Sampling and Analysis Plan for Sammamish River Valley Groundwater

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King County

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Department of Natural Resources and Parks

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1.0. PROJECT BACKGROUND

King County's Sammamish Valley groundwater study has been designed to collect data and information that will be used to assess the groundwater quality and flow within the valley. It will also provide input to help guide recommendations for habitat improvements that are compatible with existing human uses of the river corridor, including recreation, agriculture, and urban development including development of reclaimed water projects. This Sampling and Analysis Plan describes how this study will be conducted in order to best meet project goals.

1.1 Project Objectives

King County's Sammamish River Valley Groundwater study has been designed to improve our understanding of key characteristics of groundwater and its relation to overall hydrology in the Sammamish River Valley.

The overall objectives of the Sammamish River Valley (SRV) Groundwater study are to:

- Delineate the groundwater flow in the Sammamish River valley;
- Describe the groundwater quality of this region; and
- Provide an assessment of groundwater conditions in the Sammamish River valley.

1.2 Study Area

Sammamish River runs north and west from Lake Sammamish 12 miles to Lake Washington. Its entire length was channelized for flood control in 1964. Along this waterway, four main basins drain into the valley, Figure 1. The subbasins from Lake Sammamish to Lake Washington are as follows: Big Bear Creek; Little Bear Creek, North Creek, Swamp Creek.

The Sammamish River Valley was primarily small farms and pasturelands that have given way to urbanization. Residential and commercial development is focused near the edges of the valley.

1.3 Previous Work

The King County Department of Natural Resources and Parks (DNRP) performed an investigation of the geology and hydrology of the SRV to assess the quality and quantity of groundwater in the study area and to assess the interaction of groundwater and surface water in the SRV (Golder, 2002 and King County, 2004). The objectives of the study were to provide a baseline assessment of the groundwater system, to make recommendations regarding habitat improvement in the SRV and to assess opportunities to mitigate impacts of development on the flow and temperature of the Sammamish River (King County, 2003). The previous work started in 2002 and continued into early 2005. The monitoring (quality and quantity) data was summarized in a data report (King County, 2005).

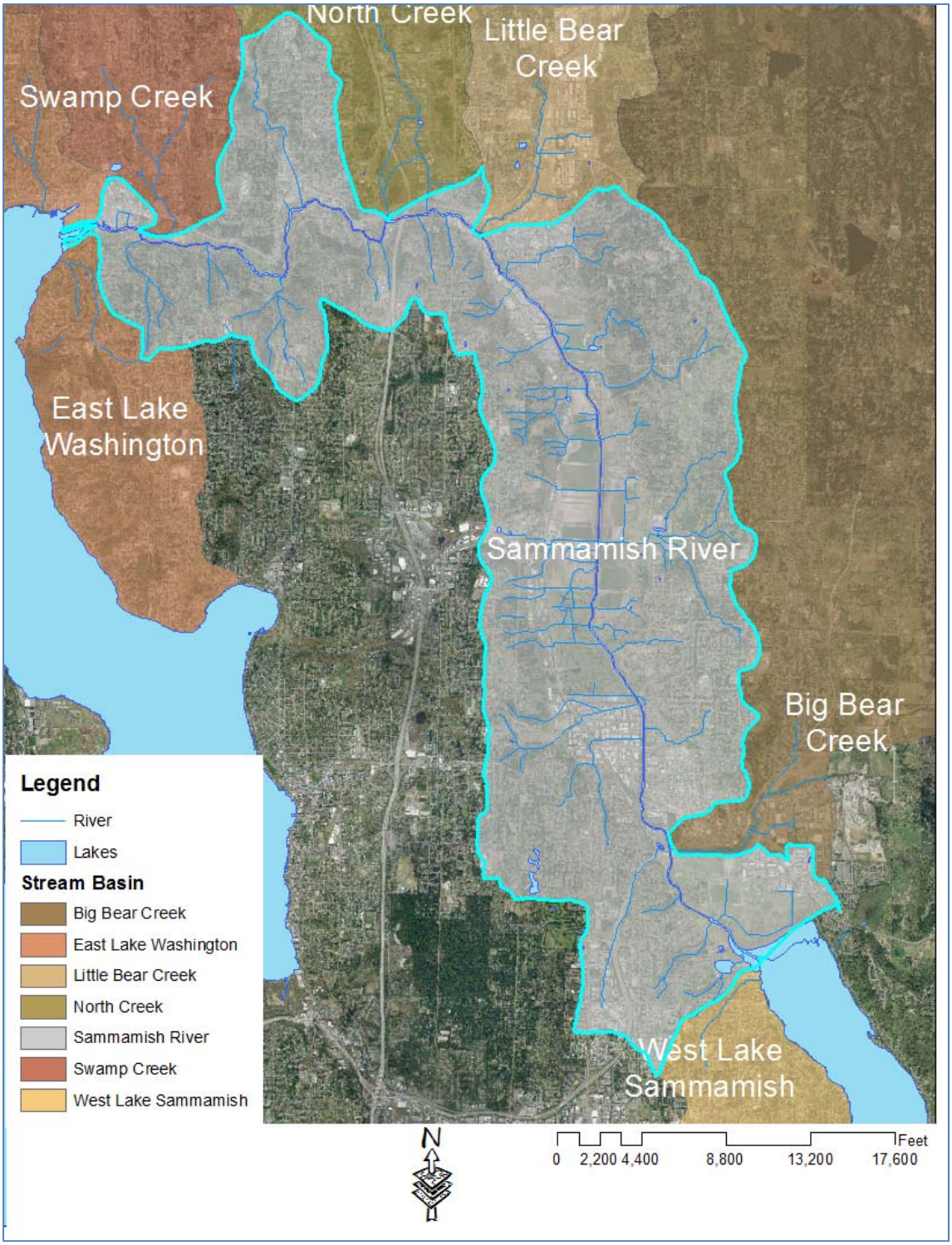

Figure 1. Sammamish River Valley. Sammamish River runs north and west from Lake Sammamish 12 miles to Lake Washington.
The subbasins from Lake Sammamish to Lake Washington are as follows: Big Bear Creek; Little Bear Creek, North Creek, Swamp Creek.

2.0. PROJECT MANAGEMENT

2.1 Roles and Responsibilities

Project team members and their responsibilities are summarized in Table 1. The primary sampling tasks will be done by staff from King County Department of Natural Resources and Parks Water and Land Resources Division (WLRD).

Table 1. Project Team members and responsibilities.

Name/Telephone	Title	Division/Section	Responsibility
Eric W. Ferguson 206-477-4690	Water Quality Planner	WLRD/Science	Project lead; data collection; project reporting.
Katherine Bourbonais 206-477-7112	Laboratory Project Manager	KCEL	Coordination of sampling and analytical activities; laboratory QA/QC and data reporting
Christopher Barnes 206-477-7143	Environmental Field Scientist	KCEL/FSU	Sampling activities
David Robinson 206-477-7150	Environmental Field Scientist	KCEL/FSU	Sampling activities
	Engineer	WTD/	

BNA: Water and Land Resources Division
KCEL: King County Environmental Lab
FSU: Field Science Unit
WTD: Wastewater Treatment Division

2.2 Project Schedule

This groundwater quality work will be conducted annually. The timing of the sampling is tentatively scheduled for the end of the dry period. This period typically occurs in late August/September when the water table is near its lowest level. The groundwater quantity (water level) data is continuously collected by recorders within the monitoring wells. These devices are downloaded quarterly.

2.2.1 Project Deliverables

Laboratory analysis results will be reported in an excel spreadsheet. A brief case narrative will describe any significant sampling issues that have been brought to the lab's attention, and laboratory quality assurance/quality controls (QA/QC) results.

A water quality summary report of the sampling will be completed in late 2014. Groundwater water level data will also be summarized and reported in late 2014-early 2015.

