ASAOC, stormwater and solids samples will initially be collected from the lift station during seven events between November 2010 and April 2011. These seven events will include five storm events and two base flow events. Stormwater and filtered solids will also be collected during three additional storm events to provide data for the Ecology NBF/GTSP remedial investigation/feasibility study (RI/FS). The definition of a storm event will be consistent with the definition previously used by Ecology: "a 24-hour period with 0.15 inch or more of rain over a period of at least 5 hours, preceded by at least 24 hours of no greater than a trace amount (0.04 inch) of precipitation" (SAIC 2009). One sampling event will be during a storm with over 0.5 inches of rain and one sampling event will be during a storm with at least 1.08 inches of rain as required by the ASAOC. Ecology/SAIC will monitor predicted rainfall and select storm events for sampling.

If precipitation is less than 0.15 inches, but at least 0.1 inches, for a sampling event, the stormwater and solids samples will be submitted to the laboratory for those analyses required under the ASAOC only (see Section 2.3.4). If the precipitation is less than 0.1 inches for a sampling event, the stormwater and solids samples will be discarded.

During three of the events, Ecology/SAIC plans to collect solids samples at the lift station using a continuous-flow centrifuge and submit the samples for PCB analysis. After April 2011, stormwater and solids samples will be collected from the lift station on a monthly or quarterly basis (the sampling frequency will be determined after results from the initial ten sampling events have been evaluated). A summary of the planned sampling at the lift station during operation of the STST facility is provided in Table 1.

2.3.2 SAMPLING DEVICES

This section describes the sampling devices that will be used to collect the whole water and solids samples at the lift station. The methodology for positioning these devices in the lift station is also described. It should be noted that the installation and some potential maintenance of the stormwater and solids sampling equipment will require confined space entry. A summary of the sampling devices and ownership of the devices (e.g., Boeing or Ecology/SAIC) is provided in Table 2.

2.3.2.1 Whole Water

Whole water samples of the stormwater at the lift station will be collected using a Boeing-owned ISCO 6712 automated sampler with a jumbo base. Each whole water stormwater sample collected will be a flow-weighted composite collected in a Boeing-owned 5-gallon laboratory-cleaned glass carboy located in the base of the ISCO unit. The sample collected in the carboy will consist of equal volume aliquots sampled at predetermined runoff volume intervals. When collecting a flow-weighted composite sample, aliquots will be collected more frequently at high flow rates and less frequently at low flow rates. The volume intervals between aliquots will be calculated using the anticipated volume of runoff for each forecasted storm event to be sampled. Based on data from past storm events that have been sampled, a regression line that plots predicted inches of rainfall versus total runoff will be used to estimate the runoff from the storm event to be sampled based on the inches of predicted rainfall.

The sampler will be equipped with a Model 750 Area Velocity Flow Module. Flow will be measured continuously at 1-minute intervals.

Once the automated sampler has been programmed according to the predicted runoff for the storm event, the sampling program will be set to begin when the storm event causes runoff (i.e., the event has not started if the precipitation only results in surface retention). The criteria for the designation of a storm event are presented in Section 2.3.1. Specific details on installation and programming of the ISCO 6712 stormwater samplers can be found in the 6712 Portable Samplers Installation and Operation Guide (Teledyne Isco 2010) and the 750 Area Velocity Module Installation and Operation Guide (Teledyne ISCO 2009). All field personnel will be familiar with these documents.

The stormwater collected for laboratory analysis will be drawn from the lift station outlet pipe. A peristaltic pump attached to the autosampler and a Teflon® suction line will be used to draw water from the outlet pipe. The intake of the suction line will be connected to a stainless-steel strainer to remove any large debris. The strainer and the Area Velocity Flow Module will be attached to an expanding scissors ring with a diameter matching the outlet pipe dimensions. The scissors ring will be placed at least one pipe diameter (48 inches) downstream of the opening of the outlet pipe. Installation will require confined space entry. Prior to placement of the expanding ring, any accumulated solids will be scraped off the pipe walls to ensure the ring will create a firm seal. The flow sensor will be installed so that it faces upstream and is oriented at the very bottom of the pipe. The strainer will also be installed facing upstream and situated so that the intake screen is near, but not touching, the surface of the pipe to avoid excess sediment accumulation. The strainer will be positioned so that it is completely underwater during storm events, otherwise improper aliquot volumes may be collected due to the presence of air. The suction line and electrical cords will be secured to the side of the pipe using plastic zip-ties. The suction line will be installed in a manner that does not allow it to kink under higher velocity flows and in a manner that does not allow loops to form so that the Area Velocity Flow Module can work properly and provide flow measurements representative of the stormwater flow through the lift station outlet pipe. The strainer and suction line will also be checked periodically to prevent it from becoming plugged with debris. If it is necessary to shorten the suction line during installation, the exact length of the line will be recorded in the field logbook and the sampler will be (re)programmed with the corrected length.

After the suction line and electrical cords have been attached to the autosampler, the sampler will be plugged into the nearest AC power source and the autosampler will go through a self check process. If the check is acceptable, the autosampler will be left in place to collect a sample.

2.3.2.2 Solids

Solids samples from the lift station stormwater will be collected at the lift station using an in-line stormwater filtration system. The system will consist of a sump pump which will push water upward through two filters housed in canisters. A flow totalizer will measure the volume of water passing through each filter, and a pressure gauge will indicate when the filter bags need to be replaced. The filtration design will include parallel filter housings, each equipped with a 20-inch long, 4-inch diameter filter bag purchased by Boeing. All bags will be made of 5 micron (μm) polypropylene felt, pressure rated to 15 pounds per square inch (psi).

The sump pump will be positioned in the lift station discharge vault, just to the side of the outlet pipe (upstream of the stormwater autosampler flow sensor and suction line intake) and anchored to the lift station vault ladder to prevent movement of the pump during high flow events. Ideally, the sump pump would be located downstream of the autosampler suction line intake, but the geometry of the lift station and the potential for high velocity flows [10,000 gallons per minute (gpm) for each lift station pump] limits where the sump pump can be mounted. A float switch, placed next to the sump pump, will trigger sample collection when stormwater flow is at a level high enough for proper pump operation. Adequate flow levels should be present whenever the lift station pumps are activated and water is being discharged through the outlet pipe. Rigid polyvinyl chloride (PVC) pipe and flexible reinforced PVC tubing connected to the sump pump will transfer stormwater to the filter housing.

A flow totalizer capable of measuring flows between 0.5 and 20 gpm will be located downstream of the filter housing to measure the volume of water that has passed through the filter. A pressure gauge, placed immediately upstream of the filter housing, will measure pressure within the tubing to monitor accumulation of solids on the filter bag's surface. As solids accumulate, stormwater flow through the filter will decrease and pressure will increase. Although the maximum pressure within the tubing is not expected to exceed the filter bag maximum pressure rating of 15 psi, damage to the sump pump may occur and the pump should be turned off and/or the filter bag should be replaced prior to a pressure of 15 psi. Filtered stormwater will be directed back to the storm drain downstream of the sump pump intake and the ISCO suction line via rigid PVC pipe and flexible reinforced PVC tubing attached to the outlet side of the filter housing.

The parallel housing system will be mounted on a wooden frame and housed in a weatherproof shed along with the autosampler.

2.3.3 SAMPLE COLLECTION METHODS

This section describes the methodology for collecting stormwater and stormwater solids samples from the lift station.

2.3.3.1 Whole Water Samples

Whole water samples of the stormwater at the lift station will be collected during storm events and periods of base flow. Sample collection methodologies for both types of flow are described below.

Storm Events

As previously defined in Section 2.3.1, storm events are roughly categorized as a 24-hour period with 0.15 inches or more of rain over at least a 5-hour period, preceded by at least 24 hours of no greater than a trace (0.04 inch) of precipitation. The sampling duration is planned to include at least 75 percent of the storm event hydrograph, or at least 75 percent of the first 24 hours if the storm event lasts longer than 24 hours. Actual sampling duration may be different depending on actual rainfall amount, runoff volume, and equipment performance. During each event, at least ten aliquots with a minimum volume of 200 milliliters (mL) will be collected (Ecology 2009). The total volume of stormwater collected is planned to be sufficient to complete all chemical analyses required under the ASAOC and the analyses needed by Ecology, a volume of 10 to 15 liters (see Section 2.3.4).

Necessary parameters for flow-weighted sampling include: predicted amount of precipitation, expected runoff volume, expected storm duration, minimum volume required for analysis, minimum number of aliquots, sample aliquot size, and maximum bottle volume (Ecology 2009). Each program will be set up to meet the aliquot size and frequency requirements and the analytical volume requirements without filling the carboy with more than 15 liters of stormwater; however, the actual amount collected may be different than that planned due to the actual amount of precipitation, stormwater runoff, storm duration, and equipment performance.

The sample collection process begins with precipitation monitoring, which will be conducted by Ecology/SAIC. Precipitation can be tracked online through the Seattle Boeing Field rain gauge at http://www.wrh.noaa.gov/mesowest/getobext.php?wfo=sew&sid=KBFI&num=48&raw=0&dbn=m. Once the required 24-hour dry period is achieved, the stormwater sampling team should begin to monitor for potential storm events. The National Oceanic and Atmospheric Administration (NOAA) website offers a Quantitative Precipitation Forecast for 6-hour increments: http://www.wrh.noaa.gov/forecasts/graphical/sectors/sew.php#tabs. When Ecology/SAIC determines that the forecasts indicate a storm is pending that is likely to meet the 0.15-inch criterion, the sampling team will begin preparation for stormwater collection, including programming the autosampler and calibrating the autosampler peristaltic pump. Following calibration of the pump, the suction line will be connected to the pump and the autosampler. The autosampler will be set to purge the suction line before and after collecting each aliquot. Next, the decontaminated 5-gallon carboy will be installed in the sample base and ice placed around the base of the carboy.

The sampling team will retrieve the carboy within 12 hours after the sampling event has concluded. At that point, the flow data from the autosampler will be downloaded for analysis. The flow hydrographs will be evaluated along with the Seattle Boeing Field-King County International Airport rain gauge (identified as "KBFI" rain gauge data to determine that:

- At least 0.15 or 0.1 inches of rain fell, qualifying as a storm event.
- Stormwater aliquots were collected during at least 75 percent of the hydrograph or at least 75 percent of the first 24 hours if the storm event lasts longer than 24 hours and the minimum volume requirements were met for each aliquot.

If both conditions are met, the carboy will be capped with a Teflon®-lined cap, labeled as described in Section 2.8, and submitted to the laboratory for the analyses required under the ASAOC and for the analyses needed for Ecology. If precipitation is less than 0.15 inches, but at least 0.1 inches, for a sampling event, the stormwater and solids samples will be submitted to the laboratory for the analyses required under the ASAOC only. If the precipitation is less than 0.1 inches for a sampling event, the stormwater and solids samples will be discarded.

The filled carboy will be heavy and fragile. To avoid damage, special totes with handles will be used to move the carboy. During transit, the carboy will be surrounded with ice. Chain-of-custody forms will be filled out onsite (Section 2.6.1), and custody of the carboy will be transferred to ARI upon delivery. Using a churn splitter or similar device, laboratory staff will distribute proper volumes of homogenized stormwater to bottles for preservation or immediate analysis. Should there be an event where sample volume is insufficient to perform all of the requested analyses, Landau Associates will direct ARI in the priority of analysis (described further in Section 2.3.4). If, during the planning phase, it seems likely a sampling event will end on a weekend or during non-business hours, arrangements will be made with ARI staff to ensure that a technician is present to process the samples.

Base Flow and Monthly (or Quarterly) Samples

The methods described above for whole water sampling during storm events will generally be used to collect base flow and monthly (or quarterly; to be determined after completion of the initial 10 sampling events) whole water samples from the lift station. However, the autosampler will be programmed to collect an aliquot during every lift station pump cycle and may be allowed to run for multiple days during dry periods in order to collect enough sample for analysis.

2.3.3.2 Filtered Solids Sample Collection

To collect filtered solids samples from the lift station stormwater, the in-line filtration system described in Section 2.3.2.2 will be activated. Prior to activation, new filter bags pre-weighed and numbered by ARI, will be installed. The number of the filter bag used at each sampling location will be recorded in the field logbook.

Once sampling begins, the pressure gauge will be monitored about every 4 hours. If the pressure is near 15 psi, the system will be deactivated and the filter bags will be replaced. The flow rate through the first set of filter bags will be recorded in the field logbook. After filter bags have been removed, residual water in the bags will be allowed to gravity drain. Once drained, the filter bags will be placed in a sealable plastic bag and again labeled with the sample location name, sampler's name, flow volume, date, and time. Collected samples will be stored in a cooler with ice packed in sealable plastic bags.

2.3.3.3 Bed Load Sample Collection

The presence and impact of solids that are transported at the bottom of the storm drain pipes, and are not captured by other planned sampling methods, will be evaluated by samples collected using a bed-load sampler. Bed-load samples will be collected during five storm events including one storm event with rainfall of over 0.5 inches and one storm event with rainfall of at least 1.08 inches, and two base flow events, unless otherwise approved by EPA. The specific type of bed-load sampling unit and a location for installation of the sampling unit has not yet been determined. That information will be provided to EPA for approval prior to the start of bed-load sampling.

2.3.4 LABORATORY ANALYSES

This section identifies the laboratory analyses for the whole water and solids samples collected at the lift station. All analyses will be performed at ARI laboratory located in Tukwila, Washington, or other EPA-approved lab. A summary of the analyses to be performed is provided in Table 1. Additional analyses may also be performed in accordance with the Ecology/SAIC Stormwater and Filtered Suspended Solids Sampling and Analysis Plan and addenda (SAIC 2009, 2010b, 2010c). The additional analyses will be performed by ARI except dioxins/furans analyses, which will be performed by Axys Analytical Services Ltd laboratory, located in Sydney, British Columbia.

2.3.4.1 Whole Water Samples

Whole water samples will be analyzed for PCBs using EPA Method 8082 and for TSS using Standard Method (SM) 2540. The target reporting limits for each analysis are summarized in Table 3. Additional analyses may be performed on the whole water samples for Ecology [e.g., dissolved and total metals, semivolatile organic compounds (SVOCs), and total organic carbon (TOC)].

2.3.4.2 Filtered Solids Samples

Filtered solids will be analyzed for PCBs by EPA Method 8082 and grain size using the Puget Sound Estuary Program (PSEP) protocols, if possible. If the amount of solids collected is insufficient to determine the grain size fractions less than 62.5 µm using the PSEP protocol, the smaller fractions will be determined using a sedigraph. Also, if a sufficient quantity of solids is collected, each grain size fraction greater than 62.5 µm will be analyzed for PCBs. The grain size fraction less than 62.5 µm will also be analyzed for PCBs, if a sufficient quantity of solids is present. For the PCB and grain size analyses, new filters will be weighed and numbered at ARI prior to sample collection, so that each sample can be matched to a unique, clean-filter weight. The used filter will be dried, weighed, and processed by ARI similar to the way they would process a wipe sample. For each filter, the entire filter (along with whatever material was collected) will be extracted and the analytical results presented in units of total micrograms (µg) of PCBs. Knowing the full weight of the used dried filter and the pre-filtration weight, the estimated mass of PCBs per mass of total solids can be calculated. The target reporting limits for the PCB analysis of the filtered solids are summarized in Table 3. Additional analyses are planned to be performed on the filtered solids for Ecology [e.g., metals (including mercury) and polycyclic aromatic hydrocarbons (PAHs) or dioxins/furans] if sufficient volume is collected. For sample events that include PAHs, analysis for PCBs will be done on solids collected in one filter bag and all other analyses will be performed on solids collected in a separate filter bag. When dioxins/furans analysis is required, one of the filter bags containing solids will be submitted for dioxins/furans analysis and all other analyses, including PCBs and grain size, will be performed from the second filter bag containing solids. Priority for analysis if insufficient material is available for all analyses is shown in Table 4.

2.3.4.3 Bed-Load Solids Samples

Bed-load solids will be analyzed for PCBs by EPA Method 8082.

2.3.5 EQUIPMENT DECONTAMINATION

Except the glass carboys, the equipment used to collect whole water and solids samples at the lift station is dedicated and will not be used at other locations; therefore, decontamination is not necessary for all equipment except the glass carboys. The ARI laboratory decontaminates the sample carboys between sampling events.

2.4 SHORT-TERM STORMWATER TREATMENT SYSTEM SAMPLING

Sampling at the STST facility will consist of collecting whole water grab samples of the treatment facility influent and effluent and samples of the solids entrained in the influent and effluent. This section describes the sampling devices, sample collection and handling methods, frequency of sample collection, and laboratory analyses.

2.4.1 SAMPLING FREQUENCY

To evaluate the performance of the STST facility, whole water samples will be collected from the treatment facility influent and effluent on a weekly basis using Boeing-owned equipment. These will include samples collected by Boeing/Landau Associates for PCBs and TSS analyses, as discussed in Section 2.4.2, and effluent samples collected by Clear Water for residual chitosan testing. At least five of the whole water influent and effluent samples for PCBs and TSS analyses will be collected concurrent with the lift station storm sampling events described in Section 2.3.1. Information on whether there was overflow and bypass of the treatment system during the time of whole water sampling will also be recorded.

Filtered solids samples will be collected twice a month if an adequate amount of solids is present within the filter to perform the analyses described in Section 2.4.2.2. It is expected that during the rainy season there will be adequate solids for the influent to be collected twice a month, but it is less likely that a sufficient amount of solids will be present for the effluent. A summary of the sampling plan for the STST facility is provided in Table 1.

2.4.1.1 Whole Water Sample Collection

Whole water samples will be collected from sample ports on both the influent and effluent lines of the treatment system. The specific sample collection procedures are as follows:

- Time of effluent sampling will be staggered from the time of influent sampling based on the estimated detention time in the system, to attempt to sample the same parcel of water from both sides of the system.
- Samples will be collected in laboratory-supplied sample bottles.
- Water will be allowed to purge from the sampling ports for a minimum of 20 seconds prior to collection of a sample. Purge water will be placed in the pretreatment tank or in an upstream catch basin.
- Samples will be collected by placing the appropriate sample bottles below the treatment system's sample ports and allowing the bottles to fill.
- Once a sample is collected, the bottle will be capped, sealed, and labeled.

The following items will be recorded at the time of sampling:

- Base flow conditions or storm event
- Approximate time rainfall began
- Date and time of sampling
- How the detention time in the system was calculated
- Name of the sampler(s)
- Number and types (parameters) of samples collected
- Unusual circumstances that may affect the sample results.

2.4.1.2 Filtered Solids Sample Collection

To collect solids samples from the treatment facility influent and effluent, a filtration system will be installed on each pipeline located between the CESF system and MH130A and MH130C (i.e., effluent and influent lines shown on Figure 4). A submersible pump located in MH130A will pump influent water through a pipe connected to the main line. A portion of the influent will pass through a filter bag where solids will be captured. A portion of the effluent will also be diverted through a filter bag to capture solids. A schematic of the filter assemblies is shown on Figure 4.

Twenty-inch bag filter housing with pre-weighed and pre-numbered polypropylene felt filter bags will be used to collect influent and effluent solids. The bags for the influent and effluent will be rated to 5 and 1 µms, respectively. A flow totalizer will be placed downstream of each filter and will be used to measure the total volume of stormwater flowing through the filter bags. Filtered water from influent sampling will then be conveyed to the pretreatment tank via a dedicated flexible hose, while filtered water from effluent sampling will rejoin the discharge flow prior to discharge to MH130C.

The amount of filtration time for each filter bag will be determined in the field, as the amount of solids in the influent and effluent will vary. The flow rates at each will be checked no less than twice a month. If the filter bag becomes clogged, the flow will slow or stop and a sample will be collected and a new filter installed. Each filter will be removed following successful completion of filtration and handled according to the procedures in Section 3.2.

The specific sampling procedure at each sample port (influent and effluent) is as follows:

- Use only a clean, new filter that has been pre-weighed and numbered by the laboratory.
- Once a filter bag is removed, the filter will be placed in a clean plastic bag, sealed, and labeled.
- The following items will be recorded at the time of sampling:
  - Date and time filtration began
  - Date and time filtration ended
  - The lab-determined number and weight of the filter used
  - Reading from the flow totalizer at start of filtering
  - Reading from the flow totalizer at end of filtering
  - Name of the sampler(s)
  - Unusual circumstances that may affect the sample results.

2.4.2 LABORATORY ANALYSES

This section identifies the laboratory analyses for the stormwater and solids samples collected at the short-term stormwater treatment facility to evaluate the performance of the facility. All analyses, except the residual chitosan, will be performed at ARI laboratory. A summary of the analyses to be performed is provided in Table 1.

2.4.2.1 Whole Water Samples

Whole water samples of the treatment facility influent and effluent will be analyzed at ARI for PCBs using EPA Method 8082 and for TSS using Method SM2540. The target reporting limits for each analysis are summarized in Table 3. Discrete whole water samples of the effluent will also be analyzed for residual chitosan by Clear Water.

2.4.2.2 Filtered Solids Samples

Each filtered solids sample collected from the STST facility influent and effluent will be analyzed for PCBs. The target reporting limits for the PCBs analyses are summarized in Table 3. Filtered solids will be analyzed for PCBs by EPA Method 8082. For the PCBs analyses, new filters will be weighed and numbered at ARI prior to sample collection, so that each sample can be matched to a unique, clean-filter weight. The used filter will be dried, weighed, and processed by ARI similarly to the way they would process a wipe sample. For each filter, the entire filter (along with whatever material was collected) will be extracted and the analytical results presented in units of total µg of PCBs. Knowing the full weight of the used dried filter and the pre-filtration weight, the estimated mass of PCBs per mass of total solids can be calculated.

2.4.3 EQUIPMENT DECONTAMINATION

Only dedicated sampling ports; dedicated pumps; and clean, new bottles and filters are planned to be used for sample collection. However, in the event that any equipment needs to be reused, the equipment will be cleaned by scrubbing all surfaces that will come into contact with the sample with brushes using an Alconox solution, rinsing and scrubbing with clean tap water, and rinsing a final time with distilled or de-ionized water to remove tap water impurities. Decontamination, if required, will be conducted between collection of each sample.

2.5 MANHOLE 108 SAMPLING

Sampling at MH108 will consist of collecting flow-weighted composite whole water samples of the stormwater and collecting samples of the solids entrained in the stormwater at this location. This section describes the sampling devices, frequency of sample collection, and laboratory analyses. Sampling devices and collection methodologies are consistent with those used previously by SAIC to collect stormwater samples and solids from MH108 for Ecology.

2.5.1 SAMPLING FREQUENCY

To evaluate stormwater downstream of the treatment facility that is comprised mostly of treated stormwater and, to a much lesser extent, untreated stormwater, stormwater and solids samples will initially be collected from MH108 during five storm events between November 2010 and February 2011. The sampling events will be concurrent with lift station sampling events. A summary of the sampling plan for MH108 during operation of the STST facility is provided in Table 1.

2.5.2 SAMPLING DEVICES

The sampling devices used to collect the whole water samples of the stormwater and solids at MH108 are the same as those devices used to collect whole water samples at the lift station, except that the flow sensor used at MH108 is a 4250 flow module instead of a 750 flow module. Also, the tubing intake is located in the inlet pipe instead of the outlet pipe. Similarly, the devices used to collect filtered samples at MH108 are the same as the devices used at the lift station; however, the pump for the filtered solids sample collection is located downstream of the flow sensor and water sample intake, but upstream of the filtered solids discharge pipe. A summary of the sampling devices and ownership of the devices (e.g., Boeing or Ecology/SAIC) is provided in Table 2.

2.5.3 Sampling Collection and Handling Methods

Procedures described in Section 2.3.2.1 and 2.3.3.1 for collection of whole water samples of the stormwater at the lift station will be used to collect whole water and solids samples at MH108.

2.5.4 Laboratory Analyses

Analysis of whole water and solids samples collected at MH108 will be the same as the analyses described in Section 2.3.4.1 for the lift station samples. All analyses will be performed at the ARI laboratory, except dioxins/furans analyses, which will be performed at Axys laboratory. A summary of the analyses to be performed is provided in Table 2.

2.6 SEDIMENT TRAPS

The sediment trap monitoring program that began in 2005 at the NBF site will be continued during operation of the STST facility to evaluate stormwater discharge from the other three NBF lateral storm drains (north-central, south-central, and south), which are not treated at the STST facility prior to discharge to Slip 4. Sediment traps will be installed at the locations shown on Figure 2. The traps were installed on November 12, 2010, and solids samples will be collected for laboratory analysis in April 2011 and November 2011. A summary of the sampling plan for the sediment traps is provided in Table 1.

2.6.1 Sample Collection

Each sediment trap will consist of two stainless-steel brackets and housings that each holds a Teflon® sample container. Once the containers are securely placed on the bracket, the container lids will be removed and placed in a plastic sealable bag and labeled with the sample location. After the desired sample duration has elapsed, the lids will be placed back on the containers and the containers removed. The containers will be labeled as described in Section 2.8.2. Each sample will be placed in clean, plastic sealable bags (double bagged) and stored on ice in a cooler for transportation to ARI laboratory. New laboratory-cleaned containers will be placed in the brackets for collection of the next round of samples

2.6.2 Laboratory Analysis

Analysis of the sediment trap solids samples will include PCBs using EPA Method 8082; SVOCs using Puget Sound Dredged Disposal Analysis (PSDDA) SVOCS SW8270D (full scan); total metals (arsenic, copper, lead, mercury, and zinc) using Methods 6010 and 7471; diesel-range and motor oil-range petroleum hydrocarbons using Ecology Method NWTPH-Dx; TOC using the method described in Plumb (1981), and grain size. Depending on the quantity of solids collected, the laboratory may not be able to analyze all parameters, in which case, the analysis of parameters will be prioritized in the order listed above. The target reporting limits for each analysis are summarized in Table 3.

Prior to field mobilization, all sampling equipment and utensils will be thoroughly decontaminated. The ARI laboratory will be responsible for decontamination of the Teflon® sample container.

2.7 WEIR TANK SAMPLING

Grab samples of the residual solids at the bottom of the STST facility weir tank will be collected by Boeing/Landau Associates to determine appropriate disposal of the solids. The samples will be collected when more than an average of 12 inches of solids is measured in the tank. The amount of solids in each unit will be measured on a monthly basis by Clear Water. The measurement will be made by using an extension probe rod and a flashlight to estimate the solids thickness by both sight and feel at a minimum of four points in the tank on the inlet side of the weir wall. The four points will be selected evenly between the inlet side and the weir side of the tank length. The solids thickness from the individual measuring points will be averaged to determine if the thickness exceeds 12 inches and requires solids removal. The Operation and Maintenance (O&M) Manual in Appendix A of the *Removal Action Work Plan, Short-Term Stormwater Treatment, North Boeing Field, Seattle, Washington* provides more detailed procedures for measuring the amount of accumulated solids.

Disposal characterization sampling will also be conducted for the sand media in the sand filter system. At a minimum, sampling of the filter sand will be conducted prior to the final decommissioning of the STST system. It is possible that, if reduced sand filtration performance is observed during the course of operation, the used sand media would be replaced prior to system decommissioning and, in that case, a sample of the used sand would be collected prior to replacement.

2.7.1 SAMPLE COLLECTION

The grab samples will be collected from the bottom of the weir tank using a clean laboratory-supplied 8-ounce glass soil sampling jar affixed to the end of a telescoping sampling pole. Water will be decanted from each jar, to the extent possible, and the solids from each jar will be combined and homogenized in a clean stainless-steel bowl using a clean stainless-steel spoon, placed into a separate sample jar, labeled, and stored in a cooler on ice. The sampler will remove material greater than about ¼-inch diameter prior to placing the soil in the sample container. A new clean sample jar will be affixed to the telescoping sample pole at each new location.

2.7.2 LABORATORY ANALYSIS

Each solids sample will be analyzed for PCBs using EPA Method 8082; PAHs using EPA Method 8270D (full scan); metals (arsenic, barium, cadmium, chromium, lead, mercury, selenium, and silver) using the toxicity characteristic leaching procedure (TCLP); diesel-range and motor oil-range petroleum hydrocarbons using Ecology Method NWTPH-Dx; and gasoline-range petroleum hydrocarbons using Ecology Method NWTPH-Gx.

2.7.3 Equipment Decontamination

All non-disposable sampling equipment (e.g., stainless-steel bowls and spoons), or other equipment used to collect the sediment trap samples that contacts the solids, will be decontaminated as follows:

- Potable water rinse
- Alconox/Liquinox detergent wash
- Potable water rinse
- Deionized (DI) water rinse
- Air dry.

2.8 SAMPLE LABELING AND HANDLING

This section describes the sample labeling and handling procedures that will be used during the stormwater and stormwater solids sampling that will be conducted while the STST facility is operating.

2.8.1 Sample Identification and Labels

Sample container labels will be completed immediately before or immediately following sample collection. Container labels will include the project name (Boeing NBF); the Boeing project manager's name (Carl Bach); the project number (025082.210.006 for 2010 samples and 025082.211.006 for 2011 samples); the sample ID; the initials of the person collecting the sample; the date and time of collection; and the analysis required. All samples collected during the investigation will be labeled clearly and legibly. Sample labels will be self-adhering, waterproof material. An indelible pen will be used to fill out each label.

2.8.2 Sample Containers, Preservation, and Storage

Samples submitted to the analytical laboratory for analysis will be collected in the appropriate sample container provided by the analytical laboratory appropriate for the matrix being analyzed and the requested analytes with the following exceptions. Pre-purchased sediment trap containers and 5-gallon glass carboys will be reused at each sediment trap location and at the lift station and MH108. Each container will be cleaned by ARI laboratory between uses. New filters will be purchased by Boeing for each filtered solids sample. Each filter will be pre-weighed and numbered by ARI prior to use. All samples will be preserved by cooling to a temperature of 6° Celcius (C) and as required by the analytical method. Maximum holding and extraction times until analysis will be strictly adhered to by field personnel and the analytical laboratory. Sample containers, preservatives, and holding times for each chemical analysis to be performed are presented in Table 5.

2.8.3 SAMPLE PACKAGING AND SHIPPING

The transportation and handling of samples will be accomplished in a manner that not only protects the integrity of the sample, but also prevents any detrimental effects due to the possible hazardous nature of samples. Regulations for packing, marking, labeling, and shipping of hazardous materials are promulgated by the U.S. Department of Transportation in the Code of Federal Regulations (CFR), 49 CFR 173.6 and 173.24.

Prior to transportation to the laboratory, samples will be placed on double-bagged ice in coolers following collection. At the end of the day, samples sent to the analytical laboratory will be inventoried. A plastic cooler will be used as a transportation container, with the drain plug taped shut. When appropriate, approximately 1 inch of packing material will be placed in the bottom cooler. The chain-of-custody accompanying the samples to the laboratory will be placed inside a separate plastic bag and placed inside the cooler. The cooler will be secured with signed custody seals.

Samples will be transported to the laboratory within 24 hours of sample collection. The cooler will be transported to the laboratory by the laboratory's courier or delivered to the laboratory by field sampling personnel.

2.8.4 SAMPLE CUSTODY

The primary objective of sample custody is to create an accurate, written record that can be used to trace the possession and handling of samples so that their quality and integrity can be maintained from sample collection until completion of all required analyses. Adequate sample custody will be achieved by means of approved field and analytical documentation. Such documentation includes the chain-of-custody record, which is initially completed by the sampler and is, thereafter, signed by those individuals who accept custody of the sample.

3.0 QUALITY ASSURANCE PROJECT PLAN

This QAPP presents the QA and QC plan for the field sampling and laboratory analyses associated with the NBF STST removal action. The purpose of this plan is to ensure that all necessary actions or protocols are implemented to acquire data of the type and quality needed to meet the project goals.

This QAPP was prepared in accordance with EPA Requirements for Quality Assurance Project Plans (QA/R-5)(EPA/240/B-01/003, March 2001a) and the following EPA guidance documents: Guidance for Quality Assurance Project Plans (QA/G-5) (EPA/240/R-02/009, December 2002) and Quality Assurance/Quality Control Guidance for Removal Activities. (EPA/540/G-90/004, April 1990).

3.1 QUALITY ASSURANCE OBJECTIVES

The QA objectives for this project are to develop and implement procedures that will ensure collection of representative data of known, acceptable, and defensible quality. The data quality parameters used to assess the acceptability of the data are precision, accuracy, representativeness, comparability, and completeness. These parameters are discussed in the following sections.

3.1.1 DECISION QUALITY OBJECTIVES

The decision quality objectives define the type, quality, and quantity of data necessary to support project decisions. As presented in the ASAOC, the project goal is to reduce PCB concentrations in stormwater discharging to the Slip 4 EAA of the LDW Superfund site to below 0.014 µg/L and the amount of storm drain solids discharged to below 100 ppb dry weight total PCBs. Interim goals for the STST system, discussed previously in Section 1.3, include reducing PCBs concentrations to below 0.014 µg/L in stormwater and below 420 (micrograms per kilogram (µg/kg) dry weight in stormwater solids, reducing TSS concentrations in stormwater to below 10 mg/L (daily maximum) and 5 mg/L (monthly average), and collecting sufficient data to support design of a long-term treatment facility. The project decisions, therefore, include determining whether or not the STST facility is effective in reducing PCB concentrations, determining whether or not the stormwater discharge to Slip 4 from NBF is in compliance with the STST interim goals following treatment of stormwater, and determining the long-term treatment facility needs to meet the long-term interim goals. To support these decisions, samples of stormwater and stormwater solids must be collected from the storm drain system. The samples must be representative of site conditions during a variety of stormwater flows, the results must be comparable to the STST and long-term interim goals, and the data must be complete to ensure sufficient data is collected to support the project decisions. Representativeness, comparability, and completeness are discussed further below.

3.1.1.1 Representativeness

Representativeness expresses the degree to which data accurately and precisely represent an actual condition or characteristic of a population. Representativeness can be evaluated using replicate samples, representative sampling locations, and blanks. The FSP (Section 2.0) specifies the types and number of samples to collect and the appropriate sampling locations. As described in the FSP, stormwater and stormwater solids samples will be collected from the storm drain system prior to and following treatment. In some cases, samples will be collected during both storm events and during base flow, other samples will be collected weekly, and other information will be collected on a continuous basis. This range of sampling frequency will provide data that is representative of a variety of storm flow conditions at the site. Additionally, to determine that the analytical results are representative of the sampled item and not influenced by cross-contamination, method blanks will be analyzed with each analysis as described in Section 3.5.5.5.

3.1.1.2 Comparability

Comparability expresses the confidence with which one data set can be evaluated in relation to another data set. For this work, comparability of data will be established through the use of consistent sampling procedures and the use of EPA-approved analytical methods with target reporting limits that can meet the compliance criteria set for this project. Analytical methods to be used for analysis of stormwater and stormwater solids samples are discussed in Section 3.5.4.

3.1.1.3 Completeness

Completeness is a measure of the proportion of data obtained from the requested analytical method that is determined to be valid. It is calculated as the number of valid data points divided by the total number of data points requested. The QA objective for completeness during this project will be 95 percent. Completeness will be routinely determined and compared to this control criterion.

3.2 MEASUREMENT QUALITY OBJECTIVES

The measurement quality objectives (MQOs) for the project specify how good the data must be in order to meet the objectives of the project and are based on data precision, accuracy, bias, and sensitivity, as described below.

3.2.1 PRECISION

Precision measures the reproducibility of measurements under a given set of conditions. Specifically, it is a quantitative measure of the variability of a group of measurements compared to their average values.

Analytical precision is measured through matrix spike duplicate (MSD) samples for organic analysis and through laboratory duplicate samples for inorganic analyses. MSD samples will be collected as described in Section 3.5.5.4. Laboratory precision will be evaluated against quantitative relative percent difference (RPD) performance criteria provided by the laboratory.

Field precision will be evaluated by the collection of blind field duplicate stormwater samples as discussed in Section 3.5.5.1. Control limits for the field duplicates will be 20 percent unless the duplicate sample values are within five times the reporting limit, in which case the control limit interval will be plus or minus the reporting limit for water, and plus or minus two times the reporting limit for solids.

Precision measurements can be affected by the nearness of a chemical concentration to the method detection limit, where the percent error (expressed as RPD) increases. The equation used to express precision is as follows:

$$RPD = \left| \frac{D_1 - D_2}{(D_1 + D_2)/2} \right| x\,100$$

where: D1 = first sample value

D2 = second sample value (duplicate).

3.2.2 ACCURACY

Accuracy is an expression of the degree to which a measured or computed value represents the true value. Field accuracy is controlled by adherence to sample collection procedures as outlined in the FSP (Section 2.0).

Analytical accuracy may be assessed by analyzing “spiked” samples with known standards [surrogates, laboratory control samples, and/or matrix spike MS)] and measuring the percent recovery. Matrix spike samples will be collected as described in Section 5.5.3. Because MS/MSDs measure the effects of potential matrix interferences of a specific matrix, the laboratory will perform MS/MSDs only on samples from this project and not from other projects. Surrogate recoveries will be determined for every sample analyzed for organics.

Laboratory accuracy will be evaluated against quantitative MS and surrogate spike recovery performance criteria provided by the laboratory. Accuracy can be expressed as a percentage of the true or reference value, or as a percent recovery in those analyses where reference materials are not available and spiked samples are analyzed. The equation used to express accuracy is as follows:

$$\begin{matrix} Percent \\ Recovery \end{matrix} = \frac{(Spiked\ Sample\ Result - Unspiked\ Sample\ Result)}{Amount\ of\ Spike\ Added}\ x\ 100$$

Control limits for percent recovery for water and solid samples will be laboratory acceptance limits generated according to EPA guidelines.

3.2.3 BIAS

Bias is the systematic or persistent distortion of a measured process that causes errors in one direction. Bias of the laboratory results will be evaluated based on analysis of method blanks and MS samples as described in Sections 3.5.5.5 and 3.5.5.3, respectively.

3.2.4 SENSITIVITY

Sensitivity is the ability to discern the difference between very small amounts of a substance. For the purposes of this project, sensitivity is the lowest concentration that can be accurately detected by the analytical method. The analytical method will be considered sufficiently sensitive if the reporting limits are below the compliance criteria discussed in Section 1.2. Proposed method and target reporting limits are discussed in Section 3.5.4.

3.3 SPECIAL TRAINING/CERTIFICATION

All personnel performing sampling activities onsite will have completed formal 40-hour HAZWOPER health and safety training, in compliance with 29 CFR 1910.120 and Washington Administrative Code (WAC) Chapter 296 (certificates of successful completion of training will be maintained in personnel health and safety files), and will verify on-the-job training for those activities they are assigned to perform. At least one member of each field team and the designated site safety officer will be trained in cardiopulmonary resuscitation (CPR) and first aid.

The laboratory performing the analysis of the samples will be ARI or other EPA-approved lab. ARI is certified by the State of Washington and the National Environmental Lab Accreditation Conference (NELAC) to perform the methods listed in this QAPP. This laboratory is not in the Contract Laboratory Program (CLP), but follows methods and QA/QC procedures that have been submitted and approved by EPA. ARI has a documented Quality Assurance Program that complies with ANSI/ASQC E-4 1994, "*Specifications and Guidelines for Quality Systems for Environmental Data Collection and Environmental Technology Programs,*" (American National Standard, January 5, 1995) and "EPA Requirements for Quality Management Plans (QA/R-2)" (EPA/240/B-01-002, March 2001b).

Work in confined spaces (WAC 296-62-Part M) may be necessary to maintain sampling equipment at the lift station and/or MH108. Entering confined spaces requires specialized training and procedures outlined by the Occupational Safety and Health Administration (OSHA). OSHA issued a general industry standard (29 CFR 1910.146; the standard) to require protection for employees who enter permit-required confined spaces. The corresponding Labor and Industries [Washington Industrial Safety and Health Act (WISHA)] regulation is found at Chapter 296-809 WAC. All personnel entering a confined space will be trained and certified in accordance with OSHA and WISHA. Confined space entry will also be conducted in accordance with Boeing requirements.

3.3.1 DOCUMENTS AND RECORDS

This section describes the production, distribution, and storage of documents and records associated with sampling activities related to the STST facility.

3.3.2 DOCUMENT DISTRIBUTION

Prior to beginning any field activities, field staff will receive and have a chance to review all project documents pertinent to the field activities including the SAP and a Health and Safety Plan (HASP). Project managers will meet with field staff prior to field activities to review the SAP. The HASP will be reviewed by all staff collecting samples.

3.3.3 FIELD DOCUMENTATION

All field equipment (e.g., automated stormwater samplers and flow meters) will have reference manuals that will be kept available during sampling or maintenance activities. In addition, equipment that requires calibration will be accompanied by a calibration logbook. Field staff will record the calibration process in the logbook every time a calibration is performed.

A complete record of all field activities will be maintained for 10 years after notification by EPA of completion of the work under the ASAOC. Documentation necessary to meet QA objectives for this project include daily field notes, sampling forms, and sample chain-of-custody forms. All original documentation will be kept in the Landau Associates' project files. The documentation and other project records will be safeguarded to prevent loss, damage, or alteration.

If an error is made on a document, corrections will be made by drawing a single line through the error and entering the correct information. The erroneous information will not be obliterated. Corrections will be initialed and dated, and, if necessary, a footnote explaining the correction will be added. Errors will be corrected by the person who made the entry, whenever possible. Documentation will include field notes and associated documents.

The field notes will provide a description of all sampling activities, sampling personnel, weather conditions, and a record of all modifications to the procedures and plans identified in the SAP. The field notes are intended to provide sufficient data and observations to enable participants to reconstruct events that occurred during the sampling period.

Field notes will be supplemented by sample collection forms completed by field staff. Sample possession and handling will also be documented with chain-of-custody records so that the samples are traceable from the time of sample collection to arrival at the laboratory and to sample analysis. Sample handling and chain-of-custody procedures are described in Section 2.8.5.

3.3.4 Analytical Data Records

Analytical data reports consisting of a case narrative, field sample results, method blank, laboratory control sample, surrogate recovery, and MS results will be provided by the laboratory. The reports will be submitted in hard copy and electronically as PDF files. All of the analytical data, including the laboratory QC results, will be submitted as an electronic data deliverable (EDD) in the laboratory's standard Excel format. A separate EDD will also be provided to Ecology/SAIC in SAIC's preferred format.

3.3.5 Storage

Documents and records associated with the project will be stored in electronic form in project files on Landau Associates' servers, and in hard copy in Landau Associates' files for the duration of the project. After completion of the project, hard copy files will be stored at Iron Mountain storage facility for at least 10 years after notification by EPA of completion of the ASAOC requirements.

3.4 DATA GENERATION AND ACQUISITION

This section provides an overview of the data collecting and handling procedures that will be implemented to ensure the integrity of the samples and quality of the resulting data. More details about these processes are included in the FSP (Section 2.0).

3.4.1 Sampling Process Design

The sampling design includes collection of whole water stormwater samples and filtered stormwater solids samples at the lift station to monitor compliance with the STST interim goals identified in Section 1.2, and whole water and filtered solids samples from the STST facility influent and effluent to evaluate the effectiveness of the treatment facility in removing PCBs and solids from the stormwater. These samples will be collected during storm events and during base flow to evaluate the effectiveness of the STST facility under a variety of storm flows. Whole water and filtered solids samples collected from stormwater at MH108 (located downstream of the STST facility) and solids samples from sediment traps located throughout the NBF storm drain system will provide data necessary to support design of a long-term facility.

3.4.2 Sampling Methods

Whole water samples from the lift station and MH108 will be collected using automated samplers. These automated samplers will allow collection of flow-weighted composite whole water samples by collecting aliquots of the stormwater at each location more frequently at high flow rates and less frequently at low flow rates. The flow-weighted composite samples will be more representative of stormwater quality discharging to Slip 4 of the LDW than discrete samples. Solids will be collected from the lift station, MH108 stormwater, and the STST facility influent and effluent using filtration systems. The use of these systems increases the opportunity for collecting adequate solids sample volumes to perform the desired analyses.

Samples submitted to the analytical laboratory for analysis will be collected in the appropriate sample containers. Sample containers for the STST facility whole water influent and effluent grab samples, and the weir tank solid samples, will be provided by the laboratory. Whole water samples collected at the lift station and MH108 will be submitted to the analytical laboratory in pre-purchased 5-gallon glass carboys that are used in conjunction with the whole water automated sampling devices. Carboys will be cleaned between sampling uses by the analytical laboratory. Sediment trap solids will be submitted to the laboratory in the Teflon® containers used to trap sediment. The Teflon® containers will be cleaned between sampling uses by the analytical laboratory. Filtered solids samples will be submitted to the laboratory in the filter placed inside a sealable plastic bag. New filters will be used for each sample and will be pre-weighed and numbered by ARI prior to use.

Any non-dedicated sampling equipment that will be reused will be decontaminated to avoid cross contamination between samples. Decontamination procedures are described in the FSP (Section 2.0)

3.4.3 SAMPLE HANDLING AND CUSTODY

The transportation and handling of samples will be accomplished in a manner that not only protects the integrity of the sample, but also prevents any detrimental effects due to release of samples. Samples will be logged on a chain-of-custody form and will be kept in coolers on ice until delivery to the analytical laboratory. The chain-of-custody will accompany each shipment of samples to the laboratory. The storage temperatures and maximum holding times for physical/chemical analyses, presented in Table 5, will be strictly adhered to during each sampling event. Procedures for sample handling and transportation are described in greater detail in the FSP (Section 2.0).

3.4.4 ANALYTICAL METHODS

The results for the stormwater and solids sampling will be compared to the STST interim goals (0.014 µg/L PCBs in stormwater, 420 µg/kg PCBs in solids, and 10 and 5 mg/L TSS); therefore, the methods used to analyze the samples must be able to detect analyte concentrations equal to or less than the STST interim goals. Laboratory methods and target reporting limits for the analysis of stormwater and stormwater solids that meet that meet these criteria are summarized in Table 3.

3.4.5 QUALITY CONTROL

Field and analytical laboratory control samples will be collected and/or analyzed to evaluate data precision, accuracy, representativeness, completeness, and comparability of the analytical results. A summary of the quality control samples and the frequency at which they will be collected and/or analyzed is described in the following subsections.

3.4.5.1 Blind Field Duplicate

A blind field duplicate stormwater sample will be collected at the STST facility influent during each sampling event conducted concurrent with a lift station sampling event. Each blind field duplicate sample will be analyzed for PCBs and TSS. The stormwater blind field duplicates will be collected by alternately filling sample containers for both the original and the corresponding duplicate sample at the same location to decrease variability between the duplicates. Blind field duplicate sample results will be used to evaluate data precision. Due to limited sample volume, no blind field duplicate solids samples will be collected.

3.4.5.2 Field Equipment Rinsate Blanks

Field equipment rinsate blanks consist of deionized water passed over decontaminated sampling equipment and transferred to sample containers for analysis at the laboratory. Except for the residual solids sampling at the weir tank, all stormwater and solids sampling will be conducted using disposable and/or dedicated equipment, thereby eliminating potential cross contamination between samples or sampling events via sample equipment. No field equipment rinsate blank samples will be collected. Because the residual solids samples are being collected for disposal characterization and are not being collected to meet the sampling objectives, no equipment rinsate blanks will be collected in conjunction with these samples.

3.4.5.3 Laboratory Matrix Spike

One laboratory matrix spike will be collected at the STST facility effluent during each sampling event conducted concurrent with a lift station sampling. Each MS will be analyzed for PCBs. These analyses will be performed to provide information on accuracy and to verify that extraction and concentration levels are acceptable. The laboratory spikes will follow EPA guidance for matrix and blank spikes. Due to limited sample volume, no MS solids samples will be collected.

3.4.5.4 Laboratory Matrix Spike Duplicate

One laboratory MSD will be collected at the STST facility effluent during each sampling event conducted concurrent with a lift station sampling. Each MSD will be analyzed for PCBs. These analyses will be performed to provide information on the precision of chemical analyses. The laboratory spikes will follow EPA guidance for matrix and blank spikes. Due to limited sample volume, no MSD solids samples will be collected.

3.4.5.5 Laboratory Method Blanks

A minimum of 1 laboratory method blank per 20 samples, 1 every 12 hours, or 1 per batch of samples analyzed (if fewer than 20 samples are analyzed) will be analyzed for all parameters (except particle size and total solids) to assess possible laboratory contamination. Dilution water will be used whenever possible. Method blanks will contain all reagents used for analysis. The generation and analysis of additional method, reagent, and glassware blanks may be necessary to verify that laboratory procedures do not contaminate samples.

3.4.6 INSTRUMENT/EQUIPMENT/CONSUMABLES

All field equipment used for this project will be maintained and operated by Boeing or Ecology or their consultant. Maintenance and calibration of the equipment is discussed in the FSP (Section 2.0). The analytical laboratory project manager is responsible for maintaining laboratory instruments in proper working order including routine maintenance and calibration, and training of personnel in maintenance and calibration procedures. Laboratory instruments will be properly calibrated with appropriate check standards and calibration blanks for each parameter before beginning each analysis. Instrument performance check standards, where required, and calibration blank results will be recorded in a laboratory logbook dedicated to each instrument. At a minimum, the preventive maintenance schedules contained in the EPA methods and in the equipment manufacturer's instructions will be followed.

3.4.7 DATA MANAGEMENT

All laboratory analytical results, including QC data, will be submitted in hard copy and electronically. Electronic format will include comma separated value (CSV) files that will be downloaded directly to an Access database. Following validation of the data, any qualifiers will be added to the database.

Hard copies of the laboratory chemical analytical reports will include the following:

- Case narrative, including adherence to prescribed protocols, nonconformity events, corrective measures, and/or data deficiencies
- Sample analytical results
- Surrogate recoveries
- Matrix spike/matrix spike duplicate results
- Blank spike/blank spike duplicate results
- Laboratory duplicates

- Blank results
- Sample receipt forms (including signed, original chain-of-custody records)
- Analytical responsibility.

For those data that a Stage IV data validation will be performed, hard copies of the laboratory chemical analytical reports will be equivalent to an EPA Contract Laboratory Program (CLP) Level IV data package. These packages will include all of the items listed above and the following:

- Initial and continuing calibration raw data
- Instrument raw data (including all associated quantification reports and chromatograms)
- Supporting data (including sample preparation bench sheets)
- Quantitation reports.

3.5 ASSESSMENT AND OVERSIGHT

Assessments used during implementation of the project will include daily communication and updates during field work and data quality review by the Landau Associates' project and task managers. Response actions to assess issues will be coordinated between these managers; the field manager; the project managers for Boeing, EPA, and Ecology; and involved subcontractors, as appropriate.

Although not planned, the EPA QA officer or designee may conduct an audit of the field activities for this project. The auditor will have the authority to stop work upon finding a significant condition that would adversely affect the quality and usability of the data. The Landau Associates' project manager will then have the responsibility for initiating and implementing response actions to address these deficiencies identified by the site audit. Once the response action(s) have been implemented, the EPA QA officer or designee may perform a follow-up audit.

