Environment

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Groundwater Sampling Plan

NERT Remedial Investigation – Downgradient Study Area
Nevada Environmental Response Trust Site
Henderson, Nevada

Final

Groundwater Sampling Plan, Revision 0

NERT Remedial Investigation – Downgradient Study Area
Nevada Environmental Response Trust Site, Henderson, Nevada

Responsible Certified Environmental Manager (CEM) for this project

I hereby certify that I am responsible for the services described in this document and for the preparation of this document. The services described in this document have been provided in a manner consistent with the current standards of the profession and, to the best of my knowledge, comply with all applicable federal, state and local statutes, regulations and ordinances.

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2/29/2016
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Certified Environmental Manager
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List of Acronyms

DI	deionized
Downgradient Study Area	NERT Remedial Investigation – Downgradient Study Area
DQO	data quality objective
DVSR	Data Validation Summary Report
EB	equipment blank
EDD	electronic data deliverable
ENVIRON	ENVIRON International Corporation
FB	field blank
FD	field duplicate
FGD	Field Guidance Document
FS	Feasibility Study
GSP	Groundwater Sampling Plan
GWETS	Groundwater Extraction and Treatment System
HASP	Health and Safety Plan
ID	Identification number
IDW	investigation-derived waste
LCS/LCSD	laboratory control sample/laboratory control sample duplicate
LVW	Las Vegas Wash
MS/MSD	matrix spike/matrix spike duplicate
NDEP	Nevada Division of Environmental Protection
NERT	Nevada Environmental Response Trust
NERT Off-Site Study Area	off-site portion of the NERT Remedial Investigation Study Area
NERT On-Site Study Area	on-site portion of the NERT Remedial Investigation Study Area
QA	quality assurance
QAPP	Quality Assurance Project Plan
QC	quality control
RI	remedial investigation
SNWA	Southern Nevada Water Authority
TB	trip blank
USEPA	United States Environmental Protection Agency
VOC	volatile organic compound

1.0 Introduction

This Groundwater Sampling Plan (GSP) describes the sampling locations, procedures and methods for the initial groundwater sampling and analyses for the Nevada Environmental Response Trust (NERT) Remedial Investigation (RI) - Downgradient Study Area (Downgradient Study Area) in Henderson, Nevada (**Figure 1**). This GSP was developed at the direction of the Nevada Division of Environmental Protection (NDEP). The work consists of sampling up to 78 groundwater monitoring wells, if accessible, within and to the east of the Downgradient Study Area (northeast of the Tuscany Golf Course) (**Figure 2**). The groundwater sample locations were proposed by NDEP in an email to AECOM on November 17, 2015 with additional wells added by NDEP in an email dated December 8, 2015.

The objective of the Downgradient Study Area investigation is to identify subsurface pathways within the Downgradient Study Area through which perchlorate-impacted groundwater is entering Las Vegas Wash (LVW). Many of the existing groundwater monitoring wells within the Downgradient Study Area have not been sampled since 2009. As part of the planning phase for future RI activities, a comprehensive sampling of as many existing wells as possible is needed to assess current groundwater conditions beneath the Downgradient Study Area. Although this GSP is based on up to 78 well locations, it is possible that some of the wells may no longer exist or be accessible.

The Field Sampling Plan for the NERT RI/Feasibility Study (FS) (ENVIRON International Corporation [ENVIRON] 2014a) was used as the basis for the methods and field procedures in this GSP. The activities in this GSP will be conducted in conformance with the Quality Assurance Project Plan (QAPP) and the site-specific Health and Safety Plan (HASP) developed by AECOM. The site-specific QAPP and HASP will be finalized prior to mobilization into the field.

1.1 Groundwater Sampling Plan Organization

This document includes the following sections, which are summarized as follows:

- Section 1.0 provides an introduction, including the overall objectives and scope of this GSP.
- Section 2.0 discusses the data quality objectives (DQOs) for the groundwater sampling and analyses.
- Section 3.0 describes the sampling and testing objectives for the GSP and describes the sampling types, locations, and frequency.
- Section 4.0 details the sampling procedures and equipment to be used during the investigation.
- Section 5.0 describes sample designations, sampling handling, and analytical methods to be conducted as part of the investigation.
- Section 6.0 describes the schedule and report preparation that will document the results of this assessment.
- Section 7.0 provides references to sources of information.

2.0 Data Quality Objectives

In this section, the United States Environmental Protection Agency (USEPA) DQO process is followed to assist with systematic planning for the proposed environmental sampling program described in this GSP. The DQO process is USEPA's recommended planning process when environmental data are used to select between two alternatives or derive an estimate of contamination (USEPA 2001). The DQO process is used to develop performance and acceptance criteria that clarify study objectives, define the appropriate type of data, and specific tolerable levels of potential decision errors that will be used as the basis for establishing the quality and quantity of data needed to support decisions. Performance criteria apply to new data collected for the project, while acceptance criteria apply to existing data proposed for inclusion in the project.

After performance criteria have been developed, the QAPP describes in comprehensive detail the necessary quality assurance (QA), quality control (QC), and other technical activities that must be implemented to ensure that the results of the work performed will satisfy the stated performance criteria (USEPA 2001). The QAPP for the proposed sampling at the Downgradient Study Area will be a separate document adapted from the existing QAPP for the NERT RI and will be consistent with USEPA guidance (USEPA 2001).

The DQO process as described in USEPA guidance involves the following seven steps (USEPA 2006):

1. Define the problem.
2. Identify the goal of the study.
3. Identify information needed for the study.
4. Define the boundaries of the study.
5. Develop the analytic approach.
6. Specify the performance or acceptance criteria.
7. Develop the plan for obtaining data.

A summary of steps 1.0 through 6.0 is provided in this section. The sampling plan details in step 7.0 are described in Sections 3.0 through 5.0 of this GSP.

2.1 Problem Definition, Study Goals, and Data Gaps

The on-site portion of the NERT RI Study Area (NERT On-Site Study Area) has been the location of industrial operations since 1942 when it was developed by the United States government as a magnesium plant to support World War II operations (**Figure 1**). Following the war, this area continued to be used for industrial activities, including production of perchlorate, boron, and manganese compounds. Former industrial and waste management activities conducted at the NERT On-Site Study Area, as well as those conducted at adjacent properties, resulted in contamination of environmental media, including soil, groundwater, and surface water. Since 1979, the NERT On-Site Study Area has been the subject of numerous investigations and removal actions. Soil removal actions were conducted in 2010 and 2011 from the NERT On-Site Study Area to minimize potential health risks from impacted soil. Additional soil removal was performed in 2013 when the east end of the Beta Ditch was excavated. The soil removal activities and post-removal conditions are described in detail in the Revised Interim Soil Removal Action Completion Report (ENVIRON 2012). On-site groundwater removal actions include the installation of the Groundwater Extraction and Treatment System (GWETS), designed to capture and treat perchlorate and hexavalent chromium in shallow groundwater.

The distribution and concentration of perchlorate in areas downgradient of the City of Henderson Rapid Infiltration Basins (Southern and Northern) were last assessed in 2009. Groundwater data representing current perchlorate concentrations at the Downgradient Study Area are needed to evaluate the extent of perchlorate in groundwater.

2.2 Study Area Boundaries

Step 4 of the DQO process is to define the boundaries of the study area. The boundary of the Downgradient Study Area for the RI includes the LVW north, west and east of the Off-Site NERT Study Area (**Figure 1**). Wells to be sampled as part of this GSP are located within, and to the east of the Downgradient Study Area, roughly between the Duck Creek Confluence Weir and Lake Las Vegas Intake (**Figure 2**).

2.3 Analytic Approach and Performance Criteria

Steps 5 (developing the analytical approach) and 6 (specifying the performance or acceptance criteria of the DQO process) are provided in this section. The analytic approach for the groundwater sampling is based on availability of existing wells within the Downgradient Study Area. Data from wells sampled will be used to establish current conditions and to help determine future sampling locations for groundwater. As a result, no explicit performance criteria such as randomly selected versus justified sample locations were defined for the selection of groundwater sample locations for this assessment.

3.0 Sampling and Testing Objectives and Locations

3.1 Groundwater Sampling Objectives

Many of the wells identified for the initial sampling have not been sampled since 2009. Comprehensive gauging and sampling of existing wells is required to provide a preliminary assessment of current groundwater conditions. These data will be used to prepare potentiometric, perchlorate, chromium, and total dissolved solids maps depicting current groundwater gradient(s) and analyte concentration contours. These data in conjunction with results of other investigative work planned within the Downgradient Study Area, will help determine the location of new wells necessary to evaluate pathways by which perchlorate is entering the LVW.

3.2 Sampling of Existing Wells

Up to 78 existing groundwater monitoring wells will be sampled for this event. Of the 78 wells, 68 are located within the Downgradient Study Area and 10 are located outside and east of the Downgradient Study Area. The 10 wells were added at the request of NDEP to provide data in an area with limited historical data. A list of the proposed wells is presented in **Table 1**. The well locations are shown on **Figure 2**. Groundwater samples will be analyzed for the following constituents:

- Perchlorate (USEPA Method 314.0),
- Chlorate (USEPA Method 300.1),
- Chromium, Dissolved (USEPA Method 200.8 [ICP-MS]),
- Hexavalent Chromium, Dissolved[Method 218.7],
- Chloride (USEPA Method 300.0),
- Bromide (USEPA Method 300.0), and
- Total Dissolved Solids (Method SM 2540C).

Water sampling activities for the NERT RI include field-filtering water samples analyzed for perchlorate using the Sterile Filtration method described in NDEP guidance documents (2010). As directed by NDEP, field-filtering of water samples for perchlorate analysis is not required. Filtering for chromium analysis will be conducted in the field using a 0.45 micron filter. Details of the analytical program are listed in **Table 2**. Groundwater sampling activities are described in Section 4.5.

4.0 Sampling Procedures and Equipment

Sampling and other data collection equipment and associated procedures are described in the following sections. Sampling equipment will generally include pumps (with dedicated tubing) or bailers for groundwater sampling. Water levels will be measured using hand-held electronic water level sounders during groundwater sampling. Sampling methods and materials are generally based on the USEPA publication SW-846, Test Methods for Evaluating Solid Waste, Physical/Chemical Methods (USEPA 1997).

To maintain consistency in the methods applied in the field for this assessment, field activities will adhere to the procedures described in relevant Field Guidance Documents (FGDs) in the Field Sampling Plan for the NERT RI/FS (ENVIRON 2014a). The relevant FGDs for this GSP are provided in **Appendix A.**

4.1 Documentation Procedures

Records that may be generated during field work include field logs and data sheets, photographic logs, sample chain-of-custody records, equipment inspection/calibration records, and others as necessary. Units of measure for any field measurements and/or analyses will be clearly identified on the field forms and in notes and logs as necessary. The QA/QC Officer, or other appropriate person designated by the AECOM Project Manager, will review the field data to evaluate the completeness of the field records.

4.1.1 Field Notes

Field logbooks will provide the means of recording data collection activities at the time they take place. The logbooks will be bound field survey notebooks assigned to field personnel, but they will be stored with the project files in a centralized document repository at an AECOM office location when not in use. Activities will be described in as much detail as possible such that the activity being described can be reconstructed without reliance on memory. Entries will be made in language that is objective, factual, and free of personal opinions or terminology that might later prove unclear or ambiguous.

The cover of each logbook will be identified by the project name, project-specific document number, and the time period which the logbook describes (beginning and end dates). The title page of each logbook will have contact information for the AECOM Project Manager. Entries into the logbook will contain a variety of project-specific information. At the beginning of each entry, the date, start time, weather, names of team members present, level of personal protection being used, and the signature of the person making the entry will be entered. Names and affiliations of visitors to the Downgradient Study Area and the purpose of their visit will be recorded.

Entries will be made in ink, signed and dated and no erasures will be made. If an incorrect entry is made, the information will be crossed out with a single strike mark, initialed, and dated by the user. Whenever a sample is collected or a measurement is made it shall be recorded. Photographs taken will be identified by number and a description of the photograph will be provided. Equipment used to conduct measurements will be identified including serial number and any calibration conducted will be recorded.

4.1.2 Field Data Sheets

Field data sheets will be completed by field personnel during sample collection activities. The types of field data sheets used include groundwater sampling logs, and well inspection forms. If deemed necessary by the AECOM Project Manager, electronic copies of the data sheets may be produced after sampling has been completed and these will be provided in the technical report that presents the results of this assessment. Example field data sheets are provided in **Appendix B**.

4.1.3 Photographs

Digital photographs will be taken if necessary to supplement and verify information entered into field logbooks. For each photograph taken, the following will be recorded in the field logbook:

- Date, time, and location;
- Number and brief description of the photograph; and
- Direction in which the photograph was taken, if relevant.

If a number of photographs are taken during a task, general notes will be sufficient on the group of photographs taken, so long as the information outlined above can be inferred from the information provided for each photograph.

4.2 Instrument Calibration Procedures

Instruments requiring calibration include air monitoring equipment (e.g., photoionization detectors) and water quality meters (e.g., pH, dissolved oxygen, specific conductivity, and turbidity meters). Equipment that can be field calibrated will be calibrated at least once per day prior to beginning sampling activities, with calibration results documented on an Instrument Calibration Log or in the field logbook. Equipment that must be calibrated in a laboratory setting will be used only if a current calibration certificate is available (for example, a calibration certificate is provided with a piece of rental monitoring equipment). Calibration procedures will be consistent with manufacturer instruction manuals for each instrument. Calibration and maintenance procedures for field equipment are detailed in the QAPP.

