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April 2, 2014

Mr. David South, PE
Washington State Department of Ecology
Northwest Regional Office
3190 160th Avenue S.E.
Bellevue, WA 98008-5452

SUBJECT: WORK PLAN FOR HYDROGEOLOGIC DATA COLLECTION AT THE LORA LAKE PARCEL
PROJECT NUMBER: POS-LL

Dear Mr. South:

This memorandum describes Floyd|Snider's proposal to gather hydraulic and hydrogeologic data at the Lora Lake Parcel. The overall goal of early data collection is to take advantage of the time in the project schedule between completion of the Remedial Investigation/Feasibility Study (RI/FS), and initiation of remedial design for the Lora Lake Parcel. Data collection over the course of a year, including both dry and rainy seasons at the Lora Lake Parcel, will advance our assumed concepts and knowledge of the lake and creek hydraulic function, and provide Washington State Department of Ecology (WSDOE) with supporting information and a better understanding of the current system's storage capacity, hydraulic connectivity, and flood desynchronization to inform the remedial design of the Lora Lake Parcel remedy. At this time, no data are needed for resource agency coordination; however, ongoing communication with the resource agencies will keep them informed of the site status, and may help to streamline the permitting process to be conducted in coordination with design in 2014–2015.

LORA LAKE DESIGN AND DATA COLLECTION OBJECTIVES

The hydraulic and hydrogeologic data to be collected at the Lora Lake Parcel is intended to provide the information needed to meet the design objectives described below. This information can also be found in Table 1 with more detail.

Understand stormwater conveyance to Miller Creek

An understanding of the stormwater inflows and outflows at Lora Lake will allow for the calculation of a water balance and thus help evaluate the amount of stormwater currently discharging from Lora Lake to Miller Creek. This will allow for modeling of stormwater conveyance during design and provide an understanding of the hydraulic function of the lake so future conditions of discharge to Miller Creek will be consistent with the existing conditions.

Minimize channelization of the stormwater conveyance and erosion

An understanding of the timing and quantity of stormwater inflows and outflows at the lake will allow for a design that minimizes channelization and erosion. It will also allow for modeling of

stormwater conveyance during design and provide an understanding of the hydraulic function of Lora Lake.

Establish scrub/shrub wetland and minimize open water and associated wildlife hazards

An understanding of the timing of stormwater inflows and outflows at Lora Lake, the resultant change in water levels, and its hydraulic connection with surrounding groundwater will help predict seasonal water levels through numerical modeling or water balance calculations, and allow for planning of the final grades and elevations, as well as appropriate plant species in the constructed wetland. This information will also inform the design for appropriate backfill characteristics that will minimize standing water.

Engage floodplain in the design

Lake level and groundwater level measurements, in addition to evaluation of the hydraulic parameters of the subsurface materials, will be used to help evaluate the hydraulic connection between Lora Lake and the surrounding floodplain and the impacts of modifying the floodplain.

Avoid any negative impacts and, if possible, enhance hydraulics of Miller Creek (e.g., minimize potential increase in peak flows to the creek and enhance summer base flows)

Monitoring of lake levels, inflows, and outflows provides necessary information on the amount of surface water flowing into and out of Lora Lake and the lake's storage capacity. In conjunction, groundwater level measurements will be used to evaluate groundwater inflows and outflows at the lake and the impacts of seasonal fluctuations on lake and groundwater levels. Installation of a monitoring well at the elevation of the bottom of the lake will provide data on vertical gradients and an accurate hydraulic conductivity estimate of the subsurface materials in the immediate vicinity of the lake. This will help in evaluating the subsurface connectivity between the lake and Miller Creek. Mini-piezometers and stream gauging locations along Miller Creek will be used to estimate conductance of the creek bed and how much water is discharging into the creek directly from the lake or from groundwater discharge.

Collect baseline data for dissolved oxygen and temperature

Dissolved oxygen (DO) and temperature measurements are not critical to design, but temperature information will be recorded by the data logging devices installed for other purposes. This information will provide limited baseline data for conditions prior to completion of remedial activities.

Avoid direct or indirect impacts to hydrology in the Vacca Farm floodplain and wetlands, including floodplain storage capacity, surface water drainage patterns, groundwater transport dynamics

A numerical model will be developed to evaluate baseline groundwater/surface water interactions, which requires quantitative inputs, including: surface water discharge to Miller Creek from Lora Lake, hydraulic gradients between Lora Lake and groundwater, changes in

groundwater levels seasonally and due to precipitation events, the hydraulic parameters of subsurface materials, and the hydraulic gradients between groundwater and Miller Creek. The model can then be used during design to evaluate alternative backfill sequences in order to minimize impacts to surface water flows.

