Groundwater Remedy Compliance Monitoring Plan

Bee-Jay Scales Site
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Sign-off Sheet

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1.0 Introduction

Stantec Consulting Services Inc. (Stantec) is submitting this *Groundwater Remedy Compliance Monitoring Plan* (GW CMP) to the Washington Department of Ecology (Ecology) for the Bee-Jay Scales Site (the Site), on behalf of Chevron Environmental Management Company (CEMC) and Remediation Management Services Company (RMSC), on behalf of Atlantic Richfield Company (ARC) and American Oil Company (Amoco). The GW CMP has been prepared under the provisions of the Washington State Model Toxics Control Act (MTCA) Washington Administrative Code (WAC) 173-340 (WAC, 2007) to address Consent Decree No. 132017660 between Ecology, Chevron Chemical Company, and Amoco (Ecology, 2013).

The GW CMP was originally submitted to Ecology on April 14, 2017 and has been revised per Ecology's comments in letters dated November 2, 2017 and December 10, 2018, which are included in **Appendix A** along with Stantec's responses to comments.

This GW CMP details the compliance monitoring that will be implemented at the Site during the groundwater cleanup action as detailed in the *Groundwater Remedy Engineering Design Report* (GW EDR), dated November 15, 2016 (Stantec, 2016) and the *Groundwater Remedy Construction Plans and Specifications* (GW CPS), dated May 1, 2019 (Stantec, 2019). The objectives of the compliance monitoring are to:

1) Monitor for potential adverse effects in order to protect human health and the environment during cleanup actions;

2) Verify that the Site-specific cleanup levels (CULs) have been achieved during the cleanup actions; and

3) Confirm the long-term effectiveness of the cleanup actions.

Elements of the GW CMP address requirements of WAC 173-340-410 (WAC, 2007), including but not limited to:

- A description of the chemical, biological, and physical parameter testing required during the implementation of the groundwater remedy;
- A description of the required documentation of observations to check the performance of institutional controls (ICs) implemented as part of the groundwater remedy;
- A sampling and analysis plan meeting the requirements of WAC 173-340-820 which shall explain how the above objectives will be met;
- Data analysis and evaluation procedures used to demonstrate and confirm compliance and justification for these procedures; and

- A description of any statistical methods to be used.

1.1 SITE DESCRIPTION

1.1.1 Site Description

The Site is located in the City of Sunnyside (City), within Yakima County, and includes the two parcels where contaminants were historically released and the parcels where those contaminants have come to be located. The Site location is shown on **Figure 1**.

The two parcels where contaminants were historically released include Parcel No. 22102522014, located at 116 North 1st Street and owned by Bee-Jay Scales, Inc. (BJS), and Parcel No. 22102522015, located at 301 Warehouse Avenue and owned by Western General Land, LLC (WGL).

Historical releases from the BJS and WGL parcels have impacted the groundwater at those parcels and have extended down-gradient to affect several additional parcels. As of August 2015, the following parcels are affected by the contaminant groundwater plumes as defined by the GW EDR: 22102522016, 22102522902, 22102522903, 22102522555, 22102522502, 22102523416, 22102523417, 22102523418, 22102523419, 22102523420, 22102523421, 22102523437, 22102523438, 22102523439, 22102523440, 22102523441, and 22102523901.

The Site layout, including parcel numbers, monitoring well locations, the extent of contaminants (as of August 2015), and other important features, is shown on **Figure 2**.

1.2 GROUNDWATER REMEDY ACTIVITIES

The remediation of the Site groundwater and saturated soil will include a combination of enhanced in-situ bioremediation (EISB) and monitored natural attenuation (MNA). In addition, ICs will be implemented to protect human health from potential harm during the cleanup action. The GW EDR and GW CPS detailed the design of each of these components.

1.2.1 Groundwater Remedy Objectives

The objectives for the groundwater cleanup action as established by the cleanup action plan (CAP; Ecology, 2013) and described in the GW EDR are to:

- Mitigate potential for ingestion of groundwater with nitrate in excess of the Federal maximum contaminant limit (MCL) of 10 milligrams per liter (mg/L) by Site receptors by reducing nitrate concentrations in groundwater to less than 10 mg/L; and

- Design a groundwater remediation system, to the extent practicable, to reduce the potential for impacted groundwater from the Site to infiltrate storm/irrigation drains that may discharge to surface water. If it is determined that any contaminated groundwater from the Site is infiltrating storm or irrigation drains and adversely affecting surface water quality, the groundwater cleanup action shall prevent or remove the contamination so that surface water cleanup standards are met.

1.2.2 Groundwater Cleanup Standards

Though nitrate in groundwater above the MCL of 10 mg/L is the primary driver, CULs have been established for 24 constituents for groundwater at the Site. The constituents, CULs, and basis for the CUL are shown in **Table 1**. Per WAC 173-340-703, when defining cleanup requirements at a site that is contaminated with a large number of hazardous substances, some of those substances may be eliminated from consideration where those substances contribute a small percentage of the overall threat to human health and the environment. The remaining hazardous substances shall serve as indicator hazardous substances (IHSs) for purposes of defining cleanup requirements.

Twelve groundwater IHSs have been identified from the 24 groundwater constituents based on the remedial investigation and feasibility study process completed for the Site. The 12 Site groundwater IHSs were identified in the CAP and are shown in **bold** in **Table 1**. Only the IHSs are planned to be used to monitor compliance with the Site cleanup requirements.

Per the GW EDR, an arsenic remediation level (RL) of 0.04 mg/L has been applied to the Site groundwater remedial action per WAC 173-340-355. The groundwater arsenic CUL will remain as a requirement for the completion of the groundwater remedial action at the Site, unless Ecology approves an area background concentration for arsenic at a later date. A discussion regarding the application of the groundwater arsenic RL within the overall Site groundwater remedy is provided in **Section 3.3.2**.

The points of compliance (POC) for Site groundwater constituents are defined in the CAP as monitoring wells MW-4R, MW-5R, MW-6, and MW-12R, and all monitoring wells, including those to be constructed as part of the remedial action, that are located down-gradient of those wells. The POC includes all groundwater from the POC to the outer boundary of the Site plume. This plume is considered to apply to groundwater that has migrated from the BJS and WGL parcels, and any other sources would need to be considered separately. If monitoring of groundwater in the boundary wells shows that nitrate concentrations exceed the Site-specific CUL, additional groundwater monitoring wells may be constructed to define the Site plume and sampling may be conducted pursuant to a contingency plan as required by the CAP.

1.2.3 Groundwater Remedy Description

The implementation of EISB to address the Site groundwater plume will utilize groundwater injection wells to optimize the groundwater conditions for bioremediation processes to breakdown nitrogen-containing IHSs. Because the Site groundwater plume spans several different properties where land use makes access difficult, the EISB injections wells will be limited to five injection well lines and utilize a passive treatment approach to limit disruption to property owners. The installation of the EISB injection wells will be completed in two phases. The first phase will involve the installation of 10 EISB injection wells within the planned injection well lines.

The EISB groundwater remedy system (EISB system) optimization data collection and monitoring will be conducted during Phase I, and is detailed in **Section 2.0**. The data obtained during Phase I will be used to optimize the design of the full-scale EISB system, which will be completed with the Phase II EISB injection well installation. The full-scale EISB system will combine the Phase I and Phase II EISB injection wells.

The five EISB injection well lines and 10 Phase I injection well locations are shown on **Figure 3**. Once Phase II is complete, each injection well line is intended to create a continuous groundwater treatment zone which will influence shallow groundwater conditions to treat the Site IHSs down-gradient of the injection well lines. The selection of the Phase I EISB injection well locations was made to obtain representative data throughout the EISB system footprint, favor locations near existing monitoring wells to allow for the collection of additional data during the EISB system optimization monitoring, and limit disruption to commercial businesses and traffic during the Phase I injection activities.

2.0 EISB System Optimization Data Collection and Monitoring

Data collection and monitoring will be implemented during the Phase I EISB system implementation with the objective of optimizing the design of the Phase II EISB injection wells and the operating parameters of the full-scale EISB system. Ten Phase I EISB injection wells will be installed and used for EISB system optimization data collection and monitoring.

One or more of the following sampling scopes and/or tests will be implemented at each of the Phase I EISB injection wells:

- Collection of soil samples from the aquifer formation for laboratory analysis;
- Collection of soil samples from the aquifer formation for grain size analysis;
- Slug testing;
- Injection well capacity testing; and
- Tracer injection testing.

A detailed description for the implementation of each of the above sampling scopes and tests is described in the following sections.

2.1 SOIL SAMPLING FOR LABORATORY ANALYSIS

Laboratory analysis of Site IHSs and important parameters in the denitrification process will provide a better understanding of the conditions across the horizontal and vertical profile of the Site groundwater plume. Three soil samples will be collected for laboratory analysis at each of the Phase I EISB injection well locations (total of 30 soil samples) at depths between 10-15, 15-20, and 20-25 feet below ground surface (bgs). Based on historical Site data, the first indication of saturated conditions is expected at depths less than 15 feet bgs in all Phase I EISB injection well locations. If saturated conditions are not indicated above 15 feet bgs during soil boring advancement, the top soil sample will be collected from the 14-15 feet bgs interval. Soil samples for laboratory analysis will be collected following the procedures detailed in **Section 4.2.1**.

The soil samples will be submitted to Eurofins Lancaster Laboratories (Lancaster) in Lancaster, Pennsylvania for analysis of the following:

- Nitrate and sulfate by United States Environmental Protection Agency (EPA) Method 300.0;
- Ammonia by EPA Method 350.3;
- Arsenic, iron, and manganese by EPA Method 6010B; and

- Total organic carbon (TOC) by EPA Method 9060A.

The soil samples will also be submitted to Stantec's Treatability Testing Services Group in Sylvania, Ohio to measure reductant demand. The proposed EISB system will involve the adjustment of subsurface redox conditions within the Site groundwater plume. The soil reductant demand results will evaluate the effort required to achieve and maintain these conditions during the overall remediation timeframe.

2.2 GRAIN SIZE ANALYSIS

Grain size analysis will be used to supplement the existing data from the aquifer formation collected during previous assessment activities and will provide a more thorough picture of the aquifer formation across the horizontal and vertical profile of the Site groundwater plume. Soil samples for grain size analysis will be collected from each of the Phase I EISB injection wells during advancement at depths between 10-15, 15-20, and 20-25 feet bgs (total of 30 samples). Grain size soil samples will be collected at the three indicated intervals regardless of soil saturation at the time of soil boring advancement.

Soil samples for grain size analysis will be collected following the procedures detailed in **Section 4.2.1**. The grain size soil samples will be submitted to Baer Testing, Inc. in Yakima, Washington for soil classification and grain size by sieve analysis using American Society for Testing and Materials (ASTM) Method C136.

2.3 SLUG TESTING

Slug testing will be performed at each of the installed Phase I EISB injection wells to measure the horizontal hydraulic conductivity. These data will be used to supplement previous hydraulic conductivity data obtained from Site well locations. These data may help to indicate instances of local heterogeneity in the aquifer formation and possible preferential flow pathways causing the Site contaminant plumes to present tangentially to the southeast groundwater flow direction indicated by groundwater elevation data collected at the Site.

During a slug test, the water level in a groundwater well is changed rapidly and the rate of water-level response to that change is measured. The slug testing will be performed per the procedures detailed in **Section 4.2.2**. Aquifer testing software (AQTESOLV or equivalent) will be used to analyze the data from the slug testing and calculate the hydraulic conductivity of each test location.

The slug test results will be reported in summary tables identifying the monitoring well ID, test date, test type (rising head and/or falling head), the solution method(s) used, and the estimated hydraulic conductivity. The aquifer testing software charts will be provided to support the analysis summarized in the tables.

2.4 INJECTION WELL CAPACITY TESTING

Injection well capacity testing (injection testing) will verify the achievable injection rate(s) within the aquifer formation. The implementation of injection testing at each of the Phase I EISB injection wells will also indicate the degree of heterogeneity within the aquifer formation and indicate where different injection rates are expected within the groundwater plume.

The injection testing will be implemented at each of the Phase I EISB injection wells. During injection testing a set volume of the EISB injection solution will be injected, and injection rates and pressures will be monitored. The injection volume will be set based on the well screen length to provide a target radius of influence (ROI) of 10 feet assuming a high mobile porosity as defined in the GW CPS. If possible, the injection volumes for subsequent Phase I EISB injections will be optimized based on the data obtained during the tracer injection test.

The injection testing will be implemented, where possible, to multiple injection wells concurrently utilizing the injection manifold and piping plan detailed in the GW CPS. The injection testing will seek to maximize the injection rate to each injection well while attempting to limit the well head gauge pressures below 2 to 3 pounds per square inch (psi).

Injection operating parameters will be monitored and recorded throughout the injection testing as follows:

- Injection batch number;
- Injection batch volume;
- Sodium acetate and sodium triphosphate batch injection mass;
- Injection batch start and end time;
- Total batch injection volume at each injection well;
- Calculated average injection rate during each batch injection; and
- Operating well head gauge pressures will be monitored and recorded at least every hour during injection.

The injection operating parameters will be documented on an injection system log and well injection log (examples included in **Appendix B**). The injection testing at each injection well will stop when the total injection volume delivered to the injection well reaches the design injection volume.

Where existing monitoring wells are located within 10 feet of the Phase I injection well, the following monitoring and/or sampling activities will be completed at the monitoring well during injection testing:

- Groundwater elevations will be measured at least twice per day (prior to starting injection activities that day and at the conclusion of injection activities for the day); and
- Grab groundwater samples will be collected to perform laboratory analysis of biochemical oxygen demand (BOD) before the start of injection activities and at the conclusion of injection activities.

Procedures for the groundwater monitoring and sampling activities described above are detailed in **Section 4.2.3**.

2.5 TRACER INJECTION TEST

Tracer injection testing will be used to provide detailed data for the determination of the injection volume/ROI relationship, solute dilution ratio, and solute washout rates in the Site aquifer formation.

The tracer test will be implemented at injection well IW-1-1 under the same operating parameters as the injection well capacity testing at that location. This injection well will be located within IW Line #1 approximately 10 feet north-northwest of existing monitoring well MW-5R. This will allow for well MW-5R to be used as one of the injection observation wells during the tracer testing. Three additional injection observation wells will be installed within the anticipated 10-foot injection zone (ROI) of the tracer test. An additional injection observation well (OW-1) will be installed in-line between well IW-1-1 and well MW-5R, approximately 5 feet from each. The remaining two observation wells (OW-2 and OW-3) will be installed in-line 5 feet and 10 feet east-northeast of injection well IW-1-1, perpendicular to the other injection observation wells. The layout of the tracer test injection well and observation wells is shown on **Figure 4**. The injection observation well installation details are provided on **Figure 5**.

The tracer test will utilize an organic fluorescent dye as the tracer compound. Based on the high organic carbon concentrations and reducing environment resulting from the EISB groundwater remedy, fluorescein, eosine, and rhodamine WT are considered the best options for the tracer compound. Pre-injection groundwater samples will be collected to assess if compounds are present at the Site that interfere with the potential fluorescent dyes and to assess the interaction of those potential dyes with the planned EISB injection solution. Pre-injection groundwater samples for fluorescent dye analysis will be collected from the existing groundwater monitoring wells MW-3, MW-4R, MW-5R, and MW-12R during a baseline groundwater sampling event at the Site. The groundwater samples will be collected using the procedures detailed in **Section 4.2.3**. The pre-injection groundwater samples will be submitted to Ozark Underground Laboratories (Ozark) in Protem, Missouri. Once the tracer compound assessment is complete and a tracer compound has been selected, Stantec will communicate the results and the injection concentration to be used in a technical memorandum to Ecology for approval.

The tracer test monitoring and sampling can be divided into two phases, the injection phase and the drift phase. The injection phase involves frequent sampling during injection, and the drift phase involves periodic sampling after injection has been completed.

Groundwater samples will be collected during the injection phase of the tracer test from the injection and observation wells at least daily throughout the injection activities. The groundwater samples will be collected using the procedures detailed in **Section 4.2.3**. The groundwater samples will be submitted to Ozark and/or, if fluorescein or rhodamine WT is selected as the tracer compound, the Stantec Fresno, California office for analysis of the tracer compound concentration. The Stantec Fresno, California office maintains a Picofluor™ model 8000-004 fluorometer that can analyze water samples for fluorescein or rhodamine concentrations.

Groundwater samples will be collected during the drift phase of the tracer test from the injection and observation wells at least four times on the same schedule as the EISB performance monitoring samples detailed in **Section 3.2.2.1**. The groundwater samples will be collected using the procedures detailed in **Section 4.2.3**. The groundwater samples will be submitted to Ozark and/or the Stantec Fresno, California office for analysis of the tracer compound concentration.

3.0 Compliance Monitoring

Compliance monitoring will be implemented at the Site throughout the groundwater cleanup action pursuant to the provisions of WAC 173-340-410 (WAC, 2007). The main objectives of compliance monitoring are to: 1) protect human health and the environment during cleanup actions; 2) measure the effectiveness of both EISB and MNA process implementation at the Site; 3) verify that the Site-specific groundwater CULs have been achieved during the cleanup actions; and 4) confirm the long-term effectiveness of the cleanup actions.

This section details the planned compliance monitoring at the Site during the groundwater cleanup action.

3.1 PROTECTION MONITORING

Protection monitoring refers to monitoring enacted during the groundwater cleanup action to adequately protect human health and the environment. The groundwater cleanup activities will be conducted under a Site-specific *Groundwater Remedy Health and Safety Plan* (GW HASP), which will be submitted to Ecology for review prior to implementation pursuant to WAC 173-340-810 (WAC, 2007).

The objective of the GW HASP is to identify potential hazards associated with the groundwater cleanup activities and establish the mandatory safety practices and procedures that will be implemented to mitigate those hazards. The GW HASP will detail the full range of protection monitoring that will be implemented throughout the groundwater cleanup activities during construction, operation, and monitoring of the system. This protection monitoring will include air monitoring of fugitive vapors and noise monitoring of construction activities. The requirements of this protection monitoring are discussed in further detail below.

3.1.1 Air Monitoring

Real-time air monitoring will be conducted for both on-site worker and public receptor protection. Continuous real-time air monitoring will be conducted within the work area breathing zone during any soil disturbance activities associated with the advancement of soil borings for the installation of EISB injection wells or monitoring wells and during groundwater sampling activities.

The air monitoring program will monitor for volatile compounds including ammonia. The air monitoring will utilize a MultiRAE with a photo ionization detector (PID) with a 10.6 electron volt (eV) lamp and ammonia sensor. The MultiRAE air monitor will report both total volatile organic compounds (VOC) concentrations and ammonia concentrations in air. The 10.6 eV lamp can measure any VOC or volatile inorganic parameter with an ionization potential (IP) less than 10.6 eV, such as: 1,2,4-trimethylbenzene, 1,3,5-trimethylbenzene, benzene, chlorobenzene, ethylbenzene, naphthalene, toluene, xylenes, acetone, 2-butanone, ammonia, and many others.

The monitoring device will be programmed to read continuously, record data in 1-minute averages, and alert at the action levels described in the GW HASP.

If action levels are exceeded within the work area, air monitoring will also be implemented at the downwind boundary of the work area exclusion zone for the protection of public receptors. The air monitoring at the work area boundary will be conducted for a period of at least 5 minutes and results will be documented separately from the work area breathing zone results. If action levels are exceeded at the work area boundary, additional mitigation actions will be required including one or more of the following actions:

- Extending the work area exclusion zone so action levels are not exceeded at the exclusion zone boundary;
- Implementing additional mitigation controls to reduce the volatile compound concentrations; and
- Stopping work to allow concentrations to fall below the action level(s).

Additional details regarding the air monitoring program for the groundwater remedy activities will be provided in the GW HASP.

<u>Air Monitoring Equipment Maintenance</u>

The calibration and maintenance of the air monitoring equipment will follow the equipment-specific operation manuals. Air monitoring equipment will not be used if the unit is displaying an error code. In this case, the equipment will either be repaired, or new properly functioning equipment will be obtained before proceeding with work. All air monitoring equipment will be calibrated each day before use and documented on a calibration log. Blank calibrations logs will be provided in the GW HASP.

<u>Air Monitoring Reporting</u>

The documentation of all real-time air monitoring will be collected and maintained by Stantec for the duration of the project. Documentation of each day's air monitoring will be grouped together in the GW HASP. Documentation will include observations documented to the air monitoring logs and the complete data logs for the monitoring equipment used. Calibration logs will be maintained for each air monitoring device and included in the GW HASP.

3.1.2 Noise Monitoring

Real-time noise monitoring will be conducted for both on-site worker and off-site public protection. Noise monitoring will require a noise survey for each of the following pieces of equipment planned for use during the groundwater remedy activities: air knife/vacuum truck, hollow stem auger drill rig, well development rig, and generator for the EISB injection system. Real-time noise monitoring will be conducted with a hand-held sound level meter. The action level for noise monitoring will be 80 decibels A-scale (dBA). The noise monitoring survey for each of the above pieces of equipment will be conducted to:

- Assess the noise levels within the work area during normal operation of the equipment;
- Verify mitigation procedures and personal protective equipment (PPE) are sufficient to protect workers from the noise levels associated with the equipment as required in the GW HASP;
- Establish the distance around each piece of equipment in four directions (front, back, and both sides) where the average noise level during the normal operation of the equipment exceeds the noise action level; and
- Determine when signs warning of high noise levels will be required for public receptors beyond the work area exclusion zone.

Data obtained during a noise monitoring survey will be documented to a Noise Monitoring Survey Log Sheet provided within the GW HASP. Once a noise monitoring survey has been completed for a piece of equipment, no additional noise monitoring will be required for that specific equipment, and the data documented within the survey will be used to establish the hazard mitigation requirements.

3.2 PERFORMANCE MONITORING

Performance monitoring refers to sampling conducted to confirm that the cleanup action has attained the Site-specific cleanup criteria at the POCs identified in the Site CAP and to verify performance standards such as construction quality control measurements and EISB system operating parameters.

3.2.1 Injection Well Installation Performance Monitoring

Performance monitoring will be conducted and documented to verify the EISB system meets the requirements set forth in the GW CPS. Performance monitoring of the EISB injection well installations will include documentation of the soil boring advancement, injection well construction, and injection well development.

The documentation of the soil boring advancement and EISB injection well as-built details will include the following:

- Borehole drilling method;
- Borehole diameter;
- Borehole depth;
- Soil lithology observed within the soil boring;

- Soil sample collection depth and time;
- Well screen specifications, including:
  - Well screen material, diameter, screen slot size, screen configuration, and installed depth;
- Well casing material and diameter;
- Filter pack specifications, including:
  - Filter pack material and installed depth;
- Annular seal specifications, including:
  - Annular seal material, installed depth, and method of installation;
- Well monument specifications; and
- The horizontal and vertical location of the installed injection well.

The soil boring/injection well as-built details will be documented to soil boring and well detail logs. With the exception of the horizontal and vertical location of the injection wells, the above as-built details will be collected based on field observations of materials and well measurements using weighted measuring tapes. The horizontal and vertical location of each installed EISB injection well will be recorded by a licensed surveyor measuring the well top-of-casing and the adjacent ground surface. Examples of the soil boring and well detail logs are included in **Appendix B**.

Injection Well Development Performance Monitoring

Injection well development will use a combination of pressure surging and pumping to optimize the injection performance of the wells as detailed in the GW CPS. Performance monitoring will be implemented to track the well development progress. The performance monitoring will include:

- The measurement of depth-to-groundwater throughout the well development process;
- The volume of water pumped from the well during each stage of development; and
- The water quality parameters of water pumped from the well including turbidity, dissolved oxygen (DO), conductivity, pH, temperature, and oxidation-reduction potential (ORP).

Depth-to-groundwater measurements will be made using an electronic interface probe throughout the well development process as follows:

- Prior to starting well development;
- Prior to the start of each phase of pumping from the well; and
- At the conclusion of each phase of pumping from the well.

The well development monitoring will note how long it takes the water level to recover prior to initiating the next phase of surging and pumping.

Water will be pumped from the well prior to initiating well surging and frequently throughout the well development process so fines are removed, rather than forced back into the aquifer formation. The volume of water removed during each pumping cycle will be measured and each pumping cycle will attempt to remove the same approximate well casing volumes of water to better gauge progress. While pumping water from the well, water quality parameters will be measured at least once per well volume removed. Water quality parameters will be measured using a multi-parameter meter including sensors for each parameter listed above (e.g., Horiba U-50 series, YSI 6920 series, or equivalent).

Well development performance monitoring will be recorded to a well development log (example included in **Appendix B**).

3.2.2 Groundwater Remedy Performance Monitoring

Groundwater remedy performance monitoring will be implemented to measure the effectiveness of both EISB and MNA process implementation at the Site. As described in the GW CPS, the combination of two complementary and nonconcurrent monitoring and sampling programs will be used to conduct performance monitoring during the groundwater remedy:

- An EISB groundwater monitoring and sampling program which will:
    - Evaluate EISB injection zones on a quarterly basis;
    - Maintain monitoring of select IHS concentrations and MNA parameters at select monitoring wells outside of the injection zones; and
    - Be conducted for at least four events following each EISB injection event; and
- A post-EISB groundwater monitoring and sampling program to evaluate the progress of the groundwater remedy throughout the Site groundwater plume, which will be conducted on a semi-annual basis until groundwater remedy compliance is demonstrated.

Only one of the two Site groundwater remedy monitoring programs will be active at any time. The status of EISB injections will dictate which program is active at the Site. The status of the groundwater remedy performance monitoring will be communicated to Ecology with regular updates in either the monitoring and sampling reports coinciding with these monitoring events or in the monthly progress reports. Any proposed changes in the groundwater remedy performance monitoring (extension of the EISB monitoring program beyond the fourth event, change from EISB to post-EISB performance monitoring, or from post-EISB to EISB because of a planned injection event) will be communicated to Ecology for approval at least one month prior to the next monitoring event.

The details of the groundwater remedy performance monitoring programs are based on the Site conditions communicated in the GW EDR and GW CPS. Those Site conditions may change both prior to and throughout the implementation of the groundwater remedy and may justify changes to the performance monitoring programs. Some of those potential changes have been addressed in **Section 3.2.5** and **Section 3.3**, but those sections are not intended to be all inclusive. Changes to the performance monitoring programs (e.g., addition or removal of specific constituent analysis at monitoring wells) and the basis for those changes will be communicated to Ecology for approval at least one month prior to the next monitoring event.

