King County

Marine and Sediment Assessment Group 2017 Work Plan

The best decisions are based on Sound information.

Date: December 30, 2016

To: Interested parties

From: Kimberle Stark, Wendy Eash-Loucks, and Stephanie Jaeger

Subject: Transmittal of the 2017 Work Plan for the Marine and Sediment Assessment Group

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This memorandum and attachments present the 2017 Work Plan for the Marine and Sediment Assessment Group of the King County Department of Natural Resources and Parks' Water and Land Resources Division. The work plan includes all aspects of the wide-ranging marine monitoring program, including water quality, sediment, and biological components. Included with this memorandum are matrix tables that provide sampling locations, sampling frequency, and parameters to be measured for the 2017 long-term monitoring programs and NPDES-required monitoring, as well as maps showing sampling locations and details regarding special projects.

Station locations and analytical parameters may change from year to year. Any changes are based on an evaluation of previous years' data to determine if the data collected are meeting monitoring objectives for the various monitoring programs and/or budgetary constraints. Marine and Sediment Assessment Group staff evaluate data on an annual basis to determine what changes are necessary, including which parameters should continue to be analyzed.

For work expected to occur in 2017, a description of each monitoring component and special projects is provided below along with any sampling changes.

2017 ROUTINE MONITORING

Water Sampling

Marine Offshore Water Column Monitoring

Marine water column samples will be collected at 14 offshore and 4 Duwamish River stations in 2017 (Figure 1). Water column samples at 14 of the 18 stations will be collected twice monthly from February through November and monthly January and December. The four stations located in the Duwamish River (two ambient stations and two outfall stations) will be sampled

on a monthly basis. Ten of the 18 monitoring stations are located at outfalls for the Brightwater, West Point, South, and Vashon wastewater treatment plants, the Alki and Carkeek combined sewer overflow (CSO) treatment plants, the Elliott West and Henderson/MLK/Norfolk CSO treatment facilities, and the Barton Street and Hanford Street CSOs. Eight ambient monitoring stations are located at Point Jefferson, Elliott Bay, Point Williams, East Passage, the Lower Duwamish Waterway (two stations), and Quartermaster Harbor (two stations).

Discrete water samples will be collected from between one and seven depths at each offshore station, depending on the total station depth. For a list of stations, depths sampled, and parameters analyzed, see Table 1. Conductivity, temperature, depth (CTD) profiles will be conducted throughout the entire water column at 15 of the 18 stations – those stations that are sampled from King County's research vessels.

Laboratory analytes of discrete samples will include fecal indicator bacteria (fecal coliform and *Enterococcus*), chlorophyll-*a* and pheophytin pigments, suspended solids, and nutrients (ammonia-nitrogen, nitrite/nitrate-nitrogen, orthophosphate phosphorus, and silica). Total nitrogen will be analyzed on a subset of 13 samples. In past years, chlorophyll-*a* and pheophytin was measured at specific depths: 1, 15, 25, and 35 meters (m) for most stations (see Table 1). Starting in 2017, in addition to the depths listed above an additional depth between 1 and 15m will be added for a subset of stations: Point Wells, Point Jefferson, off of Point Williams, West Point outfall, Elliott Bay, South Plant outfall, and East Passage. The chlorophyll maximum will be determined during the CTD profile downcast and the bottle triggered on the upcast at the depth where the maximum chlorophyll concentration occurred. The depth of these additional chlorophyll-*a* and pheophytin samples will vary between stations and sampling events.

Bacteria samples will be collected from one to three sampling depths at each of the outfall monitoring stations, including the surface (1 m), deepest depth, and an intermediate (trapping) depth at the deeper outfall stations. Bacteria samples will only be collected from the surface at ambient monitoring stations, with the exception of the Duwamish Waterway samples. Bacteria samples will be collected from both depths at each Duwamish Waterway station (at 1 m and ~1 m from the bottom). All other laboratory parameters will be analyzed for samples collected from every depth.

In situ data will be collected at all offshore stations sampled via King County's research vessels using a CTD SeaBird SBE 25 Plus profiler with a sensor array. CTD profile data will include the following parameters; dissolved oxygen, salinity, temperature, density (calculated), transmissivity, photosynthetically active radiation (PAR), and fluorescence (as a measure of chlorophyll). Surface PAR measurements will also be collected at all of the offshore stations collected from the research vessels. Secchi depth measurements will be collected at all the offshore stations, including the two Quartermaster Harbor stations, with the exception of the Duwamish River sites. Field measurements for dissolved oxygen, salinity, and temperature will be collected using a YSI EXO2 or 6600 V2 multi-parameter data sonde instrument at the two Quartermaster Harbor stations and the Henderson/MLK/Norfolk CSO station (LTXQ01).

Dissolved oxygen measurements for the other three Duwamish River sites (HNFD01, LTKE03, and LTUM03) will be collected using the CTD as well as collecting discrete samples for laboratory analysis (Table 2).

The overarching marine monitoring program sampling and analysis plan (SAP), which includes the water column sampling component, was last updated in 2003 and is now outdated given changes to the sampling program and equipment since this time. Although various sampling components have SAPs that are current or were updated in 2016, the primary marine monitoring program SAP will be revised and updated in 2017.

Marine Beach Water Quality Monitoring

Water samples will be collected monthly from 20 marine beach stations and one stream station located in Piper's Creek (Figure 2). Nine outfall-vicinity monitoring stations are located inshore of the West Point (two stations) and Vashon Treatment Plant outfalls, the Alki (two stations), Carkeek, and Elliott West CSO Treatment Plant outfalls, and the South Magnolia and Barton CSO outfalls. All 20 of the monitoring stations will be sampled monthly for analysis of fecal coliform and *Enterococcus* bacteria, temperature, salinity, and nutrients (ammonia-nitrogen, nitrite/nitrate- nitrogen, and orthophosphate phosphorus) (Table 3). The Piper's Creek stream station will be monitored for the same parameter set as the other stations with the exception of salinity. A subset of six beach water samples will also be analyzed for Total Nitrogen.

Marine Moorings

Marine moorings that include *in situ* water quality data-gathering sensors (YSI EDS 6600 V2) are currently deployed at four locations – the Seattle Aquarium (two depths), Dockton Park (one depth), the Quartermaster Harbor Yacht Club (one depth) and on a buoy off of Point Williams in southwest Seattle (one depth) (see Figure 1). These marine mooring systems gather data at 15-minute intervals for dissolved oxygen, salinity, temperature, fluorescence (chlorophyll), and turbidity (Table 4). Turbidity is not measured at the Quartermaster Harbor Yacht Club due to the shallow depth of the mooring. All four moorings currently include standard glass electrode pH sensors that drift and do not collect high-precision data, so this data collection will be discontinued in 2017 for all moorings with the exception of the Seattle Aquarium.

A SUNA nitrate sensor also collects data at the Point Williams mooring site. Meteorological data are also collected by the mooring systems deployed at the Seattle Aquarium and Dockton Park at the same time interval as water quality parameters. Due to the location of the mooring at the Quartermaster Harbor and interference from the marina, meteorological sensors are not deployed at this site. There are currently no meteorological sensors on the Point Williams buoy, but if funding can be established in 2017, then this capability will be added. This is a priority location for weather data that could fill a wind over water Puget Sound data gap identified by the Puget Sound Ecosystem Monitoring Program's (PSEMP) Marine Waters Workgroup.

In order to validate mooring performance as well as characterize the dynamics at each mooring location, quality control water samples will be collected monthly at all sites, and bimonthly at

Quartermaster Harbor Yacht Club and Dockton Park as part of routine sampling (Table 5). In addition, a full depth CTD profile should be completed close to the Point Williams and the Seattle Aquarium sites when appropriate, in order to characterize the vertical water structure and provide context for the mooring data.

Many of the mooring sensors and cables were installed in late 2007/early 2008 and have reached the end of their expected life. The mooring hardware (data sondes, sensors, and cables) are expected to be replaced in 2017 as part of the Capital Asset Management Program (CAMP). Telemetry and communications equipment are not scheduled for replacement in 2017, as they were replaced in the last few years. An evaluation of mooring program needs, including data quality requirements, began in October 2016 and will be completed by early 2017 in order to purchase new mooring equipment. Marine & Sediment Assessment Group and the Laboratory's Field Science Unit staff will work together on mooring needs and the purchase and installation of new equipment. In addition, the end check and mooring validation procedure may change depending on the type of new equipment that is selected and will be evaluated in 2017.

As part of the mooring program and ocean acidification monitoring project, high-precision pH (SeaFET) sensors were installed on two of the moorings in 2015: the Quartermaster Harbor Yacht Club and on the Point Williams buoy. The sensors were installed at the surface depth on both moorings. A third SeaFET was installed in summer of 2016 on the University of Washington's (UW) mooring located off Richmond Beach near Point Wells, fixed at a near-surface depth. Monthly quality control (QC) samples will be collected by FSU staff for dissolved inorganic carbon (DIC) and total alkalinity (TA) at the Quartermaster Harbor Yacht Club (1 m and near bottom) and monthly at the Point Williams buoy (1 and 25 m) to assess sensor performance and provide full characterization of seawater carbonate chemistry (Table 5). DIC and TA values will be used to calculate pH, aragonite saturation, and other inorganic carbon system parameters. QC samples at UW's Richmond Beach buoy will be collected every 4-8 weeks by staff from the UW School of Oceanography. All DIC and alkalinity samples will be analyzed by staff at the Pacific Marine Environmental Laboratory (PMEL).

