SUPPLEMENTAL HOOSIC VALLEY AQUIFER GROUNDWATER SOURCE INVESTIGATION WORK PLAN

Prepared for:

Saint-Gobain Performance Plastics
14 McCaffrey Street
Hoosick Falls, NY 12090

Honeywell
115 Tabor Road
Morris Plains, NJ 07950

Prepared by:

Environmental Resources Management
99 East River Drive, 3rd Floor
East Hartford, CT 06108

III Winners Circle
Albany, New York 12205
(518) 453-4500

July 2018

TABLE OF CONTENTS

1.0 INTRODUCTION 1
  1.1 TECHNICAL APPROACH OVERVIEW 2

2.0 FIELD INVESTIGATION 3
  2.1 Geophysical Survey 3
  2.2 Test Borings 4
  2.3 Monitoring Well Installation 5
  2.4 Initial Water Quality Sampling 5
  2.5 Test Well and Additional Monitoring Well Installation 6
  2.6 Test Well Development 6
  2.7 Well Disinfection 6
  2.8 Site Survey 7
  2.9 Health and Safety 7
  2.10 Special Precautions for PFCs 7
  2.11 Decontamination Procedures 7

3.0 WATER QUANTITY TESTING & DATA COLLECTION 8
  3.1 Step Drawdown Test 8
  3.2 Constant Rate Pumping Test 8
  3.3 Schedule 9

4.0 WATER QUALITY TESTING ASSOCIATED WITH PUMPING 10
  4.1 Groundwater Quality 10
  4.2 Interconnection Between Groundwater & Surface Water 10

5.0 AQUIFER CHARACTERIZATION 11

6.0 REPORTING 13

7.0 REFERENCES 14

LIST OF FIGURES

Figure 1 Conditions in and Around Hoosick Falls
Figure 2 Conditions in and Around Hoosick Falls (Enlarged)
Figure 3 Aquifer Characterization
Figure 4 Project Schedule

APPENDICES

Appendix A: Standard Operating Procedures

List of Acronyms & aBBREVIATIONS

bgs	Below Ground Surface
CHA	CHA Consulting, Inc.
DER	Division of Environmental Remediation
ELAP	Environmental Laboratory Accreditation Program
ERM	Environmental Resources Management
HSA	Hollow Stem Auger
MS/MSD	Matrix Spike/Matrix Spike Duplicate
NYCRR	New York Code, Rules and Regulations
NYSDEC	New York State Department of Environmental Conservation
NYSDOH	New York State Department of Health
PCB	Polychlorinated Biphenyls
PFAS	Per- and Polyfluoroalkyl Substances
PFCs	Perfluorinated Compounds
PFOA	Perfluorooctanoic acid
PID	Photoionization Detector
POC	Principal Organic Contaminant
PPE	Personal Protection Equipment
QA	Quality Assurance
QC	Quality Control
SCGs	Standards, Criteria and Guidelines

1.0 INTRODUCTION

The Remedial Investigation and Feasibility Study (RI/FS) Work Plan prepared pursuant to Order on Consent and Administrative Settlement; Index No. CO 4-20160212-18, between the New York State Department of Environmental Conservation (NYSDEC) and Saint-Gobain Performance Plastics and Honeywell (the Companies) required preparation of a study and assessment of potable water sources for the Village of Hoosick Falls (Village) Municipal Water Supply (MWS)[1]. Six alternatives were identified in the RI/FS Work Plan and are discussed in detail in the "Municipal Water Supply Study for the Village of Hoosick Falls – Interim Report" (CHA & ERM, January 2018), including Alternative 1 - development of a new groundwater source.

This Supplemental Groundwater Source Investigation Work Plan (Work Plan) presents the next steps in the evaluation of Alternative 1 as described in the Interim Report. Alternative 1 is the identification and installation of new water supply wells to replace the existing Village supply wells. It also entails a new water main to connect the wells to the Village water treatment plant and distribution system. The Interim Report includes a detailed description of work completed to date (summarized below) and future additional work to further investigate the potential for developing a new groundwater source to replace or supplement the existing Village water supply (which is the subject of this Work Plan).