4.3 Equipment Cleaning Procedures

Non-dedicated sampling and monitoring equipment that is exposed to environmental contaminants will be thoroughly decontaminated prior to first use and between uses. At a minimum, decontamination procedures will include scrubbing the equipment with a brush or sponge in a solution of Alconox™ detergent (or equivalent) in potable water, followed by a first rinse in potable water and a second rinse in distilled or deionized (DI) water. Alternatively, durable equipment (e.g., drill tooling) may be pressure washed using a steam cleaner.

Equipment that is new from the factory must be wrapped in plastic during transport to the Downgradient Study Area. If equipment is not wrapped in plastic during transport it must be decontaminated prior to use.

Instructions and guidance for decontamination of sampling equipment is included in each FGD that pertains to sampling or testing of environmental media. FGDs are provided in **Appendix A.**

4.4 Investigation-Derived Waste Management

In general, investigation-derived waste (IDW) for the collection of groundwater will consist of purged groundwater, equipment cleaning water and used PPE (disposable nitrile gloves) and household trash such as used paper towels, etc. The liquid IDW will be temporarily placed into a polyethylene tank; at the end of each day, the liquid IDW will be taken to the GWETS at the NERT On-Site Study Area and discharged into the GW-11 pond, which receives groundwater pumped from extraction wells at the Seep Area and Athens Road Well Fields. The remaining IDW will be double-bagged in plastic trash bags and will be disposed as municipal trash. The FGD for IDW management is included in **Appendix A**.

4.5 Groundwater Sampling

4.5.1 Pre-field Activities

A site-specific HASP will be developed for the Downgradient Study Area and the planned field work. The existing NERT RI QAPP will be adapted to include the proposed Downgradient Study Area investigations, including the proposed groundwater sampling described in this GSP as well as future surface water and subsurface investigations.

Access to properties with groundwater wells included in this GSP will be obtained by AECOM. Property and well owners will be contacted to obtain permission for access. Once access is obtained, NDEP, USEPA, NERT, property owners, and well owners will be notified of the sampling schedule. The groundwater well locations will be visited to verify the location and accessibility of the wells and to document the physical condition of each well.

Groundwater well locations and elevation (surface and top of casing) will be surveyed by a licensed land surveyor. Locations will be referenced to the State Plan Coordinate System and elevations will be referenced to the North American Datum (NAD) 83 Nevada East Zone (2701) with vertical datum based on NAVD 88 referenced to the City of Henderson Benchmark network.

The depth to water and total depth of the well will be measured in all wells to be sampled consistent with procedures described in Section 4.5.3 below. A table summarizing the results of the well verification will be provided to NDEP and NERT.

4.5.2 Field Activities

Groundwater sampling will be conducted using the "low-flow" method (in which low volumes of water are purged with little or no drawdown, while allowing water quality field parameters to stabilize as specified in the field guidance document, if achievable between three successive measurements. If field parameters do not stabilize by the time six volumes have been purged, then final water quality parameters will be recorded and a sample of groundwater collected. Low-flow groundwater samples may be collected using a bladder pump. The pump intake will be positioned at the approximate midpoint of the well screen.

During groundwater sampling, a water quality meter (equipped with a flow-through cell) will be used during purging to track water quality field parameters and assess when stabilization of parameters has occurred. Samplers will conduct in-field measurements for depth to water; pH, electrical conductivity, dissolved oxygen, oxidation-reduction potential, turbidity and temperature of groundwater samples. An appropriate water quality meter, calibrated as recommended by the manufacturer, will be used. The FGD for low-flow groundwater sampling is included in **Appendix A**.

Groundwater samples obtained for total chromium (i.e., combined trivalent and hexavalent chromium) will be filtered in the field using a 0.45 micron filter. Samples designated for hexavalent chromium analysis only, will also be filtered using a 0.45 micron filter. Groundwater samples designated for hexavalent chromium analysis only will be analyzed within 24 hours of sample collection or the sample will be preserved by pH adjustment upon arrival at the laboratory (i.e., within 24 hours after sample collection) to allow for a longer holding time.

4.5.3 Water Level Measurements

During each monitoring event, groundwater monitoring wells will be sounded for depth to water from top of casing. An electronic sounder or interface probe, accurate to the nearest +/- 0.01 feet, will be used to measure depth to water in each well. The electronic sounder or interface probe will be lowered down the casing to the top of the water column, and the graduated markings on the probe wire or tape will be used to measure the depth to water from the surveyed point on the rim of the well casing.

5.0 Sample Designation, Handling and Analysis

In general, field sampling personnel and subcontracted analytical laboratories will handle samples in a manner to maximize data quality. Samples will be collected, handled, and stored in such a manner that they are representative of their original condition and chemical composition. Identification of samples and maintenance of custody are important elements that will be utilized to ensure samples characterize site conditions. All samples will be properly identified and maintained under chain-of-custody protocol to protect sample integrity. The following sections discuss the sample handling and custody requirements in detail. It should be noted that this information is also provided in the QAPP, and is included in this GSP for ease of reference by field staff during the investigation.

5.1 Sample Identification

To maintain consistency, a sample identification convention has been developed and will be followed throughout the implementation of the GSP. The sample identification numbers (IDs) will be entered onto the sample labels, field forms, chain-of-custody forms, logbooks, and other records documenting sampling activities.

The identification system for primary field samples from a groundwater well consist of the well ID followed by the sample date in YYYYMMDD format. For example, a groundwater sample collected from monitoring well HMW-1 on January 28, 2016, will be identified as HMW-1-20160128.

5.1.1 Field QA/QC Sample Identification Numbers

Field QA/QC samples and procedures are discussed in Section 5.8. The field QC sample codes that may be applied include:

- EB for Equipment Blanks;
- FB for Field Blanks;
- TB for Trip Blanks (note: Trip blanks are not required unless volatile organic compounds (VOCs) are included in the analytical suite); and
- FD for Field Duplicates.

VOCs will not be analyzed as part of this initial groundwater sampling event and TBs will, therefore, not be required. However, because future sampling events may include VOC analyses, this section includes the procedures for TBs, so this GSP can be readily adapted in case VOC analyses are required. Field QA/QC sample codes will be appended to the end of the primary sample ID that is represented by the field QA/QC sample.

An EB should be named for the sample collected immediately prior to the collection of the EB.

The FB and TB each represent a group of samples: a batch of 20 for the FB, and all samples within one sample cooler or other shipping container for the TB. Thus, the FB and the TB should be named after the first sample of the batch (for FB) or the first sample placed in the cooler or shipping container (for TB).

The FD represents the primary sample that is being duplicated; thus, the FD should be named after the corresponding primary sample. FDs are submitted blindly to the laboratory (i.e., not labeled as a duplicate).

For example, the first groundwater sample to be placed in a cooler is HMW-1-20160128. The sample is to be analyzed for VOCs, and a duplicate sample is collected. A TB is placed in the cooler with the sample, and an EB is collected immediately following the collection of the soil sample (after decontamination of sampling equipment). The associated field QA/QC samples will be identified as:

- HMW-1-20160128-EB (Equipment Blank);
- HMW-1-20160128-FB (Field Blank);
- HMW-1-20160128-FD (Field Duplicate); and
- HMW-1-20160128-TB (Trip Blank).

Field QA/QC samples and the frequencies of collection are summarized in Section 5.8 of this GSP and detailed in the QAPP.

5.2 Sample Labels

A sample label will be affixed to all sample containers sent to the analytical laboratory. Field personnel will complete an identification label for each sample with the following information written in waterproof, permanent ink:

- Client or Site name ("NDEP") and project number;
- Sample location and depth, if relevant;
- Unique sample identifier;
- Date and time sample collected;
- Filtering performed, if any;
- Preservative used, if any;
- Name or initials of sampler; and
- Analyses or analysis code requested.

The use of pre-printed sample labels is preferred in order to reduce sample misidentification problems due to transcription errors. Sample labels must be completed and affixed to the sample container in the field at the time of sample collection.

If errors are made on a sample label, corrections will be made by drawing a single line through the error and recording the correct information. Corrections will be dated and initialed.

5.3 Containers, Preservation, and Hold Time

The analytical methods, type of sample containers to be used for each sample type and analysis, preservation requirements for all samples, and holding times are provided in the QAPP.

Each lot of preservative and sampling containers will be certified as contaminant-free by the provider and/or the laboratory. The laboratories will maintain certification documentation in their files. All preserved samples will be clearly identified on the sample label and chain-of-custody form. If samples requiring preservation are not preserved, field records will clearly specify the reason for the discrepancy.

Groundwater sample containers will be placed in airtight plastic bags, if possible, and refrigerated or placed in a cooler with ice to chill and maintain a sample temperature of 4 degrees (± 2 degrees) Celsius.

Chemical activity continues in the sample until it is either analyzed or preserved. Once the sample has been preserved, the sample may be held for a period of time before analysis. The time from the collection of the sample to the analysis is defined as the holding time.

The laboratory will immediately notify the AECOM Project Manager and QA/QC Officer (as described in the QAPP) in the event that the analysis or reporting of results for initial groundwater samples may be delayed beyond the acceptable hold time of corresponding contingent sample(s).

5.4 Sample Handling and Transport

Proper sample handling techniques are used to ensure the integrity and security of the samples. Field parameters will be measured prior to sample collection in the field by the sampling crew and recorded in the field logbook and field data sheets. Samples for laboratory analysis will be transferred immediately to appropriate laboratory supplied containers in accordance with the following sample handling protocols:

- Don clean gloves before touching sample containers, and take care to avoid direct contact with the sample.
- Samples will be quickly observed for color, appearance, and composition and recorded as necessary.
- The sample container will be labeled before or immediately after sampling in accordance with Section 5.2 of this GSP.
- Groundwater sample containers will be placed in Ziploc™-type plastic bags. The samples will be placed in an ice chest and cooled to 4 degrees Celsius or lower for transport to the laboratory.
- All sample lids will stay with the original containers, and will not be mixed.
- Sample bottles will be wrapped in bubble wrap as necessary to minimize the potential for breakage or damage during shipment.
- The chain-of-custody form will be placed in a separate plastic bag and taped to the cooler lid or placed inside the cooler. A custody seal will be affixed to the cooler.

The Samplers are responsible for proper handling practices until receipt at the laboratory, or by the courier, at which time the Laboratory Project Manager assumes responsibility of the samples through analysis and ultimately to the appropriate disposal of samples. Sample handling procedures specific to the laboratory are described in the individual laboratory QA Manuals provided in the QAPP.

5.5 Sample Custody

Standard sample custody procedures will be used to maintain and document sample integrity during collection, transportation, storage, and analysis. Custody documents must be written in waterproof, permanent ink. Documents will be corrected by drawing one line through the incorrect entry, entering the correct information, and initialing and dating the correction. The AECOM Project Manager is responsible for proper custody practices so that possession and handling of individual samples can be traced from the time of collection until receipt at the laboratory, or by the courier. The Laboratory Project Manager is responsible for establishing and implementing a control system for the samples in their possession that allows tracing from receipt of samples to disposal.

The chain-of-custody form provides an accurate written record that traces the possession of individual samples from the time of collection in the field until they are accepted at the analytical laboratory. The chain-of-custody form also documents the samples collected and the analyses requested. The Sampler will record the following information on the chain-of-custody forms:

- Client and project number;
- Name or initials and signature of Sampler;

- Name of destination analytical laboratory;
- Name and phone number of Project Manager and Deputy Project Manager in case of questions;
- Unique sample identifier for each sample;
- Data and time of collection for each sample;
- Number and type of containers included for each sample;
- Analysis or analyses requested for each sample;
- Preservatives used, if any, for each sample;
- Sample matrix for each sample;
- Signatures of all persons having custody of the samples;
- Dates and times of transfers of custody;
- Shipping company identification number, if applicable; and
- Any other pertinent notes, comments, or remarks.

Unused lines on the form will be crossed out and initialed.

A sample is considered to be under the control of, and in the custody of, the responsible person if the samples are in their physical possession, locked or sealed in a tamper-proof container, or stored in a secure area.

The person who collects the sample is the initial custodian of the sample. Any transfers are documented on the chain-of-custody form by the individuals relinquishing and receiving the sample, along with their signature, and the date and time of transfer. This transfer must continue until the custody is released to a commercial carrier (i.e. FedEx), or the laboratory (either at the laboratory or to a laboratory-employed courier). If relinquished to a commercial carrier, the carrier assumes custody through their shipping receipt. A copy of the shipping receipt should be attached to the chain-of-custody form as a permanent part of the custody control. If the sample is relinquished to a laboratory courier, the courier will then need to relinquish the sample to the stationary laboratory upon arrival. Once the sample has arrived at the stationary laboratory, it must be entered into the sample custody control system of the laboratory. If the sample is further transported to a subcontracted laboratory, the laboratory will produce an internal chain-of-custody form that will be available upon request. Chain-of-custody forms will be maintained in the project file by AECOM and at the analytical laboratory.

To discourage tampering during transport, a custody seal will be placed on each cooler after the samples are packed. These consist of a security tape or label with the date and initial of the sampler or person currently in possession of the sample. Receiving personnel at the laboratory will note on the cooler receipt form whether or not the custody seals are intact.