3.0. STUDY DESIGN

The objectives of this water quality and quantity characterization study, as listed in Section 1.1, are to:

1. Delineate the groundwater flow in the Sammamish River valley;
2. Describe the groundwater quality of this region;
3. Provide an assessment of groundwater conditions in the Sammamish River valley.

Planned site sampling includes collection of ground water from 17 monitoring wells. Samples will be collected and analyzed with sufficient quality assurance/quality control (QA/QC) to ensure representative and reliable results. The overall QA objective for this investigation is to ensure that all decisions based on laboratory and field data are technically sound, statistically valid, and properly documented. Specific QA protocols will be executed and are described for all activities related to collection of samples, analysis of these samples by the laboratory, and handling of data generated during the investigation. There are two parts to the QA/QC program for this project: field and laboratory, described in Sections 4.8 and 0.

3.1 Statistical Data Quality Objectives

The general data quality objective of the study is to obtain a sufficient number of water quality samples to be able to characterize the groundwater quality within the Sammamish River Basin.

3.2 Spatial Data

The site locations used in this study are within public lands, property owned by King County DNRP. Three subareas in the SRV are the focus of the study: Marymoor, Willows, and Woodinville. Each site has already been located by digital global positioning system (DGPS) equipment The location of the monitoring wells within the three subareas are shown relative to the Sammamish River basin in Figure 2 on page 5. Table 2 (page 6) summarizes location and well construction information for each well.

3.2.1 Spatial Data Quality Objectives

Selection of monitoring site locations was based on several factors such as physical access to sites, long term access for monitoring, location within the river basin and proximity of other known data sources. The objective of the spatial data is to obtain a broad base of understanding of subsurface conditions through properly locating key monitoring sites.

3.3 Laboratory Data

Samples will be analyzed for the constituents listed in Table 3 on page 10. In addition, field parameters (pH, conductivity, dissolved oxygen, turbidity, and temperature) will be

measured at all wells. Groundwater samples will be submitted to the King County Environmental Laboratory (KCEL) for analysis.

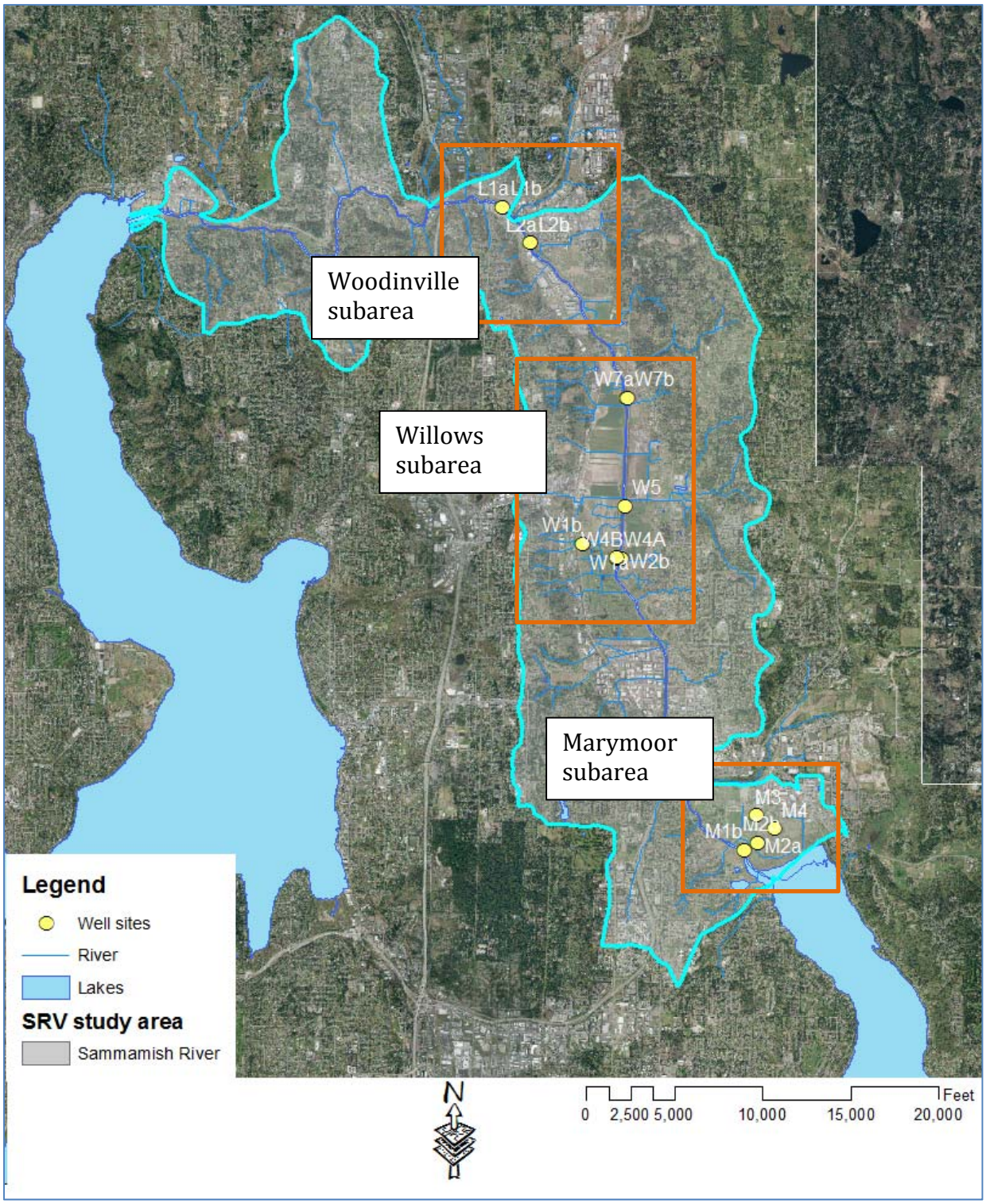

Figure 2. Groundwater sampling locations (17) within Sammamish River Valley. Three subareas are shown: Marymoor (5 sites); Willows (8 sites) and Woodinville (4 sites). Site information listed in Table 2.

Table 2. Groundwater monitoring wells

Well ID	Location	Well Diameter	Well Depth	Subarea	Northing	Easting
M1b	Marymoor Park	2	35.5	Marymoor	242266	1324910
M2a	Marymoor Park	6	34.5		242679	1325653
M2b	Marymoor Park	2	34.5		242680	1325673
M3	Marymoor Park	2	35		244233	1325564
M4	Marymoor Park	4	51.4		243481	1326609
W1a	Willows Run	4	62	Willows	259625	1315731
W1b	Willows Run	2	30		259622	1315745
W2b	Sixty Acres Park	2	33		258802	1317948
W4a	Willows Run, East	2	60		258829	1317645
W4b	Willows Run, East	2	35		258815	1317642
W5	Sammamish River Trail	2	33		261787	1318168
W7a	Hmong Farm	2	20		267261	1318383
W7b	Hmong Farm	6	21		267269	1318380
L1a	Woodinville, lil bear	2	60	Woodinville	278724	1311195
L1b	Woodinville, lil bear	2	19.5		278712	1311210
L2a	Woodinville, park	4	20		276694	1312781
L2b	Woodinville, park	2	60		276682	1312789

Well diameter units: inches;
Well depth units: feet;
Coordinates: Northing & Easting are Washington State Plane Feet – North.

3.4 Laboratory Data Quality Objectives

The data quality objectives (DQOs) of this study are to collect data of sufficient quantity and quality to meet study goals. Statistical analysis of data collected for this study will be performed to evaluate whether a sufficient quantity of data has been collected to meet the study goals. The study goals are:

- to characterize groundwater concentrations of various constituents at different monitoring well locations and depths, and
- to evaluate any differences between sites and depths, either spatially or temporally.