3.2.2.1 EISB Groundwater Remedy Performance Monitoring

The objectives of the EISB groundwater remedy performance monitoring program are:

- Assess the shallow aquifer response to the EISB remedy in the injection zones on a quarterly basis;
- Maintain monitoring of IHS concentrations and MNA parameters (BOD, ferrous iron, sulfate, and alkalinity) on a semi-annual basis at select points within the Site groundwater plume (but outside the EISB injection zones);
- Maintain monitoring of nitrate and nitrite concentrations on a semi-annual basis in all other Site monitoring wells not located within the EISB injection zones;
- Maintain monitoring of arsenic on a semi-annual basis in all Site monitoring wells that are not within the EISB injection zone and where arsenic is analyzed as part of the current groundwater monitoring program; and
- Monitor MNA parameters on a semi-annual basis in one Site monitoring well not impacted by the Site groundwater plume (MW-1) to allow for comparison.

The EISB performance monitoring program will be implemented as indicated in **Table 2** to meet the objectives of the program. Samples designated "1,2,3,4" will be collected on a quarterly basis, while samples designated "1,3" will be collected on a semi-annual basis during first and third quarters. All the Site monitoring wells will be included within the EISB performance monitoring to meet the objectives of the program, though with different frequency and parameters.

The monitoring wells anticipated to be within the injection zone of the Phase I EISB system are:

- Existing monitoring wells MW-3, MW-4R, MW-5R, MW-12R, and MW-13; and
- One proposed monitoring well (MW-21) which will be installed within the IW Line #4 injection zone as shown on **Figure 3**.

The monitoring wells anticipated to be within the injection zone of the full-scale Phase II EISB system injection(s) are:

- Existing monitoring wells MW-3, MW-4R, MW-5R, MW-12R, and MW-13;
- Proposed monitoring well MW-21 (described above);
- Proposed monitoring well MW-22 which will be installed within the IW Line #1 injection zone as shown on **Figure 3**;
- Proposed monitoring well MW-23 which will be installed within the IW Line #4 injection zone as shown on **Figure 3**; and
- Proposed monitoring well MW-24 which will be installed within the IW Line #5 injection zone as shown on **Figure 3**.

EISB performance monitoring samples will be collected on the following schedule in relation to each Phase I or Phase II injection event:

- Prior to the initiation of each injection event (pre-injection samples); and
- 1, 3, 6, and 9 months after the completion of the EISB injection event (± 1 month).

The EISB performance monitoring program may be extended beyond the fourth (9 month) sampling event based on analysis of the groundwater performance monitoring data, and the decision will be communicated to Ecology at least one month prior to any additional sampling event.

Groundwater samples for EISB performance monitoring will be collected following the procedures detailed in **Section 4.2.3**. EISB performance monitoring samples will be submitted to Lancaster for analysis or analyzed using CHEMetrics field test kits as indicated in **Table 2**.

The data collected as part of the EISB groundwater remedy performance monitoring program will be used to confirm the status of the groundwater conditions within the injection zones. The groundwater conditions and concentrations can be used to confirm the rate of reagent removal and contaminant rebound within the injection zones of the injection well lines. These data can then assist in determining if, when, where, and under what conditions additional injections will be implemented.

3.2.2.2 Post-EISB Groundwater Remedy Performance Monitoring

The objectives of the post-EISB performance monitoring are:

- Assess the progress of the groundwater remedy throughout the Site groundwater plume, including both EISB and MNA performance, as applicable; and
- Maintain monitoring of the Site boundary monitoring wells that are not included within the Site POC or nitrate groundwater plume, including monitoring of MNA parameters at MW-1.

The post-EISB groundwater remedy performance monitoring program will be implemented on a semi-annual basis as indicated in **Table 3**. All the Site monitoring wells will be included within the post-EISB performance monitoring to meet the objectives of the program as follows:

- Existing and proposed groundwater monitoring wells located within the injection zones (existing wells MW-3, MW-4R, MW-5R, MW-12R, and MW-13; and proposed wells MW-21, MW-22, MW-23, and MW-24) will continue the analysis program detailed in **Section 3.2.2.1** but on a semi-annual basis.
- Existing groundwater monitoring wells which are defined within the Site POC or located within the Site groundwater nitrate plume, but not within the injection zones (existing wells MW-6, MW-8, MW-9, MW-16, and MW-19), will be monitored for applicable IHS constituents and EISB monitoring parameters.
- The remaining existing groundwater monitoring wells (MW-1, MW-7, MW-10, MW-11, MW-14, MW-15, MW-17, MW-18, and MW-20) will be incorporated into the post-EISB performance monitoring program as boundary wells, but may be included as POC and/or nitrate plume wells per the process detailed in **Section 3.2.5**.

Groundwater samples for post-EISB groundwater remedy performance monitoring will be collected following the procedures detailed in **Section 4.2.3** after implementation of the groundwater remedy (i.e., the Phase I EISB injection) and when the EISB groundwater remedy performance monitoring program is not active.

The post-EISB groundwater remedy performance monitoring samples will be submitted to Lancaster for analysis or analyzed using CHEMetrics field test kits as indicated on **Table 3**.

<u>Monitored Natural Attenuation Performance Monitoring</u>

MNA is applicable at the Site for the following IHSs under the following conditions:

- Nitrate, nitrite, and dinoseb when the groundwater plume at a location is not influenced by the proposed EISB remedy;

- 1,2-Dichloropropane, 2,4-D, benzene, and chlorobenzene, because the effectiveness of the proposed EISB remedy is uncertain for these IHSs; and
- Arsenic, iron, and manganese, because these IHSs are expected to increase when the groundwater is influenced by the proposed EISB remedy.

Data obtained from the groundwater remedy performance monitoring will be used to assess the performance of natural attenuation when monitoring well locations are not influenced by EISB or for those IHSs that are not as strongly influenced by EISB (e.g., 1,2-dichloropropane, 2,4-D, benzene, and chlorobenzene).

MNA performance monitoring data will be evaluated on a semi-annual basis. The semi-annual MNA performance evaluation will include:

- An analysis of plume stability using:
    - The Mann-Kendall non-parametric statistical analysis on a well by well basis; and
    - Groundwater plume iso-concentrations over time (for the last six post-EISB groundwater performance monitoring events).
- An evaluation of MNA mechanisms through an analysis of the following geochemical indicators at the Site: BOD, alkalinity, sulfate, ferrous iron, and ORP.

The results of the MNA performance evaluation will be reported in semi-annual groundwater monitoring reports.

Additional evaluations of MNA performance will be conducted and reported within each Site periodic review report to be completed at least every 5 years. The periodic review MNA performance evaluation will include:

- An analysis of plume stability using:
    - Most recent well by well Mann-Kendall trend analysis;
    - Most recent analysis of groundwater plume iso-concentrations over time (for the last six post-EISB groundwater performance monitoring events);
    - Well by well linear regression analysis of log concentration vs. time (including a 95% UCL); and
    - Spatial mass flux calculation of IHSs across specified cross-sectional areas of the plume using solute transport modeling;
- An evaluation of MNA mechanisms using:

- An analysis of the following geochemical indicators at the Site: BOD, alkalinity, sulfate, ferrous iron, and ORP; and
- An estimate of the contribution ratio of plume mass removed by biodegradation to the overall plume attenuation using groundwater modeling software (MODFLOW and MT3D);

- An estimate of restoration timeframe using:
  - The well by well linear regression analysis described above; and
  - Groundwater modeling software (MODFLOW and MT3D);
- An assessment of whether the use of MNA only will be protective of human health and the environment during the estimated restoration timeframe.

Periodic MNA performance evaluations will be used to determine if additional EISB injections will be required to achieve the remedial objectives and to determine if other contingency remedial measures should be considered.

3.2.3 Storm/Irrigation Drain Monitoring

Storm/irrigation drain monitoring will be implemented to determine if groundwater from the Site is infiltrating storm or irrigation drains and adversely affecting surface water quality. There are four known storm/irrigation drain systems within the City.

- The Sunnyside Valley Irrigation District (SVID) drain system was installed over 80 years ago. In the Site area, this drain system conveys groundwater in a southeasterly direction to Sulphur Creek which drains to the Yakima River.
- The City storm drain system was installed in the 1960s to convey storm water. In many places the SVID and City drain systems are interconnected and the distinction between water conveyed by the two systems is not always possible.
- The "under-drain" system was installed in the early 1900s to lower the groundwater table in the area. Little is known about the system layout or its connections with the other drain systems, and there is no known access to this system in the area.
- The fourth drain system conveys industrial wastewater and stormwater to the Port of Sunnyside's wastewater treatment plant. This system is not believed to be connected to the other systems, nor is it believed to act as a drain for area groundwater.

The storm/irrigation drain monitoring program proposed for the Site will sample storm/irrigation drains that are part of the SVID system and the City storm drain system. Four manhole locations are proposed for the storm/irrigation drain monitoring: M-9, M-10, M-13, and M-21. The known layout of the storm/irrigation drain systems near the Site and the manhole sample locations are shown on **Figure 6**. Manhole sample location M-9 is a storm/irrigation drain location which is up-gradient of the Site and/or Site groundwater plume. Manhole sample locations M-10 and M-13 are located in the vicinity of the Site groundwater plume. Manhole sample location M-21 represents the down-gradient location where the storm/irrigation drains passing by the Site groundwater plume connects with an underground drain system canal.

Storm/irrigation drain water samples will be collected following the procedures detailed in **Section 4.2.5**. All storm/irrigation drain water samples will be analyzed for select IHSs, ammonia, and phosphorus as follows:

- Nitrate by EPA Method 353.2 or CHEMetrics Nitrate Instrumental Kit (Model K-6933);
- Nitrite by EPA Method 353.2 or CHEMetrics Nitrite Instrumental Kit (Model K-7003);
- Ammonia by Standard Methods (SM) 4500-NH_3 D-1997 or CHEMetrics Ammonia Instrumental Kit (Model K-1523);
- Benzene, chlorobenzene, and 1,2-dichloropropane by EPA Method 8260B;
- 2,4-D and dinoseb by EPA Method 8151A;
- Arsenic, iron, and manganese by EPA Method 6010B; and
- Total phosphorus by EPA Method 365.1.

The analyzed constituent concentrations and flow data from the up-gradient sample location (M-9) will be compared to the down-gradient sample locations (M-10 and M-13) to determine if plume groundwater may be infiltrating storm/irrigation drains. If infiltration is indicated, the analyzed constituent concentrations from manhole M-21 will be reviewed to determine if the plume groundwater may be adversely affecting down-gradient surface water quality.

The storm/irrigation drain monitoring will begin once the post-EISB groundwater remedy performance monitoring begins, implemented at a frequency of every other year. If after two storm/irrigation drain monitoring events the data indicate that the Site does not adversely impact the surface water quality, Stantec will petition Ecology to obtain their approval to discontinue this storm/irrigation drain monitoring.

3.2.4 Institutional Controls Performance Monitoring

Once ICs have been established within fully executed restrictive covenants at a parcel affected by Site contaminants, performance monitoring will be conducted to verify that the ICs implemented are effectively protecting the public throughout the groundwater remedy duration. Semi-annual site visits will be used to complete the following IC performance monitoring as required in the CAP:

- Verify that no buildings on the BJS parcel have been altered or removed in a manner that may have resulted in a release of contaminated material to the environment or created a new exposure pathway without prior written approval of Ecology;
- Verify that no Site property owner activities have interfered with the groundwater remedy implementation or compliance monitoring; and
- Verify that no new buildings have been constructed without vapor mitigation measures or moved to new locations on the BJS and WGL parcels that would prevent proper monitoring of soil and groundwater or result in unacceptable risks from inhalation of vapors.

Semi-annual IC performance monitoring will involve the following steps:

- Perform a visual inspection of all installed groundwater monitoring and injection wells to determine if any owner activities may have damaged or permanently limited access to those resources; and
- Perform a visual inspection of the areas on the BJS and WGL parcels that have been identified within the restrictive covenants as having restrictions on the removal of existing structures and/or the construction of new permanent structures.

Any potential violations of the ICs noted during the semi-annual visual inspections will be documented in field notes and photographs of the affected area(s). Stantec will complete an investigation, including communication with the property owner(s), to determine the cause of the issue(s) identified during the field inspection. The results of the investigation will be documented in a letter to the property owner, Ecology, and other stakeholders involved.

Per the CAP, ICs are to be implemented to restrict the installation of municipal or domestic drinking water wells in the shallow aquifer where the Site groundwater plume is present. Performance monitoring for this IC will be completed by conducting a well survey every year using the Ecology well log database. A well survey was completed using the Ecology well log database during the preparation of this document, and the well logs identified in or near the Site groundwater plume are provided in **Appendix C**. One water well was identified in the well survey; however, this corresponds to a municipal water well (Well #5) installed in 1953 and decommissioned in 2011. The well reports for the City Well #5 are also included in **Appendix C**.

If a newly installed drinking water well (municipal or domestic) is identified in an annual well survey, the finding will be reported to Ecology within 30 days of being identified. In addition, the well surveys will be documented within the remedial progress report(s) which are required every 5 years following the initiation of cleanup action at the Site per the Consent Decree.

3.2.5 Performance Monitoring Contingency Planning

Contingency measures have been considered as part of the performance monitoring plan. The contingency measures considered apply to the groundwater remedy performance monitoring, storm/irrigation drain monitoring, and IC performance monitoring. Contingency measures may also be implemented based on data collected prior to the implementation of EISB at the Site (i.e., prior to the Phase I EISB injection).

Contingency actions will be implemented when appropriate performance monitoring data indicate additional measures are required to protect human health or the environment at the Site. Potential performance monitoring triggers and proposed contingency actions are provided in **Table 4**. This proposed contingency action plan is not intended to encompass all potential issues and possible contingency measures. Additional contingency actions proposed during the cleanup action will require client and Ecology approval.

3.3 CONFIRMATIONAL MONITORING

Confirmational monitoring is intended to demonstrate the long-term effectiveness of the Site cleanup actions once CULs and other performance standards have been achieved at the Site POC(s). The groundwater CULs and POC have been defined in the GW EDR and GW CPS. The CAP defined the terms for the completion of the cleanup to be:

- All components of the remedy, including ICs, are implemented; and
- Compliance with the CULs has been achieved with a minimum of 3 years of confirmation samples at the POC.

The confirmational monitoring plan has been designed to conform to the requirements in WAC 173-340-720(9). Each defined confirmation well must meet the cleanup completion criteria over the specified confirmation period for the Site to meet the cleanup criteria. The Site confirmation wells will include each of the monitoring wells that meet the POC definition in **Section 1.2.2** (MW-4R, MW-5R, MW-6, MW-9, MW-12R, MW-13, MW-16, MW-19, MW-21, MW-23, and MW-24). Additional monitoring wells may be added to the Site POC per the contingency planning details in **Table 4**.

This section will also include a strategy to determine when additional EISB injections should be performed and when groundwater remediation by EISB and MNA can be ceased.

Confirmational monitoring of groundwater at the Site POCs will use data obtained during the groundwater remedy performance monitoring detailed in **Section 3.2.2**.

3.3.1 Strategies for Determining Additional EISB Injections

The Site groundwater remedy includes a combination of EISB, MNA, and ICs to satisfy the goal of meeting the CULs in a reasonable timeframe. Any EISB injection event will have a significant cost, and determining when to implement additional EISB injections will be critical for controlling overall project costs. The EISB system will be limited in its distribution within the Site groundwater plume, will be operated intermittently, and will not remediate each of the IHSs equally. As a result, determining if, when, and where additional EISB injections are necessary will also be critical to meet cleanup goals in a reasonable timeframe.

The expected effects of an EISB injection are as follows:

- The injected sodium acetate will remediate the nitrogen-containing IHS compounds throughout the IW Line treatment zones and may provide some remediation of additional IHS compounds (benzene and chlorinated compounds). Concurrently, dissolved concentrations of arsenic, iron, and manganese are expected to temporarily increase under the reducing geochemical conditions.
- After the completion of the injection event, the groundwater within the treatment zone will migrate down-gradient through the Site groundwater plume, and excess carbon will continue to remediate most of the Site IHSs (and temporarily increase the concentration of dissolved metals) in this down-gradient portion of the aquifer.
- As the injection solution migrates down-gradient and away from the injection wells, the IHS concentrations (excluding arsenic, iron, and manganese) may partially rebound in the injection well treatment zones, while dissolved arsenic, iron, and manganese concentrations are expected to gradually decrease to near pre-treatment concentrations.

The groundwater remedy performance monitoring detailed in **Section 3.2.2** is intended to provide data regarding the effectiveness of the above process. In addition, the EISB system optimization data collection and monitoring detailed in **Section 2.0** will provide additional data regarding the transport of groundwater, IHSs, and sodium acetate within the Site aquifer. Because of the complexity of the remediation system and its expected effects on the Site IHSs, the collective optimization and performance monitoring data obtained will be applied to a groundwater flow and transport model. The Site-wide groundwater model will incorporate a groundwater flow model (MODFLOW) and a transport model (MT3D) and will allow for the incorporation of natural attenuation.

The Site-wide groundwater model will be incorporated into the periodic evaluation of MNA performance described in **Section 3.2.2**. The evaluation of MNA performance will be analyzed by experts with knowledge of the Site to determine if, when, where, and under what parameters additional EISB injections will be applied. Such determinations will be presented to and discussed with Ecology prior to any additional injection events to obtain their concurrence.

3.3.2 Conclusion of Remediation Activities

Confirmational monitoring will take place after remediation has concluded and the Site aquifer is no longer under the influence of EISB. The concentrations of BOD, ferrous iron, sulfate, and alkalinity have been selected as the EISB monitoring parameters to determine when Site groundwater is no longer influenced by EISB. A monitoring well location will be determined to be under MNA conditions (and not influenced by EISB) if the select EISB monitoring parameters meet the following conditions:

- BOD and alkalinity concentrations are:
    - At pre-treatment concentrations; or
    - Indicating a decreasing or stable trend, and within 85% of the pre-treatment concentrations.
- Sulfate concentrations are:
    - At pre-treatment concentrations; or
    - Indicating an increasing or stable trend, and within 85% of the pre-treatment concentrations.
- Ferrous iron concentrations are:
    - At pre-treatment concentrations; or
    - Indicating a decreasing trend.

The pre-treatment concentrations of the select EISB monitoring parameters will be determined as follows:

- For BOD, ferrous iron, and alkalinity:
    - If a monitoring well location has 10 or more sample results prior to EISB implementation, an upper tolerance limit (UTL) concentration will be calculated with a coverage of 95% (UTL95) and a confidence probability of 95% (UTL95) using EPA ProUCL software with pre-treatment data from that monitoring well.
    - If a monitoring well location has less than 10 sample results prior to EISB implementation, a UTL95 concentration will be calculated using ProUCL software with pre-treatment data from all monitoring wells within the groundwater nitrate plume.
- For sulfate:
    - If a monitoring well location has 10 or more sample results prior to EISB implementation, an UTL concentration will be calculated with a coverage of 5% (UTL5) and a confidence probability of 95% using ProUCL software with pre-treatment data from that monitoring well.

- If a monitoring well location has less than 10 sample results prior to EISB implementation, a UTL5 concentration will be calculated using ProUCL software with pre-treatment data from all monitoring wells within the groundwater nitrate plume.

To determine if post-treatment EISB monitoring parameter concentrations are within 85% of pre-treatment concentrations, the maximum (for BOD and alkalinity) or minimum (for sulfate) post-injection concentration from the groundwater remedy performance monitoring at a monitoring well will be compared to the pre-treatment UTL95 or UTL5, as applicable.

In order for analytical results from Site monitoring wells within the POC to be used for confirmational monitoring, the select EISB monitoring parameter results must indicate the monitoring well is under MNA conditions and the influence of EISB is decreasing at a predictable rate.

Remediation, by either EISB or MNA processes, will be considered complete when the IHS concentrations remain at or below the respective CULs while no longer influenced by EISB or EISB is decreasing at a predictable rate. There may be instances where a specific IHS concentration, a specific confirmation well, and/or a specific IHS concentration at a specific confirmation well, meets the requirements for the conclusion of remediation activities. In these instances, the specific IHS and/or well location may be moved into the confirmational phase of the compliance monitoring. Such a determination would also influence the implementation of additional EISB injections as described in the section above.

For example, if following the implementation of a Phase II EISB injection, data at monitoring wells MW-5R, MW-6, and MW-8 indicate that the select EISB monitoring parameters are at pre-treatment concentrations and IHS concentrations are all below their respective CULs with the exception of arsenic, which is above the CUL but below the RL. Under this scenario, this portion of the Site groundwater plume may be determined to be out of the remediation phase and in the confirmation monitoring phase for all IHSs except for arsenic. In addition, these data may indicate that additional EISB injections would not be required at IW Line #1 and the west portion of IW Line #3.

<u>Special Considerations for Arsenic</u>

Arsenic differs from the other IHSs for the Site for the following two reasons:

- The distribution of arsenic in the groundwater monitoring wells indicates that there may be multiple arsenic sources or plumes which are not consistent with the groundwater plumes of the other Site IHSs; and

- Though the CUL for arsenic is 0.01 mg/L, an RL of 0.04 mg/L has been approved for the remediation of arsenic in groundwater at the Site. The RL will be used to determine when remediation is complete, and the CUL will be used to evaluate closure.

As a result, Stantec proposes that the concentration of arsenic not be analyzed against the RL at each confirmation well independently, and instead employ statistical approaches evaluating the arsenic concentrations at the Site as a whole.

To this end, the analysis of arsenic by EPA Method 6010B will be added to the post-EISB groundwater remedy performance monitoring for each of the existing Site monitoring wells after the completion of the first Phase II EISB injection. In addition, a pre-treatment monitoring event will be conducted prior to the Phase I EISB injection for comparison purposes, and arsenic will be analyzed at all existing Site monitoring wells. Arsenic data from all the monitoring wells in each independent post-EISB monitoring event will be used to calculate a Site-wide UCL95 using the EPA ProUCL software, and will be compared to the arsenic RL.

Site-wide arsenic data, from wells determined to be under MNA conditions (see **Section 3.2.2**), will be analyzed as follows:

- If the Site-wide arsenic UCL95 is above the arsenic RL of 0.04 mg/L, and concentrations are not decreasing over time, then a contingency plan will be developed to allow for additional analysis, monitoring, and/or remediation of the elevated arsenic concentrations; or
- If the Site-wide arsenic UCL95 is below the arsenic RL of 0.04 mg/L:
    - No active remediation measures for arsenic will be necessary; and
    - MNA remediation and confirmation sampling for arsenic per **Section 3.2.2** will be required.

The use of a Site-wide UCL95 for arsenic will only be applied to the arsenic RL and will not be used for the purposes of cleanup confirmation.

3.3.3 Confirmation of Cleanup

Groundwater cleanup confirmation involves the comparison of the observed IHS concentration data at each independent Site confirmation well to the respective CULs. When the observed concentration data decrease and remain below the CULs for the duration of the compliance period, the confirmation well is considered to be in compliance for those IHSs. The compliance period required for the Site as stipulated in the CAP is a period of at least 3 years. Because samples will be collected semi-annually, data from at least six confirmation groundwater sampling events will be required to support the groundwater cleanup action confirmation at a POC. In order to address the uncertainty in the observed mean of the IHS concentrations over this period, the UCL95 at each Site confirmation well will be calculated using the EPA ProUCL software.

When the 3-year UCL95 for all IHSs at all Site confirmation wells are below the respective CULs, the Site will be eligible for a no further action determination from Ecology.

4.0 Sampling and Analysis Plan

4.1 SAMPLING OBJECTIVES

The purpose of the optimization and compliance monitoring sampling programs are to acquire Site-specific data to optimize, monitor, and confirm the completion of the groundwater cleanup action. Measured data provided by samples and testing will be used to support one or more of the following objectives:

- Optimize the design and operating parameters of the Phase II EISB system;
- Monitor the performance of the EISB treatment system;
- Determine when and where additional EISB injections will be implemented;
- Monitor the natural attenuation of IHSs either not treated or increased by the EISB system;
- Determine when groundwater is no longer influenced by the EISB treatment system; and
- Confirm the completion of the groundwater remedy at each Site POC monitoring location.

4.2 FIELD SAMPLING AND TESTING METHODS

4.2.1 Soil Sampling Methods

Soil samples will be collected as part of the EISB system optimization data collection as described in **Section 2.0**.

<u>Soil Sampling for Laboratory Analysis</u>

Soil samples for laboratory analytical testing will be collected using a split-spoon sampler in advance of the drill auger at the depths specified in **Section 2.1**. After the sampler has been removed from the boring and opened, the soil samples for chemical analysis will be transferred immediately to the necessary sample containers. Sample containers will consist of 125-milliliter (mL) wide-mouth glass sample jars with Teflon®-lined caps. Jars will be completely filled with soil from the sampler. Care will be taken to limit disruption of the soil as much as possible during the transfer of soil from the sampler to the sample containers. Once filled, the sample jars will be sealed, labeled, and placed on ice in a sample cooler. Analysis of the remaining soil for lithology or collection of the soil for geotechnical analysis will proceed after the soil sample collection procedure above.

Each sample for chemical analysis will be identified with the following sample identification (ID) format:

- IW-#-#-S-DD-yymmdd
- Where:
  - IW-#-# = the location identification number of that injection well, where:
    - #-# = IW Line # - Well #
  - S = the sample matrix (soil)
  - DD = the top depth of the soil sample (in feet)
  - yymmdd = year/month/day of sample collection

Soil Sampling for Grain Size Analysis

Soil for grain size analysis will be collected using a split-spoon sampler in advance of the drill auger at the depths specified in **Section 2.2**. Soil that is not collected for chemical analysis or lithology classification at these depths will be transferred to a 1-gallon Ziploc® bag, sealed, and labeled.

Each soil sample for grain size analysis will be identified with the following sample ID format:

- IW-#-#-S-DD-yymmdd
- Where:
  - IW-#-# = the location identification number of that injection well, where:
    - #-# = IW Line # - Well #
  - S = the sample matrix (soil)
  - DD = the top depth of the soil sample (in feet)
  - yymmdd = year/month/day of sample collection

4.2.2 Slug Testing Methods

A water level change will be induced using a mechanical slug with a volume corresponding to a 1.5 to 2-foot water level change within the injection well casing. The slug testing at each injection well will utilize both a falling head test (slug-in test) and a rising head test (slug-out test). The water level measurements will be collected by an automated logging pressure transducer capable of detecting water level changes of 0.01 feet and logging data every second (In-Situ Level TROLL 700 or equivalent).

The process for completing the falling head test is as follows:

- Prior to starting any slug testing, measure the static groundwater level and total well depth.

- Document these measurements along with the well diameter, screened interval, diameter of borehole, filter pack specifications, and type of screen.

- Place the transducer in the well below the level that the slug will be submerged, but not so low that the maximum range of the transducer would be exceeded.

- Secure the transducer cable to the well casing.
- Allow the water level to recover and the transducer to adjust to the new pressure and temperature per the manufacturer's guidance.
- Position and secure the slug approximately 1-foot above the groundwater level.
- Establish a starting water level for the transducer and data logger.
- Start the data logger and simultaneously submerge the slug quickly but gently into the water. Secure the slug in this position.
- End test when the water level has stabilized within 90% of the static water level.