5.6 Shipping Procedures

If shipping samples using a commercial courier is necessary, each container sent will have a separate chain-of-custody form. Samples collected during the investigation will be identified as environmental samples. Samples will be packed in the same manner as when being transported from the sampler to the laboratory, with the following changes:

- Dry ice is not allowed to be used to chill samples requiring commercial shipment.
- Extra packing material will be used to fill the coolers in order to limit movement within the container.
- Ice will be contained in zip-closure bags and the cooler will be lined with plastic as described below.

- Coolers containing ice and/or liquid samples will be lined with a plastic bag (such as a contractor garbage bag) to limit the potential for leaks in the event of ice bags leaking or sample container breakage. Precautions will be taken to prevent liquids leaking from sample coolers while in transit.
- Coolers will be closed and taped shut. If the cooler has a drain, it too will be closed and taped shut to prevent leaks.
- A minimum of two custody seals will be affixed to the front and side openings of the cooler so that the cooler cannot be opened without breaking a seal. The seals will be covered with wide clear tape so that the seals do not accidentally break in transit.
- Non-perishable samples collected on the weekend may be held for more than three days if there is no threat of exceeding hold times. If the samples require being chilled and maintained at a cool temperature, they will be stored under refrigeration and shipped the following work day.

5.7 Field Measurement and Laboratory Analytical Methods

Field measurement methods and laboratory analytical methods will be utilized to analyze samples during implementation of the GSP.

5.7.1 Field Measurement Methods

Samplers will conduct in-field measurements for depth to water; pH, conductivity, turbidity and temperature of groundwater samples. For groundwater field parameter measurements, an appropriate water quality meter, calibrated as recommended by the manufacturer, will be used. All meter calibrations and field measurements will be recorded on the appropriate field forms and/or in the field logbook.

5.7.2 Laboratory Analytical Methods

The project will involve the analysis of groundwater samples for the following constituents:

- Perchlorate (USEPA Method 314.0);
- Chlorate (USEPA Method 300.1);
- Chromium, Dissolved (USEPA Method 200.8 [ICP-MS]);
- Hexavalent Chromium, Dissolved (USEPA Method 218.7);
- Chloride (USEPA Method 300.0);
- Bromide (USEPA Method 300.0); and
- Total Dissolved Solids (Method SM 2540C).

Water samples for the initial groundwater sampling event will not be analyzed for cation/anion balance because the main purpose of the initial sampling is to assess the current concentration of perchlorate in groundwater at the locations sampled. Once the perchlorate concentrations are known, a subset of the wells will be identified for future routine groundwater monitoring, in which cation/anion balance may be added to the Field Sampling Plan for the Downgradient Study Area investigation.

The laboratory analytical methods that will be used to analyze samples are summarized in the QAPP. Additional information about each analytical method and sampling requirements such as containers, preservation, and hold times is provided in the QAPP. Analytical methods and laboratory QA/QC procedures are further detailed in the QAPP.

5.8 Field QA/QC Procedures

Field QA/QC samples that will be collected during the proposed investigation include FD samples, FBs, TBs, and EBs. The description and purpose of these samples is discussed in this section. In addition, matrix spike/matrix spike duplicate (MS/MSD) samples and laboratory control sample/laboratory control sample duplicate (LCS/LCSD) procedures are used as laboratory control measures, and while not defined as field QA/QC samples, they may require additional sample volume as described in Section 5.8.5.

5.8.1 Equipment Blanks

EB samples are used to assess the effectiveness of decontamination procedures. EB samples are obtained by filling decontaminated sampling equipment with reagent-grade DI water, sampling this water, and submitting the sample for analysis. Alternatively, DI water can be poured over or through the decontaminated sampling equipment and then collected and submitted for analysis. EBs will be collected at a frequency of one in every 20 samples and will be analyzed for the same suite of parameters as the primary sample to assess the effectiveness of decontamination procedures.

5.8.2 Field Blanks

FB samples are used to assess the presence of contaminants arising from field sampling procedures. FB samples are obtained by filling a clean sampling container with reagent-grade DI water, in the field at a sample location. The sample then is analyzed in the same manner as the primary sample. FB samples will be collected at a frequency of one in every 20 samples and will be analyzed for the same suite of parameters as the primary sample to assess potential background contamination or errors in the sampling process.

5.8.3 Trip Blanks

TB samples are used to assess the potential for cross-contamination of VOCs between samples during storage and shipment. TB samples are only necessary when VOCs are being analyzed in the groundwater samples. A TB sample consists of one or more sample containers that are prepared at the analytical laboratory by filling with reagent-grade DI water. The TB sample is added to the sample cooler or other shipping container as soon as the first primary sample is collected. The TB sample accompanies the primary samples to the laboratory and is analyzed using the same analytical method as the primary samples. VOCs are not part of the analytical program for this sampling event. As a result, TBs are not planned to be submitted to the laboratory. If the analytical program is revised to include VOCs, then TBs will be included in the samples sent to the laboratory.

5.8.4 Field Duplicates

The FD is a replicate sample collected as close as possible to the same time that the primary sample is collected and from the same location, depth, or source, and is used to document analytical precision. FD samples will be labeled and packaged in the same manner as primary samples but with “FD” appended to the sample ID. FDs will be collected at a frequency of one in every 10 primary samples and will be analyzed for the same suite of parameters as the primary sample. The relative percent difference between the field duplicate sample and the primary sample will be evaluated to assess the homogeneity of the sample matrix and to assess the reproducibility of laboratory and field sample collection techniques.

5.8.5 Matrix Spike/Matrix Spike Duplicates and Laboratory Control Samples/Laboratory Control Sample Duplicates

The MS/MSD is a laboratory control sample on which additional QA/QC analyses are performed in order to assess the effect of matrix interference on the analytical results. MS/MSD procedures will be performed on field samples at a frequency of one per 20 samples. Field samples to be used for MS/MSD analyses must be collected with a double sample volume. Similarly, LCS/LCSDs provide controls during laboratory analysis, and may also require additional sample volume to be collected in the field.

5.9 Data Validation

Data generated from sampling activities will undergo two levels of review. Approximately 90 percent of the data will be validated to NDEP Stage-2b, and approximately 10 percent of data will be validated to NDEP Stage-4, in accordance with the data validation requirements specified in the QAPP for the NERT Site RI/FS. Additional details regarding data validation are provided in the QAPP.

6.0 Schedule and Reporting

It is anticipated that the activities described in this GSP will begin in early to mid-March 2016 after the scope of work and the GSP has been approved by NDEP, USEPA, and NERT. After AECOM is granted access to the wells, it is estimated that the field verification activities (i.e., visit each well to ascertain physical condition of wells and water levels) will take approximately 1 week. Well sampling activities are estimated to take approximately 3 weeks to complete.

The water samples will be analyzed by TestAmerica at their laboratory in Irvine, California under standard turnaround time of 7 business days. Due to the restrictions in holding time (i.e., 24 hours), hexavalent chromium samples may be analyzed at Silver State Analytical Laboratories in Las Vegas, Nevada. Standard turnaround time for Silver State Analytical Laboratories is 10 business days. Analytical results are expected to be completed and final laboratory reports received within two weeks of submittal of the last sample or approximately 5 weeks from the start of sampling. TestAmerica will provide laboratory electronic data deliverable (EDD) files to AECOM in the same format as they provide to the other contractors (Ramboll Environ, and Tetra Tech) of the NERT team. Once the final laboratory results have been transmitted to AECOM, data validation will be performed, which is estimated to take 4 weeks.

Maps showing the potentiometric surface, along with perchlorate, chlorate, chromium, and total dissolved solids will be constructed to depict the current groundwater conditions and analyte concentrations within the Downgradient Study Area. Summary tables of the laboratory data will be prepared.

A technical memorandum summarizing the results of this groundwater evaluation will be prepared. The technical memorandum will include a brief description of field methods used and a summary of analytical results and maps. The technical memorandum will also include copies of the field data sheets, the final laboratory report and data validation summary report (DVSR).

A draft of the technical memorandum will be issued within approximately 3 weeks of completion of data validation, for review by NDEP, NERT, USEPA. Upon receipt of review comments, which will be consolidated into one comment table, the technical memorandum will be finalized and distributed to NDEP, NERT, USEPA, and other stakeholders for review. It is estimated that 6 weeks will be needed for review and comment by stakeholders.

A summary of the GSP task is provided below.

Task	Approximate Schedule
Field Verification Activities	1 week
Groundwater Sampling Activities	3 weeks
Laboratory Analysis	5 weeks from the start of groundwater sampling activities
Data Validation	4 weeks
Technical Memorandum	8 weeks

7.0 References

ENVIRON International Corporation (ENVIRON). 2012. Revised Interim Soil Removal Action Completion Report, Nevada Environmental Response Trust Site, Henderson, Nevada, August 2010 – November 2011. January. Revised September 28. NDEP approved December 17, 2012.

ENVIRON. 2014a. Field Sampling Plan, Revision 1, Nevada Environmental Response Trust Site; Henderson, Nevada. January. Revised July 2014.

ENVIRON. 2014b. Quality Assurance Project Plan, Revision 1, Nevada Environmental Response Trust Site, Henderson, Nevada, January. Revised July 2014.

Nevada Division of Environmental Protection (NDEP), 2010. Email from Sara Rairick, Lab Certification Officer, Nevada Division of Environmental Protection, re: Sterile Filtration Required for Perchlorate Sampling. July 9.

United States Environmental Protection Agency (USEPA). 1997. Test Methods for Evaluating Solid Waste, Physical/Chemical Methods (SW-846). Office of Solid Waste, Washington, DC 20460. June.

USEPA. 2001. EPA Requirements for Quality Assurance Project Plans (QA/R-5). March.

USEPA. 2006. Guidance on Systematic Planning Using the Data Quality Objectives Process (QA/G-4). February.

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Tables

Table 1 List of Wells Proposed for Sampling
NERT Remedial Investigation - Downgradient Study Area
Henderson, Nevada

Well ID	Well Owner	Property Owner	Screen Interval (feet, bgs)	Water-Bearing Zone	Lithology
AA-08	LWC	CCPCS	5 - 35	Shallow	Qal
AA-20	LWC	LWC	10 - 30	Shallow	Qal
AA-22	LWC	COH	11 - 31	Shallow	Qal
AA-23R	LWC	COH	20 - 45	Shallow	Qal
AA-26	LWC	SBT	32 - 52	Shallow	Qal
AA-30	LWC	US BOR	11.7 - 31.7	Shallow	Qal
COH-1	SNWA	US BOR	157.9 - 167.9	Middle	UMCf
COH-1A	SNWA	US BOR	10 - 20	Shallow	Qal
COH-2A	SNWA	US BOR	40 - 50	Shallow	Qal
COH2B1	COH	US BOR	TBD	TBD	TBD
DBMW-1	LWC	COH	19 - 49	Shallow	Qal/UMCf
DBMW-4	LWC	COH	10 - 20	Shallow	Qal/UMCf
DBMW-5	LWC	LWC	15 - 35	Shallow	UMCf
DBMW-6	LWC	LWC	30 - 50	Shallow	Qal/UMCf
DBMW-7	LWC	COH	50 - 70	Shallow	UMCf
DBMW-8	LWC	COH	47.5 - 67.5	Shallow	UMCf
DBMW-22	LWC	CCPCS	35 - 55	Shallow	UMCf
DM4	LWC	LWC	8 - 23	Shallow	Qal
DM5	LWC	LWC	7 - 22	Shallow	Qal
HM-1	LWC	COH	TBD	TBD	TBD
HM-2	LWC	COH	? - 36.89	Shallow	TBD
HM-3	LWC	COH	TBD	TBD	TBD
HSW-1	LWC	COH	? - 23.78	TBD	TBD
HSW-2	LWC	COH	TBD	TBD	TBD
LNDMW1	SNWA	CCPCS	TBD	TBD	TBD
LNDMW2	SNWA	CCPCS	TBD	TBD	TBD
MCF-05	LWC	LWC	221 - 231	Middle	UMCf
MCF-06A-R	LWC	LWC	333 - 373	Deep	UMCf
MCF-06B	LWC	COH	67 - 82	Shallow	UMCf
MCF-06C	LWC	COH	44 - 59	Shallow	UMCf
MCF-08A	LWC	CCPCS	350 - 370	Deep	UMCf
MCF-08B-R	LWC	CCPCS	96.5 - 136.5	Middle	UMCf
MCF-18A	LWC	COH	360 - 400	Deep	UMCf
MCF-19A	LWC	COH	320 - 360	Deep	UMCf
MCF-20A	LWC	LWC	340 - 380	Deep	UMCf
MCF-31A	LWC	US BOR	361 - 381	Deep	UMCf
MCF-31B	LWC	US BOR	210 - 230	Middle	UMCf
MW-02	COH	US BOR	? - 45	Shallow	TBD

Table 1 List of Wells Proposed for Sampling
NERT Remedial Investigation - Downgradient Study Area
Henderson, Nevada