FSU staff will filter the DIC and TA samples in the field using a peristaltic pump and 0.45 μm filter to remove the majority of biological material that would alter carbonate chemistry during storage. These samples will be delivered to PMEL by courier or KCEL staff within 48 hours of collection (but preferably same-day). PMEL will preserve the samples with mercuric chloride and analyze them for DIC and TA. In August 2016, a joint trip with UW, PMEL, and KCEL was completed to assess this method of sample collection, which is different from the standard procedure of no filtration and immediate mercuric chloride poisoning for preservation. Once results are received and analyzed by early 2017, then this sample collection procedure may need to be revised to improve data quality.

Additional salinity, orthophosphate-phosphorus, and silica samples as well as temperature measurements will be collected concurrently with DIC and TA samples at the Point Williams buoy and the Quartermaster Harbor Yacht Club mooring. These data will be used to assess the

mooring data and are also used by PMEL to calculate the full suite of ocean acidification parameters using the model CO2SYS.

In order to provide more rapid quality control of pH mooring data and better understand pH dynamics, the Marine and Sediment Assessment group is working with the Conventionals group at the lab to evaluate whether spectrophotometric pH analysis can be added as an analytical procedure at KCEL in 2017. This would supplement the DIC and TA data, which currently has a 6 – 9 month turnaround time for sample results. If added, duplicate pH samples would be collected monthly at the same stations and depths as the DIC and TA samples (Table 5).

Continuous data gathering involves a high degree of data management, quality control, and website maintenance to make the data available publicly. The Marine and Sediment Assessment Group will work to improve automatic data checks and database qualifiers in 2017, and continue to provide support for webpage updates and maintenance, quality control, and data analysis.

Marine Sea Surface Temperature & Salinity Observations

At the end of 2016, a flow-through sensor system was installed on the R/V SoundGuardian to measure sea surface temperature and salinity. Data will be gathered continuously at the rate of 0.5 Hz (every two seconds) while the vessel is in Puget Sound and the Duwamish Waterway during routine marine offshore water column sampling events. Data are collected using a Sea-Bird SBE 45 thermosalinograph which includes: SBE 38 water temperature at the intake in the bow of the vessel at approximately 0.8-m depth, and salinity calculated from SBE 45 temperature and conductivity. In addition, the system appends NMEA positional data via the vessel's navigation system, so each data point will be tied to time and coordinates in space.

These data will supplement the vertical water column monitoring by providing additional horizontal spatial coverage while the vessel is underway, and can provide more information on estuarine circulation and surface processes. In 2017, the utility and management of this continuous data will be initiated and evaluated. In order to qualify poor data, such as from biofouling, one salinity sample should be collected each day from the same flow path of the thermosalinograph system, preferably while the vessel is on station at a location where the salinity is not rapidly changing. To distinguish the thermosalinograph quality control sample from CTD salinity quality control samples, data will be entered into LIMS under a new project number. In total, four discrete salinity samples will be collected per month for quality control of the system.

Biological Sampling

Marine Phytoplankton Monitoring

In 2015, the semi-quantitative phytoplankton component was replaced by the quantitative FlowCam method. In addition, the number of phytoplankton stations increased from three to

eight and sample collection began year-round (see Figure 1). Prior to 2017, samples were collected at two depths (1m and the approximate chlorophyll maximum layer) at the Point Jefferson and East Passage stations and only at the 1 m depth for all other sites. An assessment was conducted in early 2016 to determine whether differences between the two depths were evident and if so, were the differences significant enough to warrant the continuation of sample collection at the two depths. Following this assessment it was determined that the 1m sampling depth was sufficient to characterize phytoplankton community abundance and structure and the second sampling depth was discontinued. Only phytoplankton samples from the 1 m depth will be analyzed in 2017. Phytoplankton samples will continue to be collected twice monthly from February through November and monthly in January and December at the same time samples are collected for the water column monitoring program. Nutrient and chlorophyll-*a* samples will be collected and analyzed concurrent with the phytoplankton samples.

Species identification (via microscopy) will occur for all samples in order to obtain a species composition list and as a secondary check against the FlowCam results. The lowest taxonomic level the FlowCam can generally achieve is at the genera level, whereas analysts using a compound microscope can typically achieve results down to the species level. Having phytoplankton community composition data down to the species taxonomic level, whenever possible, is valuable for assessing ecosystem change and to continue the phytoplankton species dataset that began in 2008.

The FlowCam generates biovolume data (which may be able to be converted to organic carbon content using established biovolume-carbon relationships). In order to determine the relationship between these data and actual carbon content, samples were collected as part of a special study starting in June 2015 and continued until October 2016. This study includes measuring particulate organic carbon (POC) for two size fractions along with the other parameters listed above at each of eight phytoplankton stations (see Table 1). Samples were collected from the surface depth at each station twice monthly February through November and monthly January and December. All data are expected back from the contract laboratory in early spring 2017. After data results are received, an assessment of the relationship between POC and biovolume will be conducted by Marine and Sediment Assessment Group and Environmental Laboratory staff.

Marine Zooplankton Monitoring

The zooplankton sampling component that began in 2014 will continue in 2017. Zooplankton samples will be collected from three stations in the Central Puget Sound Basin: Point Jefferson, Point Williams, and East Passage (see Figure 1). Vertical zooplankton tows using a ring-net will be conducted twice-monthly February through November at all stations and monthly January and December. These tows will be to a maximum depth of 200 m, dependent upon overall station depth.

Oblique zooplankton tows using duel side-by-side nets attached to a frame (bongo nets) will be performed twice-monthly off of Point Williams during the months of February through November and monthly in January and December to focus on salmonid prey. These tows will be to a depth of 30 m. The tow will be conducted at station LSNT01. Starting in 2016, a monthly oblique tow was conducted at station KSBP01 during the first week of each month, February through November, when the Duwamish River stations are not sampled. The bongo net sampling at this station will continue in 2017. If time permits during the third week of the month when the Duwamish River stations are sampled, additional tows at this station will be collected between the months of February and November. The zooplankton work will be performed in partnership with the University of Washington, staff from which will identify and enumerate zooplankton species in each sample.

In order to start building a zooplankton image library, the second bongo net sample which is usually discarded, will be kept for at least one station approximately four times a year. A portion of the sample will be poured into a Petri dish, or other appropriate container, and observed using a dissecting scope equipped with a trinocular digital camera objective and USB connection. This work will occur in the laboratory. The digital camera will be used to capture still images of various zooplankton and stored on a network drive. These images will be uploaded at a later date to King County's marine life image library.

Sediment Sampling

The marine offshore sediment program was restructured in 2007 to focus primarily on sediment quality in Elliott Bay and to supplement Ecology's sediment monitoring program. Since 2007, sediments from eight stations in Elliott Bay have been collected every two years and every five years from six ambient sites located outside of Elliott Bay in the Central Basin. The eight Elliott Bay stations were most recently sampled in 2015 and the six ambient stations were last sampled in 2012; therefore, sediments from both programs will be sampled in 2017.

Elliott Bay Sediments

The eight Elliott Bay stations will be sampled in June 2017 (Figure 3). Samples will be analyzed for conventional parameters (total solids, total organic carbon, grain size, ammonia, and total sulfides), metals, and organic compounds (BNASMS-SUR, chlorinated pesticides, PCBs, butyltin isomers, and PBDEs) (Table 6). Coprostanol and 4-nonylphenol were added for previous sampling events and will again be analyzed in 2017. The 4-nonylphenol compound will be analyzed as a tentatively identified compound (TIC). Benthic community samples (three replicates per site) were collected at a subset of four stations for the 2015 sampling event. For the 2017 sampling event, benthos will be collected at all eight stations. Staff from the Marine and Sediment Assessment Group will assist Environmental Laboratory staff with the sampling event. The sampling and analysis plan (SAP) will be updated and amended prior to the sampling event to reflect the additional benthos samples. A report summarizing results will be prepared in early to mid-2018 as the benthos results are not expected until late fall/early winter 2017.

Ambient Subtidal Sediments

Ambient subtidal sediments from the three main basin and three embayment stations were last sampled in 2012 and will again be sampled in June 2017 (see Figure 3). Samples will be analyzed for conventional parameters (total solids, total organic carbon, grain size, ammonia, and total sulfides), metals, and organics (BNASMS-SUR, chlorinated pesticides, PCBs, and PBDEs) (see Table 6). Benthic community sampling will be added to this program in 2017 with benthos (three replicates at each site) collected at all six stations. The SAP from the 2012 sampling event will be updated and amended prior to the sampling event to reflect the addition of benthos samples. A report summarizing results, in combination with Elliott Bay sediment results, will be prepared in early to mid-2018 as the benthos results are not expected until late fall/early winter 2017.