Continuing from the falling head test, the process for completing the rising head test is as follows:

- Allow the water level to stabilize within 95% of the original water level before starting the test.
- Establish a starting water level for the transducer and data logger.
- Start the data logger and simultaneously withdraw the slug quickly but smoothly from the water.
- When the water level is equal to the initial water level, or when the readings change less than 0.01 feet per 10 minutes, stop the test.

This procedure will be repeated at least once for a total of four slug tests at each Phase 1 injection well. The test data will be analyzed in the field on the data logger or a computer to confirm it is complete and accurate. Additional testing should be completed at the well if problems with the data from more than one of the slug tests are identified.

4.2.3 Groundwater Sampling Methods

Groundwater samples will be collected for the groundwater remedy optimization, performance, and confirmational monitoring using low-flow sampling procedures with a combination of dedicated and non-dedicated equipment. The equipment will consist of a peristaltic pump with dedicated tubing (i.e., Tygon tubing and Teflon-lined polyethylene [TLPE] tubing). Prior to sampling activities, the static water level and total well depth will be measured in each well. All measurements recorded during groundwater sampling activities will be recorded on a groundwater sampling field data sheet (example included in **Appendix B**).

An electronic sounder, accurate to the nearest ±0.01 feet, will be used to measure the static groundwater level in each well. When using an electronic sounder, the probe will be lowered down the casing to the top of the water column, and the graduated markings on the probe tape will be used to measure the depth-to-groundwater from the top of the casing. Total well depth will be sounded from the top of casing measuring point by lowering the weighted probe to the bottom of the well. Depth-to-groundwater and total well depth measurements will be recorded to the nearest ±0.01 feet.

The intake end of the TLPE tubing will be placed near the mid-point of the screened interval. If possible, the intake will be kept at least 2 feet above the bottom of the well to minimize mobilization of particulates present in the bottom of the well. Once the tubing is in the well, the initial water level will be re-measured and recorded before purging begins.

The pump will be started at its lowest speed setting and the speed will be slowly increased until discharge occurs. The flow rate should be maintained at less than 0.5 liters per minute. The drawdown will be measured with the electronic sounder during well purging to assure minimal drawdown (less than 0.3 feet), and if necessary, the pump speed will be adjusted. If the minimal drawdown that can be achieved exceeds 0.3 feet but remains stable, purging will be continued until indicator field parameters have stabilized. The water level and pumping rate will be monitored and recorded every 3 to 5 minutes (or as appropriate) during purging.

Any pumping rate adjustments (both time and flow rate) will be recorded. Pumping rates will be reduced as needed to the minimum capabilities of the pump to aid in stabilization of indicator parameters. Adjustments are best made in the first 15 minutes of pumping to help minimize purging time. During pump start-up, drawdown may exceed the 0.3 feet target and then "recover" as pump flow adjustments are made.

If the recharge rate of the well is lower than the extraction rate capabilities of the pump being used and the well is essentially dewatered during purging, then the well will be sampled as soon as the water level has recovered sufficiently to collect the appropriate volume needed for all anticipated samples (ideally the intake will not be moved during this recovery period). Samples may then be collected even though the indicator field parameters have not stabilized.

During well purging, water levels and indicator field parameters (pH, ORP, specific conductivity, temperature, DO, and turbidity) will be recorded every 3 to 5 minutes. Purging is considered complete and sampling may begin when indicator field parameters have stabilized. Stabilization is considered to be achieved when three consecutive readings, taken at 3 to 5-minute intervals, are within the following limits:

- DO (10%)
- Conductivity (3%)
- Temperature (3%)
- pH (± 0.1 unit)
- ORP (± 10 millivolts)

Turbidity stabilization is discussed in **Section 4.2.3.1**. All measurements will be obtained using a multi-parameter meter with flow-through-cell (YSI 6920 or equivalent). Field instruments will be calibrated in accordance with the manufacturer's directions prior to use, which will be documented on a field equipment calibration form.

Purge volumes for each well will be recorded, and if parameters have not stabilized after three well volumes have been purged, purging will be stopped, and samples will be collected.

Depth-to-groundwater will be measured immediately prior to sample collection. Water samples for laboratory analyses must be collected before water has passed through the flow-through-cell (use a by-pass assembly or disconnect cell to obtain sample). VOC samples will be collected first and directly into pre-preserved laboratory-supplied sample containers. All sample containers will be filled by allowing the pump discharge to flow gently down the inside of the container with minimal turbulence. If a duplicate sample is to be collected at a location, all bottles designated for a particular analysis for both sample identification numbers will be filled sequentially before bottles for another analysis are filled.

4.2.3.1 Metal Specific Groundwater Sampling Methods

For any groundwater monitoring well sample locations which will include analysis of metals (arsenic, iron, or manganese), turbidity will be added as a stabilization parameter as follows:

- If all other parameters are stabilized and turbidity is <10 nephelometric turbidity units (NTU), the sample can be collected per the procedures above.
- If turbidity is >10 NTU and all other parameters have stabilized, reduce the pumping rate to approximately 0.1 liters per minute (L/min) and continue recording turbidity measurements as above for 30 minutes or until turbidity is <10 NTU.
- If turbidity remains >10 NTU after this additional purge time, continue to purge the well until three consecutive turbidity readings are ±10%, and collect the groundwater for metals analysis with filtration as follows:
    - Using an in-line, 10-micron, high capacity filter for analysis of arsenic, iron, and manganese; and
    - Using an in-line, 0.1-micron, high capacity filter for analysis of dissolved iron.

The filtered groundwater sample for metals analysis will be collected last. Groundwater sample filtration will be noted on the groundwater sampling field data sheet and laboratory chain of custody (COC).

When groundwater monitoring sampling using the above procedures are unable to attain turbidity measurements <10 NTU, the applicable monitoring wells will be considered for re-development prior to the next sampling event.

4.2.4 Field Analysis Procedures

Groundwater samples collected during the performance monitoring may utilize CHEMetrics field test kits for some of the analyses as detailed in **Section 3.2.2**. Although all the constituents for which CHEMetrics field test kits are available and fit the Site analysis objectives have been included in the monitoring plan, the use of specific tests, and the conditions under which those field tests can be used, shall be discussed with Ecology on a case-by-case basis prior to implementation at the Site. The use of CHEMetrics field test kits for nitrate and nitrite will only be considered for groundwater samples collected within the EISB injection zones as part of the EISB performance monitoring program.

Groundwater to be used for the field analysis will be collected per the groundwater sampling methods detailed in **Section 4.2.3**. Groundwater to be used in field analysis will be collected without filtration to the manufacturer-provided container prior to the collection of groundwater for laboratory analysis.

All field analysis will be conducted following the manufacturer procedures, which have been included in **Appendix D**. The field analyses will be completed as soon as possible following the collection of the groundwater to avoid changes to the water chemistry from exposure to the atmosphere. Once the groundwater has been prepared using the appropriate test kit(s), the samples will be analyzed using a CHEMetrics Direct-Readout Photometer or appropriate spectrophotometer. When initial field analysis indicates results above the test kit range, the field analysis may be repeated with groundwater diluted using deionized (DI) water or additional groundwater will be collected for submittal for laboratory analysis. Field results obtained with diluted groundwater will be multiplied by the dilution ratio.

The accuracy of the field test kits will be analyzed at least once per EISB or post-EISB performance monitoring event using a standard solution, if available. In addition, duplicate samples will be submitted for laboratory analysis for at least 10% of the samples analyzed with field test kits. Note that for some parameters such as ferrous iron, laboratory testing for total iron on a filtered sample can differ from field measurements of ferrous iron due to oxidation during filtration. Duplicate laboratory sample results will be correlated to the field test results, and the accuracy of the correlation will be reported with the performance monitoring results. If the accuracy of the field tests does not meet the project objectives after accounting for other variables, Stantec will discuss discontinuing the use of the applicable field test kit(s) with Ecology.

Field analysis procedures and results will be recorded to a field analysis log (example included in **Appendix B**).

4.2.5 Storm/Irrigation Drain Sample Procedures

Stantec will coordinate the storm/irrigation drain sampling events with the City, and if possible, City personnel will accompany the Stantec field personnel to safely open each manhole. Once open, Stantec personnel will measure the depth to water using an electronic sounder and the water flow rate and direction using a velocity meter (Flo-Mate Model 2000 or equivalent). A disposable bailer will be used to collect the grab water samples from the drain system at each manhole. At the time of the water sample collection, the pH and temperature will be measured in the field with a calibrated multi-parameter meter (YSI 556 or equivalent). Details of the irrigation/storm drain sampling including field measurements will be recorded to the field notes maintained by the Stantec field personnel.

4.3 DECONTAMINATION PROCEDURES

Any non-dedicated sampling or testing equipment that comes into contact with the ground surface or groundwater will be decontaminated between sampling/testing locations. If disposable sampling implements are used, they will be discarded after each sample and replaced with a new implement. Sampling or testing equipment that requires decontamination before reuse will be washed with Liquinox and triple rinsed with distilled water before and after each sample is collected or test performed.

The groundwater level indicator will be decontaminated following each measurement by spray-washing the probe and cable with a Liquinox solution, wiping down the probe and cable, followed by a final rinse with de-ionized water. To decontaminate groundwater sampling equipment, a Liquinox solution will be pumped from buckets through the pump, flow-through-cell, and associated equipment. All equipment will then be rinsed thoroughly with distilled water pumped from buckets. The Liquinox solution and distilled water will be changed periodically, if recycled. Dedicated tubing will be used at each monitoring well to prevent cross-contamination during groundwater sampling.

4.4 FIELD QUALITY ASSURANCE/QUALITY CONTROL SAMPLING

Samples for quality assurance/quality control (QA/QC) purposes will be collected in the field in conjunction with all sampling events. The types of QA/QC samples that must be collected, the rationale behind collection of these samples, and the frequency of QA/QC sample collection are described in further detail below.

Three types of field samples will be analyzed as part of the QA program: trip blanks, equipment blanks, and duplicates. These QA samples are described in the following sections.

4.4.1 Trip Blanks

Trip blank samples will be analyzed to evaluate cross-contamination of VOCs in groundwater samples. Trip blank samples will be prepared by the laboratory and will accompany the sample bottles throughout the sampling event, including shipping to and from the laboratory. It is not necessary that the trip blank be blind to the laboratory. Trip blanks will be analyzed for VOCs only.

Each trip blank sample will be identified with the following sample ID format:

- TB-#-W-yymmdd
- Where:
  - TB-# = trip blank number collected that day (1, 2, 3, etc.)
  - W = the sample matrix (water)
  - yymmdd = year/month/day of sample collection

4.4.2 Equipment Blanks

Equipment blanks will be analyzed to evaluate the integrity of decontamination procedures for non-dedicated sampling equipment. Equipment blanks are obtained by completing the decontamination procedure as usual and then pouring additional distilled or DI water over, or pumping the water through, the equipment and collecting the water in sample containers. Equipment blanks will be collected at a frequency of one per day per matrix. Equipment blanks will be analyzed for parameters scheduled for those samples collected up to the point the equipment blank is obtained.

Each equipment blank sample will be identified with the following sample ID format:

- EB-#-W-yymmdd
- Where:
  - EB-# = equipment blank number collected that day (1, 2, 3, etc.)
  - W = the sample matrix (water)
  - yymmdd = year/month/day of sample collection

4.4.3 Duplicates

Analysis of duplicate samples is used to monitor laboratory precision and reproducibility of the data with respect to Site-specific matrix parameters. Duplicate soil and groundwater samples will be obtained at a frequency of approximately 5 percent, or one per batch of 20 samples.

Duplicate soil samples will be obtained by filling laboratory-prepared sample jars for the same chemical analysis side by side from the same soil matrix. If soil boring samples are obtained using split-spoon liners, duplicates will not be obtained from subsurface samples. Duplicate groundwater samples will be collected by filling laboratory-prepared sample jars for the same chemical analysis side by side from the low flow sampling equipment.

Each duplicate sample will be identified with the following sample ID format:

Groundwater samples:

- MW-##-WD-yymmdd or IW-#-#-WD-yymmdd
- Where:
  - MW-## or IW-#-# = the location identification number of that sample location (same as the sample being duplicated)
  - W = the sample matrix (water)

  - D = duplicate sample
  - yymmdd = year/month/day of sample collection

Soil samples:

- IW-#-#-SD-DD-yymmdd
- Where:
  - IW-#-# = the location identification number of that injection well
  - S = the sample matrix (soil)
  - D = duplicate sample
  - DD = the top depth of the soil sample (in feet)
  - yymmdd = year/month/day of sample collection

Personnel will record in the field notes or on sampling forms which location and sample each duplicate sample corresponds with.

4.5 SAMPLE CONTAINERS AND LABELING

Sample container requirements vary according to analyte and sample matrix. Pre-cleaned sample containers will be obtained from the analytical laboratory. Sample containers shall be cleaned following the requirements described in Specifications and Guidance for Contaminant-Free Sample Containers (EPA, 1992). Required sample containers for groundwater and soil samples are provided in **Table 5**. Each sample container will be identified with a completed, laboratory provided, sample label. The label will include a unique sample ID, date, time, sampler name(s), requested analysis, and preservative.

4.6 SAMPLE HANDLING PROCEDURES

4.6.1 Sample Preservation and Holding Times

Samples will be preserved according to the requirements of the specific analytical methods to be employed, and all samples will be extracted and analyzed within method-specified holding times, as specified by the laboratory. Required sample preservatives and holding times for groundwater and soil samples are provided in **Table 5**.

4.6.2 Chain of Custody and Shipping Procedures

Chain of Custody Procedures

COC forms will be used to document the collection, custody, and transfer of samples from their initial collection to the selected laboratory. Sample custody procedures will be followed to provide a documented record that can be used to follow possession and handling of a sample from collection through analysis. A sample is considered to be in custody if it meets at least one of the following conditions:

- The sample is in someone's physical possession or view;
- The sample is secured to prevent tampering (i.e., custody seals); and
- The sample is locked or secured in an area restricted to authorized personnel.

The COC form is a vital document for all samples collected and must be properly completed. It serves as a record of sample collection information, analysis requests, and sample tracking. It is a crucial record from the time of sample collection to final reporting. COC forms will be obtained along with sample containers from the contracted analytical laboratory. Information that must be recorded on the COC record as samples are packaged includes the following:

- Project name (Bee-Jay Scales);
- Project manager's name;
- Sample date;
- Sample time;
- Sample ID (unique for each sample);
- Number of containers for each sample;
- Parameters to be determined for each sample;
- Special analytical requests (for example, fast turnaround requirement);
- Sampler's name; and
- Laboratory name.

Shipping Procedures

Generally, a laboratory representative will be given advance notification of the scheduled sampling event. Samples will be delivered to the analytical laboratory by hand or shipped by a member of the field sampling team.

Upon transferring custody of the samples, the individuals relinquishing and receiving them will sign, date, and note the time of transfer on the COC(s). The method of shipment, courier name, and other pertinent information will be entered in the remarks section of the COC. Once the record is completed, the carbon copies will be separated. The field member who relinquished the samples will retain a copy, and the original will accompany the coolers to the laboratory. The field copy will be stored in the project files.

Before any cooler leaves the Site by means other than laboratory courier or field personnel, the COC record will be placed in a sealed plastic bag at the top of the inside of the cooler. The cooler will then be sealed with packing tape, and a custody seal will be signed and dated by the relinquishing party and placed on the cooler so that the cooler cannot be opened without the custody seal being broken. The retained carbon copy of the COC will be scanned and sent to the project manager. A COC record will be maintained in the project management files.

Within 24 hours of sample receipt, the laboratory will send a notice acknowledging sample receipt to the project manager. In the acknowledgment, the laboratory will list the samples received, the associated laboratory IDs that were assigned, and any problems that were encountered at sample receipt.

Any changes to the analyses that are requested on the COC record should be noted, initialed, and dated on the COCs copies possessed by both the laboratory and the project data manager. Upon completion of analysis, the analytical laboratory will send copies of the appropriate COC record for each sample to the project manager.

4.7 PROJECT DOCUMENTATION

All compliance monitoring field activities will be documented using one or more of the following methods:

- Field notes;
- Photographs;
- COC forms;
- Sample labels;
- Soil boring and well construction logs; and
- Field documentation forms.

4.7.1 Field Notes

Field personnel will use a notebook or field report sheets to record any pertinent compliance monitoring information not captured in the other documentation forms. Any notes recorded to a notebook or field report sheets will be scanned and submitted to the project manager.

4.7.2 Field Documentation Forms and Procedures

Field documentation forms are included in **Appendix B**. Specific procedures regarding the use of these forms are discussed in the section(s) of this document associated with activities that require use of the form. The field documentation forms that will be used to document compliance monitoring activities and the sections in which they are discussed are listed below:

- COC form (**Section 4.6.2**);
- Sample labels (**Section 4.5**);
- Soil boring/well detail log (**Section 3.2.1**);
- Well development log (**Section 3.2.1**);
- Groundwater injection log (**Section 2.0**);
- Groundwater sampling field data sheet (**Section 4.2.3**); and
- Field analysis log (**Section 4.2.4**).

4.8 SURVEYING

Each installed injection well, injection observation well, or other sample location will be surveyed by a licensed surveyor. All survey data will be presented in a survey report and include the location ID, horizontal and vertical position, units, and the survey reference system used.

4.9 WASTE MANAGEMENT

Soil cuttings will be collected and transferred to waste roll-off bins, or 55-gallon Department of Transportation (DOT)-rated drums depending on the amount of soil generated. Water generated during well development, well purging, and decontamination activities will be collected and transferred to 55-gallon DOT-rated drums. The proper label(s) will be affixed, and drums/bins will be stored on the BJS parcel pending analysis and disposal. All investigatory-derived and remediation-derived wastes will be removed from the Site by an approved waste hauler in accordance with state and federal regulations.

Soil cuttings will be transported to:

Waste Management Columbia Ridge Landfill (WM Arlington landfill)
18177 Cedar Springs Lane
Arlington, OR 97812
(541) 454-2030

Soil waste must be free of all flowing material and capable of passing a paint filter test prior to transport off-site.

Water waste will be removed by an approved waste hauler, in accordance with state and federal regulations, for disposal at an approved facility.

Appropriate waste manifests will be generated for wastes shipped off-site for disposal. Upon transferring custody of the waste, the individuals relinquishing and receiving it will sign, date, and note the time of transfer on the waste manifest. Once the record is completed, the carbon copies will be separated. The field member who relinquished the waste will retain a copy, and the original will accompany the waste to the disposal facility. The field copy will be stored in the project files.

5.0 Quality Assurance and Quality Control Procedures

Quality assurance (QA) refers to the process for assuring the reliability of measurement data. Quality control (QC) refers to the application of statistical procedures to evaluate and control the accuracy of the measurement data. The QA objective for this GW CMP is to develop procedures that will provide data of known and appropriate quality for the objectives identified in **Section 4.1**.

5.1 DATA QUALITY OBJECTIVES

Data quality is assessed by the representativeness, comparability, accuracy, precision, and completeness of the data. Definitions of these terms, the applicable procedures, and level of effort are described below. The applicable QC procedures, quantitative target limits, and level of effort for assessing data quality are dictated by the intended use of the data and the nature of the analytical methods. Chemical parameters, analytical methods, applicable detection levels, analytical precision, accuracy, and completeness in alignment with needs identified in the GW CMP are presented in **Table 6**. Data quality objectives (DQOs) have been constrained to testing involving laboratory chemical analysis.

Detection levels for the analytical methods referenced in this GW CMP are shown in **Table 6**, and are below the applicable Site CULs.

Representativeness is a measure of how closely the results reflect the actual concentration or distribution of the chemical compounds in the water and soil sampled. Sampling plan design, sampling techniques, and sample handling protocols (e.g., storage, preservation, and transportation) are intended provide representative analytical data as detailed in **Section 4.0**. Documentation procedures described in **Section 4.7** will demonstrate that protocols were followed and sample identification and integrity were maintained. Equipment blanks and trip blanks will be used to assess field and transport contamination and method variation. Laboratory method blanks will be run at the minimum frequency of 5% or one per set to assess laboratory contamination.

Comparability of the data will be maintained by using standard EPA-defined procedures where available. If EPA procedures are not available, the proposed procedures are defined or referenced in this document. Data comparability will be maintained through the use of consistent methods, consistent units, and well-defined detection limits. The analytical method laboratory reporting limits are provided in **Table 6**. **Section 5.3** of this plan further describes the analytical and QC procedures. Reporting limits are established using pure standards. During measurement of an actual sample, detection limits may be elevated because of interference from other components in the matrix. Matrix interferences cannot be predicted ahead of time but will be reported if they occur.

Accuracy is an assessment of the closeness of the measured value to the true value. The accuracy of chemical test results is assessed by spiking samples with known standards and establishing the average recovery. In general, two types of recoveries are measured for VOCs: matrix spike recoveries and surrogate spike recoveries. For a matrix spike, known amounts of standard compounds identical to the compounds present in the sample of interest are added to the sample. For a surrogate spike, the standards are chemically similar but not identical to the compounds in the fraction being analyzed. The purpose of the surrogate spike is to provide QC on every sample by constantly monitoring for unusual matrix effects and gross sample processing errors. For inorganics, generally only matrix spikes are measured. Accuracy measurements will be conducted in the laboratory at a minimum frequency of 1 in 20 samples. **Table 6** lists the target quantitative accuracy objectives that will apply to each compliance monitoring parameter.

Precision is a measure of the spread of the data when more than one measurement is taken on the same sample. For duplicate measurements, precision can be expressed as the relative percent difference (RPD). Precision measurements will be conducted in the laboratory at a minimum frequency of 1 in 20 samples. Target quantitative precision objectives are listed in **Table 6**, as applicable.

5.2 QUALITY ASSURANCE QUALITY CONTROL ORGANIZATION

5.2.1 Stantec Project Manager

The Stantec project manager (PM) is responsible the overall project performance including QA/QC activities. The Stantec PM is responsible for:

- Reviewing and approving QA/QC requirements, including those stated in this document;
- Effectively communicating data management and QA/QC requirements to all applicable project personnel;
- Ensuring that all project personnel have the appropriate resources to meet the database management and QA/QC requirements;
- Reviewing and approving documents reporting data generated as part of the compliance monitoring; and
- Auditing QA/QC activities, as necessary.

5.2.2 Stantec Technical Lead

A Stantec technical lead may be assigned by the Stantec PM to coordinate all or some of the groundwater remedy compliance monitoring activities. The Stantec technical lead may be responsible for:

- Coordinating compliance monitoring activities including Stantec field personnel, sampling equipment, and laboratory supplies; and

- Ensuring Stantec and laboratory generated data meet the GW CMP objectives.

5.2.3 Stantec QA/QC Technician

Stantec will provide the technical staff necessary to perform the sampling and reporting aspects of the project. Stantec's QA/QC technician is responsible for objectively reviewing project data and deliverables, identifying problems, and resolving quality-related problems. The QA/QC technician is responsible for the following:

- Implementing the project QA/QC program;
- Data logging and tracking, data preparation, data entry and verification, data administration, and report generation;
- Reviewing QA/QC standard operating procedures (SOPs) applicable to this project;
- Auditing selected activities, as necessary;
- Consulting with the Stantec PM, as needed, on appropriate QA/QC measures and corrective actions; and
- Coordinating written reports on QA/QC activity.

5.3 QUALITY CONTROL PROCEDURES

5.3.1 Field Quality Control Procedures

Field QC procedures will include the collection of trip blanks, equipment blanks, and field duplicates as detailed in **Section 4.4**.

5.3.2 Laboratory Quality Control Procedures

Internal laboratory QC samples include laboratory blanks (i.e., method blanks, preparation blanks), laboratory duplicates, matrix spike/matrix spike duplicates (MS/MSDs), and laboratory control samples (LCS). Laboratory QC procedures will include the following:

- Analytical methodology according to specific methods listed in **Table 5**;
- Instrument calibrations according to the manufacturer guidelines and recommendations and the criteria set forth in the applicable analytical methodology including calibration blank analysis;
- Laboratory blank measurements (method blanks) at a minimum rate of one per 20 samples or one-per-sample group;

- Accuracy and precision measurements (MS/MSDs) at a minimum rate of one per 20 samples or one-per-sample group; and
- Data reduction and reporting according to specific methods listed in **Table 6**.

5.3.3 Data Review, Verification, and Validation

Data reviews will be performed at two levels: at the laboratory and outside the laboratory.

Laboratory Data Verification

The laboratory analyst is responsible for verifying data integrity. The analyst has the initial responsibility for reviewing instrument conditions and calibration integrity, and for verifying accuracy of raw data entries and calculations. Relevant laboratory summaries and extraction and analytical logs will be checked. The analyst is also responsible for ensuring all acceptance criteria for the analysis were met. If deficiencies are found, the analyst has the responsibility for correcting these as soon as they are identified, and before the data are submitted for internal review. During data review and reporting, various data qualifiers may be added to aid the data user in evaluating the data.

Laboratory Data Validation

Before analytical results are reported to the client by the laboratory, they are subjected to a data review process conducted by a trained analyst who was not involved in the original analysis. All data are reviewed against the acceptance criteria specified in the method SOP. When data review is finished, a QA audit checklist is completed. Any non-conformances are reviewed and resolved by the technical manager. The technical manager approves all final departmental reports before they are issued to data packaging personnel. The data package personnel then assemble the individual department reports into a complete data package. Prior to release to the client, the project chemist reviews and approves the entire report for completeness and achievement of client-specified objectives.

Stantec Data Review and Verification

Laboratory results will be evaluated and verified by the Stantec QA/QC technician or other designated personnel for compliance with project objectives. Throughout compliance monitoring, the data will be evaluated for completeness and usefulness, including qualified data and other obvious data quality issues. All analytical data will be evaluated for compliance with precision, accuracy, representativeness, completeness, and comparability parameter criteria.

5.4 DATA QUALITY ASSESSMENT

Following verification, the data will be assessed by the project team. The assessment will include reviewing the DQOs (accuracy, precision, completeness, and detection limits) while preparing the report to present the data results. The report will include an evaluation of the overall adequacy of the total measurement systems with regard to the DQOs of the data generated.

5.5 DATA MANAGEMENT

Following receipt of validated data, the data will be input into the project database(s) to facilitate database queries and report preparation. Data management can be defined as comprising the functions of creating and accessing stored data, enforcing data storage conventions, and regulating data input and output.

For this project, data management will involve the use of computerized data management systems. The systems will provide a centralized, secure location for data of known quality that can be shared and used for multiple purposes. The data management systems will assist in the information flow for the project by providing a means of cataloging, organizing, archiving, and accessing information.

5.6 AUDITS AND REPORTING

5.6.1 Audits

The Stantec PM and the database management team will monitor and, if necessary, audit the performance of the QA/QC procedures. When necessary, the review team will conduct field audits. Audits may be scheduled to evaluate the execution of sample ID, sample control, COC procedures, field notebooks, sampling procedures, and field measurements.