Well ID	Well Owner	Property Owner	Screen Interval (feet, bgs)	Water-Bearing Zone	Lithology
MW-03	COH	COH	? - 35	Shallow	Qal
MW-04	COH	COH	? - 30	Shallow	Qal
MW-05	COH	COH	? - 66.7	Shallow	TBD
MW-06	COH	COH	? - 52	Shallow	TBD
MW-08	COH	COH	TBD	Middle	UMCf
MW-09	COH	COH	TBD	NA	TBD
MW-10	COH	COH	? - 60	Shallow	TBD
MW-11	COH	COH	? - 70	Shallow	TBD
MW-12	COH	COH	? - 61	Shallow	TBD
MW-13	COH	COH	? - 48	Shallow	Qal
MW-14	COH	CCPCS	? - 43	Shallow	TBD
MW-K8	AMPAC	LWC	? - 50	Shallow	Qal
PC-74	NERT	CCPCS	39.5 - 49.5	Shallow	Qal
PC-76	NERT	CCPCS	15 - 20	Shallow	Qal
PC-77	NERT	CCPCS	29.5 - 39.5	Shallow	Qal
PC-78	NERT	CCPCS	11.5 - 21.5	Shallow	Qal
PMW-7	AMPAC	CCPCS	20 - 40	Shallow	Qal/xMCF
PMW-8	AMPAC	CCPCS	21 - 41	Shallow	Qal/xMCF
RIT-06	AMPAC	CCPCS	32 - 42	Shallow	Qal
RIT-10	AMPAC	CCPCS	25 - 40	Shallow	Qal
UZO-17	AMPAC	CCPCS	17 - 47	Shallow	Qal/xMCf
W02	SNWA	US BOR	TBD	Middle	UMCf
WMW3.5N	SNWA	CCPCS	TBD	TBD	TBD
WMW4.9N	SNWA	CCPCS	TBD	TBD	TBD
WMW4.9S	SNWA	CCPCS	TBD	TBD	TBD
WMW5.58S	SNWA	US BOR	TBD	TBD	TBD
WMW5.5S	SNWA	US BOR	TBD	TBD	TBD
WMW5.7N	SNWA	US BOR	TBD	TBD	TBD
WMW5.85S	SNWA	US BOR	TBD	TBD	TBD
WMW6.0N	SNWA	US BOR	TBD	TBD	TBD
WMW6.0S	SNWA	US BOR	TBD	TBD	TBD
WMW6.15N	SNWA	CCPCS	TBD	TBD	TBD
WMW6.15S	SNWA	CCPCS	TBD	TBD	TBD
WMW6.2N	SNWA	CCPCS	TBD	TBD	TBD
WMW6.55S	SNWA	CCPCS	TBD	TBD	TBD
WMW7.8N	SNWA	CCPCS	TBD	TBD	TBD
MW-1	CGC	CGC	TBD	TBD	TBD
MW-2	CGC	CGC	TBD	TBD	TBD
MW-3	CGC	CGC	TBD	TBD	TBD
MW-4	CGC	CGC	TBD	TBD	TBD

Table 1 List of Wells Proposed for Sampling
NERT Remedial Investigation - Downgradient Study Area
Henderson, Nevada

Well ID	Well Owner	Property Owner	Screen Interval (feet, bgs)	Water-Bearing Zone	Lithology

Notes:
NDEP recommended the inclusion of the following wells to be sampled in the Groundwater Sampling
AMPAC = American Pacific
bgs = below ground surface
LWC = LandWell Company
US BOR = United States Bureau of Reclamation
CCPCS = Clark County Parks and Community Services
CGC = Chimera Golf Course
COH = City of Henderson
NA = Not available
Qal = Quaternary Alluvium
SBT = School Board of Trustees
SNWA = Southern Nevada Water Authority
TBD = to be determined
UMCf = Upper Muddy Creek formation
xMCf = Transitional (or reworked) Muddy Creek formation

Table 2 Analytical Plan for Groundwater Samples

NERT Remedial Investigation - Downgradient Study Area, Henderson, Nevada

Analytes	Matrix	Analytical Method	Analytical Laboratory
Perchlorate	Water	EPA Method 314.0 (1)	TestAmerica (Irvine, CA)
Chlorate	Water	EPA Method 300.1	TestAmerica (Irvine, CA)
Chromium (dissolved)	Water	EPA Method 200.8 (ICP-MS) (2)	TestAmerica (Irvine, CA)
Hexavalent Chromium (dissolved)	Water	EPA Method 218.7 (2)	Silver State Analytical (Las Vegas, NV)
Total Dissolved Solids (TDS)	Water	SM 2540C	TestAmerica (Irvine, CA)
Chloride	Water	EPA Method 300.0	TestAmerica (Irvine, CA)
Bromide	Water	EPA Method 300.0	TestAmerica (Irvine, CA)

Notes:

EPA = United States Environmental Protection Agency

SM = Standard Method

All groundwater and surface water samples will be analyzed for the constituents listed above.

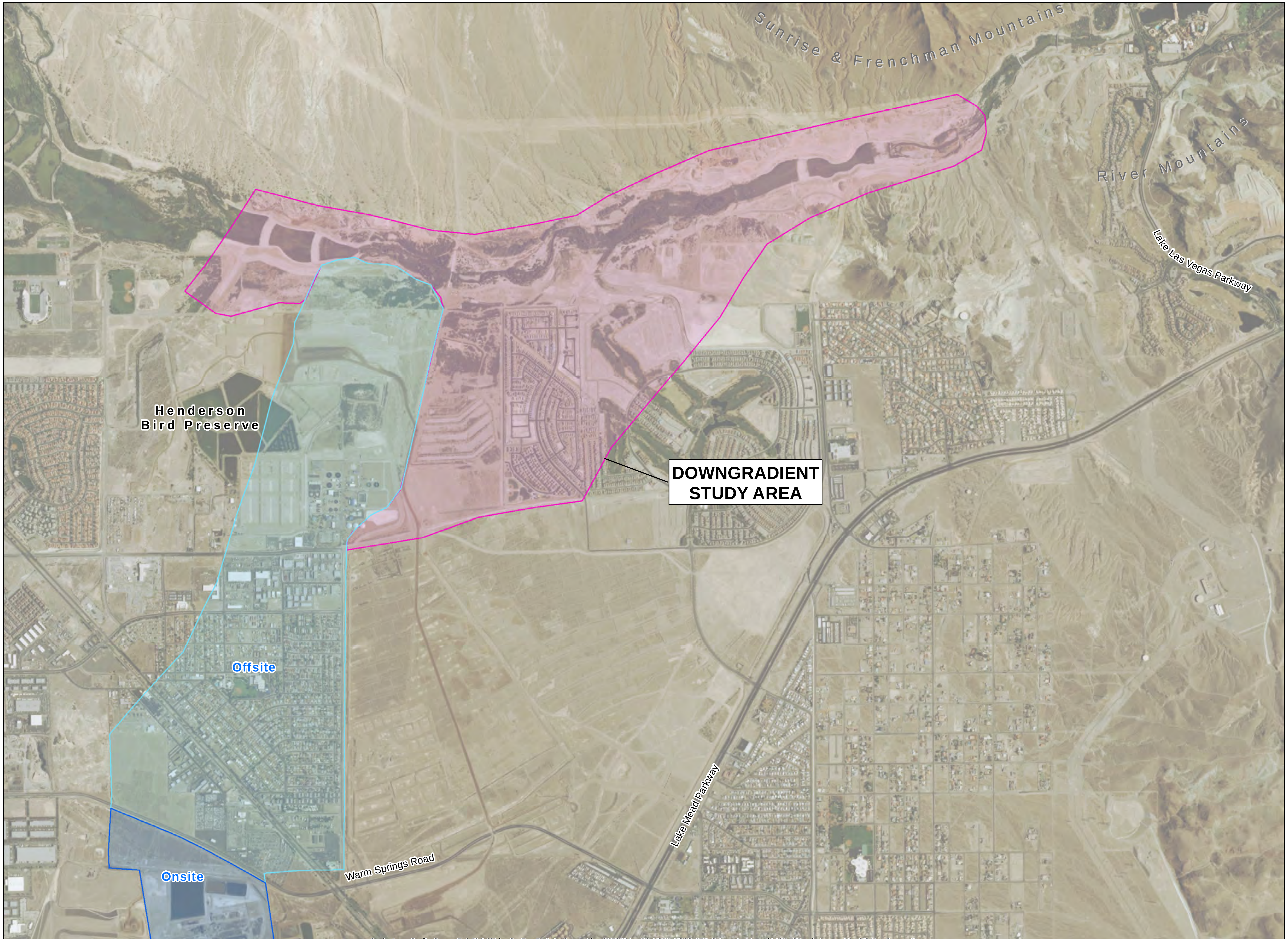
(1) For this NERT RI Downgradient Study Area, field-filtering of surface water samples for perchlorate analysis is not required (NDEP, 2015).

(2) Sampling activities for the NERT RI Study Area include field-filtering surface water samples analyzed for chromium and hexavalent chromium using a 0.45 micron filter.

Sources:

NDEP. 2015. Email from James Dotchkin, Chief Bureau of Industrial Site Cleanup, Nevada Division of Environmental Protection, re: Sterile Filtration Not Required for NERT Regional Groundwater RI Perchlorate Samples, November 18.

Figures



OVERVIEW MAP

Legend

- NERT Downgradient Study Area
- NERT Off-site Study Area
- NERT On-site Study Area

NORTH

0 2,000

Feet

Scale 1:24,000

1 inch = 2,000 feet

NERT
Remedial Investigation
Downgradient Study Area

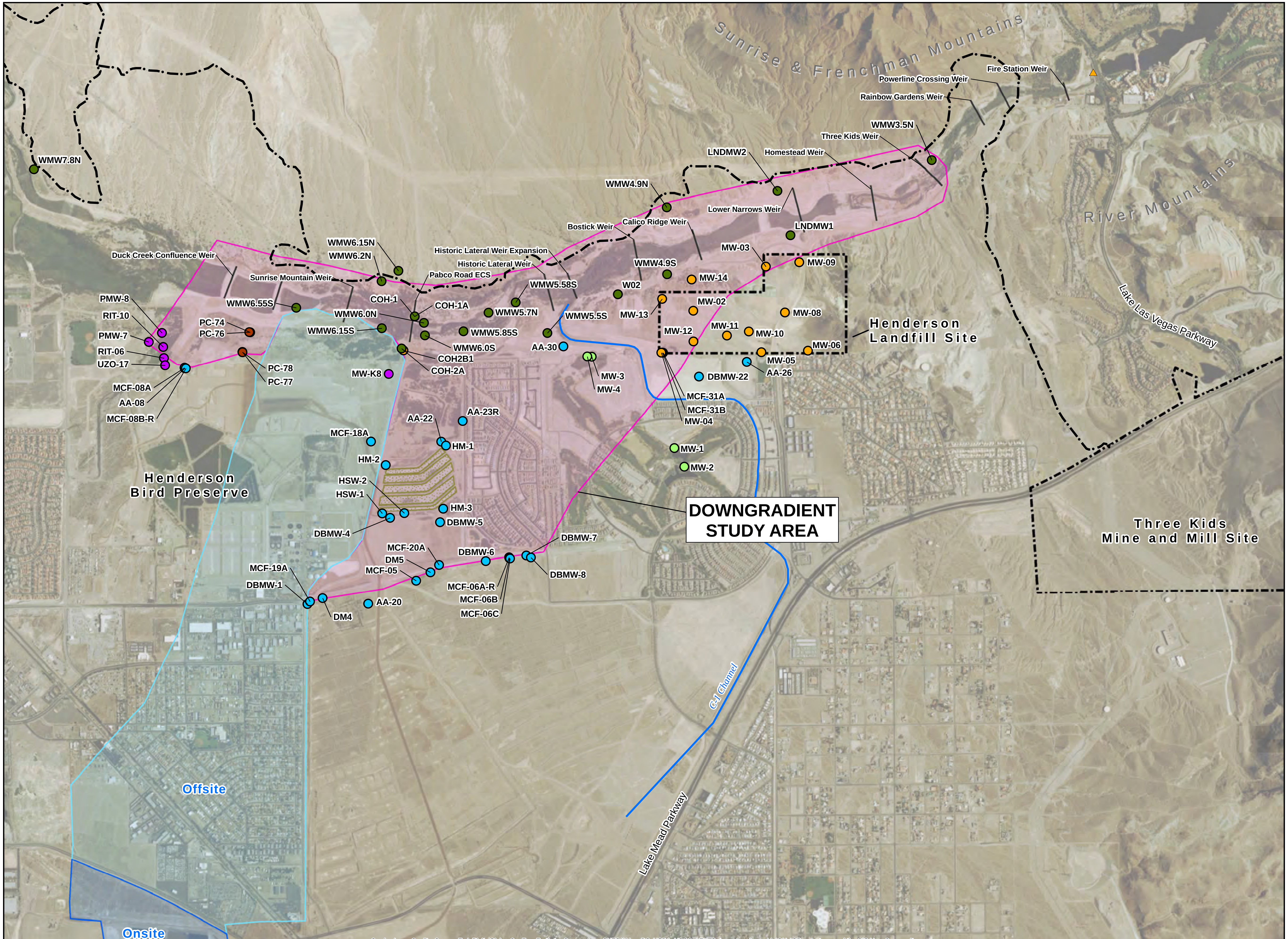
DOWNGRADIENT STUDY AREA LOCATION MAP

Date: 2/29/2016 Project: 60477365

AECOM

Figure 1

Path: J:\Client-Projects\NDEP\NERT_GW_RI\900-CAD\00-GIS\MXDs\Downgradient_Study_Area_20160229.mxd | Coordinate System: NAD 1983 StatePlane Nevada East FIPS 2701 Feet | User: ScopM1



OVERVIEW MAP

Legend

- American Pacific
- Chimera Golf Course
- City of Henderson
- LandWell Company
- NERT
- Southern Nevada Water Authority
- Lake Las Vegas Intake
- Wetlands Trail
- Channels
- Evaporation Basin
- Weir

NORTH

0 2,000 Feet

Scale 1:24,000
1 inch = 2,000 feet

NERT
Regional Groundwater
Downgradient Study Area

GROUNDWATER SAMPLING LOCATIONS

Date: 2/29/2016 Project: 60477365

AECOM

Figure 2

Path: J:\Client-Projects\NDEP\NERT_GW_RI\900-CAD\00-GIS\MXDs\GW_Sampling_Locations_20160229.mxd | Coordinate System: NAD 1983 StatePlane Nevada East FIPS 2701 Feet | User: jang_seo

Appendix A

Field Guidance Documents

FIELD GUIDANCE DOCUMENT NO. 001
MANAGING INVESTIGATION-DERIVED WASTE

Prepared by ………………………..	Elysha Anderson, PE
Peer Reviewed by ……………..	Dan Clark
Approved by ……………………..	John M. Pekala, PG, CEM
Applicable to ……………………	Nevada Environmental Response Trust Site Henderson, Nevada
Effective date …………………..	January 24, 2014
Revision Notes …………………	0 First Issuance
Documents used as reference during preparation ……………..	Code of Federal Regulations (CFR), Title 40, Part 261 CFR, Title 49, Parts 172, 173, 178, and 179 Nevada Revised Statutes (NRS) Chapter 459.400 US Environmental Protection Agency (USEPA), *Guide to Management of Investigation-Derived Waste*, Publication 9345.3-03FS, dated April 1992

Table of Contents

1.0 INTRODUCTION

This Field Guidance Document (FGD) describes procedures for managing investigation-derived waste (IDW) at the Nevada Environmental Response Trust Site that will be conducted by or under the oversight of ENVIRON personnel. Although this FGD describes procedures for managing IDW for this project, it should be understood that there may be details of this type of work not specifically discussed in this FGD that would be followed by personnel trained in these techniques. To ensure that management of IDW is performed safely and completely, ENVIRON personnel involved in field activities should be sure that they understand the scope of work and the level of detail necessary for each field activity prior to mobilizing to perform the work.