If a QA/QC audit detects unacceptable conditions or data, the Landau Associates' project manager will be responsible for developing and initiating corrective action. Corrective action may include the following:

- Reanalyzing the samples, if holding times can be met
- Resampling and analyzing
- Evaluating and amending sampling and analytical procedures
- Accepting data and acknowledging the level of uncertainty or inaccuracy by flagging the data.

All corrective actions will be documented in writing and will be signed by the project manager and implementing manager.

3.6 DATA VALIDATION AND USABILITY

All stormwater and solids data will be verified and validated to determine the results are acceptable and meet the quality objectives described in Section 3.1 Prior to submitting a laboratory report, the laboratory will verify that all the data are consistent, correct, and complete, with no errors or omissions.

A Stage 2A validation, as defined in EPA's *Guidance for Labeling Externally Validated Laboratory Analytical Data for Superfund Use* (EPA 2009), will be conducted for all of the data except the data collected for samples collected at the lift station and MH108 during one stormwater sampling event. The Stage 2A validation of the data will be performed by Landau Associates following the guidelines in the appropriate sections of the EPA *Contract Laboratory Program National Functional Guidelines for Organic and Inorganic Data Review* (EPA 1999 and 2004) and will include evaluations of the following:

- Chain-of-custody records
- Sample conditions upon receipt at the laboratory (including preservation, pH, and temperature
- Holding times
- Laboratory method blanks
- Surrogate recoveries
- Laboratory matrix spikes and matrix spike duplicates
- Blank spikes/laboratory control samples
- Blind field duplicates
- Laboratory duplicates
- Frequency of QC samples
- Corrective action records
- Completeness
- Overall assessment of data quality.

To determine that there are no systematic errors (i.e., programmatic and electronic errors) associated with the analyses of the samples, a Stage 3 and Stage 4 data validation will be conducted on data for the lift station and MH108 whole water and solids samples from one storm event. The laboratory data obtained from these samples collected during the first storm event will be selected for Stage 3 and Stage 4 data validation to identify systematic errors, if any, so that they can be corrected. If no systematic errors are identified, continuation of Stage 3 and 4 data validation on data collected during subsequent sampling events is not necessary. If systematic errors are identified, Stage 3 and Stage 4 data validation will be conducted on data collected during subsequent sampling events to confirm that the errors have been corrected. The Stage 3 and 4 data validation, as defined in EPA's *Guidance for Labeling Externally*

Validated Laboratory Analytical Data for Superfund Use (EPA 2009), will be conducted by EcoChem, Inc., located in Seattle, Washington. In addition to evaluating the items listed above, instrument quality control and performance (including initial and continuing calibration, tuning, sensitivity, and degradation) will be evaluated and instrument and sample results from the laboratory instrument responses will be recalculated. For methods requiring spectral interpretation and/or chromatography, all required instrument outputs (e.g., chromatograms, mass spectra, instrument background corrections, and interference corrections) will be checked for correct identification and quantitation of analytes. If Ecology decides to perform a Stage 3 and/or Stage 4 data validation on data collected during sampling events conducted after the first sampling event, Boeing will request that the laboratory provide Ecology with adequate documentation for Ecology to perform the validation.

In the event that a portion of the data is outside the specified control limits, or sample collection and/or documentation practices are deficient, corrective action(s) will be initiated. Corrective action, as described in Section 3.6, will be determined by the field coordinator and Landau Associates' QA Officer in consultation with the Landau Associates' project and task managers and may include any of the following:

- Rejection of the data and resampling
- Qualification of the data
- Modified field and/or laboratory procedures.

The results of the data validation will be documented in a technical memorandum and submitted to EPA with project monthly reports. Data qualification arising from data validation activities will be described in a data validation report, rather than in an individual corrective action report, and included in the data base and any tables summarizing the data.

* * * * * * *

This document has been prepared under the supervision and direction of the following key staff.

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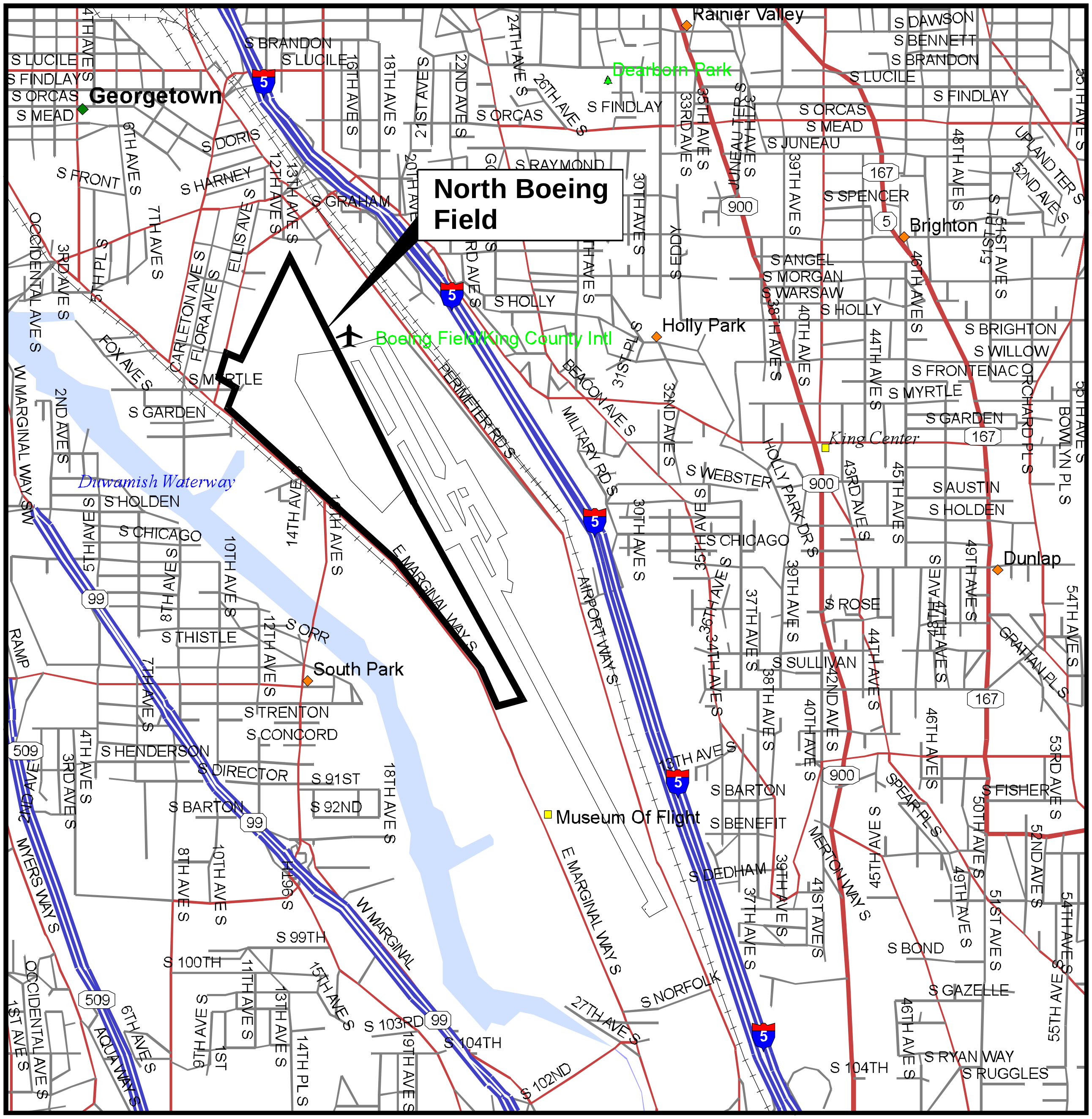

Map from DeLorme Street Atlas USA, 2002

0 ½ 1
Scale in Miles

Flume Realignment| V:\025\082\089\SD Structure & Surface Solids Investigation\Figure 1.cdr 8/29/2009

LANDAU ASSOCIATES

North Boeing Field Seattle, Washington	**Vicinity Map**	Figure 1

Y:\Projects\025082\MapDocs\210\Fig2-SamplingLocations.mxd 11/19/2010 NAD 1983 StatePlane Washington North FIPS 4601 Feet

Legend

- Sediment Trap
- Lift Station
- NBF Storm Drain Structures
- Manhole 108
- Short-Term Stormwater Treatment Facility
- North Lateral Drain Line
- North-Central Lateral Drain Line
- South-Central Lateral Drain Line
- South Lateral Drain Line
- Drainage from Building 3-380 Area
- Drainage from parking lot area

Note

1. Black and white reproduction of this color original may reduce its effectiveness and lead to incorrect interpretation.

Data Source: SAIC

0 160 320

Scale in Feet

LANDAU ASSOCIATES

North Boeing Field
Seattle, Washington

Sampling Locations

Figure
2

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Washington State Department of Ecology

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Martin Valeri/Field Lead - Field lead for performance and site-wide monitoring
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Todd Toland/Superintendent - Treatment system maintenance
Chris Augustine/President - Treatment system administration and contract

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Steve Miles/Project Manager
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425-355-2826

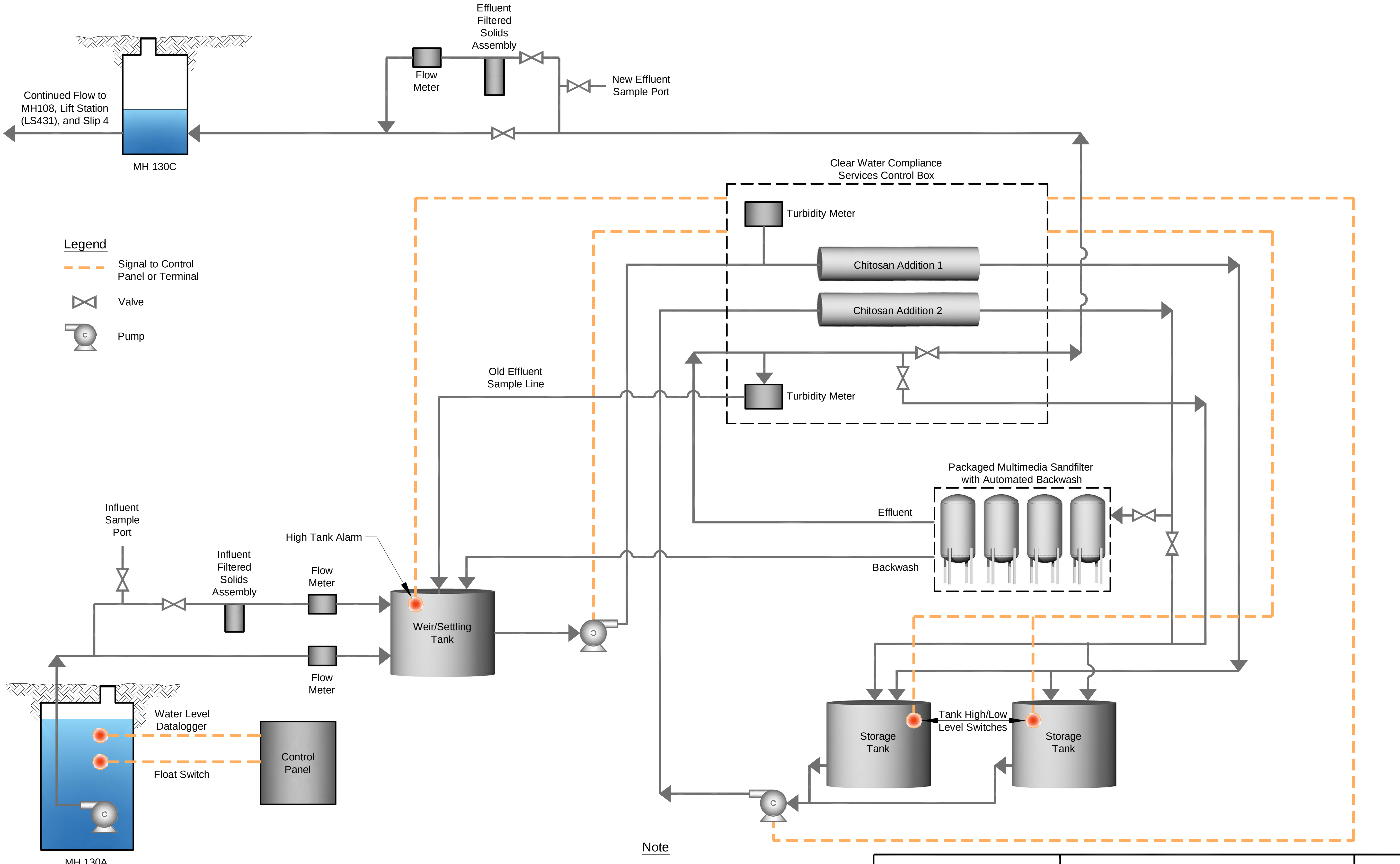
LANDAU ASSOCIATES, INC. | V:\025\082\210\004 design\F-SAP-FINAL-FIG3-CHART.dwg (A) "Figure 3" 12/13/2010

LANDAU ASSOCIATES

North Boeing Field
Seattle, Washington

Removal Action Team - Project Organization Chart

Figure 3



Note

1. Black and white reproduction of this color original may reduce its effectiveness and lead to incorrect interpretation.

LANDAU ASSOCIATES

North Boeing Filed
Seattle, Washington

Short-Term Stormwater Treatment Facility Schematic

Figure 4

TABLE 1
SHORT-TERM REMOVAL ACTION SAMPLING AND ANALYSIS SUMMARY
NORTH BOEING FIELD - SEATTLE, WASHINGTON

Location	Sample Type	Sample Media	Frequency (a)	Parameters (q)	Analytical Methods
Lift Station (LS 431)	Whole Water (b, c, p) (flow-weighted composite)	Stormwater (d)	10 Initial Events (5 storm events and 2 base flow under the ASAOC and 3 additional storm events to provide data for Ecology NBF/GTSP RI/FS), Nov 2010 - April 2011	PCBs	EPA Method 8082
				TSS	SM 2540
			To be Determined (e), starting May 2011	PCBs	EPA Method 8082
				TSS	SM 2540
	Filtered Solids (b, p, q) (in-line stormwater filtration)	Stormwater Solids	10 Initial Events (5 storm events and 2 base flow under the ASAOC and 3 additional storm events to provide data for Ecology NBF/GTSP RI/FS), Nov 2010 - April 2011	PCBs	EPA Method 8082
				TSS	Calculated (f)
				Particle Size Distribution	PSEP-PS
				PCB Concentrations by particle size (m)	EPA Method 8082
			To be Determined (e), starting May 2011	PCBs	EPA Method 8082
				TSS	Calculated (f)
				Particle Size Distribution	PSEP-PS (r)
				PCB Concentrations by particle size (m)	EPA Method 8082
	Bed Load (g)	Residual Solids	5 Storm Events and 2 Base Flow Events	PCBs	EPA Method 8082
Short-Term Stormwater Treatment System	Whole Water Influent (grab)	Stormwater (d)	Weekly (h)	PCBs	EPA Method 8082
				TSS	SM 2540
	Whole Water Effluent (grab)	Stormwater (d)	Weekly (h)	PCBs	EPA Method 8082
				TSS	SM 2540
	Whole Water Effluent (grab) (i)	Stormwater (d)	Weekly (j)	Residual Chitosan	Ecology approved procedure (k)
	Filtered Solids Influent	Stormwater Suspended Solids	Twice monthly (l)	PCBs	EPA Method 8082
				TSS	Calculated (f)
	Filtered Solids Effluent	Stormwater Suspended Solids	Twice monthly (l)	PCBs	EPA Method 8082
				TSS	Calculated (f)
Manhole 108 (MH108) (p)	Whole Water Effluent (b, p) (flow-weighted composite)	Stormwater (d)	5 Storm Events Nov 2010 - February 2011 (h)	PCBs	EPA Method 8082
				TSS	SM 2540
	Filtered Solids (b, p,q) (in-line stormwater filtration)	Stormwater Solids	5 Storm Events Nov 2010 - February 2011 (h)	PCBs	EPA Method 8082
				TSS	Calculated (f)
				Particle Size Distribution	PSEP-PS (r)
				PCB Concentrations by particle size (m)	EPA Method 8082
Sediment Traps (SL4-T1, SL4-T2, SL4-T3, SL4-T4, SL4-T4A, SL4-T5, SL4-T5A)	Grab	Stormwater Solids	Semi-Annually (n)	PCBs	EPA Method 8082
				Semivolatiles	PSDDA SVOCS SW8270D
				Total Metals	Method 6000-7000
				NWTPH-Dx	NWTPH-Dx
				Total Organic Carbon	Plumb, 1981
				Grain Size	PSEP-PS
Weir tank (filter backwash tank)	Grab	Settled Solids	As Needed (o)	PCBs	EPA Method 8082
				PAHs	SW8270D
				metals	TCLP and/or Method 6000-7000
				Petroleum Hydrocarbons	NWTPH-Dx and NWTPH-Gx

TABLE 1
SHORT-TERM REMOVAL ACTION SAMPLING AND ANALYSIS SUMMARY
NORTH BOEING FIELD - SEATTLE, WASHINGTON

Location	Sample Type	Sample Media	Frequency (a)	Parameters (q)	Analytical Methods

(a) Monitoring plan beginning November 2010. All sampling and analysis will be performed by Boeing/Landau Associates and Boeing's contract laboratory, unless otherwise noted.
(b) Boeing is coordinating with the Washington State Department of Ecology and their consultant SAIC for sampling at the lift station and Manhole 108.
Samples may be collected by either Boeing/Landau Associates or Ecology/SAIC.
(c) During three events, Ecology/SAIC will collect whole water samples at the lift station using centrifuge method (Green River) and submit the samples for PCB analysis .
(d) Stormwater is defined as all liquids, including any particles dissolved therein, in the form of base flow, storm water runoff, snow melt runoff, and drainage, as well as all solids which enter the storm drain system.
(e) Boeing will propose to EPA a sampling frequency of monthly or quarterly based on the results from the initial 10 sampling events.
(f) Calculated based on mass of filtered solids and volume of stormwater filtered.
(g) The feasible location(s) for installation and specific type of bed load sampling unit is still being determined.
(h) The five Manhole 108 stormwater and solids sampling events and at least five of the weekly influent/ effluent sampling events will be performed concurrent with the lift station storm sampling events. Whether or not weir overflow occurred (i.e., treatment system bybass) during the sampling period will be recorded.
(i) Whole water effluent grab samples for Residual Chitosan testing will be collected from the treatment facility effluent sample port by Clear Water Compliance Services.
(j) Because of the uniform low turbidity of the NBF stormwater relative to the typical chitosan effluent sand filtration (CESF) construction site projects, the fact that residual chitosan has never been detected in sand filter effluent from this project, and because of the extremely low probability of chitosan passing through the sand filters, residual chitosan is proposed to be conducted weekly.
(k) Per Clear Water O&M Manual, Ecology approves procedures for residual chitosan testing for each distributor of chitosan acetate. Testing will be conducted in accordance with the distributors approved procedures.
(l) The influent and effluent flow rate will be checked twice monthly. If the flow rate is low enough to suggest adequate amount of solids have collected on the filter, a filtered solids sample will be collected and analyzed.
(m) It is expected that there will be adequate quantity of solids for particle size distribution analysis, but there may not be an adequate amount of solids for the laboratory to analyze PCBs within selected particle size fractions.
(n) Sediment traps were installed November 12, 2010. The traps will be collected and replaced in April 2011. Depending on the quantity of solids collected, the laboratory may not be able to analyze all parameters. Analysis of parameters will be prioritized in the order listed.
(o) The thickness of accumulated solids (sludge) in the weir tank will be checked monthly by Clear Water Compliance Services. If more than an average of 12 inches of solids have accumulated a grab sample of the solids will be collected by Boeing/Landau Associates and analyzed for waste characterization purposes. Similar testing would be done of filter sand prior to disposal.
(p) Lift station and Manhole 108 whole water samples will also be analyzed for metals (arsenic, cadmium, chromium, copper, lead, mercury, silver, and zinc), SVOCs, and TOC and other conventionals in accordance with the Ecology/SAIC storm system sampling work plan and addenda (SAIC 2009, 2010b, 2010c) if sufficient volume is available.
Lift station and Manhole 108 solids samples will also be analyzed for metals (arsenic, cadmium, chromium, copper, lead, mercury, silver, and zinc), PAHs, and dioxins/furans in accordance with the Ecology/SAIC storm system sampling work plan and addenda (SAIC 2009, 2010b, 2010c) if sufficient volume is available.
(q) Analyses will be performed if sufficient sample volume is collected. The priority for analysis of samples if insufficient sample volume is collected is summarized in Table 4.
(r) Grain size fractionation/particle size distribution will be conducted using Puget Sound Estuary Protocols (PSEP) method. When low volumes of sample are collected, grain size fractionation will be accomplished using sedigraph for material less than 62.5 µm.

TABLE 2
SAMPLING DEVICES AND OWNERSHIP
SHORT-TERM STORMWATER TREATMENT FACILITY SAMPLING
NORTH BOEING FIELD
SEATTLE, WASHINGTON

Sampling Location	Sampling Device	Owner
Lift Station	ISCO Model 671 Automated Sampler	Boeing
	ISCO Model 750 Area Velocity Flow Meter	Boeing
	Glass 5-gal carboys	Boeing
	Miscellaneous equipment associated with automated sampler (tubing, expanding rings, stainless steel strainer)	Boeing
	Solids filter assemblies	SAIC
	Flow meter associated with filter solids sample collection	SAIC
	Submersible pump	SAIC
	Miscellaneous equipment associated with filtered solids sampling (pipes, pipe fittings, flow switches)	SAIC
	Weatherproof shed for housing equipment	SAIC
MH108	ISCO Model 671 Automated Sampler	Boeing
	ISCO Model 4250 Area Velocity Flow Meter	Boeing
	Glass 5-gal carboys	Boeing
	Miscellaneous equipment associated with automated sampler (tubing, epanding rings, stainless steel strainer)	Boeing
	Solids filter assemblies	SAIC
	Flow meter associated with filter solids sample collection	SAIC
	Submersible pump	SAIC
	Miscellaneous equipment associated with filtered solids sampling (pipes, pipe fittings, flow switches)	SAIC
	Weatherproof shed for housing equipment	SAIC
Short-Term Stormwater Treatment Facility	Solids filter assemblies	Boeing
	Flow meter associated with filtered solids sample collection	Boeing
	Submersible pump	Boeing
	Miscellaneous equipment associated with filtered solids sampling (pipes, pipe fittings, flow switches)	Boeing

TABLE 3
ANALYTICAL METHODS AND TARGET REPORTING LIMITS
SHORT-TERM STORMWATER TREATMENT FACILITY SAMPLING
NORTH BOEING FIELD
SEATTLE, WASHINGTON

	Analytical	Target Reporting Limits (b)		
			Filtered	Unfiltered
Analyte	**Method (a)**	**Water**	**Solids**	**Solids**
PCBs				
Aroclor 1016	EPA Method 8082 (c)	0.01 µg/L	5 µg	10 µg/kg
Aroclor 1221	EPA Method 8082 (c)	0.01 µg/L	5 µg	10 µg/kg
Aroclor 1232	EPA Method 8082 (c)	0.01 µg/L	5 µg	10 µg/kg
Aroclor 1242	EPA Method 8082 (c)	0.01 µg/L	5 µg	10 µg/kg
Aroclor 1248	EPA Method 8082 (c)	0.01 µg/L	5 µg	10 µg/kg
Aroclor 1254	EPA Method 8082 (c)	0.01 µg/L	5 µg	10 µg/kg
Aroclor 1260	EPA Method 8082 (c)	0.01 µg/L	5 µg	10 µg/kg
Arolclor 1262	EPA Method 8082 (c)	0.01 µg/L	5 µg	--
CONVENTIONALS				
Total Suspended Solids	SM 2540	1 mg/L	--	--
Total Organic Carbon	Plumb 1981	--	--	0.02 percent
GRAIN SIZE				
Grain Size	PSEP-PS	--	--	--
Total Petroleum Hydrocarbons				
Diesel-Range	NWTPH-Dx (d,e)	--	--	5.0 mg/kg
Motor Oil-Range	NWTPH-Dx (d,e)	--	--	10.0 mg/kg
Gasoline-Range	NWTPH-Gx (d)	--	--	5.0 mg/kg
METALS				
Arsenic	EPA Method 6010	--	--	5.0 mg/kg
Copper	EPA Method 6010	--	--	0.2 mg/kg
Lead	EPA Method 6010	--	--	2.0 mg/kg
Mercury	EPA Method 7471	--	--	0.1 mg/kg
Zinc	EPA Method 6010	--	--	1.0 mg/kg
			--	
TCLP METALS				
Arsenic	EPA Method 1311/6010	0.2 mg/L	--	--
Barium	EPA Method 1311/6010	0.2 mg/L	--	--
Cadmium	EPA Method 1311/6010	0.01 mg/L	--	--
Chromium	EPA Method 1311/6010	0.02 mg/L	--	--
Lead	EPA Method 1311/6010	0.1 mg/L	--	--
Mercury	EPA Method 1311/7471	0.0001 mg/L	--	--
Selenium	EPA Method 1311/6010	0.2 mg/L	--	--
Silver	EPA Method 1311/6010	0.02 mg/L	--	--

TABLE 3
ANALYTICAL METHODS AND TARGET REPORTING LIMITS
SHORT-TERM STORMWATER TREATMENT FACILITY SAMPLING
NORTH BOEING FIELD
SEATTLE, WASHINGTON

Analyte	Analytical Method (a)	Target Reporting Limits (b) Water	Filtered Solids	Unfiltered Solids
PAHs				
Naphthalene	EPA Method 8270D	--	--	67 µg/kg
2-Methylnaphthalene	EPA Method 8270D	--	--	67 µg/kg
Acenaphthylene	EPA Method 8270D	--	--	67 µg/kg
Acenaphthene	EPA Method 8270D	--	--	67 µg/kg
Dibenzofuran	EPA Method 8270D	--	--	67 µg/kg
Fluorene	EPA Method 8270D	--	--	67 µg/kg
Phenanthrene	EPA Method 8270D	--	--	67 µg/kg
Anthracene	EPA Method 8270D	--	--	67 µg/kg
Fluoranthene	EPA Method 8270D	--	--	67 µg/kg
Pyrene	EPA Method 8270D	--	--	67 µg/kg
Benzo(a)anthracene	EPA Method 8270D	--	--	67 µg/kg
Chrysene	EPA Method 8270D	--	--	67 µg/kg
Benzo(b,k)fluoranthene	EPA Method 8270D	--	--	67 µg/kg
Benzo(a)pyrene	EPA Method 8270D	--	--	67 µg/kg
Indeno(1,2,3-cd)pyrene	EPA Method 8270D	--	--	67 µg/kg
Dibenz(a,h)anthracene	EPA Method 8270D	--	--	67 µg/kg
Benzo(g,h,i)perylene	EPA Method 8270D	--	--	67 µg/kg
1-Methylnaphthalene	EPA Method 8270D	--	--	67 µg/kg
SEMIVOLATILES				
Phenol	PSDDA SW 8270	--	--	20 µg/kg
Bis-(2-Chloroethyl) Ether	PSDDA SW 8270	--	--	20 µg/kg
2-Chlorophenol	PSDDA SW 8270	--	--	20 µg/kg
1,3-Dichlorobenzene	PSDDA SW 8270	--	--	20 µg/kg
1,4-Dichlorobenzene	PSDDA SW 8270	--	--	20 µg/kg
Benzyl Alcohol	PSDDA SW 8270	--	--	20 µg/kg
1,2-Dichlorobenzene	PSDDA SW 8270	--	--	20 µg/kg
2-Methylphenol	PSDDA SW 8270	--	--	20 µg/kg
2,2'-Oxybis(1-Chloropropane)	PSDDA SW 8270	--	--	100 µg/kg
4-Methylphenol	PSDDA SW 8270	--	--	20 µg/kg
N-Nitroso-Di-N-Propylamine	PSDDA SW 8270	--	--	20 µg/kg
Hexachloroethane	PSDDA SW 8270	--	--	20 µg/kg
Nitrobenzene	PSDDA SW 8270	--	--	100 µg/kg
Isophorone	PSDDA SW 8270	--	--	20 µg/kg
2-Nitrophenol	PSDDA SW 8270	--	--	200 µg/kg
2,4-Dimethylphenol	PSDDA SW 8270	--	--	20 µg/kg
Benzoic Acid	PSDDA SW 8270	--	--	100 µg/kg
bis(2-Chloroethoxy) Methane	PSDDA SW 8270	--	--	20 µg/kg
2,4-Dichlorophenol	PSDDA SW 8270	--	--	20 µg/kg
1,2,4-Trichlorobenzene	PSDDA SW 8270	--	--	100 µg/kg
Naphthalene	PSDDA SW 8270	--	--	20 µg/kg
4-Chloroaniline	PSDDA SW 8270	--	--	100 µg/kg
Hexachlorobutadiene	PSDDA SW 8270	--	--	20 µg/kg
4-Chloro-3-methylphenol	PSDDA SW 8270	--	--	20 µg/kg
1-Methylnaphthalene	PSDDA SW 8270	--	--	100 µg/kg
2-Methylnaphthalene	PSDDA SW 8270	--	--	100 µg/kg
Hexachlorocyclopentadiene	PSDDA SW 8270	--	--	100 µg/kg
2,4,6-Trichlorophenol	PSDDA SW 8270	--	--	20 µg/kg
2,4,5-Trichlorophenol	PSDDA SW 8270	--	--	100 µg/kg
2-Chloronaphthalene	PSDDA SW 8270	--	--	20 µg/kg
2-Nitroaniline	PSDDA SW 8270	--	--	20 µg/kg
SEMIVOLATILES				
Dimethylphthalate	PSDDA SW 8270	--	--	100 µg/kg

TABLE 3
ANALYTICAL METHODS AND TARGET REPORTING LIMITS
SHORT-TERM STORMWATER TREATMENT FACILITY SAMPLING
NORTH BOEING FIELD
SEATTLE, WASHINGTON

		Target Reporting Limits (b)		
Analyte	**Analytical Method (a)**	**Water**	**Filtered Solids**	**Unfiltered Solids**
Acenaphthylene	PSDDA SW 8270	--	--	20 µg/kg
3-Nitroaniline	PSDDA SW 8270	--	--	200 µg/kg
Acenaphthene	PSDDA SW 8270	--	--	100 µg/kg
2,4-Dinitrophenol	PSDDA SW 8270	--	--	20 µg/kg
4-Nitrophenol	PSDDA SW 8270	--	--	100 µg/kg
Dibenzofuran	PSDDA SW 8270	--	--	100 µg/kg
2,6-Dinitrotoluene	PSDDA SW 8270	--	--	20 µg/kg
2,4-Dinitrotoluene	PSDDA SW 8270	--	--	20 µg/kg
Diethylphthalate	PSDDA SW 8270	--	--	100 µg/kg
4-Chlorophenyl-phenylether	PSDDA SW 8270	--	--	200 µg/kg
Fluorene	PSDDA SW 8270	--	--	20 µg/kg
4-Nitroaniline	PSDDA SW 8270	--	--	100 µg/kg
4,6-Dinitro-2-Methylphenol	PSDDA SW 8270	--	--	20 µg/kg
N-Nitrosodiphenylamine	PSDDA SW 8270	--	--	20 µg/kg
4-Bromophenyl-phenylether	PSDDA SW 8270	--	--	100 µg/kg
Hexachlorobenzene	PSDDA SW 8270	--	--	20 µg/kg
Pentachlorophenol	PSDDA SW 8270	--	--	20 µg/kg
Phenanthrene	PSDDA SW 8270	--	--	20 µg/kg
Carbazole	PSDDA SW 8270	--	--	20 µg/kg
Anthracene	PSDDA SW 8270	--	--	20 µg/kg
Di-n-Butylphthalate	PSDDA SW 8270	--	--	20 µg/kg
Fluoranthene	PSDDA SW 8270	--	--	20 µg/kg
Pyrene	PSDDA SW 8270	--	--	100 µg/kg
Butylbenzylphthalate	PSDDA SW 8270	--	--	20 µg/kg
3,3'-Dichlorobenzidine	PSDDA SW 8270	--	--	20 µg/kg
Benzo(a)anthracene	PSDDA SW 8270	--	--	20 µg/kg
bis(2-Ethylhexyl)phthalate	PSDDA SW 8270	--	--	20 µg/kg
Chrysene	PSDDA SW 8270	--	--	20 µg/kg
Benzo(b,k)fluoranthene	PSDDA SW 8270	--	--	20 µg/kg
Di-n-Octyl phthalate	PSDDA SW 8270	--	--	20 µg/kg
Benzo(a)pyrene	PSDDA SW 8270	--	--	20 µg/kg
Indeno(1,2,3-cd)pyrene	PSDDA SW 8270	--	--	20 µg/kg
Dibenz(a,h)anthracene	PSDDA SW 8270	--	--	20 µg/kg
Benzo(g,h,i)perylene	PSDDA SW 8270	--	--	20 µg/kg

SM = Standard Method
(a) Analytical methods are from SW-846 (EPA 1986) and upddates unless otherwise noted. Additional analyses may also be performed in accordance with the Ecology/SAIC storm system sampling work plan and addenda (SAIC 2009, 2010b, 2010c)
(b) Reporting limits goals are based on current laboratory data and may be modified during the investigation process as methodology is refined. Laboratory reporting will be based on the lowest standard on the calibration curve. Instances may arise where high sample concentrations, nonhomogeneity of samples, or matrix interferences preclude achieving the desired reporting limits.
(c) Unfiltered solids will be analyzed by PSDDA Method 8082.
(d) Methods NWTPH-Dx and NWTPH-Gx as described in *Analytical Methods for Petroleum Hydrocarbons* Washington State Department of Ecology, Publication ECY97-602, June 1997 (Ecology 1997)
(e) An acid silica gel cleanup cleanup will be performed for all NWTPH-Dx analyses.

TABLE 4
LIFT STATION AND MANHOLE 108 FILTERED SOLIDS SAMPLE ANALYSIS PRIORITY
SHORT-TERM STORMWATER TREATMENT FACILITY SAMPLING
NORTH BOEING FIELD
SEATTLE, WASHINGTON

		Analyses	
Event	**Priority**	**Filter Bag A**	**Filter Bag B**
Events with PAH Analysis	1	PCBs	Metals (including mercury)
	2	--	PAHs
	3	--	Grain Size
Events with Dioxin/Furan Analysis	1	Dioxin/Furans	PCBs
	2	--	Metals (including mercury)
	3	--	Grain Size

TABLE 5
SAMPLE CONTAINERS, PRESERVATIVES, AND HOLDING TIME REQUIRMENTS
SHORT-TERM STORMWATER TREATMENT FACILITY SAMPLING
NORTH BOEING FIELD
SEATTLE, WA

	Analytical	Lift Station and Manhole 108 Whole Water Stormwater Samples				Lift Station and Manhole 108 Solids Samples				Stormwater Treatment Facility Whole Water Influent/Effluent Samples				Stormwater Treatment Facility Influent/Effluent Solids			
Analyte	Method	Volume Required	Container	Preservation	Holding Time	Volume Required	Container	Preservation	Holding Time	Volume Required	Container	Preservation	Holding Time	Volume Required	Container	Preservation	Holding Time
PCBs	EPA SW8082/PSDAA 8082	2 Liters	5-gallon glass carboy	Store cool at 6^{o}C	7 days after they are churn split	8 oz.	Filter Bag	Store cool at 6^{o}C	14 days	1 Liter	1 Liter Amber Glass	Store cool at 6^{o}C	7 days after they are churn split	Volume collected in bag will be used	Filter Bag	Store cool at 6^{o}C	14 days
TSS	SM 2540 D-97	I Liter		Store cool at 6^{o}C	7 days after they are churn split	-- (a)	-- (a)	-- (a)	-- (a)	I Liter	1 L HDPE	Store cool at 6^{o}C	7 days after they are churn split	-- (a)	-- (a)	-- (a)	-- (a)
Particle Size Distribution	PSEP-PS	--	--	--	--	7 oz	Filter Bag	Store cool at 6^{o}C	no hold time	--	--	--	--	--	--	--	--
PCB concentration by particle size	EPA SW8082	--	--	--	--	8 oz.		Store cool at 6^{o}C	14 days	--	--	--	--	--	--	--	--
Diesel-range and motor-oil range petroleum hydrocarbons	NWTPH-Dx	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Gasoline-Range Petroleum Hydrocarbons	NWTPH-Gx	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
PAHs	EPA SW8270D	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Total Organic Carbon	Plumb, 1981	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
SVOCs	PSDDA SW8270D	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
TCLP Metals	EPA 6010/7470																
Total Metals	EPA SW6010	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Mercury	EPA SW7471	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--

TABLE 5
SAMPLE CONTAINERS, PRESERVATIVES, AND HOLDING TIME REQUIRMENTS
SHORT-TERM STORMWATER TREATMENT FACILITY SAMPLING
NORTH BOEING FIELD
SEATTLE, WA

	Analytical	Sediment Traps				Weir Tank and Sand Filtration Units Residual Solids			
Analyte	Method	Volume Required	Container	Preservation	Holding Time	Volume Required	Container	Preservation	Holding Time
PCBs	EPA SW8082/PSDAA 8082	N/A	Teflon Bottle	Store cool at 6°C	14 days	8 oz.	8 oz. WMG	Store cool at 6°C	14 days
TSS	SM 2540 D-97	--	--	--	--	--	--	--	--
Particle Size Distribution	PSEP-PS	--	--	--	--	--	--	--	--
PCB concentration by particle size	EPA SW8082	--	--	--	--	--	--	--	--
Diesel-range and motor-oil range petroleum hydrocarbons	NWTPH-Dx	N/A	Teflon Bottle	Store cool at 6°C	14 days	8 oz.	8 oz. WMG	Store cool at 6°C	14 days
Gasoline-Range Petroleum Hydrocarbons	NWTPH-Gx	--	--	--	--	2 oz.	2 oz. WMGS (1)	Store cool at 6°C	14 days
PAHs	EPA SW8270D	--	--	--	--	8 oz.	8 oz. WMG	Store cool at 6°C	14 days
Total Organic Carbon	Plumb, 1981	N/A	Teflon Bottle	Store cool at 4°C	14 days	--	--	--	--
SVOCs	PSDDA SW8270D	N/A	Teflon Bottle	Store cool at 6°C	14 days	--	--	--	--
TCLP Metals	EPA 6010/7470	--	--	--	--	8 oz	8 oz. WMG	Store cool at 6°C	180 Days
Total Metals	EPA SW6010	N/A	Teflon Bottle	Store cool at 6°C	180 Days	--	--	--	--
Mercury	EPA SW7471	N/A	Teflon Bottle	Store cool at 6°C	28 days	--	--	--	--

Total Metals = Arsenic, Cadmium, Chromium, Copper, Lead, Mercury, and Zinc
TCLP Metals = Arsenic, Barium, Cadmium, Chromium, Lead, Mercury Selenium, Silver
TCLP = Toxicity Characteristic Leachate Procedure
PCB = Polychlorinated biphenyl
PAH = Polycyclic aromatic hydrocarbon
SVOC = Semivolatile organic compound

oz. = ounce
AG = amber glass boston round bottle
HDPE = High Density Polypropylene
WMG = wide mouth glass jar
WMGS = wide mouth glass jar with septa lid

(a) The laboratory will report the mass of filtered solids and TSS will be calculated based on the mass reported and the volume of stormwater filtered.

Note:
1. No headspace.

APPENDIX D

Health and Safety Plans

Landau Associates HASP

LANDAU ASSOCIATES
ENVIRONMENTAL | GEOTECHNICAL | NATURAL RESOURCES

WORK LOCATION PERSONNEL PROTECTION AND SAFETY EVALUATION FORM

Attach Pertinent Documents/Data
Fill in Blanks As Appropriate

Job No.:	025082.210.002		
Prepared by:	Ken Reid	Reviewed by:	Chris Kimmel
Date:	September 8, 2008	Date:	September 10, 2008
Updated by:	Colette Griffith	Reviewed by:	Kristy Hendrickson
Date:	June 25, 2010	Date:	June 25, 2010
Updated by:	Kristy Hendrickson	Reviewed by:	Chris Kimmel
Date:	August 27, 2010	Date:	August 29, 2010

A. WORK LOCATION DESCRIPTION

1. **Project Name:** Boeing – North Boeing Field (NBF)
2. **Location:** Seattle, Washington
3. **Anticipated Activities:** Collecting subsurface soil samples using direct-push methods and hand-auger techniques, collecting samples from storm drain structures, collecting wipe samples, performing surface cleaning of asphalt and concrete material, removing asphalt, excavating soil, collecting samples from stormwater treatment facility, building material sampling.
4. **Size:** Approximately 10 Acres
5. **Surrounding Population:** Industrial, some commercial
6. **Buildings/Homes/Industry:** Industrial and commercial
7. **Topography:** Mostly flat, sloping gently to the west
8. **Anticipated Weather:** Possible rain, 30 to 80 degrees F.
9. **Unusual Features:** None, possible metal, brick, or wood in subsurface.
10. **Site History:** PCBs have been found in or near NBF, at the adjacent Georgetown Steam Plant, and in the sediments of Slip 4. Activities on or near the NBF property include various industrial activities and aircraft landing and taxiing.

B. HAZARD DESCRIPTION

1. Background Review: ☒ Complete ☐ Partial

If partial, why?

2. Hazardous Level: ☐ B ☐ C ☒ D ☐ Unknown

Justification: Past work at site: Numerous investigations in and around the North Boeing Field.

3. Types of Hazards: (Attach additional sheets as necessary)

A. ☒ Chemical ☒ Inhalation ☐ Explosive
☐ Biological ☒ Ingestion ☐ O2 Def. ☒ Skin Contact

Describe: Contact with contaminated soil, groundwater, surface water, or sediment. Inhalation of dust or vapors. Ingestion of dust.

B. ☒ Physical ☒ Cold Stress ☒ Noise ☒ Heat Stress ☐ Other

Describe: Hazards associated with work around heavy machinery, including street sweeping vehicles and excavation equipment. Special care must be taken (i.e., placement of reflective cones) when working near or around open storm drain structures to prevent trips and falls. Depending on the weather conditions, heat stress or cold stress may be a factor.

C. ☐ Radiation

Describe:

4. Nature of Hazards:

☒ Air	Describe: Dust from contaminated soil and solids (once dry).
☒ Soil/Sediment	Describe: Dermal contact with or ingestion of contaminated soil and solids.
☒ Surface Water	Describe: Dermal contact with or ingestion of contaminated water in storm drain structures or decontamination water.
☒ Groundwater	Describe: Dermal contact with or ingestion of contaminated groundwater or decontamination water.
☐ Other	Describe:

5. Chemical Contaminants of Concern ☐ N/A

Contaminant	Hazards Encountered Upland or Offshore?	PEL-TWA (mg/cu.m)	I.D.L.H. (mg/cu.m)	Source/Quantity Characteristics	Route of Exposure	Symptoms of Acute Exposure	Instruments Used to Monitor Contaminant
PCBs	Soil and storm drain system solids	0.001	5	Concentrations in soil and solids from non-detect to greater than 50 parts per million (ppm)	Dust Inhalation, Ingestion, Dermal Contact, Absorption	Eye irritation, liver damage, carcinogen	N/A
PAHs	Soil and storm drain system solids	0.2	Unknown	Possible fuel releases	Inhalation, Absorption, Dermal Contact	Dermatitis, bronchitis, carcinogen	N/A
Bis [2-ethylhexyl] phthalate	Soil and storm drain system solids	5.0 ppm	10.0 ppm	Possible fuel releases, or stormwater discharges	Inhalation, Ingestion, Dermal Contact, Absorption	Eye irritation, mucous membranes, liver damage, teratogen, carcinogen	N/A

6. Physical Hazards of Concern ☐ N/A

Hazard	Description	Location	Procedures Used to Monitor Hazard
Falling	Falls or trips into open storm drain structures	At the edges of storm drain structures	Do not leave storm drain structures open and unattended. Use reflective cones near the edges of open storm drain structures
Drilling Equipment	Falling or swinging objects, flying debris, rotating augers	At the back of the probe rig within about a 10-ft radius.	Be observant. Minimize time spent close to the probe rig.
Excavation Equipment	Crushing by machinery, flying debris	Within the swing radius of equipment and proximity to moving parts	Be observant. Minimize time spent close to the excavation machinery.
Aircraft	Work locations may be near flight line where moving aircraft may be present.	Near the flight line at North Boeing Field.	Be observant. Minimize time spent near the flight line. Do not enter flight line areas without proper escorts.

7. Work Location Instrument Readings ☒ N/A

Location: ____________________

Percent O_2: ____________________ Percent LEL: ____________________

Radioactivity: ____________________ PID: ____________________

FID: ____________________ Other: ____________________

Other: ____________________ Other: ____________________

Other: ____________________ Other: ____________________

Location: ____________________

Percent O_2: ____________________ Percent LEL: ____________________

Radioactivity: ____________________ PID: ____________________

FID: ____________________ Other: ____________________

Other: ____________________ Other: ____________________

Other: ____________________ Other: ____________________

Location: ____________________

Percent O_2: ____________________ Percent LEL: ____________________

Radioactivity: ____________________ PID: ____________________

FID: ____________________ Other: ____________________

Other: ____________________ Other: ____________________

Other: ____________________ Other: ____________________

Location: ____________________

Percent O_2: ____________________ Percent LEL: ____________________

Radioactivity: ____________________ PID: ____________________

FID: ____________________ Other: ____________________

Other: ____________________ Other: ____________________

Other: ____________________ Other: ____________________

8. Hazards Expected In Preparation For Work Assignment ☒ N/A

<u>Describe:</u>

C. PERSONAL PROTECTIVE EQUIPMENT

1. Level of Protection During *Sediment Sampling and Processing Activities and Oversight of Contractor Cleaning Activities*

☐ A ☐ B ☐ C ☒ D

Location/Activity: All

2. Protective Equipment During *Soil Sampling* (specify probable quantity required)

Respirator ☐ N/A

☐ SCBA, Airline
☐ Full-Face Respirator
☐ Half-Face Respirator
☐ Escape mask
☐ None
☐ Other:
☐ Other:

Clothing ☐ N/A

☐ Fully Encapsulating Suit
☐ Chemically Resistant Splash Suit
☐ Apron, Specify:
☐ Tyvek Coverall or Raingear
☐ Saranex Coverall
☐ Coverall, Specify
☐ Other: life jacket while on boat

Head & Eye ☐ N/A

☒ Hard Hat
☐ Goggles
☐ Face Shield
☒ Safety Eyeglasses
☐ Other:

Hand Protection ☐ N/A

☒ Undergloves; Type: Nitrile
☐ Gloves; Type: Solvex
☐ Overgloves; Type:
☐ None
☐ Other:

Foot Protection ☐ N/A

☒ Neoprene Safety Boots with Steel Toe/Shank
☐ Disposable Over-boots
☒ Other: Steel Toe Work Boots

3. Monitoring Equipment ☐ N/A

☐ CGI
☐ O^2 Meter
☐ Rad Survey
☐ Detector Tubes (optional)

☐ PID
☐ FID
☐ Other

Type:

D. PERSONNEL DECONTAMINATION (ATTACH DIAGRAM)

☒ Required- Soap and Water - Hands ☐ Not Required

EQUIPMENT DECONTAMINATION

☒ Required ☐ Not Required

If required, describe and list equipment:
Any non-disposable sampling equipment will be washed with tap water and Alconox, and rinsed with tap water, prior to each use.

E. PERSONNEL

	Name	Work Location Title/Task	Medical Current	Fit Test Current
1.	**Colette Griffith**	**Senior Staff Engineer**	☒	☒
2.	**Alan Starr**	**Senior Technician**	☒	☒
3.	**Martin Valeri**	**Staff Engineer**	☒	☒
4.	**Chris Burke**	**Senior Staff Hydrogeologist**	☒	☒
5.	**Christophe Venot**	**Staff Scientist**	☒	☒
6.	**Susan Dickerson**	**Intern Geologist**	☒	☒
7.			☐	☐
8.			☐	☐
9.			☐	☐
10.			☐	☐

Site Safety Coordinator: Alan Starr or other employee listed above, depending on activity

F. ACTIVITIES COVERED UNDER THIS PLAN

Task No.	Description	Preliminary Schedule
1	Surface and soil cleanup	Spring 2010
2	Storm drain structure sampling events	Spring – Summer 2010
3	Storm drain structure cleaning	Spring – Fall 2010
4	Soil and groundwater investigation	Summer – Fall 2010
5	Human Health Risk Assessment and Transport Evaluation for PCBs in Concrete Joint Material sampling	Fall 2010
6	Short-term stormwater treatment compliance sampling	Fall 2010 – Spring 2011

G. SUBCONTRACTOR'S HEALTH AND SAFETY PROGRAM EVALUATION ☐ N/A

Name and Address of Subcontractor: Cascade Drilling
PO Box 1184
Woodinville, WA 98072

EVALUATION CRITERIA

Item	Adequate	Inadequate	Comments
Medical Surveillance Program	☒	☐	
Personal Protective Equipment Availability	☒	☐	
Onsite Monitoring Equipment Availability	☒	☐	
Safe Working Procedures Specification	☒	☐	
Training Protocols	☒	☐	
Ancillary Support Procedures (if any)	☒	☐	
Emergency Procedures	☒	☐	
Evacuation Procedures Contingency Plan	☒	☐	
Decontamination Procedures Equipment	☒	☐	
Decontamination Procedures Personnel	☒	☐	

GENERAL HEALTH AND SAFETY PROGRAM EVALUATION: ☒ Adequate ☐ Inadequate

Additional Comments: Review based on terms of Basic Subcontractor Agreement with Landau Associates, previous experience with subcontractor, and subcontractor's experience at the site.

Evaluation Conducted By: ______________________________ Date: ______________

EMERGENCY FACILITIES AND NUMBERS

Hospital:
Harborview Medical Center
325 9th Ave, Seattle, WA
Seattle, WA 98104
(206) 744-3000

Telephone:
Boeing Emergency Line (if on Boeing property) – 206-655-222
Emergency Transportation Systems (Fire, Police, Ambulance) – 911
Harborview Medical Center – 206-744-3000

Emergency Routes – Map (Attached)

Emergency Contacts:

Landau Associates Project Manager (Kristy Hendrickson)	425-778-0907
Boeing Environmental Affairs Project Contact (Carl Bach)	206-898-0438

<u>In the event of an emergency, do the following:</u>

1. Call for help as soon as possible. Call 911. Give the following information:
   - WHERE the emergency is – use cross streets or landmarks
   - PHONE NUMBER you are calling from
   - WHAT HAPPENED – type of injury
   - WHAT is being done for the victim(s)
   - YOU HANG UP LAST – let the person you called hang up first.
2. If the victim can be moved, paramedics will transport to the hospital. If the injury or exposure is not life threatening, decontaminate the individual first. If decontamination is not feasible, wrap the individual in a blanket or sheet of plastic prior to transport.
3. Notify the Landau Associates project manager.
4. Notify the Boeing Environmental Affairs Project Contact.