If QC monitoring or audits result in detection of unacceptable conditions or data, the PM will be responsible for initiating corrective action. The Ecology PM will be notified if nonconformance is of program significance or requires special expertise not normally available to the project team. Corrective actions may include the following:

- Reanalyzing samples if holding-time criteria permit;
- Resampling and analyzing;
- Evaluating and amending sampling and analytical procedures; and
- Accepting data while acknowledging level of uncertainty.

5.6.2 Reporting

The Groundwater Remedy Construction Completion Report (GW CCR) will document the groundwater cleanup actions through the completion of the Phase II EISB injections. Prior to Ecology approval of the GW CCR, progress reports will be submitted monthly to Ecology documenting on-site activities, any deviations from the planned scope of work or schedule, and planned future activities. Any data collected during these activities will be made available to Ecology upon request. Otherwise, data and any analysis of the data including QA/QC activities will be reported to Ecology in the GW CCR and/or in the groundwater monitoring reports, as applicable.

Following Ecology approval of the GW CCR, progress reports will be submitted to Ecology quarterly and include any compliance monitoring data collected during the reporting period, as specified in the Consent Decree.

6.0 References

Stantec, 2016. *Groundwater Remedy Engineering Design Report*, November 15.

Stantec, 2019. *Groundwater Remedy Construction Plans and Specifications*, May 1.

United States Environmental Protection Agency (EPA), 1992. *Specifications and Guidance for Contaminant-Free Sample Containers*, December.

Washington Administrative Code (WAC), 2007. *MTCA Cleanup Regulation*, WAC 173-340-400, October 12.

Washington Department of Ecology (Ecology), 2013. *Consent Decree No. 132017660*, State of Washington, Yakima County Superior Court, May 28.

TABLES

Table 1
Groundwater Cleanup Levels
Bee-Jay Scales Site
Sunnyside, Washington

Analyte	Groundwater Cleanup Level (mg/L)	Source
1,2,3-Trichloropropane	0.00001	Modified MTCA Method B
1,2,4-Trimethylbenzene	0.4	Modified MTCA Method B
1,2-Dichloropropane	0.005	Primary MCL
1,3,5-Trimethylbenzene	0.4	Modified MTCA Method B
2-Methylnaphthalene	0.032	Modified MTCA Method B
2,4,5-T	0.16	Modified MTCA Method B
2,4,5-TP	0.05	Primary MCL
2,4-D	0.07	Primary MCL
2,4-DB	0.128	Modified MTCA Method B
Arsenic	0.01	Primary MCL
Benzene	0.005	Primary MCL
Chlorobenzene	0.1	Primary MCL
Dicamba	0.48	Modified MTCA Method B
Dinoseb	0.007	Primary MCL
Ethylbenzene	0.7	Primary MCL
Iron	11.2	Modified MTCA Method B
Manganese	2.2	Standard MTCA Method B
Naphthalene	0.16	Modified MTCA Method B
Nitrate Nitrogen	10	Primary MCL
Nitrite Nitrogen	1	Primary MCL
Pentachlorophenol	0.001	Primary MCL
Toluene	1	Primary MCL
TPH-Gx	0.8	Standard MTCA Method A
Xylenes	10	Primary MCL

Notes:

2,4,5-T = 2,4,5-Trichlorophenoxyacetic acid
2,4,5-TP = 2(2,4,5-Trichlorophenoxy)propionic acid
2,4-D = 2,4-Dichlorophenoxyacetic acid
2,4-DB = 4-(2,4-Dichlorophenoxy)butyric acid
TPH-Gx = Total petroleum hydrocarbons in the gasoline range
mg/L = milligrams per liter
MCL = Maximum Contaminant Level
MTCA = Model Toxics Control Act
Bold analytes are indicator hazardous substances (IHSs).

Table 2
EISB Groundwater Remedy Performance Monitoring Program
Bee-Jay Scales Site, Sunnyside, Washington

	Site Indicator Hazardous Substances (IHS)											Enhanced In-Situ Bioremediation (EISB) Monitoring Parameters					
	Nitrate	Nitrite	Arsenic[1]	Iron[1]	Manganese[1]	2,4-D	Dinoseb	Benzene	Chlorobenzene	1,2-DCP	2-MN	BOD	Ferrous Iron[2]	Sulfate	Alkalinity	Ammonia	Phosphorus[3]
Laboratory Analytical Method	EPA 353.2	EPA 353.2	EPA 6010B	EPA 6010B	EPA 6010B	EPA 8151A	EPA 8151A	EPA 8260B	EPA 8260B	EPA 8260B	EPA 8260B	SM 5210B	EPA 6010D	EPA 300.0	SM 2320B	SM 4500-NH_3	EPA 365.1
CHEMetrics Field Test Kit Model	K-6933	K-7003	NA	NA	K-6503	NA	NA	NA	NA	NA	NA	NA	K-6203	K-9203	NA	K-1523	K-8503
Location																	
MW-1	1,3	1,3										1,3	1,3	1,3	1,3		
MW-3	1,2,3,4	1,2,3,4	1,2,3,4	1,2,3,4	1,2,3,4	1,2,3,4	1,2,3,4	1,2,3,4	1,2,3,4	1,2,3,4	1,2,3,4	1,2,3,4	1,2,3,4	1,2,3,4	1,2,3,4	1,2,3,4	1,2,3,4
MW-4R	1,2,3,4	1,2,3,4	1,2,3,4	1,2,3,4	1,2,3,4	1,2,3,4	1,2,3,4	1,2,3,4	1,2,3,4	1,2,3,4	1,2,3,4	1,2,3,4	1,2,3,4	1,2,3,4	1,2,3,4	1,2,3,4	1,2,3,4
MW-5R	1,2,3,4	1,2,3,4	1,2,3,4	1,2,3,4	1,2,3,4	1,2,3,4	1,2,3,4	1,2,3,4	1,2,3,4	1,2,3,4	1,2,3,4	1,2,3,4	1,2,3,4	1,2,3,4	1,2,3,4	1,2,3,4	1,2,3,4
MW-6	1,3	1,3	1,3														
MW-7	1,3	1,3															
MW-8	1,3	1,3															
MW-9	1,3	1,3				1,3	1,3	1,3	1,3	1,3	1,3	1,3	1,3	1,3	1,3		
MW-10	1,3	1,3	1,3														
MW-11	1,3	1,3	1,3														
MW-12R	1,2,3,4	1,2,3,4	1,2,3,4	1,2,3,4	1,2,3,4	1,2,3,4	1,2,3,4	1,2,3,4	1,2,3,4	1,2,3,4	1,2,3,4	1,2,3,4	1,2,3,4	1,2,3,4	1,2,3,4	1,2,3,4	1,2,3,4
MW-13	1,2,3,4	1,2,3,4	1,2,3,4	1,2,3,4	1,2,3,4	1,2,3,4	1,2,3,4	1,2,3,4	1,2,3,4	1,2,3,4	1,2,3,4	1,2,3,4	1,2,3,4	1,2,3,4	1,2,3,4	1,2,3,4	1,2,3,4
MW-14	1,3	1,3															
MW-15	1,3	1,3	1,3														
MW-16	1,3	1,3				1,3	1,3	1,3	1,3	1,3	1,3	1,3	1,3	1,3	1,3		
MW-17	1,3	1,3															
MW-18	1,3	1,3	1,3														
MW-19	1,3	1,3	1,3			1,3	1,3	1,3	1,3	1,3	1,3	1,3	1,3	1,3	1,3		
MW-20	1,3	1,3	1,3														
MW-21	1,2,3,4	1,2,3,4	1,2,3,4	1,2,3,4	1,2,3,4	1,2,3,4	1,2,3,4	1,2,3,4	1,2,3,4	1,2,3,4	1,2,3,4	1,2,3,4	1,2,3,4	1,2,3,4	1,2,3,4	1,2,3,4	1,2,3,4
MW-22[4]	1,2,3,4	1,2,3,4	1,2,3,4	1,2,3,4	1,2,3,4	1,2,3,4	1,2,3,4	1,2,3,4	1,2,3,4	1,2,3,4	1,2,3,4	1,2,3,4	1,2,3,4	1,2,3,4	1,2,3,4	1,2,3,4	1,2,3,4
MW-23[4]	1,2,3,4	1,2,3,4	1,2,3,4	1,2,3,4	1,2,3,4	1,2,3,4	1,2,3,4	1,2,3,4	1,2,3,4	1,2,3,4	1,2,3,4	1,2,3,4	1,2,3,4	1,2,3,4	1,2,3,4	1,2,3,4	1,2,3,4
MW-24[4]	1,2,3,4	1,2,3,4	1,2,3,4	1,2,3,4	1,2,3,4	1,2,3,4	1,2,3,4	1,2,3,4	1,2,3,4	1,2,3,4	1,2,3,4	1,2,3,4	1,2,3,4	1,2,3,4	1,2,3,4	1,2,3,4	1,2,3,4

Notes:

[1] = Analysis will be for total concentration of the constituent.

[2] = Analysis will be for dissolved iron if lab analyzed, and for ferrous iron if field kit analyzed.

[3] = Analysis will be for total phosphorus if lab analyzed, and for ortho-phosphate if field kit analyzed.

[4] = Monitoring wells will be installed and monitored as part of the Phase II EISB system and will not be present for monitoring during the Phase I injection event.

1,2,3,4 = Sampling will be conducted at this monitoring well for this constituent prior to EISB injection and every quarter until the cessation of the program.

1,3 = Sampling will be conducted at this monitoring well for this constituent during the first and third quarters until the cessation of the program.

EISB = Enhanced in-situ bioremediation

2,4-D = 2,4-Dichlorophenoxyacetic acid

1,2-DCP = 1,2-Dichloropropane

2-MN = 2-Methylnaphthalene

BOD = Biochemical oxygen demand

EPA = United States Environmental Protection Agency

SM = Standard Methods

NA = Not applicable

Table 3
Post-EISB Groundwater Remedy Performance Monitoring Program
Bee-Jay Scales Site, Sunnyside, Washington

	Site Indicator Hazardous Substances (IHS)											Enhanced In-Situ Bioremediation (EISB) Monitoring Parameters					
	Nitrate	Nitrite	Arsenic[1]	Iron[1]	Manganese[1]	2,4-D	Dinoseb	Benzene	Chlorobenzene	1,2-DCP	2-MN	BOD	Ferrous Iron[2]	Sulfate	Alkalinity	Ammonia	Phosphorus[3]
Laboratory Analytical Method	**EPA 353.2**	**EPA 353.2**	**EPA 6010B**	**EPA 6010B**	**EPA 6010B**	**EPA 8151A**	**EPA 8151A**	**EPA 8260B**	**EPA 8260B**	**EPA 8260B**	**EPA 8260B**	**SM 5210B**	**EPA 6010D**	**EPA 300.0**	**SM 2320B**	**SM 4500-NH_3**	**EPA 365.1**
CHEMetrics Field Test Kit Model	**NA**	**NA**	**NA**	**NA**	**K-6503**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**K-6203**	**K-9203**	**NA**	**K-1523**	**K-8503**
Location																	
MW-1	1,3	1,3	1,3									1,3	1,3	1,3	1,3		
MW-3	1,3	1,3	1,3	1,3	1,3	1,3	1,3	1,3	1,3	1,3	1,3	1,3	1,3	1,3	1,3	1,3	1,3
MW-4R	1,3	1,3	1,3	1,3	1,3	1,3	1,3	1,3	1,3	1,3	1,3	1,3	1,3	1,3	1,3	1,3	1,3
MW-5R	1,3	1,3	1,3	1,3	1,3	1,3	1,3	1,3	1,3	1,3	1,3	1,3	1,3	1,3	1,3	1,3	1,3
MW-6	1,3	1,3	1,3	1,3	1,3							1,3	1,3	1,3	1,3	1,3	1,3
MW-7	1,3	1,3	1,3														
MW-8	1,3	1,3	1,3	1,3	1,3							1,3	1,3	1,3	1,3	1,3	1,3
MW-9	1,3	1,3	1,3	1,3	1,3	1,3	1,3	1,3	1,3	1,3	1,3	1,3	1,3	1,3	1,3	1,3	1,3
MW-10	1,3	1,3	1,3														
MW-11	1,3	1,3	1,3														
MW-12R	1,3	1,3	1,3	1,3	1,3	1,3	1,3	1,3	1,3	1,3	1,3	1,3	1,3	1,3	1,3	1,3	1,3
MW-13	1,3	1,3	1,3	1,3	1,3	1,3	1,3	1,3	1,3	1,3	1,3	1,3	1,3	1,3	1,3	1,3	1,3
MW-14	1,3	1,3	1,3														
MW-15	1,3	1,3	1,3														
MW-16	1,3	1,3	1,3	1,3	1,3	1,3	1,3	1,3	1,3	1,3	1,3	1,3	1,3	1,3	1,3	1,3	1,3
MW-17	1,3	1,3	1,3														
MW-18	1,3	1,3	1,3														
MW-19	1,3	1,3	1,3	1,3	1,3	1,3	1,3	1,3	1,3	1,3	1,3	1,3	1,3	1,3	1,3	1,3	1,3
MW-20	1,3	1,3	1,3														
MW-21	1,3	1,3	1,3	1,3	1,3	1,3	1,3	1,3	1,3	1,3	1,3	1,3	1,3	1,3	1,3	1,3	1,3
MW-22[4]	1,3	1,3	1,3	1,3	1,3	1,3	1,3	1,3	1,3	1,3	1,3	1,3	1,3	1,3	1,3	1,3	1,3
MW-23[4]	1,3	1,3	1,3	1,3	1,3	1,3	1,3	1,3	1,3	1,3	1,3	1,3	1,3	1,3	1,3	1,3	1,3
MW-24[4]	1,3	1,3	1,3	1,3	1,3	1,3	1,3	1,3	1,3	1,3	1,3	1,3	1,3	1,3	1,3	1,3	1,3

Notes:

[1] = Analysis will be for total concentration of the constituent.

[2] = Analysis will be for dissolved iron if lab analyzed, and for ferrous iron if field kit analyzed.

[3] = Analysis will be for total phosphorus if lab analyzed, and for ortho-phosphate if field kit analyzed.

[4] = Monitoring wells will be installed and monitored as part of the Phase II EISB system and will not be present for monitoring during the Phase I injection event.

1,3 = Sampling will be conducted at this monitoring well for this constituent during the first and third quarters.

EISB = Enhanced in-situ bioremediation

2,4-D = 2,4-Dichlorophenoxyacetic acid

1,2-DCP = 1,2-Dichloropropane

2-MN = 2-Methylnaphthalene

BOD = Biochemical oxygen demand

EPA = United States Environmental Protection Agency

SM = Standard Methods

NA = Not applicable

Table 4
Groundwater Remedy Performance Monitoring Contingency Plan
Bee-Jay Scales Site, Sunnyside, Washington

Performance Monitoring Data Trigger	Contingency Actions
Groundwater Remedy Performance Monitoring	
Nitrate concentrations at a down-gradient boundary monitoring well (MW-15, 17, 18, 19, and 20) or future down-gradient monitoring well indicate a UCL95 above the Site CUL of 10 mg/L over the previous 3 years.	The monitoring well will be included as a Site POC and analysis of the applicable EISB monitoring parameters will be added to the EISB and post-EISB groundwater remedy performance monitoring, if not already included. Additional groundwater monitoring well(s) will be installed to define the boundary of the Site groundwater plume. The new groundwater monitoring well(s) will be added to the EISB and post-EISB groundwater remedy performance monitoring. The sampling plan for the new monitoring well(s) will be submitted to Ecology for approval prior to implementation.
Nitrate concentrations at an up-gradient monitoring well (MW-1, 7, 10, 11, and 14) indicate a UCL95 above the Site CUL of 10 mg/L over the previous 3 years.	Analysis for BOD, ferrous iron, sulfate, and alkalinity will be added to the EISB groundwater remedy performance monitoring; and analysis for iron, manganese, and all EISB monitoring parameters will be added to the post-EISB groundwater remedy performance monitoring.
IHS concentrations in a boundary monitoring well indicate a 3-year UCL95 above the Site CUL (or above the RL for arsenic) and the Mann-Kendall trend analysis indicates an increasing trend when the well is under MNA conditions.	If an existing monitoring well is located down-gradient of the location, the applicable analysis will be added to the EISB and post-EISB groundwater remedy performance monitoring for that monitoring well location. If there is not an existing down-gradient monitoring well, additional groundwater monitoring well(s) will be installed to define the boundary of the Site groundwater plume, and the applicable sampling analysis will be added to the EISB and post-EISB groundwater remedy performance monitoring for the new monitoring well(s).
Storm/Irrigation Drain Monitoring	
Down-gradient storm/irrigation sample locations (M-10 and/or M-13) indicate possible groundwater infiltration, and the constituent concentrations at M-21 indicate that groundwater infiltration may be adversely affecting down-gradient surface water quality.	An additional storm/irrigation sampling plan will be developed to isolate the source of the increased down-gradient constituent concentrations in the storm/irrigation drain system. The plan will be submitted to Ecology for approval prior to implementation.
Institutional Controls Performance Monitoring	
Property owner actions are found to interfere with the implemented institutional controls.	Investigate the institutional control violation(s), including communication with the property owner(s). Report investigation findings to the property owner, clients, Ecology, and any other affected stakeholders.

Notes:
POC = Point of Compliance
UCL95 = Upper One Sided 95% Confidence Limit
CUL = Cleanup Level
RL = Remediation Level
MNA = Monitored Natural Attenuation
BOD = biochemical oxygen demand

Table 5
Compliance Monitoring Analytical Methods and Parameters
Bee-Jay Scales Site, Sunnyside, Washington

Analyte	Laboratory	Method	Sample Containers	Preservative	Holding Time
Soil					
Nitrate	Lancaster	EPA 300.0	125 mL glass jar	None	28 days
Sulfate	Lancaster	EPA 300.0	125 mL glass jar	None	28 days
Ammonia	Lancaster	EPA 350.3	125 mL glass jar	None	28 days
Arsenic, Total	Lancaster	EPA 6010B	125 mL glass jar	None	6 months
Iron, Total	Lancaster	EPA 6010B	125 mL glass jar	None	6 months
Manganese, Total	Lancaster	EPA 6010B	125 mL glass jar	None	6 months
TOC	Lancaster	EPA 9060A	125 mL glass jar	None	28 days
Reductant Demand	Stantec	NA	125 mL glass jar	None	NA
Groundwater					
Nitrate	Lancaster	EPA 353.2	40 mL glass vial	H_2SO_4	28 days
Nitrite	Lancaster	EPA 353.2	40 mL glass vial	None	48 hours
Ammonia	Lancaster	SM 4500-NH_3	500 mL glass bottle	H_2SO_4	28 days
Arsenic, Total	Lancaster	EPA 6010B	250 mL plastic bottle	HNO_3	6 months
Iron, Total	Lancaster	EPA 6010B	250 mL plastic bottle	HNO_3	6 months
Manganese, Total	Lancaster	EPA 6010B	250 mL plastic bottle	HNO_3	6 months
Sulfate	Lancaster	EPA 300.0	40 mL glass vials	None	28 days
BOD	Lancaster	SM 5210B	500 mL plastic bottle	None	48 hours
Iron, Dissolved	Lancaster	EPA 6010D	250 mL plastic bottle	HNO_3	6 months
Alkalinity	Lancaster	SM 2320B	250 mL plastic bottle	None	14 days
Total Phosphorus	Lancaster	EPA 365.1	250 mL plastic bottle	H_2SO_4	28 days

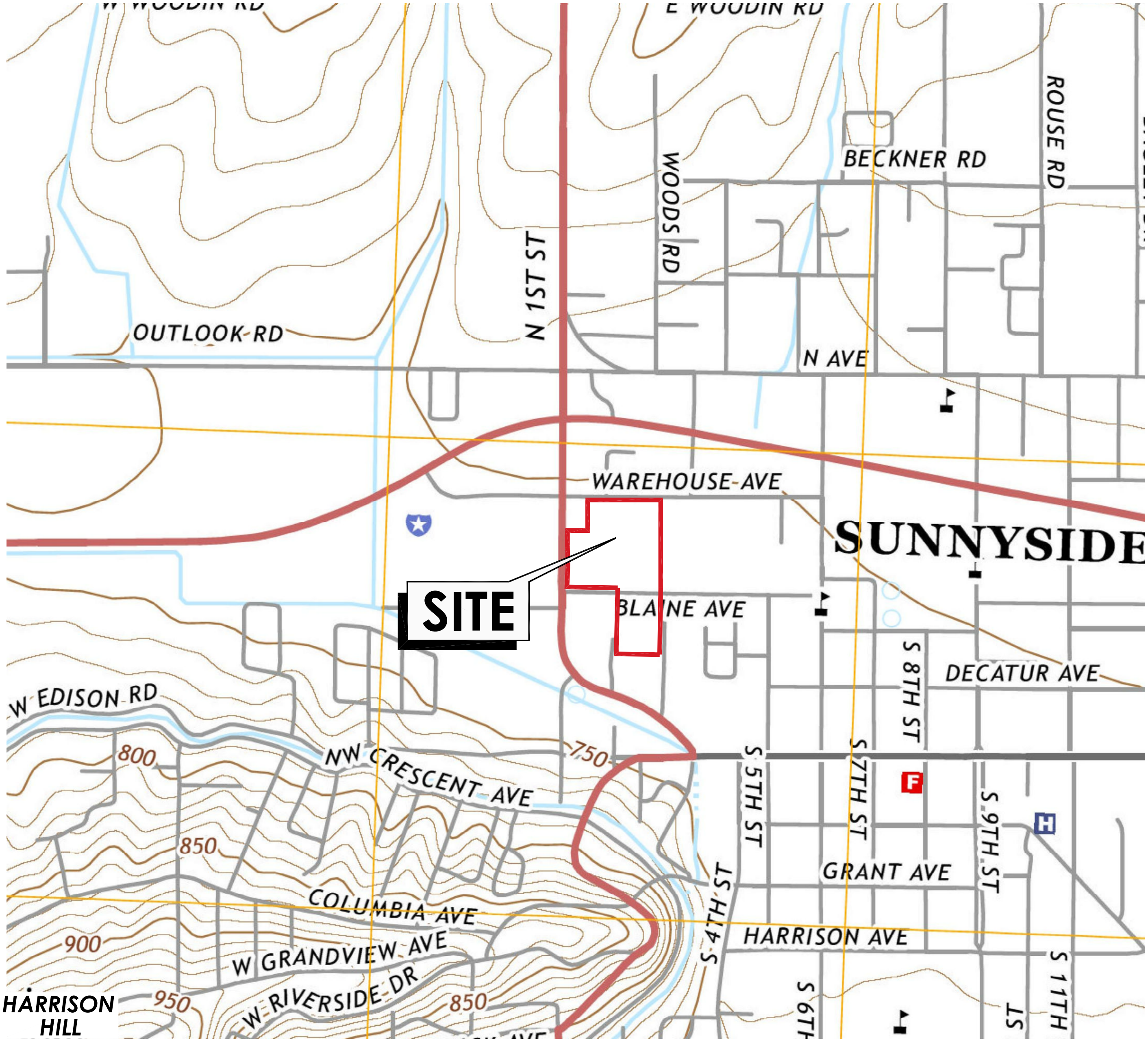
Notes:
Lancaster = Eurofins Lancaster Laboratories in Lancaster, Pennsylvania
Stantec = Stantec Treatability Testing Services Group in Sylvania, Ohio
EPA = United States Environmental Protection Agency
SM = Standard Methods for the Examination of Water and Wastewater
TOC = total organic carbon
BOD = biochemical oxygen demand
mL = milliliter
HCl = hydrochloric acid
H_2SO_4 = sulfuric acid
HNO_3 = nitric acid

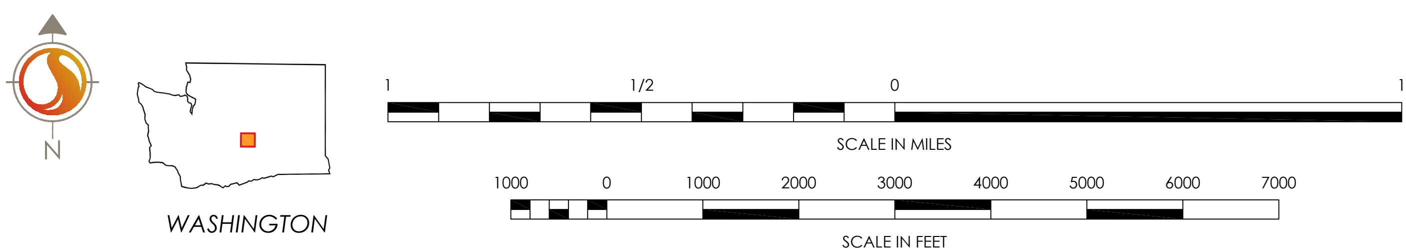
Table 6
Compliance Monitoring Analytical Performance Criteria
Bee-Jay Scales Site, Sunnyside, Washington

Analyte	Laboratory	Laboratory Analytical Method	Method Detection Limit	Site Cleanup Level	Analytical Accuracy (% Recovery)	Analytical Precision (RPD)
Soil						
Nitrate	Lancaster	EPA 300.0	0.5 mg/kg	220 mg/kg	90-110	20
Sulfate	Lancaster	EPA 300.0	5 mg/kg	NA	90-110	20
Ammonia	Lancaster	EPA 350.3	3.3 mg/kg	385 mg/kg	85-115	15
Arsenic, Total	Lancaster	EPA 6010B	0.6 mg/kg	NA	75-125	20
Iron, Total	Lancaster	EPA 6010B	3.33 mg/kg	NA	75-125	20
Manganese, Total	Lancaster	EPA 6010B	0.12 mg/kg	NA	75-125	20
TOC	Lancaster	EPA 9060A	100 mg/kg	NA	47-143	20
Reductant Demand	Stantec	NA	NA	NA	NA	20
Groundwater						
1,2-DCP	Lancaster	EPA 8260B	0.0005 mg/L	0.005 mg/L	80-120	30
2-Methylnaphthalene	Lancaster	EPA 8260B	0.002 mg/L	0.032 mg/L	27-120	30
Benzene	Lancaster	EPA 8260B	0.0005 mg/L	0.005 mg/L	78-120	30
Chlorobenzene	Lancaster	EPA 8260B	0.0005 mg/L	0.1 mg/L	80-120	30
Nitrate	Lancaster	EPA 353.2	0.04 mg/L	10 mg/L	90-110	20
Nitrite	Lancaster	EPA 353.2	0.015 mg/L	1 mg/L	90-110	20
Ammonia	Lancaster	SM 4500-NH_3	0.05 mg/L	NA	78-128	20
Dinoseb	Lancaster	EPA 8151A	0.00012 mg/L	0.007 mg/L	16-163	30
2,4-D	Lancaster	EPA 8151A	0.00016 mg/L	0.07 mg/L	68-155	30
Arsenic, Total	Lancaster	EPA 6010B	0.0078 mg/L	0.01 mg/L	75-125	20
Iron, Total	Lancaster	EPA 6010B	0.0333 mg/L	11.2 mg/L	75-125	20
Manganese, Total	Lancaster	EPA 6010B	0.0012 mg/L	2.2 mg/L	75-125	20
Sulfate	Lancaster	EPA 300.0	1.5 mg/L	NA	90-110	20
Iron, Dissolved	Lancaster	EPA 6010D	0.085 mg/L	NA	80-114	20
Alkalinity	Lancaster	SM 2320B	1.7 mg/L	NA	77-114	5
BOD	Lancaster	SM 5210B	2 mg/L	NA	85-115	8
Total Phosphorus	Lancaster	EPA 365.1	0.05 mg/L	NA	90-110	20