Fill the lake in such a way as to isolate contaminated sediments

Hydraulic conductivity testing of wells completed in wetland soils will aid in the design of the soil cap. This conductivity information will confirm the sediment cap modeling conducted in the RI/FS, and can also inform any additional modeling conducted during design.

DATA COLLECTION

Data collection has been divided into three areas: surface water data, groundwater data, and other data. A brief summary of each type of data collected as part of this hydraulic/hydrogeologic data collection event is listed below. For more specific information, refer to Table 2. For data collection field details, refer to Table 3.

Surface Water Data

The following is a list of surface water data to be collected:

- Lora Lake water levels
- Lora Lake inlet and outlet flows
- Lora Lake features and berm survey
- Surface water levels in surrounding areas
- Miller Creek stream gauging
- Dissolved oxygen in Lora Lake and Miller Creek
- Temperature in Lora Lake and Miller Creek

Groundwater Data

The following is a list of groundwater data to be collected:

- Groundwater level data for wells upgradient and cross-gradient of Lora Lake
- Installation of a new well adjacent to Lora Lake
- Groundwater level data from mini-piezometers downgradient of Lora Lake
- Monitoring well and surface water elevation data at Lora Lake and Miller Creek
- Hydraulic conductivity in Lora Lake and Miller Creek
- Temperature in Lora Lake and Miller Creek

Other Data

The following is a list of other data to be collected:

- Utility survey
- Topographic survey of Lora Lake Parcel

Hydraulic and hydrogeologic data collection was initiated in Spring 2013, and will continue through Spring 2014.

REPORTING

Data collection is dependent on weather patterns and budget, and is expected to be completed in Summer 2014. Results of data collection activities will be presented to WSDOE in a Data Summary Memorandum no more than 60 days following termination of data collection. This memorandum will constitute the deliverable for this Work Plan. Collected data will be provided to WSDOE electronically in Microsoft Access database format. Any modifications to the data collection or reporting methods or schedule will be approved by WSDOE.

Please feel free to contact me with any questions regarding the actions described in this work plan.

Sincerely yours,
FLOYD | SNIDER

Megan McCullough, PE
Project Engineer

Encl.: Table 1 Lora Lake Parcel Design Data Collection Objectives and Rationale
Table 2 Lora Lake Parcel Design Data Collection Scope Details
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Figure 1 Baseline Surface Water and Groundwater Monitoring Locations
Copies: Don Robbins, Port of Seattle
Bob Duffner, Port of Seattle
Floyd|Snider, Project Record