HEALTH AND SAFETY PLAN
APPROVAL/SIGN OFF FORMAT

I have read, understood, and agreed with the information set forth in this Health and Safety Plan (and attachments) and discussed in the Personnel Health and Safety briefing.

Name	Signature	Date
Name	Signature	Date
Name	Signature	Date
Name	Signature	Date
Name	Signature	Date
Site Safety Coordinator	Signature	Date
Christine Kimmel Landau Health and Safety Manager	Signature	Date
Project Manager	Signature	Date

Personnel Health and Safety Briefing Conducted By:

Name	Signature	Date

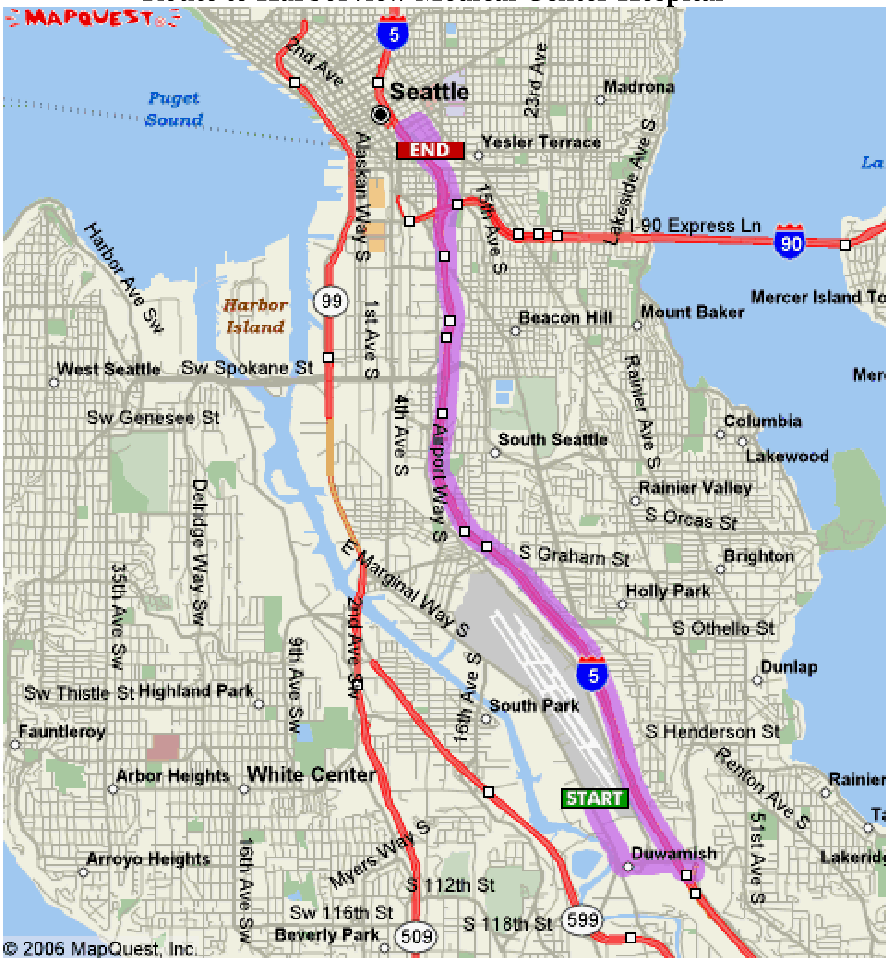
ATTACHMENT A

ACTION LEVELS FOR RESPIRATORY PROTECTION

Monitoring Parameter	Reading	Level of Protection

ROUTE TO HOSPITAL

Route to Harborview Medical Center Hospital



DIRECTIONS

1. Start out going SOUTHEAST on E MARGINAL WAY S toward S NORFOLK ST.
2. Turn LEFT onto S BOEING ACCESS RD.
3. Merge onto I-5 N toward SEATTLE.
4. Take the DEARBORN ST. / JAMES ST. exit- EXIT 164A- toward MADISON ST
5. Take the JAMES ST exit.
6. Turn RIGHT onto JAMES ST.
7. Turn right on Boren Avenue and drive 3 blocks to Broadway
8. Turn right, and then make a quick right turn onto Alder St
9. Continue for three blocks to 8th Avenue

Clear Water HASP

Clear Water Compliance Services®

ONSITE PROJECT HEALTH AND SAFETY PLAN

Construction Stormwater Treatment Operations

For

Clear Water Compliance Services
6501 212th St. SW
Lynnwood, WA 98036

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HOSPITAL ROUTE

For injury situations that require more assistance than simple first aid, but less than emergency medical response, outside medical care will be necessary. A vicinity map with driving directions has been provided, to show the nearest hospital emergency room or other medical care facility.

Onsite Project Health and Safety Plan for ------

The purpose of this Health and Safety Plan (HASP) is to provide procedures and guidance to ensure the health and physical well being of Clear Water Compliance Services, Inc. (Clear Water) personnel during field water-treatment operations. The HASP is intended to address Federal (OSHA) occupational health and safety requirements for identifying and evaluating workplace hazards and implementing policies and procedures to protect worker safety and welfare.

In 1973, the legislature passed the Washington Industrial Safety and Health Act or WISHA (Revised Code of Washington (chapter 49.17 RCW)). WISHA requires employers to provide safe and healthful workplaces for all employees. It gives the Washington State Department of Labor and Industries (L&I) the responsibility to establish and enforce workplace safety and health rules. These rules are the Washington Administrative Code (WAC), specifically WAC 296-800-100.

PROJECT SITE LOCATION – (Site Address)

Figure 1.0 Vicinity Map

PROJECT DESCRIPTION AND OBJECTIVES

ORGANIZATION AND RESPONSIBILITIES

Tyrone Clager has been designated as the Company Safety Officer, with overall responsibility and authority to implement Clear Water’s Health and Safety Program.

---, Project Manager, has been designated as the Project Safety Officer, with delegated responsibility and authority to implement Clear Water's Health and Safety Program for this project.

The Company Safety Officer is responsible for the Health and Safety Program on a company-wide basis. The Site Safety Officer is responsible for implementing the Health and Safety Program for specific field projects.

Responsibilities of the Company Safety Officer are as follows:

- Establish workplace safety objectives, and develop and implement rules of safe practices for each project function.
- Develop and implement safe operating rules for use of electrical and mechanical equipment, consistent with the manufacturer's recommendations and specifications.
- Develop and implement a program of employee safety education and training, and instruct personnel regarding safety activities and responsibilities.
- Develop and implement a system to encourage employees to report unsafe conditions immediately.
- Conduct inspections to identify and correct potential unsafe working conditions.
- Conduct a thorough investigation of each accident or safety incident (near miss), whether or not it results in an injury, to determine the cause of the accident or incident and to prevent recurrence.
- Maintain records of training, periodic inspections, corrective actions, and accident investigations.

Clear Water field personnel working on this project will maintain vigilance at all times to ensure that the work is conducted in a safe and efficient manner.

HAZARD ASSESSMENT

Clear Water performs a hazard assessment of the stormwater treatment equipment and materials, and an assessment of the physical conditions of the jobsite. Site specific hazards and safety protocols will be communicated to all system operators along with all generic HASP information. Recognized potential hazards include chemical exposure, fire hazards, biological hazards, physical hazards, electrical hazards, heat and cold, noise, and confined-space entry. General anticipated hazard categories and construction site safety protocols are discussed below.

ONSITE SAFETY MEETINGS

During the installation and startup phase of this project, the Company Safety Officer or Project Manager will conduct an initial safety meeting. The meeting will review the general requirements of the company HASP, the general contractor's site HASP, and any other site-specific safety concerns. Pertinent information gathered in this initial meeting will be disseminated to system operators.

System operators will review any safety meeting minutes and general safety policies on a weekly basis. A jobsite health and safety checklist covering the HASP and other requirements will be reviewed and signed by the project site technician on a weekly basis. A copy of the HASP will be available in the stormwater treatment system container for reference.

Operations management will discuss general operational and safety issues with all Clear Water operators on a regular basis. These regular operator meetings are intended to keep all operators current on relevant safety issues.

Any safety-related issue or problem pertaining to stormwater treatment operations will immediately be conveyed to the project safety officer. General construction site safety issues will be conveyed to the site superintendent through the project safety officer. If required, the project site operators will attend the general contractor's site safety meetings.

SITE HAZARDS

CHEMICAL EXPOSURE

The likelihood of adverse chemical exposure is minimal however, potential exposure is possible while handling flocculent chemicals, solid carbon dioxide, gaseous carbon dioxide, caustic chemicals used for pH adjustment, and during normal laboratory operations. Follow the procedures outlined in the Chemical Hazard Communication Plan (CHCP) and the Chemical Hygiene Plan to reduce the likelihood of adverse chemical exposure.

Plastic pipe (PVC) primer and glue will be used occasionally to make pipe connections and repairs. Potential adverse exposure to personnel from these substances is possible if proper handling procedures are not followed. Always wear appropriate PPE (gloves and eye protection) when handling these chemicals and use them in a well ventilated area.

If unspecified hazardous wastes are encountered by the stormwater treatment operator during stormwater treatment operations, the general contractor and safety officers will be informed. Observations of unusual odors and sheens, indicating possible chemical hazards, will be noted and disseminated to the contractor and the project safety officer.

Follow the company CHCP for information concerning the dangers of all hazardous chemicals present at the office and jobsite. Additional health and safety procedures, pertaining to general construction site hazardous chemicals, will be in relayed to Clear Water employees through the general contractor's site safety plan.

BIOLOGICAL HAZARDS

Potential Hazard	Control Measures
Poison ivy, poison oak, poison sumac *are typically found in brush or wooded areas. They are more commonly found in moist areas or along the edges of woods.*	*Become familiar with identity of plants. Wear protective clothing to cover exposed skin. If skin is contacted, wash area with soap and water.*
Bees and other stinging insects *may be encountered anywhere.*	*Look for and avoid nests. Minimize exposed skin. Carry a kit if you have allergic reactions. Remove stinger, if present. Wash and disinfect sting, cover, and apply ice.*
Ticks *may cause infection and may carry Lyme disease or RMSF.*	*Check often for ticks during warm weather. If bitten, remove tick with tweezers; wash hands and disinfect area. Seek medical attention if tick cannot be completely removed.*
Blood borne pathogen exposure *may occur when rendering first aid/CPR or if contact is made with potentially infectious waste.*	*Specific first-aid training, in which blood borne pathogens are addressed, is required prior to working onsite.*

PHYSICAL HAZARDS

Physical hazards are expected to be associated primarily with operation of the treatment system equipment, but also include nearby construction activities. The hazards of concern and control measures may be summarized as follows:

Description	Potential Hazard	Control Measures
Rotating machinery	*Becoming entangled*	*Install physical guards; use lockout/tagout procedure for maintenance and repairs*
Vehicle traffic and	*Collision, crushing*	*Designate equipment work areas;*

Description	Potential Hazard	Control Measures
heavy equipment		*listen for backup alarms; maintain eye contact with operator*
Elevated work areas	*Falls*	*Provide safety railings and ladders; use body harnesses, as necessary*
Slippery surfaces	*Slips and falls*	*Install anti-slip surfacing where appropriate; maintain vigilance; exercise care; immediately cleanup liquid spills*
Uneven or rough terrain	*Trips and falls*	*Identify and remove tripping hazards; level the uneven ground, if practicable; exercise extra caution*
Clearing brush	*Lacerations, eye injury*	*Provide appropriate PPE, such as chaps, leather gloves, face and eye protection.*
Lifting heavy objects	*Back injury, muscle injury*	*Use proper lifting techniques or provide mechanical lifting aids*
Open ponds, water bodies (greater than 3-feet-deep)	*Dunking, drowning*	*Install protective fencing, where practicable; have retrieval poles and life rings or other flotation devices available; install climb out ropes.*
Welding/cutting/ grinding	*Burns, eye injury*	*Provide appropriate PPE, such as chaps, leather gloves, face and eye protection*
Noise	*Hearing loss*	*Use ear plugs at all times during operation of equipment.*
Ladders	*Slips and falls*	*Inspect ladder for defects and obstructions. Make sure ladder is properly secured. Follow all ladder safety rules.*
Driving vehicles	*Collision, crushing*	*Inspect vehicle for defects. Wear seatbelts. Follow speed limits.*

FIRE HAZARDS

The risk of fire during treatment operations is minimal, but does exist. Electric motors and control equipment present a potential fire hazard by the burning of electrical insulation or nearby combustible materials. This may be caused by such occurrences as overheated components or electrical short circuits. Additionally, welding and cutting may be necessary to facilitate repairs to the treatment system equipment. High temperatures and/or open flame present a potential for igniting combustible materials.

A dry chemical fire extinguisher will be permanently mounted and readily available in the CESF treatment container for use in the event of fire danger. Clear Water employees will be trained in the use of fire extinguishers and general fire safety. Periodic inspections of the treatment system will be performed to identify potential fire hazards.

ELECTRICAL HAZARDS

Treatment equipment includes generators, high-voltage electric motors, and control equipment that present the potential for electrical shock, burns, and death. Isolation of electrical equipment using a lockout/tagout procedure is required for electrical maintenance or repair activities, with the exception of those situations where troubleshooting or repairs require that the equipment remain energized. Electrical work is only to be performed by company or contracted electricians. All systems are equipped with back up power. Voltage is still present even if generator and shore power is secured. Do not open any electrical enclosure without specific permission or under direct supervision of a Clearwater electrician. All equipment is to be verified de-energized by a Clearwater electrician. Lockout/tag-out procedures are to be performed prior to removal or replacement of any electrical component.

HEAT & COLD

During periods of extreme heat or cold, workers shall monitor themselves and each other for signs of heat stress or frostbite and hypothermia. Work periods will be limited as necessary to reduce the effects of heat or cold. Space heaters will be installed in the treatment system module to provide heat.

NOISE

Noise levels near Clear Water operating machinery will vary widely and may exceed 85 dBA, and pose a noise hazard. Hearing protection will be provided and shall be worn whenever working in the presence of excessive noise. Additional procedures will be followed to ensure that communication between technicians is not impaired.

CONFINED SPACE ENTRY

Large, steel storage tanks will be used in the stormwater treatment process for collection of runoff and for pre-settling of suspended solids. Field personnel may be required to enter the tanks periodically to perform maintenance tasks. Due to their configuration, the tanks are considered confined spaces. Clear Water employees will only perform confined space entry duties on **non-permit required** confined spaces. All permit required confined space entry work will be subcontracted to individuals certified to perform such tasks. A permit will be required for those circumstances where the confined space meets one or more of the following conditions:

- The space may contain a hazardous atmosphere – one that lacks oxygen, that is not safe to breathe, or that could ignite or explode.
- The space contains a liquid or a granular material that could drown, crush, or bury a worker.
- The space is shaped in a way that could trap a worker.
- The space contains any other hazard, such as rotating machinery or exposed electrical equipment.

Refer to the company’s confined space policy for proper entry procedures.

FIRE RESPONSE

Immediate reaction of Clear Water personnel to a fire will depend upon the source, size, and extent of the fire. Fires typically will come to the attention of personnel when: 1) smoke is smelled or observed, or 2) flames are observed.

Small Fires: Before attempting to put out a fire, personnel first must assess their likelihood of success. That is, will the situation be best served by fighting the fire or by sounding the alarm and summoning the fire department? Most small fires may be extinguished using a hand-held extinguisher or by smothering the fire if it is largely enclosed within a container (e.g., a trash can, drum, or box). When attempting to extinguish a small fire, personnel will:

- Physically position themselves so that they can readily escape should the fire become uncontrollable.
- If attempts are not successful within the first 15 to 20 seconds, or if the fire flairs out of control, abandon all extinguishing efforts and, if possible, seal off the affected area (close doors) to help contain the fire. **DO NOT RISK YOUR LIFE TO FIGHT A FIRE.**
- Immediately summon help by calling **9-1-1 Emergency Services** to request fire suppression assistance.

Fires of Greater Severity or Extent. Whenever a fire is too large to address with portable extinguishers, Clear Water personnel shall take the following actions:

- If possible, seal off the affected area (close doors) to help contain the fire.
- Warn others to evacuate the immediate area.
- Call 9-1-1 Emergency Services to request fire suppression assistance.
- Shut down and secure electrical power to equipment that may be damaged by the fire.
- As time allows, call Clear Water management (if not onsite) and other onsite personnel, as appropriate, and notify them of the situation.
- Meet the emergency-response units as they arrive onsite, and provide essential information and assistance, as necessary.

INJURY RESPONSE PROCEDURE

In the event of work time injuries involving a Clear Water employee, the following individuals must be contacted and given a situation briefing:

Name	Company and Title	Phone
Tyrone Clager	Clear Water Company Safety Officer	425-754-4016
	Site Supervisor	

The Injured employee shall cease operations, if necessary, and seek appropriate medical attention. After the injury has been treated the employee shall fill out an Incident Report Form as soon as possible and submit it to the Company Safety Officer.

Site Field Techs must verbally notify the Clear Water Project Manager when site injuries occur. If the injury incident becomes a lost work time injury, or appears suspicious in nature, an unplanned event investigation will be conducted.

The Company Safety Officer must follow all OSHA injury reporting requirements. Project Managers must observe relevant injury reporting requirements mentioned in the general contractor's health and safety program.

Clear Water personnel working onsite will have, at all times, ready access to a telephone or radio for communications.

EMERGENCY CONTACTS

Name	Company and Title	Phone
Tyrone Clager	Company Safety Officer	425-754-4016
	Project Manager	
	Senior Project Manager	
Eddie Sanchez	Director of Field Operations	425-754-0082
	Field Technician	

PERSONNEL

The Clear Water personnel who may work on this project are:

Nate Holloway	Neil Doherty	Lenny Odd	Matt Ringstad
Tyrone Clager	Todd Toland	Bryan Dennis	Keith Ramsey
Dan Lipinski	Neil Robbins	Ciaran Wilburn	Ryan Gibson
Eddie Sanchez	Meghan Apshaga	Adam Oliver	Brad Harper

Company Health and Safety Plan

Clear Water Compliance Services, Inc.

Safety Policy

Clear Water Compliance Services highly values the safety of its employees. Clear Water is committed to providing a safe workplace and has developed this program for injury prevention to involve administrators, managers, and all employees in identifying and eliminating hazards that may develop during our work process.

It is the basic safety policy of this company that no task is so important that an employee must violate a safety rule or take a risk of injury or illness in order to get the job done.

Employees are required to comply with all company safety rules and are encouraged to actively participate in identifying ways to make our company a safer place to work. Every individual will be presented with a safety orientation and a copy of the Health and Safety Plan (HASP) explaining each individual's safety responsibilities. All Clear Water team members are obligated to uphold their responsibilities to the company HASP.

Obligations of Everyone at Clear Water

1. Never perform any task which exposes you or others to risk. Never perform any task which you are untrained to do or are uncomfortable doing.

2. Never let another employee engage in an unsafe activity – ignoring another employee's negligence makes you negligent.

3. If there is disagreement between two or more people about whether a job is safe, assume that it is not and involve others to help resolve the issue.

Safety is a team effort – let's work together to keep this a safe and healthy workplace.

CHRIS AUGUSTINE
PRESIDENT

TYRONE CLAGER
SAFETY/COMPLIANCE MANAGER

SAFETY AND HEALTH RESPONSIBILITIES

Management Responsibilities:

1. Ensure that a company wide safety committee is formed and is carrying out its responsibilities as described in this program.
2. Ensure that sufficient resources are provided for safety equipment, training and any other aspect of the safety program.
3. Ensure that each employee has received an initial orientation *before* beginning work.
4. Ensure that each employee is competent or receives training on safe operation of equipment or tasks *before* starting work on that equipment or project.
5. Ensure that each employee receives required personal protective equipment (PPE) *before* starting work on a project requiring PPE.
6. Ensure that incidents are fully investigated and corrective action taken to prevent the hazardous conditions or behaviors from happening again.
7. Ensure that a record of injuries and illnesses is maintained and posted as described in this program.
8. Hold periodic management meetings about changes to work practices or equipment that will improve employee safety.

Employee Responsibilities:

1. Follow safety rules described in this program, OSHA/WISHA safety standards and training you receive.
2. Report unsafe conditions or actions to your supervisor or safety committee representative promptly.
3. Report all injuries to your supervisor promptly.
4. Report near-miss incidents to your supervisor promptly.
5. Always use personal protective equipment (PPE) in good working condition where it is required.
6. Do not operate equipment that you are uncomfortable with or have not been trained on.
7. Do not remove or defeat any safety device or safeguard provided for employee protection.
8. Encourage co-workers by your words and example to use safe work practices on the job.
9. Make suggestions to your supervisor, safety committee representative or management about changes you believe will improve employee safety.

BASIC SAFETY

Each employee will be given a safety orientation by the Company Safety Officer. The orientation will cover the following items:

1. A description of the accident prevention program:

- We have a formal written accident prevention program as described in WISHA regulations (WAC 296-800-140).
- It includes the safety orientation and a safety committee that is described below.
- We also have basic safety rules that all employees must follow. They are:
    - Never do anything that is unsafe in order to get the job done. If a job is unsafe, report it to your supervisor or safety committee representative. We will find a safer way to do that job.
    - Do not remove or disable any safety device! Keep guards in place at all times on operating machinery.
    - Never operate a piece of equipment unless you have been trained and are authorized.
    - Use personal protective equipment whenever it is required.
    - Obey all safety warning signs.
    - Working under the influence of alcohol or illegal drugs or using them at work is prohibited.
    - Do not bring firearms or explosives onto company property.
    - Smoking is prohibited inside any company building or vehicle. Smoking is allowed outside, but you must be at least 25 feet from any entry or ventilation intake as required by WA state law.
    - Clean up spills immediately.
    - Do not allow scraps to accumulate where they will become a hazard. Good housekeeping helps prevent accidents.

2. Company Safety Committee

- The committee will consist of four members including the Company Safety Officer and one representative each from the shop crew, field operators, and management.
- Employees will elect from among themselves a representative to be on the committee.
- The committee's purpose is to identify safety problems, develop solutions, review incident reports and evaluate the effectiveness of our safety program.
- The committee will conduct monthly meetings.
- Site inspections will be conducted at regular intervals at a time determined by committee vote.

3. Employee Training Program

- All Clear Water employees will attend a Health and Safety training presentation. The training presentation will explain the details of the Health and Safety Program and the rights and responsibilities of each Clear Water employee.
- All employees will be shown the proper safety techniques to use for all equipment and procedures by their supervisor. Employees will not be expected to engage in activities they are unfamiliar or uncomfortable with.
- All employees will be given a copy of the company Health and Safety Program.

4. Chemical Hazard Communication Program (CHCP)

- Safe use of chemicals and emergency actions to take following an accidental exposure.
- We use several chemicals, including acids, bases, solvents and cleaners. Employees will receive a separate orientation as part of our chemical hazard communication program on the hazards of these chemicals before working with them or working in an area where they are used.
- Laboratory operations are a critical aspect of CESF stormwater treatment. Clear Water operators must be proficient in laboratory operations. A separate Chemical Hygiene Plan has been established to dictate proper laboratory procedures.

5. Personal Protective Equipment (PPE)

- Some tasks in our company require an employee to wear PPE to protect against injury.
- Clear Water employees will be provided any PPE necessary to engage in required work duties.
- You will be instructed by your supervisor, using the manufacturer's instructions that are attached to this program, on how to use and care for your PPE.

6. On-the-job training about what you need to know to perform the job safely

- Before you are first assigned a task, your supervisor will demonstrate the task properly, give safety instructions, and distribute required PPE.
- We have established safety rules and personal protective equipment (PPE) requirements based upon a hazard assessment for each task.
- Do not use equipment or attempt to do any of these tasks until you have received the required training and PPE.
- The Company Safety Officer, in conjunction with the supervisors, will document the safety training completed by each employee.

7. Safety Bulletin Board

- A Safety Bulletin Board will be placed in the Lynnwood and Auburn Offices for employees to reference relevant HASP information.
- The Safety Bulletin Board will contain a required WISHA poster which informs employees of their health and safety protection rights.
- The board will also include relevant health and safety information such as accident statistics, emergency phone numbers, evacuation maps and safety updates.

8. How and when to report injuries.

- If you are injured or become ill on the job, report this to your immediate supervisor.
- Verbally contact the Company Safety Officer immediately and submit an Incident Report Form.
- Upon conference, the project manager and employee will complete a second Incident Investigation Report Form.
- All Incident Investigation Report Forms shall be collected by the Company Safety Officer and reviewed by the Safety Committee.
- Incident Investigation Report Forms will be located next to the Safety Bulletin Board and included in all onsite HASPs.
- Record all minor injuries that happen on site in the Minor Injury Record Log.

9. How to report unsafe conditions and practices

- If you see something that is unsafe or someone working unsafely, promptly report it to your immediate supervisor. You and your supervisor should jointly fill out a Hazard Report Form and submit it to the Safety Committee. Employees may fill out Hazard Report Forms anonymously.
- Hazard Report Forms will be located next to the Safety Bulletin Board and included in all onsite HASPs. A box will be provided for employees to submit Hazard Report Forms anonymously.
- The Safety Committee shall make regular inspections of work sites and standard operating procedures to evaluate for potential work related hazards.

10. First Aid

- First aid kits are located next to the safety bulletin board and in all the storm water treatment containers. Kits will remain clearly visible and easily accessible.
- All supervisors are required to have first-aid/CPR training. Additionally, all employees are encouraged to have first-aid/CPR training.
- Emergency eye wash stations will be located adjacent to first-aid kits. Several chemicals used by Clear Water require the presence of emergency eye wash stations.

- Emergency phone numbers will be posted on the safety bulletin board and in all the containers.

11. Core Safety Rules

- A list of core safety issues has been compiled of which all Clear Water employees should be aware.
- Core safety rules address work environments and activities that the average employee will engage on a regular basis.
- The observation of the core safety rules will prevent the most avoidable, yet most common types, of work place accidents.

12. Driving and Strapping

- Statistically, driving a vehicle is the most dangerous activity Clear Water employees will engage in. Always drive cautiously and observe all traffic laws.
- Clear Water employees may be provided with company vehicles to engage in work related tasks when necessary. Company vehicles all have the name, logo and telephone number of the company printed on the outside of the vehicle. Be aware that you are representing the company when driving a company vehicle. Unsafe driving by one employee can reflect negatively on the company as a whole.
- Clear Water employees frequently haul heavy equipment and supplies on flat bed trucks. Unsecured or improperly secured loads represent a significant hazard to our fellow commuters.
- Proper loading and strapping techniques will be instructed to all Clear Water employees before engaging in hauling activities.

13. Lockout/Tagout Program

- Procedure designed to prevent the unintended release of stored energy (mechanical, electrical, pneumatic or water pressure) during the maintenance or repair of equipment.
- Clear Water treatment systems contain multiple components where stored energy presents a significant health and safety risk. Following established Lockout/Tagout protocols will reduce these risks.

14. Construction Site Operations

- In addition to the normal HASP protocols, extra precautions must be taken when operating on a construction site.
- Construction sites are particularly dangerous areas to operate because of factors such as heavy equipment operations, changing ground conditions, unstable slopes, falling objects and trip hazards.

- Some construction companies require extra training or special operational protocols when working on their sites.

15. What to do in an emergency, including how to exit the workplace

- An evacuation map for the building is posted on the company safety board. It will show the location of exits, fire extinguishers, first aid kits, and where to assemble outside.

16. Fire Emergency

- Training on the use of fire extinguishers shall be part of this orientation.
- If a fire is discovered, tell another person immediately.
- If the fire is small (such as a wastebasket fire) and there is minimal smoke, you may try to put it out with a fire extinguisher.
- If the fire grows or there is thick smoke, do not continue to fight the fire. Call or have someone call 911 and a supervisor.
- Supervisors should tell other employees in the area to evacuate and go to the designated assembly point outside the building.
- If an employee is missing, *do not* re-enter the building! Notify the responding fire personnel that an employee is missing and may be in the building.

SAFETY DISCIPLINARY POLICY

Clear Water Compliance Services believes that a Health & Safety Accident Prevention Program is more enforceable with some type of disciplinary policy. Our company believes that in order to maintain a safe and healthful workplace, the employees must be cognizant and aware of all company, State, and Federal safety and health regulations as they apply to the specific job duties required. The following disciplinary policy is in effect and will be applied to all safety and health violations.

The following steps will be followed unless the seriousness of the violation would dictate going directly to Step 2 or Step 3.

- A first time violation will be discussed orally between company supervisor and the employee. This will be done as soon as possible.
- A second time offense will be followed up in written form and a copy of this written documentation will be entered into the employee’s personnel folder.
- A third time violation may result in time off or possible termination, depending on the seriousness of the violation.

SAFETY COMMITTEE

The purpose of the Safety Committee is to evaluate, communicate and implement safety and health issues within the company. Clear Water Compliance Services is committed to providing a safe work place for all of its employees and the Safety Committee is an important and necessary tool in achieving this goal.

The Safety Committee will be made up of four members including the Company Safety Officer, and representatives from the field operators, manufacturing crew, and management. Two of the members will be elected by the employees. Each member will serve a term of one year at which point the committee may be reorganized.

The committee will determine frequency and location of committee meetings. Meetings will last until all matters are addressed and minutes will be kept by one of the committee members. Meeting topics will include:

- A review of Incident Investigation Reports to identify and rectify the cause of the reported incident.
- A review of Workplace Hazard Reports to assess and, if necessary, rectify the reported hazard.
- Evaluate previous incident and hazard issues to assure that the proposed solution was effectively implemented.
- Reevaluate the company Health & Safety Program to identify sections that may need to be added or improved.
- Record meeting minutes and attendance and make the records available for review by company employees or Labor & Industry officials.

Meeting attendance, topics and full minutes will be recorded. Records of the meeting will be kept on file for one year. Records will be available for review by employees, Labor and Industries representatives and health and safety consultants.

CHEMICAL HAZARD COMMUNICATION PROGRAM

1. Company Policy

To ensure that information about the dangers of all hazardous chemicals used by Clear Water Compliance Services is known by all affected employees, the following hazardous communication program has been established. Under this program, you will be informed of the contents of the OSHA/WISHA Hazard Communications standard, the hazardous properties of chemicals with which you work, safe handling procedures and measures to take to protect yourself from these chemicals.

This program applies to all work operations in our company where you may be exposed to hazardous chemicals under normal working conditions or during an emergency situation. All employees of this company will participate in the Hazard Communication Program.

The Company Safety Officer is the program coordinator, with overall responsibility for the program, including reviewing and updating this plan as necessary.

2. Container Labeling

The Company Safety Officer will verify that all containers received for use will be clearly labeled as to the contents, note the appropriate hazard warning, and list the manufacturer's name and address.

The Company Safety Officer and the Project Manager for each site will ensure that all secondary containers are labeled with either an extra copy of the original manufacturer's label or with labels marked with the identity, the appropriate hazard warnings and necessary PPE for handling.

Sample labels for secondary labeling are at the back of the Chemical Hazard Communication Program section.

3. Material Safety Data Sheets (MSDSs)

The Company Safety Officer is responsible for establishing and monitoring the company MSDS program. He/she will ensure that procedures are developed to obtain the necessary MSDSs and will review incoming MSDSs for new or significant health and safety information. He/she will see that any new information is communicated to affected employees. The procedure below will be followed when an MSDS is not received at the time of initial shipment:

- Obtain a MSDS for each hazardous chemical used as soon as possible, if the MSDS is not provided with the shipment of a hazardous chemical, from the chemical manufacturer or importer.

- To obtain a MSDS, you may try calling the manufacturer or checking their website.
- If you have a commercial account with a retailer or wholesaler, you have the right to request and receive a MSDS about hazardous chemicals you purchase.
- If a chemical is purchased from a retailer with no commercial accounts, you have the right to request and receive the manufacturer's name and address so that you can contact them and request a MSDS for the chemical.
- Whoever prepares the MSDS is required to mark all blocks on the form, even if there is no relevant information for that section.

An electronic folder is available on the Clear Water server under Public/Safety/MSDS. Copies of MSDSs for all hazardous chemicals to which employees are exposed or potentially exposed will be kept in this folder. Additionally, all department heads have a CD containing copies of all MSDSs kept online. All operational sites will have MSDSs for relevant chemicals in the onsite Health and Safety Plan. Therefore, MSDSs will be readily available to all employees during each work shift. If an MSDS is not located in the MSDS folder, contact the Company Safety Officer.

4. Employee Training and Information

The Company Safety Officer is responsible for the Hazard Communication Program and will ensure that all program elements are carried out.

Everyone who works with or may be potentially exposed to hazardous chemicals will receive initial training on the hazard communication standard and this plan before starting work. Each new employee will attend a health and safety orientation that includes the following information and training:

- An overview of the OSHA/WISAH hazard communication standard
- The hazardous chemicals present at his/her work area
- The physical and health risks of the hazardous chemicals
- Symptoms of overexposure
- How to determine the presence or release of hazardous chemicals in the work area
- How to reduce or prevent exposure to hazardous chemicals through use of control procedures, work practices, and personal protective equipment
- Steps the company has taken to reduce or prevent exposure to hazardous chemicals
- Procedures to follow if employees are overexposed to hazardous chemicals
- How to read labels and MSDSs to obtain hazard information
- Location of the MSDS file and written Hazard Communication program

Prior to introducing a new chemical hazard into any section of this company, each employee in that section will be given information and training as outlined above for the new chemical hazard.

5. Informing Other Employers/Contractors

It is the responsibility of the Company Safety Officer to provide other employers and contractors with information about hazardous chemicals that their employees may be exposed to on a job site and suggested precautions for employees. It is also the responsibility of the Company Safety Officer to obtain information about hazardous chemicals used by other employers to which employees of this company may be exposed.

Other employers and contractors will be provided with MSDSs for all chemicals used during this company's operations on the specific work site. Also, copies of the secondary container label format and any chemical specific handling instructions will be provided. These documents will all be included in the Health & Safety section of the STP provided to the contractor by the site Project Manager

MSDSs for hazardous chemicals used by the contractor should be provided to the Project Manager if Clear Water employees are likely to come into contact with those chemicals. Contractor provided MSDSs should be added to the project Health & Safety Plan and explained to any system operators.

6. List of Hazardous Chemicals

A list of all known hazardous chemicals used by our employees is attached to this plan. This list includes the name of the chemical, the manufacturer and the work area in which the chemical is used. Further information on each chemical may be obtained from the MSDSs, located in the MSDS folder on the Clear Water server.

When new chemicals are received, this list is updated (including date the chemicals were introduced) within 30 days. The Company Safety Officer shall be responsible for introducing the new chemical to the chemical list and the MSDS folder.

7. Chemicals in Unlabeled Pipes

Clear Water treatment systems frequently have chemicals transferred through unlabeled pipes. Contractors and non-company employees, who are likely to come into contact with Clear Water treatment systems, should be notified of chemicals transferred through unlabeled pipes and informed of possible hazards.

Work activities are sometimes performed by Clear Water clients in areas where chemicals are transferred through unlabeled pipes. Prior to starting work in these areas, the Project Manager shall contact the contractor for information regarding:

- The chemical in the pipes
- Potential hazards
- Required safety precautions.

CHEMICAL HYGIENE PLAN

1. Responsibilities- All Laboratory Personnel

- Be aware of his/her individual safety responsibilities.
- Participate in required training activities.
- Know and comply with safety guidelines, regulations, and procedures required for the task assigned.
- Understand the selection, use and limitations of personal protective equipment (PPE).
- Protect the face, skin, and eyes, at all times by wearing appropriate PPE. Remove these items before leaving the laboratory. Do NOT wear potentially contaminated protective equipment out of the lab.
- Do not eat, drink, smoke, or apply cosmetics in the laboratory or in any location where chemicals or other hazardous agents are used or stored.
- Never drink out of laboratory glassware.
- Consider any unlabeled chemical solution hazardous until it is identified.
- Look out for the safety of others in the laboratory, including visitors.
- Know and follow emergency procedures, including the location and route to the nearest hospital.

2. Equipment

- Know the location and use of the emergency equipment (fire extinguisher, eyewash, first aid kit) in your area. Know how to obtain additional help in an emergency and be familiar with emergency procedures.
- Use equipment only for its designated purpose.
- Use PPE (gloves and eye protection) whenever performing laboratory operations. Remove PPE when lab operations are complete.
- Handle glass lab ware with care. Avoiding cracks and breaks will reduce the potential for injury.

3. General

As you walk through a well-kept laboratory, you should note a clean and orderly workplace.

- Floors should be free of hazards. Never leave carelessly discarded objects, dropped objects, or spilled material on the floor.
- Always keep bench tops, floors, aisles, and worktops clear of all material not being used.
- There should always be a clear passageway to the exit.

- There should always be clear space around eyewashes, first aid kits, fire extinguishers, and electrical controls.
- Any frequently used bench apparatus should be kept well away from any edges and secured whenever possible.
- Clean work areas upon completion of an experiment or at the end of each day.
- Bench tops and bench liners should be free of visible contamination.

4. Storage

- Standard lab equipment (beakers, stir rods, etc.) should be stored on the bench top in an orderly fashion.
- Clothing should be hung in proper locations and not draped over equipment or benches.
- Excess chemical inventory should be kept in storage.
- Do not store chemical containers on the floor.
- Keep food, drink and all personal items away from laboratory bench top and chemicals
- Keep excess cardboard boxes, equipment boxes, Styrofoam, etc. off the floor. These items should be stored on shelves or in cabinets throughout the lab.

PERSONAL PROTECTIVE EQUIPMENT (PPE) PROGRAM

The purpose of the Personal Protective Equipment Program is to protect the employees of Clear Water Compliance Services from exposure to work place hazards and the risk of injury through the use of personal protective equipment (PPE). PPE is not a substitute for more effective control methods and its use will be considered only when other means of protection against hazards are not adequate or feasible. It will be used in conjunction with other controls unless no other means of hazard control exist.

Personal protective equipment will be provided, used, and maintained when it has been determined that its use is required to ensure the safety and health of our employees and that such use will lessen the likelihood of occupational injury and/or illness.

This section addresses general PPE requirements, including eye and face, head, foot and leg, hand and arm, body (torso) protection, fall protection, respiratory and hearing protection, and protection from drowning.

The Clear Water Personal Protective Equipment Program includes:

- Responsibilities of supervisors and employees
- Hazard assessment and PPE selection
- Employee training
- Cleaning and maintenance of PPE

1. Responsibilities

Safety Committee

The Safety Committee is responsible for the development, implementation, and administration of Clear Water's PPE program. This involves

- Conducting workplace hazard assessments to determine the presence of hazards which necessitate the use of PPE.
- Selecting and purchasing PPE.
- Reviewing, updating, and conducting PPE hazard assessments whenever
  - a job changes
  - new equipment is used
  - there has been an accident
  - a supervisor or employee requests it
  - or at least every year
- Maintaining records on hazard assessments.
- Maintaining records on PPE assignments and training.

- Providing training, guidance, and assistance to supervisors and employees on the proper use, care, and cleaning of approved PPE.
- Periodically re-evaluating the suitability of previously selected PPE.
- Reviewing, updating, and evaluating the overall effectiveness of PPE use, training, and policies.

Supervisors

Supervisors have the primary responsibility for implementing and enforcing PPE use and policies in their work area or job site. This involves:

- Providing appropriate PPE and making it available to employees.
- Ensuring that employees are trained on the proper use, care, and cleaning of PPE.
- Ensuring that PPE training certification and evaluation forms are signed and given to Safety Committee.
- Ensuring that employees properly use and maintain their PPE, and follow Clear Water's PPE program and rules.
- Notifying Clear Water management and the Safety Committee when new hazards are introduced or when processes are added or changed.
- Ensuring that defective or damaged PPE is immediately disposed of and replaced.

Employees

The PPE user is responsible for following the requirements of the PPE policies. This involves:

- Properly wearing PPE as required.
- Attending required training sessions.
- Properly caring for, cleaning, maintaining, and inspecting PPE as required.
- Following the Clear Water PPE program.
- Informing the supervisor of the need to repair or replace PPE.

2. Hazard Assessment for PPE

The Safety Committee, in conjunction with Supervisors, will conduct a walk-through survey of each work area to identify sources of work hazards. Each survey will be documented using the Hazard Assessment Checklist, which identifies the work area surveyed, the person conducting the survey, findings of potential hazards, and date of the survey. The Safety Committee will keep the forms on file in the Hazard Assessment Checklist folder.

The Safety Committee will conduct, review, and update the hazard assessment for PPE whenever:

- a job changes
- new equipment or process is installed
- there has been an accident
- whenever a supervisor or employee requests it
- or at least every year

Any new PPE requirements that are developed will be added into the Clear Water written accident prevention program.

3. Selection of PPE

Once the hazards of a workplace have been identified, the Safety Committee and relevant supervisors will determine if the hazards can first be eliminated or reduced by methods other than PPE, i.e., methods that do not rely on employee behavior, such as engineering controls or activity elimination.

If such methods are not adequate or feasible, then the Safety Committee will determine the suitability of the PPE presently available; and as necessary, will select new or additional equipment which ensures a level of protection greater than the minimum required to protect our employees from the hazard. Care will be taken to recognize the possibility of multiple and simultaneous exposure to a variety of hazards. Adequate protection against the highest level of each of the hazards will be recommended for purchase.

All personal protective clothing and equipment will be of safe design and construction for the work to be performed and will be maintained in a sanitary and reliable condition. Only those items of protective clothing and equipment that meet NIOSH or ANSI (American National Standards Institute) standards will be procured or accepted for use. Newly purchased PPE must conform to the updated ANSI standards which have been incorporated into the PPE regulations, as follows:

- Eye and Face Protection ANSI Z87.1-1989
- Head Protection ANSI Z89.1-1986
- Foot Protection ANSI Z41.1-1991
- Hand Protection (There are no ANSI standards for gloves, however, selection must be based on the performance characteristics of the glove in relation to the tasks to be performed.)

Affected employees whose jobs require the use of PPE will be informed of the PPE selection and will be provided PPE by Clear Water at no charge. Careful consideration will be given to the comfort and proper fit of PPE in order to ensure that the right size is selected and that it will be used.

4. Training

Any worker required to wear PPE will receive training in the proper use and care of PPE before being allowed to perform work requiring the use of PPE. Periodic retraining will be offered to PPE users as needed. The training will include, but not necessarily be limited to, the following subjects:

- When PPE is necessary to be worn
- What PPE is necessary
- How to properly use the PPE
- The limitations of the PPE
- The proper care, maintenance, useful life, and disposal of the PPE

After the training, the employees will demonstrate that they understand how to use PPE properly, or they will be retrained.

Training of each employee will be documented using the Personal Protective Equipment Training Documentation Form and kept on file. The document certifies that the employee has received and understood the required training on the specific PPE he/she will be using.

Retraining

The need for retraining will be indicated when

- an employee's work habits or knowledge indicates a lack of the necessary understanding, motivation, and skills required to use the PPE (i.e., uses PPE improperly)
- new equipment is installed
- changes in the work place make previous training out-of-date
- changes in the types of PPE to be used make previous training out-of-date

5. Cleaning and Maintenance of PPE

It is important that all PPE be kept clean and properly maintained. Cleaning is particularly important for eye and face protection where dirty or fogged lenses could impair vision. Employees must inspect, clean, and maintain their PPE according to the manufacturers' instructions before and after each use. Supervisors are responsible for ensuring that users properly maintain their PPE in good condition.

Personal protective equipment should not be shared between employees until it has been properly cleaned and sanitized. PPE will be distributed for individual use whenever possible.

If employees provide their own PPE, make sure that it is adequate for the work place hazards, and that it is maintained in a clean and reliable condition.

Defective or damaged PPE will not be used and will be immediately discarded and replaced.

> ***NOTE:*** *Defective equipment can be worse than no PPE at all. Employees would avoid a hazardous situation if they knew they were not protected; but they would get closer to the hazard if they erroneously believed they were protected, and therefore would be at greater risk.*

It is also important to ensure that contaminated PPE which cannot be decontaminated is disposed of in a manner that protects employees from exposure to hazards.

FIRST AID

1. Minor Injury Accidents

Clear Water supervisors and operation's personnel will receive basic first aid training. First aid items, provided onsite by Clear Water, include an industrial-type first aid kit and an eye-wash station.

In the case of minor injury accidents, any necessary first aid should be immediately administered by those individuals closest to the accident. Red Cross first aid procedures should be followed.

2. Hospital Route

For injury situations that require more assistance than simple first aid, but less than emergency medical response, outside medical care will be necessary. Maps and driving directions will be provided at all Clear Water job sites and offices to the nearest hospital emergency room or other medical care facility.

3. Emergency Medical Response

In the event of a medical emergency, Clear Water personnel must act immediately to assist the "victim." The following emergency response protocol will be followed:

- Check the scene for safety. Do not needlessly endanger yourself to provide assistance. If feasible, mitigate any dangers before rendering assistance.
- Do not move seriously injured persons from the immediate scene unless they are in serious danger of sustaining additional injuries (such as from a toxic atmosphere or an advancing fire).
- If unconscious, check the victim's ABCs – Airway, Breathing, and Circulation:
- Tap and shout to see if the person responds.
- If no response, look, listen, and feel for breathing for about 5 seconds.
- If no breathing, position victim on back while supporting the head and neck.
- Tilt head back and lift chin.
- Look, listen, and feel for breathing for about 5 seconds.
- If no breathing, give 2 slow breaths and check pulse for 5 to 10 seconds.
- If there is no pulse, start CPR and call 9-1-1- Emergency Services at the first opportunity.
- Continue to perform CPR until the victim begins breathing on their own or until emergency services personnel take over.
- Check for, and stop, any severe bleeding.

Call **9-1-1 Emergency Services** for emergency medical assistance if the victim:

- Is unconscious.
- Has trouble breathing.
- Has chest pain or pressure.
- Is bleeding severely.
- Has pressure or pain in the abdomen that does not go away.
- Is vomiting or passing blood.
- Has repeated seizures or a seizure that lasts for more than a few minutes.
- Has a severe headache or slurred speech.
- Appears to have been poisoned.
- Has injuries to the head, neck, or back.
- Has possible broken bones.

In addition to location information, be prepared to give the following information to the 9-1-1 dispatcher: 1) what happened, 2) number of victims, 3) kind of injury or injuries, and 4) what aid is being given. <u>Do not hang up until the dispatcher hangs up</u>.

As time allows, inform Clear Water management and onsite management of the emergency situation and provide status reports as the incident progresses.

Apply First Aid principles to care for life-threatening conditions. If there are no life-threatening conditions:

- Prevent shock.
- Watch for changes in breathing and consciousness.
- Help the victim rest comfortably.
- Keep the victim from getting chilled or overheated (depending upon circumstances).
- Reassure the victim.

Meet, or have someone meet, the emergency-response personnel when they arrive onsite. Provide assistance as necessary.

CORE SAFETY ISSUES

1. Housekeeping

Keep all areas of your workplace, storage rooms, and service rooms in a clean, orderly and sanitary condition to the extent the nature of the work allows. Keep your workplace free of obstructions such as nails, splinters, loose boards and miscellaneous debris. Always leave walkways unobstructed and free of any tripping hazards. Make sure the integrity of floors is maintained and free of holes, cracks and uneven elevations. Control vegetation in your work areas when necessary to create a safe working environment.

Promptly clean up liquid spills and excessive dust as these are slipping hazards. Sweep and mop in a manner that minimizes exposure area. Prevent, to a reasonable extent, the introduction of dust into the air by controlled sweeping techniques.

Make sure your workplace is constructed, equipped and maintained so it restricts pests from entering or living in it. Keep food away from work areas and clean up food promptly after eating. Empty trash cans regularly. A pest free, sanitary workplace will reduce the incidence of employee illness.

Store materials so they do not create a hazard. Maintain storage areas in an organized and accessible manner. Secure stored items such as bundles, containers, and bags to prevent them from falling, sliding, or collapsing by properly stacking and securing them. Make sure stored items are limited in height so that they are stable and secure to prevent sliding or collapse.

2. Lighting

Provide and maintain adequate lighting for all work activities in your workplace. See the following table:

Lighting Table		
Activity	Minimum acceptable average lighting level in an area: (Foot-candles)	Any one single measurement used to determine the average lighting level* can't be less than: (Foot-candles)
Indoor task	10	5
Outdoor task	5	2.5
Nontask activities for both indoor and outdoor	3	1.5

Have adequate light for employees to see nearby objects that might be potential hazards or to see to operate emergency controls or other equipment, if general lighting is not available.

3. Hearing

Prevent employee hearing loss by minimizing employee noise exposures and make sure that employees exposed to noise are protected. Examples of information or situations that can indicate noise exposures which may pose a hearing loss hazard include:

- Noise in the workplace that interferes with people speaking, even at a close range.
- Information from the manufacturer of equipment being used in the workplace that indicates high noise levels for machines in use.
- Reports from employees of ringing in their ears or temporary hearing loss.
- Cell phone rings or alarms are difficult to hear.
- Use of any Heavy equipment, machinery, power tools, or compressed air equipment.

All Clear Water operators can expect to be exposed to excessive noise when operating a stormwater treatment system. High pressure water conveyance, pneumatic valves and air compressors are all recognized sources of excessive noise.

Employees will be provided with appropriate PPE for hearing protection. Clear Water operators will use the provided hearing protection when present on a functioning site.

4. Electrical

Inspect electrical equipment to make sure there are no recognized hazards likely to cause employee death or serious physical harm. Determine the safety of the equipment by using the following list:

- Has been approved or listed by a recognized testing laboratory, such as Underwriters Laboratories (UL) or other approving agency.
- Is approved, or listed as approved, for the purpose it is being used.
- Has strong and durable guards providing adequate protection, including parts designed to enclose and protect other equipment.
- Is insulated.
- Will not overheat under conditions of use.
- Will not produce arcs during normal use.

Make sure electrical outlets are rated equal or greater to the electrical load supplied. Make sure the proper mating configuration exists when connecting the attachment plug to a receptacle. Make sure when electrical outlets, cord connectors, and receptacles are joined, they accept the attachment plug with the same voltage or current rating.

Make sure electrical equipment used or located in wet or damp locations is designed for such use. They must be constructed or installed so that water cannot enter or accumulate in wireways, lampholders, or other electrical parts. Switches, circuit breakers and switchboards located in wet locations must be in weatherproof enclosures.

Maintain all flexible cords and cables in good condition and use safely. Perform visual inspection before using. Do not use cords with loose or missing pins, loose plug, damaged or cut insulation, or pinched wires that might indicate internal damage.

All electrical work shall be performed by Clear Water electricians only. Non-electrician employees should not attempt to wire, rewire or perform maintenance on open electrical equipment. The hazard of electric shock is a very real and present possibility that could result in serious injury or death.

5. Power Tools

Power tools should all be equipped with appropriate safe switches. Make sure the operating switch is located in a position that makes it difficult to accidentally operate the tool. Chain saws and hand held grinders should be equipped with constant pressure switches that will shut off when pressure is released. Some constant pressure switches have a lock on feature. Make sure the lock mechanism can be easily disengaged with one finger. Many hand held power tools simply have a positive “on/off” switch.