Notes:
TOC = total organic carbon
1,2-DCP = dichloropropane
2,4-D = 2,4-Dichlorophenoxyacetic acid
BOD = biochemical oxygen demand
TPH-Gx = total petroleum hydrocarbons in the gasoline range
Stantec = Stantec Treatability Testing Services Group in Sylvania, Ohio
Lancaster = Eurofins Lancaster Laboratories, Lancaster, Pennsylvania
EPA = United States Environmental Protection Agency
SM = Standard Methods for the Examination of Water and Wastewater
mg/kg = milligrams per kilogram
mg/L = milligrams per liter

FIGURES

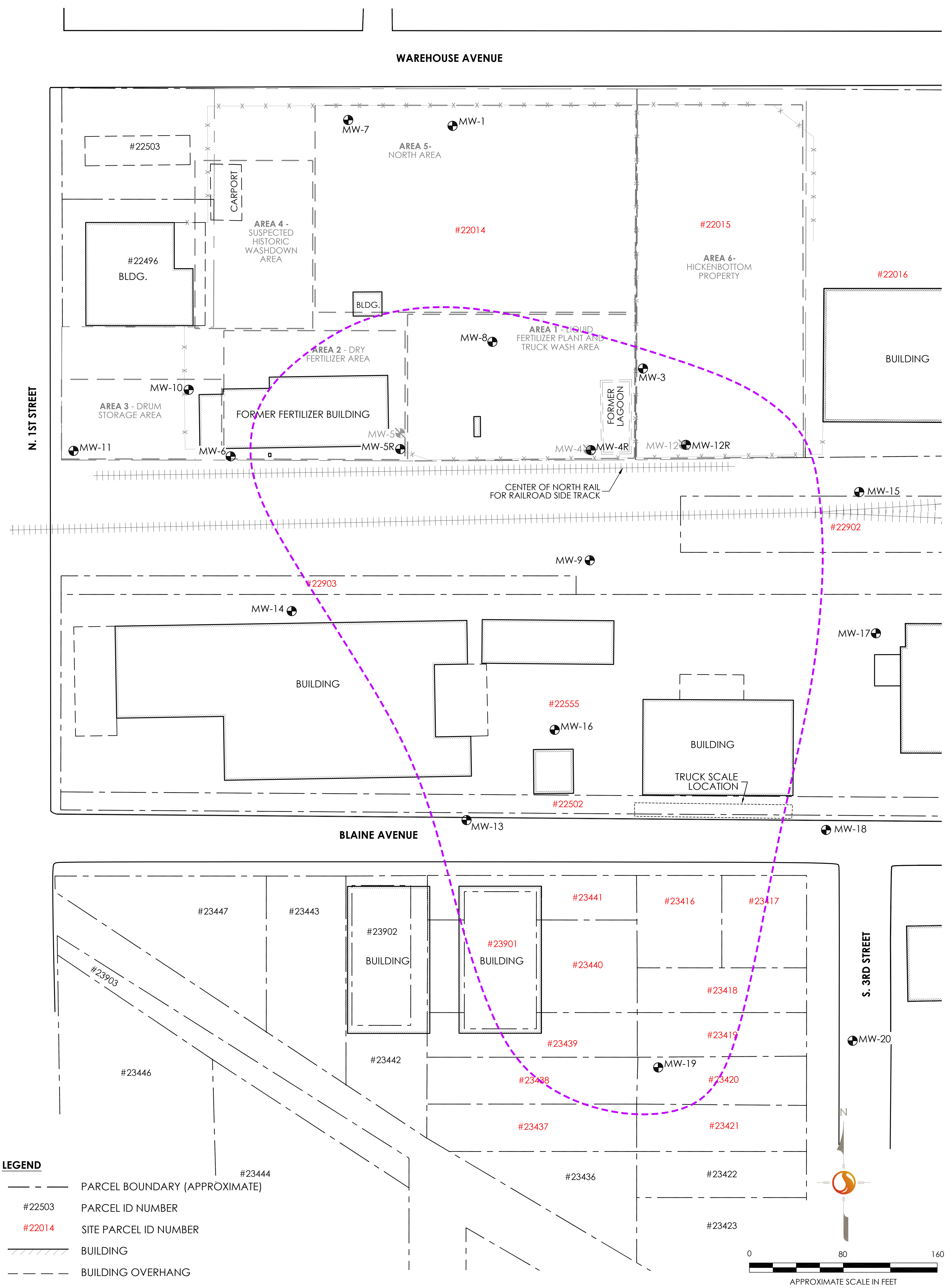




REFERENCE: USGS 7.5 MINUTE QUADRANGLE;
SUNNYSIDE, WASHINGTON; 2013

Stantec 2321 Club Meridian Drive, Suite E Okemos, MI 48864 PHONE: (517)349-9499 FAX: (517)349-6863	FOR: BEE-JAY SCALES SITE SUNNYSIDE, WASHINGTON		SITE LOCATION MAP		FIGURE: 1
	JOB NUMBER: 213202156/213202157	DRAWN BY: JRO	CHECKED BY: MRK/EJB	APPROVED BY: ASM	DATE: 11/18/16

FILEPATH:C:\Users\jopalekopsahl\Documents\0_travel_cad\0_okemos\213202156_bjscales\213202156_grcp_2h15.dwg | JOpalekOpsahl | Nov 18, 2016 at 9:03 | Layout: fig1_slm



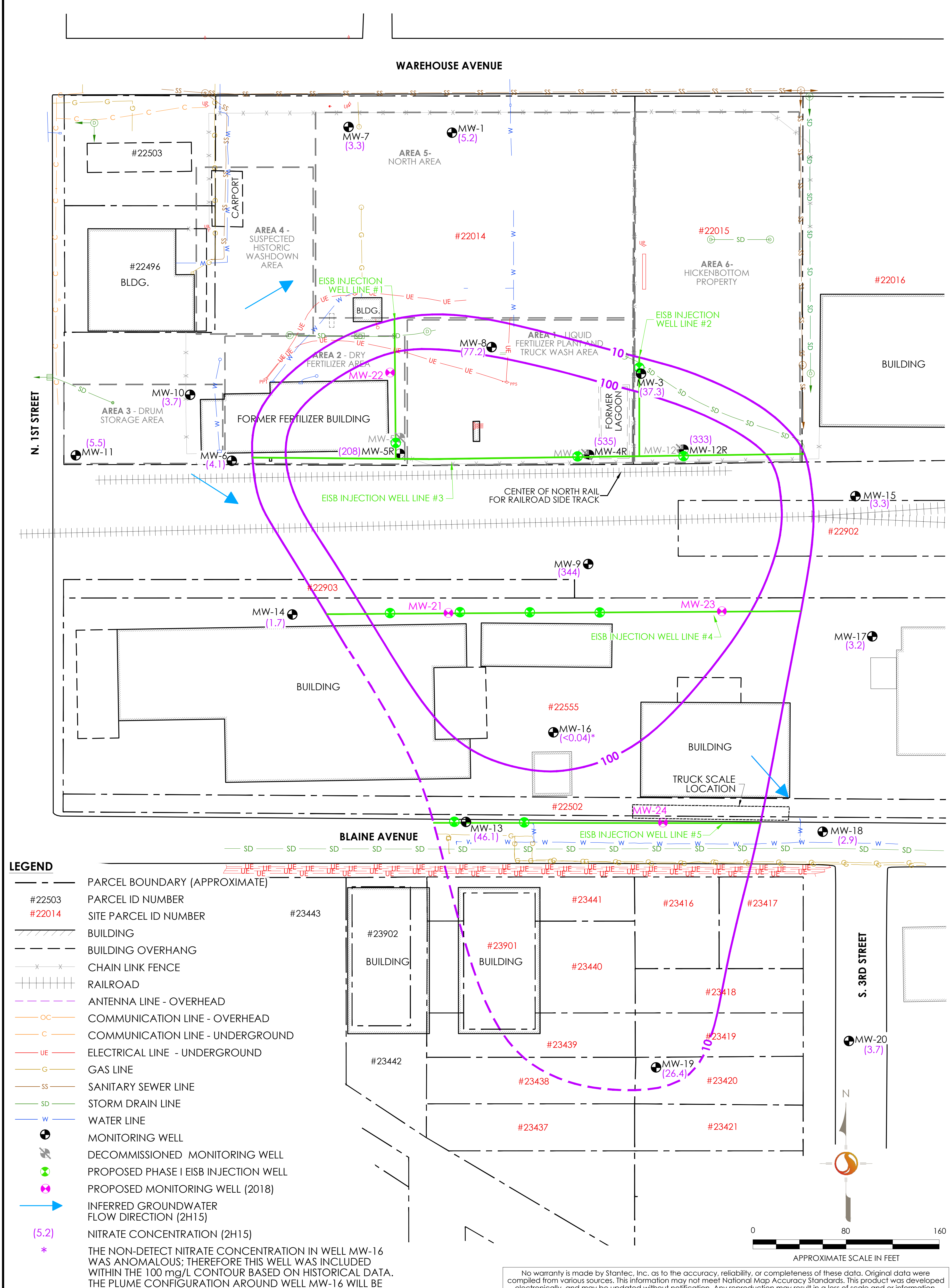
LEGEND

- PARCEL BOUNDARY (APPROXIMATE)
- #22503 PARCEL ID NUMBER
- #22014 SITE PARCEL ID NUMBER
- BUILDING
- BUILDING OVERHANG
- CHAIN LINK FENCE
- RAILROAD
- DECOMMISSIONED MONITORING WELL
- MONITORING WELL
- SITE GROUNDWATER PLUME EXTENT (EXCLUDING ARSENIC)

Stantec
2321 Club Meridian Drive, Suite E
Okemos, MI 48864
PHONE: (517)349-9499 FAX: (517)349-6863

FOR:				FIGURE:
BEE-JAY SCALES SITE SUNNYSIDE, WASHINGTON		SITE PLAN		2
JOB NUMBER: 213202156/213202157	DRAWN BY: JRO	CHECKED BY: MRK/EJB	APPROVED BY: ASM	DATE: 11/18/16

FILEPATH:C:\Users\jopalekopsahl\Documents\0_travel_cad\0_okemos\213202156_bjscales\213202156_grcp_2h15.dwg | JOpalekOpsahl | Nov 18, 2016 at 9:04 | Layout: fig2_sp



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Okemos, MI 48864
PHONE: (517)349-9499 FAX: (517)349-6863

FOR:				FIGURE:
BEE-JAY SCALES SITE SUNNYSIDE, WASHINGTON		PROPOSED EISB INJECTION WELL LINE AND PHASE I INJECTION WELL LOCATIONS		3
JOB NUMBER: 213202156/213202157	DRAWN BY: JRO	CHECKED BY: MRK/EJB	APPROVED BY: ASM	DATE: 11/16/16

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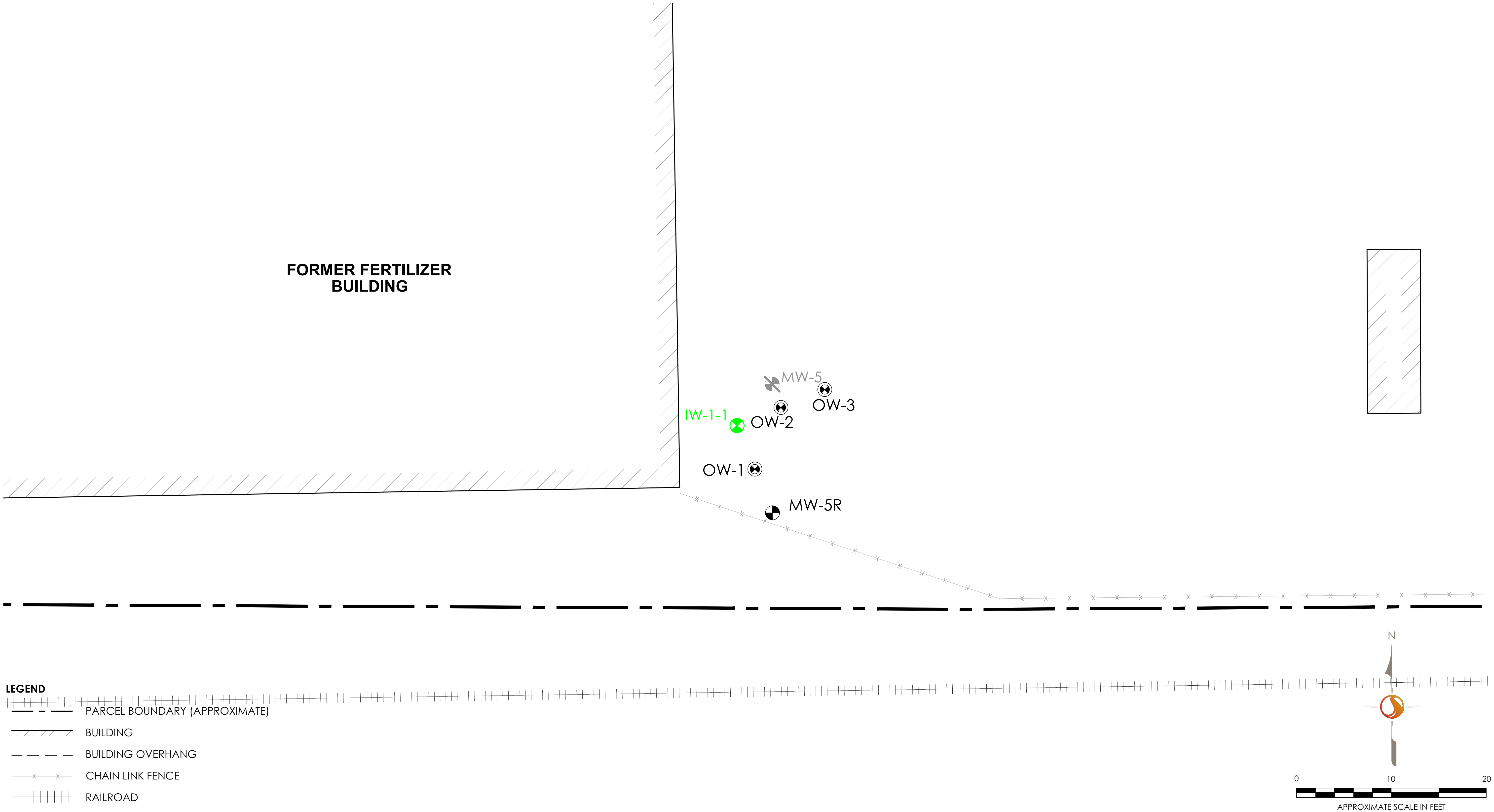

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FOR:
BEE-JAY SCALES SITE
SUNNYSIDE, WASHINGTON

TRACER TEST INJECTION AND OBSERVATION WELL LAYOUT

FIGURE: 4

JOB NUMBER:	DRAWN BY:	CHECKED BY:	APPROVED BY:	DATE:
213202156/213202157	JRO	MRK/EJB	ASM	11/16/16

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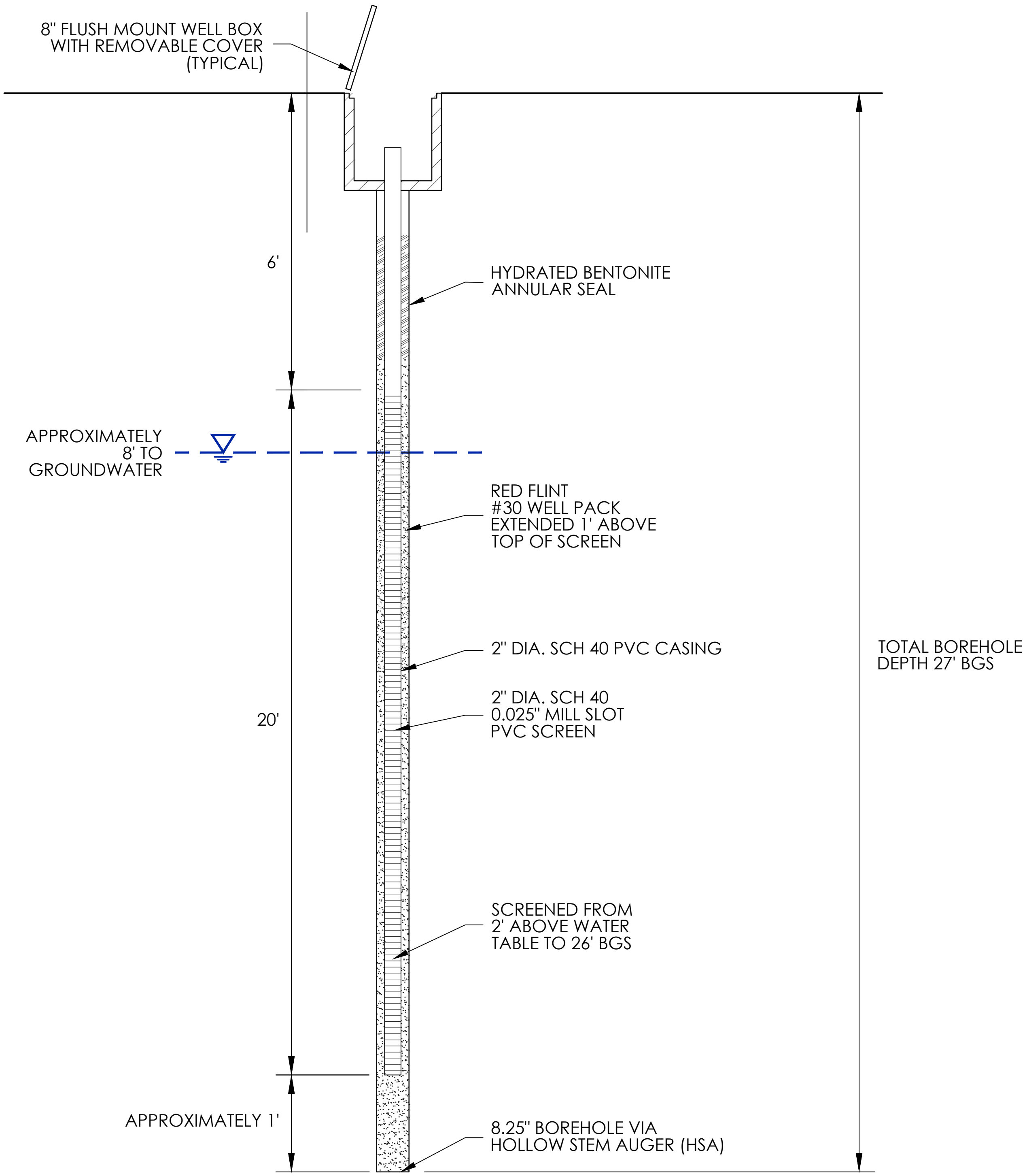

TRACER TEST OBSERVATION WELL DETAIL

(TYPICAL)

NOT TO SCALE

Stantec

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Okemos, MI 48864
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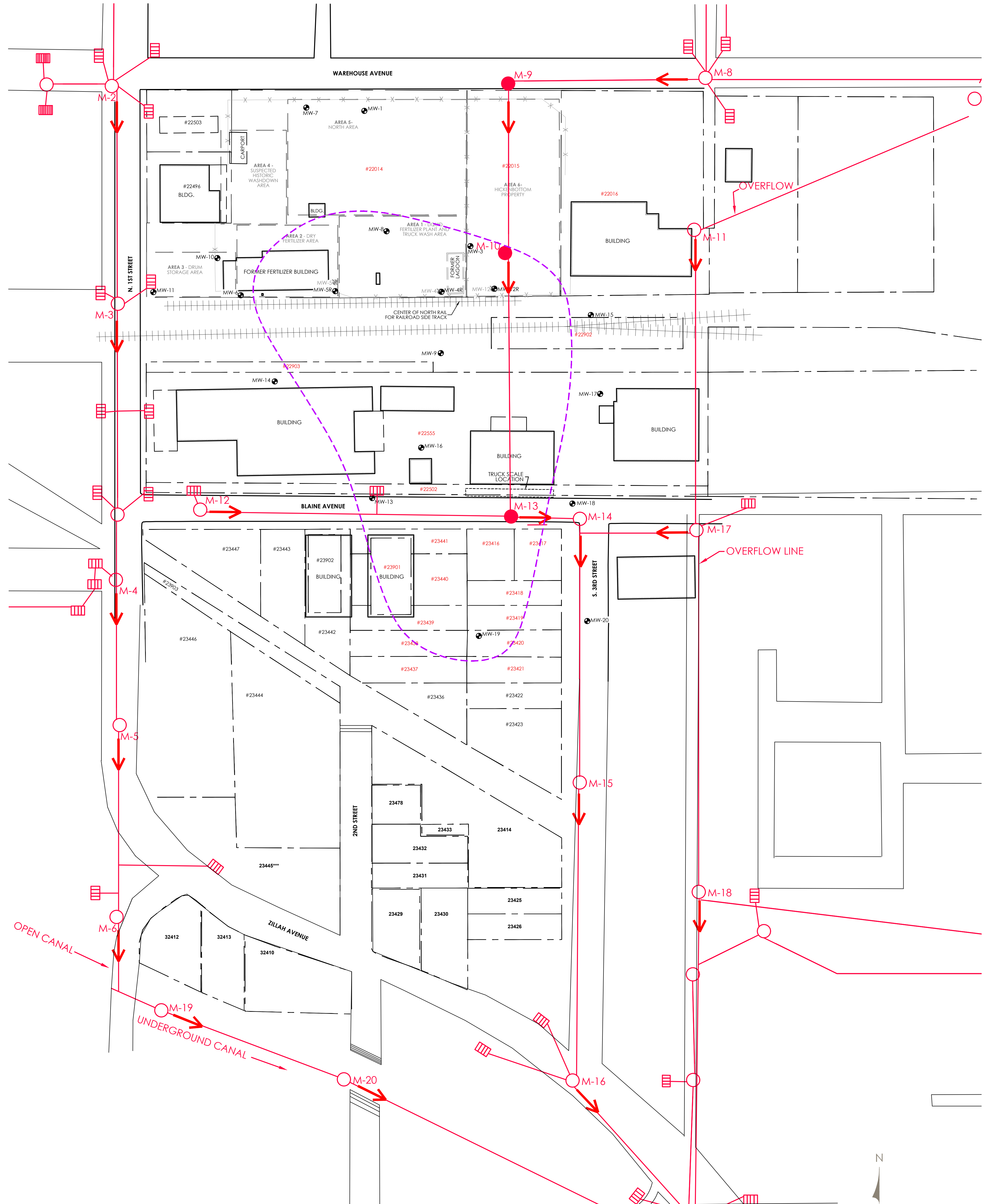
FOR:		TITLE	FIGURE:
BEE-JAY SCALES SITE SUNNYSIDE, WASHINGTON		TRACER TEST OBSERVATION WELL DETAIL	5

JOB NUMBER:	DRAWN BY:	CHECKED BY:	APPROVED BY:	DATE:
213202156/213202157	JRO	MRK/EJB	ASM	04/12/18



LEGEND

— —	PARCEL BOUNDARY (APPROXIMATE)
#22503	PARCEL ID NUMBER
#22014	SITE PARCEL ID NUMBER
	BUILDING
	BUILDING OVERHANG
	CHAIN LINK FENCE
	RAILROAD
	DECOMMISSIONED MONITORING WELL
	MONITORING WELL
	SITE GROUNDWATER PLUME EXTENT (EXCLUDING ARSENIC)
M-2	STORM/IRRIGATION DRAIN
M-9	STORM/IRRIGATION DRAIN MONITORING LOCATION
	CATCH BASIN
	FLOW DIRECTION

NOTE: STORM DRAIN FEATURES NOT SHOWN TO SCALE

Stantec
Club Meridian Drive, Suite E
Okemos, MI 48864
PHONE: (517)349-9499 FAX: (517)349-6863

FOR: BEE-JAY SCALES SITE SUNNYSIDE, WASHINGTON

STORM/IRRIGATION DRAIN MONITORING PLAN

FIGURE: 6

JOB NUMBER:	DRAWN BY:	CHECKED BY:	APPROVED BY:	DATE:
213202156/213202157	RMN	MRK/EJB	ASM	04/12/18

FILEPATH:V:\1826\active\213202156\05_report_deliv\deliverables\reports\groundwater_remedy\cmp\figures\213202156_grcp_2h15.dwg | JOpalekOpsahl | Apr 12, 2018 at 13:49 | Layout: fig6_storm drain

APPENDIX A
Ecology Comments on Groundwater Remedy Compliance Monitoring Plan

STATE OF WASHINGTON
DEPARTMENT OF ECOLOGY
1250 W Alder St • Union Gap, WA 98903-0009 • (509) 575-2490

December 10, 2018

Marisa Kaffenberger, P.E.
Senior Engineer
Stantec Consulting Services, Inc.
2321 Club Meridian Drive, Suite E
Okemos, MI 48864

Re: Groundwater Remedy Compliance Monitoring Plan for the Bee-Jay Scales Site

Site Name:	Bee Jay Scales
Site Address:	116 N 1st Street, Sunnyside
Facility/Site ID No.:	504
Cleanup Site ID No:	3641

Dear Marisa Kaffenberger,

The Washington State Department of Ecology (Ecology) has reviewed your most recent submittal in response to our comments on the Groundwater Remedy Compliance Monitoring Plan for the Bee-Jay Scales Site. Our responses are below:

2.1 Soil Sampling for Laboratory Analysis

Do you plan to collect 30 soil samples during the installation of the Phase I EISB injection wells, or collect samples only if the saturated zone is located at the depths between 10-15, 15-20 and 20-25 feet below ground surface (bgs)? Please be more clear about your plan to sample soils during the well installation as well as the type of reductant demand you will be measuring (i.e., soil reductant demand associated with in-situ groundwater treatment?)

2.2 Grain Size Analysis

Will grain size analysis samples also be collected from the saturated zone only? Please add this information.

2.3 Slug Testing

How will you be reporting the results of the slug testing? Please advise.

3.1.1 Air Monitoring Equipment Maintenance

This section states: "Air monitoring equipment will not be used if the unit is displaying an error code," but makes no mention of any substitution or a work stoppage. Please advise.