Tables

Table 1
Lora Lake Parcel Design Data Collection Objectives and Rationale

Overall goal of early data collection: Take advantage of early evaluation of existing data and getting more data prior to the official start of design to advance our assumed concepts and knowledge of the lake and creek hydraulic function, and be able to provide WSDOE with supporting information and a better understanding of storage, hydraulic connection, and flood desynchronization during the RI/FS, CAP, CD public comment periods in 2013. At this time, no data are needed for resource agency coordination; however, keeping in touch and communicating the advancement of our knowledge will hopefully keep/confirm their support of lake to wetland conversion during public comment and ease permitting to be conducted during design in 2014.		
Lora Lake Design Objectives *(Objectives provided by the Port at the beginning of the Lora Lake Parcel Design Data Collection discussions)*	**Information Required to Achieve Design Objective** *(Site-specific information needed to meet design objective)*	**Data Need Numbers** *(Data to be collected to provide site-specific information needed to achieve design objectives)*
Maintain stormwater conveyance to Miller Creek	Understanding of the stormwater inflows and outflows at Lora Lake will allow for the calculation of a water balance and thus help evaluate the amount of stormwater discharging to Miller Creek. Allows for modeling of stormwater conveyance during design and an understanding of the hydraulic function of the lake.	Table 2, #1, #2, #3
Minimize channelization of the stormwater conveyance	Understanding the timing and quantity of stormwater inflows and outflows at the lake will allow for a design that minimizes channelization and erosion. Allows for modeling of stormwater conveyance during design and an understanding of the hydraulic function of Lora Lake.	Table 2, #1, #2 , #3
Minimize erosion	Understanding the timing and quantity of stormwater inflows and outflows at the lake will allow for a design that minimizes channelization and erosion. Allows for modeling of stormwater conveyance during design and an understanding of the hydraulic function of Lora Lake.	Table 2, #1, #2, #3
Establish scrub/shrub wetland	Understanding of the timing of stormwater inflows and outflows at Lora Lake, the resultant change in water levels, and its hydraulic connection with surrounding groundwater will help predict seasonal water levels through numerical modeling or water balance calculations and allow for planning of the final grades and elevations, and appropriate plant species in the constructed wetland.	Table 2, #1, #9, #10
Minimize creation of open water and associated wildlife hazards	Understanding of the timing of stormwater inflows and outflows at Lora Lake, the resultant change in water levels, and its hydraulic connection with surrounding groundwater will help predict seasonal water levels through numerical modeling or water balance calculations and thus design appropriate backfill characteristics that minimize standing water.	Table 2, #1, #9, #10
Engage floodplain in the design (e.g., get rid of the berms, design within flood plain requirements)	Lake level and groundwater level measurements, in addition to evaluation of the hydraulic parameters of the subsurface materials, will be used to help evaluate the hydraulic connection between Lora Lake and the surrounding floodplain and the impacts of modifying the floodplain.	Table 2, #1, #9, #10, #13
Avoid any negative impacts and, if possible, enhance hydraulics of Miller Creek (e.g., minimize potential increase in peak flows to the creek and enhance summer base flows)	Monitoring of lake levels, inflows, and outflows provides necessary information on the amount of surface water flowing into and out of Lora Lake and the lake's storage capacity. In conjunction, groundwater level measurements will be used to evaluate groundwater inflows and outflows at the lake and the impacts of seasonal fluctuations on lake and groundwater levels. Installation of the additional monitoring well at the elevation of the bottom of the lake will provide data on vertical gradients and an accurate hydraulic conductivity estimate of the subsurface materials in the immediate vicinity of the lake. This will help evaluate the subsurface connectivity between Lora Lake and Miller Creek. The mini-piezometers and stream gauging locations along Miller Creek will be used to estimate conductance of the creek bed and how much water is discharging into the creek directly from the lake or from groundwater discharge.	Table 2, #1, #2, #3, #4, #5, #6, #9, #10, #11, #12, #13, #14
Avoid any negative impacts and, if possible, enhance water quality of Miller Creek (e.g., minimize the low DO and elevated temperature water quality impacts to the creek)	DO and temperature measurements are not critical to design, but temperature information will be recorded by the data logging devices installed for other purposes. This information will provide limited baseline data for conditions prior to remedial activities.	Table 2, #7, #8, #14
Avoid direct or indirect impacts to hydrology in the Vacca Farm floodplain and wetlands, including floodplain storage capacity, surface water drainage patterns, and groundwater transport dynamics	A numerical model will be developed to evaluate baseline groundwater/surface water interactions, which requires quantitative inputs, including: surface water discharge to Miller Creek from Lora Lake, hydraulic gradients between Lora Lake and groundwater, changes in groundwater levels seasonally and due to precipitation events, the hydraulic parameters of subsurface materials, and the hydraulic gradients between groundwater and Miller Creek. The model can then be used during design to evaluate alternative backfill sequences in order to minimize impacts to surface water flows.	Table 2, #1, #2, #3, #4, #5, #6, #9, #10, #11, #12, #13, #14
Avoid structural and functional changes to the Miller Creek Relocation floodplain berm that would alter existing floodplain function	The data collection activities proposed to address other data needs will provide the information necessary to address this objective during design. No specific data collection is required to meet this objective.	NA
Fill the lake in such a way as to isolate contaminated sediments	Hydraulic conductivity testing of wells completed in wetland soils will aid in the design of the soil cap. This conductivity information will confirm the sediment cap modeling conducted in the RI/FS, and additional modeling may be conducted during design. No other data collection is required.	Table 2, #13

Abbreviations:

CAP	Cleanup Action Plan
CD	Consent Decree
DO	Dissolved oxygen
NA	Not applicable
Port	Port of Seattle
RI/FS	Remedial Investigation/Feasibility Study
WSDOE	Washington State Department of Ecology