The consulting firm Arcadis, working on behalf of the NYSDEC, conducted an initial screening study and preliminary field investigations of some potential areas where a new groundwater source might be located, including the Wysocki Farm property (Arcadis, July 12, 2016). Due to identification of favorable geological deposits, a test production well and observation wells were installed on the Wysocki Farm property for a more detailed study of water supply potential and water quality in that area. The results of the work found that the aquifer has a recharge boundary, indicating it is not entirely confined, and the maximum yield of the test well was 300 gallons per minute (Arcadis, July 6, 2017). This yield was below the targeted production rate of 694 gpm (1.0 MGD) for the Village. The investigation also indicated the geological framework was complex, preventing an assessment of whether multiple pumping wells could be installed in this hydrogeologic unit to sustain a higher pumping capacity based on the available data. Arcadis recommended that additional investigations should be conducted "north and east" of the Wysocki Farm property to determine the extent of the semi-confined aquifer.

Based on the results of the Desktop Study (described in Section 3.3 of the Interim Report) and the work conducted by Arcadis, an Evaluation Area south of the Village of Hoosick Falls has been selected for further evaluations (see Figures 1 and 2). This area is mapped as glacial outwash sand and gravel deposits and includes the Wysocki Farm property, as well as an area north and east of the Wysocki Farm property. The mapping represents surficial geology and does not reflect any potential deeper semi-confined or confined aquifers.

---

[1] The Interim Report has been prepared pursuant to the Order on Consent and Administrative Settlement Index No. 4-201-160212-18, and the reservations of rights set forth therein are expressly incorporated herein, including, but not limited to, Paragraphs 14, II.A.2, and Appendix A, Paragraph III.E of the Order.

The Interim Report states that a Work Plan will be prepared identifying the work associated with the further investigation of the Evaluation Area, including drilling test borings, performing geophysical surveys, installing monitoring wells and test production wells, performing water quality sampling, and conducting pumping tests within the Evaluation Area. The objective is to identify an alternative source of groundwater that can contribute to, or replace, the current source of supply for the Village. (Note, any references to “meeting the target yield” in this Work Plan refer to the total need for the Village of Hoosick, which could be met with one or more new supply wells).

This Work Plan describes that additional work in detail.

1.1 TECHNICAL APPROACH OVERVIEW

The approach for developing a new groundwater supply will utilize industry-standard procedures focused on the Evaluation Area identified on Figure 2. These tasks are presented in Sections 2.0, 3.0 and 4.0 of this Work Plan and includes: (1) geophysical surveys; (2) test borings; (3) installation of monitoring wells; (4) installation of a test well; (5) conducting a 72-hour pumping test; and (6) groundwater quality testing. These work items are iterative whereby subsequent steps will depend on prior results. If the results of geophysical surveys, test borings, and groundwater sampling show promise from a water quantity and quality standpoint, work will proceed (e.g., observation and test well installation and performance of a pumping test). The Companies will collaborate with NYSDEC throughout Work Plan implementation as interim results are generated to reach concurrence with NYSDEC on how best to move the investigation forward.

The work items planned for the Evaluation Area will be supplemented with investigation activities to better understand: (1) areal and vertical extent of the deep confined aquifer and its recharge characteristics; and (2) areal and vertical extent of the overlying aquitard. These investigations will include geophysical surveys, installation of test borings and installation of monitoring wells. Figure 3 presents the proposed locations for these additional investigation activities; further detail is provided in Section 5.0.

Implementation of this Work Plan requires access to private property. Access has already been obtained to certain properties; however, additional access will be required for full implementation. Requests for access to conduct field investigations will be submitted to the appropriate land owners as required.

Following the completion of the additional work that is the subject of this Work Plan, the findings will be incorporated into the “Municipal Water Supply Study for the Village of Hoosick Falls – Final Report” and used to revise, as appropriate, Alternative 1.

2.0 FIELD INVESTIGATION

The field investigation activities will be conducted on select sites in the Evaluation Area where access agreements with property owners are obtained. The progression of activities involved in this field investigation is as follows:

1. Surface geophysical surveys will be performed on one or more properties where the stratigraphy suggests there is sufficient saturated thickness to meet the water yield target. The surface geophysical surveys will be used to determine the lateral and vertical extent of the water-bearing unit(s).
2. Two to three soil test borings will be installed through the unconsolidated deposits on one or more properties; the final number of borings will be dependent upon the size of the area to be investigated and accessibility for a drilling rig. Stratigraphic information will be collected in the field, from surface grade to bedrock.
3. Two to three monitoring wells will be installed on one or more properties where preliminary soil borings and geophysical surveys demonstrate the desired subsurface characteristics.
4. Preliminary groundwater samples will be collected from the monitoring wells and analyzed for a variety of analytes. These data will be reviewed with the NYSDEC and NYSDOH before progressing to the next activity. Refer to Section 2.4 for details about the analysis of initial water quality samples.
5. At locations with the highest potential for capacity and acceptable water quality, one 10” diameter test production well, and two to three additional monitoring wells will be installed. The test production well will be designed for use in a step-drawdown pumping test and a constant rate pumping test to determine the yield of the aquifer and other aquifer parameters.
6. Groundwater quality sampling will be performed near the end of the pumping tests to establish groundwater quality for both the test well and the surrounding monitoring wells. Refer to Section 2.4 for details about the analysis of the groundwater quality samples.
7. Findings will be reported to NYSDEC after the completion of field activities. The data from the field activities, (including validated laboratory analytical data) will be provided to NYSDEC in a Data Summary Memorandum. The findings will be incorporated into the “Municipal Water Supply Study for the Village of Hoosick Falls – Final Report”.