West Point Treatment Plant Outfall Sediments

The National Pollutant Discharge Elimination System (NPDES) permit for the West Point Treatment Plant was renewed by Ecology in February 2015. Sediments at the treatment plant outfall were last sampled in July 2011 to fulfill requirements for the previous NPDES permit. To fulfill one of the requirements for the current permit, sediments around the outfall must be sampled between mid-August and September 2017. Another permit requirement states the SAP for this sampling event must be submitted to Ecology for review by December 1, 2016. The 2011 SAP was updated in November 2016 and sent to Ecology. Unless Ecology requests changes to the SAP, eight stations around the outfall (Figure 4) will be sampled between mid-August and September, 2017 for conventional parameters (total solids, total organic carbon, grain size, ammonia, and total sulfides), metals, and organic compounds (BNASMS-SUR, chlorinated pesticides, PCBs, and PBDEs) and benthic community analyses (three replicates per station) (Table 7). Coprostanol will also be analyzed. These stations have been sampled previously for physical and chemical parameters and benthos. An assessment of the chemistry data will be conducted as soon as results have been uploaded to the Environmental Laboratory's database in order to determine if chemical concentrations meet the Washington State Sediment Management Standards. If SMS criteria are exceeded, additional toxicity testing will be necessary. If samples are collected in late September, it is not anticipated that all chemistry results will be available until late November. Therefore, any follow up sampling will not occur until 2018. To fulfill the permit reporting requirement, a report summarizing results from 2017 will be prepared by mid-to late 2018 as the benthos results are not expected until early spring 2018.

South Treatment Plant Outfall Sediments

The NPDES permit for the South Treatment Plant was renewed by Ecology in August 2015. Sediments at the treatment plant outfall were last sampled in July 2011 to fulfill requirements for the previous NPDES permit. To fulfill one of the requirements for the current permit, sediments around the outfall must be sampled between mid-August and September, 2017. Another permit requirement states the SAP for this sampling event must be submitted to Ecology for review by December 1, 2016. The 2011 SAP was updated in November 2016 and sent to Ecology. Unless Ecology requests changes to the SAP, eight stations around the outfall (see Figure 4) will be sampled between mid-August and September, 2017 for conventional

parameters (total solids, total organic carbon, grain size, ammonia, and total sulfides), metals, and organic compounds (BNASMS-SUR, chlorinated pesticides, PCBs, and PBDEs) and benthic community analyses (three replicates per station) (see Table 7). Coprostanol will also be analyzed. These stations have been sampled previously for physical and chemical parameters and benthos. To fulfill the permit reporting requirement, a report summarizing results from 2017 will be prepared in mid to late 2018 as the benthos results are not expected until early spring 2018.

Benthic Reference Study

In order to identify appropriate deep water marine benthic infauna reference stations for NPDES outfall sediments, a proposal to collect and analyze sediment samples for benthic infauna was sent to Ecology in late 2016 for review. The proposal includes sediment sample collection at prospective reference sites in Puget Sound that are anticipated to have similar physical characteristics to sediments at King County's regional marine wastewater treatment plant outfalls. Sediment chemistry samples will also be collected concurrently with the benthos. Results will be compared to Ecology's Sediment Quality Standards (SQS). The benthos samples will only be identified and quantified at prospective reference stations if there are no exceedances of the chemical SQS. The benthic data will be evaluated for their ability to serve as a benthic reference site for three WWTPs (West Point, South Plant, and the Brightwater System). In addition, benthic invertebrate data will be summarized using the following indices: total abundance, major taxa abundances, total richness, major taxa richness, diversity, evenness, and species dominance. These index values will assist in determining the appropriateness of the sites as benthic infauna reference sites. The intent of this study is to establish appropriate reference sites for future NPDES outfall sediment sampling events so that benthos data can be used as a chronic effects biological toxicity test, if necessary, in addition to being used to assess overall sediment health. If Ecology approves the proposal, sediment sampling is expected to occur at 12 stations in August or September, 2017.

Beach Sediments

The beach sediment program was restructured in 2005 and beach sediments from 17 stations (both outfall-vicinity and ambient sites) are now collected every five years. Beach sediments were last sampled in August 2015 and will not be sampled in 2017.

Station coordinates for all sampling stations are provided in Table 8.

PROJECT-SPECIFIC MONITORING

Brightwater Marine Outfall

The following Brightwater marine outfall project work is expected to occur in 2017:

Brightwater Marine Outfall Stories Project

To build the Brightwater (BW) Marine Outfall, major efforts were made in oceanographic and water quality data collection and eelgrass restoration as well as other mitigation measures. During these efforts, photographs and video footage was collected and technical

memos/and or reports produced. Dependent upon staff availability WTD and WLRD staff plan to create webpage content, an educational display, and fact sheets based on existing video, photographs, reports and graphics related to the siting, construction, and mitigation of the BW Marine Outfall. This outreach package will promote King County's innovative and collaborative work that meets public infrastructure needs while enhancing Puget Sound and provide a platform to share information with resource agencies, researchers, and the general public. The four elements of the BW Marine Stories Project are:

- ***Underwater habitat for rare fish*** **-** The outfall pipes have become an underwater reef colonized with marine life, providing habitat for threatened and endangered rockfish. Ongoing studies and surveys are evaluating use of these outfalls by marine life.
- ***Eelgrass restoration*** **-** In a collaborative effort, King County developed an innovative program to culture and restore eelgrass disturbed during construction. Eelgrass from the Brightwater site is still being used to restore other Puget Sound sites.
- ***Derelict fishing gear removal*** **-** King County supported work to remove abandoned "ghost gear" - fishing nets and crab pots that had continued fishing for years, killing marine animals, diving birds, and fish, and degrading habitat.
- ***Oceanographic studies*** **-** When King County searched for the best place to put the outfall, our studies greatly expanded knowledge of the sea floor and the movement of currents above it. The oceanographic data collected in the Triple Junction area is one of the most comprehensive data sets ever collected in this area.

For this project in 2017, an educational display featuring photographs and signage, at least two fact sheets for the underwater habitat and eelgrass restoration topic areas, and content for a stand-alone web page will be the focus.

Brightwater Marine Outfall Structural Integrity and Biological Assessment Project

The purpose of this project is to determine if marine organisms attached to the pipe may affect the structural integrity of the Brightwater marine outfall HDPE pipes over time. A secondary purpose is to document the presence and abundance of marine organisms on the pipes over time. A goal of this project is to obtain sufficient and quality data to aid state natural resource agencies in assessing the effectiveness and amount of habitat artificial structures provide to various marine organisms.

HDPE pipe segments were placed on the seafloor in 2012 at three locations in close proximity to the marine outfall and also a reference site further away from the pipe at the 600 ft depth. The pipe material will be allowed to remain in place for pre-defined time intervals: 2, 5, and 10 years. Thirty-six approximately 2 ft^2 portions of pipe were placed at the -100 ft, -300 ft, and -600 ft mean lower low water (MLLW) depths adjacent to the south outfall pipe (3 replicates were placed at each depth and for each time interval) and the reference site. In fall of 2014, the first 12 samples were retrieved (3 from each depth and the reference site). Each 2 ft^2 portion was assessed for total percent cover by placing a mesh grid over the sample and estimating the biota coverage in each grid cell. The mesh grid contained 21 cells and each cell (~4 x 4 inches) was photographed. The first survey report will be finalized in early 2017 and

the 5-year plates will be retrieved. The 12 plates from the 5-year time interval will be assessed in the field for total percent cover and photographs taken. All the photographs will be organized following retrieval and renamed by sample site, replicate, and grid cell. The photographs will be stored on a network drive. Dependent upon month of sample retrieval, sample analysis may begin in late 2017.

Inter-Laboratory Nutrient Comparison Study

King County will continue to partner with the Washington State Department of Ecology (Ecology) on an inter-laboratory nutrient comparison study. Ecology nutrient samples are analyzed by the University of Washington Marine Chemistry Laboratory. The goals of the study are to:

- determine direct comparability of nutrient data currently collected and analyzed for central Puget Sound sites;
- provide a means to share data and utilize each agency's results collected for current and historical monitoring projects in Puget Sound;
- provide an understanding (degree, extent, and affected parameters) of similarities/differences of nutrient results provided by each agency to be used for a combined trend analysis for Central Basin stations; and
- provide comparative data for evaluation of laboratory performance and methods, should a transition or need for utilization of another analytical lab arise for future monitoring/projects.

It is anticipated in mid or late 2017 that at least one round of side-by-side field split samples will be analyzed, possibly more, in support of this ongoing inter-laboratory assessment effort. Delivery of samples to the King County Environmental Laboratory (KCEL) and the University of Washington Marine Chemistry Laboratory will be coordinated between agency staff. King County and the University of Washington laboratories will follow their standard protocols for analysis of nutrients.

Comprehensive Sediment Quality Summary Report

- An update to the *2009 Comprehensive Sediment Quality Summary Report* must be submitted to Ecology no later than December 1, 2018. The 2009 report summarized sediment data collected at all CSO outfalls, including CSO treatment plants, and the updated report must provide any new site-specific information, including receiving water characteristics, near the CSO outfalls. The update to this report is expected to begin in 2017 and the Marine and Sediment Assessment Group will provide assistance, particularly updating the receiving water characteristics sections.