3.2.2 Groundwater Remedy Performance Monitoring

This section states that only quarterly or semi-annual groundwater monitoring will be active at any time. Ecology does not agree. The different groundwater monitoring regimes will be monitoring different plume processes, and should be active concurrently. CHEMetrics field test kits can still be used for the quarterly groundwater monitoring, and Ecology requires laboratory analysis of nitrate, manganese, ferrous iron, sulfate, ammonia and phosphorus for the semi-annual groundwater monitoring. Please revise accordingly.

3.2.2.2 Semi-Annual Groundwater Remedy Performance Monitoring

Ecology has some concerns about whether MW-20 is actually downgradient or crossgradient. Based on this site's proximity to the Simplot site immediately to the south of the Bee Jay Scales site, there is the potential that more monitoring wells will be needed to the south of MW-19.

Monitored Natural Attenuation Performance Monitoring

Please review Ecology's guidance for use of Monitored Natural Attenuation (MNA) for Groundwater. One of the requirements for use of MNA is a stable or shrinking groundwater plume. It is unclear to Ecology that this groundwater plume is either stable or shrinking. Please provide more information and/or revise accordingly.

3.3.2 Conclusion of Remediation Activities

General comment: Why are you switching between Upper Tolerance Limits for confirmation of cleanup for each well, and Upper Confidence Limits for Arsenic Remediation Levels and 3-year Upper Confidence Level for all IHSs? Please explain.

3.2.4 Institutional Controls Performance Monitoring

In addition to verifying that no new buildings have been constructed without vapor mitigation, please verify that no buildings have been demolished without some type of site assessment.

4.2.1 Soil Sampling Methods

Ecology requires use of EPA Method 5035 for collection of soil samples to be analyzed for VOCs. Please edit this section to include use of this method.

4.4.3 Duplicates

Please collect duplicates at a rate of at least 1 per batch of 20 samples.

Ecology thanks you for your excellent responses to the comments on the latest iteration of this Groundwater Remedy Compliance Monitoring Plan. It is our belief that once these last few comments are addressed, this document will be ready to be finalized.

Regards,

Mary Monahan
Site Manager
Toxics Cleanup Program
Central Regional Office

Stantec Consulting Services Inc.
2321 Club Meridian Dr., Suite E
Okemos, MI 48864
Tel: (517) 349-9499
Fax: (517) 349-6863

May 1, 2019

Attention: Ms. Mary Monahan
Department of Ecology
Central Regional Office
1250 West Alder Street
Union Gap, WA 98903-0009

Reference: Response to Comments on Groundwater Remedy Compliance Monitoring Plan for the Bee-Jay Scales Site

Dear Ms. Monahan,

Below is a response to comments on the Groundwater Remedy Compliance Monitoring Plan (GW CMP) provided in a letter from the Washington State Department of Ecology (Ecology) on December 10, 2018. Ecology comments are in bold text, while responses are provided in regular text. In addition, based on Ecology comments, we have revised the GW CMP and will provide the updated document for your review.

2.1 Soil Sampling for Laboratory Analysis

Do you plan to collect 30 soil samples during the installation of the Phase I EISB injection wells, or collect samples only if the saturated zone is located at the depths between 10-15, 15-20 and 20-25 feet below groundwater surface (bgs)? Please be more clear about your plan to sample soils during the well installation as well as the type of reductant demand you will be measuring (i.e., soil reductant demand associated with in-situ groundwater treatment?)

Yes, the plan is to collect 30 soil samples (three per Phase I EISB injection well soil boring) regardless of saturation conditions found during soil boring advancement.

The first paragraph of Section 2.1 has been edited to clarify analytical soil sampling plan as follows:

> "Laboratory analysis of Site IHSs and important parameters in the denitrification process will provide a better understanding of the conditions across the horizontal and vertical profile of the Site groundwater plume. Three soil samples will be collected for laboratory analysis at each of the Phase I EISB injection well locations (total of 30 soil samples) at depths between 10-15, 15-20, and 20-25 feet below ground surface (bgs). Based on historical Site data, the first indication of saturated conditions is expected at depths less than 15 feet bgs in all Phase I EISB injection well locations. If saturated conditions are not indicated above

> 15 feet bgs during soil boring advancement, the top soil sample will be collected from the 14-15 feet bgs interval. Soil samples for laboratory analysis will be collected following the procedures detailed in Section 4.2.1."

The following sentences have been added to the end of the last paragraph in Section 2.1 to further describe the soil reductant demand analysis:

> "The proposed EISB system will involve the adjustment of subsurface redox conditions within the Site groundwater plume. The soil reductant demand results will evaluate the effort required to achieve and maintain these conditions during the overall remediation timeframe."

2.2 Grain Size Analysis

Will grain size analysis samples also be collected from the saturated zone only? Please add this information.

No. The first paragraph of Section 2.2 has been edited to state:

> "Soil samples for grain size analysis will be collected from each of the Phase I EISB injection wells during advancement at depths between 10-15, 15-20, and 20-25 feet bgs (total of 30 samples). Grain size soil samples will be collected at the three indicated intervals regardless of soil saturation at the time of soil boring advancement."

2.3 Slug Testing

How will you be reporting the results of the slug testing? Please advise.

The following paragraph has been added to Section 2.3:

> "The slug test results will be reported in summary tables identifying the monitoring well ID, test date, test type (rising head and/or falling head), the solution method(s) used, and the estimated hydraulic conductivity. The aquifer testing software charts will be provided to support the analysis summarized in the tables."

3.1.1 Air Monitoring Equipment Maintenance

This section states: "Air monitoring equipment will not be used if the unit is displaying an error code," but makes no mention of any substitution or a work stoppage. Please advise.

Reference: Response to Comments on Groundwater Remedy Compliance Monitoring Plan for the Bee-Jay Scales Site

A statement has been added to Section 3.1.1 of the GW CMP indicating "In this case, the equipment will either be repaired, or new properly functioning equipment will be obtained before proceeding with work."

3.2.2 Groundwater Remedy Performance Monitoring

This section states that only quarterly or semi-annual groundwater monitoring will be active at any time. Ecology does not agree. The different groundwater monitoring regimes will be monitoring different plume processes, and should be active concurrently.

Significant edits have been made to the text in Section 3.2.2 and in Tables 2 and 3 to maintain monitoring of the different plume processes in two groundwater monitoring programs, an EISB program and a post-EISB program. The two programs will be complementary and nonconcurrent; however, the approach was approved in follow-up discussions with Ecology in response to these comments.

CHEMetrics field test kits can still be used for the quarterly groundwater monitoring, and Ecology requires laboratory analysis of nitrate, manganese, ferrous iron, sulfate, ammonia and phosphorus for the semiannual groundwater monitoring. Please revise accordingly.

Table 3 has been edited to remove the use of field tests for nitrate and nitrite during the post-EISB performance monitoring program. Additionally, field testing will not be considered for nitrate and nitrite samples collected on a semi-annual basis outside of the EISB injection zones as part of the EISB performance monitoring program, and text in Section 4.2.4 has been edited to state:

> "The use of CHEMetrics field test kits for nitrate and nitrite will only be considered for quarterly groundwater samples collected within the EISB injection zones as part of the EISB performance monitoring program."

Stantec is requesting the flexibility to use field test kits for manganese and ferrous iron in both the EISB and post-EISB performance monitoring based on Ecology's standard operating procedures for sampling metals and for sulfate, ammonia, and phosphorus in both EISB and post-EISB performance monitoring as these constituents are not IHSs for the Site.

Use of the CHEMetrics field test kits at the Site will be contingent on the accuracy of the results obtained from the analysis. To specifically address concerns regarding the accuracy of the field tests, the fourth paragraph of Section 4.2.4 has been edited to state:

Reference: Response to Comments on Groundwater Remedy Compliance Monitoring Plan for the Bee-Jay Scales Site

> "The accuracy of the field test kits will be analyzed at least once per EISB or post-EISB performance monitoring event using a standard solution, if available. In addition, duplicate samples will be submitted for laboratory analysis for at least 10% of the samples analyzed with field test kits. Note that for some parameters such as ferrous iron, laboratory testing for total iron on a filtered sample can differ from field measurements of ferrous iron due to oxidation during filtration. Duplicate laboratory sample results will be correlated to the field test results, and the accuracy of the correlation will be reported with the performance monitoring results. If the accuracy of the field tests does not meet the project objectives after accounting for other variables, Stantec will discuss discontinuing the use of the applicable field test kit(s) with Ecology."

3.2.2.2 Semi-Annual Groundwater Remedy Performance Monitoring

Ecology has some concerns about whether MW-20 is actually downgradient or crossgradient. Based on this site's proximity to the Simplot site immediately to the south of the Bee Jay Scales site, there is the potential that more monitoring wells will be needed to the south of MW-19.

We agree that additional monitoring wells may be required south of MW-19. Once the GW CPS and GW CMP are approved, and prior to the first EISB injection, data at MW-19 will be analyzed for conditions requiring contingency actions per Section 3.2.5 and Table 4 of the GW CMP.

Monitored Natural Attenuation Performance Monitoring

Please review Ecology's guidance for use of Monitored Natural Attenuation (MNA) for Groundwater. One of the requirements for use of MNA is a stable or shrinking groundwater plume. It is unclear to Ecology that this groundwater plume is either stable or shrinking. Please provide more information and/or revise accordingly.

The plume statuses were reviewed with non-parametric statistical analysis using the Mann-Kendall test and the majority of Site wells and parameters have already demonstrated decreasing or stable concentration trends, even without groundwater remedy implementation. And for those wells and/or parameters with increasing trends, the trends have been decreasing since soil removal efforts in 2014.

We have completed a review of the Groundwater MNA Guidance referenced in Ecology's comment above. Based on the guidance, the MNA Performance Monitoring portion of Section 3.2.2 has been updated to incorporate additional methods to evaluate MNA performance at the Site. MNA performance evaluation will include an analysis of plume stability, an evaluation of MNA mechanisms, an estimate of restoration timeframe, and an assessment of whether the use of MNA only will be protective of human health and the environment. Stantec believes that these changes will address concerns regarding the evaluation of plume stability and the use of MNA throughout the groundwater remediation process at the Site.

As described in the GW EDR and GW CMP, arsenic concentrations at the Site do not appear to present as a single plume and are not consistent with the groundwater plumes of the other Site IHSs. As arsenic concentrations are expected to temporarily increase with the implementation of EISB at the Site, Site-wide monitoring of arsenic has been proposed after the completion of the first Phase II EISB injection. This arsenic performance monitoring data will be analyzed with existing historical arsenic data from the Site as part of the MNA performance monitoring described in the paragraph above.

3.3.2 Conclusion of Remediation Activities

General comment: Why are you switching between Upper Tolerance Limits for confirmation of cleanup for each well, and Upper Confidence Limits for Arsenic Remediation Levels and 3-year Upper Confidence Level for all IHSs? Please explain.

For clarification, upper tolerance limits (UTLs) have not been proposed for the confirmation of cleanup, but alternately to determine whether the IHS concentration data from the associated sample can be used for confirmational monitoring as required by the MTCA regulations (WAC 173-340-720). As stated in Section 3.3.2, in order for analytical results from Site monitoring wells within the POC to be used for confirmational monitoring, the sample results must indicate the monitoring well is under MNA conditions and the influence of EISB is decreasing at a predictable rate. The concentrations of BOD, ferrous iron, sulfate, and alkalinity have been selected as the EISB monitoring parameters to determine when Site groundwater is no longer influenced by EISB.

The establishment and use of UTLs has been selected for the proposed EISB monitoring parameters in order to establish an upper threshold value for the pre-treatment concentrations. Following the implementation of the EISB system, Site EISB monitoring parameter concentrations during each independent sampling event will be compared to the calculated pre-treatment UTLs to determine if a monitoring well is influenced by EISB. This use of UTLs and single concentration results is consistent with the ProUCL 5.1 Tech Guide which states:

> "A UPL, an upper percentile, or a UTL represents an upper limit to be used for point-by-point individual site observation comparisons. UPLs and UTLs are computed based upon background data sets, and point-by-point onsite observations are compared with those limits. A site observation exceeding a background UTL may lead to the conclusion that the

> constituent is present at the site at levels greater than the background concentrations level."

According to the ProUCL 5.1 Tech Guide, Upper Confidence Limits (UCLs) represent the estimated upper confidence interval of a population mean which can be compared to other average values (pre-established or estimated), such as a cleanup level, and are not appropriate for comparisons to individual site observations (i.e., sample results). The use of UCLs is consistent with the requirements for data analysis in the MTCA regulations and is appropriate for comparison of a "population" data set (either the three-year IHS concentration data from a monitoring well or the Site-wide arsenic concentration data from a single sampling event) to the applicable cleanup level (CUL) or remediation level (RL). As stated in Section 3.3.3, the confirmation of cleanup involves the comparison of observed IHS concentration data at each independent Site confirmation well to the respective CULs.

3.2.4 Institutional Controls Performance Monitoring

In addition to verifying that no new buildings have been constructed without vapor mitigation, please verify that no buildings have been demolished without some type of site assessment.

The following statement has been added to Section 3.2.4:

> "Verify that no buildings on the BJS parcel have been altered or removed in a manner that may have resulted in a release of contaminated material to the environment or created a new exposure pathway without prior written approval of Ecology".

In addition, removal was added to the following statement in Section 3.2.4:

> "Perform a visual inspection of the areas on the BJS and WGL parcels that have been identified within the restrictive covenants as having restrictions on the removal of existing structures and/or the construction of new permanent structures".

4.2.1 Soil Sampling Methods

Ecology requires use of EPA Method 5035 for collection of soil samples to be analyzed for VOCs. Please edit this section to include use of this method.

Per EPA guidance, ammonia is not considered a VOC, and is therefore not included in the EPA Method 5035 soil sampling scope. No changes to the document have been made.

Reference: Response to Comments on Groundwater Remedy Compliance Monitoring Plan for the Bee-Jay Scales Site

4.4.3 Duplicates

Please collect duplicates at a rate of at least 1 per batch of 20 samples.

The text of Section 4.4.3 has been revised to read "Duplicate soil and groundwater samples will be obtained at a frequency of approximately 5 percent, or one per batch of 20 samples."

We hope these responses and the revised GW CMP adequately address to your comments and we can finalize the Groundwater Remedy Compliance Monitoring Plan.

If you have any questions, please do not hesitate to contact me.

Regards,

Stantec Consulting Services Inc.

Marisa Kaffenberger, P.E.
Senior Engineer
Phone: 517-202-0459
marisa.kaffenberger@stantec.com

cc:

Ms. Caryl Weekley, Chevron Environmental Management Company, 6001 Bollinger Canyon Road, San Ramon, CA 94583 – Electronic Copy

Mr. Kyle Christie, Remediation Management Services Company, 4 Centerpointe Drive, LPR 4-221, La Palma, CA 90623-1006 – Electronic Copy

Mr. Eric Bassett, Stantec Consulting Services Inc., 733 Marquette Avenue, Suite 1000, Minneapolis, MN 55402 – Electronic Copy

APPENDIX B
Field Documentation Forms

Soil Boring Log and Well Detail Log

PROJECT: LOCATION: PROJECT NUMBER:	WELL / PROBEHOLE / BOREHOLE NO: Stantec
DRILLING: STARTED COMPLETED: INSTALLATION: STARTED COMPLETED: DRILLING COMPANY: DRILLING EQUIPMENT: DRILLING METHOD: SAMPLING EQUIPMENT:	NORTHING (ft): EASTING (ft): LATITUDE: LONGITUDE: GROUND ELEV (ft): TOC ELEV (ft): INITIAL DTW (ft): BOREHOLE DEPTH (ft): STATIC DTW (ft): WELL DEPTH (ft): WELL CASING DIAMETER (in): BOREHOLE DIAMETER (in): LOGGED BY: CHECKED BY:

Time & Depth (feet)	Graphic Log		Description	Sample	Time Sample ID	Measured Recov. (feet)	Blow Count	Headspace PID (units)	Depth (feet)	Borehole Backfill

PROJECT: LOCATION: PROJECT NUMBER:	WELL / PROBEHOLE / BOREHOLE NO:

DRILLING: STARTED	COMPLETED:	NORTHING (ft):	EASTING (ft):
INSTALLATION: STARTED	COMPLETED:	LATITUDE:	LONGITUDE:
DRILLING COMPANY:		GROUND ELEV (ft):	TOC ELEV (ft):
DRILLING EQUIPMENT:		INITIAL DTW (ft):	BOREHOLE DEPTH (ft):
DRILLING METHOD:		STATIC DTW (ft):	WELL DEPTH (ft):
SAMPLING EQUIPMENT:		WELL CASING DIAMETER (in):	BOREHOLE DIAMETER (in):
		LOGGED BY:	CHECKED BY:

Time & Depth (feet)	Graphic Log		Description	Sample	Time Sample ID	Measured Recov. (feet)	Blow Count	Headspace PID (units)	Depth (feet)	Borehole Backfill

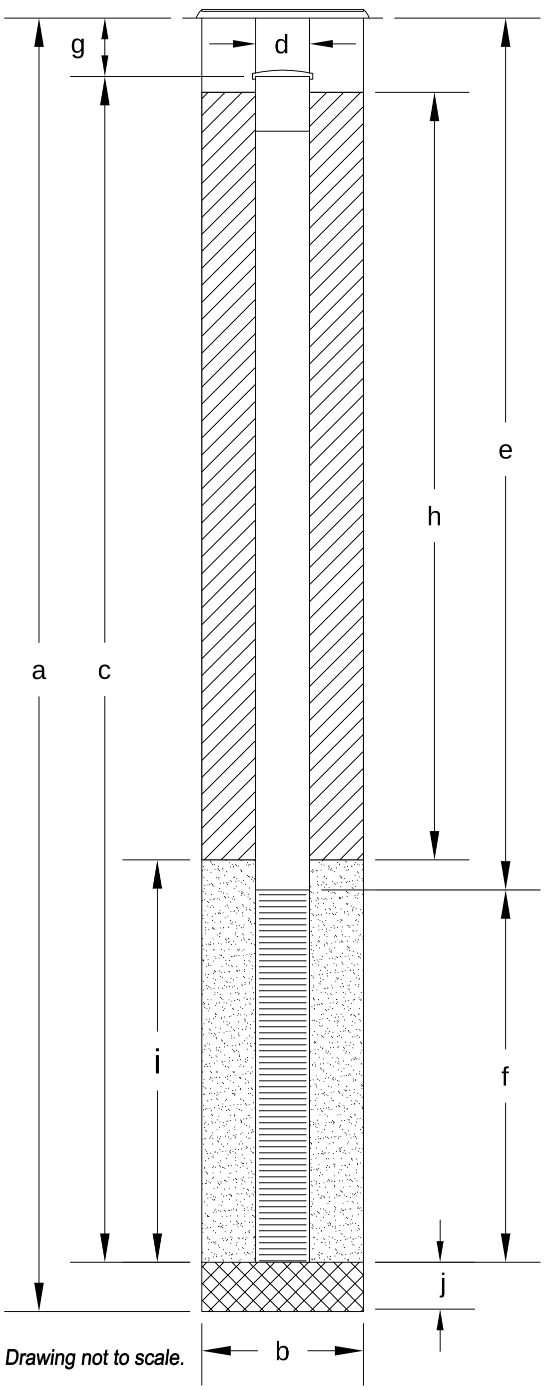
PROJECT: LOCATION: PROJECT NUMBER:	WELL / PROBEHOLE / BOREHOLE NO: Stantec
DRILLING: STARTED COMPLETED: INSTALLATION: STARTED COMPLETED: DRILLING COMPANY: DRILLING EQUIPMENT: DRILLING METHOD: SAMPLING EQUIPMENT:	NORTHING (ft): EASTING (ft): LATITUDE: LONGITUDE: GROUND ELEV (ft): TOC ELEV (ft): INITIAL DTW (ft): BOREHOLE DEPTH (ft): STATIC DTW (ft): WELL DEPTH (ft): WELL CASING DIAMETER (in): BOREHOLE DIAMETER (in): LOGGED BY: CHECKED BY:

Time & Depth (feet)	Graphic Log	USCS	Description	Sample	Time Sample ID	Measured Recov. (feet)	Blow Count	Headspace PID (units)	Depth (feet)	Borehole Backfill

WELL DETAIL

Stantec

WELL DETAIL		Boring/ Well No.:
Project Name:		Project Number:
Location:		Driller:
Well Permit No.:	Coordinates:	
Ground Surface Elevation:	Top of Casing Elevation:	Installation Date:



Note: Drawing not to scale.

EXPLORATORY BORING

a. Total Depth: ______________ ft.

b. Diameter: ______________ in.

Drilling method: ______________

WELL CONSTRUCTION

c. Total Casing Length: ______________ ft.

Material ______________

Casing joined by: ______________

d. Diameter (nominal): ______________ in.

e. Depth to top of perforations: ______________ ft.

f. Perforated Length: ______________ ft.

Perforated Interval from: ________ to ________ ft.

Perforation Type: ______________

Perforation Size: ______________

g. Surface Seal: ______________ ft.

Surface Seal Interval from: ________ to ________ ft.

Material: ______________

h. Seal: ______________ ft.

Seal Interval from: ________ to ________ ft.

Material: ______________

i. Filter Pack: ______________ ft.

Filter Pack Interval from: ________ to ________ ft.

Material: ______________

j. Bottom Seal: ______________ in.

Bottom Seal Interval from: ________ to ________ ft.

Material: ______________

Comments:

Logged By: ______________ Date: ________

Reviewed By: ______________ Date: ________

Well Development Log

Stantec Consulting Services Inc.

WELL DEVELOPMENT LOG

PROJECT #: ______ PURGED BY: ______ WELL I.D.: ______

CLIENT NAME: ______ SAMPLED BY: ______ SAMPLE I.D.: ______

LOCATION: ______ QA SAMPLES: ______

DATE PURGED ______ START (2400hr) ______ END (2400hr) ______

DATE SAMPLED ______ SAMPLE TIME (2400hr) ______

SAMPLE TYPE: Groundwater x Surface Water ____ Treatment Effluent ____ Other ______

CASING DIAMETER:	2"	3"	4"	5"	6"	8"	Other
Casing Volume: (gallons per foot)	(0.17)	(0.38)	(0.67)	(1.02)	(1.50)	(2.60)	( )

DEPTH TO BOTTOM (feet) = ______ CASING VOLUME (gal) = ______

DEPTH TO WATER (feet) = ______ CALCULATED PURGE (gal) = ______

WATER COLUMN HEIGHT (feet) = ______ ACTUAL PURGE (gal) = ______

FIELD MEASUREMENTS

TIME (2400hr)	VOLUME (gal)	DO	ORP	TEMP. (degrees F)	CONDUCTIVITY	pH (units)	COLOR (visual)	TURBIDITY (NTU)

SAMPLE INFORMATION

SAMPLE DEPTH TO WATER: ______ SAMPLE TURBIDITY: ______

80% RECHARGE: ____ YES ____ NO ANALYSES: ______

ODOR: ______ SAMPLE VESSEL / PRESERVATIV ______

PURGING EQUIPMENT

____ Bladder Pump
____ Centrifugal Pump
____ Submersible Pump
____ Peristalic Pump
____ Bailer (Teflon)
____ Bailer (PVC)
____ Bailer (Stainless Steel)
____ Dedicated ______

Other: ______

Pump Depth: ______

____ Bladder Pump
____ Centrifugal Pump
____ Submersible Pump
____ Peristalic Pump
____ Bailer (Teflon)
____ Bailer (____ PVC or ____ disposable)
____ Bailer (Stainless Steel)
____ Dedicated ______

Other: ______

WELL INTEGRITY: ______ LOCK#: ______

REMARKS: ______

SIGNATURE: ______ Page ____ of ____

Injection System Log

Stantec Consulting Services, Inc.

INJECTION SYSTEM LOG

STANTEC PROJECT NO.: ______________________ FACILITY NAME: ______________________

FIELD PERSONNEL: ____

INJECTION SYSTEM DESCRIPTION: ____

INJECTION SYSTEM OPERATING PARAMETERS:

Date	**Batch Number**	**Batch Volume (gallons)**	**Batch Sodium Acetate Mass (pounds)**	**Batch Phosphorus Mass (grams)**	**Injection Start & End Time**	**Batch Applied to Injection Wells:**

SIGNATURE: ______________________

Stantec Consulting Services, Inc.

WELL INJECTION LOG

STANTEC PROJECT NO.: ______________ DATE: ______________ WELL NO.: ______________

FACILITY NAME: ______________ FIELD PERSONNEL: ______________

INJECTION METHOD: ______________

INJECTION SOLUTION: ______________ WELL TARGET INJECTION VOL.: ______________

FIELD MEASUREMENTS:

DEPTH TO WATER: Start: __________ End: __________ Reference Point Height Above Ground Surface: __________

INJECTION OPERATING PARAMETERS;

Injection Batch Number	Start & End Time	Duration (minutes)	Well Head Gauge Pressure Readings (reading time/psi)	Injection Rate Readings (start time/end time/volume)	Total Batch Volume (gallons)	Average Batch Injection Rate (gallons/min.)
TOTAL						

SIGNATURE: ______________

Groundwater Sampling Field Data Sheet

Stantec

GROUNDWATER SAMPLING FIELD DATA SHEET

PROJECT NUMBER: WELL ID: DATE:

FACILITY NAME: TEMPERATURE:

FIELD PERSONNEL: WEATHER:

FIELD MEASUREMENTS:

A. Depth to Water (DTW) below top of casing/piezometer: ________ FT. or IN

B. Thickness of Free Product, if present: _________ Inches -- FT. or IN

C. Total Depth of well (TD) from top of casing/piezometer: ________ FT. or IN

D. Height of Water Column in casing (h = TD - DTW): 0.00 FT. or IN

E. Useful approximate Purge Volumes (PV) per foot of water column for common casing sizes:

	3 Well Vols	5 Well Vols		
2" Diameter =	0.5 gals/ft	0.82 gals/ft	x ______ feet of water (h) =	PV (gal)
4" Diameter =	2.0 gals/ft	3.25 gals/ft	x ______ feet of water (h) =	PV (gal)
6" Diameter =	4.4 gals/ft	7.35 gals/ft	x ______ feet of water (h) =	PV (gal)

PURGING METHOD: DURATION:

AVERAGE FLOW RATE:

OBSERVATIONS:

Cumulative PV (gal)	Time	Turbidity	DO (mg/L)	ORP (mV)	pH	Temperature (^oC)	Conductivity (mS/cm)	DTW	Sheen/Odor

TOTAL VOLUME OF WATER PURGED FROM WELL:

PURGE WATER STORED/DISPOSED OF WHERE/HOW:

SAMPLES COLLECTED:

DEPTH TO WATER AT TIME OF SAMPLE COLLECTION:

Sample ID:	Time:	Size/Number of Container(s):	Preservative:

COMMENTS:

ADDITIONAL INFORMATION:

Casing Capacities:
2-inch hole.........0.16 gal/lin ft
4-inch hole.........0.65 gal/lin ft.
6.5-inch hole.......1.70 gal/lin ft.
8-inch hole.........2.60 gal/lin ft.
10-inch hole........4.10 gal/lin ft

Recharge Calculation at Time of Sample Collection:
Collect sample when DTW <= (TD - h x 0.80)

Signature:

Field Analysis Log

Stantec Consulting Services, Inc.