Table 2
Lora Lake Parcel Design Data Collection Scope Details

Data Need Number (Refer to Table 1)	Data	Purpose/Notes	Lead Firm	Field Event Required	Timing of Field Event/ Data	Data Collection Locations	Duration of Data Collection
Surface Water Data							
1	Lora Lake water level (continuous)	Collect 15-minute water level data to document seasonal water level variability and water level response to storms (e.g., detention/retention capacity of lake). Establishes the baseline hydroperiod that the post-project condition can be compared against. Establishes lake response to inflows and allows comparison to Miller Creek. Would be beneficial to close the gap in the berm that is allowing inflow from the creek to the lake to reduce variables in the water budget.	Aspect	Refer to Note 1	Winter 2013	Install staff gauge and water level logger at outlet from lake to creek. One location, shown on Figure 1.	1 year
2	Lora Lake inlet flows—stormwater outfall (velocity and depth measurements)	Collect 15-minute inflow data to document stormwater inflows to the lake, confirm stormwater model. These data will be used in water balance calculations to evaluate how much surface water is flowing into the lake. Provides a calibration/field check to the MGS flood model. Challenging measurement location. Could also consider modifying the culvert and installing a weir.	Aspect	Refer to Note 1	Winter 2013	Install ISCO AV sensor in pipe at location at inlet to lake, shown on Figure 1.	1 year
3	Lora Lake outlet flows	Collect measurements using the area-velocity method and a velocity meter (e.g., pygmy meter or Sontek Flowtracker) of lake outflow during field visits. Develop a rating curve between lake elevation and outlet flows to correlate a continuous (15-minute) record of outflows from the lake. Comparison measurement to Lora Lake, to determine relationship of lake and creek levels. A key design question will be how flows routed through the new wetland will influence geomorphically important flows in Miller Creek. This measurement would refine our understanding of the relationship between lake and creek levels to support our assertion that the lake currently provides very limited 'live' storage of water.	Aspect	Refer to Note 1	Winter 2013	Measure flows at lake outlet. One location, shown on Figure 1.	1 year
4	Lora Lake features and berm survey	Collect invert elevations of pipe inlet and outlet of lake discharge pipe, survey low points of berm around the lake including where inflow or outflow can occur with Miller Creek, and the wet area to the south of Lora Lake. These data will be used to help design similar discharge conditions after the backfill of the lake.	F|S	Yes	Spring 2013	Survey seven locations along Miller Creek and Lora Lake. Location shown on Figure 1.	< 1 week
5	Other surface water levels	Collect water level data in wet area south of Lora Lake and at three places along Miller Creek (near overflow area to lake, near the lake outlet pipe, downstream near the wet area) to evaluate the hydraulics of the system. These data will be used in conjunction with the stream gauging data to help evaluate the amount of water discharging into Miller Creek. Shallow groundwater well in the wetland outside the berm, and outboard of the flood berm. Helps to establishes groundwater flux in this area, so relates to cap permeability.	Aspect	Refer to Note 1	Winter 2013	Install staff gauge and water level logger in wetland area between lake and creek. One location, shown on Figure 1.	1 year
6	Stream gauging	Collect Miller Creek flow measurements downstream from lake outlet at different stage heights to establish rating curve and discharge variations. These data will be used to help evaluate the amount of water discharging into Miller Creek from drainage culverts, berm overflows, and groundwater discharge for the water balance calculations of the lake. Would also relate to the outlet design, especially if the outlet is reoriented down valley. Cost savings to two additional continuous sensors. Idea is that manual measurements would be related to the gauge and continuous recorder in the creek to determine typical water surface slopes in the project reach.	Aspect	Refer to Note 1	Winter 2013	Install new staff gauge in creek at lake outlet, install water level logger at new staff gauge and existing staff gauge near power lines. Utilize data from existing KC gauge location upstream of lake.	1 year
7	Dissolved oxygen measurements	Limited applicability to design, but would help support assertions about ecological functioning. Probably most applicable in summer.	ESA	Not at this time	NA	NA	NA
8	Temperature sensors in Lora Lake and Miller Creek	Limited applicability to design, but would help support assertions about ecological functioning. Would document temperature in the lake; may capture any lake turnover events if it does become stratified.	ESA	Not at this time	NA	NA	NA
Groundwater Data							
9	Existing groundwater level data	Compile well logs and groundwater levels from existing monitoring wells. Groundwater level data will be used to evaluate hydraulic gradients in the vicinity of the lake and thus calculate the groundwater inflow and outflow at Lora Lake. Install data loggers and pressure transducers in select wells to develop seasonal hydrographs. Hydrographs will provide information on the seasonal fluctuations in groundwater levels at key locations in the immediate vicinity of the lake and help evaluate groundwater level response to changes in lake levels and establish groundwater/surface water interaction with Miller Creek. Need a shallow/deep well pair to investigate vertical groundwater gradients. Would need a deeper boring if the existing orange riser is not the correct depth. Helps to establish groundwater flux in this area, so relates to cap permeability.	Aspect	Yes	Winter 2013–Wet Season	Quarterly groundwater level monitoring to be completed in 26 wells, including: 17 Lora Lake Apartments wells; 4 Third Runway wells; 4 shallow Port wells; and 1 new well. Micro-divers to be installed in up to six wells: one new well; four shallow Port wells (assuming they are not already instrumented); and HC99-B31.	1 year
10	Additional monitoring wells	Complete a new well to the bottom elevation of the lake in order to evaluate the surrounding hydraulic conductivity of peat soil horizons. A well completed in the peat at the bottom elevation of the lake will provide an accurate hydraulic conductivity estimate for determining groundwater discharge into and out of the lake.	Aspect	Yes	Spring 2013	Install one new monitoring well (35 feet). Location north of Lora Lake, shown on Figure 1.	< 1 week
11	Mini-piezometers	Established method used by USGS and WSDOE to document gaining/losing conditions of Miller Creek, estimate conductance of creek bed, and evaluate groundwater/surface water connection between Lora Lake and Miller Creek.	Aspect	Yes	Winter 2013–Wet Season	Install six new shallow mini-piezometers by hand, in three pairs along Miller Creek. Install micro-divers in six piezometers. Locations shown on Figure 1.	1 year
12	Monitoring well and surface water elevation survey	Will help provide an accurate datum for establishing groundwater and surface water elevations to evaluate the hydraulic head differences between the lake and creek.	Aspect	Yes	Prior to 2014 Design	Survey 12 monitoring well and mini-piezometer locations, including: 4 shallow Port wells; 1 new well; HC99-B31; and 6 new mini-piezometers. Locations shown on Figure 1.	< 1 week
13	Hydraulic conductivity testing	Evaluate hydraulic conductivity of surrounding peat horizons to support refinements in cap modeling or to support groundwater/surface water model.	Aspect	Yes	Prior to 2014 Design	Conduct slug tests in up to four wells, including: one new well; HPA1-3; HPA1-1; and HC99-B31. Locations shown on Figure 1.	1 day
14	Temperature	Evaluate temperature fluctuations between Lora Lake, Miller Creek, and groundwater to further support gaining/losing sections in Miller Creek.	Aspect	Yes	Winter 2013–Wet Season	Same locations as installation of micro-divers in select monitoring wells and mini-piezometers.	1 year