Puget Sound Ecosystem Monitoring Program

Work in 2017 will include Puget Sound Ecosystem Monitoring Program (PSEMP) support as part of the Marine Waters Workgroup. Marine and Sediment Assessment Group staff will participate in semi-monthly meetings and provide vice-chair support to the workgroup. Staff will also prepare and give data highlight presentations at the Marine Waters Workgroup 2017 annual workshop likely to occur in early April. Follow-up to the workshop will include data analyses and write-ups of King County marine data for the 2016 Puget Sound Marine Waters Overview report. Additional PSEMP work items will involve participation on the editorial team for the overview report, assist preparing workgroup products to support PSEMP and the Puget Sound Partnership activities and requests, and other vice-chair duties.

KingStat Indicators

Staff will be coordinating the Science Section's KingStat indicator annual update and update of the Science Section Tier 2 board for the KingStat measures. Work will include collaboration with Science Section staff to maintain and improve indicators and work with DNRP leadership, web designer, and visual communication designer to edit, update, and verify correctness of annual updates to website. Additional KingStat work involves updating the existing marine KingStat indicators and changes and/or development of new marine indicators that reflect changes to the marine monitoring programs (such as an increase in biological monitoring) over the last several years.

Marine Data Portal Webpage/Databases

Work expected to be completed in 2017 includes the following items:

- uploading historical data for discrete data (e.g., nutrients) and creation of web reporting tools,
- creation of new tools to assist with reviewing and qualifying discrete water quality data uploaded to the marine portal,
- creation of a public interface for downloading phytoplankton and zooplankton data,
- uploading ocean acidification project sample results,
- mooring database updates, such as creating new data summary qualifiers consistent with UNESCO standards, and improving automated quality control checks
    - tracking of SeaFET pH sensors and field logs for the ocean acidification program in mooring database. Improving pH data corrections based on salinity and on discrete water samples.
- continual of uploading current phytoplankton, zooplankton, and discrete water quality data to database,
- develop interface and management system for thermosalinograph data stream,
- migration of marine website to new King County template and SiteCore platform for easy editing.

Miscellaneous 2017 Work Items

- Preparation of data summaries for the various monitoring components to be accessible via a new updated marine webpage that includes a specific page for monitoring summaries.
- Preparation of the 2018 marine and sediment assessment group work plan.
- Technical support for the Wastewater Treatment Division's Sediment Management Plan, which may include preparation of sediment SAPs for various CSO sampling efforts that may occur in 2017.
- Transferring marine group technical reports, work plans, presentations, and posters to the Science Section documents database.
- Data downloading and analysis for outside agencies, educational facilities, private entities, and the general public.
- Preparation of sections for the Regional Wastewater Services Plan (RWSP) Update report.
- Prepare Quartermaster Harbor sediment monitoring report, time permitting.
- Prepare data report for 2015 Elliott Bay sediment sampling event.
- Prepare final shellfish and algae tissue monitoring report, time permitting. If a summer intern is hired, this will likely be an intern task.
- Prepare beach sediment data report from the 2010 and 2015 sampling event, time permitting.
- Prepare semi-quantitative phytoplankton data (2008-2014) report.
- Evaluation of sediment monitoring program and prepare tech memo with recommended changes to sampling design and/or sampling frequency.

SUMMARY OF MONITORING CHANGES FOR 2017

Changes in 2017 for the routine sampling and mooring programs are as follows:

- An additional chlorophyll-*a* sample between 1 and 15 m will be added for a subset of stations: Point Wells, Point Jefferson, off of Point Williams, West Point outfall, Elliott Bay, South Plant outfall, and East Passage. The chlorophyll maximum will be determined during the CTD profile downcast and the bottle triggered on the upcast at the depth where the maximum chlorophyll concentration occurred. The depth of these additional chlorophyll-*a* and pheophytin samples will vary between stations and sampling events.
- All four marine moorings currently include standard glass electrode pH sensors that drift and do not collect high-precision data, therefore, this data collection will be discontinued in 2017 with the exception of the Seattle Aquarium.
- Collection of a full depth CTD profile close to the Point Williams and the Seattle Aquarium mooring sites once a month, in order to characterize the vertical water structure and provide context for the mooring data.
- In 2017, the utility and management of the thermosalinograph data will be initiated and evaluated. In order to qualify poor data, such as from biofouling, one salinity sample

should be collected during each marine ambient sampling run from the same flow path of the thermosalinograph system, preferably while the vessel is on station at a location where the salinity is not rapidly changing. In total, 4 discrete salinity samples will be collected per month for quality control of the system.

- Only phytoplankton samples from the 1 m depth will be analyzed in 2017.
- No POC samples will be collected in 2017.
- To assist quality control of mooring sensors, chlorophyll samples will be collected at 1 and 10 m at the Seattle Aquarium and 1m for the Point Williams mooring, for a total of 3 chlorophyll samples per month.
- Discontinue field turbidity analysis and taking water temperature from Scott bottles at mooring sites. Switch to once a month total alkalinity and DIC sampling at MSWH01 instead of twice per month.
- Start developing a zooplankton photo library by capturing photographs using a dissecting microscope equipped with digital optics. The second bongo net sample which is usually discarded, will be kept for at least one station, approximately four times a year.

• • •

Attachments that accompany this work plan include:

- Figures showing the locations of all the 2017 marine monitoring stations and moorings.
- Tables that include all parameters measured at monitoring stations (Tables 1-7).
- A table with all sampling station coordinates (Table 8).