The details of each activity are discussed in the following sections.

2.1 GEOPHYSICAL SURVEY

A qualified geophysical survey company will perform geophysical surveys where the test borings indicate the presence of geologic deposits with sufficient porosity, permeability and saturated thickness to act as a water-bearing unit capable of meeting the target yield. The number and location of seismic and resistivity survey lines will be determined in coordination with NYSDEC. The geophysical survey lines shall be accurately mapped including the location of measuring points. Survey results will be provided and interpreted using industry-standard techniques including cross sections.

The survey will include a combination of seismic refraction and electrical resistivity to estimate subsurface conditions. Seismic refraction will be used to:

- Determine depth of competent bedrock;
- Determine depth of water table;
- Determine overburden thickness; and
- Map bedrock topography.

Electrical resistivity measures the apparent resistivity of the subsurface, and can estimate soil type and groundwater flow potential. Variations in electrical resistivity may indicate changes in soil composition and layer thickness.

2.2 TEST BORINGS

A NYS-licensed driller will install the soil test borings from surface grade to bedrock, at appropriate locations within the Evaluation Area. Dig Safely New York (DSNY) will be notified prior to the initiation of intrusive activities and requested to identify, locate, and mark utilities. A private utility location subcontractor will be retained to scan a minimum of 10 feet around each proposed drilling locations using ground penetrating radar (GPR), magnetometry/metal detection, inductive cable/pipe location, or other appropriate techniques. Proposed drilling locations will be adjusted in the field as necessary based on the results of subsurface clearance efforts.

The test borings will be installed using a hollow-stem auger drilling rig capable of reaching the anticipated depth of bedrock. Soil samples will be collected continuously throughout the depth of the boring using a two-foot long split-spoon sampler. Materials encountered in the boring will be described in accordance with Standard Operating Procedures (SOPs) #301 and #303 (See Appendix A). In addition, one or more high definition photographs will be taken of each recovered spilt-spoon soil samples once the spoon is opened for inspection.

If refusal is encountered, a five-foot core will be drilled to confirm if bedrock is present, or to confirm if another obstruction like a boulder has been encountered. The bedrock in the Evaluation Area is mapped as the Walloomsac Formation which consists primarily of slate, phyllite, schist, and metagraywacke.

The test borings will be tremie-grouted back to land surface to avoid creating conduits that could adversely affect water quality in the aquifer. Site restoration activities will be completed to repair any damage to the Property caused by the environmental activities on the Property and to reasonably restore the Property to the condition it was in before such environmental activities were undertaken.

2.3 MONITORING WELL INSTALLATION

If the results from the geophysical survey and soil borings suggest the presence of a water-bearing unit capable of yielding sufficient groundwater, a NYS-licensed well driller will be retained to install up to three monitoring wells in the area to be tested. If necessary, subsurface utility clearance procedures will be repeated, as described in Section 2.1.

Drilling methods that will not interfere with a well's hydraulic connection will be used to drill the monitoring wells (e.g., hollow-stem auger as opposed to mud rotary methods).

A pilot boring will be advanced within approximately 15 feet of the proposed test production well location to obtain samples of the targeted water-bearing zone for sieve analysis. The sieve analysis will serve as the basis for selecting the slot size for a continuous wire-wrapped stainless-steel screen and determining if the test production well can be installed as a naturally packed well (e.g., formation collapse) or with a installed filter pack.

The pilot boring will be converted to a two-inch diameter monitoring well. Two additional monitoring wells will be installed approximately 50 feet away in different directions from the pilot boring/monitoring well. The installation of the monitoring wells will be in accordance with SOP# 309 and the wells will be developed in accordance with SOP #311 (Appendix A). All monitoring wells (see Section 2.9) will be constructed with two-inch diameter PVC riser pipe and machine-slotted well screen with a slot size of 0.020-inches. The screen will be installed to penetrate the saturated thickness of the water-bearing zone. A sand pack, consisting of a minimum radial thickness of one inch, will be placed within the annulus between the borehole and the well screen. A two-foot bentonite seal will then be placed above the sand pack. The remaining borehole between the bentonite seal and the ground surface will be tremie-grouted with bentonite-cement grout.