Table 2
Lora Lake Parcel Design Data Collection Scope Details

Data Need Number (Refer to Table 1)	Data	Purpose/Notes	Lead Firm	Field Event Required	Timing of Field Event/ Data	Data Collection Locations	Duration of Data Collection
Other Data							
15	Utility survey	This will be used in the design of the stormwater conveyance system. Information needed includes: direction the gradings will be for final design, slopes and cutback, utilities, curbage, slope and direction of inlet pipe to lake from Lora Lake Apartments, invert elevation, utility pole/signal equipment for Des Moines Memorial Drive, storm and sewer pipe (location of pipe, invert elevation and slope or upstream invert elevation), and any other overhead or underground utilities (gas, power/communication, etc.) that may be in the vicinity.	SvR	Yes	Prior to 2014 Design	Conduct survey throughout Lora Lake Parcel and adjacent Des Moines Memorial Drive right-of-way.	< 1 week
16	Topographic survey of the Lora Lake Parcel	This will be the design base and would support hydraulic modeling. Information needed includes: ground elevation, minimum 2-foot contours, and spot elevations at critical points (top of berm and weir locations).	F|S	Yes	Prior to 2014 Design	Refer to #15 above.	< 1 week
17	Hydraulic model for reach including the KC gauge and project site—with Miller Creek	This would be the tool that would support an assertion that the changes to Lora Lake would not impact geomorphically-significant flows in Miller Creek. Also need to understand the original design criteria for the Miller Creek relocation reach from a flooding perspective.	SvR and ESA	No	Late 2013	NA	Late 2013
18	Basin Committee MGS flood runoff model	Estimates the largest inflow component of the water budget, and will need to be routed through the post-project wetland. Hopefully a sub-basin draining to the lake is available.	ESA	No	Late 2013	NA	Late 2013

Notes:

The wet season, standard and assumed for the mitigation area monitoring is generally considered October 31–April 15. If we are able to execute the needed winter field events by end of February that should be adequate timing, giving us an adequate understanding of the hydroperiod—prior to the start of the growing season.

1 Cost includes cost for field preparation, field implementation, and data organization and storage. Costs for detailed data analysis and interpretation are NOT included. Cost includes preliminary evaluation of data to ensure quality and usability of collected data only. Costs for detailed evaluation and analysis will be scoped as a separate phase. Field work would consist of a 2-day effort, with two staff persons to initially install and set up monitoring equipment/loggers for Needs 1, 2, 3, 5, and 6. Monthly site visits would occur during the next 11 months to download data and make manual measurements for Needs 1, 2, 3, 5, and 6. This would be accomplished in a single day by one staff person.

Abbreviations:

Aspect Aspect Consulting
AV Area Velocity
ESA Environmental Science Associates
F|S Floyd|Snider
ISCO Teledyne Isco
KC King County
MGS MGS Engineering Consultants
NA Not applicable
Port Port of Seattle
SvR SvR Design
USGS U.S. Geological Survey
WSDOE Washington State Department of Ecology

Table 3
Lora Lake Design Data Collection Field Details—for Scope Development Support