Statistical analysis of data that are "undetected"; i.e., laboratory analysis results reported as "<MDL," will use binomial calculations on the probability of a sample with a detectable concentration of the specific constituent and the probability of finding two and three samples in succession with detectable values at a given site or depth. Statistical analysis of data for those constituents that are detected regularly or occasionally will be accomplished through the use of medians and interquartile ranges.

Validation of project data will assess whether the data collected are of sufficient quality to meet the study goals. The data quality components of precision, accuracy, bias, representativeness, completeness, and comparability are described in the following sections.

3.4.1 Precision, Accuracy and Bias

Precision is the agreement of a set of results among themselves and is a measure of the ability to reproduce a result. Accuracy is an estimate of the difference between the true value and the determined mean value. The accuracy of a result is affected by both systematic and random errors. Bias is a measure of the difference, due to a systematic factor, between an analytical result and the true value of an analyte. Precision, accuracy, and bias for analytical chemistry testing may be evaluated by one or more of the following quality QA/QC procedures:

- Collection and analysis of field replicate samples. Field replicate results should exhibit a relative percent difference less than 150% in order for the evaluation of the spatial and temporal chemical concentrations to be meaningful;
- Collection and analysis of various atmospheric, field equipment and filtration blanks; and
- Analysis of various laboratory QC samples such as blanks, spikes and replicates.

3.4.2 Representativeness

Representativeness expresses the degree to which sample data accurately and precisely represent a characteristic of a population, parameter variations at the sampling point or an environmental condition. Water samples will be collected from stations with predetermined coordinates and sampling depths to represent specific site conditions, both compared to other locations and at each location over time.

3.4.3 Completeness

Completeness is defined as the total number of samples analyzed for which acceptable analytical data are generated, compared to the total number of samples submitted for analysis. Sampling at stations with known position coordinates in favorable conditions, along with adherence to standardized sampling and testing protocols will aid in providing a complete set of data for this project. The goal for completeness is 100%. If 100% completeness is not achieved, the project team will evaluate if the data quality objectives can still be met or if additional samples may need to be collected and analyzed.

3.4.4 Comparability

Comparability is a qualitative parameter expressing the confidence with which one data set can be compared with another. This goal is achieved through using standard techniques to collect and analyze representative samples, along with standardized data validation and reporting procedures. By following the guidance of this Sampling and Analysis Plan, the goal of comparability between sampling events will be achieved. Historical water quality

data from the study area may be compared with data generated from this study to enhance data analysis efforts. Previous data will be used if comparable sampling and analytical techniques were employed.

3.4.5 Relationship to Previously Collected Data

This study uses the previous sampled locations to assess any changes over time at each location and changes across the study area locations.

4.0. SAMPLES AND FIELD PROCEDURES

Consistent sample handling procedures are necessary to maintain sample integrity and provide data that is as defensible and as high a quality as possible under the sampling conditions. This section provides requirements for proper sample containers, labeling, preservation, storage, chain-of-custody practices, and field procedures.

4.1 Sample Containers and Labels

All samples will be collected into pre-cleaned, laboratory-supplied containers affixed with computer-generated labels. All ultra-low level mercury analysis sample bottles will be double bagged in zip lock closure bags, bagged in a clean room environment at the KCEL. Information contained on sample labels will include: a unique sample number; information about the sampling location; the collection date; the requested analyses; and information about any chemical used in sample preservation. Sample containers required for the various analyses are summarized in Table 3 on page 10.

4.2 Sample Preservation and Storage Requirements

Groundwater samples will be stored refrigerated at a temperature of approximately 4°C, or preserved appropriately. Sample preservation requirements and storage conditions as well as analytical holding times are summarized in Table 3.

4.3 Chain-of-Custody Practices

During sample collection, all sample bottles will be in the custody of the sampling personnel. Sampling personnel will deliver all samples to KCEL Sample Receiving and enter them into the Logbook, as described in KCEL Standard Operating Procedure (SOP) # 103v4 (Sample Management). Field sheets will be used to document the transfer of custody from the sampler to the laboratory.

4.4 Sample Retention and Disposal

The laboratory will hold, where practical, any unused sample that has not exceeded holding time for at least 30 days after the release of results. Unused samples categorized as hazardous according to state or federal guidelines will either be returned to the client or special arrangements will be made to dispose of the samples at the laboratory.

4.5 Static Water Level Measurement

The depth-to-water will be recorded to the nearest hundredth of a foot (0.01 ft.). Water levels will be measured before and after purging to assess drawdown effects at each well, and to produce a representative static groundwater contour map. To alleviate potential errors, previous water level data should be used for comparison during field activities.

Table 3. Sample containers, preservation, and holding times for Water Matrix.

Analysis	Container	Preservation	Holding Time*
Total Suspended Solids	1-Liter HDPE, CWM	Refrigerate, <6°C	7 days
Total Dissolved Solids	500-ml HDPE,CWM	Refrigerate, <6°C	7 days
Dissolved nutrients (NH3, NO23, OrthoP, Silica)	60-ml HDPE, CWM	Field filter within 15 minutes and freeze @ -20°C (Silica not frozen)	14 days @ -20°C**
Alkalinity	500-ml HDPE,CWM	Refrigerate, <6°C	14 days
Chloride, Fluoride, Sulfate	125-ml HDPE, CNM	Refrigerate, <6°C	28 days
Total Phosphorus, Total Nitrogen	250-ml HDPE, CWM	Refrigerate, <6°C and freeze within 2 days @ -20°C	28 days @-20°C
Total Organic Carbon	1 x 125-ml amber glass	H_3PO_4, pH <2, Refrigerate, <6°C	28 days***
Mercury, CVAF	500-mL Teflon, acid washed, double bagged	HCL to pH <2 within 48 hours.	90 days
Mercury, CVAF, Dissolved	500-mL Teflon, acid washed, double bagged	HCL to pH <2 within 48 hours.	90 days**
Metals, Total by ICPMS and Calculated Hardness	500-ml HDPE, Acid washed	HNO_3, pH <2	180 days
Metals, Dissolved, by ICPMS	500-ml HDPE, Acid washed	HNO_3, pH <2	180 days **
Microbiology (FC/EC)	500-ml HDPE, sterile	Refrigerate, 4°C	24 hours
VOA-SUR	2 x 40-mL glass VOA vial	Refrigerate at 4°C	7 days to analyze
Organophosphorus Pesticides	2 X 1-Liter ANM glass	Refrigerate at 4°C	7 days to extract, 40 days to analyze
Chlorinated Pesticides	2 x 1-Liter ANM glass	Refrigerate at 4°C	7 days to extract, 40 days to analyze
BNA-SUR	2 x 1-Liter ANM glass	Refrigerate at 4°C	7 days to extract, 40 days to analyze

* The start of the holding time for grab samples is the time collected in the field.
** Field filter within 15 minutes of sample collection.
*** Preserve with H_3PO_4 within 15 minutes of sample collection.

Notes:
ANM – Amber narrow mouth
BNA – Semivolatile organic compound analysis
EDC – Endocrine disrupting chemical
CWM – Clear wide mouth
CNM – Clear narrow mouth
CVAF – Cold vapor atomic fluorescence
HDPE – High density polyethylene
ICPMS – Inductively coupled plasma mass spectroscopy
VOA – Volatile organic analysis

Water levels are preferably measured before purging a well and as close in time as possible, to minimize interference from drawdown or barometric pressure effects. Groundwater elevations will be measured at all wells during each monitoring event to determine changes in seasonal or long-term water elevations.

4.6 In situ Measurements

Field sheets are printed on Rite in the Rain® paper. Each station has a set of field observation parameters that must be filled in by field personnel prior to or during sampling. Any field observations should be written on field sheets at the time of observation. Field measurements for temperature, dissolved oxygen, conductivity, turbidity, and pH will be done using QED MP20 multi-parameter water quality probe. Turbidity will be measured using a Hach turbidimeter.