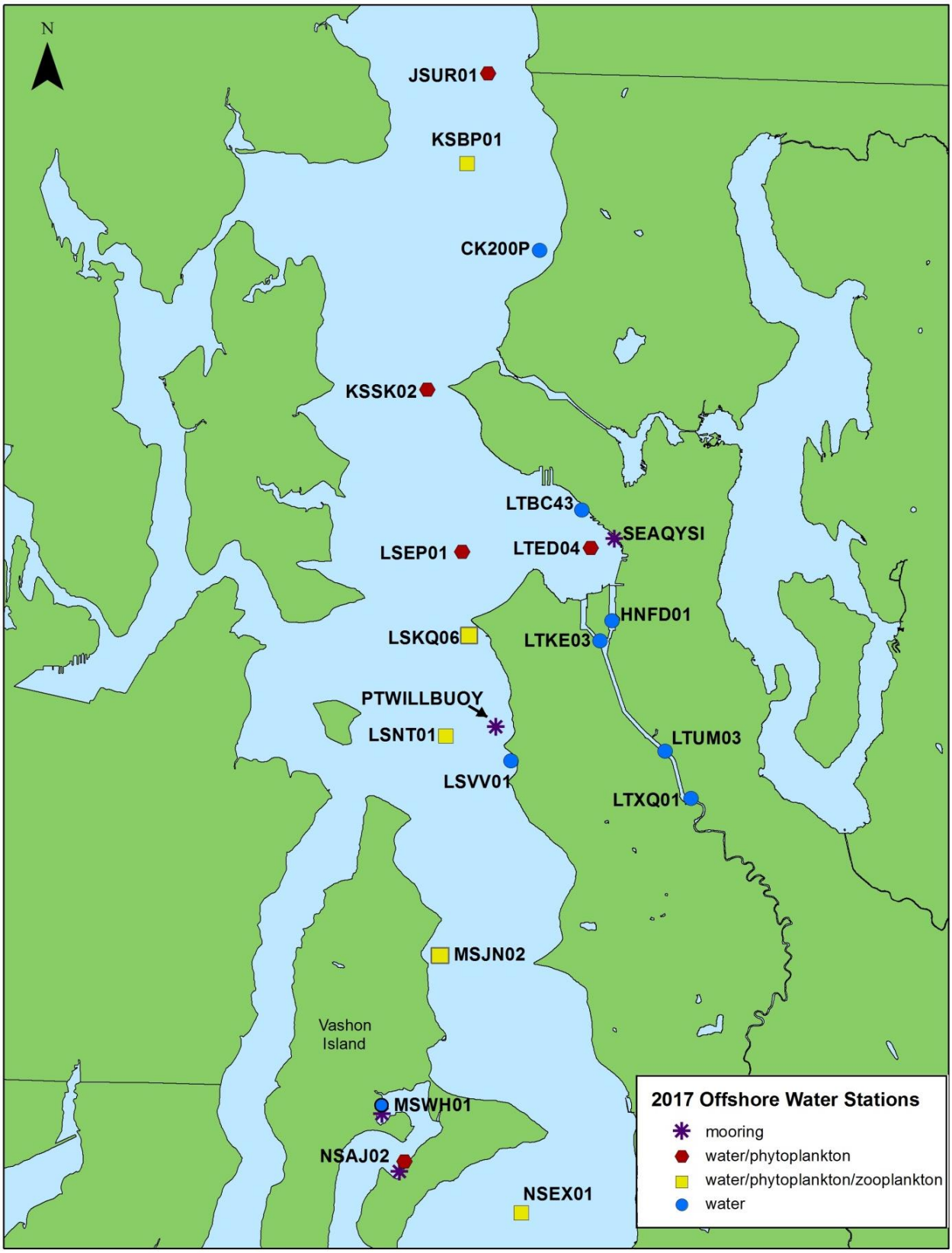

Figure 1. Offshore station locations for water, phytoplankton, and zooplankton

Figure 2. Beach water station locations

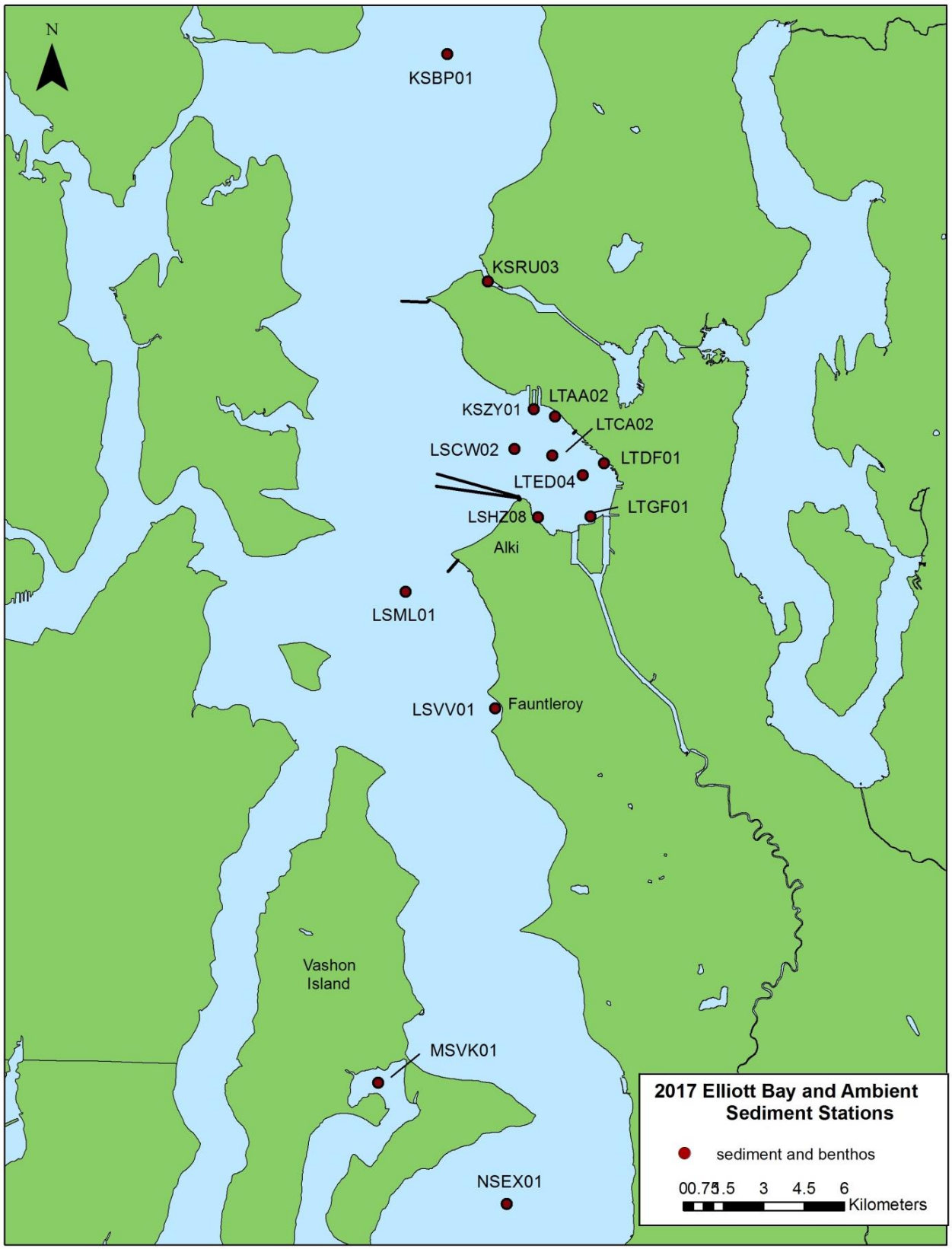

Figure 3. Elliott Bay and ambient sediment station locations

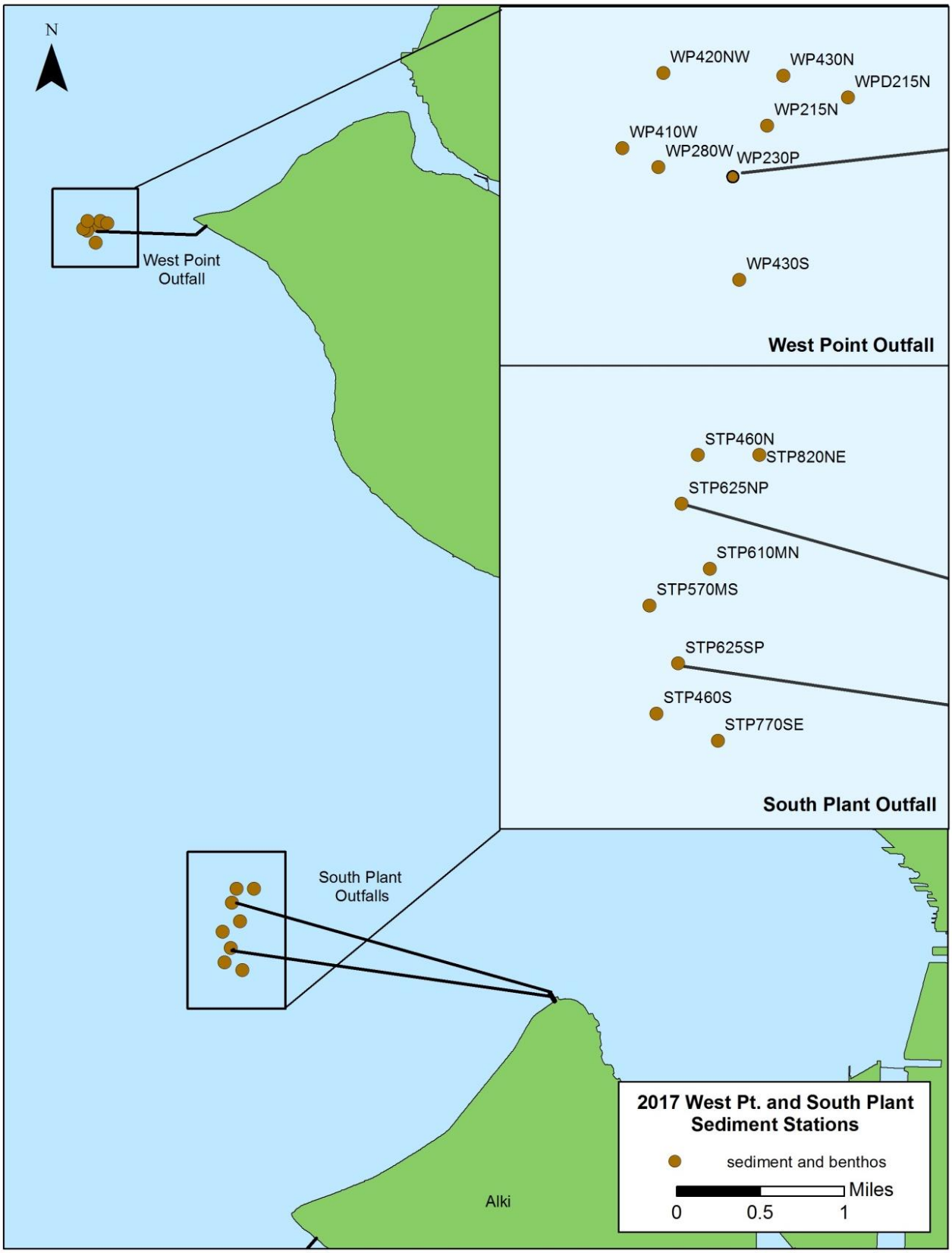

Figure 4. West Point and South Plant outfall sediment station locations

Table 1. Marine Offshore Monitoring Program Semi-Monthly Water Column Sampling Matrix