Circular saws are likely the most hazardous of power tools used at Clear Water Compliance Services. Whether a table saw or a portable hand held, they should all be equipped with a constant pressure switch. Cracked or chipped blades should be removed from service. Circular saws with a blade diameter greater than two inches should be equipped with a blade guard. Proper PPE will be employed when operating circular saws including goggles and hearing protection. Paper respiratory masks will be employed to prevent the inhalation of air borne dust particles. Gloves and long sleeves should be avoided as they may get caught in the blade. Long hair should be tied back and up to avoid entanglement. Hanging jewelry such as necklaces and ear rings should be removed.

The operation of power drills and grinders require the observation of standard hearing and eye protection procedures. A full face shield and goggles is recommended for the use of grinders as they tend to emit a large amount of flying sparks. Grinders should be used in areas where flying sparks will not come into contact with highly flammable substances such as paper or volatile chemicals. Gloves should be employed when using drills or grinders to protect hands from sparks or splinters.

6. Fall Protection

When employees are exposed to a hazard of falling from a location 10 feet or more in height, the employer shall ensure that fall restraint or fall arrest systems are provided.

Fall restraint shall consist of a guardrail which must be at least thirty-eight inches high but no more than forty-five inches high, with a mid-rail approximately midway between the top rail and the platform surface.

Fall arrest shall consist of a safety harness attached to securely rigged restraint line. All safety harness shall be capable of withstanding a tensile loading of 5,000 pounds without cracking, breaking, or taking a permanent deformation. An approved Class III full body harness shall be used. The attachment point of the body harness shall be located in the center of the wearer's back near shoulder level. The body harness systems shall be rigged to minimize free fall distance with a maximum free fall distance allowed of 3 feet, and such that the employee will not contact any lower level. All employees performing work that requires fall arrest must complete a Fall Protection Work Plan form before beginning work.

Fall arrest systems and components subjected to impact loading shall be immediately removed from service and shall not be used again for employee protection until inspected and determined by a competent person to be undamaged and suitable for reuse. Personal fall arrest systems shall be inspected prior to each use for wear, damage and other deterioration, and defective components shall be removed from service. “Competent Person” means an individual knowledgeable of fall protection equipment, including the manufacturers recommendations and instructions for the proper use, inspection, and maintenance; and who is capable of identifying existing and potential fall hazards; and who has the authority to take prompt corrective action to eliminate those hazards; and who is knowledgeable of the rules contained in this section regarding the erection, use, inspection, and maintenance of fall protection equipment and systems.

Employees working below elevated platforms must pay extra attention to possibility of falling objects. If possible, employees should delay work activities which are directly below an employee working on an elevated surface. If the work can not be delayed, the employee will wear a hard hat to protect against the hazard of falling objects.

7. Stairs

Stairs will be installed at any location where employees will travel between different levels on a predictable and regular basis. The tread run on all stairs should have slip resistant tread installed. Railings will be installed on the open side of all exposed stairways. Handrails will be present on at least one side of closed stairways, preferably on the right side while descending.

8. Ladders and Lifts

Ladders should only be used for their intended purpose. Using ladders as levers, scaffold plank or other such activities could compromise the structural integrity of the ladder. Do not exceed the maximum intended load (all persons and equipment at one time) of the ladder.

Duty Rating	Ladder Type	Use	Maximum Intended Load (Pounds)
Extra Heavy-Duty	IA	Industry, utilities, contractors	300
Heavy-Duty	I	Industry, utilities, contractors	250
Medium-Duty	II	Painters, offices, light maintenance	225
Light-Duty	III	General household use	200

Protect ladders that are set-up in a location where they could be displaced by workplace activities or traffic by either securing the ladder or using a barricade to keep traffic away. Use a spotter to hold the ladder when possible. Protect ladders that are set up in front of doors that open by locking the door, blocking the door open or using a spotter to guard the door.

Prevent accidental displacement by securing footing on a firm level surface. Do not place a ladder on ice, snow or any slippery surface. Do not place ladders on unstable bases to gain extra height. Make sure the top support of the ladder is rigid, even and able to support the weight of the intended load. Set up ladders with a safe angle. The vertical distance should not exceed four times the horizontal distance from the base of the ladder to the wall.

Use both hands and feet when climbing and descending a ladder. Face the ladder at all times and maintain a three point stance when stationary. Keep the area clear around the top and the bottom of the ladder. Do not move, shift or adjust the ladder when anybody is on it.

A-frame ladders should always be fully opened with the braces locked. Never use a folded A-frame ladder to lean against a wall. Never stand on or above the top two steps on an A-frame ladder. Use a four point stance to climb A-frame ladders but a two point stance can be used to remain stationary.

A lift is any manually, mechanically or pneumatically propelled device intended to raise a work platform. Any employee working on a platform over 6 feet off the ground must employ a properly secured body harness before proceeding with work activities. Lifts must never be employed on a slopped surface. The base of the lift must be able to withstand a minimum horizontal test force of fifty pounds applied to any point on the perimeter of the platform while the platform is carrying the rated work load.

The platform must be provided with a guardrail around its upper periphery and the guardrail must be at least thirty-eight inches high but no more than forty-five inches high, with a mid-rail approximately midway between the top rail and the platform surface. The platform must have a slip resistant surface.

Where the elevation of the platform is accomplished by an electromechanical assembly, the system must be designed to prevent free descent in the event of a generator or power failure.

9. Drowning

Clear Water employees are frequently exposed to drowning hazards when operating in the field. Open ponds, steel storage tanks, underground vaults and catch basins are all typically encountered on Clear Water project sites. Because of the nature of these sites (construction sites), drowning protection requirements are less stringent. For this reason, Clear Water employees must be extra vigilant when protecting themselves and others against drowning hazards. Additionally, employees will frequently be working alone on site and rescue assistance will be unavailable to workers who fall in a pond. Always evaluate pond configurations before working on site and avoid working in the most dangerous areas. Inform your supervisor if you cannot swim.

Clear Water employees must follow the rules and procedures spelled out in the Confined Space Program to help protect against drowning hazards. Steel storage tanks, underground vaults and catch basins are considered confined spaces and present increased drowning risks relative to open ponds. Confined space entry has many hazards including drowning and proper procedures must be strictly followed and monitored for safe completion of any job involving confined space entry.

Some ponds are lined with a plastic liner. Plastic liners are particularly slippery and pose difficulties to individuals extracting themselves from such ponds. Climb out ropes (lifelines) will be installed in all ponds with plastic liners.

LOCKOUT/TAGOUT PROGRAM

1. Introduction and Purpose

The purpose of the lockout/tagout program is to ensure that persons assigned to tasks requiring the control of hazardous energy are fully trained in the procedures for isolating machines or equipment from energy sources. An energy source may be electrical, hydraulic, pneumatic, mechanical, chemical, or gravitational in nature.

Procedures are necessary to prevent the unintentional operation of equipment that could injure employees or damage property. Lockout is the preferred method of isolating machines or equipment from energy sources. Tagout will be used to identify the activities that require the lockout procedures and will also identify the workers that initiated the lockout.

2. Responsibilities

The Company Safety Officer (CSO) is responsible for directing the implementation of the Program, and periodically reviewing and updating the Program. The CSO or designated representative will maintain all records pertaining to the program and will see that new information is passed on to affected personnel. The CSO is also responsible for scheduling health and safety training and ensuring that all field personnel have met the program training requirements.

Employees involved in operations, maintenance, manufacturing or repair will be instructed as to the significance and necessity of the lockout/tagout procedures. Each new or transferred employee whose work operations may involve the use of hazardous energy will be instructed in the purpose and use of the lockout/tagout procedures.

3. Preparation for Lockout/Tagout

The Project Safety Officer or competent individual will make a survey to identify all energy isolating devices and to be certain that the correct switches, valves, or other energy isolating devices affecting the equipment are locked or tagged. Personnel will be informed of all precautionary measures that must be observed to protect workers during normal operating conditions and during potential emergencies.

4. Information and Training

Employees will receive training on the following topics:

- Recognition of hazardous energy sources and methods of energy isolation and control
- Purpose and use of lockout/tagout procedures
- Worker and management responsibilities
- Reporting injuries/ hazardous work environment

- First aid procedures

Prior to starting work, each new employee potentially affected by the lockout/tagout program will receive lockout/tagout training. Retraining of employees may be conducted whenever 1) there is a change in job assignments, 2) there is a change in machinery, equipment, or processes that present new energy hazards, 3) inspections or other events reveal that energy control procedures are inadequate.

5. Sequence of Lockout/Tagout System

The following sequence of activities will be conducted whenever maintenance, repairs, or other work is performed on equipment subject to the release of hazardous energy:

1. Notify all affected employees that a lockout/tagout system is going to be utilized, and provide the reason for the lockout/tagout. The employees authorized to do the work will be informed of the type and magnitude of energy that the machine or equipment utilizes. The employees must demonstrate an understanding of the potential hazards.
2. If the machine or equipment is operating, shut it down by the normal stopping procedure (e.g., depress the stop button, turn the switch off, etc.).
3. Set the switch, breaker, valve, or other energy isolating device so that the equipment is isolated from the energy source. Stored energy (such as in springs, elevated machine members, flywheels, hydraulic systems, and air, gas, steam, or water pressure, etc.) must be dissipated or restrained by methods such as repositioning, disconnecting, blocking, bleeding pressure, etc.

<u>Caution</u>: Never pull fuses or open circuits under load. Severe arcing or explosions may occur.

4. Lock and tag the energy source(s) with assigned locks and appropriately labeled tags. The use of tags without locks is only permissible when it is impossible to physically secure the energy control point. This exception may only be used with the permission of the Project Safety Officer.

<u>Note</u>: Tags are warning devices and do not provide physical restraint. They must never be ignored and are not to be removed without authorization of the worker that installed the tags.

5. Check the scene to make sure that no personnel are exposed; then attempt to use or operate the equipment as a means of check that all energy sources have been isolated or secured. Check electrical circuits for the presence of high voltage.
6. If there are any doubts or questions about the lockout procedures, contact the Onsite Supervisor or the Project Safety Officer.

If a machine can be unplugged and the plug is in sight of, and under direct control of, a worker (or the energy is isolated and the entire system is in sight of, and under the direct control of, the worker), then these procedures will not be mandatory.

Tags must be legible and made of a durable material, and must be attached securely.

6. Restoring Machines or Equipment to Normal Operations

After the servicing and maintenance is complete and equipment is ready for normal operation, check the area around the machines or equipment to ensure that all tools have been removed, guards have been reinstalled, and all personnel are in the clear. Remove all locks, tags, and deactivate energy isolating devices so that energy is restored to the equipment.

7. Procedures Involving More Than One Person

In the lockout/tagout sequence presented above, if more than one individual is required to lockout/tagout the equipment, then each individual will place their own lockout device(s) or tags on the energy isolating apparatus. Where an energy isolating apparatus cannot accept multiple locks, a hasp capable of accepting multiple locks will be affixed to the apparatus.

8. List of "Don'ts" Related to Lockout/Tagout Procedures

- Don't count on control circuits to disable equipment
- Don't pull fuses and consider a system safe.
- Don't loan your lockout lock to anyone.
- Don't forget to check all sources of energy affecting a system.
- Don't hesitate to ask others if you are not sure you have identified all energy sources.
- Don't fail to test the system after lockout to be sure the power is truly disconnected.
- Don't ever remove the lockout lock of another worker from an energy isolating device.
- Don't remove guards until equipment is locked out.
- Don't use push-button switches for lockout.
- Don't assume that a job is too small to merit locking out.
- Don't make exceptions or compromises while performing lockout activities.

VOLUNTARY RESPIRATORY PROTECTION PROGRAM

1. Program Scope

The purpose of this written respiratory protection program is to give detailed instructions on how to safely use respiratory protection in the work place that complies with OSHA/WISHA requirements. This is a voluntary program and does not apply in situations where respiratory hazards, such as exposure to a substance over the permissible exposure limit (PEL) or hazardous exposure to an airborne biological hazard, are present. Voluntary use of filtering facepiece respirators (dust masks) is exempt from the written respiratory requirements.

This program applies to all employees who voluntarily choose to use a respirator. It applies to both respirators supplied by the company or brought in by employees. It will be determined that the use of a respirator does not itself create a hazard, that the proper type of respirator has been selected for use, that the employee is medically able to use the respirator, and that the respirator is cleaned, stored and maintained so that it does not present a health hazard.

To provide proper protection, respirators must be the right type, must be worn correctly at all times, and must be maintained properly. Masks are prone to leakage, require correct behavior of the user and may require much maintenance and management oversight. This is why they are considered as a last resort to protect employees from airborne chemical hazards.

It is often more protective, less trouble, and even cheaper to eliminate or reduce the respiratory hazard through various ways like exhaust ventilation, changes in process, or enclosure of the process. Sometimes the use of a hazardous substance itself can be eliminated. But, when there is no alternative, a respirator program must be implemented to protect employees from adverse health effects of exposure to chemicals in the air above their permissible exposure limits.

See addendum for rules that apply to required respirator use.

2. Responsibilities

The Company Safety Officer will act the respiratory protection Program Administrator (PA). The PA is responsible for overseeing, training and implementing the program. The PA is responsible for providing all necessary documents and information for any required medical evaluations. The PA will be responsible for providing employees with proper respiratory equipment and advisory information. The PA will train employees to evaluate methods to eliminate respiratory and work hazards that may be introduced by the use of respiratory protection.

Employees are responsible for maintaining, cleaning, and storing respirators in a proper manner. Employees are responsible for notifying the PA when their respirator filter cartridges need to be replaced.

3. Medical Evaluations

Every employee of this company who wears a respirator will be provided with a medical evaluation before they are allowed to use the respirator. A medical questionnaire will be furnished to those employees. Employees are required to fill out the questionnaire in private and provide it to the Licensed Health Care Professional (LHCP) before the evaluation. Completed questionnaires are confidential and will be sent directly to the medical provider without review by management. Employees will not be allowed to wear respirators until a LHCP has determined that they are medically able to do so.

If the medical questionnaire indicates to our medical provider that a further medical exam is required, this will be provided at no cost to the employees. Clear Water will get a recommendation from this medical provider on whether or not the employee is medically able to wear a respirator.

Additional medical evaluations will be done in the following situations:

- our medical provider recommends it,
- our respirator program administrator decides it is needed,
- an employee shows signs of breathing difficulty,
- changes in work conditions that increase employee physical stress (such as high temperatures or greater physical exertion).

Clear Water will obtain a written recommendation from the LHCP on whether or not the employee is medically able to wear a respirator. The recommendation must identify any limitations on the employee's use of the respirator, as well as specifying whether or not periodic or further medical evaluations are required by the LHCP. The PA will retain a copy of the LHCP's written recommendation for each employee subjected to a medical evaluation.

The employee will receive a copy of the LHCP's written recommendations directly from the LCHP. Information concerning diagnosis, test results, or other confidential medical information will not be disclosed to the company by the LHCP.

4. Training

Employees must be trained on the use of respirators before wearing them. Refresher training will be conducted annually. Additional training will be given if the introduction of a different type of respirator is introduced into the workplace. Training topics will include:

- Why a respirator should be used

- Respirator capabilities and limitations
- How improper fit, use or maintenance can make the respirator ineffective
- How to properly inspect, put on, seal check, use, and remove the respirator
- How to clean, repair and store the respirator

5. Respirator Use

The PA will monitor work areas in order to be aware of changing conditions where employees are using respirators.

Employees will not be allowed to wear respirators with tight-fitting facepieces if they have facial hair, absence of normally worn dentures, facial deformities (e.g., scars, deep skin creases, prominent cheekbones), or other facial features that interfere with the facepiece seal or valve function. Jewelry or headgear that projects under the facepiece seal is also not allowed.

If corrective glasses or other personal protective equipment is worn, it will not interfere with the seal of the facepiece to the face.

Note: Full-facepiece respirators can be provided with corrective glasses since corrective lenses can be mounted inside a full-facepiece respirator. Contact lenses can also be used with full facepiece respirators if they do not cause any problems for the employee.

A seal check will be performed by the employee every time a tight-fitting respirator is put on.

The PA will make sure that the NIOSH labels and color-coding on respirator filters and cartridges remain readable and intact during use.

Employees will leave the area where respirators are required for any of the following reasons:

- to replace filters or cartridges,
- when they smell or taste a chemical inside the respirator,
- when they notice a change in breathing resistance
- to adjust their respirator,
- to wash their face or respirator,
- if they become ill, if they experience dizziness, nausea, weakness, breathing difficulty, coughing, sneezing vomiting, fever or chills.

6. MAINTENANCE AND CLEANING

To ensure that the respirator does not create a health hazard for users, a maintenance program must be in place prior to respirator use. The maintenance program will address cleaning, disinfecting and storage. Respirators used must be clean, sanitary and in good working order. Clean, sanitary respirators are essential in the prevention of dermatitis, skin irritation and communicable respiratory diseases. These requirements are a vital part of any successful respiratory protection program.

Face fitting respirators will be cleaned and disinfected by the user after every use.

Cleaning Procedure

1. Remove filter cartridges or any other components recommended by the manufacturer. Discard any defective or expired parts. Filter cartridges that are not expired or saturated may be reused ONLY by the individual who originally used them. Used cartridges will be returned to the PA and will be stored in a self sealing quart sized freezer bag with the users name clearly printed on the front.

2. Wash components in warm water (110˚F) with a mild detergent or with a cleaner recommended by the manufacturer. A stiff bristle (non-wire) brush may be used to help remove dirt.

3. Immerse the mask in a 50 ppm chlorine solution for two minutes. Consult the PA for instructions on mixing this solution.

4. Throughly rinse the mask in clean warm running water. Residue from some detergents and disinfectants can cause skin irritation and cause deterioration of the mask. Therefore, the importance of over rinsing cannot be overemphasized.

5. Air dry the mask completely or hand dry with a clean, lint free cloth.

6. Return the mask to the PA for inspection and proper storage.

Respirators will be stored so that they are protected against damage, contamination, dust, sunlight, temperature extremes, excessive moisture, and damaging chemicals. When respirators are packed or stored, the facepiece and exhalation valve will be stored in a manner that prevents deformation. Each respirator will be positioned so that it retains its natural configuration.

HEAT RELATED ILLNESS PROGRAM

1. Company Policy

It is the policy of Clear Water Compliance Services, that all affected employees are required to comply with this Heat Related Illness (HRI) policy and are encouraged to actively participate in identifying ways to reduce the risk of experiencing heat-related illness in the work place.

Supervisors are responsible for the safety of their employees and as a part of their daily duties must check the workplace for unsafe conditions, monitor the health and safety of employees, and take prompt action in response to any identified HRI hazards.

Clear Water management will initiate and maintain this Heat-Related Illness program. Clear Water's HRI Program will consist of four main segments:

- Establish and implement written procedures addressing heat related illness including hazard evaluations, exposure determination, and preventative action.
- Provide and make accessible enough drinking water, when heat-related hazards are present, so that each employee can drink at least 1 quart per hour.
- Have formalized procedures in place to respond to employees experiencing signs or symptoms of heat-related illness.
- Provide effective heat-related illness prevention training to all employees and supervisors.

2. Hazard Evaluation

Several factors can influence the extent of heat related illness including air temperature, humidity, radiant heat, air movement, work load and personal protective equipment. Supervisors should consider these factors in combination with each other when evaluating the possibility of a HRI incident during a particular work day.

- Temperature and Humidity – temperatures of greater than 75°F or a 10°F spike in temperature can create HRI hazards. High humidity (approaching 80% and greater) is an important factor because it limits sweat production and evaporation. Supervisors should consult National Weather Service or similar websites to evaluate conditions before sending crews to the field.
- Radiant Heat – is the transfer of heat energy through the air. Examples include heat generated from the sun, gravel, steel tanks, asphalt, or equipment. Radiant heat can raise employee exposure as much as 15°F.
- Air Movement – can affect an employee's ability to cool off. Air temperatures less than 95°F will generally aid an employee in cooling off. Air temperature greater than 95°F may cause employees to gain heat.

- Workload Activity and Duration – physical work creates internal heat in the body and can increase susceptibility to HRI.
- Personal Protective Equipment/Clothing – PPE and/or clothing can increase the risk of HRI. Fabrics that do not “breath” freely can trap sweat next to the skin, decreasing an employee’s ability to cool off.

3. Exposure Determination

Heat-related illnesses do not always occur in the same way – a person can go from muscle cramps straight to heat stroke quickly and without experiencing any other signs or symptoms. Also, heat-related illness may progress over several days. This is why it is so important to identify symptoms of heat-related illness promptly and treat them all seriously. Also, make sure that all employees know the signs and symptoms of heat-related illness and the company plan for providing first aid and, if necessary, contacting emergency medical services.

Refer to the table below to help identify signs of HRI.

Heat-Related Illness	Symptoms you may experience	Signs to look for in others	Treatment
Heat Rash	– Red blister-like eruptions – Itching (prickly sensation)	– Red blister-like eruptions	– Rest in a cool place. – Allow the skin to dry. – Monitor for infection.
Heat Cramps	– Painful spasms	– Abnormal body posture – Grasping the affected area	– Rest in a cool place. – Drink water or a heavily diluted sports beverage (such as Gatorade). – Seek medical attention if cramping is severe or does not go away.
Severe Heat-Related Illnesses			
Heat Exhaustion	– Weakness – Fatigue – Blurred vision – Dizziness – Headache	– High pulse rate – Extreme sweating – Pale face – Insecure gait – Normal to slightly elevated temperature – Clammy and moist skin	– Lay the worker down in a cool, shaded area; do not leave them alone. – Loosen and remove heavy clothing that restricts evaporative cooling. – Give cool water to drink, about a cup every 15 minutes. – Fan the worker, spray with cool water, or apply a wet cloth to their skin to increase evaporative cooling. – Recovery should be rapid. **Call 911 if they do not feel better in a few minutes**. – Do not further expose the worker to heat that day. Have them rest and continue to drink cool water.

Heat Stroke	– Rapid pulse – Chills – Restlessness – Irritability	– Rapid pulse – Red face – Hot dry skin (25% - 50% of cases) – Disorientation – High temperature (≥ 104° F) – Erratic behavior – Shivering – Collapse – Convulsions – Fainting **Heat Stroke may resemble a heart attack.**	**Get immediate medical help, call 911 for transport to a hospital as quickly as possible.** – If the person is alert and not feeling nauseous, have them sip cool water. – Move the worker to a cool, shaded area and remove clothing that restricts cooling. – ***Seconds count*** – Cool the worker rapidly using whatever methods you have available. For example, o Immerse the worker in a tub of cool water; o Place the worker in a cool shower; o Spray the worker with cool water from a garden hose; o Sponge the worker with cool water; o If the humidity is low, wrap the worker in a cool, wet sheet and fan them vigorously. – Continue cooling until medical help arrives. – If emergency medical help is delayed, call the hospital emergency room for further instructions.

The telling difference between heat stroke and heat exhaustion is the mental confusion or disorientation that happens in ALL heat stroke victims.
To assess the level of confusion or disorientation, you can ask these 3 questions:

- What is your name?
- What day is this?
- Where are we?

If a person cannot quickly answer one or more of these questions, call 911, and take immediate action while waiting for professional help to arrive.

4. Preventative Action

There are several steps that can be taken to reduce the possibility of HRI.

- Perform work during cooler parts of the day or in the shade when possible.
- Encourage employees to take frequent, short breaks in a shaded or cooled area.
- Provide sufficient amounts of water and encourage consumption.
- Ensure first-aid trained personnel are on site.
- Encourage employees to wear breathable, light colored clothes.
- Encourage the use of sunscreen lotion and sunglasses.
- When possible, schedule multiple employees during the same shift to help monitor each other for signs of heat related illness.

5. Drinking Water

When HRI hazards are present, drinking water must be provided and made accessible in sufficient quantities. The Washington Dept. of Labor and Industries specifies that employees subjected to HRI hazards must be provided with 1 quart of drinking water per hour. Additionally, water should be kept cold to cool down a person's core body temperature. Clear Water will provide cold drinking water from either a prepackaged consumer product or prepared from a public drinking water system.

6. Heat Related Illness Response

Employees experiencing signs or symptoms of HRI must be relieved from duty and provided with a sufficient means to reduce body temperature. *Examples include, but are not limited to, the provision of shaded rest areas, consumption of cold drinking water, access to temperature controlled environments (air conditioning).* Employees experiencing signs or symptoms of HRI must be carefully evaluated to determine whether it is appropriate to return to work or if medical attention is necessary.

Refer to the table on page 47 for the different symptoms and appropriate treatment responses for various Heat Related Illnesses.

7. Heat Related Illness Training

All training must be provided prior to outdoor work assignments presenting heat-related illness hazards. Training in the following topics must be provided to all employees who may be exposed to a HRI hazards.

- The environmental factors that contribute to the risk of HRI
- Awareness of personal factors that may increase susceptibility to heat HRI
- The employer's procedures for identifying, evaluating, and controlling exposure
- The importance of removing personal protective equipment during all breaks
- The importance of frequent consumption of small quantities of water, 1 quart or more over the course of an hour may be necessary when the work environment is hot and employees may be sweating more than usual in the performance of their duties
- The different types of heat-related illness and the common signs and symptoms of heat-related illness
- The importance of immediately reporting to the Project Manager and, Safety Officer, incidents of HRI in themselves, or in co-workers
- The employer's procedures for responding to symptoms of possible heat-related illness, including how emergency medical services will be provided should they become necessary.

Attachment 1

Site HASP Checklist

Clear Water Compliance Services

Weekly Jobsite Health and Safety Checklist

Field technicians will attend the initial safety meeting and, thereafter, will review all safety requirements on a weekly basis. This weekly health and safety checklist will be reviewed and signed by all employees on site for that particular week. File all old checklists in the Health and Safety folder. Weekly reassessments of site hazards should be conducted by designated responsible individual(s) and recorded in this form.

SITE :______________________________ WEEK OF: ___________to___________

	Policy understood	Hazard present	recent change	Comments
Hazards				
Chemical Exposure				
Fire Hazards				
Biological Hazards				
Physical Hazards				
Electrical Hazards				
Heat and Cold				
Noise				
Policy & Procedures				
Responsibilities				
Training				
PPE use				
CHCP				
Lockout/Tagout				
Confined Space				
Driving Safety				
Core Safety				
Accident Reporting				
Hazard reporting				
Minor injury accidents				
First Aid/CPR				
Hospital Route				
Emergency contacts				
Disciplinary procedures				

PRINT	SIGN	DATE(S)
______________________	______________________	______________________
______________________	______________________	______________________
______________________	______________________	______________________
______________________	______________________	______________________
______________________	______________________	______________________
______________________	______________________	______________________
______________________	______________________	______________________

Attachment 2

Non-Permit Certification

CLEAR WATER COMPLIANCE SERVICES

CONFINED SPACE ENTRY
NO PERMIT REQUIRED CERTIFICATION

DATE: ________________

SITE LOCATION: ____

HAZARDS DETECTED: ____

____

____

HAZARDS ELIMINATION: _____________________________________

____

____

Site Safety Officer____
(Print/Sign)

Entrant____
(Print/Sign)

Entrant____
(Print/Sign)

Assistant____
(Print/Sign)

Assistant____
(Print/Sign)

Attachment 3

Confined Space Program

CONFINED SPACE ENTRY PROGRAM

1. Purpose

The purpose of the confined space entry program is to establish confined space safe practices in accordance with applicable federal, state, and local requirements. Clear Water and its associated work places have confined spaces that due to various chemical and physical properties may cause death or serious injury to employees who may enter them. This Confined Space Entry Program is developed and established to identify, evaluate, and control such spaces, and more importantly, to detail procedures and responsibilities for entering and working within confined spaces.

It is Clear Water's policy that every effort will be made to avoid entering a confined space. Company employees will enter confined spaces only when authorized. All necessary confined space entry will be carried out by employees who have been properly trained in confined space entry procedures.

Adherence to the policies and directives contained in this program is mandatory for all Clear Water employees. Employees failing to follow this program are subject to disciplinary action and/or dismissal. For more information concerning confined space standards, please refer to the reference section at the end of this chapter.

2. Background

A confined space is any enclosed area that is large enough for a person to enter, has limited means of entry or exit and is not designed for continuous human occupancy. Examples of confined spaces include, but are not limited to, tanks, tunnels, ventilation ducts, crawl spaces, manholes, vaults, and trenches.

Confined spaces can be hazardous in may ways. For example, confined spaces limit a worker's ability to avoid contact with electricity, moving mechanical parts or machinery, unstable substances that can engulf or hazardous atmospheres that can displace breathable air.

Confined space hazards can cause serious injury or death. Atmospheric hazards (such as oxygen deficiency and toxic air contaminants) are the leading cause of death in confined spaces. **More than 60 percent of confined space fatalities occur among would be rescuers.** The major reasons for confined space fatalities include failure to recognize and control confined space hazards and establish rescue procedures prior to entry. Because of the hazards inherent in confined spaces, emergency responders must not enter confined spaces unless they are properly trained and equipped.

Confined spaces are classified as either non-permit confined spaces or permit-required confined spaces (PRCSs). A non-permit confined space contains no hazards; however, a non-permit space can develop into a PRCS if conditions change (e.g., the type of work performed in or near the space changes or atmospheric conditions change). A PRCS may contain hazardous atmospheres or other safety and health hazards. A PRCS requires a written self-issued entry permit and an attendant prior to entry into the space.

3. Contractors

Contract employees working in or near a PRCS are responsible for:

- Obtaining any information, before work, on hazards of PRCSs employees will be entering or working near.
- Submit a copy of their HASP and PRCS procedures to Clear Water before work. PRCS procedure must meet OSHA's PRCS standards.
- Coordinate entry operations with Clear Water.
- Debrief Clear Water at the conclusion of entry operations on any matters concerning hazards created or confronted in the PRCS during entry operations.

A host employer is an employer that "arranges" to have employees of another employer perform work that involves a PRCS. Host employer responsibilities are specified in Section 29 CFR 1910.146(c)(8) of the OSHA PRCS standard. When a PRCS operation involves multiple employers, one employer must have operational control over the PRCS. This employer is the controlling employer. The host employer and the controlling employer must be clearly designated. In most incidents involving PRCS operations, EPA will function as the host employer, but not the controlling employer of the space.

4. Training

Only trained and qualified employees may be authorized as Entrant, Attendant, Entry Supervisor, or in-house Rescue Team members. The training will establish proficiency in recognizing confined spaces; evaluating the hazards of confined spaces; understanding the OSHA requirements for PRCS procedures; and ensuring that appropriate practices and procedures are adopted or developed and implemented prior to personnel entering PRCS.

Training must be completed before employee is assigned duties under this program, before there is a change in assigned duties and, whenever a supervisor has reason to believe either that there are deviations from permit space entry procedures or inadequacies in the employee's knowledge or use of this program. Additionally, a pre-entry safety meeting will be conducted by the entry supervisor before any PRCS begins.

Clear Water will provide training for an in-house PRCS rescue team. All members of the rescue team must be First Aid/CPR certified. The rescue team must engage in an actual or simulated PRCS rescue at least once every 12 months

The CSO (Company Safety Officer) will certify that the employee is familiar with the company confined space policy and the training course has been successfully completed. The certification will contain the name and signature of both the employee and trainer and, the dates of training. The certification will be kept on file.

The following elements will be incorporated for every facet of the training program:

- Clear Water's confined space safety plan
- Confined Space recognition
- Acceptable entry conditions
- Potential hazards of the space including symptoms and effects
- Communication procedures and proper use of all communication equipment
- General knowledge of the permitting system and entry procedures

Specific Duties

Entrant	Attendant	Supervisor	Rescue Team
• Proper use and maintenance of entrant PPE and equipment • Evacuation and self rescue procedures	• Unauthorized entry prevention • Emergency response recognition • Non-entry rescue procedures	• Permit required monitoring • PPE and equipment oversight • Unauthorized entry prevention • Emergency response recognition • Rescue procedures • Permit authorization and termination • Host contractor responsibilities	• Basic first aid/CPR • Non-entry and entry rescue procedures • Entry rescue procedures • Rescue PPE use and maintenance • Participation an annual rescue simulations

Table 1

5. Confined Space Recognition

The CSO will survey all work sites to determine if they contain confined spaces. All confined spaces will be identified to affected employees at their initial work site safety orientation. Additionally, confined spaces will be noted at regular tailgate safety meetings. All confined spaces will be assumed to be PRCS unless specifically identified as non-permit for a particular entry event.

All confined spaces must be constantly identified by posting a danger sign. A sign reading "DANGER – PERMIT REQUIRED CONFINED SPACE, DO NOT ENTER" must be mounted at the entry point. Mechanical measures must be taken to prevent unauthorized employees from entering the space. Pad locks, bolted covers, or covers requiring special tools to remove are examples of appropriate mechanical measures.

6. Confined Space Hazards

The hazards found in any confined space are determined by (1) the process or work taking place inside the space, (2) the material(s) being stored or used, and (3) the effects of the PRCS environment. Confined space hazards can include physical hazards and hazardous atmospheres.

Physical Hazards - Physical hazards includes drowning, engulfment, the entire spectrum of hazardous energy (e.g., activation of electrical or mechanical equipment), release of hazardous materials through lines connected with the confined space, falling objects, wet or slick surfaces, extremely hot or cold temperatures, excessive noise, and others.

Drowning hazards are common on Clear Water work sites. Open top tanks, weir tanks, and plastic lined ponds are all regular features a company employee should expect to encounter on a daily basis. These confined spaces are particularly dangerous because they are so common, can be accidentally entered through a fall, and are difficult to escape.

Hazardous Atmosphere - Among the most dangerous confined space hazards are hazardous atmospheres. A hazardous atmosphere is one that may expose workers to the risk of death, incapacitation, impairment of the ability to self-rescue, injury, acute illness, or that is otherwise immediately dangerous to life or health (IDLH). Atmospheric hazards can include oxygen deficiency or enrichment, and flammable/explosive or toxic air contaminants. Hazardous and toxic confined space atmospheres are summarized in Table 2.

7. Confined Space Atmosphere Monitoring

Air monitoring is required for evaluating the atmospheric hazards of a confined space and verifying acceptable conditions prior to and during entry. Air monitoring must be conducted with real-time direct-reading equipment and documented on the PRCS entry permit. The results of air monitoring must be presented during the PRCS pre-entry safety briefings.

No entry may be made into any confined spaces until the atmosphere has been monitored to determine if acceptable entry conditions exist prior to entry. Monitoring must be conducted with direct-reading equipment (e.g., multigas detectors) that is used, calibrated, and maintained in accordance with the manufacturer's instructions. Acceptable entry conditions and the frequency of periodic monitoring of the space (unless continuous monitoring is required) must be specified on the PRCS entry permit.

If authorized entrants, attendants, and/or entry supervisors will be using air monitoring equipment, they must receive training on the equipment's use and limitations. The equipment user must read and understand the manufacturer's instructions and practices, including calibration, prior to using the equipment.

Table 2
Hazardous Atmospheres in Confined Spaces

Oxygen Deficient	**Oxygen Enriched**	**Flammable/Explosive**	**Toxic**
An atmosphere containing less than 19.5% oxygen by volume.	An atmosphere containing more than 23.5% oxygen by volume.	Flammable gas, vapor, or mist greater than 10% of its lower flammable limit (LFL). Airborne combustible dust at a concentration that meets or exceeds its LFL. [This concentration is approximated as a condition where the dust obscures vision at a distance of 5 feet or less.]	Atmospheric concentration of any substance in excess of its OSHA Permissible Exposure Limit (PEL), ACGIH Threshold Limit Value (TLV), or recommended occupational exposure limit.

Initial Evaluation Monitoring - The atmosphere of a confined space must be monitored using equipment of sufficient sensitivity and specificity to identify and evaluate any hazardous atmospheres that might exist or arise. Evaluation and interpretation of these data, and development of the entry procedures and acceptable entry conditions, must be done (or reviewed) by a technically qualified individual.

Avoid entering (e.g., leaning over) the space. Monitor from outside the confined space using remote probes and sampling lines. If entry into the space is required to evaluate the atmospheric hazards, it must be performed in accordance with PRCS HASP procedures.

Attempt initial monitoring without disturbing the space, if possible. Monitor the air through vent hole or some other opening. Where no openings exist, open the entrance cover on the downwind side of the space just enough to allow insertion of the probe (if applicable). The purpose of this procedure is to determine if any lighter-than air gases have accumulated in the space. Monitoring prior to disturbing the space should approximate the "ambient" conditions.

Turn off mechanical ventilation if it is being used. Testing with the ventilation off will closely represent the ambient atmosphere inside a confined space in the event of a ventilation system failure. Then turn the ventilation back on and retest the space. Testing with the ventilation on will determine whether the ventilation system is removing the air contaminants, if any are present. Using this procedure may also reveal if the ventilation system is a source of air contaminants.

Verification Monitoring - All potential hazardous air contaminants identified during the initial evaluation must be monitored (using permit specified equipment) prior to entry and again during entry to ensure that contaminant concentrations are within the range of acceptable entry conditions specified on the PRCS entry permit. These conditions are specified by the Entry Supervisor before entrance. Air monitoring results must be documented on the PRCS entry permit.

Duration of Monitoring - Hazardous air contaminants must be monitored for at least the minimum response time of the test equipment specified by the equipment manufacturer (i.e., you need to allow enough time for the air sample to reach the sensors in the equipment). The configuration of the test equipment will affect the response time and must be taken into consideration. For example, if a multigas detector is configured for remote air monitoring the response time will be slowed because it is connected to remote monitoring accessories such as a sampling pump (attached to the multigas detector), a length of flexible tubing, and a probe. Consult the equipment operating manual or manufacturer for information regarding equipment response time.

Methods of Monitoring - Monitoring procedures may vary depending on the type of confined space being evaluated. Always monitor as much of the space's horizontal area as possible (i.e., within reach) and monitor several different vertical levels—top, middle, and bottom. Monitor where hazardous substances might leak or collect in the space (i.e., monitor adjacent to any pipes, ducts, conduits, or cables, below steel gratings or between rafters, and around all irregular interior surfaces). Monitor continuously or periodically for as long as the space is occupied and as appropriate for the hazard involved.

Equipment Calibration - Air monitoring with direct-reading equipment must be conducted only after the equipment has been calibrated in accordance with the manufacturers' requirements. Depending on equipment usage, more frequent calibration may be necessary to ensure reliability. At a minimum, a functional check (bump test) must be conducted prior to each entry. Equipment must be zeroed in a clean environment (e.g., an office, outdoors, etc.).

Equipment Limitations - To evaluate the atmosphere, the air monitoring equipment user must know and understand the proper operating and calibration procedures as well as the limitations of the equipment. For example, some equipment can give inaccurate test results if the temperature or humidity is too high or low, or if the air contains certain interfering chemicals. Consult the manufacturer's instructions for proper operating procedures and equipment limitations. Common limiting factors and/or error introducing factors associated with direct-reading (real-time) air monitoring equipment may include one or more of the following:

- Oxygen concentration
- Warm up time
- Lag time when using remote monitoring methods (probes, extension tubes, and lines)
- Catalyst poisons and/or interfering chemicals
- Conversion factors and response curves to convert readings for non-calibrant gases
- Temperature and/or humidity
- Electromagnetic/radiofrequency interferences (EMI/RFI)
- Battery power
- Lack of user knowledge, experience, and/or failure to calibrate properly.

8. Minimizing Confined Space Hazards

The best way to minimize confined space hazards is to eliminate them all together. It is clear waters policy to avoid entering confined spaces if at all possible. Many tasks that may appear to require confined space entry can be accomplished by other means through better design, engineering, planning, and execution.

Confined spaces can contain different types of hazards ranging from oxygen-deficient or toxic atmospheres to the release of one or more forms of hazardous energy (e.g., mechanical, electrical, hydraulic, pneumatic, chemical, thermal, or other energy). Prior to entry, appropriate protective measures must be taken to ensure the safety of workers. Any conditions making it unsafe to remove confined space entrance covers must be eliminated before the covers are removed (if applicable) and authorized entrants must be protected from external hazards (e.g., from objects falling into the space) by guarding confined space openings with temporary barriers.

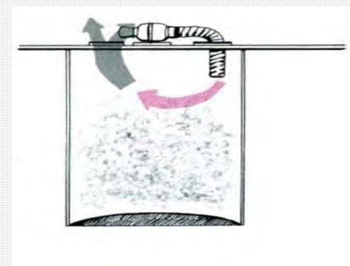
Confined space hazard control is achieved through the use of engineering controls, work practices and other administrative controls, and/or the use of PPE. The measures taken will depend on the nature of the hazards and whether the hazards will be eliminated from the space or controlled during entry. Engineering controls (such as ventilation) are the preferred method of hazard control and every effort must be made to implement effective engineering controls. When engineering and work practice controls are not feasible or insufficient, it may be necessary to protect workers with PPE. Assignment of hazard controls must be designated on the PRCS entry permit and discussed during the pre-entry safety briefings before each shift. Hazard control measures are discussed below.

Ventilation - Ventilation (such as local exhaust ventilation (LEV) and/or general dilution ventilation) controls the atmospheric hazards of a confined space by mechanical means. General ventilation flushes the atmosphere by supplying fresh air or exhausting large volumes of potentially contaminated air. Because this system does not reduce the amount (mass) of contaminants released, it is not recommended for highly toxic atmospheres. General ventilation is the best way to provide fresh air to a confined space or to control low concentrations of contaminants that are not highly toxic. Use general ventilation when contaminants are widely dispersed or for confined spaces where LEV may be difficult or impractical to install (such as a long underground pipeline or sewer). General ventilation often improves worker comfort in hot climates, especially when PPE is also employed. Ventilation must always be addressed during the PRCS pre-entry safety briefing before each shift.

Emergency responders must mechanically ventilate PRCSs until air monitoring results are within acceptable limits and provide continuous ventilation during the entry until all personnel have left the space. (**Note that purging and ventilating does not preclude the requirement for air monitoring**.) Emergency responders must ensure that the ventilation air does not create an additional hazard from recirculation of contaminants, improper arrangement of the inlet duct, or the substitution of anything other than fresh air.

Exhaust toxic or flammable air contaminants and supply fresh air when the space is oxygen-deficient. Monitor the air before entry to confirm that the ventilation has been successful and that the space is safe for entry. Continue the ventilation as long as the work in progress can make the air unsafe (e.g., using solvents) or as long as the space is occupied. Monitor the air periodically (or continuously) to ensure that the ventilation is keeping the space safe. Use natural ventilation exclusively for non-permit space entry. Keep ducts short and straight (to the extent possible) with no sharp bends. Secure ductwork if possible to prevent slip, trip, and fall hazards. Select a fan with the capacity to quickly replace the volume of air within the space. Locate the supply air fan intake in an area that will provide only clean, fresh air (e.g., upwind of the confined space entry with the inlet of the fan facing into the wind and out of the path of the purged air escaping from the space or any flammable or toxic materials that could be introduced into the space).

Avoid Recirculation of Contaminated Exhaust Air Back into the Confined Space



Recirculation occurs when a supply air fan captures and reintroduces contaminated air that is exhausted or escaping from the space. Prevent recirculation by properly locating supply air fans and/or using additional ductwork to protect the supply air from the exhaust stream. *(Illustration obtained from the Confined Space Ventilation Handbook and used with permission from Coastal Training Technologies Corporation.)*

Purge the supply air duct for a brief period of time before lowering it into the space. Ensure that supply air circulates throughout the space. Position the supply air duct at least 1 foot below the ceiling and at least 2 feet above the floor of the space. For side entry confined spaces, lay the duct on the floor of the space with the end at least 2 feet from the far wall. Arrange exhaust fans so that contaminated air discharged from the space does not present a hazard to personnel or equipment (i.e., the exhaust air should be considered hazardous) and cannot be drawn back into the space. Locate the outlet where air currents will disperse the exhaust quickly. If the exhaust could be flammable, eliminate all sources of ignition from the area.

Lockout/Tagout - Specific procedures must be developed and implemented for each confined space where the unexpected energization, start-up, or release of stored energy could endanger the entrants. Lockout/tagout procedures consist of securing, relieving, disconnecting, and/or restraining hazardous energy sources before entry.

Isolation is an energy control technique used in lockout/tagout programs. Isolation is the process whereby a PRCS is removed from service and completely protected against the release of energy and material into the space. Standard isolation techniques include: blanking and blinding; misaligning or removing sections of lines or pipes; or disconnecting all mechanical linkages.

Work Practices - Work practice controls are procedures that reduce the likelihood of exposure to a hazard (or a hazardous situation) such as written safety policies and rules, supervision, training and information. Before entering a confined space, emergency responders must review and adhere to the site-specific work procedures for safe entry and emergency exit.

Personal Protective Equipment - Appropriate PPE must be provided and worn when engineering and work practice controls do not adequately protect entrants and emergency responders in PRCSs from direct exposure to a hazard. PPE must be selected, used, and maintained in accordance with the manufacturer's requirements. PPE requirements must be specified on the PRCS entry permit and discussed in pre-entry safety briefings before each entry.

9. Communication

Communication methods and equipment to maintain contact between the attendant and entrants must be specified on the PRCS permit and discussed during PRCS pre-entry safety briefings before each shift. The OSHA PRCS standard requires employers to determine the type of communication system necessary for the PRCS being considered. Depending on the conditions existing in the PRCS, communication can be achieved in a number of ways including visual observation, voice communication, hand signals, use of a signal line (rope tugging), telephones, and other portable electronic voice communication equipment.

Continuous voice and visual contact between the attendant and entrants is the best method of communication. This promotes closer teamwork, the ability to monitor and assess the status of entrants on an ongoing basis, a reduced level of fear among entrants (more at ease, reduced stress and anxiety, less prone to feelings of claustrophobia and panic), and increased job efficiency (entrants work better and faster, and are less prone to mistakes and accidents).

Using additional equipment for communication may become necessary in some situations but can be problematic. Radio signals can be interfered and become garbled. Hard wired communication devices present extra obstructions, trip hazards, and interfere with the assigned task. Elements that add time and trouble to the situation should be avoided if possible.

10. Rescue Options

Each PRCS must be reviewed to determine whether to employ self-rescue, non-entry rescue, or entry rescue methods. This decision will depend on the size and configuration of the space; the hazards likely to be encountered, including the presence of entanglement and obstruction hazards; whether the space requires a vertical or horizontal rescue; anchor placement; and the body size of entering personnel. The rescue decisions must be documented on PRCS entry permit.

Self-Rescue - Self-rescue is always the preferred approach when evacuation is necessary. Self-rescue is critical because entrants are:

Alert and conscious; Able to recognize their own symptoms of exposure to a hazardous atmosphere or when unacceptable entry conditions occur; Physically able to evacuate the space unaided and as quickly as possible; Able to alert other workers of impending dangers; and not endangering other personnel.

Non-Entry Rescue - When self-rescue is not possible, non-entry (external) rescue with retrieval systems or methods is the second preferred option and MUST be used whenever an authorized person enters a PRCS, unless the retrieval equipment increases the overall risk of entry or would not be effective in removing the entrant.

Non-entry rescue employs a system of harnesses and lines (or other retrieval systems/aids) on the authorized entrant so the worker can be extracted by rescuers from outside the space (without exposing the rescuers to the PRCS hazards). Each authorized entrant must use a full body harness, with a retrieval line attached at the center of the entrant's back near shoulder level or above the entrant's head.

Retrieval lines must be attached to a mechanical lifting device or fixed anchor outside the PRCS. Mechanical lifting devices must be manually operated, have a mechanical advantage of at least four to one, and the capacity to lift entrants including any attached equipment and tools. Mechanical devices must be available to retrieve personnel from vertical type PRCSs more than 5 feet deep. All retrieval lines used for rescue purpose must meet or exceed ANSI standards.

If non-entry rescue is employed, the Entry Supervisor must ensure that appropriate equipment is available and that rescue personnel are proficient in the use of the equipment and their training is sufficient. Authorized attendants may perform non-entry and entry PRCS rescues provided they have been trained and equipped for rescue operations and relieved by another attendant if entry rescue is necessary.

Entry Rescue - In situations where the configuration of the space or other factors prevent the removal of workers with retrieval systems, entry rescue may be the only solution. Entry rescue involves entering the confined space to retrieve the incapacitated entrants and/or provide emergency first aid, CPR, and breathing air, if needed. Entry rescue plans and arrangements must be developed ahead of time for PRCSs where non-entry rescue is inappropriate. Under no circumstances must unauthorized individuals be allowed to enter a confined space during an emergency to attempt a rescue. **Over 60 percent of PRCS fatalities are would-be rescue personnel.**

If an onsite entry rescue service is used, the Entry Supervisor must ensure that the rescue service complies with OSHA's requirements 29 CFR 1910.146(k)(2)for PPE, training, first aid/CPR, and annual simulated rescue drills. If entry rescue will be performed by an offsite service, the Entry Supervisor must comply with the host employer requirements specified in this chapter and select a rescue service that is: capable of responding within a time frame that is appropriate for the PRCS hazards identified; equipped for and proficient in performing the needed rescue services. Prospective rescue services must be contacted in advance of PRCS work to plan and coordinate the evaluations required.

During non-entry and entry rescue, entrants must be carefully watched when being physically moved to avoid further injury.

11. MSDS

MSDSs or other hazard information for chemical substances used or known to be present in the PRCS (e.g., the contents, coatings, liners, residues, or other contaminants in the space) must be available at the response site. Placing MSDSs in the HASP is recommended. Information from the MSDSs must be discussed during the PRCS pre-entry safety meeting.

Emergency responders who may be exposed to chemical substances during PRCS operations must have immediate access to the substance MSDSs.

The Entry Supervisor is responsible for ensuring that appropriate chemical hazard information is readily available at the response site. If an injured PRCS entrant is exposed to a chemical substance the Entry Supervisor must ensure that the MSDS or other written hazard information is provided to the medical facility treating the injured employee.

12. Confined Space Entry Permit

A confined space entry permit is an authorization and approval in writing by the employer that allows and controls entry into a PRCS. It specifies the location and type of work to be done, and certifies that the space has been evaluated and tested by a qualified person and that all necessary protective measures have been taken to ensure the safety of the entrants. A confined space entry permit is self-issued and canceled. It should identify the actual or potential hazards of the space and specify the means, procedures, and practices necessary for safe entry operations. The permit must be tailored to meet the needs of the specific PRCS involved.

The confined space entry permit must include the following information:

- Identification and location of the PRCS
- Specific description of the purpose for the entry or the work to be completed
- The name of the person issuing the permit or serving as entry supervisor and the signature or initials of the entry supervisor who originally authorized entry

- Identification of the hazards that may be encountered and specific actions to be taken to protect against the hazards

- Date and authorized duration of the permit (the duration must not exceed the time required to complete the task or job identified on the permit)

- Identification of the active participants involved in the PRCS operations (e.g., authorized entrants, attendants, entry supervisors, persons who monitor the atmosphere in the space, etc.), by name or other means (e.g., rosters or tracking systems)

- Hazard control checklist, including: blocking, lockout/tagout, cleaning, purging, or ventilating to be completed prior to entry and certification that these procedures have been completed

- Required equipment (such as PPE, special tools, air monitoring equipment, communication equipment, alarm systems, rescue equipment, etc.)