FIELD ANALYSIS LOG

STANTEC PROJECT NO.:____________________ WEATHER: ____________________

FACILITY NAME: ____________________ FIELD PERSONNEL:____________________

FIELD ANALYSIS DETAILS:

Date	Well Number	Constituent Analyzed	Test Kit Used	Sample Dilution Ratio	Raw Test Result	Corrected Test Result	Comments

SIGNATURE: ____________________

APPENDIX C
Washington Department of Ecology Well Log Search, November 16, 2016

Well Log ID	Well Depth	Well Diameter	Well Owner	Township	Range	Section	Quarter	Quarter	Well Completion Date	County	Well Type	State Plane Easting Coordinate	State Plane Northing Coordinate
521002	20	2	BEE JAY SCALES	10N	22E	25	NW	NW	3/10/2008	Yakima	Resource	1762310	363529
1010198	17.5	6	Bee Jay Scales	10N	22E	25	NW	NW	2/12/2015	Yakima	Resource	1762310	363529
1010228	17	6	Bee Jay Scales	10N	22E	25	NW	NW	2/12/2015	Yakima	Resource	1762310	363529
1010265	16	6	Bee Jay Scales	10N	22E	25	NW	NW	2/12/2015	Yakima	Resource	1762310	363529
520999	20	2	BEE JAY SCALES | SECOR	10N	22E	25	NW	NW	3/10/2008	Yakima	Abandoned	1762310	363529
394430	18	8	BEE-JAY SCALES	10N	22E	25	NW	NW	10/21/2004	Yakima	Resource	1762310	363529
394431	18	8	BEE-JAY SCALES	10N	22E	25	NW	NW	10/21/2004	Yakima	Resource	1762310	363529
394432	18	8	BEE-JAY SCALES	10N	22E	25	NW	NW	10/21/2004	Yakima	Resource	1762310	363529
394433	20	8	BEE-JAY SCALES	10N	22E	25	NW	NW	10/20/2004	Yakima	Resource	1762310	363529
926769	20	0	Bee-Jay Scales	10N	22E	25	NW	NW	6/3/2014	Yakima	Abandoned	1762310	363529
926770	20	0	Bee-Jay Scales	10N	22E	25	NW	NW	6/3/2014	Yakima	Abandoned	1762310	363529
926833	20	0	Bee-Jay Scales	10N	22E	25	NW	NW	6/4/2014	Yakima	Abandoned	1762310	363529
926851	20	0	Bee-Jay Scales	10N	22E	25	NW	NW	6/2/2014	Yakima	Abandoned	1762310	363529
926852	20	0	Bee-Jay Scales	10N	22E	25	NW	NW	6/3/2014	Yakima	Abandoned	1762310	363529
926853	20	0	Bee-Jay Scales	10N	22E	25	NW	NW	6/4/2014	Yakima	Abandoned	1762310	363529
926854	20	0	Bee-Jay Scales	10N	22E	25	NW	NW	6/4/2014	Yakima	Abandoned	1762310	363529
728001	9	4	Bee-Jay Scales Inc	10N	22E	25	NW	NW	3/23/2011	Yakima	Resource	1762310	363529
727924	10	4	Bee-Jay Scales Inc | Stantec	10N	22E	25	NW	NW	3/22/2011	Yakima	Resource	1762310	363529
727926	10	4	Bee-Jay Scales Inc | Stantec	10N	22E	25	NW	NW	3/22/2011	Yakima	Resource	1762310	363529
727928	7.5	4	Bee-Jay Scales Inc | Stantec	10N	22E	25	NW	NW	3/22/2011	Yakima	Resource	1762310	363529
727930	7	4	Bee-Jay Scales Inc | Stantec	10N	22E	25	NW	NW	3/22/2011	Yakima	Resource	1762310	363529
727932	7.8	4	Bee-Jay Scales Inc | Stantec	10N	22E	25	NW	NW	3/22/2011	Yakima	Resource	1762310	363529
727934	9	4	Bee-Jay Scales Inc | Stantec	10N	22E	25	NW	NW	3/22/2011	Yakima	Resource	1762310	363529
727936	9.5	4	Bee-Jay Scales Inc | Stantec	10N	22E	25	NW	NW	3/22/2011	Yakima	Resource	1762310	363529
728003	9	4	Bee-Jay Scales Inc | Stantec	10N	22E	25	NW	NW	3/23/2011	Yakima	Resource	1762310	363529
728005	10	4	Bee-Jay Scales Inc | Stantec	10N	22E	25	NW	NW	3/23/2011	Yakima	Resource	1762310	363529
728007	9	4	Bee-Jay Scales Inc | Stantec	10N	22E	25	NW	NW	3/23/2011	Yakima	Resource	1762310	363529
728009	2	4	Bee-Jay Scales Inc | Stantec	10N	22E	25	NW	NW	3/23/2011	Yakima	Resource	1762310	363529
728011	7	4	Bee-Jay Scales Inc | Stantec	10N	22E	25	NW	NW	3/23/2011	Yakima	Resource	1762310	363529
728013	8	4	Bee-Jay Scales Inc | Stantec	10N	22E	25	NW	NW	3/23/2011	Yakima	Resource	1762310	363529
728015	8	4	Bee-Jay Scales Inc | Stantec	10N	22E	25	NW	NW	3/23/2011	Yakima	Resource	1762310	363529
728017	8	4	Bee-Jay Scales Inc | Stantec	10N	22E	25	NW	NW	3/23/2011	Yakima	Resource	1762310	363529
728019	10	4	Bee-Jay Scales Inc | Stantec	10N	22E	25	NW	NW	3/23/2011	Yakima	Resource	1762310	363529
728021	9	4	Bee-Jay Scales Inc | Stantec	10N	22E	25	NW	NW	3/24/2011	Yakima	Resource	1762310	363529
728023	10	4	Bee-Jay Scales Inc | Stantec	10N	22E	25	NW	NW	3/24/2011	Yakima	Resource	1762310	363529
728025	10	4	Bee-Jay Scales Inc | Stantec	10N	22E	25	NW	NW	3/24/2011	Yakima	Resource	1762310	363529
728027	10	4	Bee-Jay Scales Inc | Stantec	10N	22E	25	NW	NW	3/22/2011	Yakima	Abandoned	1762310	363529
728029	10	4	Bee-Jay Scales Inc | Stantec	10N	22E	25	NW	NW	3/22/2011	Yakima	Abandoned	1762310	363529
728031	7.5	4	Bee-Jay Scales Inc | Stantec	10N	22E	25	NW	NW	3/22/2011	Yakima	Abandoned	1762310	363529
728033	7	4	Bee-Jay Scales Inc | Stantec	10N	22E	25	NW	NW	3/22/2011	Yakima	Abandoned	1762310	363529
728035	7.8	4	Bee-Jay Scales Inc | Stantec	10N	22E	25	NW	NW	3/22/2011	Yakima	Abandoned	1762310	363529
728037	9	4	Bee-Jay Scales Inc | Stantec	10N	22E	25	NW	NW	3/22/2011	Yakima	Abandoned	1762310	363529
728039	9.5	4	Bee-Jay Scales Inc | Stantec	10N	22E	25	NW	NW	3/22/2011	Yakima	Abandoned	1762310	363529
728041	9	4	Bee-Jay Scales Inc | Stantec	10N	22E	25	NW	NW	3/23/2011	Yakima	Abandoned	1762310	363529
728043	9	4	Bee-Jay Scales Inc | Stantec	10N	22E	25	NW	NW	3/23/2011	Yakima	Abandoned	1762310	363529

APPENDIX C
Washington Department of Ecology Well Log Search
November 16, 2016
Bee-Jay Scales Site, Sunnyside, Washington

Well Log ID	Well Depth	Well Diameter	Well Owner	Township	Range	Section	Quarter	Quarter	Well Completion Date	County	Well Type	State Plane Easting Coordinate	State Plane Northing Coordinate
728045	10	4	Bee-Jay Scales Inc | Stantec	10N	22E	25	NW	NW	3/23/2011	Yakima	Abandoned	1762310	363529
728047	9	4	Bee-Jay Scales Inc | Stantec	10N	22E	25	NW	NW	3/23/2011	Yakima	Abandoned	1762310	363529
728049	2	4	Bee-Jay Scales Inc | Stantec	10N	22E	25	NW	NW	3/23/2011	Yakima	Abandoned	1762310	363529
728051	7	4	Bee-Jay Scales Inc | Stantec	10N	22E	25	NW	NW	3/23/2011	Yakima	Abandoned	1762310	363529
728053	8	4	Bee-Jay Scales Inc | Stantec	10N	22E	25	NW	NW	3/23/2011	Yakima	Abandoned	1762310	363529
728055	8	4	Bee-Jay Scales Inc | Stantec	10N	22E	25	NW	NW	3/23/2011	Yakima	Abandoned	1762310	363529
728057	8	4	Bee-Jay Scales Inc | Stantec	10N	22E	25	NW	NW	3/23/2011	Yakima	Abandoned	1762310	363529
728059	10	4	Bee-Jay Scales Inc | Stantec	10N	22E	25	NW	NW	3/23/2011	Yakima	Abandoned	1762310	363529
728061	9	4	Bee-Jay Scales Inc | Stantec	10N	22E	25	NW	NW	3/24/2011	Yakima	Abandoned	1762310	363529
728067	10	4	Bee-Jay Scales Inc | Stantec	10N	22E	25	NW	NW	3/24/2011	Yakima	Abandoned	1762310	363529
728069	10	4	Bee-Jay Scales Inc | Stantec	10N	22E	25	NW	NW	3/24/2011	Yakima	Abandoned	1762310	363529
1063704	14	2.25	BeeJay Scales	10N	22E	25	NW	NW	8/10/2015	Yakima	Abandoned	1762310	363529
1063712	14	2.25	BeeJay Scales	10N	22E	25	NW	NW	8/10/2015	Yakima	Resource	1762310	363529
1063722	14	2.25	BeeJay Scales	10N	22E	25	NW	NW	8/10/2015	Yakima	Resource	1762310	363529
1063723	14	2.25	BeeJay Scales	10N	22E	25	NW	NW	8/10/2015	Yakima	Abandoned	1762310	363529
120507	15	12	CASCADE NATURAL GAS CORP/CITY OF SUNNYSIDE	10N	22E	25	NW	SW	7/15/1994	Yakima	Resource	1762308	362211
120508	15	12	CASCADE NATURAL GAS CORP/CITY OF SUNNYSIDE	10N	22E	25	NW	SW	7/15/1994	Yakima	Resource	1762308	362211
120509	17	12	CASCADE NATURAL GAS CORP/CITY OF SUNNYSIDE	10N	22E	25	NW	SW	7/15/1994	Yakima	Resource	1762308	362211
296226	461	16	CITY OF SUNNYSIDE	10N	22E	25	NW	SW	12/23/1953	Yakima	Water	1762308	362211
498369	399.5	6	CITY OF SUNNYSIDE	10N	22E	25	NW	SW	9/20/2007	Yakima	Resource	1762308	362211
713078	457	20	City of Sunnyside	10N	22E	25	NW	SW	2/2/2011	Yakima	Abandoned	1762308	362211
885880	16	8	City of Sunnyside | Stantec	10N	22E	25	NW	NW	8/20/2013	Yakima	Resource	1762310	363529
885884	16	8	City of Sunnyside | Stantec	10N	22E	25	NW	NW	8/20/2013	Yakima	Resource	1762310	363529
885882	16	8	Mary Ann Bliesner | Stantec	10N	22E	25	NW	NW	8/20/2013	Yakima	Resource	1762310	363529
111901	20	4	MW-1/MW-2/MW-3	10N	22E	25	NW	NW	4/11/1991	Yakima	Resource	1762310	363529
885878	16	8	Northwest America Land | Stantec	10N	22E	25	NW	NW	8/21/2013	Yakima	Resource	1762310	363529
117687	20	4	POWELL-CHRISTANSON - JOHNNYS SERVICE ST	10N	22E	25	NW	NW	2/14/1989	Yakima	Resource	1762310	363529
291795	20	4	POWELL-CHRISTANSON - JOHNNYS SERVICE ST	10N	22E	25	NW	NW	2/14/1989	Yakima	Resource	1762310	363529
291796	20	4	POWELL-CHRISTANSON - JOHNNYS SERVICE ST	10N	22E	25	NW	NW	2/15/1989	Yakima	Resource	1762310	363529
291797	20	4	POWELL-CHRISTANSON - JOHNNYS SERVICE ST	10N	22E	25	NW	NW	2/21/1989	Yakima	Resource	1762310	363529
291798	20	4	POWELL-CHRISTANSON - JOHNNYS SERVICE ST	10N	22E	25	NW	NW	2/15/1989	Yakima	Resource	1762310	363529
291799	37	10.5	POWELL-CHRISTANSON - JOHNNYS SERVICE ST	10N	22E	25	NW	NW	2/14/1989	Yakima	Resource	1762310	363529
291800	20.6	4	POWELL-CHRISTANSON - JOHNNYS SERVICE ST	10N	22E	25	NW	NW	2/14/1989	Yakima	Resource	1762310	363529

Well Log ID	Well Depth	Well Diameter	Well Owner	Township	Range	Section	Quarter	Quarter	Well Completion Date	County	Well Type	State Plane Easting Coordinate	State Plane Northing Coordinate
291801	20	4	POWELL-CHRISTANSON - JOHNNYS SERVICE ST	10N	22E	25	NW	NW	2/17/1989	Yakima	Resource	1762310	363529
291802	20	4	POWELL-CHRISTANSON - JOHNNYS SERVICE ST	10N	22E	25	NW	NW	2/20/1989	Yakima	Resource	1762310	363529
291803	20	4	POWELL-CHRISTANSON - JOHNNYS SERVICE ST	10N	22E	25	NW	NW	2/16/1989	Yakima	Resource	1762310	363529
498363	8	2	SCHILPEROOT	10N	22E	25	NW	NW	9/5/2007	Yakima	Resource	1762310	363529
498364	11	2	SCHILPEROOT	10N	22E	25	NW	NW	9/5/2007	Yakima	Resource	1762310	363529
498365	8	2	SCHILPEROOT	10N	22E	25	NW	NW	9/5/2007	Yakima	Resource	1762310	363529
498366	8	2	SCHILPEROOT | GN-NORTHERN	10N	22E	25	NW	NW	9/5/2007	Yakima	Abandoned	1762310	363529
498367	11	2	SCHILPEROOT | GN-NORTHERN	10N	22E	25	NW	NW	9/5/2007	Yakima	Abandoned	1762310	363529
498368	8	2	SCHILPEROOT | GN-NORTHERN	10N	22E	25	NW	NW	9/5/2007	Yakima	Abandoned	1762310	363529
624102	12	3	Simplot Grower Solutions | HDR Engineering	10N	22E	25	NW	SW	9/24/2009	Yakima	Resource	1762308	362211
624104	12	3	Simplot Grower Solutions | HDR Engineering	10N	22E	25	NW	SW	9/24/2009	Yakima	Resource	1762308	362211
624106	12	3	Simplot Grower Solutions | HDR Engineering	10N	22E	25	NW	SW	9/24/2009	Yakima	Resource	1762308	362211
624108	12	3	Simplot Grower Solutions | HDR Engineering	10N	22E	25	NW	SW	9/24/2009	Yakima	Resource	1762308	362211
624110	12	3	Simplot Grower Solutions | HDR Engineering	10N	22E	25	NW	SW	9/24/2009	Yakima	Resource	1762308	362211
624112	12	3	Simplot Grower Solutions | HDR Engineering	10N	22E	25	NW	SW	9/24/2009	Yakima	Resource	1762308	362211
624114	12	3	Simplot Grower Solutions | HDR Engineering	10N	22E	25	NW	SW	9/24/2009	Yakima	Resource	1762308	362211
624116	12	3	Simplot Grower Solutions | HDR Engineering	10N	22E	25	NW	SW	9/24/2009	Yakima	Resource	1762308	362211
624118	12	3	Simplot Grower Solutions | HDR Engineering	10N	22E	25	NW	SW	9/24/2009	Yakima	Resource	1762308	362211
624120	12	3	Simplot Grower Solutions | HDR Engineering	10N	22E	25	NW	SW	9/24/2009	Yakima	Resource	1762308	362211
624122	12	3	Simplot Grower Solutions | HDR Engineering	10N	22E	25	NW	SW	9/24/2009	Yakima	Resource	1762308	362211
624124	12	3	Simplot Grower Solutions | HDR Engineering	10N	22E	25	NW	SW	9/24/2009	Yakima	Resource	1762308	362211
728077	20	2	Simplot Grower Solutions | HDR Engineering	10N	22E	25	NW	SW	3/15/2011	Yakima	Resource	1762308	362211
728079	15	2	Simplot Grower Solutions | HDR Engineering	10N	22E	25	NW	SW	3/15/2011	Yakima	Resource	1762308	362211
728081	17.5	2	Simplot Grower Solutions | HDR Engineering	10N	22E	25	NW	SW	3/15/2011	Yakima	Resource	1762308	362211

APPENDIX C
Washington Department of Ecology Well Log Search
November 16, 2016
Bee-Jay Scales Site, Sunnyside, Washington

Well Log ID	Well Depth	Well Diameter	Well Owner	Township	Range	Section	Quarter	Quarter	Well Completion Date	County	Well Type	State Plane Easting Coordinate	State Plane Northing Coordinate
728083	20	2	Simplot Grower Solutions | HDR Engineering	10N	22E	25	NW	SW	3/15/2011	Yakima	Resource	1762308	362211
728085	20	2	Simplot Grower Solutions | HDR Engineering	10N	22E	25	NW	SW	3/16/2011	Yakima	Resource	1762308	362211
852384	36	8	Simplot Grower Solutions | HDR Engineering Inc.	10N	22E	25	NW	SW	1/16/2013	Yakima	Resource	1762308	362211
831079	20	2	Simplot Growers Solutions | HDR Engineering Inc	10N	22E	25	NW	SW	11/16/2012	Yakima	Abandoned	1762308	362211
831081	25	8	Simplot Growers Solutions | HDR Engineering Inc	10N	22E	25	NW	SW	11/16/2012	Yakima	Resource	1762308	362211
831083	25	8	Simplot Growers Solutions | HDR Engineering Inc	10N	22E	25	NW	SW	11/16/2012	Yakima	Resource	1762308	362211
831085	20	8	Simplot Growers Solutions | HDR Engineering Inc	10N	22E	25	NW	SW	11/16/2012	Yakima	Resource	1762308	362211
567848	20	2	SKYHAWK LAND LLC	10N	22E	25	NW	SW	12/9/2008	Yakima	Resource	1762308	362211
567849	20	2	SKYHAWK LAND LLC	10N	22E	25	NW	SW	12/9/2008	Yakima	Resource	1762308	362211
567850	16	2	SKYHAWK LAND LLC	10N	22E	25	NW	SW	12/9/2008	Yakima	Resource	1762308	362211
567851	20	2	SKYHAWK LAND LLC	10N	22E	25	NW	SW	12/9/2008	Yakima	Resource	1762308	362211
567897	20	2	SKYHAWK LAND LLC	10N	22E	25	NW	SW	12/9/2008	Yakima	Resource	1762308	362211
567899	16	2	SKYHAWK LAND LLC	10N	22E	25	NW	SW	12/9/2008	Yakima	Resource	1762308	362211
567900	20	2	SKYHAWK LAND LLC	10N	22E	25	NW	SW	12/9/2008	Yakima	Resource	1762308	362211
567901	20	2	SKYHAWK LAND LLC	10N	22E	25	NW	SW	12/9/2008	Yakima	Resource	1762308	362211
885886	16	8	Valley Processing | Stantec	10N	22E	25	NW	NW	8/21/2013	Yakima	Resource	1762310	363529
885888	16	8	Valley Processing | Stantec	10N	22E	25	NW	NW	8/21/2013	Yakima	Resource	1762310	363529
885889	16	8	Valley Processing | Stantec	10N	22E	25	NW	NW	8/21/2013	Yakima	Resource	1762310	363529
927629	7	8	Western General Land LLC	10N	22E	25	NW	NW	6/2/2014	Yakima	Resource	1762310	363529
927635	9	8	Western General Land LLC	10N	22E	25	NW	NW	6/5/2014	Yakima	Resource	1762310	363529
927636	7	8	Western General Land LLC	10N	22E	25	NW	NW	6/5/2014	Yakima	Resource	1762310	363529
927637	7	8	Western General Land LLC	10N	22E	25	NW	NW	6/5/2014	Yakima	Resource	1762310	363529
927638	7	8	Western General Land LLC	10N	22E	25	NW	NW	6/4/2014	Yakima	Resource	1762310	363529
927639	7	8	Western General Land LLC	10N	22E	25	NW	NW	6/2/2014	Yakima	Abandoned	1762310	363529
927640	4	8	Western General Land LLC	10N	22E	25	NW	NW	6/4/2014	Yakima	Abandoned	1762310	363529
927641	7	8	Western General Land LLC	10N	22E	25	NW	NW	6/5/2014	Yakima	Abandoned	1762310	363529
927642	7	8	Western General Land LLC	10N	22E	25	NW	NW	6/5/2014	Yakima	Abandoned	1762310	363529
927643	7	8	Western General Land LLC	10N	22E	25	NW	NW	6/4/2014	Yakima	Abandoned	1762310	363529
927644	7	8	Western General Land LLC	10N	22E	25	NW	NW	6/4/2014	Yakima	Abandoned	1762310	363529
927652	4	8	Western General Land LLC	10N	22E	25	NW	NW	6/4/2014	Yakima	Resource	1762310	363529
927653	7	8	Western General Land LLC	10N	22E	25	NW	NW	6/5/2014	Yakima	Resource	1762310	363529
927654	7	8	Western General Land LLC	10N	22E	25	NW	NW	6/5/2014	Yakima	Resource	1762310	363529
927655	7	8	Western General Land LLC	10N	22E	25	NW	NW	6/4/2014	Yakima	Resource	1762310	363529
927656	7	8	Western General Land LLC	10N	22E	25	NW	NW	6/4/2014	Yakima	Resource	1762310	363529
927657	7	8	Western General Land LLC	10N	22E	25	NW	NW	6/2/2014	Yakima	Abandoned	1762310	363529
927658	9	8	Western General Land LLC	10N	22E	25	NW	NW	6/5/2014	Yakima	Abandoned	1762310	363529
927659	7	8	Western General Land LLC	10N	22E	25	NW	NW	6/5/2014	Yakima	Abandoned	1762310	363529
927660	7	8	Western General Land LLC	10N	22E	25	NW	NW	6/5/2014	Yakima	Abandoned	1762310	363529

APPENDIX C
Washington Department of Ecology Well Log Search
November 16, 2016
Bee-Jay Scales Site, Sunnyside, Washington

Well Log ID	Well Depth	Well Diameter	Well Owner	Township	Range	Section	Quarter	Quarter	Well Completion Date	County	Well Type	State Plane Easting Coordinate	State Plane Northing Coordinate
927661	7	8	Western General Land LLC	10N	22E	25	NW	NW	6/4/2014	Yakima	Abandoned	1762310	363529
927666	7	8	Western General Land LLC	10N	22E	25	NW	NW	6/2/2014	Yakima	Resource	1762310	363529

STATE OF WASHINGTON
DEPARTMENT OF CONSERVATION
AND DEVELOPMENT

WELL LOG No. Appli. #3300 Permit #3099

Date January 30, 19 54

Record by Don E. Gray

Source Driller's record

Location: State of WASHINGTON

County Yakima

Area

Map

SW¼ SW¼ NW¼ sec. 25 T 10 N., R. 22 E.

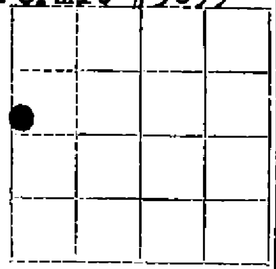


Diagram of Section

Drilling Co. Gray & Osborne, Consulting Engrs.

Address Yakima, Washington

Method of Drilling Date Dec. 23, 19 53

Owner City of Sunnyside, Wash.

Address

Land surface, datum ft. above / below

Correlation	Material	Thickness (feet)	Depth (feet)
	(Transcribe driller's terminology literally but paraphrase as necessary, in parentheses. If material water-bearing, so state and record static level if reported. Give depths in feet below land-surface datum unless otherwise indicated. Correlate with stratigraphic column, if feasible. Following log of materials, list all casings, perforations, screens, etc.)		
	See attached sheet		
Pump	test:		
	Dim: 461' x 20x16"		
	SWL: flowing		
	D.D. 160'		
	Yield 1400 g.p.m.		
	Casing: 20" dia. std. weight from 0 to 379 ft.		
	Perforations: Johnson 10" Everdur 45 slot from 388 to 450 ft.		
	Motor or engine: 150 h.p. turbine		

Turn up

Sheet ...... of ......

10/22-25E
A 3300 P 3099

LOG OF WELL
CITY OF SUNNYSIDE

Material	Thickness (feet)	Depth (feet)
Earth	12	12
Medium soft hardpan	23	35
Gray Hard clay	3	38
Sand and silt	10	48
Light, medium clay and gravel	15	63
Light, soft clay	21	84
Yellow soft clay	5	89
Yellow medium soft sand and clay	11	100
Black, soft sand and clay	2	102
Green, medium hard clay	30	132
Gray, medium clay and gravel	15	147
Blue, soft clay	53	200
Yellow, very soft clay and gravel	5	205
Yellow hard clay	9	214
Gray, soft, silt, sand and gravel	3	217
Gray, hard, clay, sand and gravel	3	220
Medium cement gravel	4	224
Light, soft clay and sand	4	228
Light, soft sand and gravel	2	230
Brown hard cement gravel	2	232
Yellow, medium clay, sand and rock	12	244
Gray loose sand	5	249
Gray, loose sand clay and gravel	24	273
Blue, med. gravel, clay and sand	4	277
Blue, hard cemented gravel	3	280
Gravel and sand	2	282
Green, sticky, clay	7	289
Green soft clay	6	295
Medium, clay, sand and gravel	5	300
Gray, hard clay, sand and gravel	3	303
Yellow, sticky clay	16	319
Yellow, soft clay and sand	16	335
Clay and sand	2	337
Gray soft sand	5	342
Yellow, soft clay, very sticky	12	354
Yellow, soft sandy clay	21	375
Gray hard sandstone	1	376
Gray soft sand	1	377
Gray, soft sand and gravel	13	390
Gravel	13	403
Gray, medium sand and gravel	23	426
Gray soft sand	27	453
Clay, sand and gravel	5	458
Gray medium hard basalt	3	461

WATER WELL REPORT

Original & 1st copy – Ecology, 2nd copy – owner, 3rd copy – driller

WASHINGTON STATE DEPARTMENT OF ECOLOGY

Construction/Decommission (*"x" in circle*)

☐ Construction 406905

⦿ Decommission *ORIGINAL INSTALLATION Notice of Intent Number* ______

CURRENT

Notice of Intent No. AEO9504

Unique Ecology Well ID Tag No. NA

Water Right Permit No. ______

Property Owner Name City of Sunnyside

Well Street Address 400 S. First St.