A steel stick-up protective pipe or a flush-mounted road box, as appropriate for site conditions, will be installed at each well location to protect the riser pipe. The wells will be constructed in such a manner (e.g. using gripper caps on the well risers and stick-up protective casings to avoid detrimental effects during high water/flooding events associated with the Hoosic River.

2.4 INITIAL WATER QUALITY SAMPLING

The monitoring wells will be analyzed for the list of parameters in the NYSDOH Part 5 regulations for a public drinking water source, in addition to the following fluorinated compounds by United States Environmental Protection Agency (USEPA) Method 537-1.1 Modified:

- Perfluorobutanoic acid
- Perfluoropentanoic acid
- Perfluorohexanoic acid
- Perfluoroheptanoic acid
- Perfluorooctanoic acid (PFOA)
- Perfluorononanoic acid
- Perfluorobutane sulfonic acid
- Perfluorohexane sulfonic acid
- Perfluoroheptane sulfonic acid
- Perfluorooctane sulfonic acid (PFOS)
- Perfluorodecane sulfonic acid
- 6:2 Fluorotelomersulfonic acid

- Perfluorodecanoic acid
- Perfluoroundecanoic acid
- Perfluorododecanoic acid
- Perfluoro-n-tridecanoic acid
- Perfluorotetradecanoic acid
- 8:2 Fluorotelomersulfonic acid
- Perfluorooctanesulfonamide
- N-methyl perfluoro-1-octanesulfonamidoacetic acid
- N-ethyl perfluoro-1-octanesulfonamidoacetic acid
- 2,3,3,3-tetrafluoro(1,1,2,2,3,3,3,-heptafluoropropoxy) propanoic acid (aka GenX)

The analytical method will achieve detection limits for these PFAS compounds ranging from 2.0 to 10 ng/L. Additionally, the samples will be analyzed for 1,4-dioxane using an ELAP Certified Laboratory Method capable of achieving a method detection limit no higher than 0.28 µg/l.
The laboratory data will be used to screen the groundwater for the presence of contaminants and suitable water quality. The data will be reviewed for compliance with SCGs and shared with NYSDEC. Confirmatory sampling may be conducted if anomalous results are obtained.

If after consultation with NYSDEC and suitable groundwater quality is confirmed, a test production well and additional monitoring wells will be installed and a pumping test will be conducted.

2.5 TEST WELL AND ADDITIONAL MONITORING WELL INSTALLATION

In consultation with NYSDEC and the NYSDOH, the water quality data will be reviewed to ascertain whether it meets potable drinking water criteria and/or can be readily treated to meet drinking water criteria, prior to determining to move forward with installation of a ten-inch diameter test well. A well installation specification will be prepared based on the soil boring information in accordance with NYSDEC and NYSDOH requirements for drinking water wells and to meet typical production well standards. The method of drilling and methods of construction will be selected in coordination with NYSDEC and NYSDOH based on the targeted depth of the well and whether the well is being installed in an unconfined or confined aquifer.

Two to three additional monitoring wells will be installed at distances greater than 100 feet from the proposed test well location to serve as observation wells during pumping tests (described below in Section 3.0).

2.6 TEST WELL DEVELOPMENT

After installation, the test well will be developed by alternating cycles of surging with a surge block/high-velocity jetting and air-lift pumping until the turbidity level is less than five nephelometric turbidity units (NTUs). See SOP #311 for further details (Appendix A). At the end of the development phase, transducers will be placed in nearby monitoring wells to verify that the test well specific capacity is stable.

2.7 WELL DISINFECTION

After the temporary pumping equipment is installed in the test well, the well and pumping equipment will be disinfected by adding calcium hypochlorite and circulating the solution for up to one hour, in accordance with American Water Works Association (AWWA) standard C654-03. See Sections 3.1 and 3.2 regarding pumping equipment.

2.8 SITE SURVEY

The horizontal and vertical location of installed borings, monitoring wells, seismic lines, and other features critical to the investigation will be surveyed by a NY licensed professional surveyor. The well casing elevations will be surveyed with an accuracy of 0.01 feet vertically and 0.1 feet horizontally. All other features shall be surveyed to a horizontal and vertical accuracy of 0.1 feet. All data will be tied to the New York State Plane Coordinate System (NAD83), horizontally and vertically to NAVD 88.