		Bacteria		Laboratory									CTD								Field				Phyto	ZooPl	
Station	Depth (m)	Enterococcus	Fecal Coliform	Ammonia Nitrogen	Nitrite + Nitrate Nitrogen	Total Nitrogen	Orthophosphorus	Silica	Chlorophyll-a	Phaeophytin	Total Suspended Solids	Salinity	Chlorophyll, Field	Density, Field	Dissolved Oxygen, Field	Light Intensity (PAR), Field	Salinity, Field	Sample Temperature, Field	Surface Light Intensity (PAR), Field	Transmissivity, Field	Dissolved Oxygen, Field	Sample Depth	Sample Start Time	Secchi Transparency	Abundance, biovolume, & qual	Vertical Tow[3]	Oblique Tow[4]
JSUR01	1	1	1	1	1	1	1	1	1	1	1		1	1	1	1	1	1	1	1		1	1	1	1		
	chlorophyll max								1	1			1	1	1	1	1	1	1	1							
	15			1	1		1	1	1	1	1		1	1	1	1	1	1	1	1		1	1				
	25			1	1		1	1	1	1	1		1	1	1	1	1	1	1	1		1	1				
	35			1	1		1	1	1	1	1		1	1	1	1	1	1	1	1		1	1				
	55			1	1		1	1			1		1	1	1	1	1	1	1	1		1	1				
	100	1	1	1	1		1	1			1		1	1	1	1	1	1	1	1		1	1				
	175	1	1	1	1		1	1			1		1	1	1	1	1	1	1	1		1	1				
KSBP01	1	1	1	1	1	1	1	1	1	1	1		1	1	1	1	1	1	1	1		1	1	1	1		
	chlorophyll max								1	1			1	1	1	1	1	1	1	1		1	1				
	15			1	1		1	1	1	1	1		1	1	1	1	1	1	1	1		1	1				
	25			1	1		1	1	1	1	1		1	1	1	1	1	1	1	1		1	1				
	30																										1
	35			1	1		1	1	1	1	1		1	1	1	1	1	1	1	1		1	1				
	55			1	1		1	1			1		1	1	1	1	1	1	1	1		1	1				
	100			1	1		1	1			1		1	1	1	1	1	1	1	1		1	1				
	200			1	1		1	1			1		1	1	1	1	1	1	1	1		1	1			1	
CK200P	1	1	1	1	1		1	1	1	1	1		1	1	1	1	1	1	1	1		1	1	1			
	15			1	1		1	1	1	1	1		1	1	1	1	1	1	1	1		1	1				
	25			1	1		1	1	1	1	1		1	1	1	1	1	1	1	1		1	1				
	35	1	1	1	1		1	1	1	1	1		1	1	1	1	1	1	1	1		1	1				
	55	1	1	1	1		1	1			1		1	1	1	1	1	1	1	1		1	1				
KSSK02	1	1	1	1	1	1	1	1	1	1	1		1	1	1	1	1	1	1	1		1	1	1	1		
	chlorophyll max								1	1			1	1	1	1	1	1	1	1							
	15			1	1		1	1	1	1	1		1	1	1	1	1	1	1	1		1	1				
	25	1	1	1	1		1	1	1	1	1		1	1	1	1	1	1	1	1		1	1				
	35			1	1		1	1	1	1	1		1	1	1	1	1	1	1	1		1	1				
	55	1	1	1	1	1	1	1			1		1	1	1	1	1	1	1	1		1	1				
LTBC43	1	1	1	1	1		1	1	1	1	1		1	1	1	1	1	1	1	1		1	1	1			
	15	1	1	1	1		1	1	1	1	1		1	1	1	1	1	1	1	1		1	1		_		
LTED04	1	1	1	1	1	1	1	1	1	1	1		1	1	1	1	1	1	1	1		1	1	1	1		
	chlorophyll max								1	1			1	1	1	1	1	1	1	1							
	15			1	1		1	1	1	1	1		1	1	1	1	1	1	1	1		1	1				
	25			1	1		1	1	1	1	1		1	1	1	1	1	1	1	1		1	1				
	35			1	1		1	1	1	1	1		1	1	1	1	1	1	1	1		1	1				
	55			1	1		1	1			1		1	1	1	1	1	1	1	1		1	1				
	75			1	1		1	1			1		1	1	1	1	1	1	1	1		1	1				
LSEP01	1	1	1	1	1	1	1	1	1	1	1		1	1	1	1	1	1	1	1		1	1	1	1		
	chlorophyll max								1	1			1	1	1	1	1	1	1	1							
	15			1	1		1	1	1	1	1		1	1	1	1	1	1	1	1		1	1				
	25			1	1		1	1	1	1	1		1	1	1	1	1	1	1	1		1	1				
	35			1	1		1	1	1	1	1		1	1	1	1	1	1	1	1		1	1				
	55			1	1		1	1			1		1	1	1	1	1	1	1	1		1	1				
	100	1	1	1	1	1	1	1			1		1	1	1	1	1	1	1	1		1	1				
	180	1	1	1	1		1	1			1		1	1	1	1	1	1	1	1		1	1				

		Bacteria		Laboratory									CTD								Field				Phyto	ZooPl	
Station	Depth (m)	Enterococcus	Fecal Coliform	Ammonia Nitrogen	Nitrite + Nitrate Nitrogen	Total Nitrogen	Orthophosphorus	Silica	Chlorophyll-a	Phaeophytin	Total Suspended Solids	Salinity	Chlorophyll, Field	Density, Field	Dissolved Oxygen, Field	Light Intensity (PAR), Field	Salinity, Field	Sample Temperature, Field	Surface Light Intensity (PAR), Field	Transmissivity, Field	Dissolved Oxygen, Field	Sample Depth	Sample Start Time	Secchi Transparency	Abundance, biovolume, & qual	Vertical Tow[3]	Oblique Tow[4]
LSKQ06	1	1	1	1	1		1	1	1	1	1		1	1	1	1	1	1	1	1		1	1	1	1		
	15			1	1		1	1	1	1	1		1	1	1	1	1	1	1	1		1	1				
	25			1	1		1	1	1	1	1		1	1	1	1	1	1	1	1		1	1				
	35	1	1	1	1		1	1	1	1	1		1	1	1	1	1	1	1	1		1	1				
LSNT01	1	1	1	1	1	1	1	1	1	1	1		1	1	1	1	1	1	1	1		1	1	1	1		
	chlorophyll max								1	1			1	1	1	1	1	1	1	1							
	15			1	1		1	1	1	1	1		1	1	1	1	1	1	1	1		1	1				
	25			1	1		1	1	1	1	1		1	1	1	1	1	1	1	1		1	1				
	30												1	1	1	1	1	1	1	1		1	1				1
	35			1	1		1	1	1	1	1		1	1	1	1	1	1	1	1		1	1				
	55			1	1		1	1			1		1	1	1	1	1	1	1	1		1	1				
	100			1	1		1	1			1		1	1	1	1	1	1	1	1		1	1				
	180			1	1		1	1			1		1	1	1	1	1	1	1	1		1	1			1	
LSVV01	1	1	1	1	1		1	1	1	1	1		1	1	1	1	1	1	1	1		1	1	1			
	5	1	1	1	1		1	1	1	1	1		1	1	1	1	1	1	1	1		1	1				
MSJN02	1	1	1	1	1		1	1	1	1	1		1	1	1	1	1	1	1	1		1	1	1	1		
	15			1	1		1	1	1	1	1		1	1	1	1	1	1	1	1		1	1				
	25	1	1	1	1		1	1	1	1	1		1	1	1	1	1	1	1	1		1	1				
	35			1	1		1	1	1	1	1		1	1	1	1	1	1	1	1		1	1				
	55	1	1	1	1		1	1			1		1	1	1	1	1	1	1	1		1	1				
MSWH01[2]	1	1	1	1	1	1	1	1	1	1	1	1									1	1	1	1			
	variable[2]			1	1	1	1	1	1	1	1	1									1	1	1				
NSAJ02[2]	1	1	1	1	1	1	1	1	1	1	1	1									1	1	1	1	1		
	variable[2]			1	1	1	1	1	1	1	1	1									1	1	1				
NSEX01	1	1	1	1	1	1	1	1	1	1	1		1	1	1	1	1	1	1	1		1	1	1	1		
	chlorophyll max								1	1			1	1	1	1	1	1	1	1		1	1				
	15			1	1		1	1	1	1	1		1	1	1	1	1	1	1	1		1	1				
	25			1	1		1	1	1	1	1		1	1	1	1	1	1	1	1		1	1				
	30																										
	35			1	1		1	1	1	1	1		1	1	1	1	1	1	1	1		1	1				
	55			1	1		1	1			1		1	1	1	1	1	1	1	1		1	1				
	100			1	1		1	1			1		1	1	1	1	1	1	1	1		1	1				
	170			1	1		1	1			1		1	1	1	1	1	1	1	1		1	1			1	
Total # samples per month [5]		**54**	**54**	**136**	**136**	**26**	**136**	**136**	**110**	**110**	**136**	**8**	**144**	**144**	**144**	**144**	**144**	**144**	**144**	**144**	**8**	**142**	**142**	**28**	**20**	**6**	**3**
Total # Samples for 2017 [5]		**594**	**594**	**1496**	**1496**	**286**	**1496**	**1496**	**1210**	**1210**	**1496**	**88**	**1584**	**1584**	**1584**	**1584**	**1584**	**1584**	**1584**	**1584**	**88**	**1562**	**1562**	**308**	**220**	**66**	**32**

[2] Sample collected 1m above the bottom (depth variable with tide height).
[3] Vertical tow (200 m) will be done twice monthly February through November, monthly January & December.
[4] Oblique tow (to 30 m) at LSNT01 is twice monthly February through November, monthly January & December. Oblique tow at KSBP01 monthly February-November.
[5] Total number of samples per month/year assumes monthly sampling at all stations in January and December.