The purge volume to be pumped will be determined in the field based on stabilization of field parameters: specific conductance, dissolved oxygen, pH, temperature, and turbidity. Samples from all wells will be collected once these parameter values have stabilized within the variability listed below over the course of three sets of measurements:

- Dissolved oxygen 2 mg/L
- pH 0.1
- Specific conductance 10 µS
- Temperature 0.1 °C
- Turbidity <5 NTU

A field measurement replicate is defined as a separate in situ measurement made following all procedures typically done between individual measurements. The probe typically would be removed from the water body and then returned to the same position used in the original measurement.

One field replicate per twenty samples should be analyzed to assess precision of the temperature, dissolved oxygen, conductivity, and pH sensors. If any of the parameters are found to be outside of control limits, the sensors must be recalibrated before further use. .

MP20 probe calibration and QC sheets are intended for documentation of field measurement QC samples (Table 4, page 12). This includes initial calibration, continuing calibration verification replicates, duplicates, and post-run calibration check. The analyst will include the calibration and analysis date; standard lot numbers and concentrations; and instrument readings, recovery calculations, and initials.

Relative Percent Difference (RPD) is defined as the absolute difference between the two measurements divided by the average of the two measurements. See the below equation:

$$RPD = \left(\frac{|r_1 - r_2|}{r_1 + r_2} \right) \times 200$$

Where, r1 = result for first measurement and r2 = result for second measurement.

Table 4. Field probe quality and control requirements.

Parameter	Replicate Samples	Field Calibration Check Standards	Calibration Drift End Check
Dissolved Oxygen	RPD ≤ 20%	Not applicable	± 4 %
Temperature	± 0.3 ^{o}C	Not applicable	Not applicable
Conductivity	RPD ≤ 10%	± 10 %	± 10 %
pH	± 0.2 pH units	± 0.2 pH units	± 0.2 pH units
Turbidity	RPD ≤ 20%	Not applicable	± 20 %

4.7 Sample Collection

This section describes methodologies for the collection of groundwater and field QC samples from the monitoring wells located in the study area. Samples will be collected by King County DNRP staff. Monitoring wells will be purged and sampled for all parameters using low-flow purging methods. The wells will be purged by pumping a small volume of water to ensure sampled water represents aquifer conditions. The volume pumped will be determined in the field based on stabilization of field parameters, see section 4.6. Wells will be purged slowly by lowering semi-rigid thermoplastic elastomer tubing (e.g., C-Flex or similar) to a depth corresponding to roughly the top of the screen zone, securing the tubing to prevent vertical movement, connecting it to a peristaltic pump, and then pumping at a rate not to exceed 0.5 liters/minute (0.132 gallons per minute). At minimum, two pump and tubing volumes should be purged (1/2" I.D. tubing = 0.010 gallon/lineal foot). Sampling equipment will be pre-cleaned (acid-washed) and cleanliness verified before the first sampling event.

Once each well has been properly purged, samples can be collected. When filling sample bottles, the following procedures and precautions will be adhered to:

1. Sample bottles will be filled directly from the pump tubing, with minimal air contact.
2. Bottle caps will be removed carefully so that the inside of the cap is not touched. Caps must never be put on the ground.
3. The sampling team will wear clean gloves, as needed. PVC or vinyl gloves can leave trace levels of phthalate or vinyl chloride. Gloves will be changed between wells or more often if needed.
4. Tubing or hoses from the sampling systems must not touch or be placed in the sample bottles.
5. Sample bottles, caps, or septums that fall on the ground before filling will be discarded.
6. For ultra-low level mercury samples, collection methods will follow the clean hands/dirty hands technique as per EPA Method 1669. Mercury bottles will be double bagged in plastic zip lock bags and the sampling team will wear multiple layers of powder free PVC gloves to facilitate the frequent glove changes required by the method.

The total metals sample bottles will be rinsed three times with water prior to filling, and then sample bottle will be filled, leaving some headspace to allow room to add preservative. An atmosphere blank will be prepared each week for total mercury analysis. A bottle filled in the lab with de-ionized water will accompany the sample bottles in a cooler with ice for the duration of the sampling day. At one randomly selected site, the atmosphere blank bottle will be opened using "clean hands/dirty hands" technique, and exposed to the atmosphere for approximately the same duration that is required to fill the mercury sample bottle.

The microbiology sample bottle will be filled next; up just below the top shoulder of the bottle. The extra headspace is required so that the bottle may be agitated before filtering. The bottle is not to be rinsed with sample.

The conventional analyses bottles are filled in a similar manner as the microbiology sample. The last bottles to be filled are to be the organics bottles. All sample and blank containers will be placed in a cooler with ice until transported to sample receiving at the laboratory.

If a well can be pumped dry prior to reaching the desired purge volume, it will be allowed to recover prior to sampling, using the minimum time between purging and sampling that would allow collection of sufficient sample volume. Samples will be pumped directly into the appropriate containers, as provided by the laboratory. A field data sampling sheet will be filled out for each well. All purge water will be disposed of on the ground near each well.

4.7.1 Field Filtration Procedures

4.7.1.1 Mercury and inductively coupled plasma mass spectroscopy (ICPMS) metals samples

One dissolved mercury field filter blank is collected each week in the following manner, following EPA method 1669. Both "clean hands" (CH) and "dirty hands" (DH) don clean PVC gloves. DH sets up the peristaltic pump and attaches the battery. DH selects a double bagged pre-cleaned filter apparatus and opens the outer bag. CH opens the inner bag and removes the filter apparatus. DH attaches the pump tubing to the filter suction port. DH opens the outer bag containing the filter blank bottle filled with RO water. CH opens the inner bag and extracts the filter blank bottle. CH opens the filter lid and blank bottle lid and pours the contents of the blank bottle into the filter apparatus and closes the lid. DH turns on the peristaltic pump. When the blank water has filtered, DH turns off the pump and removes the tubing from the port. CH unscrews the filter top from the filtrate bottom and caps the filtrate bottle. CH puts the filtrate bottle into the inner bag and closes the bay. DH closes the outer bag and places the double-bagged sample into the sample cooler.
One dissolved ICPMS metals field filter blank will also be collected each week in a similar manner, although adherence to EPA method 1669 is not necessary.
The dissolved portion of the ICPMS metals samples will be collected and filtered within 15 minutes of sample collection. Sample filtering will follow the same procedure described above for collecting the ICPMS metals field filter blank.

4.7.1.2 Dissolved Nutrients Samples

The first dissolved nutrients sample filtered on a given field run should be a field filter blank. After donning the blue powderless nitrile gloves supplied by the laboratory, rinse the 30 or 60ml plastic syringe and plunger thoroughly with RO water. Screw a 0.45µm SFCA nalgene filter onto the end of the syringe and rinse again. Purge about 10 – 20ml of RO water through the filter, and then begin to fill the blank bottle. Dissolved nutrient bottles are 60ml and need to be filled to near the shoulder.

Following the blank, samples should be collected using the same steps. Filters need to be changed for every sample collected; however, syringes may be rinsed with ambient water thoroughly and used multiple times. The samples should be filtered within 15 minutes of collection.

4.8 Field QC

Field QC samples will be collected as follows:

- One replicate per 10 samples, to be analyzed for the entire suite of laboratory analyses.
- One field atmosphere blank per sampling week, to be analyzed for total mercury.
- Field filtering blanks per sampling week to be analyzed for relevant parameters as noted in section 4.7.1.
- One field equipment blank per sampling week, to be collected on the first sampling day of the given sampling week, and to be analyzed for dissolved nutrients and silica, all metals parameters and semivolatile organic compounds (BNA-SUR).
- One carboy blank to be collected at the beginning of the sampling effort, to be analyzed for all metals parameters and BNA-SUR. This sample may be collected in the laboratory prior to taking the carboy to the field.
- One trip blank per sampling day, to be analyzed for volatile organic compounds (VOA-SUR).