Data Need Number (Refer to Table 1)	Data	Port Equipment to be Used	Additional Instrumentation Required	Data Collection and Data Analysis Methods	Data Collection Locations	Field Staff Lead	Existing Data/ Dedicated Equipment
Surface Water Data							
1	Lake Lora water level (continuous)	Hobo U20 water level logger, 3.33 feet staff gauge section.	None, pending inspection of Port equipment.	Install staff gauge and water level logger, record water level at 15-minute intervals. Confirm operation during site visit to inspect and download data.	Install staff gauge and water level logger at outlet from lake to creek. One location, shown on Figure 1.	Aspect to deploy, Port to inspect, download	None.
2	Lora Lake inlet flows—stormwater outfall (velocity and depth measurements)	ISCO AV Sensor, logger, and cable.	None, pending inspection of Port equipment, other than bucker/stopwatch for manual measurements.	Install ISCO AV sensor and logger in stormwater inlet pipe, record inflows at 15-minute intervals. Confirm data with manual measurements during site visit to inspect and download data.	Install ISCO AV sensor in pipe at location at inlet to lake, shown on Figure 1.	Port to install flow meter in outfall inlet to the lake. Aspect to perform individual measurements—monthly or storms	Can also use stormwater to model inflow to lake; this data collection item would be used to double check model.
3	Lake outlet flows	None.	Pygmy meter or Sontek Flowtracker.	Monthly measurements of outflow with area-velocity method.	Measure flows at lake outlet. One location, shown on Figure 1.	Aspect to deploy, Port to inspect, download	None.
4	Lora Lake features and berm survey	Port Survey Crew to conduct work.	None.	Data provided by Port Survey Crew to LLA Team in NAVD 88 and NAD 83.	Survey seven locations along creek and lake. Locations shown on Figure 1.	Port	None.
5	Other surface water levels (wetland area between creek and lake)	Hobo U20 water level logger, 3.33 feet staff gauge section.	None, pending inspection of Port equipment.	Install staff gauge and water level logger, record water level at 15-minute intervals. Confirm operation during site visit to inspect gauge and download data.	Install staff gauge and water level logger in wetland area between lake and creek. One location, shown on Figure 1.	Aspect to deploy, Port to inspect, download	None.
6	Stream gauging (water level and flow monitoring in Miller Creek)	Two Hobo U20 water level loggers or ISCO equipment TBD, one 3.33 feet staff gauge section.	Stream Flow Measurements using FlowTracker for manual measurements, provided by Aspect. Will utilize two existing staff gauges up and downstream of lake.	Install new staff gauge in creek at lake outlet, install water level logger at new staff gauge and existing staff gauge near power lines. Water levels will be recorded at 15-minute intervals, manual measurements will be made using FlowTracker during site visits. Analysis will include using existing KC gauge data located upstream of Lora Lake.	Install new staff gauge in creek at lake outlet, install water level logger at new staff gauge and existing staff gauge near power lines. Utilize data from existing KC gauge location upstream of Lora Lake.	Aspect to deploy, Port to inspect, download	Would utilize existing staff gauge installed in creek near power lines, and existing KC flow data from gauge located upstream of lake.
7	Dissolved oxygen measurements	Handheld YSI 550A available at stormwater lab.	Lora Lake/Miller Creek pairs.	Not collected at this time.	NA	NA	NA
8	Temperature sensors in Lora Lake and Miller Creek	Port level loggers also record temperature if this is sufficient.	In Lora Lake (toward the rim, rather than at depth) and in the creek near the outlet.	Not collected at this time.	NA	NA	NA
Groundwater Data							
9	Existing groundwater level data	None (not enough ISCO pressure transducers).	Six Schlumberger Micro-Divers.	Manual water level measurements will be made on a quarterly basis using a Waterline water level indicator. Micro-divers will be installed in select wells and downloaded. Hydrographs and contours developed by Aspect (or F|S).	Quarterly groundwater level monitoring to be completed in 26 wells, including: 17 Lora Lake Apartments wells; 4 Third Runway wells; 4 shallow Port wells; and 1 new well. Micro-divers to be installed in up to six wells: one new well; four shallow Port wells (assuming they are not already instrumented); and HC99-B31.	Aspect to conduct quarterly groundwater monitoring events, Port to conduct monthly Micro-divers downloading	One shallow well south of lake has years of data, and one well north of lake has some data.
10	Additional monitoring well	None.	None.	Install monitoring well using hollow stem auger drilling techniques. Assumes Port will construct access off of access road to north of lake. Develop well using pump and surge techniques with a Waterra Hydrolift pump.	One new monitoring well location north of Lora Lake, shown on Figure 1.	Aspect	Data gaps around lake, NW area—no wells. Existing shallow wells are likely representative of both groundwater and surface water.
11	Mini-piezometers	None (not enough ISCO pressure transducers).	Six Solinst 615N Stainless Steel Drive Points (7-foot length).	Install new shallow mini-piezometers by hand. Install micro-divers in mini-piezometers and download.	At three paired locations along Miller Creek, shown on Figure 1.	Aspect to install, Port to inspect, download	None.
12	Monitoring well and surface water elevation survey	Port Survey Crew to conduct work.	None.	Data provided by Port Survey Crew to LLA Team in NAVD 88 and NAD 83.	Survey 12 monitoring well and mini-piezometer locations, including: 4 shallow Port wells; 1 new well; HC99-B31; and 6 new mini-piezometers shown on Figure 1.	Port	Existing Lora Lake Apartments wells have already been surveyed as part of the RI/FS.
13	Hydraulic conductivity testing	None.	Slug rods and PT2X pressure transducer.	Displacement slug tests will be performed using slug rods and analyzed using AQTESOLV.	Conduct slug tests in up to four wells, including: new well; HPA1-3; HPA1-1; and HC99-B31, shown on Figure 1.	Aspect	None.
14	Temperature	None (not enough ISCO pressure transducers).	Schlumberger Micro-Divers installed in select monitoring wells and mini-piezometers also measure temperature.	Install micro-divers in select wells and mini-piezometers.	Same monitoring wells and mini-piezometers as above.	Aspect	Existing temperature data for shallow wells as part of mitigation monitoring.