This FGD is intended as a guidance document and does not supersede ENVIRON Health and Safety procedures or Site-Specific Health and Safety Plan (HASP) requirements. All ENVIRON employees shall follow the guidelines, rules, and procedures contained in site-specific HASPs prior to adhering to any procedures recommended in this FGD. The ENVIRON Project Manager and Task Leader must ensure that all project personnel review and sign the applicable HASP, and that the completed HASP and relevant project information is maintained in the project file. The signatures of the Project Manager and Task Leader indicate approval of the methods and precautions outlined in the HASP. The ENVIRON Project Manager and Task Leader will also be responsible for seeing that project personnel involved in field activities follow the procedures outlined in this and other applicable FGDs.

All personnel performing on-site operations with the potential for exposure to hazardous substances or health hazards are required to be 40-hour trained in accordance with Code of Federal Regulations (CFR) 1910.120 and will meet the personnel training requirements in accordance with 29 CFR 1910.120(e).

Environmental investigation activities such as drilling and sampling may generate solid, liquid, and other wastes that must be properly managed. This FGD describes the procedures to be followed for handling and managing routine IDW, including:

- Solid waste, both hazardous and non-hazardous (e.g., soil cuttings, contaminated debris or equipment)
- Liquid waste, both hazardous and non-hazardous (e.g., purge water, rinse water from decontamination)
- Personal Protective Equipment (PPE) (e.g., gloves, spent respirator cartridges, chemical-resistant coveralls)

This FGD is not applicable to the handling of flammable liquid wastes such as non-aqueous phase liquids (NAPL), which require additional protective measures. Nor is this FGD designed to address management of industrial wastes unrelated to an environmental investigation. This FGD describes the procedures for assisting clients with on-site handling and managing of IDW; however, disposal of IDW is the responsibility of the client.

The procedures presented herein are intended to be of general use and may be supplemented by a Work Plan, Sampling and Analysis Plan, Quality Assurance Project Plan, and/or a Health and Safety Plan. Some of these procedures may not be required depending on the specific scope of work being conducted. As the work progresses, and if warranted, appropriate revisions may be made by the Task Manager. Procedures in this protocol may be superseded by applicable regulatory requirements.

2.0 EQUIPMENT/MATERIALS

Equipment and materials needed to conform to this FGD include:

- Health and Safety Plan (HASP)
- Site information (maps, contact numbers, previous field logs, etc.)
- Containers for waste (e.g., 55-gallon open and closed top drums, or covered roll-off bins) and material to cover waste to protect from weather
- Fire extinguisher and spill containment equipment
- Equipment for transferring solid wastes (e.g., shovels, buckets, front-end loaders, etc.)
- Equipment for transferring liquid wastes (e.g., pumps, portable tanks, etc.)
- Secondary containment pallet for drums containing liquids
- Equipment for moving containers (e.g., drum dolly, truck with lift gate, etc.)
- Air monitoring equipment (i.e., air monitoring pumps, Photoionization Detector (PID), Flame Ionization Detector (FID), other as required by the HASP)
- Water quality meters for measuring temperature, pH, and specific electrical conductance
- Sampling equipment (trowels, telescoping sampling arm, dipper or coliwasa, sample pump and tubing, etc.)
- Certified-clean sample containers and preservation supplies, sample labels, ZiplocTM bags
- Cooler with ice
- Decontamination supplies (e.g., phosphate-free detergent, alconox, distilled water)
- Tool kit with appropriate tools (socket wrench set, pry bar, drum wrench)
- Hazardous/non-hazardous waste drum labels
- Permanent marking pens
- Plastic garbage bags, ZiplockTM storage bags, roll of plastic sheeting
- PPE (Long-sleeved shirt and pants, steel-toed boots, hardhat, nitrile gloves, safety glasses with side sheets, etc.)

- Field Forms (If the project requires it, a project-specific Field Logbook may substitute for the following)
  - *Field Investigation Daily Log*

3.0 PROCEDURES

Several types of waste are generated during site investigations that may require special handling methods. These include solid, liquid, and used PPE. The storage and handling of these materials is discussed below.

3.1 Solid Waste

Soil cuttings and drilling mud generated during investigation activities shall be kept on-site in containers. Covers should be included on the containers and must be secured at all times and only open during filling activities. The containers shall be labeled in accordance with this FGD. An inventory containing the source, volume, and description of material put in the containers shall be logged on prescribed forms and kept in the project file.

3.2 Liquid Waste

Groundwater generated during monitoring well development, purging, and sampling can be collected in truck-mounted containers and/or other transportable containers (i.e., 55-gallon drums). Only closed-top drums will be used for storing liquid wastes; open-top drums are generally not appropriate containers for liquids. Bungs on drums must be secured at all times and only open during filling or pumping activities. The containers shall be labeled in accordance with this FGD. Waste that is generated during equipment decontamination shall be collected in a separate container. All waste containers shall be properly accounted for through an inventory process.

3.3 Personal Protective Equipment (PPE)

PPE that is generated throughout investigation activities shall be placed in plastic garbage bags and stored in secure containers. The containers shall be properly sealed and labeled according to this FGD. If the solid or liquid waste is characterized as hazardous waste, then the corresponding PPE should also be disposed as hazardous waste. If not, all PPE should be disposed as non-hazardous waste at an appropriate facility. Trash that is generated as part of field activities may be disposed of in regular collection facilities as long as the trash was not exposed to hazardous media.

3.4 Waste Container Labeling

For situations where the waste characteristics are known, the waste containers should be packaged and labeled in accordance with state and federal regulations that govern the labeling of waste. General labeling requirements are discussed below.

The following information shall be placed on all non-hazardous waste labels:

- Description of waste (i.e., purge water, soil cutting);
- Contact information (i.e., contact name and telephone number); and
- Date when the waste was first accumulated.

The following information shall be placed on all hazardous waste labels:

- Description of waste (i.e., purge water, soil cutting);
- Generator information (i.e., name, address, contact telephone number);
- EPA identification number (supplied by on-site client representative); and
- Date when the waste was first accumulated.

When the final characterization of a waste is unknown, a notification label should be placed on the drum with the words "waste characterization pending analysis" (or similar) and the following information included on the label:

- Description of waste (i.e., purge water, soil cutting);
- Generator information (i.e., contact name and telephone number);
- Date when the waste was first accumulated.

Once the waste has been characterized, the label should be changed as appropriate for a non-hazardous or hazardous waste.

Waste labels should be constructed of a weatherproof material and filled out with a permanent marker to prevent being washed off or becoming faded by sunlight. It is recommended that waste labels be placed on the side of the container, since the top is more subject to weathering.

However, when multiple containers are accumulated together, it also may be helpful to include duplicate labels on the top of the containers to facilitate organization and disposal. Each container of waste generated shall be recorded in the field notebook used by the person responsible for labeling the waste. After the waste is disposed of, either by transportation off-site or disposal on-site in an approved disposal area, an appropriate record shall be made in the same field notebook to document proper disposal of the IDW.

3.5 Waste Characterization

Waste characterization will be performed to determine if the IDW generated is a hazardous waste as defined by federal and state regulations. Waste characterization will be performed through the use of existing information and without additional testing if the existing information is sufficient to make a professional judgment (e.g., manifests, Material Safety Data Sheets, preliminary assessments, previous test results, knowledge of the waste generation process, direct observation of the IDW for discoloration, odor or other indicators of contamination). If existing information is not available to properly characterize the IDW, testing will be performed using USEPA-recommended methods described in SW 846: Test Methods for Evaluating Solid Waste Physical/Chemical Methods, or other methods as applicable.

Discrete samples collected during the environmental investigation may be used for waste characterization by comparing sample results to federal hazardous waste characteristic thresholds. The Toxicity Characteristic Leaching Procedure (TCLP) is the threshold based on Federal guidelines. This applies to organic as well as inorganic compounds.

Solid IDW concentrations can be compared to twenty times the established federal TCLP (20xTCLP) values. The 20xTCLP values is generally regarded as a threshold level for requiring additional leach testing to characterize the toxicity characteristics of a waste.

Acid leach testing may be performed following the federal TCLP for comparison with the TCLP value. The TCLP method uses an acetic acid buffer solution as the extraction fluid. The mixing is done for 18 hours during the TCLP test. The dilution factor is 20x for the TCLP test. If a sample has a total metal concentration less than 20x its TCLP value, it cannot fail with respect to the TCLP index even if the compound is totally soluble; hence, the comparisons to 20x TCLP values.

3.6 Waste Accumulation On-site

The accumulation of IDW on-site is the responsibility of the client and/or the site owner. The following procedures should be followed for accumulation of IDW.

Solid, liquid, or PPE waste generated during investigation activities that are classified as nonhazardous or “characterization pending analysis” should be disposed of as soon as possible by the client. Until disposal, such containers should be inventoried, stored as securely as possible, and inspected regularly, as a general good practice.

Solid, liquid, or PPE waste generated during investigation activities that are classified as hazardous shall not be accumulated on-site longer than 90 days. All hazardous waste containers shall be stored in a secured storage area. The following requirements for the hazardous waste storage area must be implemented:

- Proper hazardous waste signs shall be posted as required by any state or federal statutes that may govern the labeling of waste;
- Secondary containment to contain spills;
- Spill containment equipment must be available;
- Fire extinguisher; and
- Adequate aisle space for unobstructed movement of personnel.

Weekly storage area inspections shall be performed and documented to ensure compliance with these requirements. Throughout the project, an inventory shall be maintained to itemize the type and quantity of the waste generated.

3.7 Waste Sampling and Profiling

The waste material will be profiled and approval will be received before transportation and disposal is arranged. Final determination of the disposal site will be based on approval from the disposal facility. The facility may require profiling of the containerized IDW including collection of additional samples from the containers themselves. The following procedures will be followed for sampling IDW containers.

In general, one composite sample will be collected using a trowel or coring device from each large container or from a group of drums containing equivalent solid wastes. Small samples of soil cuttings or drill mud will be taken from several locations and depths of the handling containers and placed in sampling jars. Composite samples should not be collected in a manner to dilute high concentration wastes with low concentration wastes. Grab water samples will be collected using a dipper or composite liquid waste sampler or “coliwasa.” Sampling handling and custody procedures will be followed as described in Section 7 of this SOP. Documentation of the sampling will be performed in accordance with the procedures outlined in Section 8 herein.

If a container is known or suspected to contain a hazardous waste based on the initial characterization, the applicable procedures outlined in USEPA document, Samplers and Sampling Procedures for Hazardous Waste Streams (EPA-600/2-80-018) will be followed.

3.8 Waste Transport

Non-hazardous or unclassified waste that is presumed to be non-hazardous or non-designated waste may be transported on-site to a waste accumulation area using appropriate tools such as a drum dolly or a truck with a lift-gate. Containers must be properly closed during transport and care must be taken to secure the containers so they do not move in an uncontrolled manner.

Hazardous waste may be moved on-site using the same precautions as described above. However, it may not be transported using a vehicle in the public right-of-way. A state-certified hazardous waste hauler shall transport all wastes classified as hazardous. Typically, the facility receiving any waste can coordinate a hauler to transport the waste. Shipped hazardous waste shall be disposed of in accordance with all RCRA/USEPA requirements. All waste manifests or bills of lading will be signed either by the client or the client’s designee. In general, ENVIRON personnel should not sign client manifests.

3.9 Waste Disposal

The disposal of IDW is the responsibility of the client. This section is for assisting the client in IDW disposal. All waste generated during field activities will be stored, transported, and disposed of according to applicable state, federal, and local regulations. All wastes classified as hazardous will be disposed of by the client at a licensed treatment storage and disposal facility or managed in other approved manners.