- The frequency of air monitoring and the results of initial and periodic monitoring, with the initials of the individual monitoring the atmosphere in the space and the time the monitoring was performed

- Documentation that acceptable entry conditions exist

- The communication procedures to be used by authorized entrants and attendants to maintain contact during the entry

- Rescue and emergency services and the means for summoning those services

The completed permit must be made available at the time of entry to all authorized entrants, by posting it at the entry portal or by any other equally effective means, so that entrants can confirm the pre-entry preparations have been completed. The content of the PRCS permit must always be addressed in the pre-entry safety briefing before each shift.

The Entry Supervisor person is responsible for authorizing entry for a PRCS by preparing or reviewing, verifying, and signing (approving) the entry permit, identifying all active participants (including employees of other employers), and discussing the permit during the PRCS pre-entry safety briefings before each shift.

Permit Cancellation - At the conclusion of the entry operation the Entry Supervisor, must document the cancellation of the entry and closure of the PRCS entry permit.

Canceled entry permits must be retained by the CSO for at least one year after the permits have been canceled for internal review of the PRCS plan and procedures. Within one year after each entry, or during a single annual review, CSO must review the organization's confined space safety plan using the canceled permits and revise the plan as necessary to ensure that all individuals participating in entry operations are protected from PRCS hazards.

13. Required PRCS Modifications

The Entry Supervisor must document on the permit any problems encountered during an entry operation, review those problems with affected employees, and make appropriate revisions to PRCS procedures in the HASP before subsequent entries are authorized. Circumstances requiring documentation on the permit include but are not limited to:

- Any unauthorized entry of a permit space;
- Detection of a hazard not covered by the entry permit;
- Detection of a condition prohibited by the permit;
- Occurrence of an injury or near-miss during entry;
- A change in the use or configuration of a PRCS; and
- Employee complaints about the effectiveness of the procedures.

Additionally, if emergency rescue or response was conducted for a PRCS operation, the PRCS procedures must be reviewed because this action might be an indication of deficiencies in the procedures, equipment, training, or permit system.

Alternate Entry Procedures - The OSHA confined space standard allows a PRCS to be entered without the need for a written permit under two conditions: (1) The only hazard in the PRCS is an atmospheric hazard and the PRCS can be maintained in a condition safe for entry by using mechanical ventilation alone; or (2) All hazards within the PRCS have been eliminated and the space has been reclassified as a non-permit confined space.

The two conditions require employers to demonstrate and document (certify) compliance with the respective procedures for alternate entries described herein. Alternate entry certifications are retained according to the requirements in section 15.

If the only hazard of the PRCS is an actual or potential atmospheric hazard that can be controlled with continuous forced air ventilation alone, the PRCS may be entered without a written permit when all of the following conditions are met:

- The atmosphere has been monitored for oxygen, flammable gases/vapors, and potential toxic air contaminants and determined safe for entry.

- The atmosphere within the space is periodically monitored to ensure the effectiveness of the forced air ventilation.

- Hazardous conditions are eliminated before the entrance cover is removed (if applicable).

- The entrance opening is guarded to prevent people and objects from falling into the space (if applicable).

- Continuous forced air ventilation is used until all employees have left the space.

If an initial entry of the PRCS is necessary to obtain the required air monitoring data, the entry must be performed utilizing a PRCS entry permit and attendant.

The alternate entry procedure would **not** be acceptable if atmospheric hazards in the space quickly increased in the event the ventilation failed. Sufficient time must be available for an entrant to safely exit the space if the ventilation stops.

If the alternate entry procedure is used, the Entry Supervisor must document (certify) that there are no non-atmospheric hazards and that ventilation alone will keep the air inside the PRCS safe for entry. The applicable sections of the PRCS entry permit can be used to certify that the PRCS meets the alternate entry requirements. The certification must include at a minimum:

- Date and time

- Location and volume of the space

- Capacity and configuration of the ventilation equipment

- Identified atmospheric hazards (including atmospheric hazards created by work in the space)

- Air monitoring results from routine monitoring of the space from the time ventilation begins through final determination of acceptable entry conditions a

Safe Contaminant Levels for Alternate Entry with Atmospheric Hazard Only

The minimal “safe for entry” level for air contaminants under the alternate entry procedure is:

1. Fifty (50) percent of the toxic substance's occupational exposure limit (e.g., PEL, TLV, other); or

2. Five (5) percent of a flammable substance's LFL.

Examples:
The 8-hour TWA PEL for carbon monoxide is 50 parts per million (ppm). Fifty percent of the PEL is 25 ppm. Under the alternate entry procedure, the measured concentration of carbon monoxide in the PRCS cannot exceed 25 ppm with continuous forced air ventilation.
The LFL for methane is 5% (by volume) or 50,000 ppm. Five percent of the LFL is 0.25% or 2,500 ppm. Under the alternate entry procedure, the measured concentration of methane in the PRCS cannot exceed 0.25% (2,500 ppm) with continuous forced air ventilation.

- Signature of the person providing the written certification.

The certification must be discussed during the pre-entry safety briefing and posted at the entrance to the PRCS so employees can review the measures taken for their protection.

Non-Permit Classification - If a PRCS poses no actual or potential atmospheric hazard and if all other (non-atmospheric) hazards are eliminated without entry into the space (e.g., through one of the isolation techniques specified in the OSHA PRCS standard), the PRCS may be *reclassified* as a non-permit confined space and may be entered without a written permit.

If hazards may be eliminated by such actions as purging or inerting tank/vessels of contaminants, emptying material from hoppers/bins, use of company lockout/tag procedures for electrical/ mechanical hazards. The control of atmospheric hazards through forced air ventilation does not constitute elimination of that hazard (it only controls the hazard: the preceding Alternate Entry Procedures must be used in such cases).

Entry Supervisor must document the basis for determining that all hazards in the PRCS have been eliminated through a certification that includes at a minimum the date, time, location of the space, and the signature of the person making the determination. The certification must be discussed during the pre-entry safety briefing and posted at the entrance to the PRCS so employees can review the measures taken for their protection. Applicable sections of the PRCS entry permit may be used to document and certify this information.

If it is necessary to enter the PRCS to eliminate hazards, the entry must be performed utilizing a PRCS entry permit and attendant.

14. Program Evaluation

An evaluation Clear Water's confined space safety plan must be performed to ensure the plan is being implemented properly and that Clear Water's Confined Space Safety Program is performing satisfactorily.

Clear Water must assess their written confined space safety plan at least annually. This is accomplished by reviewing this customized chapter, canceled entry permits, certifications, and any other records deemed necessary, and conducting interviews. The purpose of the internal evaluation is two-fold:

1)Assess if employee safety is being maintained (eliminate PRCS injuries and fatalities).
2)Assess if confined space safety measures are being implemented in accordance with the minimum requirements presented throughout this chapter (written plan, PRCS procedures in the HASP, host employer responsibilities, confined space identification and evaluation, PRCS entry permits, air monitoring, hazard control, rescue operations,

training, recordkeeping, etc.). An OSHA requirement reference table and program evaluation checklist are included in the reference section to assist with this task.

15. Recordkeeping

Proper recordkeeping is an essential component of a confined space safety program. The goal is to ensure that consistent, readily accessible records are maintained by Clear Water. The following section describes what records are to be kept and who is responsible for generating and maintaining these records.

Permits - PRCS entry permits must be completed by the Entry Supervisor, and retained on file by the CSO for at least one year after the permits have been canceled for the confined space safety plan and procedures review. Entry permits that show the composition of a hazardous atmosphere to which an employee is exposed (even if the employee is using a respirator) are considered exposure records and must be retained on file for at least 30 years.

PRCS Modifications - The basis for reclassifying a PRCS for alternate entry or non-permit must be documented as a written certification that is posted at the entry to the PRCS by the Entry Supervisor. The reclassification permit must be retained on file by the CSO for one year after the permits have been canceled for the confined space safety plan and procedures review. Alternate entry certifications that show the composition of an atmosphere to which an employee is exposed (even if the employee is using a respirator) are considered exposure records and must be retained on file for at least 30 years.

Material Safety Data Sheets - Material Safety Data Sheets, air monitoring data, and other information on the contents, coatings or liners, potential hazardous atmospheres, and residues found or anticipated in a PRCS must be compiled by Entry Supervisor. These documents are considered exposure records and must be retained on file for at least 30 years.

Equipment Calibration - Air monitoring equipment calibration must be verified through appropriate documentation. A calibration form is included in the reference section to assist with this activity. Calibration and bump test documentation must be compiled by the Entry Supervisor and retained on file by the CSO for at least one year for the confined space safety plan and procedures review.

Training Records - OSHA’s PRCS standard requires a record of certification that the standard’s training requirements have been met. The certification must contain the employee’s name/job title, the names and signatures of the trainers, dates the training was conducted, and information on the content covered. In addition, a training roster will be maintained as evidence of the training class. The roster will be signed by the course instructor and all attendees of the class. The certifications and class rosters will be retained on file by the CSO for at least one year for confined space safety plan and procedures review.

Pre-entry safety briefing discussion topics and attendance also need to be documented. This information will be incorporated within the entry permit and maintained on file accordingly.

Evaluation Form – The Clear Water CSO along with members of the company Safety Committee will review the PRCS safety program annually. These evaluations will be recorded in an evaluation form and retained on file by the CSO.

Attachment 4

PRSC Entry Permit

CLEAR WATER COMPLIANCE SERVICES
CONFINED SPACE ENTRY PERMIT

This is a self-issued confined space entry permit. This permit must be completed in entirety and posted at the entrance of the confined space before entry. This permit will be cancelled and retained as program records once the entry incident is complete.

1)Permit Begins: Date:________Time:________AM/PM **Permit Expires: Date:________Time:________AM/PM**

2)Location, Description, and Volume (if available) of the PRCS:

3)Purpose of Entry and Description of Work:

4) Names of authorized individuals (including contractors)

Host:	**Controller:**	**Entry Supervisor:**

1. Entrant (print/sign)
2. Entrant (print/sign)
3. Attendant (print/sign)
4. Attendant(print/sign)
5. Rescue (print/sign)
6. Rescue (print/sign)

5) Hazard Identification: (Y= yes, N = no, N/A = not applicable)

Oxygen Enrichment (> 23.5%)	Mechanical energy source
Oxygen deficiency (< 19.5%)	Engulfment
Flammable/combustible atmosphere	Drowning
Flammable/combustible vapors	Entrapment
Flammable/combustible dusts	Temperature
Toxic Vapors	Noise/Vibration
Toxic Gas	Slip/Trip/Fall
Electrical energy source	Other

6) Hazard Control Checklist

☐ Purging/Flushing	☐ Blanking/Blocking
☐ Ventilation	☐ Misaligning/Disconnecting
☐ Inerting	☐ Cleaning
☐ Electrical Lockout/Tagout	☐ Baracade/Signs/Attendant

7) PPE Checklist

☐ Direct read multi gas meter	☐ Hardhat	☐ Gloves
☐ Harness	☐ Eye Protection	☐ Moisture Protection
☐ Lanyard	☐ Hearing Protection	☐ Phone
☐ Respiratory protection	☐ Safety Boots	☐ Other

8) Communication Device/Method

9) Atmospheric Monitroing	Make/Model:	Calibration Date:

	TEST 1	TEST 2	TEST 3
Oxygen			
LEL			
CO			
H_2S			
Other			

10) Rescue/Emergency Services	Rescue Equipment	
☐ In house rescue team (names, training dates, drill dates)	☐ Tripod	☐ First-Aid kit
	☐ Lanyard	☐ Ladder
☐ Outside rescue service (service, telephone, location)	☐ Harness	☐ Other
	☐ SCBA	☐ Other

11) Acceptable Entry Conditions

12) ☐ **Alternate Entry** or ☐ **Non-Permit Certification**		Entry Supervisor Signature:	
☐ Atmosphere monitored	☐ Hazards eliminated	☐ Continuous monitoring	☐ Forced air ventilation
☐ Attendant guarding	☐ Recertification discussed	Comments	

13) Pre-entry safety topics

14) Permit Cancellation

Entry Supervisor:	Time:	Date:

Attachment 5

Fall Protection Work Plan

Clear Water Compliance Services
Fall Protection Work Plan

Location/#:	Date:
Prepared by:	Harness wearer:
Co-Worker:	Co-Worker:

1) Describe fall hazards greater than 10 feet in the work area.

2) Describe the method of fall arrest or fall restraint to be used. For fall protection equipment include details, such as manufacturer, model, size etc**.**

3) Procedures for assembly, disassembly, maintenance and inspection of fall protection system.
- Fall protection systems will be assembled and maintained according to manufacturer's instructions when using a manufactured system. These instructions will be available in the on-site HASP and provided with the fall protection system when checked out of inventory.
- Any fall protection system used will meet WISHA regulations as contained in WAC 296-155 Part C-1.
- Prior to installation, equipment will be inspected for signs of cuts, abrasion damage, mildew, UV deterioration, or other damage according to the manufacturer's recommendation and recorded in inspection log.
- All snap-hooks will be tested to ensure they function properly.
- Prior to leaving the ground, each employee will don their body harness as outlined by the manufacturer and have it checked for proper fit and adjustment by a co-worker or site supervisor.

4) Procedures for handling, storing and securing the fall protection system
- After using a fall protection system, re-inspect snap-hooks, lanyards, and harnesses.
- Fall protection equipment that has been exposed to moisture will be hung in a suitably warm and dry location, away from excessive sunlight, and allowed to dry overnight.
- Fall protection equipment will be stored in a clean, dry location, away from excessive sunlight, and secured against theft. Harnesses will be hung by their dorsal D-ring to maintain their shape. Lanyards will be hung by the snap-hook.

5) Describe overhead protection for individuals working below the work area.
- Hard hats are required on all job sites

6) Removal of injured worker
- All on site co-workers must assist in administering appropriate medical attention to an injured worker including, if appropriate, requesting 911 assistance.
- If a worker has fallen and is suspended from a harness they must be brought to the ground within 3 minutes.
- The following equipment is available on site to facilitate lowering the injured worker:

7) Training of employees
- All employees must read the fall protection section of the Health and Safety Plan before engaging in work requiring fall restraint
- All employees wearing a full body harness must read the manufacturer's instructions before donning.
- All co-workers on site must review and sign this Fall Protection Work Plan before any fall arrest work begins.
- All Fall Protection Work Plans must be kept on-site in the HASP inside the control unit.

Attachment 6

Treatment System MSDSs

GARDENA, CA
NEW BRUNSWICK, NJ

Material Safety Data Sheet

NFPA	HMIS	Personal Protective Equipment
Health: 2, Flammability: 0, Reactivity: 0	Health Hazard 2 Fire Hazard 0 Reactivity 0	See Section 15.

Section 1. Chemical Product and Company Identification

Common Name/ Trade Name	**Acetic Acid, 1N**
Manufacturer	SPECTRUM QUALITY PRODUCTS INC. 14422 S. SAN PEDRO STREET GARDENA, CA 90248
Commercial Name(s)	Not available.
Synonym	Not available.
Chemical Name	Not applicable.
Chemical Family	Acid.
Chemical Formula	Not applicable.
Supplier	SPECTRUM QUALITY PRODUCTS INC. 14422 S. SAN PEDRO STREET GARDENA, CA 90248

Catalog Number(s).	A-098
CAS#	Mixture.
RTECS	Not applicable.
TSCA	TSCA 8(b) inventory: Acetic acid; Water
CI#	Not applicable.

IN CASE OF EMERGENCY
CHEMTREC (24hr) 800-424-9300

CALL (310) 516-8000

Section 2.Composition and Information on Ingredients

Name	CAS #	TWA (mg/m^3)	STEL (mg/m^3)	CEIL (mg/m^3)	% by Weight
		Exposure Limits			
1) Acetic acid	64-19-7	10			6
2) Water	7732-18-5				94

Toxicological Data on Ingredients

Acetic acid:
ORAL (LD50): Acute: 3310 mg/kg [Rat]. 4960 mg/kg [Mouse]. 3530 mg/kg [Rat].
DERMAL (LD50): Acute: 1060 mg/kg [Rat].

Section 3. Hazards Identification

Potential Acute Health Effects

Hazardous in case of ingestion, . Slightly hazardous in case of skin contact (corrosive, irritant, permeator), of eye contact (irritant), of inhalation (lung irritant, lung sensitizer). Liquid or spray mist may produce tissue damage particularly on mucous membranes of eyes, mouth and respiratory tract. Skin contact may produce burns. Inhalation of the spray mist may produce severe irritation of respiratory tract, characterized by coughing, choking, or shortness of breath.

Continued on Next Page

Potential Chronic Health Effects	Non-corrosive for skin. Non-irritant for skin. Non-sensitizer for skin. Non-permeator by skin. Non-irritating to the eyes. Non-hazardous in case of ingestion. Non-hazardous in case of inhalation. **CARCINOGENIC EFFECTS**: Not available. **MUTAGENIC EFFECTS**: Not available. **TERATOGENIC EFFECTS**: Not available. **DEVELOPMENTAL TOXICITY**: Not available. The substance is toxic to blood, kidneys, lungs, mucous membranes, bladder, gastrointestinal tract, upper respiratory tract. Repeated or prolonged exposure to the substance can produce target organs damage. Repeated or prolonged contact with spray mist may produce chronic eye irritation and severe skin irritation. Repeated or prolonged exposure to spray mist may produce respiratory tract irritation leading to frequent attacks of bronchial infection.

Section 4. First Aid Measures

Eye Contact	Check for and remove any contact lenses. In case of contact, immediately flush eyes with plenty of water for at least 15 minutes. Cold water may be used. Get medical attention immediately.
Skin Contact	In case of contact, immediately flush skin with plenty of water for at least 15 minutes while removing contaminated clothing and shoes. Cover the irritated skin with an emollient. Cold water may be used.Wash clothing before reuse. Thoroughly clean shoes before reuse. Get medical attention immediately.
Serious Skin Contact	Not available.
Inhalation	If inhaled, remove to fresh air. If not breathing, give artificial respiration. If breathing is difficult, give oxygen. Get medical attention immediately.
Serious Inhalation	Evacuate the victim to a safe area as soon as possible. Loosen tight clothing such as a collar, tie, belt or waistband. If breathing is difficult, administer oxygen. If the victim is not breathing, perform mouth-to-mouth resuscitation. WARNING: It may be hazardous to the person providing aid to give mouth-to-mouth resuscitation when the inhaled material is toxic, infectious or corrosive. Seek immediate medical attention.
Ingestion	Do NOT induce vomiting unless directed to do so by medical personnel. Never give anything by mouth to an unconscious person. Loosen tight clothing such as a collar, tie, belt or waistband. Get medical attention if symptoms appear.
Serious Ingestion	Not available.

Section 5. Fire and Explosion Data

Flammability of the Product	Non-flammable.
Auto-Ignition Temperature	Not applicable.
Flash Points	Not applicable.
Flammable Limits	Not applicable.
Products of Combustion	Not available.
Fire Hazards in Presence of Various Substances	Not applicable.
Explosion Hazards in Presence of Various Substances	Risks of explosion of the product in presence of mechanical impact: Not available. Risks of explosion of the product in presence of static discharge: Not available.
Fire Fighting Media and Instructions	Not applicable.
Special Remarks on Fire Hazards	Not available.
Special Remarks on Explosion Hazards	Not available.

Continued on Next Page

Section 6. Accidental Release Measures

Small Spill	Dilute with water and mop up, or absorb with an inert dry material and place in an appropriate waste disposal container. If necessary: **Neutralize the residue with a dilute solution of sodium carbonate.**
Large Spill	Corrosive liquid. Stop leak if without risk. Absorb with DRY earth, sand or other non-combustible material. Do not get water inside container. Do not touch spilled material. Use water spray curtain to divert vapor drift. Prevent entry into sewers, basements or confined areas; dike if needed. Call for assistance on disposal. **Neutralize the residue with a dilute solution of sodium carbonate.** Be careful that the product is not present at a concentration level above TLV. Check TLV on the MSDS and with local authorities.

Section 7. Handling and Storage

Precautions	Keep container dry. Do not ingest. Do not breathe gas/fumes/ vapor/spray. Never add water to this product. In case of insufficient ventilation, wear suitable respiratory equipment. If ingested, seek medical advice immediately and show the container or the label. Avoid contact with skin and eyes.
Storage	Keep container tightly closed. Keep container in a cool, well-ventilated area.

Section 8. Exposure Controls/Personal Protection

Engineering Controls	Provide exhaust ventilation or other engineering controls to keep the airborne concentrations of vapors below their respective threshold limit value.
Personal Protection	Face shield. Full suit. Vapor respirator. Be sure to use an approved/certified respirator or equivalent. Gloves. Boots.
Personal Protection in Case of a Large Spill	Splash goggles. Full suit. Vapor respirator. Boots. Gloves. A self contained breathing apparatus should be used to avoid inhalation of the product. Suggested protective clothing might not be sufficient; consult a specialist BEFORE handling this product.
Exposure Limits	**Acetic acid** TWA: 10 STEL: 15 (ppm) from ACGIH (TLV) [United States] [1998] TWA: 10 (ppm) from NIOSH TWA: 10 (ppm) [Australia] Consult local authorities for acceptable exposure limits.

Section 9. Physical and Chemical Properties

Physical state and appearance	Liquid.	**Odor**	Strong.
Molecular Weight	Not applicable.	**Taste**	Strong.
pH (1% soln/water)	Acidic.	**Color**	Light.
Boiling Point	The lowest known value is 100°C (212°F) (Water). Weighted average: 101.09°C (214°F)		
Melting Point	May start to solidify at 16.6°C (61.9°F) based on data for: Acetic acid.		
Critical Temperature	Not available.		
Specific Gravity	Weighted average: 1 (Water = 1)		
Vapor Pressure	The highest known value is 2.3 kPa (@ 20°C) (Water). Weighted average: 2.25 kPa (@ 20°C)		
Vapor Density	The highest known value is 2.07 (Air = 1) (Acetic acid). Weighted average: 0.71 (Air = 1)		
Volatility	Not available.		
Odor Threshold	The highest known value is 1.018 ppm (Acetic acid)		
Water/Oil Dist. Coeff.	The product is more soluble in water.		
Ionicity (in Water)	Not available.		
Dispersion Properties	Partially dispersed in methanol, diethyl ether, n-octanol. See solubility in water, methanol, diethyl ether, n-octanol, acetone.		

Continued on Next Page

Solubility	Easily soluble in cold water, hot water, methanol, acetone. Partially soluble in diethyl ether, n-octanol.

Section 10. Stability and Reactivity Data

Stability	The product is stable.
Instability Temperature	Not available.
Conditions of Instability	Not available.
Incompatibility with various substances	Slightly reactive to reactive with acids, alkalis.
Corrosivity	Corrosive in presence of zinc. Slightly corrosive in presence of aluminum, of copper. Non-corrosive in presence of glass, of steel, of stainless steel(304), of stainless steel(316).
Special Remarks on Reactivity	Not available.
Special Remarks on Corrosivity	Not available.
Polymerization	Will not occur.

Section 11. Toxicological Information

Routes of Entry	Absorbed through skin. Dermal contact. Eye contact. Inhalation. Ingestion.
Toxicity to Animals	Acute oral toxicity (LD50): 55167 mg/kg (Rat) (Calculated value for the mixture). Acute dermal toxicity (LD50): 17667 mg/kg (Rat) (Calculated value for the mixture).
Chronic Effects on Humans	Not available.
Other Toxic Effects on Humans	Hazardous in case of skin contact (corrosive), of eye contact (corrosive), of ingestion, of inhalation (lung corrosive).
Special Remarks on Toxicity to Animals	Not available.
Special Remarks on Chronic Effects on Humans	Not available.
Special Remarks on other Toxic Effects on Humans	Not available.

Section 12. Ecological Information

Ecotoxicity	Not available.
BOD5 and COD	Not available.
Products of Biodegradation	Possibly hazardous short term degradation products are not likely. However, long term degradation products may arise.
Toxicity of the Products of Biodegradation	The product itself and its products of degradation are not toxic.
Special Remarks on the Products of Biodegradation	Not available.

Continued on Next Page

Section 13. Disposal Considerations

Waste Disposal

Section 14. Transport Information

DOT Classification	Class 8: Corrosive material
Identification	: CORROSIVE LIQUIDS, N.O.S. (Acetic acid) UNNA: UN1760 PG: II
Special Provisions for Transport	Not available.
DOT (Pictograms)	

Section 15. Other Regulatory Information and Pictograms

Federal and State Regulations

Rhode Island RTK hazardous substances: Acetic acid
Pennsylvania RTK: Acetic acid
Florida: Acetic acid
Minnesota: Acetic acid
Massachusetts RTK: Acetic acid
New Jersey: Acetic acid
TSCA 8(b) inventory: Acetic acid; Water
CERCLA: Hazardous substances.: Acetic acid: 5000 lbs. (2268 kg);

California Proposition 65 Warnings

Other Regulations OSHA: Hazardous by definition of Hazard Communication Standard (29 CFR 1910.1200).

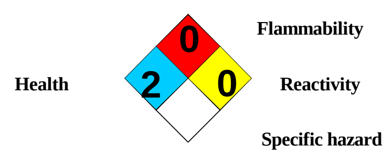
Other Classifications

WHMIS (Canada)	CLASS E: Corrosive liquid.
DSCL (EEC)	R34- Causes burns.

HMIS (U.S.A.)

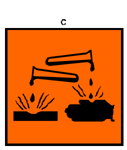
Health Hazard	2
Fire Hazard	0
Reactivity	0
Personal Protection	

National Fire Protection Association (U.S.A.)



WHMIS (Canada) (Pictograms)

DSCL (Europe) (Pictograms)



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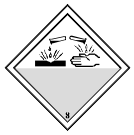
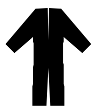
TDG (Canada) (Pictograms)



ADR (Europe) (Pictograms)

Protective Equipment

Gloves.



Full suit.

Vapor respirator. Be sure to use an approved/certified respirator or equivalent. Wear appropriate respirator when ventilation is inadequate.

Face shield.

Section 16. Other Information

MSDS Code	**A098S**
References	Not available.
Other Special Considerations	Not available.

Validated by Sonia Owen on 1/20/2003.	**Verified by Sonia Owen.** **Printed 8/23/2004.**

CALL (310) 516-8000

Notice to Reader

All chemicals may pose unknown hazards and should be used with caution. This Material Safety Data Sheet (MSDS) applies only to the material as packaged. If this product is combined with other materials, deteriorates, or becomes contaminated, it may pose hazards not mentioned in this MSDS. It shall be the user's responsibility to develop proper methods of handling and personal protection based on the actual conditions of use. While this MSDS is based on technical data judged to be reliable, Spectrum Quality Products, Inc. assumes no responsibility for the completeness or accuracy of the information contained herein.

Material Safety Data Sheet

Aqua Solutions
6913 Highway 225
Deer Park, TX 77536

Phone (281) 479-2569
Chemtrec 800-424-9300
24 Hour Emergency Assistance

Section 1 Identification

Product Number:	1500
Product Name:	Buffer Solution, pH 7 (Yellow) Traceable to N.I.S.T.
Trade/Chemical Synonyms	
Formula:	N/A
RTECS:	None
C.A.S	See Below

Health:	1
Flammability	0
Reactivity	0

Hazard Rating:
Least Slight Moderate High Extreme
0 1 2 3 4
NA = Not Applicable NE = Not Established

Section 2 Component Mixture

Sara 313	Component	CAS Number	%	Dim	Exposure Limits:
☐	Water, Deionized ASTM Type II	CAS# 7732-18-5	Balance	V/V	None Established
☐	Potassium Phosphate Monobasic	CAS# 7778-77-0	0.68%	W/V	None Established
☑	Sodium Hydroxide	CAS# 1310-73-2	0.01%	W/V	OSHA PEL 2 mg/mf ACGIH 2mg/mf

Section 3 Hazard Identification (Also see section 11)

Generally not hazardous in normal handling, however good laboratory practices should always be used. Avoid long term exposure to skin or by inhalation.

Section 4 First Aid Measures

Generally not hazardous in normal handling, however good laboratory practices should always be used. Avoid long term exposure to skin or by inhalation.

FIRST AID: SKIN: Wash exposed area with soap and water. If irritation persists, seek medical attention.

EYES: Wash eyes with plenty of water for at least 15 minutes, lifting lids occasionally. Seek Medical Aid. INHALATION: Remove to fresh air. If not breathing, give artificial respiration. If breathing is difficult, give oxygen

INGESTION: If swallowed, induce vomiting immediately after giving two glasses of water. Never give anything by mouth to an unconscious person.

Section 5 Fire Fighting Measures

Fire Extinguisher Type:	Any means suitable for extinguishing surrounding fire
Fire/Explosion Hazards:	None
Fire Fighting Procedure:	Wear self-contained breathing apparatus and protective clothing to prevent contact with skin and clothing.

Section 6 Accidental Release Measures

Absorb spill with inert material. Flush excess down drain.

Section 7 Handling and Storage

Store in a cool dry place. This Material is not considered hazardous. Handle using safe laboratory practices.

Section 8 Exposure Controls & Personal Protection

Respiratory Protection:None required

Ventilation: Mechanical: ☐ Local Exhaust: ☑

Hand Protection: Gloves to prevent skin exposure as latex or vinyl

Eye Protection: Splash Goggles

Other Protective Equipment: Use safe laboratory handling procedures.

Section 9 Physical and Chemical Properties

Melting Point:	~0°C	Specific Gravity	~1
Boiling Point:	~100°C	Percent Volatile by Volume:	>98
Vapor Pressure:	Information not available	Evaporation Rate:	Information not available
Vapor Density:	Information not available	Evaporation Standard:	
Solubility in Water:	Soluble	Auto ignition Temperature:	Not applicable
Appearance and Odor:	Clear, yellow, odorless liquid	Lower Flamm. Limit in Air:	Not applicable
Flash Point:	Not flammable	Upper Flamm. Limit in Air:	Not applicable

Section 10 Stability and Reactivity Information

Stability: Stable Conditions to Avoid: High temperatures

Materials to Avoid:
Concentrated Acids and Bases, Water reactive materials.

Hazardous Decomposition Products:
None known

Hazardous Polymerization:Will Not Occur

Condition to Avoid:None known

Section 11 Additional Information

Conditions aggravated/target organs: None known. Acute: Essentially non-hazardous. Possible irritation of eyes/stomach. Chronic: none known.

DOT Classification: Not Regulated

DOT regulations may change from time to time. Please consult the most recent version of the relevant regulations.

Revision No:0.1 Date Entered: 9/1/2006 Approved by: WPF

MATERIAL SAFETY DATA SHEET

1. CHEMICAL PRODUCT AND COMPANY IDENTIFICATION

Product Name: StablCal® Standard, 800 NTU
Catalog Number: 2660542

Hach Company
P.O.Box 389
Loveland, CO USA 80539
(970) 669-3050

Emergency Telephone Numbers:
(Medical and Transportation)
(303) 623-5716 24 Hour Service
(515)232-2533 8am - 4pm CST

MSDS Number: M01401
Chemical Name: Not applicable
CAS No.: Not applicable
Chemical Formula: Not applicable
Chemical Family: Not applicable
Hazard: May cause irritation. May cause allergic reaction.
Date of MSDS Preparation:
Day: 11
Month: October
Year: 2007

2. COMPOSITION / INFORMATION ON INGREDIENTS

Hexamethylenetetramine
CAS No.: 100-97-0
TSCA CAS Number: 100-97-0
Percent Range: 1.0 - 10.0
Percent Range Units: weight / volume
LD50: Oral mouse LDLo = 512 mg/kg
LC50: None reported
TLV: Not established
PEL: Not established
Hazard: May cause irritation. Flammable solid. May cause allergic reaction.

Demineralized Water
CAS No.: 7732-18-5
TSCA CAS Number: 7732-18-5
Percent Range: 90.0 - 100.0
Percent Range Units: volume / volume
LD50: None reported
LC50: None reported
TLV: Not established
PEL: Not established
Hazard: No effects anticipated.

Other components, each
CAS No.: Not applicable
TSCA CAS Number: Not applicable
Percent Range: < 1.0

Percent Range Units: weight / volume
LD50: Not applicable
LC50: Not applicable
TLV: Not established
PEL: Not established
Hazard: Any ingredient(s) of this product listed as "Other component(s)" is not considered a health hazard to the user of this product.

Formazin Polymer
CAS No.: Not available
TSCA CAS Number: Various
Percent Range: < 1.0
Percent Range Units: weight / volume
LD50: None reported.
LC50: None reported.
TLV: Not established.
PEL: Not established.
Hazard: Toxic properties unknown.

3. HAZARDS IDENTIFICATION

Emergency Overview:
Appearance: Turbid, milky suspension
Odor: None
MAY CAUSE EYE AND SKIN IRRITATION
MAY CAUSE ALLERGIC SKIN REACTION

HMIS:
Health: 2
Flammability: 0
Reactivity: 0
Protective Equipment: X - See protective equipment, Section 8.
NFPA:
Health: 2
Flammability: 0
Reactivity: 0
Symbol: Not applicable
Potential Health Effects:
Eye Contact: May cause irritiation
Skin Contact: May cause irritiation May cause allergic reaction
Skin Absorption: None reported
Target Organs: Not applicable
Ingestion: May cause: gastrointestinal irritation kidney damage
Target Organs: Kidneys
Inhalation: No effects anticipated
Target Organs: Not applicable
Medical Conditions Aggravated: Allergies or sensitivity to hexamethylenetetramine.
Chronic Effects: Chronic overexposure may cause symptoms similar to acute exposure.
Cancer / Reproductive Toxicity Information:
This product does NOT contain any OSHA listed carcinogens.

This product does NOT contain any IARC listed chemicals.

This product does NOT contain any NTP listed chemicals.

Additional Cancer / Reproductive Toxicity Information: Contains: an experimental mutagen.
Toxicologically Synergistic Products: None reported

4. FIRST AID

Eye Contact: Immediately flush eyes with water for 15 minutes. Call physician.
Skin Contact (First Aid): Wash skin with soap and plenty of water.
Ingestion (First Aid): Induce vomiting using syrup of ipecac or by sticking finger down throat. Never give anything by mouth to an unconscious person. Call physician immediately.
Inhalation: None required.

5. FIRE FIGHTING MEASURES

Flammable Properties: During a fire, this product decomposes to form toxic gases.
Flash Point: Not applicable
Method: Not applicable
Flammability Limits:
Lower Explosion Limits: Not applicable
Upper Explosion Limits: Not applicable
Autoignition Temperature: Not determined
Hazardous Combustion Products: Toxic fumes of: ammonia formaldehyde nitrogen oxides. carbon monoxide, carbon dioxide.
Fire / Explosion Hazards: None reported
Static Discharge: None reported.
Mechanical Impact: None reported
Extinguishing Media: Use media appropriate to surrounding fire conditions
Fire Fighting Instruction: As in any fire, wear self-contained breathing apparatus pressure-demand and full protective gear. Evacuate area and fight fire from a safe distance.

6. ACCIDENTAL RELEASE MEASURES

Spill Response Notice:
Only persons properly qualified to respond to an emergency involving hazardous substances may respond to a spill according to federal regulations (OSHA 29 CFR 1910.120(a)(v)) and per your company's emergency response plan and guidelines/procedures. See Section 13, Special Instructions for disposal assistance.
Containment Technique: Absorb spilled liquid with non-reactive sorbent material. Dike large spills to keep spilled material from entering sewage and drainage systems or bodies of water.
Clean-up Technique: Absorb spilled liquid with non-reactive sorbent material. Sweep up material. Place material in a plastic bag. Mark bag 'Non-hazardous trash', and dispose of as normal refuse. Decontaminate the area of the spill with a soap solution.
Evacuation Procedure: Evacuate as needed to perform spill clean-up. If conditions warrant, increase the size of the evacuation.
Special Instructions (for accidental release): Not applicable
304 EHS RQ (40 CFR 355): Not applicable
D.O.T. Emergency Response Guide Number: Not applicable

7. HANDLING / STORAGE

Handling: Avoid contact with eyes skin Do not breathe mist or vapors. Wash thoroughly after handling. Maintain general industrial hygiene practices when using this product.
Storage: Keep container tightly closed when not in use. Protect from: heat
Flammability Class: Not applicable

8. EXPOSURE CONTROLS / PROTECTIVE EQUIPMENT

Engineering Controls: Have an eyewash station nearby. Maintain general industrial hygiene practices when using this product.
Personal Protective Equipment:
Eye Protection: safety glasses with top and side shields
Skin Protection: disposable latex gloves
Inhalation Protection: adequate ventilation
Precautionary Measures: Avoid contact with: eyes skin Do not breathe: mist/vapor Wash thoroughly after handling.
TLV: Not established
PEL: Not established

9. PHYSICAL / CHEMICAL PROPERTIES

Appearance: Turbid, milky suspension
Physical State: Liquid
Molecular Weight: Not applicable
Odor: None
pH: 7.36
Vapor Pressure: Not determined
Vapor Density (air = 1): Not determined
Boiling Point: 100°C; 212°F
Melting Point: Not determined
Specific Gravity (water = 1): 1.01
Evaporation Rate (water = 1): Not determined
Volatile Organic Compounds Content: Not determined
Partition Coefficient (n-octanol / water): Not applicable
Solubility:
Water: Miscible
Acid: Miscible
Other: Not determined
Metal Corrosivity:
Steel: Not determined
Aluminum: Not determined

10. STABILITY / REACTIVITY

Chemical Stability: Stable when stored under proper conditions.
Conditions to Avoid: Extreme temperatures
Reactivity / Incompatibility: Incompatible with: oxidizers
Hazardous Decomposition: Heating to decomposition releases: ammonia carbon monoxide formaldehyde nitrogen oxides
Hazardous Polymerization: Will not occur.

World Headquarters
Hach Company
P.O.Box 389
Loveland, CO USA 80539
(970) 669-3050

11. TOXICOLOGICAL INFORMATION

Product Toxicological Data:
LD50: None reported
LC50: None reported
Dermal Toxicity Data: None reported
Skin and Eye Irritation Data: None reported
Mutation Data: Hexamethylenetetramine: Cytogenetic analysis in human Hela cells @ 1 mmol/l; Oncogenic Transformation - hamster kidney - 10 mg/L
Reproductive Effects Data: None reported
Ingredient Toxicological Data: Hexamethylenetetramine: Oral mouse LDLo = 512 mg/kg

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12. ECOLOGICAL INFORMATION

Product Ecological Information: --
No ecological data available for this product.
Ingredient Ecological Information: Hexamethylenetetramine: Water Pollution Factors: BOD_5: 0.015, 0.026, std. dil. sew.

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13. DISPOSAL CONSIDERATIONS

EPA Waste ID Number: None
Special Instructions (Disposal): Dilute material with excess water making a weaker than 5% solution. Open cold water tap completely, slowly pour the material to the drain. Flush system with plenty of water.
Empty Containers: Rinse three times with an appropriate solvent. Dispose of empty container as normal trash.
NOTICE (Disposal): These disposal guidelines are based on federal regulations and may be superseded by more stringent state or local requirements. Please consult your local environmental regulators for more information.

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14. TRANSPORT INFORMATION

D.O.T.:
D.O.T. Proper Shipping Name: Not Currently Regulated
--
DOT Hazard Class: NA
DOT Subsidiary Risk: NA
DOT ID Number: NA
DOT Packing Group: NA
I.C.A.O.:
I.C.A.O. Proper Shipping Name: Not Currently Regulated
--
ICAO Hazard Class: NA
ICAO Subsidiary Risk: NA
ICAO ID Number: NA
ICAO Packing Group: NA
I.M.O.:
I.M.O. Proper Shipping Name: Not Currently Regulated
--
I.M.O. Hazard Class: NA

I.M.O. Subsidiary Risk: NA
I.M.O. ID Number: NA
I.M.O. Packing Group: NA
Additional Information: This product may be shipped as part of a chemical kit composed of various compatible dangerous goods for analytical or testing purposes. This kit would have the following classification: Proper Shipping Name: Chemical Kit
Hazard Class: 9 UN Number 3316.

15. REGULATORY INFORMATION

U.S. Federal Regulations:
O.S.H.A.: This product meets the criteria for a hazardous substance as defined in the Hazard Communication Standard. (29 CFR 1910.1200)
E.P.A.:
S.A.R.A. Title III Section 311/312 Categorization (40 CFR 370): Immediate (Acute) Health Hazard Delayed (Chronic) Health Hazard
S.A.R.A. Title III Section 313 (40 CFR 372): This product does NOT contain any chemical subject to the reporting requirements of Section 313 of Title III of SARA.
--
302 (EHS) TPQ (40 CFR 355): Not applicable
304 CERCLA RQ (40 CFR 302.4): Not applicable
304 EHS RQ (40 CFR 355): Not applicable
Clean Water Act (40 CFR 116.4): Not applicable
RCRA: Contains no RCRA regulated substances.
C.P.S.C.: Not applicable
State Regulations:
California Prop. 65: No Prop. 65 listed chemicals are present in this product.
Identification of Prop. 65 Ingredient(s): None
California Perchlorate Rule CCR Title 22 Chap 33:
Trade Secret Registry: Not applicable
National Inventories:
U.S. Inventory Status: All ingredients in this product are listed on the TSCA 8(b) Inventory (40 CFR 710).
TSCA CAS Number: Not applicable

16. OTHER INFORMATION

Intended Use: Standard solution
References: 29 CFR 1900 - 1910 (Code of Federal Regulations - Labor). Air Contaminants, Federal Register, Vol. 54, No. 12. Thursday, January 19, 1989. pp. 2332-2983. CCINFO RTECS. Canadian Centre for Occupational Health and Safety. Hamilton, Ontario Canada: 30 June 1993. Fire Protection Guide on Hazardous Materials, 10th Ed. Quincy, MA: National Fire Protection Fire Protection Guide on Hazardous Materials, 10th Ed. Quincy, MA: National Fire Protection Association, 1991. IARC Monographs on the Evaluation of the Carcinogenic Risks to Humans. World Health Organization (Volumes 1-42) Supplement 7. France: 1987. Lefevre, Marc J. First Aid Manual for Chemical Accidents, 2nd Ed. New York: Van Nostrand Reinhold Company, 1989. List of Dangerous Substances Classified in Annex I of the EEC Directive (67/548) - Classification, Packaging and Labeling of Dangerous Substances, Amended July 1992. Sixth Annual Report on Carcinogens, 1991. U.S. Department of Health and Human Services. Rockville, MD: Technical Resources, Inc. 1991. Technical Judgment. TLV's Threshold Limit Values and Biological Exposure Indices for 1992-1993. American Conference of Governmental Industrial Hygienists, 1992. Verschueren, Karel. Handbook of Environmental Data on Organic Chemicals. New York: Van Nostrand Reinhold Co., 1977.
Revision Summary: European MSDS Only Updates in Heading(s) 2,

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Legend:

NA - Not Applicable	w/w - weight/weight
ND - Not Determined	w/v - weight/volume
NV - Not Available	v/v - volume/volume

USER RESPONSIBILITY: Each user should read and understand this information and incorporate it in individual site safety programs in accordance with applicable hazard communication standards and regulations.

THE INFORMATION CONTAINED HEREIN IS BASED ON DATA CONSIDERED TO BE ACCURATE. HOWEVER, NO WARRANTY IS EXPRESSED OR IMPLIED REGARDING THE ACCURACY OF THESE DATA OR THE RESULTS TO BE OBTAINED FROM THE USE THEREOF.

DATE: February 16, 2004 REVISION: 20

MATERIAL SAFETY DATA SHEET

HF scientific, inc.
3170 Metro Parkway
Fort Myers, FL 33916-7597
(239) 337-2116
Mon-Fri 8:30 am-4:30 pm

24 Hour Emergency
Telephone Number
CHEMTREC
1-800-424-9300

SECTION 1 PRODUCT IDENTIFICATION

PRODUCT NAME: CALIBRATION TURBIDITY STANDARDS

CATALOG NUMBERS:
HF scientific, inc.:

19069	19824	19832	19928	19965	22407
19071	19825	19833	19933	19966	70851
19611	19826	19843	19938	19967	70852
19820	19828	19845	19953	19968	70853
19821	19829	19855	19957	19969	70854
19822	19830	19887	19961	19970	70858
19823	19831	19927	19964	19973	19782

U.S. Filter/Wallace & Tiernan:
AAC1526 AAC1529 AAC1532 AAC1535

CHEMICAL FAMILY: Not applicable
SYNONYMS: Not applicable
FORMULA: A 25 ml solution containing:
Water >99.5%
Sodium Azide <0.025%
Confidential Polymer <0.2%
And one of the following surfactants
Triton X-100 <0.02%
Sodium Dodecyl Sulfate (SDS) <0.02%
Tergitol <0.02%

SECTION 2 HAZARDOUS INGREDIENTS

Hazardous Ingredient(s):	OSHA PEL	ACGIH TLV	Other Limits Recommended
Sodium Azide CAS #: 26628-22-8	0.1 ppm skin as HN_3. 0.3 mg/m^3 as NaN_3.	0.1 ppm ceiling	None

OTHER LIMITS RECOMMENDED: see toxicity data, section 5

SECTION 3 PHYSICAL DATA

BOILING POINT: 100^o C, (212^o F)
SOLUBILITY IN WATER: Infinite in water
VAPOR PRESSURE (mm Hg): 760mm
MELTING POINT: 0^o C, (32^o F)
APPEARANCE AND ODOR: clear to slightly turbid solution with no odor
VAPOR DENSITY (AIR=1): 0.95
SPECIFIC GRAVITY (H_20 = 1): 1.00
EVAPORATION RATE (BUTYL ACETATE = 1): NA

SECTION 4 FIRE AND EXPLOSION HAZARD DATA

FLASH POINT (METHOD USED): Not flammable
FLAMMABLE LIMITS:
LEL: Not applicable **UEL:** Not applicable
FIRE EXTINGUISHING MEDIA: Suitable to cause of fire
SPECIAL FIRE FIGHTING PROCEDURES: Suitable to cause of fire
UNUSUAL FIRE AND EXPLOSIVE HAZARDS: None

SECTION 5 HEALTH HAZARD EFFECTS AND FIRST AID

ROUTES OF ENTRY: Inhalation? No. Skin? Yes. Ingestion? Yes.
HEALTH HAZARDS (ACUTE & CHRONIC): Not expected to be a health hazard.
CARCINOGENICITY: OSHA? NTP? IARC Monographs?
Not listed
TOXICITY DATA (RTECS, 1986) Sodium Azide:
Oral rat LD50: 27mg/kg
Skin rabbit LD50: 20mg/kg
SIGNS AND SYMPTOMS OF EXPOSURE: Nausea, vomiting, headache, restlessness, and diarrhea.
MEDICAL CONDITIONS GENERALLY AGGRAVATED BY EXPOSURE: None
EMERGENCY FIRST AID PROCEDURES:
Eye Exposure: Wash eyes with plenty of water for at least 15 minutes, lifting lower and upper eyelids occasionally. Get medical attention immediately.
Skin Exposure: In case of contact, immediately flush skin with plenty of water for at least 15 minutes while removing contaminated clothing and shoes. Wash clothing before reuse. Thoroughly clean shoes before reuse. Get medical attention immediately
Ingestion: If swallowed, induce vomiting immediately by giving two glasses of water, or milk if available and sticking finger down throat. Call a physician immediately. Never give anything by mouth to an unconscious person.
Inhalation: Not applicable.

SECTION 6 REACTIVITY DATA

STABILITY: Stable. May flocculate at temperatures of 0^o C, (32^o F) and below.
CONDITIONS TO AVOID: Extremes in temperature.
INCOMPATIBILITIES (MATERIALS TO AVOID): Water reactive chemicals
HAZARDOUS DECOMPOSITION PRODUCTS: None
HAZARDOUS POLYMERIZATION: Will not occur

SECTION 7 SAFE HANDLING AND USE

Steps to be taken if material is released or spilled: Wear standard laboratory protective gear and use standard laboratory safety equipment. Absorb solution with inert material.
WASTE DISPOSAL METHOD: DISPOSE OF IN ACCORDANCE WITH ALL FEDERAL, STATE, AND LOCAL REGULATIONS.
PRECAUTIONS TO BE TAKEN IN HANDLING AND STORING: Store away from extremes in temperature. Prevent from freezing. Freezing causes flocculation. Do not break seal. If seal is broken, the value of the standard is no longer valid. Do not shake. Shaking induces air bubbles and increases the turbidity.
OTHER PRECAUTIONS: None

SECTION 8 CONTROL MEASURES

RESPIRATORY PROTECTION: Not necessary in normal use.
VENTILATION SYSTEMS: General mechanical ventilation satisfactory in normal use.
EYE PROTECTION: Safety glasses
SKIN PROTECTION: Rubber gloves
OTHER PROTECTIVE CLOTHING OR EQUIPMENT: Lab coat, eye wash, safety shower
WORK/HYGIENIC PRACTICES: Wash well after handling. Avoid skin contact.

Dungeness Development Associates
12969 74th Place Northeast
Kirkland, WA 98034

MATERIAL SAFETY DATA SHEET

1. Product Name/Identification

ChitoVan™ Stormwater Flocculent 1%

2. Composition

Active Ingredient: **Chitosan**	CAS # 90-12-76-4
Chemical name(s):	chitosan, acetic acid, and balance water
Source:	n/a

3. Physical/Chemical Properties

Appearance and Odor:	Clear to pale yellow viscous liquid with a pungent vinegar odor.
Solubility:	Completely soluble in water at pH < 6.5 and precipitates at pH > 6.5
Specific Gravity:	1.0 to 1.1
Boiling Point:	211ºF
pH:	3.9 to 4.1

4. Toxicological Data

Acute oral, LD50 (mice)	>16 g/kg

5. Fire and Explosion Hazard Data

Flash Point:	n/a
Flammability:	Non-flammable
Unusual Fire and Explosion Hazards:	In the form of a water solution, there is no danger of fire or explosion.
Fire Fighting Media:	Use water or foam (not flammable in nature)

6. Health Hazards Information

Acute Health Effects – Signs and Symptoms of Exposure, Emergency and First Aid Procedures:	Eye Contact: ChitoVan is mildly irritating to eyes. Flush with water for 15 minutes to remove and call a physician. Skin Contact: ChitoVan is not hazardous but cleansing the skin after use is advisable. Inhalation: if large amounts of fumes are inhaled remove to fresh air and call a physician. Ingestion: If swallowed, no specific intervention is indicated as the compound is not likely to be hazardous by ingestion. However, consult a physician if necessary.
Potential Chronic Health Effects:	n/a
Carcinogenicity:	n/a

7. Personal Protective Equipment

Respiratory Protection:	Not required, neither are local or mechanical exhausts.
Protective Gloves:	Rubber gloves are recommended.
Eye Protection:	Safety glasses are recommended.
Other Protective Clothing:	Not needed.