Table 2. 2017 Marine Offshore Monitoring Program Lower Duwamish River Monthly Water Column Sampling Matrix

		Bacteria		Laboratory									CTD								Field		
Station	Depth (m)	Enterococcus	Fecal Coliform	Ammonia Nitrogen	Nitrite + Nitrate Nitrogen	Orthophosphorus	Silica	Total Suspended Solids	Dissolved Organic Carbon	Total Organic Carbon	Dissolved Oxygen - Winkler	Salinity	Chlorophyll, Field	Density, Field	Dissolved Oxygen, Field	Light Intensity (PAR), Field	Salinity, Field	Sample Temperature, Field	Surface Light Intensity (PAR), Field	Transmissivity, Field	Dissolved Oxygen, Field	Sample Depth	Sample Start Time
LTKE03	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1		1	1
	variable[1]	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1		1	1
LTUM03	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1		1	1
	variable[1]	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1		1	1
HNFD01	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1		1	1
	variable[1]	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1		1	1
LTXQ01[2]	1	1	1	1	1	1		1				1									1	1	1
Total # Samples/Month:		**7**	**7**	**7**	**7**	**7**	**6**	**7**	**6**	**6**	**6**	**7**	**6**	**6**	**6**	**6**	**6**	**6**	**6**	**6**	**1**	**7**	**7**
Total # Samples for 2017:		**80**	**80**	**80**	**80**	**80**	**68**	**80**	**68**	**68**	**68**	**80**	**68**	**68**	**68**	**68**	**68**	**68**	**68**	**68**	**8**	**80**	**80**

[1] Sample collected one meter above the bottom (depth variable with tidal height).
[2] This station is sampled from land.

Table 3. 2017 Marine Beaches Monitoring Program Monthly Water Sampling Matrix

		Bacteria		Laboratory Conventionals					Field
Locator	**Station Description**	**Enterococcus**	**Fecal Coliform**	**Ammonia Nitrogen**	**Nitrite + Nitrate Nitrogen**	**Total Nitrogen**	**Orthophosphorus**	**Salinity**	**Sample Temperature, Field**
JSVW04	Richmond Beach	1	1	1	1	1	1	1	1
ITCARKEEKP	Carkeek Park - North	1	1	1	1		1	1	1
KSHZ03	Carkeek Park - Piper's Creek Mouth	1	1	1	1	1	1	1	1
KTHA01	Carkeek Park - Piper's Creek Upstream	1	1	1	1		1		1
KSLU03	Golden Gardens	1	1	1	1		1	1	1
KSSN04	West Point - North	1	1	1	1		1	1	1
KSSN05	West Point - South	1	1	1	1		1	1	1
KSYV02	South Magnolia CSO	1	1	1	1		1	1	1
LTBD27	SAM Sculpture Park Beach	1	1	1	1		1	1	1
LSGY01	Seacrest Park	1	1	1	1		1	1	1
LSHV01	Alki Beach	1	1	1	1		1	1	1
LSKR01	Alki Beach - Alki Plant	1	1	1	1		1	1	1
LSKS01	Richey Viewpoint	1	1	1	1		1	1	1
LSVW01	Fauntleroy Cove	1	1	1	1	1	1	1	1
MTLD03	Normandy Park	1	1	1	1		1	1	1
MTUJ01	Des Moines Creek Park	1	1	1	1		1	1	1
NTFK01	Redondo Beach	1	1	1	1	1	1	1	1
NSJY01	Dumas Bay Park	1	1	1	1	1	1	1	1
MSJL01	Vashon Island - Gorsuch Road	1	1	1	1		1	1	1
MSSM05	Vashon Island - Tramp Harbor	1	1	1	1		1	1	1
MSXK01	Vashon Island - Burton Acres Park	1	1	1	1	1	1	1	1
	Total # samples per month:	**21**	**21**	**21**	**21**	**6**	**21**	**20**	**21**
	Total # samples for 2017:	**252**	**252**	**252**	**252**	**72**	**252**	**240**	**252**

Table 4. Marine Mooring Parameters Collected Continuously

Station	Depth (m)	Temperature	Salinity	Pressure	Dissolved Oxygen	pH	Nitrate	Chlorophyll fluorescence	Turbidity	Meteorological data (Air temp, barometric pressure, wind, rain, and light intensity)
PTWILLBUOY	1	X	X	X	X	X	X	X	X	X [1]
MSWH01	1	X	X	X	X	X		X	X	
NSAJ02	variable[2]	X	X	X	X			X	X	X
SEAQYSI	1	X	X	X	X	X		X	X	X
	10	X	X	X	X	X		X	X	

[1] Dependent upon funding.

[2] Variable - Sample collected one meter above the bottom (depth variable with tidal height).

Table 5. 2017 Mooring Program Quality Control/Calibration Samples[0]

		Conventionals Lab								CTD profile							Field Probe, in-situ		
Station	**Depth (m)**	**Seawater pH in total scale[4]**	**Dissolved inorganic carbon / Total alkalinity[3]**	**Nitrate Nitrogen**	**Orthophospahte phosphorus**	**Silica**	**Dissolved Oxygen**	**Salinity**	**Chlorophyll**	**Chlorophyll, Field**	**Dissolved Oxygen, Field**	**Light Intensity (PAR), Field**	**Salinity, Field**	**Sample Temperature, Field**	**Surface PAR, Field**	**Transmissivity, Field**	**Dissolved Oxygen, Field**	**Sample Depth**	**Sample Temperature[1]**
PTWILLBUOY	1	2	1	1	1	1	1	1	1	1	1	1	1	1	1	1			
	25	2	1	1	1	1		1		1	1	1	1	1	1	1			
MSWH01	1	2	1		*a*	*a*	1	*a*	*a*								*a*	*a*	*a*
	variable[2]	2	1		*a*	*a*		*a*	*a*								*a*	*a*	*a*
NSAJ02	variable[2]						1	*a*	*a*								*a*	*a*	*a*
SEAQYSI	1						1	1	1	1	1	1	1	1	1	1			
	10						1	1	1	1	1	1	1	1	1	1			
	Total # samples per month:	**8**	**4**	**2**	**6**	**6**	**5**	**10**	**9**	**4**	**4**	**4**	**4**	**4**	**4**	**4**	**6**	**6**	**6**
	Total # samples for 2017:	**96**	**48**	**24**	**72**	**72**	**60**	**120**	**108**	**48**	**48**	**48**	**48**	**48**	**48**	**48**	**72**	**72**	**72**

[0] Sample time recorded for all. Samples collected before recovering a mooring, as close to mooring sample time as possible.
[1] Same method for field temperature, where probe is hung at mooring depth in-situ
[2] Variable - Sample collected one meter above the bottom (depth variable with tidal height).
[3] DIC and total alkalinity will be analyzed at PMEL. Duplicates will be collected at various times.
[4] Depends on lab ability to do pH spec. analysis in 2017.
a: Samples collected bimonthly as part of routine sampling program.

Table 6. 2017 Elliott Bay and Subtidal Sediment Sampling

		Laboratory											Field						
Locator	**Station Description**	**BNAs**	**Chlorinated Pest/PCBs**	**PBDEs**	**Tributyltin**	**Total Metals**	**Total Solids**	**Total Organic Carbon**	**Grain size**	**Ammonia**	**Total Sulfide**	**Benthic infauna**	**Sample Start Time**	**Sample Depth**	**Sediment Sampling Depth**	**Sediment Sampling Range**	**SampcoordX**	**SampcoordY**	**Sediment Description**
KSZY01	Elliott Bay - Pier 90/91	1	1	1	1	1	1	1	1	1	1	3	1	1	1	1	1	1	1
LTAA02	Elliott Bay - Grain Terminal	1	1	1	1	1	1	1	1	1	1	3	1	1	1	1	1	1	1
LSCW02	Elliott Bay - Outer	1	1	1	1	1	1	1	1	1	1	3	1	1	1	1	1	1	1
LTCA02	Elliott Bay - North Central	1	1	1	1	1	1	1	1	1	1	3	1	1	1	1	1	1	1
LTDF01	Elliott Bay - Central Waterfront	1	1	1	1	1	1	1	1	1	1	3	1	1	1	1	1	1	1
LTED04	Elliott Bay - South Central	1	1	1	1	1	1	1	1	1	1	3	1	1	1	1	1	1	1
LSHZ08	Elliott Bay - Cove 2	1	1	1	1	1	1	1	1	1	1	3	1	1	1	1	1	1	1
LTGF01	Elliott Bay - Harbor Island	1	1	1	1	1	1	1	1	1	1	3	1	1	1	1	1	1	1
KSRU03	Outer Salmon Bay	1	1	1	1	1	1	1	1	1	1	3	1	1	1	1	1	1	1
LSML01	Central Basin/West Seattle	1	1	1	1	1	1	1	1	1	1	3	1	1	1	1	1	1	1
MSVK01	Inner Quartermaster Harbor	1	1	1	1	1	1	1	1	1	1	3	1	1	1	1	1	1	1
NSEX01	East Passage	1	1	1	1	1	1	1	1	1	1	3	1	1	1	1	1	1	1
LSVV01	Barton CSO Outfall	1	1	1	1	1	1	1	1	1	1	3	1	1	1	1	1	1	1
KSBP01	Jefferson Head	1	1	1	1	1	1	1	1	1	1	3	1	1	1	1	1	1	1
	Total samples for 2017:	**14**	**14**	**14**	**14**	**14**	**14**	**14**	**14**	**14**	**14**	**42**	**14**	**14**	**14**	**14**	**14**	**14**	**14**