Solid, liquid, and PPE waste will be characterized for disposal through the use of client knowledge, laboratory analytical data created from soil or groundwater samples gathered during the field activities, and/or composite samples from individual containers.

In general, waste disposal should be carefully coordinated with the facility receiving the waste. Facilities receiving waste have specific requirements that vary even for non-hazardous waste, so characterization should be conducted to support both applicable regulations and facility requirements.

3.10 Equipment Decontamination

The equipment used to transfer wastes, all sampling equipment, and water quality meters will be decontaminated by the following procedures:

- The sampling and waste transferring equipment (shovels, buckets, pumps) will be hand washed with phosphate-free detergent and a scrubber, then thoroughly rinsed with distilled water, or steam-cleaned.
- Water quality meter sensors will be rinsed with distilled water between sampling locations. No other decontamination procedures are necessary or recommended for these meters since they are sensitive instruments. After sampling, the meters must be cleaned and maintained per the manufacturer's requirements.
- Decontamination water will be collected and stored on-site for future disposal by the client unless other arrangements have been made.

3.11 Sample Handling and Custody

Samples (if required for waste characterization) will be collected, handled, and stored in such a manner that they are representative of their original condition and chemical composition. Identification of samples and maintenance of custody are important elements that must also be utilized to ensure samples characterize site conditions. All samples will be properly identified and maintained under chain-of-custody protocol to protect sample integrity. The following sections discuss the sample handling and custody requirements.

3.11.1 Sample Identification

To maintain consistency, a sample identification convention including unique identifiers for all groundwater and QC samples must be developed and followed throughout the project. The sample identifiers will be entered onto the sample labels, field forms, chain-of-custody forms, and other records documenting sampling activities.

3.11.2 Sample Labels

A sample label will be affixed to all sample containers sent to the analytical laboratory. Field personnel will complete an identification label for each sample with the following information written in waterproof, permanent ink:

- Client and project number
- Sample location and depth, if relevant
- Unique sample identifier
- Date and time sample collected
- Filtering performed, if any
- Preservative used, if any
- Name or initials of sampler
- Analyses or analysis code requested

The use of pre-printed sample labels is preferred in order to reduce sample misidentification problems due to transcription errors. Sample labels must be completed and affixed to the sample container in the field at the time of sample collection.

If errors are made on a sample label, corrections will be made by drawing a single line through the error and recording the correct information. Corrections will be dated and initialed.

3.11.3 Containers, Preservation, and Hold Time

Each lot of preservative and sampling containers will be certified as contaminant-free by the supplier. All preserved samples will be clearly identified on the sample label and Chain-of-Custody form. If samples requiring preservation are not preserved, field records will clearly specify the reason for the discrepancy.

Chemical activity continues in the sample until it is either analyzed or preserved. Once the sample has been preserved, the sample may be held for a period of time before analysis. The time from the collection of the sample to the analysis is defined as the holding time. The holding time varies depending on the media being sampled and the analyses being performed. The collection, preservation, and analysis of samples must be conducted to avoid exceeding relevant holding times.

3.11.4 Sample Handling and Transport

Proper sample handling techniques are used to ensure the integrity and security of the samples. Samples for field measured parameters will be analyzed immediately in the field and recorded in the appropriate field forms. Samples for laboratory analysis will be transferred immediately to appropriate laboratory supplied containers in accordance with the following sample handling protocols:

- Don clean gloves before touching any sample containers, and take care to avoid direct contact with the sample;
- Samples will be quickly observed for color, appearance, and composition and recorded as necessary;
- The sample container will be labeled before or immediately after sampling;
- Sample containers and liners will be capped with Teflon®-lined caps before being placed in Ziploc™-type plastic bags. The samples will be placed in an ice chest kept at 4 °C for transport to the laboratory.
- All sample lids will stay with the original containers, and will not be mixed.
- Sample bottles will be wrapped in bubble wrap as necessary to minimize the potential for breakage during shipment.
- The *Chain-of-Custody* form will be placed in a separate plastic bag and taped to the cooler lid or placed inside the cooler. A custody seal will be affixed to the cooler if the samples are to be shipped by commercial carrier. For shipped samples, U.S. Department of Transportation shipping requirements will be followed and the sample shipping receipt will be retained in the project files as part of the permanent Chain-of-Custody document.

3.11.5 Sample Chain of Custody

Sample chain-of-custody procedures will be used to maintain and document sample integrity during collection, transportation, storage, and analysis. A sample is considered to be under the control of, and in the custody of, the responsible person if the samples are in their physical possession, locked or sealed in a tamper-proof container, or stored in a secure area.

The *Chain-of-Custody* form provides an accurate written record that traces the possession of individual samples from the time of collection in the field until they are accepted at the analytical laboratory. The Chain-of-Custody form also documents the samples collected and the analyses requested. The sampler will record the following information on the Chain-of-Custody forms:

- Client and project number
- Name or initials and signature of sampler
- Name of destination analytical laboratory
- Name and phone number of Project Leader in case of questions
- Unique sample identifier for each sample
- Data and time of collection for each sample
- Number and type of containers included for each sample
- Analysis or analyses requested for each sample

- Preservatives used, if any, for each sample
- Sample matrix for each sample
- Any filtering performed, if applicable, for each sample
- Signatures of all persons having custody of the samples
- Dates and times of transfers of custody
- Shipping company identification number, if applicable
- Any other pertinent notes, comments, or remarks

Blank spaces on the Chain-of-Custody will be crossed out and initialed by the field sampler between the last sample listed and the signatures at the bottom of the sheet.

The field sampler will sign the Chain-of-Custody and will record the time and date at the time of transfer to the laboratory or an intermediate person. A set of signatures is required for each relinquished/received transfer, including internal transfer. The original imprint of the Chain-of-Custody will accompany the sample containers and a duplicate copy will be kept in the project file.

If the samples are to be shipped to the laboratory, the original *Chain-of-Custody* relinquishing the samples will be sealed inside a plastic bag within the ice chest, and the chest will be sealed with custody tape that has been signed and dated by the last person listed on the *Chain-of-Custody*. U.S. Department of Transportation shipping requirements will be followed and the sample shipping receipt will be retained in the project files as part of the permanent *Chain-of-Custody* document. The shipping company (e.g., Federal Express, UPS) will not sign the *Chain-of-Custody* forms as a receiver; instead the laboratory will sign as a receiver when the samples are received.

4.0 PRECAUTIONS

Certain precautions should be taken to ensure safety during the implementation of this FGD. It is important to always remain alert and aware of your surroundings.

The activities described in this FGD require the implementation of a site-specific Health and Safety Plan to inform personnel of the hazards associated with this work and to describe the methods that will be employed to mitigate those hazards. The HASP must be prepared and approved by the Project Manager, Task Leader and the Project Health and Safety Coordinator prior to initiating field work.

5.0 RECORDKEEPING

Information collected during the performance of these procedures may be recorded on individual field forms. If the project requires it, a project-specific Field Logbook may replace any of the individual field forms with the exception of the Chain-of-Custody form. Following review by the Task Manager, the original field records will be kept in the project file. The following forms may be used to document the field activities:

- *Field Investigation Daily Log*
- *Equipment Calibration Log*
- *Chain-of-Custody*

The *Field Investigation Daily Log* will be completed for each day of fieldwork containing (at a minimum) the times and descriptions of the work performed, the activities of any contractors and/or visitors on-site, arrival and departure times for all involved, and any other pertinent information. For larger projects, or when otherwise deemed appropriate by the Task Manager, this information may alternatively be recorded in a field logbook. In these cases, a separate Field Logbook must be used for each project or site.

The *Equipment Calibration Log* will be used to document the calibration and status of any measuring instruments used in the field, e.g., PID/FID, water level measuring device, water quality meters, etc. The frequency and method of calibration will depend on the instrument. Any instruments used will be used in accordance with the factory-provided operating and/or service manuals.

Locations and unique identification of samples collected will be recorded on the *Field Investigation Daily Log*, a site map, and/or other appropriate forms.

Sample names, date/times, analyses to be performed and other pertinent information will be recorded on the *Chain-of-Custody* form as a means of identifying and tracking the samples.

FIELD GUIDANCE DOCUMENT NO. 006
LOW-FLOW GROUNDWATER SAMPLING

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Applicable to	Nevada Environmental Response Trust Site Henderson, Nevada
Effective date	January 24, 2014
Revision Notes	0 First Issuance
Documents used as reference during preparation	United States Environmental Protection Agency (USEPA) *Standard Operating Procedure for Low-Stress (Low Flow)/Minimal Drawdown Ground-Water Sample Collection*, dated 2002.

Table of Contents

1.0 INTRODUCTION

This Field Guidance Document (FGD) describes procedures for low-flow groundwater sampling at the Nevada Environmental Response Trust Site that will be conducted by or under the oversight of ENVIRON personnel. Although this FGD describes procedures for low-flow groundwater sampling for this project, it should be understood that there may be details of this type of work not specifically discussed in this FGD that would be followed by personnel trained in these techniques. To perform this work in a safe and competent manner, ENVIRON personnel involved in field activities should be sure that they are trained in those field activities they are tasked with, and they understand the scope of work and the level of detail necessary for each field activity prior to mobilizing to perform the work.

This FGD is intended as a guidance document and does not supersede ENVIRON Health and Safety procedures or Site-Specific Health and Safety Plan (HASP) requirements. All ENVIRON employees shall follow the guidelines, rules, and procedures contained in site-specific HASPs prior to adhering to any procedures recommended in this FGD. The ENVIRON Project Manager and Task Leader must have project personnel review and sign the applicable HASP, and maintain the completed HASP and relevant project information in the project file. The signatures of the Project Manager and Task Leader indicate approval of the methods and precautions outlined in the HASP. The ENVIRON Project Manager and Task Leader will also be responsible for seeing that project personnel involved in field activities follow the procedures outlined in this and other applicable FGDs.

All personnel performing on-site operations with the potential for exposure to hazardous substances or health hazards are required to be 40-hour trained in accordance with Code of Federal Regulations (CFR) 1910.120 and will meet the personnel training requirements in accordance with 29 CFR 1910.120(e).

2.0 EQUIPMENT/MATERIALS

Equipment and materials needed to conform to this FGD include:

- Health and Safety Plan
- Site information (maps, contact numbers, etc.)
- Well information (previous water levels, well depths and screen intervals, previous purge logs, etc.)
- Electronic water level meter (Solinst or similar)
- Photoionization Detector (PID) and/or Flame ionization detector (FID)
- Adjustable-rate sampling bladder pump capable of rates <0.5 liters per minute (e.g., QED Sample Pro); other pumps may be acceptable, but must be approved by the Project Manager and/or Task Leader prior to use
- Bladders for sample pump

- Pump controller with or without on-board air compressor (If no on-board compressor, have a stand-alone air compressor and/or nitrogen tanks for operating bladder pumps
- Sample tubing (Teflon® or Teflon®-lined tubing for sampling organic compounds)
- Multi-parameter meter (e.g. YSI 556 Multi-Parameter Meter or equivalent) with flow through cell capable of measuring (at a minimum) temperature, pH, specific electrical conductance (SEC), dissolved oxygen (DO), and oxidation-reduction potential (ORP)
- Turbidity meter
- In-line filters (if required, e.g., for dissolved metals)
- Certified-clean sample containers and preservation supplies, sample labels, Ziploc™ bags
- Cooler with ice
- Decontamination supplies (e.g. phosphate-free detergent, distilled water)
- Tool kit with appropriate tools (socket wrench set, pry bar, Dolphin locks/keys)
- Drum(s) to collect purged water and decontamination water
- Drum labels
- PPE typically will consist of:
  - Long-sleeved shirt and long pants
  - Steel-toed boots
  - Hardhat
  - Nitrile gloves
  - Safety glasses with side shields
  - Other as required by the site-specific Health and Safety Plan
- Field Forms
  - *Field Investigation Daily Log*
  - *Water Level Measurement Log*
  - *Low-Flow Purging and Sampling Log*
  - *Equipment Calibration Log*
  - *Chain-of-Custody*

3.0 METHODOLOGY

This FGD has been prepared in accordance with the United States Environmental Protection Agency (USEPA) Standard Operating Procedure for Low-Stress (Low Flow)/Minimal Drawdown Ground-Water Sample Collection, dated 2002. This guidance document is included as Attachment 3 of the Ground-Water Sampling Guidelines for Superfund and RCRA Project Managers.

Unlike traditional purging methods, low-flow purging and sampling does not require the removal of an arbitrary volume of water from a well prior to sampling. Instead, low-flow purging and sampling relies on careful monitoring of water quality indicator parameters to determine when a representative groundwater sample can be collected. The low-flow methodology minimizes the effects on groundwater chemistry caused by the purging process by minimizing drawdown, reducing the amount of water removed from the well, and reducing the amount of turbidity in groundwater samples.

4.0 PROCEDURES

The following sections discuss the procedures to follow during low-flow purging and sampling of shallow monitoring wells with dedicated or non-dedicated equipment since both are employed. Where applicable and when possible, the purging and sampling techniques should remain consistent from one sampling event to the next.

Non-dedicated pumps made of inert materials may be used (see Section 2). To prevent cross-contamination, at least two separate pumps must be maintained for use at the Site: one for on-site wells with higher contaminant concentrations, and one for off-site wells having lower contaminant concentrations. All non-dedicated pumps must be easily decontaminated in the field. Tubing must be changed between each well. The reuse of tubing dedicated to a single well is encouraged to reduce waste between sampling events.