City Sunnyside County Yakima

Location SW1/4-1/4 NW1/4 Sec 25 Twn 10 R 22 EWM ☐ or WWM ☑ circle one

Lat/Long (s, t, r Still **REQUIRED**) Lat Deg 46 Lat Min/Sec 19/34 Long Deg 120 Long Min/Sec 1/16

Tax Parcel No. N/A

PROPOSED USE: ☐ Domestic ☐ Industrial ☑ Municipal ☐ DeWater ☐ Irrigation ☐ Test Well ☐ Other ______

TYPE OF WORK: Owner's number of well (if more than one) #5

☐ New well ☐ Reconditioned *Method*: ☐ Dug ☐ Bored ☐ Driven ☐ Deepened ☐ Cable ☐ Rotary ☐ Jetted

DIMENSIONS: Diameter of well 20 inches, drilled ______ ft. Depth of completed well 457 ft.

CONSTRUCTION DETAILS

Casing Installed: ☐ Welded 20" Diam. from 0 ft. to 379 ft. ☐ Liner installed ______" Diam. from ______ ft. to ______ ft. ☐ Threaded ______" Diam. from ______ ft. to ______ ft.

Perforations: ☑ Yes ☐ No

Type of perforator used Mills Knife

SIZE of perfs 1/2 in. by 4 in. and no. of perfs 8 from 210 ft. to 4 ft.

Screens: ☐ Yes ☑ No ☐ K-Pac Location 350'

Manufacturer's Name Johson Everdur

Type ______ Model No. ______

Diam. 10 Slot size 0.045 from 388 ft. to 457 ft.

Diam. ______ Slot size ______ from ______ ft. to ______ ft.

Gravel/Filter packed: ☐ Yes ☐ No ☐ Size of gravel/sand ______

Materials placed from ______ ft. to ______ ft.

Surface Seal: ☐ Yes ☐ No To what depth? ______ ft.

Material used in seal ______

Did any strata contain unusable water? ☐ Yes ☐ No

Type of water? ______ Depth of strata ______

Method of sealing strata off ______

PUMP: Manufacturer's Name ______

Type: ______ H.P. ______

WATER LEVELS: Land-surface elevation above mean sea level ______ ft.

Static level ______ ft. below top of well Date ______

Artesian pressure ______ lbs. per square inch Date ______

Artesian water is controlled by ______ (cap, valve, etc.)

WELL TESTS: Drawdown is amount water level is lowered below static level

Was a pump test made? ☐ Yes ☐ No If yes, by whom? ______

Yield: ______ gal./min. with ______ ft. drawdown after ______ hrs.

Yield: ______ gal./min. with ______ ft. drawdown after ______ hrs.

Yield: ______ gal./min. with ______ ft. drawdown after ______ hrs.

Recovery data (time taken as zero when pump turned off) (water level measured from well top to water level)

Time	Water Level	Time	Water Level	Time	Water Level

Date of test ______

Bailer test ______ gal./min. with ______ ft. drawdown after ______ hrs.

Airtest ______ gal./min. with stem set at ______ ft. for ______ hrs.

Artesian flow ______ g.p.m. Date ______

Temperature of water ______ Was a chemical analysis made? ☐ Yes ☐ No

CONSTRUCTION OR DECOMMISSION PROCEDURE

Formation: Describe by color, character, size of material and structure, and the kind and nature of the material in each stratum penetrated, with at least one entry for each change of information. (USE ADDITIONAL SHEETS IF NECESSARY.)

MATERIAL	FROM	TO
This steel cased well was abandoned in accordance		
with variance dated February 8th 2011		
cement was installed	461	212
casing was perforated	210	4
cement was installed	212	4
total of 40 yrds of material installed		
Job # 10-1599-03		

RECEIVED FEB 24 2011 DEPARTMENT OF ECOLOGY - CENTRAL REGIONAL OFFICE

Start Date 1/26/11 Completed Date 2/2/11

WELL CONSTRUCTION CERTIFICATION: I constructed and/or accept responsibility for construction of this well, and its compliance with all Washington well construction standards. Materials used and the information reported above are true to my best knowledge and belief.

☐ Driller ☐ Engineer ☐ Trainee Name (Print) James Vignali

Driller/Engineer/Trainee Signature [signature]

Driller or trainee License No. 0987

If TRAINEE, Driller's Licensed No. ______

Driller's Signature ______

Drilling Company Tacoma Pump & Drilling Co., Inc.

Address 30316 Mountain Highway

City, State, Zip Graham, WA 98338

Contractor's Registration No. TACOMPD203PF Date 2/21/11

Ecology is an Equal Opportunity Employer.

ECY 050-1-20 (Rev.3/05)

APPENDIX D
Field Test Kit Instructions

Nitrate Vacu-vials® Kit

K-6903: 0 - 1.50 ppm N (Prog. # 119)
K-6923: 0 - 7.50 ppm N (Prog. # 120)
K-6933: 0 - 50.0 ppm NO_3 (Prog. # 121)

Instrument Set-up

For CHEMetrics photometers, follow the **Setup and Measurement Procedures** in the operator's manual.

For spectrophotometers, follow the manufacturer’s instructions to set the wavelength to 520 nm and to zero the instrument using the ZERO ampoule supplied.

Safety Information

Read SDS (available at www.chemetrics.com) before performing this test procedure. Wear safety glasses and protective gloves.

Sample Preparation for K-6923 and K-6933

Using the syringe, measure and dispense the specified volume of the sample to be tested into the empty reaction tube. Dilute to the 15 mL mark with distilled water. Perform the test procedure below beginning with Step 2.

K-6923: use 3 mL of the sample to be tested
K-6933: use 2 mL of the sample to be tested

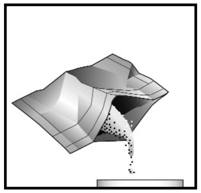


Figure 1

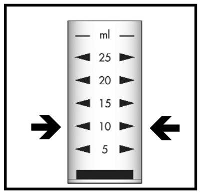


Figure 2

Test Procedure

1. Fill the **reaction tube** (green screw cap tube) to the 15 mL mark with the sample to be tested.
2. Empty the contents of one Cadmium Foil Pack into the reaction tube (fig 1). Cap the reaction tube and shake it vigorously for exactly **3 minutes.** Allow the sample to sit undisturbed for **2 minutes**.
3. Pour 10 mL of the treated sample into the empty **25 mL sample cup** (fig 2), being careful not to transfer any cadmium particles to the sample cup.
4. Place the Vacu-vial ampoule, tip first, into the sample cup. Snap the tip. The ampoule will fill leaving a bubble for mixing (fig 3).
5. To mix the ampoule, invert it several times, allowing the bubble to travel from end to end.
6. Dry the ampoule and wait **10 minutes** for color development.

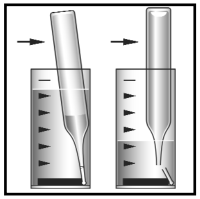


Figure 3

7. Insert the Vacu-vial ampoule into the photometer, flat end first, and obtain a test result.

NOTE: **If using a spectrophotometer** that is not pre-calibrated for CHEMetrics products, then use the **equation below** or the **Concentration Calculator** found under the Support tab at *www.chemetrics.com*. If instrument response is > 2 absorbance (abs), dilute sample and retest.

K-6903: ppm N = $-0.39\ (abs)^2 + 1.66\ (abs) + 0.02$
K-6923: ppm N = $-1.95\ (abs)^2 + 8.32\ (abs) + 0.09$
K-6933: ppm NO_3 = $-13\ (abs)^2 + 55.2\ (abs) + 0.64$

Test Method

The Nitrate Vacu-vials®[1] test kit employs the cadmium reduction method.[2,3,4] Nitrate is reduced to nitrite in the presence of cadmium. In an acidic solution, the nitrite diazotizes with a primary aromatic amine and then couples with another organic molecule to produce a highly colored azo dye. The resulting pink-orange color is proportional to the nitrate concentration.

Samples containing nitrite will give erroneous, high test results. Samples containing in excess of 2000 ppm chloride will give low test results. Certain metals, chlorine, oil and grease will also give low test results.

1. Vacu-vials is a registered trademark of CHEMetrics, Inc. U.S. Patent No. 3,634,038
2. APHA Standard Methods, 22nd ed., Method 4500-NO_3^- E -2000
3. ASTM D 3867 - 09, Nitrite-Nitrate in Water, Test Method B
4. EPA Methods for Chemical Analysis of Water and Wastes, Method 353.3 (1983)

Visit www.chemetrics.com to view product demonstration videos.
Always follow the test procedure above to perform a test.

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www.chemetrics.com

Feb. 16, Rev. 20

Nitrite Vacu-vials® Kit

K-7003: 0 - 1.00 ppm N (Prog. # 125)

Instrument Set-up

For CHEMetrics photometers, follow the **Setup and Measurement Procedures** in the operator's manual. For spectrophotometers, follow the manufacturer's specifications to set the wavelength to 520 nm and to zero the instrument using the ZERO ampoule supplied.

Safety Information

Read SDS (available at www.chemetrics.com) before performing this test procedure. Wear safety glasses and protective gloves.

Test Procedure

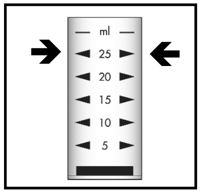

Figure 1

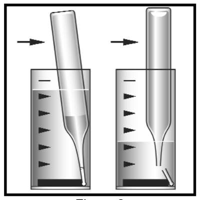
Figure 2

1. Fill the sample cup to the 25 mL mark with the sample to be tested (fig 1).
2. Place the Vacu-vial ampoule, tip first, into the sample cup. Snap the tip. The ampoule will fill leaving a bubble for mixing (fig 2).
3. To mix the ampoule, invert it several times, allowing the bubble to travel from end to end.
4. Dry the ampoule and wait **10 minutes** for color development.
5. Insert the Vacu-vial ampoule into the photometer, flat end first, and obtain a reading in ppm (mg/Liter) nitrite-nitrogen (NO_2-N).

NOTE: **If using a spectrophotometer** that is not pre-calibrated for CHEMetrics products, then use the **equation below** or the **Concentration Calculator** found under the Support tab at *www.chemetrics.com*. If instrument response is > 2 absorbance (abs), dilute sample and retest.

$$\text{ppm N} = 0.24\,(\text{abs})^3 - 0.67\,(\text{abs})^2 + 1.17\,(\text{abs})$$

NOTE: To convert to ppm Nitrite (NO_2), multiply test result by 3.3.

Test Method

The Nitrite Vacu-vials®[1] test kit employs the azo dye formation method.[2,3] In an acidic solution, nitrite diazotizes with a primary aromatic amine and then couples with another organic molecule to produce a highly colored azo dye. The resulting pink-orange color is proportional to the nitrite concentration in the sample.

1. Vacu-vials is a registered trademark of CHEMetrics, Inc. U.S. Patent No. 3,634,038
2. APHA Standard Methods, 22nd ed., Method 4500-NO_2^- B - 2000.
3. EPA Methods for Chemical Analysis of Water and Wastes, Method 354.1 (1983).

Visit www.chemetrics.com to view product demonstration videos.
Always follow the test procedure above to perform a test.

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Feb. 18, Rev. 16

Ammonia Vacu-vials® Kit

K-1503: 0 - 7.00 ppm N (Prog. # 15)

K-1523: 0 - 14.0 ppm N (Prog. # 16)

Instrument Set-up

For CHEMetrics photometers, follow the **Setup and Measurement Procedures** in the operator's manual.

For spectrophotometers, follow the manufacturer's instructions to set the wavelength to 430 nm and to zero the instrument using the ZERO ampoule supplied.

Non-Seawater Test Procedure

1. Fill the sample cup to the 25 mL mark with the sample to be tested (fig. 1).
2. Add 2 drops of A-1500 Stabilizer Solution (fig. 2). Stir to mix the contents of the cup.
3. Place the Vacu-vial ampoule, tip first, into the sample cup. Snap the tip. The ampoule will fill leaving a bubble for mixing (fig. 3).
4. To mix the ampoule, invert it several times, allowing the bubble to travel from end to end.
5. Dry the ampoule and wait **2 minutes** for color development.
6. Insert the Vacu-vial ampoule into the photometer, flat end first, and obtain a reading in ppm (mg/Liter) ammonia-nitrogen (NH_3-N).

   NOTE: **If using a spectrophotometer** that is not pre-calibrated for CHEMetrics products, then use the **equation below** or the **Concentration Calculator** found under the Support tab at *www.chemetrics.com*.

K-1503: ppm = 7.16 (abs) - 0.16

K-1523: ppm = 16.39 (abs) - 0.50

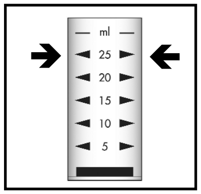

Figure 1

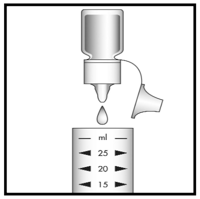

Figure 2

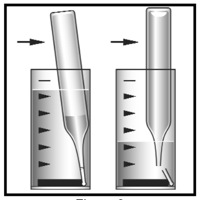
Figure 3

Seawater Test Procedure

1. Using the syringe, add 1.0 mL of A-1501 Stabilizer Solution to the sample cup.
2. Fill the sample cup to the 25 mL mark with the seawater sample to be tested (fig. 1).
3. Perform the Test Procedure above, beginning with Step 3.

Test Method

The Ammonia Vacu-vials®[1] test kit employs direct nesslerization.[2,3] In a strongly alkaline solution, ammonia reacts with Nessler Reagent (K_2HgI_4) to produce a yellow-colored complex in direct proportion to the ammonia concentration.

This method is applicable to drinking water, clean surface water, good quality nitrified wastewater effluent and seawater. Other types of samples may require a preliminary distillation step. Ketones, alcohols, and aldehydes may cause off-color test results. Glycine and hydrazine will cause high test results. Aromatic and aliphatic amines, iron, sulfide, calcium and magnesium may cause turbidity.

1. Vacu-vials is a registered trademark of CHEMetrics, Inc. U.S. Patent No. 3,634,038
2. APHA Standard Methods, 18th ed., Method 4500-NH_3 C - 1988
3. ASTM D 1426 - 08, Ammonia Nitrogen in Water, Test Method A

Safety Information

Read SDS (available at www.chemetrics.com) before performing this test procedure. Wear safety glasses and protective gloves.

Visit www.chemetrics.com to view product demonstration videos.
Always follow the test procedure above to perform a test.

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Feb. 18, Rev. 25

Manganese Vacu-vials® Kit

K-6503: 0 - 30.0 ppm (Prog. # 110)

Instrument Set-up

For CHEMetrics photometers, follow the **Setup and Measurement Procedures** in the operator's manual. For spectrophotometers, follow the manufacturer's specifications to set the wavelength to 520 nm and to zero the instrument using the ZERO ampoule supplied.

Test Procedure

1. Fill the sample cup to the 20 mL mark with the sample to be tested (fig. 1).
2. Using the syringe, add 1 mL of A-6501 Activator Solution. Stir to mix the contents of the cup.
3. Place the Vacu-vial ampoule, tip first, into the sample cup. Snap the tip. The ampoule will fill leaving a bubble for mixing (fig. 2).
4. To mix the ampoule, invert it several times, allowing the bubble to travel from end to end.
5. Dry the ampoule and wait **1 minute** for color development.
6. Insert the Vacu-vial ampoule into the photometer, flat end first, and obtain a reading in ppm (mg/Liter) manganese (Mn).

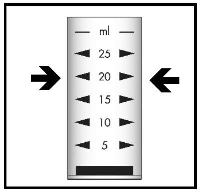

Figure 1

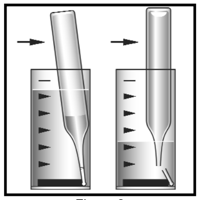
Figure 2

NOTE: **If using a spectrophotometer** that is not pre-calibrated for CHEMetrics products, then use the **equation below** or the **Concentration Calculator** found under the Support tab at *www.chemetrics.com*.

$$ppm = 5.61\ (abs)^2 + 35.48\ (abs) - 0.19$$

Test Method

The Manganese Vacu-vials®[1] test kit employs the periodate chemistry.[2] Soluble manganous compounds are oxidized by periodate in a slightly acidic solution to form permanganate ion. The resulting pink color is proportional to the manganese (Mn) concentration in the sample.

Permanganate (MnO_4^-) develops approximately 25% more color with this reagent than other forms of manganese, causing a high bias. If the sample is known to contain manganese in the form of permanganate only, multiplying test results by 0.8 will improve the accuracy of the results.

1.Vacu-vials is a registered trademark of CHEMetrics, Inc. U.S. Patent No. 3,634,038

2.APHA Standard Methods, 14th ed., Method 314C (1975).

Safety Information

Read SDS (available at www.chemetrics.com) before performing this test procedure. Wear safety glasses and protective gloves.

Visit www.chemetrics.com to view product demonstration videos.
Always follow the test procedure above to perform a test.

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Feb. 18, Rev. 12

Iron Vacu-vials® Kit

K-6003: 0 - 6.00 ppm (Prog. # 100)
K-6203: 0 - 6.00 ppm (Prog. # 100 or 103)

Instrument Set-up

For CHEMetrics photometers, follow the **Setup and Measurement Procedures** in the operator's manual. For spectrophotometers, follow the manufacturer's instructions to set the wavelength to 505 nm and to zero the instrument using the ZERO ampoule supplied.

Soluble Iron Procedure: K-6003
Ferrous Iron Procedure: K-6203

1. Fill the sample cup to the 25 mL mark with the sample to be tested (fig 1).
2. Place the Vacu-vial ampoule, tip first, into the sample cup. Snap the tip. The ampoule will fill leaving a bubble for mixing (fig 2).
3. To mix the ampoule, invert it several times, allowing the bubble to travel from end to end.
4. Dry the ampoule and wait **1 minute** for color development.
5. Insert the Vacu-vial ampoule into the photometer, flat end first, and obtain a reading in ppm (mg/Liter) iron (Fe).

NOTE: **If using a spectrophotometer** that is not pre-calibrated for CHEMetrics products, then use the **equation below** or the **Concentration Calculator** found under the Support tab at *www.chemetrics.com*.

$$ppm = 6.35 (abs) - 0.03$$

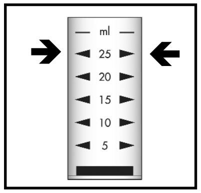

Figure 1

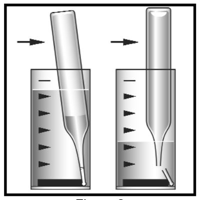
Figure 2

Total Iron Procedure

1. Fill the sample cup to the 25 mL mark with the sample to be tested.
2. Add 5 drops of A-6000 Activator Solution. Stir briefly. Wait **4 minutes**.
3. After 4 minutes, stir the sample once again and then perform the **Soluble/Ferrous Iron Procedure** using this pretreated sample.

Test Method

The Iron Vacu-vials®[1] test kit employs the phenanthroline chemistry.[2,3,4] Ferrous iron reacts with 1,10-phenanthroline to form an orange colored complex in direct proportion to the ferrous or soluble iron concentration. Total iron is determined by adding a mixture of thioglycolic acid and ammonia to the sample. This mixture dissolves most forms of particulate iron.

Various metals will produce high test results. Certain forms of very insoluble iron (magnetite, ferrite, etc.) require the following digestion procedure in place of the Total Iron test procedure:

a. Fill a heat-resistant, glass container to 25 mL with the sample to be tested.
b. Add 5 drops of A-6000 Solution. Stir briefly.
c. Gently boil the sample to reduce volume to 10-15 mL.
d. Cool the sample and dilute to 25 mL with iron-free water.
e. Perform the **Soluble/Ferrous Iron Procedure** using this pretreated sample.

1. Vacu-vials is a registered trademark of CHEMetrics, Inc. U.S. Patent No. 3,634,038

2. APHA Standard Methods, 22nd ed., Method 3500-Fe B - 1997
3. ASTM D 1068 - 77, Iron in Water, Test Method A
4. J.A. Tetlow and A.L. Wilson, "The Absorptiometric Determination of Iron in Boiler Feed-water," Analyst. Vol. 89, p 442 (1964)

Safety Information

Read SDS (available at www.chemetrics.com) before performing this test procedure. Wear safety glasses and protective gloves.

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Feb. 18, Rev. 18

Sulfate Vacu-vials® Kit

K-9203: 0 - 100.0 ppm (Prog. # 174)

Instrument Set-up

For CHEMetrics photometers, follow the **Setup and Measurement Procedures** in the operator's manual. For spectrophotometers, follow the manufacturer's specifications to set the wavelength to 420 nm and to zero the instrument using the ZERO ampoule supplied.

Different instrument platforms vary widely in their ability to measure turbidity. Since this method is a turbidimetric determination, the calibration equation is for reference only. It is strongly recommended that sulfate standards be run to validate the calibration equation or to generate an instrument specific calibration.

Sample Pretreatment

If the sample is turbid, it must be filtered prior to performing this test procedure.

Test Procedure

1. Fill the sample cup to the 20 mL mark with the sample to be tested (fig. 1).
2. Add 7 drops of A-9200 Acidifier Solution (fig. 2). Stir to mix the contents of the cup.
   NOTE: The appearance of bubbles on the side and bottom of the sample cup is an indication of extremely high alkalinity levels, (>2000 ppm as $CaCO_3$). Under these conditions stir the sample for approximately 1 minute to allow this gas to be dispersed.
3. Add 1 scoop of A-9202 Activator Powder to the sample. Stir for **10 seconds**.
   NOTE: It is not critical that all of the crystals dissolve.

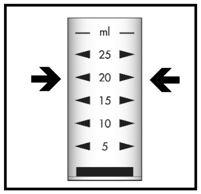

Figure 1

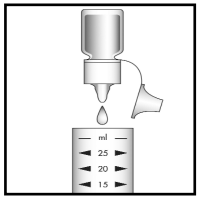

Figure 2

4. Place the Vacu-vial ampoule, tip first, into the sample cup. Snap the tip. The ampoule will fill leaving a bubble for mixing (fig. 3).
5. To mix the ampoule, invert it several times, allowing the bubble to travel from end to end.
6. Dry the ampoule and wait **1 minute**.
7. Insert the Vacu-vial ampoule into the photometer, flat end first, and obtain a reading in ppm (mg/Liter) sulfate (SO_4).
   NOTE: If using a spectrophotometer that is not pre-calibrated for CHEMetrics products and an instrument specific calibration has not been generated as recommended, then use the equation below or the Concentration Calculator found under the Support tab at www.chemetrics.com

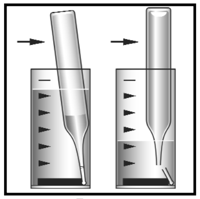
Figure 3

$$ppm = 91.9(abs)^3 - 124.8\ (abs)^2 + 150.3\ (abs) + 1.9$$

Test Method

The Sulfate Vacu-vials®[1] test kit employs the turbidimetric method.[2,3,4] Sulfate ion reacts with barium chloride in an acidic solution to form a suspension of barium sulfate crystals of uniform size. The resulting turbidity is proportional to the sulfate concentration of the sample.

1.Vacu-vials is a registered trademark of CHEMetrics, Inc. U.S. Patent No. 3,634,038.
2.APHA Standard Methods, 15th ed., Method 426 C (1980).
3.EPA Methods for Chemical Analysis of Water and Wastes, Method 375.4 (1983).
4.ASTM 516 - 07, Sulfate Ion in Water.

Safety Information

Read SDS (available at www.chemetrics.com) before performing this test procedure. Wear safety glasses and protective gloves.

Visit www.chemetrics.com to view product demonstration videos.
Always follow the test procedure above to perform a test.

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Apr. 16, Rev. 13

Phosphate Vacu-vials® Kit

K-8503: 0 - 80.0 ppm PO_4 (Prog. # 158)

Instrument Set-up

For CHEMetrics photometers, follow the **Setup and Measurement Procedures** in the operator's manual.

For spectrophotometers, follow the manufacturer's instructions to set the wavelength to 420 nm and to zero the instrument using the ZERO ampoule supplied.

Test Procedure

1. Fill the sample cup to the 25 mL mark with the sample to be tested (fig. 1).
2. Place the Vacu-vial ampoule, tip first, into the sample cup. Snap the tip. The ampoule will fill leaving a bubble for mixing (fig. 2).
3. To mix the ampoule, invert it several times, allowing the bubble to travel from end to end.
4. Dry the ampoule and wait **5 minutes** for color development.
5. Insert the Vacu-vial ampoule into the photometer, flat end first, and obtain a reading in ppm (mg/Liter) phosphate (PO_4).

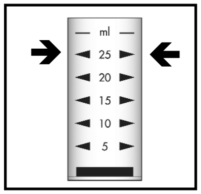

Figure 1

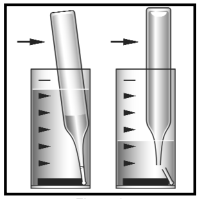
Figure 2

NOTE: **If using a spectrophotometer** that is not pre-calibrated for CHEMetrics products, then use the **equation below** or the **Concentration Calculator** found under the Support tab at *www.chemetrics.com*.

$$ppm = 72.9\ (abs) - 1.8$$

Test Method

The Phosphate Vacu-vials®[1] test kit employs the vanadomolybdophosphoric acid chemistry.[2,3] In an acidic solution, ortho-phosphate reacts with ammonium molybdate and ammonium vanadate to produce a yellow colored complex in direct proportion to the phosphate concentration.

Condensed phosphates (pyro-, meta-, and other polyphosphates) and organically bound phosphates do not respond to this test. Sulfide, thiosulfate, and thiocyanate will cause low test results.

1. Vacu-vials is a registered trademark of CHEMetrics, Inc. U.S. Patent No. 3,634,038.
2. APHA Standard Methods, 22nd ed., Method 4500-P C - 1999
3. ASTM D 515 - 82, Phosphorus in Water, Test Method C

Safety Information

Read SDS (available at www.chemetrics.com) before performing this test procedure. Wear safety glasses and protective gloves.

Visit www.chemetrics.com to view product demonstration videos.
Always follow the test procedure above to perform a test.

CHEMetrics
Simplicity in Water Analysis

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