Replicate samples at two randomly selected grab sites will be collected for all parameters. A field replicate is a separate sample collection done repeating the sampling steps and appropriate rinsing procedures but with separate sample containers.

4.9 Sample Documentation

This section provides guidance for documenting sampling and data gathering activities. The documentation of field activities provides important project information and data that can support data generated by laboratory analyses.

4.9.1 Sample Numbers and Labels

Unique sample numbers will be assigned to each sampling location. Sample numbers will be assigned prior to the sampling event and waterproof labels generated for each sample container.

4.9.2 Field Notes

Field data will be maintained using pre-printed field sheets for all field activities, including the collection of samples and the gathering of field meter data. The field sheets will be printed on water-resistant paper and all field documentation will be recorded in indelible, black (or blue?) ink. Information recorded on field notes will include, but not be limited to:

- name of recorder,
- sample or site id number,
- date and time of sample collection,
- results for all field measurements (well water level, temperature, pH, dissolved oxygen turbidity and conductivity),
- well water level,
- purging information (equipment used, time, and if the well was dry, purged dry, or was otherwise impossible to sample, this will be noted), and
- physical characteristics of water such as color, clarity, and odor.

Additional information that may be recorded on the field sheets includes sampling methodology and any deviations from established sampling protocols. Additional anecdotal information pertaining to observations of unusual sampling events or circumstances may also be recorded on the field sheets.

4.9.3 Field Analytical Results

Field analytical and QC results will be recorded on field sheets and/or groundwater field book in a manner that easily identifies the information as analytical or QC data. Daily field instrument calibration records will be recorded in instrument-specific logbooks. All entries will be recorded in waterproof, indelible black (or blue) ink.

5.0. MEASUREMENT PROCEDURES

Adherence to standardized analytical protocols and associated QA/QC guidelines for both chemical and biological testing will help produce data able to meet the project goals and objectives.

5.1 Chemical Testing

This section presents the chemical analytical methodologies that will be employed during this project, along with associated detection limits. The KCEL distinguishes between a method detection limit (MDL) and a reporting detection limit (RDL).

- The MDL is defined as the minimum concentration of a chemical constituent that can be detected.
- The RDL is defined as the minimum concentration of a chemical constituent that can be reliably quantified.

5.2 Microbiology Analyses and Detection Limits

Microbiology analyses, methodologies, and associated detection limits are summarized in Table 5. The KCEL will perform all microbiology analyses.

Table 5. Microbiology analyses.

Analysis/Method	Method Summary	MDL (cfu/100ml)	RDL (cfu/100ml)
Fecal coliform by Membrane Filtration	Std Method 21st ed., 9222D	1	N/A
E. coli by Membrane Filtration	Std Methods 22nd ed, 9213D MI Agar Method	1	N/A

5.3 Conventional Analyses and Detection Limits

Conventional analyses, analytical methods, and associated detection limits are summarized in Table 6. All conventional analyses will be performed at the KCEL.

Table 6. Conventional analyses.

Analysis/Method	Method Summary	MDL (mg/L)	RDL (mg/L)
Total Suspended Solids SM 2540 D	Gravimetric	0.5	1
Total Dissolved Solids SM 2540 C	Gravimetric	10	20
Alkalinity SM 2320-B	Titration (Units = mg CaCO3/L)	1	5

Analysis/Method	Method Summary	MDL (mg/L)	RDL (mg/L)
(Continued from page 16)			
Ammonia Nitrogen Kerouel & Aminot 1997	Fluorometric, Automated	0.002	0.01
Nitrate+Nitrite Nitrogen SM 4500-NO_3-F	Colorimetric, Cd Red., Automated	0.01	0.04
Orthophosphate phosphorus SM 4500-P-F	Colorimetric, Automated	0.0005	0.002
Total Phosphorus SM 4500-P-B, F	Colorimetric, Automated	0.005	0.01
Total Nitrogen SM 4500-N-C	Colorimetric, Cd Red., Automated	0.05	0.1
Total Organic Carbon SM 5310-B	High Temperature Combustion, Catalytic Conversion, IR Detection	0.5	1.0
Silica as Silicate Whitledge 1981	Colorimetric, Automated	0.05	0.1
Chloride SM 4110-B	Ion Chromatography	0.05	0.1
Fluoride SM 4110-B	Ion Chromatography	0.02	0.04
Sulfate SM 4110-B	Ion Chromatography	0.1	0.2

5.4 Metal Analyses and Detection Limits

Target ICPMS elements and CVAF Hg analytical methods and associated detection limits are summarized in Table 7. Sample collection methods and methods of analysis are designed to achieve the multiple project goals. Mercury grab samples will be collected using clean techniques (EPA Method 1669) and will be analyzed using the most sensitive method to achieve the lowest detection limit.

Table 7. Total and dissolved metal analyses for water samples.

Element	Analytical Method	MDL (mg/L)	RDL (mg/L)
Mercury	EPA 1631E	0.0000002	0.0000005
Calculated Hardness	EPA Method 200.8 / SM 2340B[1]	0.33 mg $CaCO_3$/L	0.33 mg $CaCO_3$/L
ICPMS metals – total and dissolved			
Aluminum	EPA Method 200.8	0.002	0.010
Antimony	EPA Method 200.8	0.0003	0.001
Arsenic	EPA Method 200.8	0.0001	0.0005
Barium	EPA Method 200.8	0.00005	0.00025

Element	Analytical Method	MDL (mg/L)	RDL (mg/L)
(Continued from page 17)			
Beryllium	EPA Method 200.8	0.0001	0.0005
Cadmium	EPA Method 200.8	0.00005	0.00025
Chromium	EPA Method 200.8	0.0002	0.001
Copper	EPA Method 200.8	0.0004	0.0020
Manganese	EPA Method 200.8	0.0001	0.0005
Nickel	EPA Method 200.8	0.0001	0.0005
Lead	EPA Method 200.8	0.0001	0.0005
Selenium	EPA Method 200.8	0.0005	0.001
Silver	EPA Method 200.8	0.00004	0.0002
Thallium	EPA Method 200.8	0.00004	0.0002
Zinc	EPA Method 200.8	0.0005	0.0025
Calcium	EPA Method 200.8	0.050	0.250
Iron	EPA Method 200.8	0.01	0.05
Magnesium	EPA Method 200.8	0.050	0.250
Potassium	EPA Method 200.8	0.10	0.50
Sodium	EPA Method 200.8	0.10	0.10

[1] Calculated Hardness may also be done by EPA Method 200.7 / SM 2340B in which case the MDL and RDL would be 0.25 mg $CaCO_3$/L and 1.25 mg $CaCO_3$/L.

5.5 Trace Organics Parameters

Trace organics parameters analyzed for this project include volatile organic compounds (VOAs), semivolatile organic compounds (BNAs), chlorinated pesticides, and organophosphorus pesticides. The following sections and tables describe and list parameters, methods, and detection limits. The KCEL will perform all organic analyses.

5.5.1 Chlorinated Pesticides

Chlorinated pesticide sample preparation will be performed according to EPA Method 3520C (SW 846 [EPA, 1986]), which is a continuous liquid-liquid extraction technique. Approximately one liter of sample is extracted with approximately 300 ml of methylene chloride for 18 to 24 hours. The extract is dried with sodium sulfate and concentrated to a 1.0-milliliter (ml) effective final volume. An alumina cleanup is performed according to EPA Method 3610 (SW 846). Chlorinated pesticide sample analysis will be performed according to EPA Method 8081B (SW846), which uses gas chromatography with an electron capture detector (GC-ECD). Dual column confirmation will be performed on all chlorinated pesticide analyses. Table 8 on page 19 lists the target chlorinated pesticide analytes and their respective detection limits.