4.1 Pre-Sampling Activities

To the extent practical, sampling should begin at the well with the least contamination and proceed systematically to the wells with the higher expected concentrations. All measuring devices and monitoring equipment should be calibrated according to the manufacturer's instructions. Water quality meters must be calibrated daily before use. Equipment calibration details should be recorded in the *Equipment Calibration Log*.

If opening a well cap for sampling, the headspace at the top of the wells will be monitored for VOCs with a PID or FID. If VOCs are present, monitor worker breathing zones during purging/sampling and record measurements on field logs.

The proper procedure is as follows:

1. Unlock well and/or remove well cap. Note that wells may be flush-mount or above-grade completions.
2. Monitor the headspace at the top of the well for VOCs.
3. Measure the water level to obtain the static water level (see Section 4.2). Water levels should be measured to the nearest 0.01 foot relative to the TOC.

4. Use existing site information for total depth (TD) and the water level measurement to calculate the volume of water in the well.

4.2 Water Level Measurement

Water levels will be recorded on a *Water Level Measurement Log* and/or a *Water Purging and Sampling Log*.

Water levels can be measured by several techniques, but the most common method is using an electronic water level meter (e.g., Solinst). Other methods used at the site may include remote data logging via pressure transducers or from a pressure gauge at the top of artesian wells. Refer to manufacture's manuals for specific protocols for collecting data from remote water level measuring devices. For artesian wells, readings of pressure in pounds per square inch (psi) are recorded from a pressure gauge at the wellhead.

Water level meters must be decontaminated before initial use and after measurements are made in each well.

The proper sequence for water level measurement is as follows:

1. Turn water level meter on and check that its indicator is working.

2. Record the following information on the *Water Level Measurement Log* or the *Water Purging and Sampling Log*:

    - Well number
    - Top of casing elevation
    - Surface elevation, if available.

3. Use caution when opening the well. If pressure has developed inside the well casing, allow the well to stand without a cap for a few minutes until the water level stabilizes before taking a water level measurement. Record observance of positive or negative pressures in the well.

4. Inspect well for abnormalities (e.g., broken locks, damaged casing, blockages, etc.) and note on field logs. If there is dedicated tubing inside the well, it may have to be removed prior to gauging the well to avoid blocking the water level meter.

5. Lower the water level meter cable slowly into the well until the buzzer indicates a closed circuit. Raise and lower the electric cable slightly until the maximum response on the indicator is found. Record the static water level to the nearest hundredth (0.01) foot from the surveyed reference mark on the top edge of the well casing (TOC). If no reference mark is present, record in the log book where the measurement was taken (e.g., from the north side of the inner casing).

6. Repeat the measurement as necessary to confirm the level by raising and lowering the probe until the maximum response is observed.

7. Record the time and day of the measurement.

8. Compare measurement against historical measurements to perform a “reality check” of the measurement and recheck water level as needed.

9. The probe (or portion of the instrument that was immersed in ground water) will be cleaned with a solution of laboratory-grade phosphate-free detergent (e.g., Alconox™) and deionized water. The equipment will then be rinsed with deionized water and dried with a clean paper towel. Steam-cleaning is also an acceptable method of decontaminating the probe.

Water level measurements at the site will be taken as quickly as practically possible, to best represent the potentiometric surface across the site at a single time. Care will be taken not to drop foreign objects into the wells and not to allow the monitoring and sampling equipment to touch the ground or any other contaminating surfaces.

4.3 Purging and Sampling

1. If using a dedicated pump, attach sample tubing to the wellhead according to manufacturer’s procedures.

2. If there is dedicated tubing in the well, but no dedicated pump, using appropriate PPE, pull the tubing and keep it from kinking or knotting by using a reel or by hand coiling it. Inspect the tubing for damage while removing it from the well and protect the tubing from touching the ground or other contaminated surfaces. If necessary to store the tubing, place in a clean plastic bag. If there is no tubing, or the dedicated tubing needs replacement, use only new tubing.

3. If using a non-dedicated pump, attach the tubing to the pump according to manufacturer’s procedures, place the pump and support equipment at the well head and slowly lower the pump and tubing down into the monitoring well until the location of the pump intake is set at a predetermined location within the screen interval. Where possible, pre-measured tubing should be used to place the pump intake at the same depth as previous sampling events, or at a depth where there is known contamination within the screen interval. If there is no previous information for the well, the pump intake should be placed at the middle (or slightly above the middle) of the screen interval. Record the pump depth in the *Low-Flow Purging and Sampling Log*.

4. Measure depth to water to the nearest 0.01 feet relative to the reference measuring point on the TOC with an electronic water level indicator. Record depth to groundwater information in the *Low-Flow Purging and Sampling Log*. Leave water level indicator in the well.

5. Connect the discharge line from the pump to a flow-through cell that at a minimum measures temperature, pH, SEC, DO, and ORP. Turbidity measurements can be made using a separate turbidity meter. The discharge line from the flow-through cell must be directed to a container to hold purge water collected during purging and sampling of the well. Purge water will be collected in a portable tank (e.g., trailer-mounted polyethylene tank) and discharged to the on-site groundwater treatment system at the end of the sampling or when tank is full.

6. Connect the air lines to the flow controller and start pumping the well at a flow rate of between 0.1 and 0.5 liters per minute (L/min) and slowly increase the flow rate. (For new wells or wells with no purging history, start at the lower end of that range.) Check the water level. Maintain a steady flow rate while maintaining a drawdown of less than 0.3 feet. (Zero drawdown is optimal, but may not be achievable). If drawdown is greater than 0.3 feet, lower the flow rate; 0.3 feet is a goal to help guide with the flow rate adjustment. This goal will be difficult to achieve in some wells due to low hydraulic conductivities and limitations to the lowest flow rate a pump can produce while maintaining steady flow. See the Special Advisory at the end of these procedures.

7. Measure the discharge rate of the pump with a graduated cylinder and a stopwatch. Also, measure the water level and record both flow rate and water level on the *Low-Flow Purging and Sampling Log*. Continue purging, monitor and record water level and pump rate every 3 to 5 minutes. Purging rates should be kept at minimal flow to ensure minimal drawdown in the monitoring well.

8. A minimum of one tubing volume (including the volume of the water in the pump and flow cell) must be purged prior to recording the water quality indicator parameters. After this has been accomplished, monitor and record the water quality indicator parameters every three to five minutes in the *Low-Flow Purging and Sampling Log*. Stable readings of temperature, pH, SEC, DO, turbidity and ORP indicate when a representative sample can be collected. The stabilization criterion is based on three successive readings of the water quality indicator parameters as shown in Table 1. ORP may not always be an appropriate stabilization parameter and will depend on site-specific conditions. However, readings should be recorded because of its value for double-checking oxidizing conditions.

TABLE 1: Recommended Stabilization Criteria for Water Quality Indicator Parameters During Low-Flow Purging and Sampling	
Parameter	**Stabilization Criteria**
Temperature	± 3% of reading (minimum of ±0.2° C)
pH	± 0.1 pH units
Specific Electrical Conductance (SEC)	± 3% S/cm
Dissolved Oxygen (DO)	± 0.3 milligrams per liter
Turbidity	± 10% NTUs (when turbidity is greater than 10 NTUs)
Oxidation-Reduction Potential (ORP)	± 10 millivolts

9. Once stabilization is achieved samples can be collected. Maintain the same pumping rate or reduce slightly for sampling as necessary in order to minimize disturbance of the water column. Disconnect the pump's tubing from the flow-through cell so that the samples are collected from the pump's discharge tubing. For samples collected for dissolved gases or VOC analyses, the pump tubing needs to be completely full of ground water to prevent the ground water from being aerated as it flows through the tubing. Generally, the sequence of the samples is immaterial unless filtered (dissolved) samples are collected. Filtered samples must be collected last (see below). All sample containers should be filled with minimal turbulence by allowing the ground water to flow from the tubing gently down the inside of the container. When filling VOC samples using volatile organic analysis (VOA) vials, a meniscus must be formed over the mouth of the VOA vial to eliminate the formation of air bubbles and head space prior to capping. Effervescence and colorimetric reactions should be recorded in the *Low-Flow Purging and Sampling Log.*

10. If a filtered (dissolved) metal sample is to be collected (or filtered samples for any other analyte are required), then an inline filter is fitted at the end of the discharge tubing and the sample is collected after the filter. The inline filter must first be flushed in accordance with manufacturer's recommendations and if there are no recommendations for flushing, a minimum of 0.5 to 1.0 liter of groundwater from the monitoring well must pass through the filter prior to sampling. (Note: Groundwater filter cartridges are dedicated sampling equipment. A new cartridge should be used at each sampling location. Do not attempt to clean filter cartridges. If the filter becomes clogged or groundwater flow is too slowed, remove and replace with a new filter cartridge.)

11. For non-dedicated systems, remove the pump from the monitoring well. Decontaminate the pump and hang the tubing within the well for the next sampling event. If tubing is damaged or otherwise needs replacing, remove and dispose of the tubing. For dedicated systems, disconnect the tubing that extends from the plate at the wellhead (or cap) and discard after use.

12. Close and lock the well.

Special Advisory: If a stabilized drawdown in the well can't be maintained at 0.3 feet and the water level is approaching the top of the screened interval, reduce the flow rate or turn the pump off (for 15 minutes) and allow for recovery. It should be noted whether or not the pump has a check valve. A check valve is required if the pump is to be shut off during purging. Under no circumstances should the well be pumped dry. Begin pumping at a lower flow rate, if the water draws down to the top of the screened interval again, turn pump off and allow for recovery. If two tubing volumes (including the volume of water in the pump and flow cell) have been removed during purging, then sampling can proceed next time the pump is turned on. This information should be noted in the *Low-Flow Purging and Sampling Log.* This behavior may necessitate an alternative purging and sampling procedure for subsequent sampling events.

4.4 Equipment Decontamination

The electronic water level meter and the water quality meters will be decontaminated by the following procedures:

1. The water level meter will be hand washed with phosphate-free detergent (e.g., Alconox™) and a scrubber, then triple rinsed with distilled water, or steam-cleaned.

2. The water quality meters and flow-through cell (if used) will be rinsed with distilled water between sampling locations. No other decontamination procedures are necessary or recommended for these meters since they are sensitive instruments. After the sampling event, the flow-through cell and sensors must be cleaned and maintained per the manufacturer's requirements.

Sample tubing will either be replaced or be dedicated to an individual well. Non-dedicated pumps will be decontaminated between monitoring wells and prior to moving off-site. The pump and discharge line (including support cable and electrical wires which were in contact with the groundwater in the well casing) must be decontaminated by the following procedure:

1. The outside of the pump, support cable, and electrical wires must be pressure-sprayed with soapy water, tap water and distilled water. Use bristle brush to help remove visible dirt and contaminants.

2. Place the sampling pump and discharge line in a bucket or in a short cylinder (e.g., a 4-inch diameter casing) with one end capped. The pump must be completely submerged in the water.

A small amount of phosphate-free detergent (e.g., Alconox™) must be added with the potable (tap) water.

3. Remove the pump from the bucket or 4-inch casing and scrub the outside of the pump housing and cable.

4. Place pump and discharge line back in the container, start pump and re-circulate soapy water for approximately 2 minutes. Add 5 gallons of potable (tap) water as needed.

5. Turn pump off and place pump into a second bucket of potable (tap) water. Turn on pump and allow to run until rinsed free of soapy water, adding tap water as necessary.

6. Turn off and place pump into a third bucket which contains 3 to 5 gallons of distilled/deionized water. Turn on pump and cycle water through until gone.

7. If hydrophobic contaminants are present (such as separate phase (i.e. LNAPL or DNAPL, high levels of PCBs, etc.) an additional decontamination step, or steps, may be required.

8. Decontamination water will be collected in a portable tank (e.g., trailer-mounted polyethylene tank) and discharged to the on-site groundwater treatment system.

Other decontamination procedures may be proposed, but must be reviewed and approved by the Trust prior to implementation.

4.5 Quality Control Procedures

All field Quality Control (QC) samples must be prepared the same as primary samples with regard to sample volume, containers, and preservation. The sample handling and chain-of-custody procedures for the QC samples will be identical to the primary samples. The following are QC samples that may be collected during groundwater sampling:

- A field duplicate is an independent sample collected as close as possible to the same time that the primary sample is collected and from the same source. Field duplicates are used to document sample precision. Field duplicates will be labeled and packaged in the same manner as primary samples so that the laboratory cannot distinguish between the primary sample and the duplicate sample. Field duplicates are analyzed for the same suite of parameters as the primary samples. The frequency of analysis of field duplicates is generally one for every 20 primary samples, but may vary depending on project requirements.
- Equipment blanks are obtained by running distilled or deionized water over or through the sample collection equipment after it has been decontaminated, and capturing the water in the appropriate sample containers for analysis. Equipment blanks are analyzed for the same suite of parameters as the primary samples. The frequency of analysis of equipment blanks is

generally one for every day that non-dedicated sampling equipment is used, but may vary depending on project requirements.