8. Regulatory

TSCA:	Not listed on the TSCA inventory.
OSHA:	Not considered hazardous.
RCRA	Under RCRA, it is the responsibility of the product user to determine

Phone: (425) 823-0770 Fax: (425) 823-0770 Cell: (206) 390-2432 Email: jdvano@aol.com

	at the time of disposal, whether a waste material containing the product, or derived from the product should be classified as a hazardous waste.
EPA:	Exempt from EPA code.
SARA Section 302:	Does not have an RQ or TPQ.
SARA Section 313:	Not reportable under Section 313.

9. Storage, Handling and Disposal

Storage:	10-50°C recommended (will freeze at ~3°C). Shelf life is indefinite but viscosity will decrease over time. The container should be kept closed to prevent contamination.
Usage Shelf-life	After 18 months from date of manufacture product must be retested to determine usability. Date of manufacture can be found on all storage containers.
For Spills of ChitoVan:	Utilize protective clothing. Dilute with water and hose down.
Waste Disposal Method:	Land disposal is acceptable as the compound is biodegradable. Follow local, state and federal regulations.
Work/Hygiene Practices:	Follow good hygienic and housekeeping practices. Clean up areas where Liqui-Floc was used.

10. Transportation Information

DOT Shipping Name:	Chitosan Acetate
Technical Shipping Name:	Chitosan Acetate
DOT Hazard Class	Class 55
Product RQ (lbs):	None
DOT Label:	None
DOT Placard:	None required
Product Label:	ChitoVan

11. Stability and Reactivity

Chemical Family:	Natural polysaccharide
Stability:	Stable 18 months minimum
Hazardous Polymerization:	Polymerization will not occur.
Incompatibility:	Incompatible with strong oxidants and strong bases.
Decomposition:	Decomposition will not occur.
Instability Conditions:	Stable at normal temperatures and storage conditions.
Decomposition Temperature:	211°F (will boil)
Decomposition Products:	H_2O and chitosan acetate salt (clear film).

Prepared by: Dungeness Development Associates– Revised 10/06

CLEAR PRIMER - NSF

SECTION 1 **IDENTITY OF MATERIAL**

Trade Name:	OATEY CLEAR PRIMER - NSF
Product Numbers:	30750, 30751, 30752, 30753, 30754, 31485, 31486, 31487, 31488, 31525, 31526, 31527, 31528, 31529, 31652, 31653, 31966, 31967, 31968, 31969
Formula:	Organic Solvents
Synonyms:	Methyl Ethyl Ketone, Cyclohexanone, Acetone and Tetrahydrofuran
Firm Name & Mailing Address:	OATEY CO. 4700 West 160th Street P.O. Box 35906 Cleveland, Ohio 44135, U.S.A. http://www.oatey.com
Oatey Phone Number:	(216) 267-7100
Emergency Phone Numbers:	For Emergency First Aid call 1-303-623-5716 COLLECT. For chemical transportation emergencies ONLY, call Chemtrec at 1-800-424-9300

SECTION 2 **COMPOSITION**

INGREDIENTS:	%:	CAS NUMBER:	ACGIH TLV TWA:	OSHA PEL TWA:	OTHER:
Acetone	0 - 5%	67-64-1	500 ppm 750 ppm STEL	1000 ppm	
Cyclohexanone	15 - 23%	108-94-1	20 ppm(skin)	25 ppm	
Tetrahydrofuran	7 - 15%	109-99-9	200 ppm 750 ppm STEL	200 ppm	25 ppm (Mfg)
Methyl Ethyl Ketone	65 - 80%	78-93-3	200 ppm	200 ppm	

SECTION 3 **EMERGENCY OVERVIEW**

Clear liquid with an ether-like odor. Extremely flammable liquid and vapor. Vapors may cause flash fire. May cause eye and skin irritation. Inhalation of vapors or mist may cause respiratory irritation and central nervous system effects. Swallowing may cause irritation, nausea, vomiting, diarrhea and kidney or liver disorders. Aspiration hazard. May be fatal if swallowed. Symptoms may be delayed.

NFPA Hazard Signal: Health: 2 Stability: 1 Flammability: 3 Special: None
HMIS Hazard Signal: Health: 3 Stability: 1 Flammability: 3 Special: None
OSHA Hazard Classification: Flammable, irritant, organ effects
Canadian WHIMS Classification: Class B, Division 2; Class D, Division 2, Subdivision B

SECTION 4 **EMERGENCY AND FIRST AID PROCEDURES - CALL 1-303-623-5716 COLLECT**

Skin: Remove contaminated clothing immediately. Wash all exposed areas with soap and water. Get medical attention if irritation develops. Remove dried cement with Oatey Plumber's Hand Cleaner or baby oil.

Eyes: If material gets into eyes or if fumes cause irritation, immediately flush eyes with water for 15 minutes. If irritation persists, seek medical attention.

Inhalation: If symptoms of exposure develop, remove to fresh air. If breathing becomes difficult, administer oxygen. Administer artificial respiration if breathing has stopped. Seek immediate medical attention.

Ingestion: **DO NOT INDUCE VOMITING.** Rinse mouth with water. Never give anything by mouth to a person who is unconscious or drowsy. Get immediate medical attention by calling a Poison Control Center, or hospital emergency room. If medical advice cannot be obtained, then take the person and product to the nearest medical emergency treatment center or hospital.

SECTION 5 FIRE FIGHTING MEASURES

Flashpoint / Method:	0 - 5 Degrees F. / PMCC
Flammability:	LEL = 1.8 % Volume, UEL = 11.5 % Volume
Extinguishing Media:	Use dry chemical, CO_2, or foam to extinguish fire. Cool fire exposed container with water. Water may be ineffective as an extinguishing agent.
Special Fire Fighting Procedure:	Firefighters should wear positive pressure self-contained breathing apparatus and full protective clothing for fires in areas where chemicals are used or stored
Unusual Fire and Explosion Hazards:	Extremely flammable liquid. Keep away from heat and all sources of ignition including sparks, flames, lighted cigarettes and pilot lights. Containers may rupture or explode in the heat of a fire. Vapors are heavier than air and may travel to a remote ignition source and flash back. This product contains tetrahydrofuran that may form explosive organic peroxide when exposed to air or light or with age.
Hazardous Decomposition Products:	Combustion will produce toxic and irritating vapors including carbon monoxide, carbon dioxide and hydrogen chloride.

SECTION 6 ACCIDENTAL RELEASE MEASURES

Spill or Leak Procedures:	Remove all sources of ignition and ventilate area. Stop leak if it can be done without risk. Personnel cleaning up the spill should wear appropriate personal protective equipment, including respirators if vapor concentrations are high. Soak up spill with an inert absorbent such as sand, earth or other non-combusting material. Put absorbent material in covered, labeled metal containers. Prevent liquid from entering watercourses, sewers and natural waterways. Report releases to authorities as required. See Section 12 for disposal information.

SECTION 7 HANDLING AND STORAGE

Handling:	Avoid contact with eyes, skin and clothing. Avoid breathing vapors or mists. Use with adequate ventilation (equivalent to outdoors). Wash thoroughly after handling. Do not eat, drink or smoke in the work area. Keep product away from heat, sparks, flames and all other sources of ignition. No smoking in storage or use areas. Keep containers closed when not in use.
Storage:	Store in a cool, dry, well-ventilated area away from incompatible materials. Keep containers closed when not in use.
Other:	"Empty" containers retain product residue and can be hazardous. Follow all MSDS precautions in handling empty containers. Do not cut or weld on or near empty or full containers.

SECTION 8 ECOLOGICAL INFORMATION

	This product is not expected to be toxic to aquatic organisms. Cyclohexanone: 96 hour LC50 values for fish is over 100 mg/l. Tetrahydrofuran: 96 hour LC50 fathead minnow: 2160 mg/L. Methyl Ethyl Ketone: 96 hour LC50 for fish is greater than 100 mg/L. Acetone: 96 hour LC50 for fish is greater than 100 mg/L.
VOC Information:	This product emits VOC's (volatile organic compounds) in its use. Make sure that use of this product complies with local VOC emission regulations, where they exist.
VOC Level:	600 g/l per SCAQMD Test Method 316A.

SECTION 9 EXPOSURE CONTROLS/PERSONAL PROTECTION

Ventilation:	Open doors & windows. Provide ventilation capable of maintaining emissions at the point of use below recommended exposure limits. If used in enclosed area, use exhaust fans. Exhaust fans should be explosion-proof or set up in a way that flammable concentrations of solvent vapors are not exposed to electrical fixtures or hot surfaces.
Respiratory Protection:	For operations where the exposure limit may be exceeded, a NIOSH approved organic vapor respirator or supplied air respirator is recommended. Equipment selection depends on contaminant type and concentration, select in accordance with 29 CFR 1910.134 and good industrial hygiene practice. For firefighting, use self-contained breathing apparatus.
Skin Protection:	Rubber gloves are suitable for normal use of the product. For long exposures chemical resistant gloves may be required such as 4H(tm) or Silver Shield(tm) to avoid prolonged skin contact.
Eye Protection:	Safety glasses with side shields or safety goggles.
Other:	Eye wash and safety shower should be available.

SECTION 10 PHYSICAL AND CHEMICAL PROPERTIES

Boiling Point:	174 Degrees F / 79 C
Melting Point:	N/A
Vapor Pressure:	70 mmHg @ 20 Degrees C
Vapor Density:	(Air = 1) 2.5
Volatile Components:	100%
Solubility In Water:	28 parts
pH:	N/A
Specific Gravity:	0.84 +/- 0.02
Evaporation Rate:	(BUAC = 1) = 5.5 - 8.0
Appearance:	Clear Liquid
Odor:	Ether-Like
Will Dissolve In:	Water, organic solvents
Material Is:	Liquid

SECTION 11 STABILITY AND REACTIVITY

Stability:	Stable.
Conditions To Avoid:	Avoid heat, sparks, flames and other sources of ignition.
Hazardous Decomposition Products:	Combustion will produce toxic and irritating vapors including carbon monoxide, carbon dioxide and hydrogen chloride.
Incompatibility/ Materials To Avoid:	Oxidizing agents, alkalies, amines, ammonia, acids, chlorine compounds, chlorinated inorganics (potassium, calcium and sodium hypochlorite) and hydrogen peroxides. May attack plastic, resins and rubber.
Hazardous Polymerization:	Will not occur.

SECTION 12 DISPOSAL INFORMATION

Waste Disposal: Dispose in accordance with current local, state and federal regulations.

SECTION 13 TOXICOLOGICAL INFORMATION

Inhalation:	Vapors or mists may cause mucous membrane and respiratory irritation, coughing, headache, dizziness, dullness, nausea, shortness of breath and vomiting. High concentrations may cause central nervous system depression, narcosis and unconsciousness. May cause kidney, liver and lung damage.
Skin:	May cause irritation with redness, itching and pain. Methyl ethyl ketone and cyclohexanone may be absorbed through the skin causing effects similar to those listed under inhalation.
Eye:	Vapors may cause irritation. Direct contact may cause irritation with redness, stinging and tearing of the eyes. May cause eye damage.
Ingestion:	Swallowing may cause abdominal pain, nausea, vomiting and diarrhea. Aspiration during swallowing or vomiting can cause chemical pneumonia and lung damage. May cause kidney and liver damage.
Chronic Toxicity:	Prolonged or repeated overexposure cause dermatitis and damage to the kidney, liver, lungs and central nervous system.

Toxicity Data:	Acetone:	Oral rat LD50: 5,800 mg/kg Inhalation rat LC50: 50,100 mg/m3/8 hours
	Cyclohexanone:	Oral rat LD50: 1,620 mg/kg Inhalation rat LC50: 8,000 ppm/4 hours Skin rabbit LD50: 1 mL/kg
	Tetrahydrofuran:	Oral rat LD50: 1,650 mg/kg Inhalation rat LC50: 21,000 ppm/3 hours
	Methyl Ethyl Ketone:	Oral rat LD50: 2,737 mg/kg Inhalation rat LC50: 23,500 mg/m3/8 hours Skin rabbit LD50: 6,480 mg/kg

Sensitization:	None of the components are known to cause sensitization.
Carcinogenicity:	None of the components are listed as a carcinogen or suspect carcinogen by NTP, IARC or OSHA. The National Toxicology Program has reported that exposure of mice and rats to Tetrahydrofuran (THF) vapor levels up to 1800 ppm 6 hr/day, 5 days/week for their lifetime caused an increased incidence of kidney tumors in male rats and liver tumors in female mice. The significance of these findings for human health are unclear at this time, and may be related to "species specific" effects. Elevated incidences of tumors in humans have not been reported for THF. ACGIH has classified cyclohexanone (CYH) as “A3,” Confirmed Animal Carcinogen with Unknown Relevance to Humans. incidences of tumors in humans have not been reported for THF.
Mutagenicity:	Acetone has been positive in a mammal cell cytogenic analysis but negative in many other assays. At most, acetone is weakly genotoxic. Cyclohexanone has been positive in bacterial and mammalian assays. Tetrahydrofuran was positive in a bacterial assay. Methyl ethyl ketone is not considered genotoxic based on laboratory studies.
Reproductive Toxicity:	Methyl ethyl ketone and cyclohexanone have been shown to cause embryofetal toxicity and birth defects in laboratory animals. Acetone and tetrahydrofuran have been found to cause adverse developmental effects only when exposure levels cause other toxic effects to the mother.
Medical Conditions Aggravated By Exposure:	Persons with pre-existing skin, lung, kidney or liver disorders may be at increased risk from exposure to this product.

SECTION 14 TRANSPORTATION INFORMATION

DOT	Less than 1 Liter (0.3 gal)	Greater than 1 Liter (0.3 gal)
Proper Shipping Name:	Consumer Commodity	Flammable Liquid NOS
Hazard Class/Packing Group:	ORM-D	3, PGII
UN/NA Number:	None	UN1993
Hazard Labels:	None	Flammable Liquid (Methyl Ethyl Ketone, Cyclohexanone)

IMDG		
Proper Shipping Name:	Flammable Liquid, N.O.S.	Limited Quantity
Hazard Class/Packing Group:	3, II	
UN Number:	UN1993	
Label:	None (Limited Quantities are excepted from labeling)	

RCRA Hazardous Waste Number: U002, U057, U159, U213
EPA Hazardous Waste ID Number: D001, D035, F003, F005
EPA Hazard Waste Class: Ignitable Waste. Toxic Waste (Methyl Ethyl Ketone content)
2000 North American Emergency Response Guidebook Number: 127 or 128

SECTION 15 REGULATIONS

Hazard Category for Section 311/312:	Acute Health, Chronic Health, Flammable
Section 302 Extremely Hazardous Substances (TPQ):	This product does not contain chemicals regulated under SARA Section 302.
Section 313 Toxic Chemicals:	This product contains the following chemicals subject to SARA Title III Section 313 Reporting requirements:

Chemical	CAS #	%
Methyl Ethyl Ketone	78-93-3	70-80%

CERCLA 103 Reportable Quantity:	Spills of this product over the RQ (reportable quantity) must be reported to the National Response Center. The RQ for the product, based on the RQ for Methyl Ethyl Ketone (80% maximum) of 5,000 lbs, is 6,250 lbs. Many states have more stringent release reporting requirements. Report spills required under federal, state and local regulations.
California Proposition 65:	This product does not contain any chemicals subject To California Proposition 65 regulation.
TSCA Inventory:	All of the components of this product are listed on the TSCA inventory.

SECTION 16 DISCLAIMER

The information herein has been compiled from sources believed to be reliable, up-to-date, and is accurate to the best of our knowledge. However, Oatey cannot give any guarantees regarding information from other sources, and expressly does not make warranties, nor assumes any liability for its use.

Material Safety Data Sheet

Aqua Solutions
6913 Highway 225
Deer Park, TX 77536

Phone (281) 479-2569
Chemtrec 800-424-9300
24 Hour Emergency Assistance

Section 1 Identification

Product Number:	6920
Product Name:	Conductivity Standard 0.01 Molar Traceable to N.I.S.T.
Trade/Chemical Synonyms	
Formula:	N/A
RTECS:	None
C.A.S	See Below

Health:	1
Flammability	0
Reactivity	0

Hazard Rating:

Least	Slight	Moderate	High	Extreme
0	1	2	3	4

NA = Not Applicable NE = Not Established

Section 2 Component Mixture

Sara 313	Component	CAS Number	%	Dim	Exposure Limits:
☐	Water, Deionized ASTM Type II	CAS# 7732-18-5	Balance	V/V	None Established
☐	Potassium Chloride	CAS# 7447-40-7	<1%	W/V	None Established

Section 3 Hazard Identification (Also see section 11)

Generally not hazardous in normal handling, however good laboratory practices should always be used. Avoid long term exposure to skin or by inhalation.

Section 4 First Aid Measures

Generally not hazardous in normal handling, however good laboratory practices should always be used. Avoid long term exposure to skin or by inhalation.

FIRST AID: SKIN: Wash exposed area with soap and water. If irritation persists, seek medical attention.

EYES: Wash eyes with plenty of water for at least 15 minutes, lifting lids occasionally. Seek Medical Aid. INHALATION: Remove to fresh air. If not breathing, give artificial respiration. If breathing is difficult, give oxygen

INGESTION: Give several glasses of milk or water. Vomiting may occur spontaneously, but DO NOT INDUCE! Never give anything by mouth to an unconscious person.

Section 5 Fire Fighting Measures

Fire Extinguisher Type:	Any means suitable for extinguishing surrounding fire
Fire/Explosion Hazards:	None
Fire Fighting Procedure:	Use any means suitable for extinguishing surrounding fire. Use water spray cool fire exposed containers.

Section 6 Accidental Release Measures

Absorb spill with inert material. Flush excess down drain.

Section 7 Handling and Storage

This Material is not considered hazardous. Handle using safe laboratory practices.

Section 8 Exposure Controls & Personal Protection

Respiratory Protection:None required

Ventilation: Mechanical: ☐ Local Exhaust: ☑

Hand Protection: Wear appropriate gloves to prevent skin exposure

Eye Protection: Safety Glasses w/Side Shields

Other Protective Equipment: None required

Section 9 Physical and Chemical Properties

Melting Point:	~0° C	Specific Gravity	1
Boiling Point:	~100° C	Percent Volatile by Volume:	>99%
Vapor Pressure:	N/E	Evaporation Rate:	N/A
Vapor Density:	information not available	Evaporation Standard:	Not Applicable
Solubility in Water:	Soluble	Auto ignition Temperature:	N/A
Appearance and Odor:	Clear water white / no odor	Lower Flamm. Limit in Air:	N/A
Flash Point:	N/A	Upper Flamm. Limit in Air:	N/A

Section 10 Stability and Reactivity Information

Stability: Stable Conditions to Avoid: Protect from freezing.

Materials to Avoid: None

Hazardous Decomposition Products: Not known to occur.

Hazardous Polymerization:Will Not Occur

Condition to Avoid:None known

Section 11 Additional Information

Conditions aggravated/target organs: Persons with preexisting skin, eye or respiratory disorders may be more susceptible. Acute: Essentially non-hazardous. Possible eye and digestive tract irritation. Chronic: None known.

DOT Classification: Not Regulated

DOT regulations may change from time to time. Please consult the most recent version of the relevant regulations.

Revision No:0 Date Entered: 9/1/2006 Approved by: WPF

RICCA CHEMICAL COMPANY

MSDS

For RICCA, SpectroPure, Red Bird, and Solutions Plus Brands
Emergency Contact(24 hr) – CHEMTREC®
Domestic: 800-424-9300
International: 703-527-3887

ELECTRODE CLEANING SOLUTION

Material Safety Data Sheet

Section 1: Chemical Product and Company Identification

Catalog Number: 2794	
Product Identity: ELECTRODE CLEANING SOLUTION	
Manufacturer's Name: RICCA CHEMICAL COMPANY LLC	**Emergency Contact(24 hr) – CHEMTREC®** Domestic: 800-424-9300 International: 703-527-3887
CAGE Code: 0V553	
Address: 448 West Fork Dr Arlington, TX 76012	**Telephone Number For Information:** 817-461-5601
Date Prepared: 4/7/99	**Revision:** 2 Last Revised: 09/10/2001 Date Printed: 06/19/2006 6:25:59 pm

Section 2. Composition/Information on Ingredients

Component	CAS Registry #	Concentration	ACGIH TLV	OSHA PEL
Hydrochloric Acid	7647-01-0	<1	C 5 ppm C 7.5 mg/m3	C 5 ppm C 7 mg/m3
Water, Deionized	7732-18-5	Balance	Not Available Not Available	Not Available Not Available
Pepsin	9001-75-6	0.9-1.1	Not Available Not Available	Not Available Not Available

Section 3: Hazard Identification

Emergency Overview: Does not present any significant health hazards. May cause irritation and allergic reaction. Wash areas of contact with water. If swallowed, give large amounts of water. Do not induce vomiting. Call a physician if necessary.

Target Organs: eyes, skin, respiratory system.

Eye Contact: May cause irritation, redness, pain, and tearing.

Inhalation: May cause irritation.

Skin Contact: May cause slight irritation.

Ingestion: Large doses may cause nausea, vomiting and diarrhea.

Chronic Effects/Carcinogenicity: None

IARC - Hydrochloric Acid is unclassifiable as to carcinogenicity to humans.

NTP - No.

RICCA CHEMICAL COMPANY

MSDS

For RICCA, SpectroPure, Red Bird, and Solutions Plus Brands
Emergency Contact (24 hr) -- CHEMTREC®
Domestic: 800-424-9300
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Section 4: First Aid Measures - In all cases, seek qualified evaluation.

Eye Contact: Irrigate immediately with large quantity of water for at least 15 minutes. Call a physician if irritation develops.
Inhalation: Remove to fresh air. Give artificial respiration if necessary. If breathing is difficult, give oxygen.
Skin Contact: Flush with plenty of water for at least 15 minutes. Call a physician if irritation develops.
Ingestion: Dilute with water or milk. Call a physician if necessary.

Section 5: Fire Fighting Measures

Flash Point: Not Available.
Method Used: Not Available.
LFL: Not Available.
UFL: Not Available.
Extinguishing Media: Use any means suitable for extinguishing surrounding fire.
Fire & Explosion Hazards: Not considered to be a fire or explosion hazard.
Fire Fighting Instructions: Use normal procedures/instructions.
Fire Fighting Equipment: Use protective clothing and breathing equipment appropriate for the surrounding fire.

Section 6: Accidental Release Measures

Absorb with suitable material and treat as normal refuse. Small amounts of the liquid may be flushed to the drain with excess water. Always dispose of in accordance with local regulations.

Section 7. Handling and Storage

As with all chemicals, wash hands thoroughly after handling. Avoid contact with eyes and skin. Protect from freezing and physical damage.
Safety Storage Code: General

Section 8: Exposure Control/Personal Protection

Engineering Controls: No specific controls are needed. Normal room ventilation is adequate.
Respiratory Protection: Normal room ventilation is adequate.
Skin Protection: Chemical resistant gloves.
Eye Protection: Safety glasses or goggles.

Section 9: Physical and Chemical Properties

Appearance: Clear, colorless to yellow liquid
Odor: odorless to slight ammoniacal odor
Solubility in Water: Infinite
Specific Gravity: Approximately 1.14
pH: approximately 7.2 (10% solution)
Boiling Point(°C): Not Available.
Melting Point(°C): Not Available.
Vapor Pressure: Not Applicable.

Section 10: Stability and Reactivity

Chemical Stability: Stable under normal conditions of use and storage.
Incompatibility: Strong oxidizing agents, acids, bases, nitrates, lithium, bromine trifluoride, brass, bronze.
Hazardous Decomposition Products: Oxides of Nitrogen and Carbon, Ammonia.
Hazardous Polymerization: Will not occur.

Section 11. Toxicological Information

LD50 Oral, Rat: (Urea) 8471 mg/kg. Details of toxic effects not reported other than lethal dose value.

RICCA CHEMICAL COMPANY

MSDS

For RICCA, SpectroPure, Red Bird, and Solutions Plus Brands
Emergency Contact (24 hr) -- CHEMTREC®
Domestic: 800-424-9300
International: 703-527-3887

ELECTRODE CLEANING SOLUTION 2

Section 12. Ecological Information

Ecotoxicological Information: This product is expected to have a low order of toxicity.
Chemical Fate Information: No information found.

Section 13. Disposal Considerations

Dilute with water and flush to sewer if local regulations allow. If not allowed, save for recovery or recycling in an approved waste disposal facility. Dispose of in accordance with local, state, and federal regulations.

Section 14. Transport Information

Part Numbers:

This product is not regulated.

Section 15. Regulatory Information (Not meant to be all inclusive - selected regulation represented)

OSHA Status: These items meet the OSHA Hazard Communication Standard (29 CFR 1910.1200) definition of a hazardous material.
TSCA Status: All components of this solution are listed on the TSCA Inventory or are mixtures (hydrates) of items listed on the TSCA Inventory.

Sara Title III:
- **Section 302 Extremely Hazardous Substances:**Not Applicable.
- **Section 311/312 Hazardous Catagories:**No
- **Section 313 Toxic Chemicals:**Not Applicable.

California: None Reported.
Pennsylvania: None Reported.
RCRA Status: Not Applicable.
CERCLA Reportable Quantity: None Reported.

WHMIS: Not Applicable.

Section 16. Other Information

NFPA Ratings:

Health: 1	Flammability: 0	Reactivity: 0	Special Notice Key:None

HMIS Ratings:

Health: 1	Flammability: 0	Reactivity: 0	Protective Equipment:B (Protective Eyewear, Gloves)

RICCA CHEMICAL COMPANY

MSDS

For RICCA, SpectroPure, Red Bird, and Solutions Plus Brands
Emergency Contact (24 hr) -- CHEMTREC®
Domestic: 800-424-9300
International: 703-527-3887

ELECTRODE CLEANING SOLUTION 2

Material Safety Data Sheet

Aqua Solutions
6913 Highway 225
Deer Park, TX 77536

Phone (281) 479-2569
Chemtrec 800-424-9300
24 Hour Emergency Assistance

Section 1 Identification

Product Number:	3675	Health:	1
Product Name:	Electrode Storage	Flammability	0
Trade/Chemical Synonyms		Reactivity	0
Formula:	N/A		
RTECS:			
C.A.S	See Below		

Hazard Rating:
Least Slight Moderate High Extreme
0 1 2 3 4
NA = Not Applicable NE = Not Established

Section 2 Component Mixture

Sara 313	Component	CAS Number	%	Dim	Exposure Limits:
☐	Water, Deionized ASTM Type II	CAS# 7732-18-5	Balance	V/V	None Established
☐	Potassium Chloride	CAS# 7447-40-7	11.2%	W/V	None Established
☐	Potassium Hydrogen Phthalate	CAS# 877-24-7	0.51%	W/V	TXDS: orl-rat LD•□: 3200 mg/Kg

Section 3 Hazard Identification (Also see section 11)

May be harmful if swallowed. May cause irritation. Avoid breathing vapors, or dusts. Use with adequate ventilation. Avoid contact with eyes, skin, and clothes. Wash thoroughly after handling.

Section 4 First Aid Measures

May be harmful if swallowed. May cause irritation. Avoid breathing vapors, or dusts. Use with adequate ventilation. Avoid contact with eyes, skin, and clothes. Wash thoroughly after handling.

FIRST AID: SKIN: Remove contaminated clothing. Wash exposed area with soap and water. if irritation persists, seek medical attention.

EYES: Wash eyes with plenty of water for at least 15 minutes, lifting lids occasionally. Seek Medical Aid. INHALATION: Remove to fresh air. If not breathing, give artificial respiration. If breathing is difficult, give oxygen

INGESTION: If swallowed, induce vomiting immediately after giving two glasses of water. Never give anything by mouth to an unconscious person.

Section 5 Fire Fighting Measures

Fire Extinguisher Type:	Any means suitable for extinguishing surrounding fire.
Fire/Explosion Hazards:	None Known.
Fire Fighting Procedure:	Wear self-contained breathing apparatus and protective clothing to prevent contact with skin and clothing.

Section 6 Accidental Release Measures

Absorb spill with inert material. Flush excess down drain.

Section 7 Handling and Storage

Store in a cool dry place. This material is not considered hazardous. Handle using safe laboratory practices.

Section 8 Exposure Controls & Personal Protection

Respiratory Protection: None required

Ventilation:	Mechanical: ☐	Hand Protection:	Gloves to prevent skin exposure as latex or vinyl
	Local Exhaust: ☑	Eye Protection:	Splash Goggles

Other Protective Equipment: Wear appropriate clothing to prevent skin exposure

Section 9 Physical and Chemical Properties

Melting Point:	Information not available	Specific Gravity	~1.1
Boiling Point:	Information not available	Percent Volatile by Volume:	~87
Vapor Pressure:	Information not available	Evaporation Rate:	Information not available
Vapor Density:	Information not available	Evaporation Standard:	
Solubility in Water:	Soluble	Auto ignition Temperature:	Not applicable
Appearance and Odor:	Clear, colorless, odorless liquid	Lower Flamm. Limit in Air:	Not applicable
Flash Point:	Not flammable	Upper Flamm. Limit in Air:	Not applicable

Section 10 Stability and Reactivity Information

Stability: Stable Conditions to Avoid: None known

Materials to Avoid:
Bromine triflouride, potassium permaganate plus sulfuric acid

Hazardous Decomposition Products:
None known

Hazardous Polymerization: Will Not Occur

Condition to Avoid: None known

Section 11 Additional Information

Can also produce gastrointestinal irritaition and vomiting. May produce weakness and circulatory problems. Can also cause skin rash or eye irritation. Chronic: None found . Target organs: None. Persons with pre-existing disorders may be more susceptible.

DOT Classification: Not Regulated

DOT regulations may change from time to time. Please consult the most recent version of the relevant regulations.

Revision No:0 Date Entered: 9/1/2006 Approved by: WPF

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MSDS1743

MATERIAL DATA SAFETY SHEET

HMIS Ratings Health: 0
Flammability: 0
Reactivity: 0

Identity: Eyesaline® solution - Product #s 32-000400, 32-000401, 32-000433, 32-000440, 32-000445, 32-00446, 32-000448, 32-000449, 32-000451, 32-000452, 32-000454, 32-000455, 32-000457, 32-000458, 32-000460, 32-000461, 32-000462, 32-000463, 32-000470, 32-000471, 32-000492, 32-000493, 32-000494, 32-000496, 32-000497, 32-000498, 32-00049932-000502, 32-000504, 32-000505, 32-000506, 32-000507, 32-000508, 32-000510, 32-000512, 32-000533, 32-000534, 32-000535, 32-001050, 32-001052

Section I

Manufacturer: Fendall, Inc.	**Emergency Telephone:** 1-401-232-1200
Address: 825 East Highway 151	**Information Telephone:** 800-543-4842
Platteville, WI 53818 USA	**Date Prepared:** 08/05/04

Hazardous Components (Specific Chemical Identity; Common Name(s))	OSHA PEL	ACGIH TLV	Other limits recommended	% (optional)
BENZALKONIUM CHLORIDE CAS #8001-54-5	NONE	NONE	N/A	<0.1%

Boiling Point: 200°F (93.3°C)	**Specific Gravity (H2O)=1:** NOT DETERMINED
Vapor Pressure (mm Hg.): 760	**Melting Point:** N/A
Vapor Density (Air = 1): NOT DETERMINED	**Evaporation Rate (Butyl Acetate = 1):** NOT DETERMINED

Solubility in Water: 100%

Appearance and Odor: COLORLESS LIQUID WITH NO DISCERNABLE ODOR

Flash Point (Method Used): N/A	**Flammable Limits:**	**LEL:** N/A	**UEL:** N/A

Extinguishing Media: THIS IS A NONFLAMMABLE AQUEOUS SOLUTION

Special Fire Fighting Procedures: N/A

Unusual Fire and Explosion Hazards: N/A

Stability	**Unstable:** NO **Stable:** YES	**Conditions to Avoid:** THIS PRODUCT IS STABLE AND CONSIDERED NON-REACTIVE UNDER NORMAL CONDITIONS OF STORAGE AND USAGE

Incompatibility (Materials to Avoid): NONE KNOWN

Hazardous Decomposition or Byproducts: NONE

Hazardous Polymerization	**May Occur:** NO **Will Not Occur:** YES	**Conditions to Avoid:** NONE

Route(s) of Entry: **Inhalation?** NO **Skin?** NO **Ingestion?** YES

Health Hazards (Acute and Chronic): INGESTION OF VOLUMES IN EXCESS OF 20 LITERS MAY CAUSE GASTRIC IRRITATION

Carcinogenicity: **NTP?** NO **IARC Monographs?** NO **OSHA Regulated?** NO

Signs and Symptoms of Exposure: N/A

Medical Conditions Generally Aggravated by Exposure: N/A

Emergency First Aid Procedures: NOTES TO PHYSICIAN: IN THE UNLIKELY EVENT OF RAPID INGESTION OF LARGE VOLUMES OF THE SOLUTION, INDUCE VOMITING AND OBSERVE THE PATIENT FOR GASTRIC IRRITATION.

Section VII - Precautions for Safe Handling and Use

Steps to Be Taken in Case Material is Released or Spilled: FLUSH AREA WITH WATER. THE SOLUTION IS NOT RCRA HAZARDOUS WASTE.

Waste Disposal Method: N/A

Precautions to Be Taken in Handling and Storing: DO NOT FREEZE OR EXPOSE TO TEMPERATURES IN EXCESS OF 110°F (43°C) FOR EXTENDED PERIODS.

Other Precautions: N/A

Respiratory Protection: N/A

Ventilation	**Local Exhaust:** N/A **Mechanical:** N/A	**Special:** N/A **Other:** N/A

Protective Gloves: N/A **Eye Protection:** N/A

Other Protective Clothing: N/A

Work Hygienic Practices: N/A

SPECTRUM®

GARDENA, CA
NEW BRUNSWICK, NJ

ISO 9002 CERTIFIED

Material Safety Data Sheet

NFPA	HMIS	Personal Protective Equipment
Health 3, Fire 0, Reactivity 0, OXY	Health Hazard 3 Fire Hazard 0 Reactivity 0	See Section 15.

Section 1. Chemical Product and Company Identification

Common Name/ Trade Name	**Iodine Solution, 0.1N**
Manufacturer	SPECTRUM CHEMICAL MFG. CORP. 14422 S. SAN PEDRO STREET GARDENA, CA 90248
Commercial Name(s)	Not available.
Synonym	Not available.
Chemical Name	Not applicable.
Chemical Family	Oxidizing agent.
Chemical Formula	Not applicable.
Supplier	SPECTRUM CHEMICAL MFG. CORP. 14422 S. SAN PEDRO STREET GARDENA, CA 90248

Catalog Number(s).	I-118
CAS#	Mixture.
RTECS	Not applicable.
TSCA	TSCA 8(b) inventory: Iodine; Potassium Iodide; Hydrochloric acid; Water
CI#	Not applicable.

IN CASE OF EMERGENCY
CHEMTREC (24hr) 800-424-9300

CALL (310) 516-8000

Section 2.Composition and Information on Ingredients

		Exposure Limits			
Name	**CAS #**	**TWA (mg/m³)**	**STEL (mg/m³)**	**CEIL (mg/m³)**	**% by Weight**
1) Iodine	7553-56-2			0.1	1.4
2) Potassium Iodide	7681-11-0				4
3) Hydrogen chloride	7647-01-0	7.5		5	0.0037
4) Water	7732-18-5				94.6

Toxicological Data on Ingredients

Iodine:
ORAL (LD50): Acute: 14000 mg/kg [Rat].
Potassium Iodide
LD50: Not available.
LC50: Not available.

Continued on Next Page

Section 3. Hazards Identification

Potential Acute Health Effects	Hazardous in case of skin contact (corrosive, irritant, sensitizer, permeator), of eye contact (irritant), of ingestion, of inhalation. Prolonged exposure may result in skin burns and ulcerations. Over-exposure by inhalation may cause respiratory irritation.
Potential Chronic Health Effects	Hazardous in case of skin contact (corrosive, irritant, sensitizer, permeator), of eye contact (irritant), of ingestion, of inhalation. **CARCINOGENIC EFFECTS**: Not available. **MUTAGENIC EFFECTS**: Not available. **TERATOGENIC EFFECTS**: Not available. **DEVELOPMENTAL TOXICITY**: PROVEN [Potassium Iodide] The substance is toxic to lungs, the nervous system, the reproductive system, mucous membranes, gastrointestinal tract, upper respiratory tract. Repeated or prolonged exposure to the substance can produce target organs damage.

Section 4. First Aid Measures

Eye Contact	Check for and remove any contact lenses. Immediately flush eyes with running water for at least 15 minutes, keeping eyelids open. Cold water may be used. Do not use an eye ointment. Seek medical attention.
Skin Contact	If the chemical got onto the clothed portion of the body, remove the contaminated clothes as quickly as possible, protecting your own hands and body. Place the victim under a deluge shower. If the chemical got on the victim's exposed skin, such as the hands : Gently and thoroughly wash the contaminated skin with running water and non-abrasive soap. Be particularly careful to clean folds, crevices, creases and groin. Cold water may be used. If irritation persists, seek medical attention. Wash contaminated clothing before reusing.
Serious Skin Contact	Wash with a disinfectant soap and cover the contaminated skin with an anti-bacterial cream. Seek medical attention.
Inhalation	Allow the victim to rest in a well ventilated area. Seek immediate medical attention.
Serious Inhalation	Evacuate the victim to a safe area as soon as possible. Loosen tight clothing such as a collar, tie, belt or waistband. If breathing is difficult, administer oxygen. If the victim is not breathing, perform mouth-to-mouth resuscitation. Seek medical attention.
Ingestion	Do not induce vomiting. Loosen tight clothing such as a collar, tie, belt or waistband. If the victim is not breathing, perform mouth-to-mouth resuscitation. Seek immediate medical attention.
Serious Ingestion	Not available.

Section 5. Fire and Explosion Data

Flammability of the Product	Non-flammable.
Auto-Ignition Temperature	Not applicable.
Flash Points	Not applicable.
Flammable Limits	Not applicable.
Products of Combustion	Not available.
Fire Hazards in Presence of Various Substances	Not applicable.
Explosion Hazards in Presence of Various Substances	Risks of explosion of the product in presence of mechanical impact: Not available. Risks of explosion of the product in presence of static discharge: Not available.
Fire Fighting Media and Instructions	Not applicable.
Special Remarks on Fire Hazards	Not available.
Special Remarks on Explosion Hazards	Not available.

Continued on Next Page

Section 6. Accidental Release Measures

Small Spill	Dilute with water and mop up, or absorb with an inert dry material and place in an appropriate waste disposal container.
Large Spill	Oxidizing material. Stop leak if without risk. Avoid contact with a combustible material (wood, paper, oil, clothing...). Keep substance damp using water spray. Do not touch spilled material. Prevent entry into sewers, basements or confined areas; dike if needed. Call for assistance on disposal. Be careful that the product is not present at a concentration level above TLV. Check TLV on the MSDS and with local authorities.

Section 7. Handling and Storage

Precautions	Keep container dry. Keep away from heat. Keep away from sources of ignition. Keep away from combustible material Do not ingest. Do not breathe gas/fumes/ vapour/spray. Never add water to this product In case of insufficient ventilation, wear suitable respiratory equipment If ingested, seek medical advice immediately and show the container or the label. Avoid contact with skin and eyes Keep away from incompatibles such as oxidizing agents, acids.
Storage	Oxidizing materials should be stored in a separate safety storage cabinet or room.

Section 8. Exposure Controls/Personal Protection

Engineering Controls	Provide exhaust ventilation or other engineering controls to keep the airborne concentrations of vapors below their respective threshold limit value. Ensure that eyewash stations and safety showers are proximal to the work-station location.
Personal Protection	Splash goggles. Lab coat. Vapor respirator. Be sure to use an approved/certified respirator or equivalent. Gloves.
Personal Protection in Case of a Large Spill	Splash goggles. Full suit. Vapor respirator. Boots. Gloves. A self contained breathing apparatus should be used to avoid inhalation of the product. Suggested protective clothing might not be sufficient; consult a specialist BEFORE handling this product.
Exposure Limits	**Iodine** CEIL: 0.1 (ppm) from ACGIH (TLV) CEIL: 1 (mg/m^3) from OSHA Consult local authorities for acceptable exposure limits.

Section 9. Physical and Chemical Properties

Physical state and appearance	Liquid.	**Odor**	Not available.
Molecular Weight	Not applicable.	**Taste**	Not available.
pH (1% soln/water)	Neutral.	**Color**	Clear Brown. (Dark.)

Boiling Point	The lowest known value is 100°C (212°F) (Water).
Melting Point	Not available.
Critical Temperature	Not available.
Specific Gravity	Weighted average: 1.04 (Water = 1)
Vapor Pressure	The highest known value is 17.535 mm of Hg (@ 20°C) (Water).
Vapor Density	The highest known value is 0.62 (Air = 1) (Water).
Volatility	Not available.
Odor Threshold	Not available.
Water/Oil Dist. Coeff.	Not available.
Ionicity (in Water)	Not available.

Continued on Next Page

Dispersion Properties	See solubility in water, methanol, diethyl ether, acetone.
Solubility	Easily soluble in cold water, hot water. Soluble in methanol, diethyl ether. Partially soluble in acetone.

Section 10. Stability and Reactivity Data

Stability	The product is stable.
Instability Temperature	Not available.
Conditions of Instability	Not available.
Incompatibility with various substances	Reactive with acids. Slightly reactive to reactive with combustible materials, organic materials, metals.
Corrosivity	Slightly corrosive to corrosive in presence of steel, of aluminum, of zinc, of copper. Non-corrosive in presence of glass.
Special Remarks on Reactivity	Reacts violently with water especially when water is added to the product. (Hydrogen chloride)
Special Remarks on Corrosivity	Not available.
Polymerization	Not available.

Section 11. Toxicological Information

Routes of Entry	Absorbed through skin. Dermal contact. Eye contact. Inhalation. Ingestion.
Toxicity to Animals	Acute oral toxicity (LD50): 14000 mg/kg [Rat]. (Iodine).
Chronic Effects on Humans	**DEVELOPMENTAL TOXICITY**: PROVEN [Potassium Iodide] The substance is toxic to lungs, the nervous system, the reproductive system, mucous membranes, gastrointestinal tract, upper respiratory tract.
Other Toxic Effects on Humans	Hazardous in case of skin contact (corrosive, irritant, sensitizer, permeator), of ingestion, of inhalation.
Special Remarks on Toxicity to Animals	Not available.
Special Remarks on Chronic Effects on Humans	Not available.
Special Remarks on other Toxic Effects on Humans	Material is extremely destructive to tissue of the mucous membranes and upper respiratory tract. (Hydrogen chloride)

Section 12. Ecological Information

Ecotoxicity	Not available.
BOD5 and COD	Not available.
Products of Biodegradation	Possibly hazardous short term degradation products are not likely. However, long term degradation products may arise.
Toxicity of the Products of Biodegradation	Not available.
Special Remarks on the Products of Biodegradation	Not available.

Continued on Next Page

Section 13. Disposal Considerations

Waste Disposal	

Section 14. Transport Information

DOT Classification	
Identification	
Special Provisions for Transport	Not available.
DOT (Pictograms)	

Section 15. Other Regulatory Information and Pictograms

Federal and State Regulations	California prop. 65: This product contains the following ingredients for which the State of California has found to cause cancer, birth defects or other reproductive harm, which would require a warning under the statute: Potassium Iodide California prop. 65: This product contains the following ingredients for which the State of California has found to cause birth defects which would require a warning under the statute: Potassium Iodide Pennsylvania RTK: Iodine; Hydrochloric acid Massachusetts RTK: Iodine; Hydrochloric acid TSCA 8(b) inventory: Iodine; Potassium Iodide; Hydrochloric acid; Water SARA 302/304/311/312 extremely hazardous substances: Hydrochloric acid SARA 313 toxic chemical notification and release reporting: Hydrochloric acid CERCLA: Hazardous substances.: Hydrochloric acid;
California Proposition 65 Warnings	California prop. 65: This product contains the following ingredients for which the State of California has found to cause cancer which would require a warning under the statute: No products were found. California prop. 65: This product contains the following ingredients for which the State of California has found to cause birth defects which would require a warning under the statute: Potassium Iodide
Other Regulations	OSHA: Hazardous by definition of Hazard Communication Standard (29 CFR 1910.1200).

Other Classifications	**WHMIS (Canada)**	CLASS C: Oxidizing material. CLASS D-2A: Material causing other toxic effects (VERY TOXIC).
	DSCL (EEC)	R36/38- Irritating to eyes and skin. R43- May cause sensitization by skin contact.

HMIS (U.S.A.)

Health Hazard	3
Fire Hazard	0
Reactivity	0
Personal Protection	h

National Fire Protection Association (U.S.A.)

Flammability

Health

Reactivity

Specific hazard

WHMIS (Canada) (Pictograms)

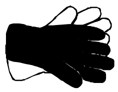
DSCL (Europe) (Pictograms)

Continued on Next Page

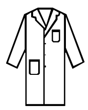
TDG (Canada) (Pictograms)

ADR (Europe) (Pictograms)

Protective Equipment



Gloves.



Lab coat.

Vapor respirator. Be sure to use an approved/certified respirator or equivalent. Wear appropriate respirator when ventilation is inadequate.

Splash goggles.

Section 16. Other Information

MSDS Code	**I118S**
References	Not available.
Other Special Considerations	Not available.

Validated by Sonia Owen on 1/20/2003.	**Verified by Sonia Owen.** **Printed 8/25/2004.**

CALL (310) 516-8000

Notice to Reader

ITEM: 5WZ49 - Gauge Liquid Filled

PICK_REQ: 1059098714 **MATERIAL SAFETY DATA SHEET (MSDS)** **MSDS: B2489**

This MSDS should be attached or kept with the respective product with which it is associated.

MATERIAL SAFETY DATA SHEET - B2489

Associated Grainger Item: 5WZ49 - Gauge Liquid Filled

5WZ49, 5WZ50, 5WZ51, 5WZ52, 5WZ60, 5WZ61, 5WZ62, 5WZ63, 5WZ64, 5WZ65, 5WZ66 5WZ67, 5WZ68, 5WZ69, 5WZ70, 5WZ71, 5WZ72

MATERIAL SAFETY DATA SHEET

GLYCERIN / GLYCEROL 99.7% MIN.

MSDS NO.: 01-GLY997

DATE OF PREPARATION: 02/01

REVISION: 1.1

SECTION 1 - CHEMICAL PRODUCT AND COMPANY IDENTIFICATION

PRODUCT / CHEMICAL NAME: GLYCERIN / GLYCEROL 99.7% MIN.

CHEMICAL FORMULA: $C_3H_5(OH)_3$

CAS NUMBER: 56-81-5

OTHER DESIGNATIONS: 1,2,3-TRIHYDROXYPROPANE, 1,2,3-PROPANETRIOL

SUPPLIER:
KIC CHEMICALS, INC.
84 BUSINESS PARK DRIVE
ARMONK, NY 10504
U.S.A.

PHONE: (914)-273-6555

FAX: (914)-273-6760

CHEMTREC 24-HOUR EMERGENCY PHONE NUMBER: (800)-424-9300

SECTION 2 - COMPOSITION / INFORMATION ON INGREDIENTS

INGREDIENT	CAS NUMBER	% WT OR % VOL
GLYCEROL	56-81-5	>99.7%

INGREDIENT	OSHA PEL TWA	OSHA PEL STEL	ACGIH TLV TWA	ACGIH TLV STEL	NIOSH REL TWA	NIOSH REL STEL	NIOSH IDLH
GLYCEROL	10 MG/M3 (GLYCERIN MIST-TOTAL DUST) 5 MG/M3 (GLYCERIN MIST - RESPIRABLE FRACTION)	NDA	10 MG/M3 (GLYCERIN MIST)	NDA	NDA	NDA	NDA

SECTION 3 - PHYSICAL AND CHEMICAL PROPERTIES

PHYSICAL STATE: LIQUID

WATER SOLUBILITY AT 25 DEG. C: MISCIBLE WITH ALL PROPORTIONS

APPEARANCE AND ODOR: CLEAR, SWEET ODOR

OXIDIZING PROPERTIES:
CONTACT WITH STRONG OXIDIZING AGENTS SUCH AS CHROMIUM TRIOXIDE, POTASSIUM CHLORATE, OR POTASSIUM PERMANGANATE MAY PRODUCE AN EXPLOSION

ETHANOL SOLUBILITY AT 25 DEG. C: EASILY SOLUBLE

BOILING POINT AT 760 MMHg: APPROX. 290 DEG. C

FREEZING/MELTING POINT: APPROX. 18 DEG. C

SPECIFIC GRAVITY AT 25 DEG. C (H_2O=1, AT 4 DEG. C): 1.2606

pH: NEUTRAL TO LITMUS

SECTION 4 - FIRE-FIGHTING MEASURES

FLASH POINT: APPROX. 349 DEG. F (176 DEG. C)
FLASH POINT METHOD: OPEN CUP

AUTOIGNITION TEMPERATURE: 698 DEG. F (370 DEG. C)

FLAMMABILITY CLASSIFICATION: NON-FLAMMABLE

EXTINGUISHING MEDIA: FOAM, CARBON DIOXIDE, WATER, OR DRY CHEMICAL

UNUSUAL FIRE OR EXPLOSION HAZARDS:
KEEP AWAY FROM STRONG ACIDS OR OXIDIZING MATERIALS

NFPA:
1
1
0

FIRE-FIGHTING INSTRUCTIONS:
INDIVIDUALS SHOULD PERFORM ONLY THOSE FIRE-FIGHTING PROCEDURES FOR WHICH THEY HAVE BEEN TRAINED. WATER OR FOAM MAY CAUSE FROTHING WHEN APPLIED TO FLAMMABLE LIQUIDS HAVING FLASH POINTS ABOVE 212 DEG. F (100 DEG. C). THE REMARK IS INCLUDED ONLY AS A PRECAUTION AND DOES NOT MEAN THAT WATER OR FOAM SHOULD NOT OR COULD NOT BE USED IN FIGHTING FIRES IN SUCH LIQUIDS. THE FROTHING MAY BE QUITE VIOLENT AND COULD ENDANGER THE LIFE OF THE FIREFIGHTER PARTICULARLY WHEN SOLID STREAMS ARE DIRECTED INTO THE HOT BURNING LIQUID. ON THE OTHER HAND, WATER SPRAY CAREFULLY APPLIED HAS FREQUENTLY BEEN USED WITH SUCCESS IN EXTINGUISHING SUCH FIRES BY CAUSING THE FROTHING TO OCCUR ONLY ON THE SURFACE AND THIS FOAMING ACTION BLANKETS AND EXTINGUISHES THE FIRE. (NFPA 325M-1984)

FIRE-FIGHTING EQUIPMENT:
BECAUSE FIRE MAY PRODUCE TOXIC THERMAL DECOMPOSITION PRODUCTS, WEAR A SELF-CONTAINED BREATHING APPARATUS (SCBA) WITH A FULL FACEPIECE OPERATED IN PRESSURE-DEMAND OR POSITIVE-PRESSURE MODE.