Notes:
Samples will be collected from the 0 to 2 cm depth stratum
Metals will include Al, As, Cd, Cr, Cu, Fe, Pb, Hg, Ni, Se, Ag, Sn, and Zn
Indicates 4-nonylphenol & coprostanol will be analyzed

Table 7. 2017 West Point and South Plant Outfall Sediment Sampling

		Laboratory									Field						
Locator	**Station Description**	**BNAs (incl. coprostanol)**	**PCBs**	**Total Metals**	**Total Solids**	**Total Organic Carbon**	**Grain size**	**Ammonia**	**Total Sulfide**	**Benthic infauna**	**Sample Start Time**	**Sample Depth**	**Sediment Sampling Depth**	**Sediment Sampling Range**	**SampcoordX**	**SampcoordY**	**Sediment Description**
WP230P	West Pt. TP outfall	1	1	1	1	1	1	1	1	3	1	1	1	1	1	1	1
WP215N	West Pt. TP outfall	1	1	1	1	1	1	1	1	3	1	1	1	1	1	1	1
WP430N	West Pt. TP outfall	1	1	1	1	1	1	1	1	3	1	1	1	1	1	1	1
WP430S	West Pt. TP outfall	1	1	1	1	1	1	1	1	3	1	1	1	1	1	1	1
WPD215N	West Pt. TP outfall	1	1	1	1	1	1	1	1	3	1	1	1	1	1	1	1
WP280W	West Pt. TP outfall	1	1	1	1	1	1	1	1	3	1	1	1	1	1	1	1
WP410W	West Pt. TP outfall	1	1	1	1	1	1	1	1	3	1	1	1	1	1	1	1
WP420NW	West Pt. TP outfall	1	1	1	1	1	1	1	1	3	1	1	1	1	1	1	1
STP820NE	South Plant outfall	1	1	1	1	1	1	1	1	3	1	1	1	1	1	1	1
STP460N	South Plant outfall	1	1	1	1	1	1	1	1	3	1	1	1	1	1	1	1
STP625NP	South Plant outfall	1	1	1	1	1	1	1	1	3	1	1	1	1	1	1	1
STP610MN	South Plant outfall	1	1	1	1	1	1	1	1	3	1	1	1	1	1	1	1
STP570MS	South Plant outfall	1	1	1	1	1	1	1	1	3	1	1	1	1	1	1	1
STP625SP	South Plant outfall	1	1	1	1	1	1	1	1	3	1	1	1	1	1	1	1
STP460S	South Plant outfall	1	1	1	1	1	1	1	1	3	1	1	1	1	1	1	1
STP770SE	South Plant outfall	1	1	1	1	1	1	1	1	3	1	1	1	1	1	1	1
	Total samples for 2017:	**16**	**16**	**16**	**16**	**16**	**16**	**16**	**16**	**48**	**16**	**16**	**16**	**16**	**16**	**16**	**16**

Notes:
Samples will be collected from the 0 to 10 cm depth stratum
Metals will include As, Cd, Cr, Cu, Pb, Hg, Ag, and Zn

Table 8. Marine Monitoring Program sampling stations, matrices, and station coordinates.

Locator	Description	Stratum	Matrices	Northing[1]	Easting[1]
JSVW04	Richmond Beach/Point Wells	Beach	Water	286171	1257194
ITCARKEEKP	Carkeek Park	Beach	Water	263756	1259915
KSHZ03	Piper's Creek Mouth	Beach	Water	263736	1259784
KTHA01	Piper's Creek	Stream	Water	262962	1262305
KSLU03	Golden Gardens	Beach	Water	256354	1253305
KSSN04	West Point North	Beach	Water	245729	1246032
KSSN05	West Point South	Beach	Water	245272	1245980
KSYV02	Magnolia CSO	Beach	Water	234547	1254488
LTBD27	SAM Sculpture Park	Beach	Water	228851	1264297
LSGY01	Seacrest Park	Beach	Water	218711	1258776
LSHV01	Alki Beach	Beach	Water	216852	1253532
LSKR01	Alki North	Beach	Water	213666	1249416
LSKS01	Richey Viewpoint	Beach	Water	212668	1250283
LSVW01	Fauntleroy Cove	Beach	Water	194969	1254846
MTLD03	Normandy Park	Beach	Water	165142	1263285
MTUJ01	Des Moines Creek Park	Beach	Water	151129	1269533
NTFK01	Redondo Beach	Beach	Water	131067	1270899
NSJY01	Dumas Bay Park	Beach	Water	122831	1255835
MSJL01	Vashon - Gorsuch Creek	Beach	Water	169666	1241897
MSSM05	Vashon - Tramp Harbor	Beach	Water	154908	1243459
MSXK01	Vashon - Burton Acres Park	Beach	Water	146481	1240772
JSUR01	Brightwater TP outfall	Offshore	Water/Phyto	287580	1250910
KSBP01	Jefferson Head	Offshore	Water/Phyto/Zoo/Sediment	275439	1248062
CK200P	Carkeek CSO TP Outfall	Offshore	Water	263819	1257728
KSSK02	West Point TP Outfall	Offshore	Water/Phyto	245121	1242740
LTBC43	Elliott West CSO TP Outfall	Offshore	Water	228985	1263430
SEAQYSI	Seattle Aquarium	Offshore	Mooring	225168	1267840
LTED04	Elliott Bay	Offshore	Water/Phyto/Sediment	223909	1264675
HNFD01	East Waterway	Offshore	Water	214139	1267488
LTKE03	Duwamish River	Offshore	Water	211418	1265871
LTUM03	Duwamish River	Offshore	Water	196629	1274591
LTXQ01	Henderson/MLK CSO TP Outfall	Offshore	Water	190313	1278053
LSEP01	South TP Outfall	Offshore	Water/Phyto	223360	1247399
LSKQ06	Alki CSO TP Outfall	Offshore	Water/Phyto	212065	1248334
PTWILLBUOY	Point Williams	Offshore	Mooring	205989	1252069
LSNT01	Fauntleroy/Vashon	Offshore	Water/Phyto/Zoo	198653	1245194
LSVV01	Barton CSO Outfall	Offshore	Water/Sediment	195347	1253935
MSJN02	Vashon TP Outfall	Offshore	Water/Phyto	169328	1244585
NSEX01	East Passage	Offshore	Water/Phyto/Zoo/Sediment	134701	1255331
MSWH01	Quartermaster Harbor	Offshore	Water/Mooring	147976	1236667
NSAJ02	Quartermaster Harbor	Offshore	Water/Mooring/Phyto	140223	1239011
KSZY01	Elliott Bay - Pier 90/91	Offshore	Sediment	231983	1258639

Locator	Description	Stratum	Matrices	Northing[1]	Easting[1]
LTAA02	Elliott Bay - Grain Terminal	Offshore	Sediment	231054	1261260
LSCW02	Elliott Bay - Outer	Offshore	Sediment	227106	1256271
LTCA02	Elliott Bay - North Central	Offshore	Sediment	226303	1260915
LTDF01	Elliott Bay - Central Waterfront	Offshore	Sediment	225367	1267270
LSHZ08	Elliott Bay - Cove 2	Offshore	Sediment	218767	1259170
LTGF01	Elliott Bay - Harbor Island	Offshore	Sediment	218854	1265592
KSRU03	Outer Salmon Bay	Offshore	Sediment	247607	1253037
LSML01	Central Basin/West Seattle	Offshore	Sediment	209645	1242954
MSVK01	inner Quartermaster Harbor	Offshore	Sediment	149555	1239632
WP230P	West Pt. TP outfall	Offshore	Sediment	245160	1242423
WP215N	West Pt. TP outfall	Offshore	Sediment	245340	1242537
WP430N	West Pt. TP outfall	Offshore	Sediment	245506	1242590
WP430S	West Pt. TP outfall	Offshore	Sediment	244827	1242444
WPD215N	West Pt. TP outfall	Offshore	Sediment	245433	1242805
WP280W	West Pt. TP outfall	Offshore	Sediment	245202	1242175
WP410W	West Pt. TP outfall	Offshore	Sediment	245265	1242055
WP420NW	West Pt. TP outfall	Offshore	Sediment	245515	1242191
STP820NE	South Plant outfall	Offshore	Sediment	224490	1247431
STP460N	South Plant outfall	Offshore	Sediment	224490	1246880
STP625NP	South Plant outfall	Offshore	Sediment	224053	1246735
STP610MN	South Plant outfall	Offshore	Sediment	223471	1246989
STP570MS	South Plant outfall	Offshore	Sediment	223142	1246446
STP625SP	South Plant outfall	Offshore	Sediment	222623	1246704
STP460S	South Plant outfall	Offshore	Sediment	222174	1246509
STP770SE	South Plant outfall	Offshore	Sediment	221932	1247060

[1]North American Datum 1983 (NAD83) - State Plane Coordinate System - Washington North 4601