- Field blanks are used to assess the presence of contaminants arising from field sampling procedures. Field blank samples are obtained by filling a clean sampling container with reagent-grade deionized water. Field blanks are analyzed for the same suite of parameters as the primary samples. Field blanks may or may not be incorporated into a groundwater sampling plan depending on project requirements.
- Trip blanks are sample containers that are used to evaluate sample cross-contamination of VOCs during shipment. For groundwater sampling, trip blanks consist of hydrochloric acid-preserved, analyte-free, deionized water prepared by the laboratory in VOA vials that will be carried to the field, stored with the samples, and returned to the laboratory for VOC analysis. Generally, one trip blank is required to accompany each sample shipping container or cooler that contains samples for VOC analysis; however, this may vary depending on project requirements.

4.6 Sample Handling and Custody

Samples will be collected, handled, and stored in such a manner that they are representative of their original condition and chemical composition. Identification of samples and maintenance of custody are important elements that must also be utilized to ensure samples characterize site conditions. All samples will be properly identified and maintained under chain-of-custody protocol to protect sample integrity. The following sections discuss the sample handling and custody requirements.

4.6.1 Sample Identification

To maintain consistency, a sample identification convention including unique identifiers for all groundwater and QC samples must be developed and followed throughout the project. The sample identifiers will be entered onto the sample labels, field forms, chain-of-custody forms, and other records documenting sampling activities.

4.6.2 Sample Labels

A sample label will be affixed to all sample containers sent to the analytical laboratory. Field personnel will complete an identification label for each sample with the following information written in waterproof, permanent ink:

- Client and project number
- Sample location and depth, if relevant
- Unique sample identifier
- Date and time sample collected
- Filtering performed, if any
- Preservative used, if any

- Name or initials of sampler
- Analyses or analysis code requested

The use of pre-printed sample labels is preferred in order to reduce sample misidentification problems due to transcription errors. Sample labels must be completed and affixed to the sample container in the field at the time of sample collection.

If errors are made on a sample label, corrections will be made by drawing a single line through the error and recording the correct information. Corrections will be dated and initialed.

4.6.3 Containers, Preservation, and Hold Time

Each lot of preservative and sampling containers will be certified as contaminant-free by the supplier. All preserved samples will be clearly identified on the sample label and Chain-of-Custody form. If samples requiring preservation are not preserved, field records will clearly specify the reason for the discrepancy.

Chemical activity continues in the sample until it is either analyzed or preserved. Once the sample has been preserved, the sample may be held for a period of time before analysis. The time from the collection of the sample to the analysis is defined as the holding time. The holding time varies depending on the media being sampled and the analyses being performed. The collection, preservation, and analysis of samples must be conducted to avoid exceeding relevant holding times.

4.6.4 Sample Handling and Transport

Proper sample handling techniques are used to ensure the integrity and security of the samples. Samples for field measured parameters will be analyzed immediately in the field and recorded in the appropriate field forms. Samples for laboratory analysis will be transferred immediately to appropriate laboratory supplied containers in accordance with the following sample handling protocols:

- Don clean gloves before touching any sample containers, and take care to avoid direct contact with the sample;
- Samples will be quickly observed for color, appearance, and composition and recorded as necessary;
- The sample container will be labeled before or immediately after sampling;
- Sample containers and liners will be capped with Teflon®-lined caps before being placed in Ziploc™-type plastic bags. The samples will be placed in an ice chest kept at 4 °C for transport to the laboratory.
- All sample lids will stay with the original containers, and will not be mixed.
- Sample bottles will be wrapped in bubble wrap as necessary to minimize the potential for breakage during shipment.

- The *Chain-of-Custody* form will be placed in a separate plastic bag and taped to the cooler lid or placed inside the cooler. A custody seal will be affixed to the cooler if the samples are to be shipped by commercial carrier. For shipped samples, U.S. Department of Transportation shipping requirements will be followed and the sample shipping receipt will be retained in the project files as part of the permanent Chain-of-Custody document.

4.6.5 Sample Chain of Custody

Sample chain-of-custody procedures will be used to maintain and document sample integrity during collection, transportation, storage, and analysis. A sample is considered to be under the control of, and in the custody of, the responsible person if the samples are in their physical possession, locked or sealed in a tamper-proof container, or stored in a secure area.

The *Chain-of-Custody* form provides an accurate written record that traces the possession of individual samples from the time of collection in the field until they are accepted at the analytical laboratory. The Chain-of-Custody form also documents the samples collected and the analyses requested. The sampler will record the following information on the Chain-of-Custody forms:

- Client and project number
- Name or initials and signature of sampler
- Name of destination analytical laboratory
- Name and phone number of Project Leader in case of questions
- Unique sample identifier for each sample
- Data and time of collection for each sample
- Number and type of containers included for each sample
- Analysis or analyses requested for each sample
- Preservatives used, if any, for each sample
- Sample matrix for each sample
- Any filtering performed, if applicable, for each sample
- Signatures of all persons having custody of the samples
- Dates and times of transfers of custody
- Shipping company identification number, if applicable
- Any other pertinent notes, comments, or remarks

Blank spaces on the Chain-of-Custody will be crossed out and initialed by the field sampler between the last sample listed and the signatures at the bottom of the sheet.

The field sampler will sign the Chain-of-Custody and will record the time and date at the time of transfer to the laboratory or an intermediate person. A set of signatures is required for each relinquished/received transfer, including internal transfer. The original imprint of the Chain-of-Custody will accompany the sample containers and a duplicate copy will be kept in the project file.

If the samples are to be shipped to the laboratory, the original *Chain-of-Custody* relinquishing the samples will be sealed inside a plastic bag within the ice chest, and the chest will be sealed with custody tape that has been signed and dated by the last person listed on the *Chain-of-Custody*. U.S. Department of Transportation shipping requirements will be followed and the sample shipping receipt will be retained in the project files as part of the permanent *Chain-of-Custody* document. The shipping company (e.g., Federal Express, UPS) will not sign the *Chain-of-Custody* forms as a receiver; instead the laboratory will sign as a receiver when the samples are received.

5.0 PRECAUTIONS

Certain precautions should be taken to ensure safety during the implementation of this FGD. It is important to always remain alert and aware of your surroundings. All personnel performing on-site operations with the potential for exposure to hazardous substances or health hazards are required to be 40-hour trained in accordance with Code of Federal Regulations (CFR) 1910.120 and will meet the personnel training requirements in accordance with 29 CFR 1910.120(e).

The laboratory must be certified by the appropriate regulating agency for the analyses to be performed.

The activities described in this FGD require the implementation of a site-specific Health and Safety Plan to inform personnel of the hazards associated with this work and to describe the methods that will be employed to mitigate those hazards. The Health and Safety Plan must be prepared and approved by the Project Manager, Task Leader and Project Health and Safety Coordinator prior to initiating field work.

6.0 RECORDKEEPING

Information collected during groundwater sampling may be recorded on individual field forms. A project-specific Field Logbook may replace any of the individual field forms with the exception of the Chain-of-Custody form. Following review by the Task Leader, the original field records will be kept in the project file. The following forms may be used to document the field activities:

- *Field Investigation Daily Log*
- *Water Level Measurement Log*
- *Low-Flow Purging and Sampling Log*
- *Equipment Calibration Log*
- *Chain-of-Custody*

The *Field Investigation Daily Log* will be completed for each day of fieldwork containing (at a minimum) the times and descriptions of the work performed, the activities of the drillers and any other subcontractors or visitors on-site, arrival and departure times for all involved, and any other pertinent information. For larger projects, or when otherwise deemed appropriate by the Task Leader, this information may alternatively be recorded in a Field Logbook. In these cases, a separate Field Logbook must be used for each project or site.

The *Water Level Measurement Log* will be used to record water level measurements for all wells. The type, serial number, and calibration date for the water level measuring device will be included on this form. Additionally, this form will be used to record general observations of the conditions of the wells, wellheads, well boxes, and/or monuments.

The *Low-Flow Purging and Sampling Log* will be used to record the details of purging and sampling information for each well including the depth of the pump, purge rates, and volume purged from each well. This form will also be used to record all of the measurements of drawdown and water quality indicator parameters used for evaluating stabilization.

The *Equipment Calibration Log* will be used to document the calibration and status of any measuring instruments used in the field (e.g., PID/FID, water level measuring device, water quality meters, etc.). The frequency and method of calibration will depend on the instrument. Any instruments used will be used in accordance with the factory-provided operating and/or service manuals.

Samples names, date/times, analyses to be performed, and other pertinent information will be recorded on the *Chain-of-Custody* form as a means of identifying and tracking the samples.

Appendix B

Field Data Sheet Templates

AECOM

Well ID:

Low-Flow Ground Water Sample Collection Record

Client: ______ Date: ______ Time: Start ______ am/pm
Project No: ______ Finish ______ am/pm
Site Location: ______
Weather Conds: ______ Collector(s): ______

1. WATER LEVEL DATA: (measured from Top of Casing)

a. Total Well Length ______ c. Length of Water Column ______ (a-b)

Casing Diameter/Material ______

b. Water Table Depth ______ d. Calculated System Volume (see back) ______

2. WELL PURGE DATA

a. Purge Method: ______

b. Acceptance Criteria defined (see workplan)

- Temperature	± 2°C	-D.O.	0.3 mg/l
- pH	± 0.1 unit	Turbidity	10% if NTU reading is > 10 NTUs
- Sp. Cond.	± 3%	ORP	± 10 milivolts

c. Field Testing Equipment used: Make Model Serial Number

______
______
______

Time (24hr)	Volume Removed (Liters)	Temp. (°C)	pH	Spec. Cond. (μS/cm)	DO (mg/L)	ORP (mV)	Turbidity (NTU)	Flow Rate (ml/min)	Drawdown (feet)	Color/Odor

d. Acceptance criteria pass/fail Yes No N/A (continued on back)

Have parameters stabilized ☐ ☐ ☐

If no or N/A - Explain below.

______

3. SAMPLE COLLECTION: Method: ______

Sample ID	Container Type	No. of Containers	Preservation	Analysis Req.	Time

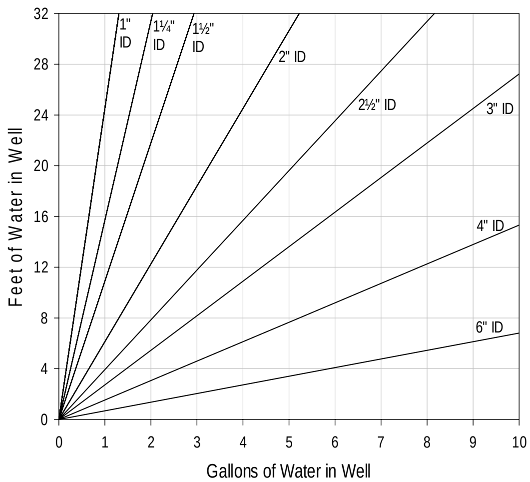
Comments ______

______

Signature ______ Date ______

AECOM

Purge Volume Calculation



Volume / Linear Ft. of Pipe		
ID (in)	Gallon	Liter
0.25	0.0025	0.0097
0.375	0.0057	0.0217
0.5	0.0102	0.0386
0.75	0.0229	0.0869
1	0.0408	0.1544
1.25	0.0637	0.2413
1.5	0.0918	0.3475
2	0.1632	0.6178
2.5	0.2550	0.9653
3	0.3672	1.3900
4	0.6528	2.4711
6	1.4688	5.5600

(continued from front)

Time (24 hr)	Volume Removed (Liters)	Temp (°C)	pH	Spec. Cond. (µS/cm)	DO (mg/L)	ORP (mV)	Turbidity (NTU)	Flow Rate (ml/min)	Drawdown (ft)	Color/Odor

WELL INSPECTION FORM

Project Information	AECOM Project Team
Project Number:	Inspection Date:
Project Name:	Time on Site:
Site Address:	Field Inspection Performed by:
City/State:	

Question No.		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	
Well number	Well diameter (inches)	Well box type (flushed or raised)	Well No. identified on the well box?	Well box concrete apron cracked?	Well cover bolted?	No. of bolts missing	Well covered with vegetation or other debris?	Bolts tighten down flush?	Bolt holes require re-tapping?	Dangerous insects/ creatures in or around well box?	Water present in well box?	Well gasket in place?	Well casing capped?	Well casing locked?	Well casing cracked?	Gauging point marked in casing?	Notes

Additional Notes:

Well Inspection Instructions	
Question No.	**Instructions**
1	List the well box type. E - EMCO, C - Christy, M - Monument, O - Other.
2	Is the well number clearly identified on the well box? Yes or No question.
3	Is the well box cracked? Yes or no question.
4	Is the well cover bolted? Yes or no question.
5	How many bolts are missing from the well cover? If no bolts are missing write "NA."
6	Is the well difficult to locate due to bushes, grass, falling leaves, etc.? Yes or no question.
7	Do the bolts tighten flush with the top of the lid, or do they get stuck halfway? Yes or no question?
6	Is the well gasket in place? Yes or no question. If the gasket appears to be broken worn, etc., please identify in the notes section.
7	Is the well box full of sediment or water. Yes or no question. If other debris in in the well box please note in the notes section.
8	If the bolts do not tighten all the way, or at all, do the screw holes need to be re-tapped (re-threaded)? Yes or no question?
9	Have dangerous insects or other creatures ever been found in or around the well box? Yes or no. (Specify what types)
10	Is water present inside of well box when first opened? Yes or no.
11	Is the rubber well gasket in place? Yes or no.
12	Is the well casing capped? Yes or no question. If well cap is in poor condition please note in the notes section.
13	Is the well casing locked? Yes or no question.
14	Is the well casing cracked? Yes or no question.
15	Is the gauging point marked or notched on the well casing? Yes or no question.