Table 8. Target chlorinated pesticide analytes and detection limits.

Chlorinated Pesticide	MDL (µg/L)	RDL (µg/L)
Aldrin	0.005	0.010
alpha-BHC	0.005	0.010
beta-BHC	0.005	0.010
delta-BHC	0.005	0.010
gamma-BHC (Lindane)	0.005	0.010
alpha-Chlordane	0.005	0.010
trans-Chlordane	0.005	0.010
Chlordane	0.010	0.025
4,4'-DDD	0.005	0.010
4,4'-DDE	0.005	0.010
4,4'-DDT	0.005	0.010
Dieldrin	0.005	0.010
Endosulfan I	0.005	0.010
Endosulfan II	0.005	0.010
Endosulfan Sulfate	0.005	0.010
Endrin	0.005	0.010
Endrin Aldehyde	0.005	0.010
Heptachlor	0.005	0.010
Heptachlor Epoxide	0.005	0.010
Methoxychlor	0.025	0.050
Toxaphene	0.10	0.500

5.5.2 Base/Neutral/Acid Extractable Semivolatile Compounds (BNAs)

Sample preparation for BNAs will be performed according to EPA Method 3520C, described in Section 5.5.1. The extraction will be performed on a separate 1-liter volume of sample matrix; however, no sample cleanup will be necessary. BNA sample analysis will be performed according to EPA Method 8270D (SW846), which uses gas chromatography with mass spectroscopy (GC-MS). Table 9 lists the target BNA analytes and their respective detection limits based on extract concentration to a final volume of 0.5 ml. KCEL Trace Organics will attempt to achieve lower MDLs/RDLs using a higher concentration factor. In that case lower MDL/RDL values may be reported. In addition to the BNA target list below, BNA surveys will also be performed in order to report out any TICs (tentatively identified compounds) which will receive a J2 qualifier indicating that their values are estimates because they were not calibrated against a curve.

Table 9. Target base/neutral/acid analytes and detection limits.

BNA Compound	MDL (μg/L)	RDL (μg/L)
1,2,4-Trichlorobenzene	0.15	0.250
1,2-Diphenylhydrazine	0.50	1.00
2,3-Dichloroaniline	0.50	1.00
2,4,5-Trichlorophenol	1.00	2.00
2,4,6-Trichlorophenol	1.00	2.00
2,4-Dichlorophenol	0.25	0.500
2,4-Dimethylphenol	0.25	0.500
2,4-Dinitrophenol	1.50	2.50
2,4-Dinitrotoluene	0.25	1.00
2,6-Dinitrotoluene	0.25	1.00
2-Chloronaphthalene	0.15	0.250
2-Chlorophenol	0.50	1.00
2-Methylnaphthalene	0.40	0.750
2-Methylphenol	0.25	0.500
2-Nitroaniline	1.00	1.50
2-Nitrophenol	0.25	0.500
3,3'-Dichlorobenzidine	1.00	1.00
3-,4-Methylphenol	0.25	0.500
3-Nitroaniline	1.00	1.50
4,6-Dinitro-O-Cresol	1.00	2.50
4-Bromophenyl Phenyl Ether	0.10	0.150
4-Chloro-3-Methylphenol	0.50	1.00
4-Chloroaniline	1.00	2.00
4-Chlorophenyl Phenyl Ether	0.15	0.250
4-Nitroaniline	1.00	1.50
4-Nitrophenol	1.00	2.50
Acenaphthene	0.10	0.200
Acenaphthylene	0.15	0.250
Aniline	0.50	1.00
Anthracene	0.15	0.250
Benzidine	15.0	45.0
Benzo(a)anthracene	0.15	0.250
Benzo(a)pyrene	0.25	0.500
Benzo(b,j,k)fluoranthene	0.40	0.750
Benzo(g,h,i)perylene	0.25	0.500
Benzoic Acid	4.00	4.00
Benzyl Alcohol	0.25	0.500
Benzyl Butyl Phthalate	0.15	0.250

BNA Compound	MDL (μg/L)	RDL (μg/L)
(Continued from page 20)		
Bis(2-Chloroethoxy)Methane	0.25	0.500
Bis(2-Chloroethyl)Ether	0.15	0.250
Bis(2-Chloroisopropyl)Ether	0.50	1.00
Bis(2-Ethylhexyl)Phthalate	0.25	1.00
Carbazole	0.25	0.500
Chrysene	0.15	0.250
Dibenzo(a,h)anthracene	0.40	0.750
Dibenzofuran	0.25	0.500
Diethyl Phthalate	0.25	0.500
Dimethyl Phthalate	0.10	0.150
Di-N-Butyl Phthalate	0.25	0.500
Di-N-Octyl Phthalate	0.15	0.250
Fluoranthene	0.15	0.300
Fluorene	0.15	0.250
Hexachlorobenzene	0.15	0.250
Hexachlorobutadiene	0.25	0.500
Hexachlorocyclopentadiene	1.00	2.50
Hexachloroethane	0.25	0.500
Indeno(1,2,3-Cd)Pyrene	0.25	0.500
Isophorone	0.25	0.500
Naphthalene	0.40	0.750
n-Decane	0.15	0.300
Nitrobenzene	0.25	0.500
N-Nitrosodimethylamine	1.00	1.50
N-Nitrosodi-N-Propylamine	0.25	0.500
N-Nitrosodiphenylamine	0.50	1.00
n-Octadecane	0.15	0.300
Pentachlorophenol	0.25	0.500
Phenanthrene	0.15	0.250
Phenol	1.00	1.50
Pyrene	0.15	0.250
Bisphenol A	0.50	1.00
Bis(2-ethylhexyl)adipate	0.50	1.00

5.5.3 Organophosphorus Pesticides

Sample preparation for organophosphorus pesticide (OPP) analysis will be performed according to EPA Method 3520C, described in Section 5.5.1. OPP analysis will be performed according to EPA Method 8270D (SW846), which uses gas chromatography/ mass spectrometry in the select ion mode. Table 10 lists the target OPP compounds and their respective detection limits.

Table 10. Target organophosphorus pesticide analytes and detection limits

OPP Compound	MDL (µg/L)	RDL (µg/L)
Chlorpyriphos	0.034	0.050
Diazinon	0.043	0.050
Disulfoton	0.027	0.050
Malathion	0.048	0.050
Ethyl Parathion	0.045	0.050
Methyl Parathion	0.036	0.050
Phorate	0.033	0.050

5.5.4 Volatile Organic Compounds

Volatile organic compounds (VOAs) will be analyzed by EPA Method 624, which uses gas chromatography with mass spectroscopy. Table 11 lists the target volatile organic compounds and their respective detection limits.

Table 11. Target volatile organic compound analytes and detection limits.