SECTION 5 - STABILITY AND REACTIVITY

STABILITY: STABLE

POLYMERIZATION: WILL NOT OCCUR

CHEMICAL INCOMPATIBILITIES: STRONG OXIDIZERS AND STRONG ACIDS.

CONDITIONS TO AVOID: AVOID EXCESSIVE HEAT AND OPEN FLAMES.

HAZARDOUS DECOMPOSITION PRODUCTS:
CORROSIVE FUMES OF ACROLEIN, CARBON MONOXIDE, AND CARBON DIOXIDE.

SECTION 6 - HEALTH HAZARD INFORMATION

HEALTH PROTECTION:

PRIMARY ENTRY ROUTES: EYES, MOUTH

EYES:
WEAR SAFETY GLASSES WHICH MEET THE SPECIFICATIONS OF ANSI STANDARD Z87.1 WHENEVER THERE IS THE POSSIBILITY OF SPLASHING OR OTHER CONTACT WITH THE EYES.

MONTH: NONE

SKIN:
WEAR GLOVES AND PROTECTIVE CLOTHING WHICH ARE IMPERVIOUS TO GLYCERIN DURING THE PERIOD OF EXPOSURE IF THERE IS POTENTIAL FOR REPEATED SKIN CONTACT.

RESPIRATORY: USE OSHA, NIOSH APPROVED EQUIPMENT WHEN EXPOSED TO MIST.

CARCINOGENICITY: IARC, NTP, AND OSHA DO NOT LIST GLYCERIN AS A CARCINOGEN.

EMERGENCY AND FIRST AID PROCEDURES:

EYE CONTACT:
FLUSH THE CONTAMINATED EYE(S) WITH COOL WATER FOR AT LEAST 15 MINUTES, HOLDING THE EYELID OPEN.

SKIN CONTACT: WASH SKIN WITH PLENTY OF WATER.

INGESTION:
GIVE 3-4 GLASSES OF WATER & INDUCE VOMITING UNTIL VOMITUS IS CLEAR. DO NOT INDUCE VOMITING IF VICTIM IS UNCONSCIOUS OR CONVULSING. SEEK IMMEDIATE MEDICAL ATTENTION.

AFTER FIRST AID, GET APPROPRIATE IN-PLANT, PARAMEDIC, OR COMMUNITY MEDICAL SUPPORT.

SECTION 7 - SPILL, LEAK, AND DISPOSAL PROCEDURES

SPILL / LEAK PROCEDURES: WIPE UP WITH CLOTH AND WASH AREA WITH WATER

REGULATORY REQUIREMENTS:
FOLLOW APPLICABLE OSHA REGULATIONS (29 CFR 1910.120). LISTED IN TSCA INVENTORY.

DISPOSAL:
FOLLOW APPLICABLE FEDERAL, STATE AND LOCAL REGULATIONS FOR PROPER DISPOSAL.

CONTAINER CLEANING AND DISPOSAL:
CONTAINER IS HAZARDOUS WHEN EMPTIED - ALL PRECAUTIONS ON THIS MSDS MUST BE OBSERVED.

ECOLOGICAL INFORMATION: KEEP GLYCERIN AWAY FROM WATERWAYS AND SEWERS.

EPA REGULATIONS:
RCRA HAZARDOUS WASTE CLASSIFICATION: NOT CLASSIFIED
SARA EHS (EXTREMELY HAZARDOUS SUBSTANCE) (40 CFR 355): NOT LISTED

SECTION 8 - EXPOSURE CONTROLS / PERSONAL PROTECTION

VENTILATION:
PROVIDE GENERAL OR LOCAL EXHAUST VENTILATION SYSTEMS TO MAINTAIN AIRBORNE CONCENTRATIONS BELOW OSHA PELS (SEC. 2). LOCAL EXHAUST VENTILATION IS PREFERRED BECAUSE IT PREVENTS CONTAMINANT DISPERSION INTO THE WORK AREA BY CONTROLLING IT AT ITS SOURCE.

RESPIRATORY PROTECTION:
SEEK PROFESSIONAL ADVICE PRIOR TO RESPIRATOR SELECTION AND USE. FOLLOW OSHA RESPIRATOR REGULATIONS (29 CFR 1910.134) AND, IF NECESSARY, WEAR A MSHA/NIOSH-APPROVED RESPIRATOR. SELECT RESPIRATOR BASED ON ITS SUITABILITY TO PROVIDE ADEQUATE WORKER PROTECTION FOR GIVEN WORKING CONDITIONS, LEVEL OF AIRBORNE CONTAMINATION, AND PRESENCE OF SUFFICIENT OXYGEN. FOR EMERGENCY OR NONROUTINE OPERATIONS (CLEANING SPILLS, REACTOR VESSELS, OR STORAGE TANKS), WEAR AN SCBA.

WARNING!

AIR-PURIFYING RESPIRATORS DO NOT PROTECT WORKERS IN OXYGEN-DEFICIENT ATMOSPHERES. IF RESPIRATORS ARE USED, OSHA REQUIRES A WRITTEN RESPIRATORY PROTECTION PROGRAM THAT INCLUDES AT LEAST: MEDICAL CERTIFICATION, TRAINING, FIT-TESTING, PERIODIC ENVIRONMENTAL MONITORING, MAINTENANCE, INSPECTION, CLEANING, AND CONVENIENT, SANITARY STORAGE AREAS.

PROTECTIVE CLOTHING/EQUIPMENT:
WEAR CHEMICALLY PROTECTIVE GLOVES, BOOTS, APRONS, AND GAUNTLETS TO PREVENT PROLONGED OR REPEATED SKIN CONTACT. WEAR PROTECTIVE EYEGLASSES OR CHEMICAL SAFETY GOGGLES, PER OSHA EYE- AND FACE-PROTECTION REGULATIONS (29 CFR 1910.133). CONTACT LENSES ARE NOT EYE PROTECTIVE DEVICES. APPROPRIATE EYE PROTECTION MUST BE WORN INSTEAD OF, OR IN CONJUNCTION WITH CONTACT LENSES.

SAFETY STATIONS:
MAKE EMERGENCY EYEWASH STATIONS, SAFETY/QUICK-DRENCH SHOWERS, AND WASHING FACILITIES AVAILABLE IN WORK AREA.

CONTAMINATED EQUIPMENT:
SEPARATE CONTAMINATED WORK CLOTHES FROM STREET CLOTHES. LAUNDER BEFORE REUSE. REMOVE THIS MATERIAL FROM YOUR SHOES AND CLEAN PERSONAL PROTECTIVE EQUIPMENT.

COMMENTS:
NEVER EAT, DRINK, OR SMOKE IN WORK AREAS. PRACTICE GOOD PERSONAL HYGIENE AFTER USING THIS MATERIAL, ESPECIALLY BEFORE EATING, DRINKING, SMOKING, USING THE TOILET, OR APPLYING COSMETICS.

SECTION 9 - SPECIAL PRECAUTIONS AND COMMENTS

HANDLING PRECAUTIONS: ASSUME GENERAL SAFE HANDLING PRECAUTIONS.

STORAGE REQUIREMENTS: HYGROSCOPIC IN CHARACTER - AVOID EXPOSURE TO AIR.

DOT TRANSPORTATION DATA (49 CFR 172.101): NOT REGULATED

PREPARED BY: ERIC KORT

REVISION NOTES:
1.0 - INITIAL RELEASE
1.1 - REVIEWED

DISCLAIMER:
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NDA = NO DATA AVAILABLE

REVISION DATE: 03/05

LIQUINOX MSDS

Section 1 : MANUFACTURER INFORMATION

Supplier: Same as manufacturer.

Manufacturer: Alconox, Inc.
30 Glenn St.
Suite 309
White Plains, NY 10603.

Manufacturer emergency phone number: 800-255-3924.
813-248-0585 (outside of the United States).

Manufacturer: Alconox, Inc.
30 Glenn St.
Suite 309
White Plains, NY 10603.

Supplier MSDS date: 2005/02/24

D.O.T. Classification: Not regulated.

Section 2 : HAZARDOUS INGREDIENTS

C.A.S.	CONCENTRATION %	Ingredient Name	T.L.V.	LD/50	LC/50
25155-30-0	10-30	SODIUM DODECYLBENZENESULFONATE	NOT AVAILABLE	438 MG/KG RAT ORAL 1330 MG/KG MOUSE ORAL	NOT AVAILABLE

Section 3 : PHYSICAL / CHEMICAL CHARACTERISTICS

Physical state: Liquid.

Appearance & odor: Odourless.
Pale yellow.

Odor threshold (ppm): Not available.

Vapour pressure (mmHg): @ 20°C (68°F).
17

Vapour density (air=1): >1

<u>Volatiles (%)</u>

By volume: Not available.

Evaporation rate (butyl acetate = 1): < 1.

Boiling point (°C):	100 (212F)
Freezing point (°C):	Not available.
pH:	8.5
Specific gravity @ 20 °C:	(water = 1). 1.083
Solubility in water (%):	Complete.
Coefficient of water\oil dist.:	Not available.
VOC:	None

Section 4 : FIRE AND EXPLOSION HAZARD DATA

Flammability:	Not flammable.
Conditions of flammability:	Surrounding fire.
Extinguishing media:	Carbon dioxide, dry chemical, foam. Water Water fog.
Special procedures:	Self-contained breathing apparatus required. Firefighters should wear the usual protective gear. Use water spray to cool fire exposed containers.
Auto-ignition temperature:	Not available.
Flash point (°C), method:	None
Lower flammability limit (% vol):	Not applicable.
Upper flammability limit (% vol):	Not applicable.

Not available.

Sensitivity to mechanical impact:	Not available.
Hazardous combustion products:	Oxides of carbon (COx). Hydrocarbons.
Rate of burning:	Not available.
Explosive power:	Containers may rupture if exposed to heat or fire.

Section 5 : REACTIVITY DATA

Chemical stability:	Product is stable under normal handling and storage conditions.
Conditions of instability:	Extreme temperatures.
Hazardous polymerization:	Will not occur.
Incompatible substances:	Strong acids. Strong oxidizing agents.
Hazardous decomposition products:	See hazardous combustion products.

Section 6 : HEALTH HAZARD DATA

Route of entry:	Skin contact, eye contact, inhalation and ingestion.
<u>Effects of Acute Exposure</u>	
Eye contact:	May cause irritation.
Skin contact:	Prolonged and repeated contact may cause irritation.
Inhalation:	May cause headache and nausea.
Ingestion:	May cause vomiting and diarrhea. May cause gastric distress.
Effects of chronic exposure:	See effects of acute exposure.
LD50 of product, species & route:	> 5000 mg/kg rat oral.
LC50 of product, species & route:	Not available.
Exposure limit of material:	Not available.
Sensitization to product:	Not available.
Carcinogenic effects:	Not listed as a carcinogen.
Reproductive effects:	Not available.
Teratogenicity:	Not available.
Mutagenicity:	Not available.
Synergistic materials:	Not available.
Medical conditions aggravated by exposure:	Not available.
<u>First Aid</u>	
Skin contact:	Remove contaminated clothing. Wash thoroughly with soap and water. Seek medical attention if irritation persists.
Eye contact:	Check for and remove contact lenses. Flush eyes with clear, running water for 15 minutes while holding eyelids open: if irritation persists, consult a physician.
Inhalation:	Remove victim to fresh air. If irritation persists, seek medical attention.
Ingestion:	Do not induce vomiting, seek medical attention. Dilute with two glasses of water. Never give anything by mouth to an unconscious person.

Section 7 : PRECAUTIONS FOR SAFE HANDLING AND USE

Leak/Spill:	Contain the spill. Prevent entry into drains, sewers, and other waterways. Wear appropriate protective equipment. Small amounts may be flushed to sewer with water. Soak up with an absorbent material. Place in appropriate container for disposal. Notify the appropriate authorities as required.
Waste disposal:	In accordance with local and federal regulations.
Handling procedures and equipment:	Protect against physical damage. Avoid breathing vapors/mists. Wear personal protective equipment appropriate to task.

Wash thoroughly after handling.
Keep out of reach of children.
Avoid contact with skin, eyes and clothing.
Avoid extreme temperatures.
Launder contaminated clothing prior to reuse.

Storage requirements: Store away from incompatible materials.
Keep containers closed when not in use.

Section 8 : CONTROL MEASURES

Precautionary Measures

Gloves / Type:

Wear appropriate gloves.

Respiratory / Type: None required under normal use.

Eye / Type:

Safety glasses recommended.

Footwear / Type: Safety shoes per local regulations.

Clothing / Type: As required to prevent skin contact.

Other / Type: Eye wash facility should be in close proximity.
Emergency shower should be in close proximity.

Ventilation requirements: Local exhaust at points of emission.

RAIN-R-SHINE PVC CEMENT

SECTION 1 **IDENTITY OF MATERIAL**

Trade Name:	OATEY RAIN-R-SHINE PVC CEMENT
Product Numbers:	30890, 30891, 30893, 30894, 30895, 30896, 31480, 31481, 31482, 31583, 31584, 31954, 31955, 31956, 31957
Formula:	PVC Resin in Solvent Solution
Synonyms:	PVC Plastic Pipe Cement
Firm Name & Mailing Address:	OATEY CO. 4700 West 160th Street P.O. Box 35906 Cleveland, Ohio 44135, U.S.A. http://www.oatey.com
Oatey Phone Number:	(216) 267-7100
Emergency Phone Numbers:	For Emergency First Aid call 1-303-623-5716 COLLECT. For chemical transportation emergencies ONLY, call Chemtrec at 1-800-424-9300

SECTION 2 **COMPOSITION**

INGREDIENTS:	%:	CAS NUMBER:	ACGIH TLV TWA:	OSHA PEL TWA:	OTHER:
Cyclohexanone	7 - 12%	108-94-1	20 ppm(skin)	25 ppm	
Tetrahydrofuran	40 - 55%	109-99-9	200 ppm 750 ppm STEL	200 ppm	25 ppm (Mfg)
Methyl Ethyl Ketone	24 - 31%	78-93-3	200 ppm	200 ppm	
Blue Colorant (Non-hazardous)	1 - 3%	N/A	None Established	None Established	
PVC Resin (Non-hazardous)	14 - 18%	9002-86-2	10 mg/m3	15 mg/m3	
Amorphous Fumed Silica (Non-hazardous)	1 - 3%	112945-52-5	10 mg/m3	None Established	

SECTION 3 **EMERGENCY OVERVIEW**

Blue liquid with an ether-like odor. Extremely flammable liquid and vapor. Vapors may cause flash fire. May cause eye and skin irritation. Inhalation of vapors or mist may cause respiratory irritation and central nervous system effects. Swallowing may cause irritation, nausea, vomiting, diarrhea and kidney or liver disorders. Aspiration hazard. May be fatal if swallowed. Symptoms may be delayed.

NFPA Hazard Signal: Health: 2 Stability: 1 Flammability: 3 Special: None
HMIS Hazard Signal: Health: 3 Stability: 1 Flammability: 3 Special: None
OSHA Hazard Classification: Flammable, irritant, organ effects
Canadian WHIMS Classification: Class B, Division 2; Class D, Division 2, Subdivision B

SECTION 4 **EMERGENCY AND FIRST AID PROCEDURES - CALL 1-303-623-5716 COLLECT**

Skin: Remove contaminated clothing immediately. Wash all exposed areas with soap and water. Get medical attention if irritation develops. Remove dried cement with Oatey Plumber's Hand Cleaner or baby oil.

Eyes: If material gets into eyes or if fumes cause irritation, immediately flush eyes with water for 15 minutes. If irritation persists, seek medical attention.

Inhalation: If symptoms of exposure develop, remove to fresh air. If breathing becomes difficult, administer oxygen. Administer artificial respiration if breathing has stopped. Seek immediate medical attention.

Ingestion: **DO NOT INDUCE VOMITING.** Rinse mouth with water. Never give anything by mouth to a person who is unconscious or drowsy. Get immediate medical attention by calling a Poison Control Center, or hospital emergency room. If medical advice cannot be obtained, then take the person and product to the nearest medical emergency treatment center or hospital.

SECTION 5 FIRE FIGHTING MEASURES

Flashpoint / Method:	0 - 5 Degrees F. / PMCC
Flammability:	LEL = 1.8 % Volume, UEL = 11.8 % Volume
Extinguishing Media:	Use dry chemical, CO_2, or foam to extinguish fire. Cool fire exposed container with water. Water may be ineffective as an extinguishing agent.
Special Fire Fighting Procedure:	Firefighters should wear positive pressure self-contained breathing apparatus and full protective clothing for fires in areas where chemicals are used or stored
Unusual Fire and Explosion Hazards:	Extremely flammable liquid. Keep away from heat and all sources of ignition including sparks, flames, lighted cigarettes and pilot lights. Containers may rupture or explode in the heat of a fire. Vapors are heavier than air and may travel to a remote ignition source and flash back. This product contains tetrahydrofuran that may form explosive organic peroxide when exposed to air or light or with age.
Hazardous Decomposition Products:	Combustion will produce toxic and irritating vapors including carbon monoxide, carbon dioxide and hydrogen chloride.

SECTION 6 ACCIDENTAL RELEASE MEASURES

Spill or Leak Procedures:	Remove all sources of ignition and ventilate area. Stop leak if it can be done without risk. Personnel cleaning up the spill should wear appropriate personal protective equipment, including respirators if vapor concentrations are high. Soak up spill with an inert absorbent such as sand, earth or other non-combusting material. Put absorbent material in covered, labeled metal containers. Prevent liquid from entering watercourses, sewers and natural waterways. Report releases to authorities as required. See Section 12 for disposal information.

SECTION 7 HANDLING AND STORAGE

Handling:	Avoid contact with eyes, skin and clothing. Avoid breathing vapors or mists. Use with adequate ventilation (equivalent to outdoors). Wash thoroughly after handling. Do not eat, drink or smoke in the work area. Keep product away from heat, sparks, flames and all other sources of ignition. No smoking in storage or use areas. Keep containers closed when not in use.
Storage:	Store in a cool, dry, well-ventilated area away from incompatible materials. Keep containers closed when not in use.
Other:	"Empty" containers retain product residue and can be hazardous. Follow all MSDS precautions in handling empty containers. Do not cut or weld on or near empty or full containers.

SECTION 8 ECOLOGICAL INFORMATION

	This product is not expected to be toxic to aquatic organisms. Cyclohexanone: 96 hour LC50 values for fish is over 100 mg/l. Tetrahydrofuran: 96 hour LC50 fathead minnow: 2160 mg/L. Methyl Ethyl Ketone: 96 hour LC50 for fish is greater than 100 mg/L.
VOC Information:	This product emits VOC's (volatile organic compounds) in its use. Make sure that use of this product complies with local VOC emission regulations, where they exist.
VOC Level:	600 g/l per SCAQMD Test Method 316A.

SECTION 9 EXPOSURE CONTROLS/PERSONAL PROTECTION

Ventilation:	Open doors & windows. Provide ventilation capable of maintaining emissions at the point of use below recommended exposure limits. If used in enclosed area, use exhaust fans. Exhaust fans should be explosion-proof or set up in a way that flammable concentrations of solvent vapors are not exposed to electrical fixtures or hot surfaces.
Respiratory Protection:	For operations where the exposure limit may be exceeded, a NIOSH approved organic vapor respirator or supplied air respirator is recommended. Equipment selection depends on contaminant type and concentration, select in accordance with 29 CFR 1910.134 and good industrial hygiene practice. For firefighting, use self-contained breathing apparatus.
Skin Protection:	Rubber gloves are suitable for normal use of the product. For long exposures chemical resistant gloves may be required such as 4H(tm) or Silver Shield(tm) to avoid prolonged skin contact.
Eye Protection:	Safety glasses with side shields or safety goggles.
Other:	Eye wash and safety shower should be available.

SECTION 10 PHYSICAL AND CHEMICAL PROPERTIES

Boiling Point:	151 Degrees F / 66 C
Melting Point:	N/A
Vapor Pressure:	145 mmHg @ 20 Degrees C
Vapor Density:	(Air = 1) 2.5
Volatile Components:	82-86%
Solubility In Water:	Negligible
pH:	N/A
Specific Gravity:	0.94 +/- 0.02
Evaporation Rate:	(BUAC = 1) = 5.5 - 8.0
Appearance:	Blue Liquid
Odor:	Ether-Like
Will Dissolve In:	Tetrahydrofuran
Material Is:	Liquid

SECTION 11 STABILITY AND REACTIVITY

Stability:	Stable.
Conditions To Avoid:	Avoid heat, sparks, flames and other sources of ignition.
Hazardous Decomposition Products:	Combustion will produce toxic and irritating vapors including carbon monoxide, carbon dioxide and hydrogen chloride.
Incompatibility/ Materials To Avoid:	Oxidizing agents, alkalies, amines, ammonia, acids, chlorine compounds, chlorinated inorganics (potassium, calcium and sodium hypochlorite) and hydrogen peroxides. May attack plastic, resins and rubber.
Hazardous Polymerization:	Will not occur.

SECTION 12 DISPOSAL INFORMATION

Waste Disposal: Dispose in accordance with current local, state and federal regulations.

SECTION 13 TOXICOLOGICAL INFORMATION

Inhalation:	Vapors or mists may cause mucous membrane and respiratory irritation, coughing, headache, dizziness, dullness, nausea, shortness of breath and vomiting. High concentrations may cause central nervous system depression, narcosis and unconsciousness. May cause kidney, liver and lung damage.
Skin:	May cause irritation with redness, itching and pain. Methyl ethyl ketone and cyclohexanone may be absorbed through the skin causing effects similar to those listed under inhalation.
Eye:	Vapors may cause irritation. Direct contact may cause irritation with redness, stinging and tearing of the eyes. May cause eye damage.
Ingestion:	Swallowing may cause abdominal pain, nausea, vomiting and diarrhea. Aspiration during swallowing or vomiting can cause chemical pneumonia and lung damage. May cause kidney and liver damage.
Chronic Toxicity:	Prolonged or repeated overexposure cause dermatitis and damage to the kidney, liver, lungs and central nervous system.

Toxicity Data:		
	Cyclohexanone:	Oral rat LD50: 1,620 mg/kg Inhalation rat LC50: 8,000 ppm/4 hours Skin rabbit LD50: 1 mL/kg
	Tetrahydrofuran:	Oral rat LD50: 1,650 mg/kg Inhalation rat LC50: 21,000 ppm/3 hours
	Methyl Ethyl Ketone:	Oral rat LD50: 2,737 mg/kg Inhalation rat LC50: 23,500 mg/m3/8 hours Skin rabbit LD50: 6,480 mg/kg

Sensitization:	None of the components are known to cause sensitization.
Carcinogenicity:	None of the components are listed as a carcinogen or suspect carcinogen by NTP, IARC or OSHA. The National Toxicology Program has reported that exposure of mice and rats to Tetrahydrofuran (THF) vapor levels up to 1800 ppm 6 hr/day, 5 days/week for their lifetime caused an increased incidence of kidney tumors in male rats and liver tumors in female mice. The significance of these findings for human health are unclear at this time, and may be related to "species specific" effects. Elevated incidences of tumors in humans have not been reported for THF. ACGIH has classified cyclohexanone (CYH) as “A3,” Confirmed Animal Carcinogen with Unknown Relevance to Humans. incidences of tumors in humans have not been reported for THF.
Mutagenicity:	Cyclohexanone has been positive in bacterial and mammalian assays. Tetrahydrofuran was positive in a bacterial assay. Methyl ethyl ketone is not considered genotoxic based on laboratory studies.
Reproductive Toxicity:	Methyl ethyl ketone and cyclohexanone have been shown to cause embryofetal toxicity and birth defects in laboratory animals. Tetrahydrofuran has been found to cause adverse developmental effects only when exposure levels cause other toxic effects to the mother.
Medical Conditions Aggravated By Exposure:	Persons with pre-existing skin, lung, kidney or liver disorders may be at increased risk from exposure to this product.

SECTION 14 TRANSPORTATION INFORMATION

DOT	Less than 1 Liter (0.3 gal)	Greater than 1 Liter (0.3 gal)
Proper Shipping Name:	Consumer Commodity	Adhesives
Hazard Class/Packing Group:	ORM-D	3, PGII
UN/NA Number:	None	UN1133
Hazard Labels:	None	Flammable Liquid
IMDG		
Proper Shipping Name:	Adhesives	Adhesives
Hazard Class/Packing Group:	3, II	3, II
UN Number:	UN1133	UN1133
Label:	None (Limited Quantities are excepted from labeling)	Class 3 (Flammable Liquid)

RCRA Hazardous Waste Number: U057, U159, U213
EPA Hazardous Waste ID Number: D001, D035, F003, F005
EPA Hazard Waste Class: Ignitable Waste. Toxic Waste (Methyl Ethyl Ketone content)
2000 North American Emergency Response Guidebook Number: 127 or 128

SECTION 15 REGULATIONS

Hazard Category for Section 311/312:	Acute Health, Chronic Health, Flammable
Section 302 Extremely Hazardous Substances (TPQ):	This product does not contain chemicals regulated under SARA Section 302.
Section 313 Toxic Chemicals:	This product contains the following chemicals subject to SARA Title III Section 313 Reporting requirements:

Chemical	CAS #	%
Methyl Ethyl Ketone	78-93-3	24-31%

CERCLA 103 Reportable Quantity:	Spills of this product over the RQ (reportable quantity) must be reported to the National Response Center. The RQ for the product, based on the RQ for Tetrahydrofuran (55% maximum) of 1,000 lbs, is 1,818 lbs. Many states have more stringent release reporting requirements. Report spills required under federal, state and local regulations.
California Proposition 65:	This product does not contain any chemicals subject To California Proposition 65 regulation.
TSCA Inventory:	All of the components of this product are listed on the TSCA inventory.

SECTION 16 DISCLAIMER

The information herein has been compiled from sources believed to be reliable, up-to-date, and is accurate to the best of our knowledge. However, Oatey cannot give any guarantees regarding information from other sources, and expressly does not make warranties, nor assumes any liability for its use.

POWER
Power for a World of Applications

Material Safety Data Sheet (U.S.) Workplace Hazardous Material Information System (Canada)

* See page 4 for shipping notice

Product Name: **Product Information:** **Manufacturer:**	**Sealed Lead Acid Battery (VRLA)** **(973) 523-8630** **Power Battery Company, Inc.** **25 Mclean Blvd.** **Paterson, NJ 07514-1507** **Fax: (973) 523-3023**	NFPA Hazard Rating: Flammability (Red) = 0 Health (Blue) = 3 Reactivity (Yellow) = 2	**Transportation Emergency Phone:** **1-800-424-9300** (Services 24 hours)

Section 1: Material Identification

Battery Types:	PRC, TC, TL, MC, MCG, FT, CSL, MRG, PSG, WCG, SL, SLF, TG, PM, CV
Common name:	Sealed Lead Acid Battery, Valve Regulated Lead Acid Battery (VRLA), Absorbed Glass Matt (AGm), Gel Battery (MCG, MRG, PSG, WCG Only)
Chemical Family:	Toxic and Corrosive Material Mixture
Synonyms:	Electric Storage Battery
CAS No.:	Mixture
CFR49	Power Battery VRLA batteries have been tested to CFR49, 173.159, (d.), (3.) (i) and (ii)
D. O. T. Hazard Class:	Battery wet, non-spillable, hazard class 8, UN2800, PGIII Corrosive or Batteries, wet, non-spillable, electric storage, IMO Class 8, UN2800
Shipping: D.O.T., IATA and IMA: IMO:	Battery wet, non-spillable, hazard class 8, UN2800, PGIII Corrosive or Batteries, wet, non-spillable, electric storage, IMO Class 8, UN2800 NOTE: Power Battery VRLA batteries are Exempt CFR49, Subchapter C if 1) Terminals are protected against Short Circuit 2) Each Battery and its outer packaging must be plainly marked "Non-Spillable Battery"
Proposition 65:	Battery posts, terminals and related accessories contain lead, arsenic and lead compounds, chemicals known to the State of California to cause cancer and reproductive harm. Batteries also contain other chemicals known to the State of California to cause cancer. Wash hands after handling.

Section 2: Hazardous Ingredients HMIS Rating for Sulfuric Acid: Health (Blue): 3 Fire (Red): 1 Reactivity (Yellow): 2

Ingredient	CAS Number	% Weight	LD_{50}			SARA applies				Air contaminant levels	
			Oral	Inhalation	Contact	302	304	311/312	313	ACGIH/TLV (mg/m^3)	OSHA PEL (mg/m^3)
Lead Lead Dioxide Lead Sulfate	7439-92-1 1309-60-0 7446-14-2	65-75 %	<500mg/kg	<20mg/m^3	N/A	N	N	Y	Y	0.150	0.050
Sulfuric Acid	7664-93-9	17- 30 %	2.14 g/kg	18 mg/m3	Eye rabbit 250 mcg (severe)	Y Reportable Qty: 1000 lbs		Y	*	1.0 STEL 3 mg/m^3 (15 min. max./8 hour shift)	1.0

* Only sulfuric acid aerosols are reportable. These include mists, vapors, gas, fog, and other airborne forms of any particle size.
All ingredients are listed with EPA TSCA Inventory of Chemical Substances.

Section 3: Physical Data

VOC content: 0%

	Lead	Antimony	Arsenic	Electrolyte (30 %)	Hydrogen	Plastic/ Battery case
Boiling Point	1515 °C	1440 °C	Sublimes 615 °C	133 °C	-252 °C	N/A
Vapor Pressure	N/A	N/A	N/A	< 1mm Hg	N/A	N/A
Vapor Density (Air = 1)	N/A	N/A	N/A	~3.4	~ 0.07	N/A
Melting Point	327.4 °C	630 °C	814 °C	-56 °C	-259 °C	Polypropylene: >160 °C
Specific Gravity (H_20 =1)	11.3	6.68	5.72	1.3	0.089 (gas) g/l	0.9
Solubility in Water	17 ppm @ pH=7 (Lead oxide)	Insoluble	Insoluble	100 %	N/A	N/A
Appearance and Odor:	Silver-gray metal	Silver-white metal.	Silver-gray solid	Oily colorless liquid, characteristic acid odor when hot or charging.	Colorless, odorless gas.	Solid
pH:	N/A	N/A	N/A	< 1	N/A	N/A

Section 4: Fire and Explosion Hazard Data

◈ Flash Point: Not Applicable ◈ Flammable Limits: Hydrogen LEL: 4 %; UEL: 74.2 % ◈ Hydrogen gas may be flammable and explosive when mixed with oxygen, air or chlorine. Unusual Hazards: Hydrogen and oxygen gases are generated in the cells during normal battery operations. Highly flammable hydrogen gas is generated during charging and operation of batteries. Keep sparks and other ignition sources away from the batteries. Ensure proper ventilation of charging areas consistent with OSHA (40 CFR 1910), National Fire Code, ACGIH, Building Code and other relevant standards. Lead acid batteries will not burn or will burn with difficulty. ◈ Special Fire Fighting Procedures: If batteries are on charge, shut off power. Use positive pressure, self contained breathing apparatus and acid resistant clothing. Water applied to electrolyte generates heat and can cause it to splatter. Use "ABC" Type Fire extinguisher for battery fires. ◈Extinguishing Media: Halon, dry chemical, foam or CO_2. Cool exterior of batteries exposed to fire to prevent ruptures. Hydrogen gas may be present. Hydrogen gas and acid mist are generated during charging, or in fire. Sulfuric acid mist and vapors generated by battery overcharge, heat or fire are corrosive. Do not allow metallic materials to contact negative and positive terminals simultaneously of cells and batteries. Follow manufacturer's instructions for installation and service.

Section 5: Reactivity Data

Stable: yes √ **No** ▯ **Hazardous Polymerization:** Will not occur.

Conditions to Avoid: Avoid overcharging battery. Avoid mixing acid with other chemicals. Avoid high temperatures. Do not allow smoking, open flame or sparks near batteries while charging. Battery electrolyte will react with water and produce heat. Keep battery case away from strong oxidizers. Short circuits may result in fire.

Incompatibility: Lead/lead compounds: carbides, phosphorus, peroxides, potassium, sulfur. Battery electrolyte: strong bases, combustible and organic materials, most metals, nitrates, chlorates. Battery case: strong oxidizing agents.

Hazardous Decomposition/ Byproducts: Sulfur Dioxide, Sulfur Trioxide, Hydrogen Sulfide, Hydrogen. An explosive hydrogen and oxygen mixture within the battery may be generated during charging and overcharging. Sanding and grinding of battery posts, post building and connector burning activities will release airborne lead.

Section 6: Heath Hazard Data

Under normal conditions of battery use, battery materials will not present a health hazard.

♦ **Routes of entry:** Sulfuric Acid: Harmful by all routes of entry.
Exposure to lead from a battery can occur during lead reclaim operations by breathing or ingesting lead dusts and fumes. Ingestion: possible via hand contaminated by contact with lead or acid components of the battery. Inhalation: acid mist generated during battery charge may cause respiratory irritation. Eye contact: possible if the battery electrolyte is splashed. Skin Contact: possible. Skin absorption is not a significant route of entry for lead. Battery electrolyte is corrosive to skin.

♦**Acute Health Effect:** Overexposure to lead compounds may cause upset stomach, vomiting, headache, loss of appetite, sleeplessness, and dizziness. Contact with battery electrolyte (acid) may irritate the skin. Battery electrolyte may cause corneal damage of the eyes or irritation of the mucous membranes and/or inflammation of the upper respiratory system.

♦**Chronic Health Effects** The toxic effects of lead are cumulative, and slow to appear. Overexposure to lead may cause chronic anemia, kidney and nervous system damage, muscles and joints pain. Lead may also cause reproductive system damage. Repeated contact with battery electrolyte may lead to irritation of the skin and may result in dermatitis. Battery electrolyte may scar the cornea, causing blindness, and cause chronic bronchitis. Prolonged contact to acid vapor may cause erosion of tooth enamel.

♦**Carcinogenicity:** **Sulfuric Acid:** The **IARC** has classified strong inorganic acid mists containing sulfuric acid as a Category 1 carcinogen, a substance that is carcinogenic to humans. The **AGGIH** has classified "strong inorganic acid mist containing sulfuric acid" as an A2, suspected human carcinogen. These classifications do not apply to liquid forms of sulfuric acid or electrolyte contained within the battery. Under normal battery use, sulfuric acid mist is not generated. Misuse of the product, such as overcharging, may result in the generation of sulfuric acid mist.
Lead: NTP and IARC have classified lead as an animal carcinogen (A3), likely in animals at extreme doses. Proof of carcinogenicity in humans is lacking at present and lead is unlikely to cause cancer in humans except under uncommonly high levels of exposure.
Arsenic: Listed by the National Toxicology Program **(NTP),** International Agency for Research on Cancer **(IARC), OSHA** and **NIOSH** as a carcinogen only after prolonged exposure at high levels.

♦**Signs/Symptoms of Exposure:** Under normal battery use, the components do not present a health hazard. Under abnormal conditions or in case of fire, breakage or overcharge, battery can cause the following symptoms:
SKIN: Irritation or skin burn. EYES: Burning. INGESTION: upset stomach, fatigue, irritation or burn in the mouth and the gastrointestinal system. INHALATION: Breathing the acid vapor may cause respiratory difficulties.

♦**Medical Condition Generally Aggravated by Exposure:** Lead and its compounds can cause chronic liver, kidney and neurological problems. Contact with battery electrolyte may cause dermatitis or eczema of the skin. Sulfuric acid mist may irritate the respiratory system.

Section 7 First Aid Measures

Emergency and First Aid: SKIN: Remove from source. Wash thoroughly with soap and water. Treat as acid burn. If battery electrolyte is splashed in shoes, remove immediately and discard. Remove contaminated clothing and obtain medical attention.
EYES: Call physician immediately. Flush with cool water lifting lids until physician arrives. Treat as an acid burn.
INHALATION: Remove to ventilated area. Get medical attention.
INGESTION: Lead/lead compounds: consult physician. Battery Electrolyte: **Do not induce vomiting**, keep quiet, get medical attention immediately. Do not give anything to an unconscious person.

Section 8 Preventative Measures

Respiratory Protection: None required under normal handling conditions. During battery formation or recharge, acid mist may be generated. If irritation occurs use a high efficiency particulate respirator for protection. HEPA respirators should be worn during reclaim operations, if OSHA PEL is exceeded. **Ventilation:** Store lead acid batteries in cool, dry and properly ventilated area. Never recharge batteries in a closed, unventilated area. **Protective Gloves**: Acid resistant rubber or plastic gloves.
Eye Protection: Wear chemical safety goggles or face-shield during battery maintenance and non-routine tasks.
Other Protective Clothing or Equipment: Eye wash and safety shower installed near to storage or charging area, safety shoes with rubber or neoprene boots and aprons. **Work/Hygienic Practices**: Make sure vent caps are tight. Do not smoke or use open flames in charging area. Wash your skin thoroughly after handling battery. Discard contaminated clothing according to state or EPA regulations.
Electrical safety: due to low internal resistance of POWER batteries and high power density, high levels of short circuit current can be developed across the battery terminals. Do not rest tools or cables on the battery. Use insulated tools only. Follow manufacturer's installation instructions and diagrams when installing or maintaining battery systems.

Section 9 Storage and Handling

Storage Requirements: Store lead acid batteries in cool, dry and properly ventilated area. Make sure vent caps are in place. Keep the batteries from extreme heat or freezing. Place a minimum of two layers of corrugated cardboard or honeycomb layer sheet between battery layers for storage. **Protect terminals to prevent short circuits.** Keep out of reach of children.

Section 10 Spill Clean-up and Waste Disposal

Steps to be Taken in Case Material is Released or Spilled: Stop leak at source. Ventilate the area. Remove combustible material and all sources of ignition. Wear protective clothing, acid resistant boots and gloves, face shield and goggles. Segregate the spill and neutralize with sodium bicarbonate (baking soda), sodium carbonate (soda ash), calcium oxide (lime) or use an appropriate acid absorbent. Collect residue in an approved container. Do not release to streams, lakes, sewer, etc.
Waste Disposal Method: Return spent batteries to distributor, manufacturer or lead recycler. Neutralize acid spill or use proper absorbent and place waste in proper container. Acid waste that is not neutralized (pH</=2.0) is hazardous waste, Class D002 (corrosive). Cracked or leaking batteries being recycled must be stored and shipped in a container that is sturdy, acid resistant, leak proof and kept closed. Recycle batteries and components according to all local, state and federal regulations. Some states regulate leaking batteries as hazardous waste, classification **D002 (corrosive)** and **D008 (lead)** even when recycled. Check with state authorities.

Section 11 Battery Recycling -

Battery recycling
It is illegal to discard batteries in the trash. State and provincial laws require batteries to be recycled by a permitted recycling facility. Batteries should be returned to the manufacturer or distributor for recycling, or directly to a permitted recycling facility.

Packaging of spent batteries for recycling:

1. Recycle batteries should be palletized.
2. Place heavier batteries on bottom layer of pallet.
3. Arrange layers to avoid pallet overhang.
4. Place a minimum of two (2) sheets of corrugated cardboard between layers or one (1) honeycomb layer sheet.
5. Keep battery layers reasonably flat for top loading.
6. Limit each pallet to three (3) layers of batteries.
7. Keep battery terminals aligned to prevent short circuits; no side terminal contact. No exposed terminals.
8. Stretch wrap or band with plastic banding is mandatory. No steel strapping.

Shipping Classification for ALL Scrap or spent VRLA, Non-spillable batteries:
DOT, IATA and IMA: Battery, wet, filled with acid, hazard class 8, UN 2794, PG III, Corrosive
IMO: Batteries, wet, filled with acid, hazard class 8, UN 2794, PG III, Corrosive
Cracked or leaking batteries being recycled must be stored and shipped in a container that is sturdy, acid resistant, leak proof and kept closed. Transport requirements vary by state and province.
A copy of this material safety data sheet must accompany shipment and be supplied to any scrap dealer or secondary lead smelter.

Power Battery Company and its subsidiaries can coordinate, collect and recycle all Lead Acid batteries at an EPA approved recycling plant. All documentation, transportation and certificates will be provided. 1-800-769-6992 in USA, 1-450-346-3273 in Canada.

POWER BATTERY COMPANY, INC. 25 Mclean Blvd., Paterson, NJ 07514-1507, Phone: (973) 523-8630, Fax: (973) 523-3023
POWER BATTERY (IBERVILLE) LTD. 770, Ave. Thomas, Iberville (Quebec) J2X 5E7, Phone: (450) 346-3273, Fax: (450) 346-8003
POWER BATTERY LTD. Premier Way, Abbey Park Industrial Estate, Romsey, Hampshipe SO51 9AQ, Phone: +44(0) 1794 835900, Fax: +44(0) 1794 835910

NOTICE

INSTRUCTIONS IF THIS SHIPMENT IS DAMAGED OR SHORT

This shipment has been properly crated, packed, and/or marked and acknowledged by the originating transportation company to be in good condition and as described by the bill of lading. If, on delivery, there is damage or shortage, please make a notation on all copies of the delivering carrier's delivery receipt before signing.

If damage or shortage is discovered after delivery, it is your responsibility to notify the delivering carrier immediately and request an inspection and freight claim form.

Power Battery Company, Inc. will assist you whenever possible in establishing claims against the transportation company for loss or damage in transit. We will not, however, assume the responsibility for submitting or collecting claims or replacing lost or damaged material.

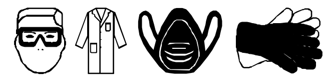
Returned goods will not be accepted by the factory unless prior approval has been granted by Power Battery Co., Inc. All returned goods must be properly packaged in compliance with shipping regulations and all transportation charges paid by the shipper.

Please direct all inquiries regarding loss or the return of damaged goods to :

25 McLean Blvd., Paterson, NJ 07514 (973) 523-8630

GARDENA, CA
NEW BRUNSWICK, NJ

Material Safety Data Sheet

NFPA	HMIS	Personal Protective Equipment
	Health Hazard 2 Fire Hazard 0 Reactivity 0	 See Section 15.

Section 1. Chemical Product and Company Identification

Page Number: 1

Common Name/ Trade Name	**Sodium bicarbonate**	**Catalog Number(s).**	S1145, S1147, S1148, SO125
		CAS#	144-55-8
Manufacturer	SPECTRUM CHEMICAL MFG. CORP. 14422 S. SAN PEDRO STREET GARDENA, CA 90248	**RTECS**	Not available.
		TSCA	TSCA 8(b) inventory: Sodium bicarbonate
Commercial Name(s)	Not available.	**CI#**	Not available.
Synonym	Not available.		
Chemical Name	Not available.		
Chemical Family	Not available.		
Chemical Formula	$NaHCO_3$		
Supplier	SPECTRUM CHEMICAL MFG. CORP. 14422 S. SAN PEDRO STREET GARDENA, CA 90248		

IN CASE OF EMERGENCY
CHEMTREC (24hr) 800-424-9300

CALL (310) 516-8000

Section 2.Composition and Information on Ingredients

		Exposure Limits			
Name	**CAS #**	**TWA (mg/m^3)**	**STEL (mg/m^3)**	**CEIL (mg/m^3)**	**% by Weight**
1) Sodium bicarbonate	144-55-8				100

Toxicological Data on Ingredients

Sodium bicarbonate:
ORAL (LD50): Acute: 4220 mg/kg [Rat].

Section 3. Hazards Identification

Potential Acute Health Effects

Hazardous in case of eye contact (irritant), of inhalation. Slightly hazardous in case of skin contact (irritant), of ingestion.

Potential Chronic Health Effects

CARCINOGENIC EFFECTS: Not available.
MUTAGENIC EFFECTS: Not available.
TERATOGENIC EFFECTS: Not available.
DEVELOPMENTAL TOXICITY: Not available.
Repeated or prolonged exposure is not known to aggravate medical condition.

Continued on Next Page

Section 4. First Aid Measures

Eye Contact	Check for and remove any contact lenses. Immediately flush eyes with running water for at least 15 minutes, keeping eyelids open. Cold water may be used. Do not use an eye ointment. Seek medical attention.
Skin Contact	After contact with skin, wash immediately with plenty of water. Gently and thoroughly wash the contaminated skin with running water and non-abrasive soap. Be particularly careful to clean folds, crevices, creases and groin. Cold water may be used. Cover the irritated skin with an emollient. If irritation persists, seek medical attention.
Serious Skin Contact	Not available.
Inhalation	Allow the victim to rest in a well ventilated area. Seek immediate medical attention.
Serious Inhalation	Not available.
Ingestion	Do not induce vomiting. Loosen tight clothing such as a collar, tie, belt or waistband. If the victim is not breathing, perform mouth-to-mouth resuscitation. Seek immediate medical attention.
Serious Ingestion	Not available.

Section 5. Fire and Explosion Data

Flammability of the Product	Non-flammable.
Auto-Ignition Temperature	Not applicable.
Flash Points	Not applicable.
Flammable Limits	Not applicable.
Products of Combustion	Not available.
Fire Hazards in Presence of Various Substances	Not applicable.
Explosion Hazards in Presence of Various Substances	Risks of explosion of the product in presence of mechanical impact: Not available. Risks of explosion of the product in presence of static discharge: Not available.
Fire Fighting Media and Instructions	Not applicable.
Special Remarks on Fire Hazards	Not available.
Special Remarks on Explosion Hazards	Not available.

Section 6. Accidental Release Measures

Small Spill	Use appropriate tools to put the spilled solid in a convenient waste disposal container. Finish cleaning by spreading water on the contaminated surface and dispose of according to local and regional authority requirements.
Large Spill	Use a shovel to put the material into a convenient waste disposal container. Finish cleaning by spreading water on the contaminated surface and allow to evacuate through the sanitary system.

Continued on Next Page

Section 7. Handling and Storage

Precautions	Do not ingest. Do not breathe dust. Avoid contact with eyes Wear suitable protective clothing In case of insufficient ventilation, wear suitable respiratory equipment If ingested, seek medical advice immediately and show the container or the label. Keep away from incompatibles such as acids.
Storage	No specific storage is required. Use shelves or cabinets sturdy enough to bear the weight of the chemicals. Be sure that it is not necessary to strain to reach materials, and that shelves are not overloaded.

Section 8. Exposure Controls/Personal Protection

Engineering Controls	Use process enclosures, local exhaust ventilation, or other engineering controls to keep airborne levels below recommended exposure limits. If user operations generate dust, fume or mist, use ventilation to keep exposure to airborne contaminants below the exposure limit.
Personal Protection	Splash goggles. Lab coat. Dust respirator. Be sure to use an approved/certified respirator or equivalent. Gloves.
Personal Protection in Case of a Large Spill	Splash goggles. Full suit. Dust respirator. Boots. Gloves. A self contained breathing apparatus should be used to avoid inhalation of the product. Suggested protective clothing might not be sufficient; consult a specialist BEFORE handling this product.
Exposure Limits	Not available.

Section 9. Physical and Chemical Properties

Physical state and appearance	Solid.
Molecular Weight	84.01 g/mole
pH (1% soln/water)	Not available.
Odor	Not available.
Taste	Not available.
Color	Not available.
Boiling Point	Not available.
Melting Point	Decomposes. (50°C or 122°F)
Critical Temperature	Not available.
Specific Gravity	2.159 (Water = 1)
Vapor Pressure	Not applicable.
Vapor Density	Not available.
Volatility	Not available.
Odor Threshold	Not available.
Water/Oil Dist. Coeff.	Not available.
Ionicity (in Water)	Not available.
Dispersion Properties	See solubility in water.
Solubility	Soluble in cold water.

Section 10. Stability and Reactivity Data

Stability	The product is stable.
Instability Temperature	Not available.
Conditions of Instability	Not available.
Incompatibility with various substances	Reactive with acids.
Corrosivity	Non-corrosive in presence of glass.

Continued on Next Page

Special Remarks on Reactivity	Not available.
Special Remarks on Corrosivity	Not available.
Polymerization	No.

Section 11. Toxicological Information

Routes of Entry	Eye contact. Inhalation.
Toxicity to Animals	Acute oral toxicity (LD50): 4220 mg/kg [Rat].
Chronic Effects on Humans	Not available.
Other Toxic Effects on Humans	Hazardous in case of inhalation. Slightly hazardous in case of skin contact (irritant), of ingestion.
Special Remarks on Toxicity to Animals	Not available.
Special Remarks on Chronic Effects on Humans	Not available.
Special Remarks on other Toxic Effects on Humans	Not available.

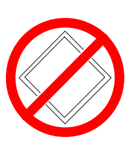
Section 12. Ecological Information

Ecotoxicity	Not available.
BOD5 and COD	Not available.
Products of Biodegradation	Possibly hazardous short term degradation products are not likely. However, long term degradation products may arise.
Toxicity of the Products of Biodegradation	The products of degradation are more toxic.
Special Remarks on the Products of Biodegradation	Not available.

Section 13. Disposal Considerations

Waste Disposal	

Section 14. Transport Information

DOT Classification	Not a DOT controlled material (United States).
Identification	Not applicable.
Special Provisions for Transport	Not applicable.
DOT (Pictograms)	

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Section 15. Other Regulatory Information and Pictograms

Federal and State Regulations: TSCA 8(b) inventory: Sodium bicarbonate

California Proposition 65 Warnings

Other Regulations: Not available..

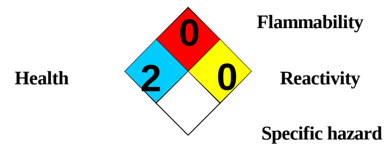
Other Classifications

WHMIS (Canada)	Not controlled under WHMIS (Canada).
DSCL (EEC)	R36- Irritating to eyes.

HMIS (U.S.A.)

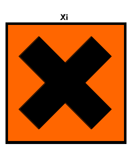
Health Hazard	2
Fire Hazard	0
Reactivity	0
Personal Protection	E

National Fire Protection Association (U.S.A.)

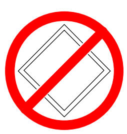


WHMIS (Canada) (Pictograms)

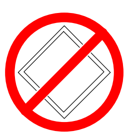
DSCL (Europe) (Pictograms)



TDG (Canada) (Pictograms)

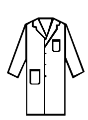


ADR (Europe) (Pictograms)



Protective Equipment

Gloves.



Lab coat.

Dust respirator. Be sure to use an approved/certified respirator or equivalent.

Splash goggles.

Continued on Next Page

Section 16. Other Information

MSDS Code	**S3660**
References	Not available.
Other Special Considerations	Not available.

Validated by Sonia Owen on 1/20/2003.	**Verified by Sonia Owen.** **Printed 8/26/2004.**

CALL (310) 516-8000

Attachment 7

Hazard Report Form

CLEAR WATER COMPLIANCE SERVICES

HAZARD REPORT FORM

The purpose of this form is to inform members of the Clear Water Company Safety Committee of the presence of workplace hazards. This is an optional form that any Clear Water employee can use to report a hazard. Give completed forms to your supervisor for conveyance to the Company Safety Committee.