Table 3
Lora Lake Design Data Collection Field Details—for Scope Development Support

Data Need Number (Refer to Table 1)	Data	Port Equipment to be Used	Additional Instrumentation Required	Data Collection and Data Analysis Methods	Data Collection Locations	Field Staff Lead	Existing Data/ Dedicated Equipment
Other Data							
15	Utility survey	Port Survey Crew to conduct work.	None.	Data provided by Port Survey Crew to LLA Team in NAVD 88 and NAD 83. Elevation data used by SvR for plan development.	Not conducted at this time.	NA	Port will likely have utilities info from within the LL Apartments Parcel.
16	Topographic survey of the Lora Lake Parcel	Port Survey Crew to conduct work.	None.	Data provided by Port Survey Crew to LLA Team in NAVD 88 and NAD 83. Contours developed by Aspect (or F|S) or Port PMG.	Not conducted at this time.	Port	Existing topographical.
17	Hydraulic model for reach including the KC gauge and project site—with Miller Creek	Team to obtain model from Port/ Port to run model.	None.	Not conducted at this time.	Not conducted at this time.	None	Existing model.
18	Basin Committee MGS flood runoff model	Team to obtain model from Port/ Port to run model (Bruce Barker at MGS has this model).	None.	Not conducted at this time.	Not conducted at this time.	None	Existing model.

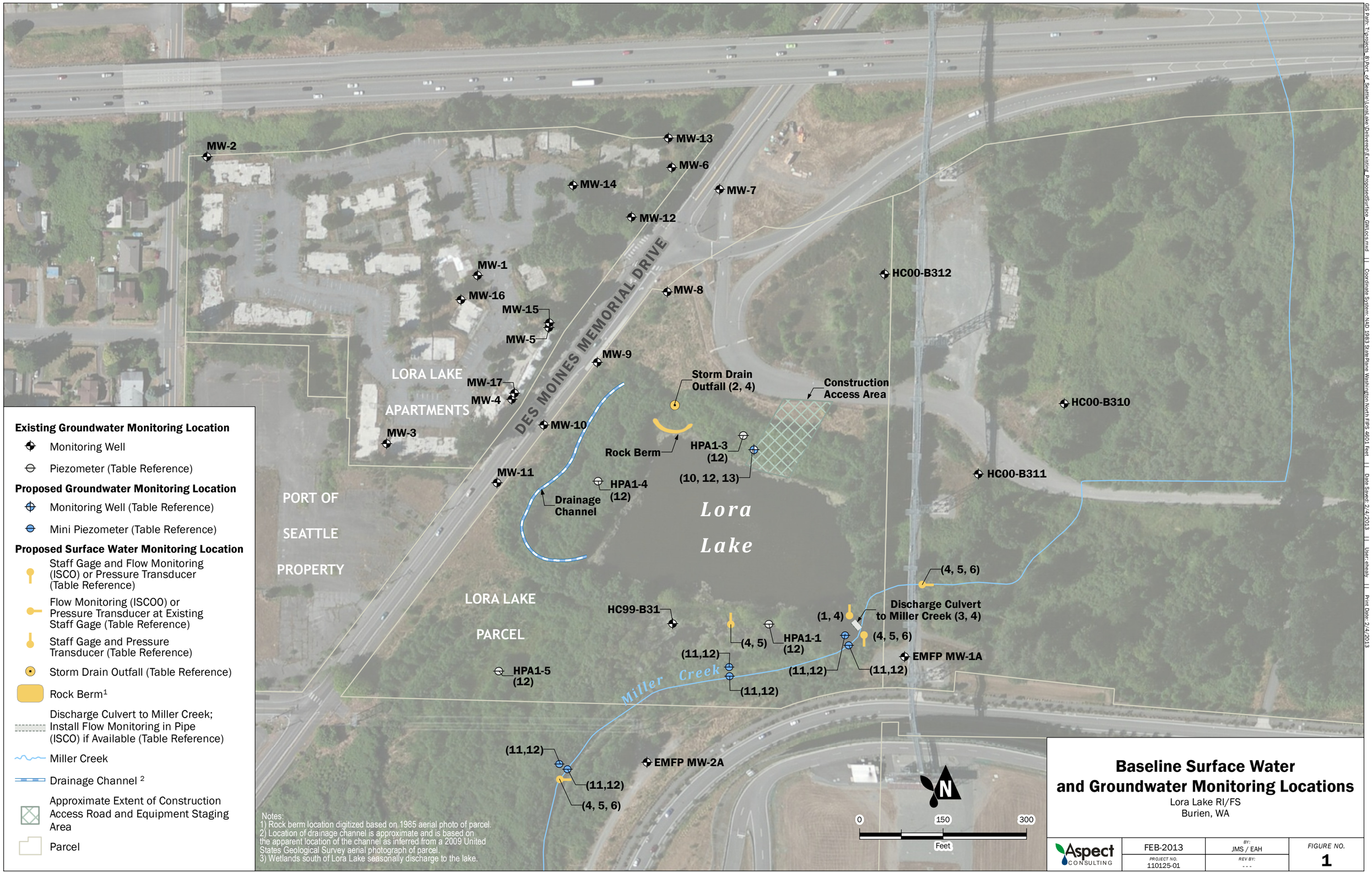
Notes:

Port available monitoring equipment
ISCO AV Sensors: Five ready to deploy (lengths of 12, 20, 20, 25, and 25 feet).
ISCO AV Extension Cables: Three (lengths 10, 20, and 20 feet).
ISCO 4150 AV Flow Loggers: Two working and deployable.
ISCO Pressure Transducers: Three (lengths of 50, 10, and 10 feet).
ISCO 4120 Submerged Probe Loggers: One working, one that has not been tested (but believed to be working).
The AV Sensors and Pressure Transducers require separate loggers (4150's and 4120's respectively) that run on two 6-Volt batteries. Batteries need frequent replacement and are purchased as needed.
Rubbermaid Housings: Eight, appropriately sized.
Scissor Rings: We have the base sections and extension components to build both a 12-inch and 24-inch installation, but do not have any serviceable scissor mechanisms, as they are all currently deployed.
Staff gauges: In-house we have five lower portions (from 0–3.3 feet) and one upper portion (from 3.3–6.7 feet).
Hobo U20 Water Level Logger

Abbreviations:

AQTESOLV	Aquifer Test Solver
Aspect	Aspect Consulting
AV	Area Velocity
ESA	Environmental Science Associates
F|S	Floyd|Snider
ISCO	Teledyne Isco
KC	King County
LLA	Lora Lake Apartments
MGS	MGS Engineering Consultants
NA	Not applicable
NAD 83	North American Datum of 1983
NAVD 88	North American Vertical Datum of 1988
NW	Northwest
PMG	Project Management Group
Port	Port of Seattle
RI/FS	Remedial Investigation/Feasibility Study
TBD	To be determined
SvR	SvR Design

Figure



Existing Groundwater Monitoring Location

- Monitoring Well
- Piezometer (Table Reference)

Proposed Groundwater Monitoring Location

- Monitoring Well (Table Reference)
- Mini Piezometer (Table Reference)

Proposed Surface Water Monitoring Location

- Staff Gage and Flow Monitoring (ISCO) or Pressure Transducer (Table Reference)
- Flow Monitoring (ISCOO) or Pressure Transducer at Existing Staff Gage (Table Reference)
- Staff Gage and Pressure Transducer (Table Reference)
- Storm Drain Outfall (Table Reference)
- Rock Berm[1]
- Discharge Culvert to Miller Creek; Install Flow Monitoring in Pipe (ISCO) if Available (Table Reference)
- Miller Creek
- Drainage Channel [2]
- Approximate Extent of Construction Access Road and Equipment Staging Area
- Parcel

Notes:
1) Rock berm location digitized based on 1985 aerial photo of parcel.
2) Location of drainage channel is approximate and is based on the apparent location of the channel as inferred from a 2009 United States Geological Survey aerial photograph of parcel.
3) Wetlands south of Lora Lake seasonally discharge to the lake.

Baseline Surface Water and Groundwater Monitoring Locations

Lora Lake RI/FS
Burien, WA

Aspect Consulting			
	FEB-2013	BY: JMS / EAH	FIGURE NO. 1
	PROJECT NO. 110125-01	REV BY: ---	