Volatile Compounds	MDL (µg/L)	RDL (µg/L)
1,1,1-Trichloroethane	1.00	2.00
1,1,2,2-Tetrachloroethane	1.00	2.00
1,1,2-Trichloroethane	1.00	2.00
1,1,2-Trichloroethylene	1.00	2.00
1,1-Dichloroethane	1.00	2.00
1,1-Dichloroethylene	1.00	2.00
1,2-Dibromoethane	1.00	2.00
1,2-Dichlorobenzene	1.00	2.00
1,2-Dichloroethane	1.00	2.00
1,2-Dichloropropane	1.00	2.00
1,3-Dichlorobenzene	1.00	2.00
1,4-Dichlorobenzene	1.00	2.00
2-Butanone (MEK)	5.00	10.00

Volatile Compounds	MDL (μg/L)	RDL (μg/L)
(Continued from page 22)		
2-Chloroethylvinyl ether	1.00	2.00
2-Hexanone	5.00	10.00
4-Methyl-2-Pentanone (MIBK)	5.00	10.00
Acetone	2.50	10.00
Acrolein	5.00	10.00
Acrylonitrile	1.00	2.00
Benzene	1.00	2.00
Bromodichloromethane	1.00	2.00
Bromoform	1.00	2.00
Bromomethane	5.00	10.00
Carbon Disulfide	1.00	2.00
Carbon Tetrachloride	1.00	2.00
Chlorobenzene	1.00	2.00
Chlorodibromomethane	1.00	2.00
Chloroethane	1.00	2.00
Chloroform	1.00	2.00
Chloromethane	1.00	2.00
Cis-1,3-Dichloropropene	1.00	2.00
Ethylbenzene	1.00	2.00
M/P Xylenes	1.00	2.00
Methylene Chloride	5.00	10.00
Methyl-t-butyl Ether (MTBE)	1.00	2.00
O-Xylene	1.00	2.00
Styrene	1.00	2.00
Tetrachloroethylene	1.00	2.00
Toluene	1.00	2.00
Total Xylenes	1.00	2.00
Trans-1,2-Dichloroethylene	1.00	2.00
Trans-1,3-Dichloropropene	1.00	2.00
Trichlorofluoromethane	1.00	2.00
Vinyl Acetate	5.00	10.00
Vinyl Chloride	1.00	2.00

6.0. QUALITY CONTROL

6.1 QC Practices for Chemistry Analysis

The QC samples that will be analyzed in association with chemical testing are summarized in Table 12.

Table 12. Chemistry QC samples for water analysis.

Parameter	Blank[1]	Replicate[2]	Matrix Spike	Blank Spike[3]	LCS[4] / CS[5]	Surrogates
Alkalinity	No	1 Per Batch	No	No	1 Per Batch	No
Chloride	1 Per Batch	1 Per Batch	1 Per Batch	1 Per Batch	1 Per Batch	No
Fluoride	1 Per Batch	1 Per Batch	1 Per Batch	1 Per Batch	1 Per Batch	No
Sulfate	1 Per Batch	1 Per Batch	1 Per Batch	1 Per Batch	1 Per Batch	No
Ammonia Nitrogen	1 Per Batch	1 Per Batch	1 Per Batch	1 Per Batch	1 Per Batch	No
Nitrate+Nitrite Nitrogen	1 Per Batch	1 Per Batch	1 Per Batch	1 Per Batch	1 Per Batch	No
Orthophosphate phosphorus	1 Per Batch	1 Per Batch	1 Per Batch	1 Per Batch	1 Per Batch	No
Silica	1 Per Batch	1 Per Batch	1 Per Batch	1 Per Batch	1 Per Batch	No
Total Phosphorus	1 Per Batch	1 Per Batch	1 Per Batch	1 Per Batch	1 Per Batch	No
Total Nitrogen	1 Per Batch	1 Per Batch	1 Per Batch	1 Per Batch	1 Per Batch	No
Total Dissolved Solids	1 Per Batch	1 Per Batch	No	No	1 Per Batch	No
Total Suspended Solids	1 Per Batch	1 Per Batch	No	No	1 Per Batch	No
ICPMS Metals	1 Per Batch	1 Per Batch	1 Per Batch	1 Per Batch	No	No
CVAF Mercury	1 Per Batch	1 Per Batch	1 Per Batch	1 Per Batch	No	No
Total Organic Carbon	1 Per Batch	1 Per Batch	1 Per Batch	No	1 Per Batch	No
Trace Organics	1 Per Batch	1 Per Batch	1 Per Batch	1 Per Batch	No	Yes

[1] For dissolved mercury metals parameters a field filter blank will be prepared and analyzed during each week of sample collection.

[2] Replicate: Duplicate analysis for all conventional parameters, duplicate analysis for ICPMS metal parameters, and matrix spike duplicate (MSD) for organic parameters and Hg by CVAF.

[3] A Blank Spike Duplicate will be prepared and analyzed in for Trace Organics analyses the absence of sufficient sample for Matrix Spike and Duplicate.

[4] Laboratory Control Standard

[5] Check Standard

6.2 QC Practices for Microbiology Analysis

Routine QC analyses for Microbiology monitor method performance of each sample analysis batch for each method. A sample analysis batch should not exceed 20 samples of the same matrix which are all prepared together and analyzed using the same reagents, media, equipment, and by the same analyst(s). The QC samples to be tested with this set of samples are described below:

6.2.1 Laboratory Duplicates

Laboratory duplicates are prepared for each matrix type at a frequency of 1 per batch or 5%, whichever is more frequent. The duplicate must be processed through all preparation and incubation steps used for the original sample. The acceptance limits are based on a 95% confidence limit as described in the appropriate reference methods.

6.2.2 Negative Controls

A negative control is prepared at a frequency of 1 per batch or 5%, whichever is more frequent. The negative control should show an appropriate qualitative response for the test organism and should not be identified as containing the target organism.

- For fecal coliform, the negative control organism is *Proteus sp*. or *Enterobacter sp*.
- For *E. coli*, the negative control organism is Proteus sp.

6.2.3 Positive Control

A positive control is prepared at a frequency of 1 per batch or 5%, whichever is more frequent. The positive control should show an appropriate qualitative response for the test organism.

- For fecal coliform, the positive control organism is *E. coli*.
- For *E. coli*, the positive control organism is *E. coli*.

6.2.4 Sterility Controls

Pre-filtration and post-filtration blanks are prepared each working day to evaluate the sterility of the dilution water and filtration equipment. These sterility controls are considered acceptable if the target organism is not detected.

6.3 QC Practices for Field Measurements

Calibration QC requirements for attended multi-probe field measurements involve determination of post-deployment calibration drift for the parameters of interest (except temperature). Calibration drift is determined by measuring the check standard solution at the conclusion of the field measurements. This check must be done within 12 hours of the last field measurement. The post-deployment checks must be done in the same order used for initial calibration and must be done before any maintenance or calibrations are performed, Table 13 on page 26.

Table 13. Acceptance limits for post-deployment calibration check.

Parameter	Calibration Drift Check
Dissolved Oxygen	± 4 %
Temperature	Done annually only
Conductivity	± 10 %
pH	± 0.2 pH units
Turbidity	± 20 %

QC for field measurements is typically limited to measuring precision by collection of replicate field measurements. Replicates are done at a minimum frequency of 5% of measurements or at a minimum, once per day. A field replicate is defined as a separate in-situ measurement made following all procedures typically done between individual samples. The probe would typically be removed from the water body then returned to the same depth and position used in the original measurement. Table 14 describes the acceptance limits for field replicates.

Table 14. Acceptance limits for field replicate measurements.

Parameter	Duplicate Samples
Dissolved Oxygen	RPD ≤ 20%
Temperature	± 0.3 °C
Conductivity	RPD ≤ 20%
pH	± 0.2 pH units
Turbidity	RPD ≤ 20%

Data sets that do not meet the field QC acceptance limits may require that the field measurement data be flagged. Comments on field QC results should be included in the QA review. If samples are not collected by King County staff, contracted field sampling personnel must forward field notes and data to the KCEL Laboratory Project Manager (LPM) for review.

6.4 Corrective Actions

Individual SOPs describe specific corrective actions for each analytical procedure and QC measure. If QC samples exceed their control limits, the analysis is repeated, if possible, or documented and affected samples qualified. If samples are lost or compromised, the project manager must determine whether to re-sample or to disregard the station for the specific parameter or event.

KCEL documentation and record keeping will follow standard protocols, as described in Kruger (2002). Within the analytical laboratory, each section and analytical procedure has

its own documentation protocol. The minimum documentation required in the lab includes an instrument logbook, analysis log, calibration and analysis documentation, and Laboratory Information Management System (LIMS) hardcopy sheets.