<u>Employee's Description of a Workplace hazard</u>

Date: ______________________

Employee's name (optional) ________________________

Briefly describe the workplace hazard:____

____

____

____

____

____

Where is the hazard located? ____

Has the hazard been verbally reported to your supervisor? _______________

If yes, who is the supervisor? ____________________________________

Briefly describe any suggestions you might have to eliminate this hazard:

____

____

____

____

Attachment 8

Incident Investigation Report

Clear Water Compliance Services

INCIDENT INVESTIGATION REPORT

Instructions: Complete this form as soon as possible after an incident that results in serious injury, illness, property loss or damage. (Optional: Use to investigate a minor injury or near miss that *could have resulted in a serious injury or illness*.)

THIS IS A REPORT OF A: ☐INJURY/ILLNESS ☐PROPERTY LOSS/DAMAGE ☐VEHICLE INCIDENT

☐NEAR MISS ☐ENVIRONMENTAL LOSS ☐DEATH ☐OTHER:________________

DATE OF INCIDENT	TIME OF INCIDENT	DATE OF REPORT

EMPLOYEE NAME	REPORTED BY

EMPLOYEE INFORMATION

NAME	JOB TITLE	CONTACT INFO: Ph: ( )

WORK STATUS: ☐REGULAR FULL-TIME ☐REGULAR PART-TIME ☐SEASONAL ☐TEMPORARY

WHAT PART OF EMPLOYEE'S WORKDAY? ☐ARRIVING OR LEAVING WORK ☐DURING NORMAL WORK HOURS

MONTHS IN THE COMPANY	MONTHS DOING THIS JOB

PART OF BODY AFFECTED

NATURE OF INCIDENT: ☐ILLNESS ☐SPRAIN, STRAIN ☐RESPIRATORY

☐ ABRASION, SCRAPES ☐AMPUTATION ☐BROKEN BONE ☐BRUISE ☐BURN (heat)

☐BURN (chemical) ☐CONCUSSION ☐CRUSHING INJURY ☐CUT, LACERATION, PUNCTURE

☐ EQUIPMENT THEFT/LOSS ☐ EQUIPMENT DAMAGE ☐ AUTO ACCIDENT/VIOLATION ☐ DESIGN FAILURE

☐ PROTOCOL/PROCEDURE FAILURE ☐OTHER:

INCIDENT DESCRIPTION

LOCATION WHERE INCIDENT OCCURRED:	EXACT TIME:

EQUIPMENT INVOLVED:	WITNESSES:
ATTACHMENTS: (number/type)	PPE USAGE

DESCRIBE THE EVENTS THAT LED UP TO THE INCIDENT (include names of any machines, parts, objects, tools, materials or any other important details):

INCIDENT CAUSES	
CONTRIBUTING CONDITIONS (check all that apply):	CONTRIBUTING ACTIONS (check all that apply):
☐TOOL OR EQUIPMENT DEFECTIVE	☐OPERATING WITHOUT PERMISSION
☐COMMUNICATION BREAKDOWN	☐OPERATING AT UNSAFE SPEED
☐SAFETY DEVICE IS DEFECTIVE	☐SERVICING EQUIPMENT IMPROPERLY
☐ UNGUARDED HAZARD	☐DISREGARD FOR ESTABLISHED PROCEDURES
☐HAZARDOUS WORKSTATION LAYOUT	☐USING DEFECTIVE EQUIPMENT
☐UNSAFE LIGHTING	☐USING EQUIPMENT IN AN UNAPPROVED WAY
☐UNSAFE VENTILATION	☐UNSAFE LIFTING
☐LACK OF NEEDED PERSONAL PROTECTIVE EQUIP.	☐DISTRACTION, TEASING, HORSEPLAY
☐LACK OF APPROPRIATE TOOLS OR EQUIPMENT	☐FAILURE TO WEAR PERSONAL PROTECTIVE EQUIPMENT
☐NO TRAINING OR INSUFFICIENT TRAINING	☐FAILURE TO USE AVAILABLE TOOLS OR EQUIPMENT
☐OTHER:	☐OTHER:
WHAT OTHER FACTORS CONTRIBUTED TO THIS INCIDENT?	
WAS THE POTENTIAL FOR THIS HAZARD/INCIDENT REPORTED PRIOR TO THE INCIDENT? ☐YES ☐NO IF SO, WHEN?	
HAVE THERE BEEN SIMILAR INCIDENTS PRIOR TO THIS ONE? ☐YES ☐NO IF SO, WHEN?	

CORRECTIVE ACTION
SUGGESTIONS TO PREVENT INCIDENT REOCCURRENCE: ☐STOP THIS ACTIVITY ☐GUARD THE HAZARD ☐TRAIN EMPLOYEE(S) ☐TRAIN SUPERVISOR(S) ☐REDESIGN TASK STEPS ☐REDESIGN WORK STATION ☐WRITE NEW POLICY/RULE ☐ENFORCE ☐ROUTINELY INSPECT FOR HAZARD ☐ PERSONAL PROTECTIVE EQUIP. ☐OTHER:
WHAT SHOULD BE (OR HAS BEEN) DONE TO CARRY OUT THE SUGGESTION(S) CHECKED ABOVE?

WRITTEN BY: DEPARTMENT:	TITLE: DATE:
NAMES OF INVESTIGATION TEAM MEMBERS	
REVIEWED BY:	TITLE: DATE:

Glacier Environmental HASP

Health and Safety Plan

North Boeing Field
Excavation, Storm Drain Replacement, and Manhole Modifications

Seattle, Washington

Prepared by:

Glacier Environmental Services, Inc.
4416 Russell Road, Suite A
Mukilteo, WA 98275

Prepared for:

Boeing Company
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Seattle, Washington 98124

August 2010

Health and Safety Plan
North Boeing Field Excavation, Storm Drain Replacement, and Manhole Modifications
Seattle, Washington
Table of Contents

Site Safety and Health Plan
North Boeing Field Excavation, Storm Drain Replacement, and Manhole Modifications
Seattle, Washington

I. Introduction

This site health and safety plan (HASP) has been written for use by Glacier Environmental Services, Inc. (Glacier) employees, and to guide actions of others on the construction site during this project. Glacier assumes no responsibility for its use by others. The plan is written for the specific conditions, purpose, and personnel specified in the project documents. This plan must be amended if unanticipated conditions, representing a potential hazard to Glacier employees or subcontractors, are encountered.

II. Purpose

The purpose of this HASP is to address safety and health issues arising out of the potential for worker exposures to hazardous materials or conditions encountered during the North Boeing Field Excavation, Storm Drain Replacement, and Manhole Modifications Project.

The intent of this plan is to meet the requirements of 29 CFR 1910.120, Hazardous Waste Operations and Emergency Response applicable to work in potentially hazardous conditions or where there is a potential for exposure to hazardous materials or wastes. The plan is not intended to address common construction practices covered by 29 CFR 1926. The Glacier Accident Prevention Plan addresses general construction safety.

This HASP is based on previously identified contaminants and site conditions. Where appropriate, the HASP may be supplemented with material or task-specific health plans if subsequent evaluation of the site materials, or work tasks determines that a specific risk is not adequately addressed herein.

Additional safety documentation is available to Glacier employees and its subcontractors. This information includes Glacier's Accident Prevention Plan, Hazard Communication Program, Respiratory Protective Program, and Confined Space Entry Program. These plans are incorporated into this HASP and will be available upon request. They are intended to supplement the HASP and to address normal safety practices on construction sites.

The HASP will be kept on site and available to workers in accordance with CFR 1910.120(b)(4)(i)

III. Project Description

The work consists of three separate tasks: Manhole 130 Modifications (which has since been changed to new manhole installations on the same line); Replacement of 165 LF of Storm Drain; and Excavation and Disposal of PCB contaminated Soil near the property boundary.

IV. Preliminary Findings

This plan assumes that contaminants of concern consist of polychlorinated biphenyls (PCBs) in the soil associated with all three areas of work. This HASP may have to be modified to describe additional hazards and additional worker protection if other contaminants are discovered or the scope of work changes.

V. Scope of Work

The work to be performed will include furnishing labor, materials and equipment necessary to complete Excavation, Storm Drain Replacement, and Manhole Modifications at the Site.

Glacier will install three new manholes, a Goulds WS_D4 Series Pump in a new 54-inch manhole and all piping (SCH80 PVC) to convey water to the treatment system (provided by others) including the cost of two 7.5 HP three-phase pumps.

Remove and replace approximately 165LF of storm drain and 4 associated catch basins.

Remove PCB contaminated soil as directed by the Engineer/Consultant in the area near the Boeing property line adjacent to the Georgetown Steam Plant.

VI. Airborne Hazards

The following information provides more details about potential site contaminants that pose a potential human health hazard. Chemical data sheets for suspect contaminants are included in Appendix B.

Polychlorinated biphenyls (PCBs)

Description- PCBs are man-made toxic chemicals that persist in the environment and bioaccumulate in animals and humans. PCBs were manufactured in the United States between 1950 and 1978, before their manufacture was banned by Congress due to concerns about their potential for adverse effects on human health and the environment.

Use: At one time concrete join caulk was manufactured to contain PCBs because PCBs imparted flexibility.

Health-. Exposure to PCBs can affect the immune system, reproductive system, nervous system, and endocrine system. In humans, PCBs are potentially cancer-causing. Caulk that is peeling, brittle, cracking, or deteriorating visibly in some way may have the highest potential for release of PCBs creating dust. In addition to inhalation from PCBs in the air or dust, exposure may occur when a person comes in contact with the caulk and any surrounding porous materials into which the PCBs may have been released (e.g., brick, concrete, wood). Exposure may also occur through contact with PCB-contaminated soil. Soil may become contaminated with PCBs when caulk weathers.

Target organs-Eyes, skin, respiratory system, liver

OSHA PEL: .05 mg/m^{3}TWA

VII. Physical and Biological Hazards

The following is a list of potential physical and biological hazards, which may be encountered during demolition and other construction activities.

A. Noise. Power equipment and tools used in on the project may produce high noise levels and expose workers to noise levels in excess of 85 decibels. Noise monitoring shall be conducted as needed and in accordance with 29 CFR 1910.95, 1926.52 & 1926. Operators of portable pneumatic impact equipment and personnel in proximity, within 15 feet, to compressors and compressed air powered tools are at potential risk and will wear hearing protection when the equipment is operating. Glacier will provide disposable hearing protection.

B. Overhead Lines. Prior to commencing work, a visual inspection of the sites will be conducted to identify any power lines or conduit. Any line that interferes with, or in any way may cause a hazard to workers, will be relocated. If lines are present outside of conduit, worker's may not bring conductive material closer than 20 feet to any energized power line.

C. Utilities. Some utilities may be encountered during this project. In advance of sawcutting Glacier is responsible for marking all utilities located within each of the areas where caulk removal will be performed. If utilities are exposed, they shall be protected, supported or removed as necessary to safeguard workers.

D. Slip/Trip Hazards. The site surfaces may be wet as a result of rain or dust suppression. Worker's must assure good footing while in the work area.

E. Illumination. While most work will be performed during daylight hours, natural illumination will need to be supplemented with local task lighting if night work is planned. When work areas are staffed at night, access ways, active storage areas, and field maintenance areas will have a minimum of 5 foot- candles of illumination. Rest areas, toilets, and storage/repair areas will have a minimum of 10 foot-candles and offices and first-aid stations will have a minimum of 30 foot-candles.

F. Operation of Heavy Equipment. Operation of heavy equipment at the site poses hazards to operators and workers due to uneven surface and normal congestion. Only experienced, trained operators may operate heavy equipment on site. All trucks and heavy equipment will have back- up alarms. Dump trucks will have ground assistance (spotter) when backing up.

G. Radiological. Based on current, best-available information, there are no reported radiological hazards are on site, and therefore little or no risk to human health. Any evidence observed by site workers of possible radioactive materials present on site should be reported to the Project Manager immediately.

H. Biological. No reported biological hazards are on site. Any laceration or puncture wound should be reported to the Project Manager, thoroughly cleansed and an assessment made as to the need for medical attention.

I. Insect or snake bites. Individual susceptibility to bug bites or stings may vary. Most bug bites or stings are a nuisance that may be avoided by the use of repellents. In case of rapid inflammation (reddening/swelling) of the site of bite or sting, or ANY difficulty in breathing, immediately summon medical assistance or transport individual to emergency room. All snake bites require immediate medical attention. Report any bites or stings requiring medical attention on incident report form.

G. Lock-out Tag-out Lock-out refers to isolating energy from equipment to prevent inadvertent operations that could harm the affected employee(s). Tag-out refers to notification that an energy source is locked out; the tag does not isolate the energy source. Equipment will be locked out, tagged, and operation attempted in accordance with Section 9.9 of the Glacier Accident Prevention and Safety Program for the following equipment activities.

- Installation;
- Setup;
- Adjustments;
- Inspections;
- Repairs;
- Modifications;
- Lubrication and other forms of routine, preventative maintenance; and

VIII. Medical Monitoring

All workers who will be working with hazardous materials must participate in medical monitoring, as described in 29 CFR 1910.120 (f). A medical monitoring program should consist of the following:

A. Medical and Exposure History
B. Brief "hands-on" Physical by Physician
C. Spirometry
D. Complete Blood Count, including differential

If the attending physician decides that the employee is of questionable medical status, additional tests may be run. The physician will then make a determination if the employee is capable of working on-site. If a worker becomes exposed to a chemical, or if that worker experiences suspicious symptoms, an incident physical is mandatory. This should be done as soon as possible, but in no case later than 72 hours after the incident. The physician will be given a list of all suspected chemicals the worker may have been in contact with. The worker will not be allowed back on site until a Fitness for Duty Statement is issued by the physician. If a worker may be exposed to concentrations above the Permissible Exposure Limit (PEL) for any chemical for 30 or more days a year, a full medical exam is required.

Additionally, a specialized medical examination to determine if a person is fit to wear a respirator must be performed before anyone, required to wear a respirator, is fit tested. A non-confidential notice of fitness to wear a respirator shall be maintained on file in the Glacier field office.

Non-confidential summaries of medical determination of fitness to work (Back-to-Work Exam), following any incident, will be also be maintained on site. Other medical records for Glacier personnel are maintained by the Occupational Physician, J.R. Smith, M.D., a licensed health care practitioner at Health Force Occupational Medicine, (206) 624-3651.

IX. Selection of Personal Protective Equipment

Work will be performed in modified Level D protection, described below. Periodic washing of exposed skin, especially before eating, using the toilet, or leaving the site, can further minimize health hazards.

A. <u>Head:</u> Wearing of hard hats is required when on the site. Only hard hats meeting the current ANSI Z89.1 standard are acceptable.

B. <u>Body:</u> Personnel will wear standard construction clothing, unless liquids are encountered in work area or working directly with PCB contaminated caulking. If liquids or caulking are present in work areas, disposable coveralls made of hydrophobic woven or spun polymers or "chemically resistant" rain suits will be required to minimize contact with the liquid and caulking.

C. <u>ANSI Level II or III Orange,</u> retro reflective orange work vests will be worn by all personnel entering the site.

D. <u>Feet:</u> All personnel entering the work zone will wear sturdy construction boots, meeting the current ANSI Z41 standard. While working in liquid contamination, chemically resistant boots will be worn.

E. <u>Hand:</u> Leather or cotton work gloves will suffice. However, during work in PCB-contaminated areas, the use of neoprene gloves is recommended.

F. <u>Eye protection:</u> Safety glasses are required for all workers at the Site. Workers exposed to potential eye injury such as torch cutting, grinding, sandblasting, etc will wear additional protection such as goggles or face shields meeting current ANSI Z87.1 standards. The use of contact lenses will not be restricted.

G. <u>Hearing:</u> Single-use hearing protection devices or ear muffs will be made available to personnel working on site.

Air monitoring will be utilized during dust generating operations to protect workers. If contaminates of concern are detected at concentrations greater than the Permissible Exposure Limit (PEL), workers will upgrade to Level C PPE;

A. Full-face air purifying respirators (NIOSH approved).
B. Hooded chemical-resistant clothing (such as Tyvek).
C. Gloves, outer, work type.
D. Gloves, inner, chemical-resistant.
E. Boots chemical-resistant steel toe and shank.
F. Hard hat.

When there has been contact with contamination, personnel will follow decontamination procedures outlined in Section XV of HASP prior to removal storage/disposal of personal protection.

Visitors to the site, including employees, subcontractors, representatives of Boeing, and representatives from governmental agencies shall wear personal protection deemed appropriate by Glacier or as advised by SSHO. Individuals unable or unwilling to wear the prescribed personal protection will be denied entry to the work site.

X. Ventilation

All work zones within this project are outdoors and in open areas, ambient air movement should be adequate to ventilate work areas.

XI. Access Control and Work Zones

All personnel working at the Site must complete the Boeing badging process and have received security clearance from Boeing. Badges demonstrating compliance with these requirements will be issued to all personnel and conspicuously displayed at all times.

Only persons directly working for Glacier, Landau, and their sub-contractors, representatives and officials from Boeing will be allowed in work zones. The number of persons will be limited to only necessary personnel. Evidence of current training, medical surveillance and respirator fit test credentials (if respirators are required) must be provided by visitors prior to being allowed into the work zones.

Personnel will be instructed on proper procedures for personal decontamination and decontamination of equipment by the SSHO. .

XII. Training Requirements

All Glacier personnel who will work in work zone must have completed a 40-hour Hazardous Waste Operations Training, current 8-hour refresher course, lead and silica dust awareness training. Prior to beginning this project, all personnel will participate in a site-specific orientation session. New workers will attend an orientation session before starting a work assignment. Tailgate safety meetings will be conducted by the SSHO daily. If additional meetings are required, the Project Manager will notify the workers. These meetings will discuss methods to safely work around the construction site and address other specific health hazards of concern on the site

A. Site-specific Training Content

1. Review the site Safety and Health Plan (SSHP).
2. Review of Glacier's health and safety requirements.
3. Worker responsibilities while on the job site.
4. Hazard Communication Training as defined by CFR 1910.1200.
5. Medical surveillance requirements and a review of the chemical hazards on site. This will include a list of the chemical names, permissible exposure limits, acute and chronic symptoms of exposure, first aid treatment, and any other information related to the chemicals which is deemed warranted, such as flammability.
6. Review of physical hazards on site.
7. Review of task assessments.
8. Assure that all persons required to wear respirators have medical clearance and have been fit-tested prior to respirator use.
9. Review what personal protective equipment will be used and under what circumstances, including their limitations, cleaning and inspection.
10. Review confined space entry requirements and hazards of working in confined spaces.
11. What methods of engineering controls will be used and when they are appropriate.
12. A description and demonstration of the air monitoring/gas detection equipment.
13. Review site evacuation and re-entry procedures.
14. A review of fire and explosion hazards, including the use of fire extinguishers.

15. Discussion of confined space rescue plan.

B. New Workers: Workers new to this site will also be required to have at least two days of on-site orientation under the direction of an experienced supervisor before being allowed to work unsupervised at this site.

XIII. Decontamination

A Decontamination area will be established by SSHO in the Contamination Reduction Zone near the entry/exit to the Exclusion Zone. Wash and rinse buckets and brushes, bags or drums for disposing contaminated PPE articles, and drum for storing contaminated wash/rinse water will be provided in the decontamination area. All disposable clothing (PPE) will be disposed in bag or drum that is clearly labeled "PPE Waste". Wash water from decontamination buckets will be collected in a drum marked "Waste Wash Water".

Decontamination will be accomplished as follows:

Level D decontamination

- Wash rubber boots in buckets.
- If non-cotton gloves worn, wash and remove. These may be reused.
- If cotton gloves are worn, remove and place in PPE Waste drum.
- Remove any inner glove and place in PPE Waste drum.
- Remove disposable clothing and place in PPE Waste drum.
- Remove boots and store; also inspect and store reusable gloves.
- Wash exposed skin with soap and water.
- Exit to Support Zone

Level C decontamination

- Wash rubber boots in bucket.
- Wash and outer gloves and remove. If single use, dispose in PPE Waste; if reusable, set aside.
- Remove respirator. Remove cartridge(s) and dispose of them in PPE Waste. Set respirator facepiece aside.
- Remove any inner glove and place in PPE Waste drum.
- Remove disposable clothing and place in PPE Waste drum.
- Remove boots and store; also inspect, clean and store respirator facepiece and reusable gloves.
- Wash exposed skin with soap and water.
- Exit to Support Zone

Non-disposable equipment such as concrete saws, pressure washers, vacuums, scabblers, and hand tools that come in contact with caulk, paint or the liquid or solid hazardous wastes generated by its removal will be decontaminated.

During each phase of work, PCB and Heavy Metal contaminated equipment will remain onsite and under cover each night until the end of the project. All PCB and Heavy Metal waste containers will be secured and sealed when filled and each day at the conclusion of work.

Decontamination will be performed in accordance with 40CFR 761.79. Only parts of the equipment that are reasonably believed to have come in contact with PCB-containing materials will be decontaminated. Wash water and surfactants used for decontamination will be collected and stored in Boeing provided holding tank or drums for disposal by others.

XIV. Responsibilities

The Project Manager and the SSHO are responsible for enforcing the health and safety requirements. The Project Manager will act as Site Safety and Health Officer if the designated SSHO is not on site.

A. Project Manager will:
   1. Assure that all on-site workers have received the appropriate level of Health and Safety Training;
   2. Assure that all on-site workers meet the required qualifications for site work;
   3. Assure that all standard operating procedures are followed at all times;
   4. Address any unusual problems or conditions that may be encountered on site:
   5. If the SSHO is not on site, act in that capacity;
   6. Maintain a current list of all workers working on the site; and
   7. Report to COR if any exposure is at or above the PEL.

B. Site Safety and Health Officer (SSHO) will:
   1. Walk the work site at the beginning of each shift to assure that excavation barriers, and other signage, are in place and that zone boundaries on site plan are current;
   2. Periodically monitor the work environment for health and safety hazards. The SSHO will monitor during excavation, confined space entry, and whenever there is a worker complaint of irritation or adverse exposure;
   3. Investigate all accidents/illnesses;
   4. Oversee the proper use, maintenance, and decontamination of personal protective equipment;
   5. Be present at health and safety meetings and assist in topic selection and discussion;
   6. Report any unsafe conditions or exposures at or above the PEL to the Project Manager.

C. Health and Safety Manager/ will:
   1. Review, sign and date the HASP prior to submittal.
   2. Be available for consultation on any unsafe conditions that may be present on site and assist SSHO in post-incident analysis.
   3. Visit the site as necessary to audit the effectiveness of the HASP.

4. Coordinate any modifications to the HASP with the Glacier Project Manager or SSHO.
5. Review air monitoring data and recommend any changes to engineering controls, work practices and PPE.

D. Site Workers (including all Glacier employees as well as their subcontractors) will:
1. Read and follow the Site Safety and Health Plan;
2. Complete the required training;
3. Report any accidents/illnesses, unsafe conditions, or any unusual situation to Project Manager or SSHO;
4. Check all personal safety equipment prior to entering a restricted area, to assure that the equipment is in good working order;
5. Maintain and decontaminate personal protective equipment as required;
6. Utilize change and wash facilities to maintain good personal hygiene; and
7. Avoid horseplay, fighting or other actions that could injure other workers by direct contact or through distraction from potential site hazards.

XV. Emergency Response and Contingency Procedures

In accordance with 29 CFR 1910.120(l) and ER 385-1-92 App C C-13 (b) Glacier has developed the following emergency response and contingency procedures.

A. Incidental Responses: Glacier employees will respond to incidental situations involving chemical exposures, personal injuries, fires/explosions, environmental spills and releases that are limited in quantity and pose no emergency or threat to the safety and health of workers in the immediate vicinity.

B. Emergency Response Plan: Proper emergency planning and response are important elements of the safety and health program that help minimize employee exposure and injury. The plan includes the following elements:

1. Personnel roles, lines of authority, and communication procedures. HASP Section XVII details personnel roles, lines of authority and communication procedures.

2. Pre-emergency planning. The Project Manager and SSHO will conduct pre-emergency planning and train site workers as specified in HASP Section XVII

3. Emergency recognition and prevention. All personnel who will work in the Exclusion Zone must have completed a 40-hour Hazardous Waste Operations Training and a current 8-hour refresher course, which includes emergency recognition and prevention training. In addition Glacier has initiated an Accident Prevention Plan in conjunction with this HASP.

4. **All Emergencies call 206-655-2222 with building number references**

5. Emergency medical and first-aid treatment. All Glacier personnel have current 1st Aid and CPR training. Each situation must be evaluated on-site to determine if outside medical treatment is necessary. Symptoms or exposures involving the eyes or respiratory systems, which do not readily respond to "flushing" of "Fresh Air", should be seen by medical personnel. The Glacier Project Manager or SSHO will determine when medical attention is required. If a heart attack, stroke or heat stress is suspected, immediately notify the Boeing Site Representative and dial 911. Begin CPR or other supportive care until emergency responders arrive. If 911 is unable to dispatch assistance, immediately arrange for transport by vehicle to the nearest medical facility.

6. First Aid Supplies Emergency Medical Equipment and first aid supplies, normally found on a construction site, will be maintained at the Glacier Trucks. A supply of water and waterless skin cleanser will be maintained to treat minor skin exposures, not requiring medical attention.

7. Fire Emergency In the event of a fire, the Project Manager will determine if it is within the site's capability to handle it. If on-site personnel cannot control it, call 911. In any event, workers will evacuate the site, excavation or tanks, unless involved in fire fighting, until the Project Manager notifies the workers that it is safe to return. All situations will be reported.

8. Methods or procedures for alerting onsite employees. The general warning to leave the site will be three short blasts of an air horn. This warning will be repeated until all employees have left the site.

9. Evacuation routes, Safe distances and places of refuge. The Project Manager and or SSHO will designate evacuation routes and procedures, safe distances and places of refuge prior to conducting onsite activities.

In addition to the above requirements, Glacier will maintain information regarding site topography, layout, and prevailing weather conditions; and procedures for reporting incidents to local, state, and federal government agencies.

The emergency response and contingency plan requirements will be reviewed prior to onsite activities, rehearsed regularly, reviewed periodically, and amended, as necessary, to keep them current with new or changing site conditions or information.

Additional Emergency Information

1. Emergency Jurisdiction and Notification:
   Ambulance and Fire Transportation: **Call 206-655-2222** with building numbers and references

2. Nearest Medical Facility
   Harborview Medical Center
   325 9th Ave

Seattle, Washington 98104
(206) 744-5100

For directions to hospital see Appendix A

3. Site Emergency Phone Numbers-Key Personnel:

Glacier Mukilteo Office		(425) 355-2826
Glacier Corporate Health and Safety Manager	Steve Miles	(206) 793-3711
Glacier Project Manager	Thayne Wastman	(206) 446-5280
Glacier Site Safety Health Officer (SSHO)	Thayne Wastman	(206) 446-5280
Boeing Representative	Carl Bach	(206) 898-0438

C. Accident/Incident Report All accidents/incidents will be reported on the standard Accident/Incident report form (See Appendix D). Originals will be maintained by the SSHO. Copies will be provided for the employees involved and their supervisors/companies.

XVI. General Work Practices

I. Fire Hazard Due to Boeing regulations, no smoking or open flame will be allowed on site except in designated areas.

II. Restricted Activities No eating, drinking, gum or tobacco chewing will be allowed except in specially designated locations.

III. Eye Wash A portable eye wash meeting ANSI Z358.1 will be placed at the work site in case of accidental eye contamination.

IV. Body Contamination If body contamination should occur; "clean" water will also be available to flush contaminants from the body.

V. Fire Extinguishers At least one (ABC) dry fire extinguisher will be available at all times in case of fire/explosion.

VI. First Aid A first aid kit will be available in company trucks for minor injuries. At least two persons holding a currently approved first aid card will be available during working hours.

VII. Telephone Communications Glacier's Project Manager will have a telephone for emergency use.

VIII. Sanitation Boeing washrooms and toilet facilities are available and within easy walking distance of any construction operation.

IX. General Construction Procedures All construction activities will be performed in accordance with CFR 29 1926. A copy of appropriate Glacier policies and operating procedures regarding health, safety and loss control, if any, will also be maintained on site,.

XVII. Links to Other Programs

Additional programs that are part of Glacier documentation are critical to the achievement of a safe and healthful work environment. Often these programs are generic to all work situations. Since trained workers may expect to find these programs in different documents, there is little benefit to duplicating the information in the HASP. Rather, by establishing this link, the existing programs are incorporated by reference to the HASP.

Other Glacier Programs that are linked to the HASP include:

1. Accident Prevention Plan,
2. Hazard Communication Program,
3. Respiratory Protective Program,
4. Confined Space Entry Program.

XVIII. Plan certification

I hereby certify that I have read and understand this Site Health and Safety Plan. I agree to follow the guidelines set forth in this plan during all on-site activities.

SIGNATURE:	COMPANY/AGENCY:	DATE:

Appendix A
Hospital Directions

Start out going NORTHWEST on PERIMETER RD S.
Turn LEFT onto AIRPORT WAY S
Turn LEFT onto 13TH AVE S.
Turn RIGHT onto S BAILEY ST.
Merge onto I-5 N toward VANCOUVER BC.
Take the DEARBORN ST/JAMES ST exit, EXIT 164A, toward MADISON ST.
Take the JAMES ST exit.
Turn RIGHT onto JAMES ST.
Turn RIGHT onto 9TH AVE.
325 9TH AVE is on the RIGHT.

MAPQUEST.

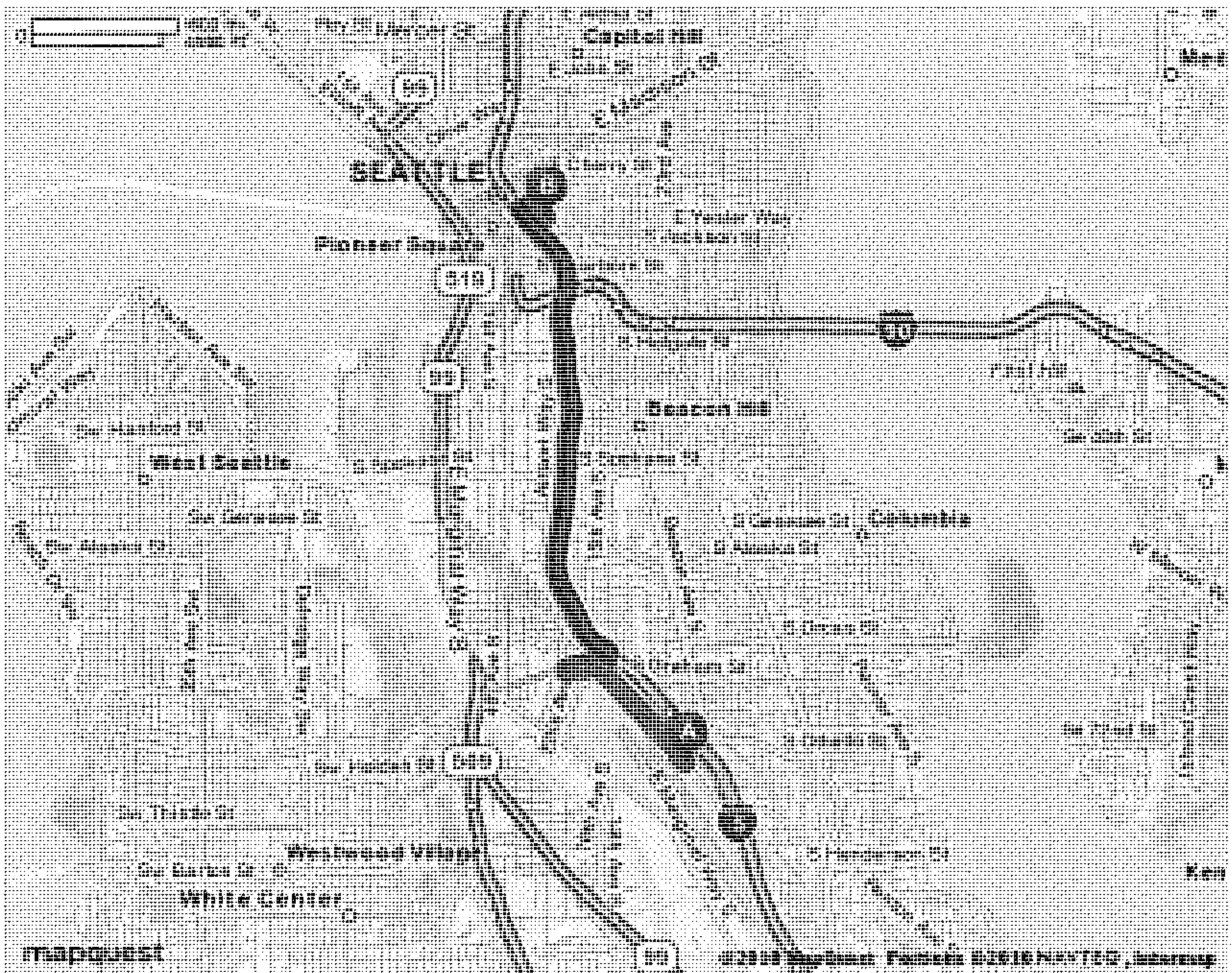
Trip to 325 9th Ave

Seattle, WA 98104-2420

6.02 miles - about 10 minutes

Notes

Route Map Hide



Appendix B
Chemical Data Sheets

AROCLOR 1232

RTECS: TQ1354000
Molecular Formula: Unspecified or Variable
Formula Weight: Average 221
Synonyms: AROCHLOR 1232; CHLORODIPHENYL (32% CL); CHLORODIPHENYL (32 PERCENT CL); PCB-1232; PCB 1232; POLYCHLOEINATED BIPHENYL 1232; POLYCHLORINATED BIPHENYL (AROCLOR 1232)
Use: formerly used as hydraulic fluid, rubber plasticizer, adhesive

Physical Properties

Boiling Point: 290 °C (554 °F) to 325 °C (617 °F)
Specific Gravity: 1.27 to 1.28
Vapor Pressure: Average 4.06 $x10^{-3}$ mm Hg at 25 °C
Water Solubility: Solubility in Water is extremely low
Other Solubilities: Soluble in oils and organic solvents
Refraction Index: 1.620 to 1.622 at 20 °C
Evaporation Rate: Evaporation loss at 100 °C at 6 hours 1 to 1.5%
Flash Point: > 141.111 °C

RTECS Toxicity Data

Acute Oral: Rat LD_{50} Dose: 4470 mg/kg.
Acute Dermal: Rabbit LD_{Lo} Route: Skin; Dose: 2 gm/kg.

Hazard Overviews

Reactivity: Stable, but subject to photodechlorination when exposed to sunlight or UV. Hazardous polymerization cannot occur. Avoid: heat and ignition sources. Hazardous decomposition products: highly toxic derivatives (polychlorinated dibenzo-para-dioxins; polychlorinated dibenzofurans); hydrogen chloride; phosgene; other irritants.
Carcinogenicity: IARC - Not listed; NIOSH - Not listed; NTP - Not listed; ACGIH - Not listed; OSHA - Not listed; EPA - Not listed; MAK - Not listed

Environmental

Ecotoxicity: LC_{50} Salmo clarki (Cutthroat trout) 2,500 ug/l/96 hr /Conditions of bioassay not specified LD_{50} Colinus virginianus (Northern bobwhite) oral 3,002 mg/kg diet/5 days on treated diet plus 3 days untreated
Environmental Fate: It is a mixture of different congeners of chlorobiphenyl and the relative importance of the environmental fate mechanisms generally depends on the degree of chlorination. In general, the persistence of the PCB congeners increase with an increase in the degree of chlorination. In contrast to the more highly chlorinated Aroclors, it appears to be reasonably degradable in the environment. One screening study has shown that it is biodegradable. Biodegradation is probably the ultimate degradation process in both natural water and soil systems since other degradation does not appear to be important. The PCB composition of the biodegraded Aroclor is different from the original Aroclor. If released to soil, the PCB congeners will become tightly adsorbed to the soil particles. In the presence of organic solvents, PCBs may have a tendency to leach through soil. Significant volatilization may occur from soil surfaces. Enrichment of the low Cl PCBs occurs in the vapor phase relative to the original Aroclor; the residue will be enriched in the PCBs containing high Cl content. If released to water, adsorption to sediment and suspended matter will be an important fate process. Although adsorption may immobilize it for relatively long periods of time, eventual resolution into the water column has been shown to occur. The PCB composition in water will be enriched in the lower chlorinated PCBs because of their greater water solubility, and the least water soluble PCBs (highest Cl content) will remain adsorbed. In the absence of adsorption, it volatilizes relatively rapidly from water. However, strong PCB adsorption to sediment significantly competes with volatilization which may have a half-life ranging from 2 months to 1 year in typical bodies of water. The PCB congeners have been shown to bioconcentrate significantly in

aquatic organisms. If released to the atmosphere, the PCB congeners will primarily exist in the vapor-phase. The dominant atmospheric transformation process for these congeners is probably the vapor-phase reaction with hydroxyl radicals which has estimated half-lives ranging from 12.9 days to 3.1 months. Physical removal from the atmosphere is accomplished by wet and dry deposition with enrichment of the most volatile PCBs, although wet deposition will be more important than dry deposition.

Cleanup/Disposal: Guide No. 171: Do not touch or walk through spilled material. Stop leak if you can do it without risk. Prevent dust cloud. Avoid inhalation of asbestos dust. Small Dry Spills: With clean shovel place material into clean, dry container and cover loosely; move containers from spill area. Small Spills: Take up with sand or other noncombustible absorbent material and place into containers for later disposal. Large Spills: Dike far ahead of liquid spill for later disposal. Cover powder spill with plastic sheet or tarp to minimize spreading. Prevent entry into waterways, sewers, basements or confined areas.

Environmental Physical Data

Henry's Law Constant: 2.28 $x10^{-4}$ to 3.43 $x10^{-4}$
Octanol/Water Partition Coefficient: log K_{ow} = > 4.54
Sorption Partition Coefficient: 4.04 to 5.25
BCF: white sucker 5500

Regulations

RCRA 40CFR: Not listed
CERCLA: 40CFR 302.4: Listed per CWA Section 311(b)(4) per CWA Section 307(a) RQ: 1 lb (0.454 kg)
SARA 40CFR 372.65: Listed as Compound
SARA EHS 40CFR 355: Not listed
TSCA: Not listed

Analytical Methods

Soil: CLP LC_PEST, MC_PEST, OHC; SW846 3630B, 8080A, 8081, 8082, 8250A, 8270B, 8270C; EPA 16, 3, PCB-009
Water / Groundwater: EPA PCB-003, 608, 617, 625, 625-S; APHA 6410-B, 6630-C, 6630-D; ASTM D3534
Drinking Water: EPA 505, 508, 525.2; ASTM D5175
Food: EPA 4
Plasma: EPA 29
Other: EPA P-009-1, 1656

Appendix C
Toolbox Safety Meeting Forms

GLACIER ENVIRONMENTAL SERVICES, INC.

TAILGATE SAFETY MEETING FORM

Date: __________ Time: __________

Project Name: ____________________________________ Job No.: _____________

Location: ____

Site Supervisor: ____

Safety Equipment Required:

____	Hard hats	____	Protective Clothing
____	Safety Glasses/Goggles	____	Safety Vest
____	Steel-toed Boots	____	Retrieval Harness
____	Respirators	____	Safety Life Nets

Special Equipment Requirements:

____	Dewatering	____	Ventilation
____	Welding/Cutting	____	Shoring/Trench Boxes
____	Rigging/Lifting	____	Lighting

Traffic Control Required: ____ Yes ____ No

Confined Space Entry: ____ Yes ____ No
(If "Yes" complete Confined Space Entry Permit)

Meeting Topics:

____
____
____
____

Work Tasks:

____
____
____
____

Emergency Procedures:

____
____
____
____

Nearest Hospital/Clinic Telephone No./Address:

____
____

(see *Route to Hospital Map* in the Site-Specific Health and Safety Plan)

I HAVE ATTENDED THIS SAFETY MEETING SESSION FOR THE PROJECT AND UNDERSTAND THE INFORMATION PRESENTED TO ME

Name (Print)	Signature

Meeting Conducted By:

Name (Print)	Signature

Appendix D
Incident/Accident Form Documentation

GLACIER ENVIRONMENTAL SERVICES, INC.
ACCIDENT/INCIDENT REPORT FORM

DATE OF INJURY/ACCIDENT: ____________

EMPLOYEE NAME: ____________

ADDRESS: ____________

CITY: ____________ STATE: ____________ ZIP: ____________

SS#: ___ - ___ - ___ AGE: ____________ SEX: ______ F ______ M

SITE NAME: ____________ JOB NUMBER: ____________

ADDRESS: ____________

CITY: ____________ STATE: ____________ ZIP: ____________

INCIDENT: ____________

EMPLOYEES ACTION AT TIME OF INCIDENT/ACCIDENT: ____________

WEATHER CONDITIONS: ____________

DESCRIBE INJURY, ILLNESS, OR PROPERTY DAMAGE:
(NOTE: COMPLETE OSHA FORM 101 IF THIS IS A RECORDABLE INJURY OR ILLNESS)

NAME OF OBJECT OR SUBSTANCE THAT CAUSED INJURY OR DAMAGE:

POSSIBLE EXPOSURE ? YES ______ NO ______

CONFIRMED EXPOSURE ? YES ______ NO ______

PROTECTIVE GEAR WORN ? YES ______ NO ______

MATERIAL EXPOSED TO:
(SPECIFY LIQUID, SOLID, GAS, VAPOR, FUME, MIST, ETC. AND ANY CHEMICAL INFORMATION KNOWN ABOUT MATERIAL, MSDS.)

____
____
____

SYMPTOMS:

____
____
____

GLACIER OFFICE NOTIFIED? YES___ NO___

CLIENT OR REPRESENTATIVE NOTIFIED? YES___ NO___

DID EMPLOYEE RECEIVE MEDICAL CARE YES___ NO___

ACTION TAKEN: AIR AND REST ____ FIRST AID ____ MEDICAL ____

TRANSPORTED BY: GLACIER VEHICLE ____ CLIENT ____ AID CAR ____

MEDICAL FACILITY: ______________________________

ADDRESS: ______________________________

CITY: ____________ STATE: ____________ ZIP: ____________

PHYSICIANS NAME: ______________________________

SAFETY RULES IN EFFECT AT TIME OF ACCIDENT/INJURY:

____
____
____

IMMEDIATE ACTION TAKEN TO PREVENT REOCCURRENCE:

____
____
____

WITNESSES:

NAME (PRINT)	SIGNATURE
____________________	____________________
____________________	____________________

____________________ ____________________

EMPLOYEE SIGNATURE SUPERVISOR SIGNATURE

Appendix E
Worker Training Certifications

Certificate

THIS CERTIFICATE HAS BEEN PRESENTED TO

RANDY BEVAN

FOR SUCCESSFUL COMPLETION OF:
8-HR HAZARDOUS MATERIAL REFRESHER TRAINING
This training meets the requirements of WAC 296.62 for general site workers, and also included: fall protection; excavation, trenching & shoring; heat & job stress; Chromium VI awareness; respirator use and Quantitative Fit Testing.

Completed on: May 12, 2010 at Glacier Environmental, Mukilteo, WA
Expires: May 12, 2011
SOUND TESTING, INC., NFPA CERTIFIED MARINE CHEMISTS
(206) 932-0206

Certificate

THIS CERTIFICATE HAS BEEN PRESENTED TO

STEVE MILES

FOR SUCCESSFUL COMPLETION OF:
8-HR HAZARDOUS MATERIAL REFRESHER TRAINING
This training meets the requirements of WAC 296.62 for general site workers, and also included: fall protection; excavation, trenching & shoring; heat & job stress; Chromium VI awareness; respirator use and Quantitative Fit Testing.

Completed on: May 12, 2010 at Glacier Environmental, Mukilteo, WA
Expires: May 12, 2011
SOUND TESTING, INC., NFPA CERTIFIED MARINE CHEMISTS
(206) 932-0206

Certificate

THIS CERTIFICATE HAS BEEN PRESENTED TO

PHIL STELLFLUG

FOR SUCCESSFUL COMPLETION OF:
8-HR HAZARDOUS MATERIAL REFRESHER TRAINING
This training meets the requirements of WAC 296.62 for general site workers, and also included: fall protection; excavation, trenching & shoring; heat & job stress; Chromium VI awareness; respirator use and Quantitative Fit Testing.

Completed on: May 12, 2010 at Glacier Environmental, Mukilteo, WA
Expires: May 12, 2011
SOUND TESTING, INC., NFPA CERTIFIED MARINE CHEMISTS
(206) 932-0206

Certificate

THIS CERTIFICATE HAS BEEN PRESENTED TO

CHRIS ERIKSSON

FOR SUCCESSFUL COMPLETION OF:
8-HR HAZARDOUS MATERIAL REFRESHER TRAINING
This training meets the requirements of WAC 296.62 for general site workers, and also included: fall protection; excavation, trenching & shoring; heat & job stress; Chromium VI awareness; respirator use and Quantitative Fit Testing.

Completed on: May 12, 2010 at Glacier Environmental, Mukilteo, WA
Expires: May 12, 2011
SOUND TESTING, INC., NFPA CERTIFIED MARINE CHEMISTS
(206) 932-0206

Certificate

THIS CERTIFICATE HAS BEEN PRESENTED TO

JESSE HAMILTON

FOR SUCCESSFUL COMPLETION OF:
8-HR HAZARDOUS MATERIAL REFRESHER TRAINING
This training meets the requirements of WAC 296.62 for general site workers, and also included: fall protection; excavation, trenching & shoring; heat & job stress; Chromium VI awareness; respirator use and Quantitative Fit Testing.

Completed on: May 12, 2010 at Glacier Environmental, Mukilteo, WA
Expires: May 12, 2011
SOUND TESTING, INC., NFPA CERTIFIED MARINE CHEMISTS
(206) 932-0206

Certificate

THIS CERTIFICATE HAS BEEN PRESENTED TO

ALAN HALL

FOR SUCCESSFUL COMPLETION OF:
8-HR HAZARDOUS MATERIAL REFRESHER TRAINING
This training meets the requirements of WAC 296.62 for general site workers, and also included: fall protection; excavation, trenching & shoring; heat & job stress; Chromium VI awareness; respirator use and Quantitative Fit Testing.

Completed on: May 12, 2010 at Glacier Environmental, Mukilteo, WA
Expires: May 12, 2011
SOUND TESTING, INC., NFPA CERTIFIED MARINE CHEMISTS
(206) 932-0206

Certificate

THIS CERTIFICATE HAS BEEN PRESENTED TO

THAYNE WASTMAN

[illegible]

Certificate

THIS CERTIFICATE HAS BEEN PRESENTED TO

KIM BRADSHAW

FOR SUCCESSFUL COMPLETION OF:
8-HR HAZARDOUS MATERIAL REFRESHER TRAINING
This training meets the requirements of WAC 296.62 for general site workers, and also included: fall protection; excavation, trenching & shoring; heat & job stress; Chromium VI awareness; respirator use and Quantitative Fit Testing.

Completed on: May 12, 2010 at Glacier Environmental, Mukilteo, WA
Expires: May 12, 2011
SOUND TESTING, INC., NFPA CERTIFIED MARINE CHEMISTS
(206) 932-0206

Certificate of Completion

This is to certify that

Cory E. McGill

has satisfactorily completed
40 hours of training in

Hazardous Waste Operations And Emergency Response

to comply with the training requirements of
OSHA 29 CFR 1910.120

Certificate Number **107868**

Instructor

ARGUS PACIFIC
TRAINING • CONSULTING

Jul 26 - 30, 2010
Date(s) of Training
Annual Refresher Required by: Jul 30, 2011

Argus Pacific, Inc. • 1900 W. Nickerson • Suite 315 • Seattle, Washington 98119 • 206.285.3373 • fax 206.285.3927

HAZARDOUS MATERIALS TRAINING

The Management of Coastal Tank Cleaning certifies that Thayne Wastman has completed 80 hours of hazardous materials and hazardous waste training. The topics covered in these courses include: DOT regulations, RCRA regulations, OSHA regulations, company policies, confined space entry, first aid and CPR, and other safety topics related to hazardous materials. Classes have been offered at Coastal Tank Cleaning or he has attended outside training. In addition he has received a minimum of three days of on the job training with another trained employee.

Tom P. Smith
Tom Smith

SEPTEMBER 17, 1990

Denis Sapiro
Denis Sapiro, CSP, CHMM

DIVERS INSTITUTE OF TECHNOLOGY

This is to attest that

Gabriel J. Snyder

Has satisfactorily completed 40 Hours of Training in Health & Safety at Hazardous Waste Sites in compliance with Federal Occupational Safety & Health Administration (OSHA) 29 CFR 1910.120, and has successfully met the 80 hours Training requirement for Washington Administrative Code (WAC) 296-62-3040 including 20 hours Contaminated Water Diving Procedures.

Presented by: DIVERS INSTITUTE OF TECHNOLOGY, Seattle, WA

Given this 18th *day of* August, 2009

Instructor	Director of Training	Executive Director

DIVERS INSTITUTE OF TECHNOLOGY

ACCSCT ACCREDITING COMMISSION OF CAREER SCHOOLS AND COLLEGES OF TECHNOLOGY

ADC

Classroom Online

Certificate of Course Completion

Hazwoper 40 Hour Course

in compliance with the 29 CFR 1910.120 Standard

Bryan Hatcher
Student's Name

Course Title

10/16/2009 01:45 CST
Course Completion Date

Bryan Hatcher
Student's Signature

1361828
Certificate Number

40
# of hours approved

Note: Trainees must have additional hands-on training in the donning, doffing, and use of the Personal Protective Equipment required for their jobsite(s) in accordance with 29 CFR 1910.120.

I hereby attest that I have completed the above named Safety course in accordance with the ethical guidelines Defined by International Board of Environmental Health & Safety. I acknowledge that I consumed all information and took All Pertinent Quizzes and/or final tests.

Classroom Online
5702 Taylor Draper Cove Ste B
Austin, TX 78759
T: 866.439.5908
F: 888.742.6518

OSHAcampus.com™
powered by 360training.com

CERTIFICATE OF COURSE COMPLETION

James Slack	Hazwoper 40 Hour Course in compliance with the 29 CFR 1910.120 Standard	08/01/2010 16:49 CST
Student's Name	Course Title	Course Completion Date MM / DD / YYYY
	1649040	40
Student's Signature	Certificate Number	Approved # of Hours

Note: Trainees must have additional hands-on training in the donning, doffing, and use of the Personal Protective Equipment required for their jobsite(s) in accordance with 29 CFR 1910.120.

IACET The Continuing Education Unit ®

360training.com, Inc. has been reviewed and approved as an Authorized Provider by the International Association for Continuing Education and Training (IACET), 8405 Greensboro Drive, Suite 800, McLean, VA 22102-5120. 360training.com, Inc. has awarded 4 CEUs to participants who successfully complete this program.

5.0 Safety CM Points

I hereby attest and certify that I personally took the above named safety lesson in accordance to OshaCampus guidelines. I further state that I have paid for the course and that I did not use another's work (Plagiarism). Students should retain certificates and refer to course instructions to receive official certification where necessary.

360training
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Austin, Texas 78727
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