For all analytical results generated by lab activities, sufficient data must be stored such that a reviewer could verify that the requirements of the reference method and SOP were met. The format of stored data may include logbook entries, field notes, bench sheets, and printouts of instrument or data files. Storage of electronic versions of these documents may be sufficient to meet current data storage requirements.

6.4.1 Logbooks

Hand written information used as supporting documentation, which is not stored directly with the analysis results, such as standards preparation records and equipment calibration checks, must be maintained in logbooks. All logbooks must be paginated. Logbooks prepared from instrument printout or other loose pages should be bound prior to storage. Logbook entries should be made using indelible black (or blue?) ink (no pencils) and dated and initialed. Logbooks and individual logbook entries must be uniquely identified if they are to be referenced in other documents. All deletions and corrections must be a single line cross-out, accompanied with the date and initials of the person making the correction.

6.4.2 Data Packages

For each analytical run or analysis sequence, a data package will be produced which will include all appropriate raw data for standards, samples and QC analyses. Data packages must include the inclusive dates and times of the analyses and the identity of the analyst(s). If corrective actions were taken or a compromised sample was analyzed, the data package will contain a copy of the Data Anomaly Form and/or a Compromised Sample Form (or their equivalent). Specific requirements for the contents of data packages are described in each method SOP. The analyst(s) who generated the data is responsible for compiling the data package and transferring it to the data reviewer. Prior to data review, the data packages are organized according to method SOPs. Data packages may reference other data sets or documents rather than requiring each data package to contain copies of all necessary information. All deletions and corrections to handwritten or printed documentation must be a single line cross-out, accompanied with the date and initials of the person making the correction.

6.4.3 Storage of Lab Data

Procedures for the storage and disposal of hardcopy lab data are summarized in KCEL's SOP #1105v1 (Records Storage) which is based on King County and Washington State governmental records storage requirements. It is the policy of the lab to store all data packages, supporting documentation, and project records for a minimum of ten years, based on the date of sample, collection, or field data measurement.

In LIMS, the final sample result and QC data are maintained indefinitely in the EDS database, which is backed up daily. Additional LIMS information specific to sample

management is maintained a minimum of one-year past the date the final results were posted. Other types of electronic data, such as photographs, instrument files, Data Anomaly Forms, etc., may also be stored. Lab-wide policy is currently under development.

7.0. DATA MANAGEMENT PROCEDURES

The KCEL will provide a 30-day turnaround time for all analytical data with the exception of metals, starting upon receipt of the last sample collected. Each laboratory unit will provide a narrative describing the contents of their data package, including any notable information of immediate interest to the recipient.

7.1 Interpretation of Chemical and Microbiological Data

Analytical results will be used to develop and calibrate the watershed water quality models.

7.2 Quality Assurance Reviews

Chemistry and microbiology data will undergo standard QA review within each laboratory unit according to the KCEL Laboratory QA Manual and method-specific SOPs. Data will be flagged accordingly. A description of the laboratory qualifiers is provided in Table 15 on page 30. The LPM will review QC results and provide a summary of the QC information in narrative form. This narrative will accompany the data when it is transmitted to project and program managers. Reviews will be done on an event basis. This level of QA review is necessary to provide project and program managers with the level of information needed to correctly interpret the data.

7.3 Record Keeping

All field and sampling records, custody documents, raw laboratory data, data summaries and case narratives will be stored according to KCEL policy.

7.4 Reporting

Project data will be presented to project and program managers in a format that will include the following:

- KCEL Comprehensive Reports consisting of spreadsheets of chemical and microbiological parameter results;
- chemistry and microbiology QC data
- A technical memorandum, summarizing field sampling, analytical work, and interpretation of the QC results (provided by the KCEL LPM).

Table 15. Laboratory qualifiers.

Qualifier	Description
General	
H	**H** indicates that a holding time criterion (preservation, filtration, preparation, or analytical) was not met prior to completion of analysis.
R	**R** indicates that the numerical result for the parameter, based on the professional judgment of the laboratory, is neither scientifically defensible nor representative of the true value for a sample. Indefensible and non-representative data occur whenever sample collection, sample handling, critical analysis conditions, or other system failures occur that would prevent the use of the result for any purpose other than an approximate minimum or maximum value.
<MDL	Applied when a target analyte is not detected or detected at a concentration less than the associated method detection limit (MDL). MDL is defined as the lowest concentration at which an analyte can be detected. The MDL is the lowest concentration at which a sample result will be reported.
<RDL	Applied when a target analyte is detected at a concentration greater than or equal to the associated MDL but less than the associated reporting detection limit (RDL). RDL is defined as the lowest concentration at which an analyte can reliably be quantified. The RDL represents the minimum concentration at which method performance becomes quantitative and is not subject to the degree of variation observed at concentrations between the MDL and RDL.
RDL	Applied when a target analyte is detected at a concentration that, in the raw data is equal to the RDL.
SH	**I**ndicates that a sample handling criterion was not met in some manner prior to analysis. The sample may have been compromised during the sampling procedure or may not comply with storage conditions or preservation requirements.
TA	Applied to a sample result when additional narrative information is available in the text field. The additional information may help to qualify the sample result but is not necessarily covered by any of the standard qualifiers.
Chemistry	
B	**B (including B2 and B3)** are applied when the parameter was detected at a concentration at or above the MDL in the associated blank(s) and has met the appropriate rule or condition, as defined by the method or regulatory program. Use: Application of the “B” flags depends on the ratio of the sample to blank result, on a wet-weight basis, and the particular parameter according to these rules: - Add a “B” flag to all parameters if the associated blank is ≥ the MDL and the sample result is ≥ MDL but ≤ 5 times the blank. - Add a “B2” flag to common organic lab contaminants (Acetone, 2-Butanone, Methylene Chloride, Bis(2-ethylhexyl) Phthalate, Butyl Benzyl Phthalate and Di-n-butyl Phthalate) if the method blank is ≥ the MDL and the sample result is > 5 and ≤ 10 times the blank. - Add a “B3” flag to all other parameters if the associated blank is ≥ the MDL and the sample result is > 5 and ≤ 10 times the blank.

Qualifier	Description
(Continued from page 30)	
>MR	Applied when a target analyte concentration exceeds the instrument or method capacity to measure accurately. The qualifier is primarily in the organics section. It is applied when the detected analyte concentration exceeds the upper instrument calibration limit and further dilution is not feasible. The reported value is an estimated analyte concentration.
E	**E** is applied to a parameter result when the reported value is above the calibration range of the analysis. Use: The E flag, when applied under this general definition, should be used whenever the measured response is above the calibration range of the method but it was not possible to dilute and re-analyze the sample.
J	**J** is applied to a parameter result when the reported value is an estimated value.
Microbiology	
FAIL	The result of the positive or negative control failed
PASS	The result of the positive or negative control passed
C	Value is an estimate, based on presence of confluent growth

8.0. DATA VERIFICATION AND VALIDATION

Data verification will be conducted using data collected on field sheets and results of lab analyses. The technical memorandum created by the LPM upon conclusion of each event will highlight any anomalies that arose and associated corrective actions.

Validation of data will be conducted during the QC review process for in-situ measurements, and through laboratory QC processes previously described.

9.0. REFERENCES

Golder Associates 2002. Sammamish River Valley Geophysical Investigation. Prepared for King County Department of Natural Resources and Parks. Seattle, Washington.

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King County 2004. Sammamish River Groundwater Study Well Data Report. Prepared by HWA GeoSciences Inc., for King County Department of Natural Resources and Parks, Water and Land Resources Division. Seattle, Washington.

King County 2005. Sammamish River Valley Groundwater Study 2003-2004 Data Report. Prepared by King County Department of Natural Resources and Parks, Water and Land Resources Division. Seattle, Washington.