2.9 HEALTH AND SAFETY

A Health and Safety Plan (HASP) will be prepared prior to initiation of field work. It will include an assessment of known or potential physical, biological, and chemical hazards typically associated with drilling and sampling activities. The HASP will include procedures to implement appropriate engineering controls and use personal protective equipment for the protection of workers.

2.10 SPECIAL PRECAUTIONS FOR PFCs

Water utilized in the execution of the field activities (e.g., drill water, decontamination water) will be obtained from a source with non-detectable concentrations of PFCs prior to us, based on laboratory analysis with an appropriate limit of quantitation. Aqueous field rinse blank samples will also be collected for PFC analysis from drilling tools, well construction materials and other downhole instruments (e.g., well screen, riser pipe, filter pack, submersible pumps, sample tubing and transducers) prior to use in the field to ensure that the equipment is not a potential source of PFCs.

2.11 DECONTAMINATION PROCEDURES

Decontamination procedures for drilling and sampling equipment used in the investigative activities at each site are described in SOPs #501 and #503 included in Appendix A. These procedures will be implemented to prevent potential cross-contamination of equipment to influence water quality sampling.

3.0 WATER QUANTITY TESTING & DATA COLLECTION

After completing the installation of the test well and monitoring wells, the pumping test phase of the field investigation will be initiated. Prior to starting any pumping tests, a discharge pipe will be installed to convey the discharged water away from the test well to eliminate the possibility that the discharged water may recharge the well or result in erosion of soil. The pumping tests consist of two parts; a step drawdown test and a constant rate pumping test.

3.1 STEP DRAWDOWN TEST

A step drawdown test will be conducted on the newly installed test well to determine the optimum pumping rate for a constant rate test and evaluate the specific capacity and anticipated well yield. The pumping equipment will be selected such that the pump's maximum rate will exceed the well's anticipated capacity. The discharge for each step test will be conducted at four progressively higher flow rates, such that each step increased the pump flow rate by approximately 1/4th of the expected well yield. Prior to beginning the step drawdown test, the static groundwater levels in the test well and monitoring wells will be measured on a continuous basis in the 24-hour period preceding each test. During each test, water level measurements will be collected using pressure transducers and data loggers on a continuous basis. Water levels will not be monitored in adjacent monitoring wells.

At the completion of the step drawdown test, water levels will be monitored until at least 90-percent recovery is achieved in the test well and in each surrounding monitoring well. The test well pumping rate, stabilized drawdown level, and calculated specific capacity will be recorded for each step. The procedures for conducting the step-drawdown test and constant rate pumping test are detailed in SOP#323, included in Appendix A.

3.2 CONSTANT RATE PUMPING TEST

A constant rate pumping test will be performed on the test well after the step drawdown test activities are completed. The constant rate pumping test will consist of three segments; an ambient period of approximately 48 hours, a 72-hour pumping period, and a recovery period of 48 hours. The pumping test will be conducted in accordance with NYSDEC's Pumping Test Procedures described in http:/www.dec.ny.gov/lands86950.html. Any deviations from this protocol will be described in writing prior to the pumping test.

During the first hour of the test, failure to pump within 10 percent of the test pumping rate for any reason will require termination of the test, recovery of water levels to static, and a restart of the test. Later pump failures must be demonstrated to have no significant effect on the data or a similar termination and restart will be necessary.

The weather will be monitored in advance of initiating the pumping test and the prediction of any period of extensive rainfall may be cause to postpone the pumping test.

Water levels in the test well and monitoring wells will be measured throughout the test using automated pressure transducers. If additional residential wells or monitoring wells are located within approximately 2,000 feet of the test well, the Companies will attempt to obtain permission to monitor water levels during the constant rate pumping test to determine if the installation and pumping from a permanent production well would impact water levels in those wells. The pressure transducers will record data continuously during each testing phase (48-hour ambient monitoring period, 72-hour pumping period and 48-hour recovery period).

To evaluate the potential hydraulic connection to the Hoosic River, at least one staff gauge will be installed within the river and monitored during each testing phase.

A weather station will be set up at the test site to record precipitation, barometric pressure and temperature throughout each testing phase, beginning at least one day before the start of the test and concluding at least one one day following the completion of the test, to evaluate potential weather effects on the test.

The pumping test data will be interpreted with the AQTESOLV modeling program to calculate the transmissivity and storativity of the aquifer. The appropriate method of analysis, based on the type of aquifer (unconfined aquifers, semi-confined, or confined) will be factored in, using results from the soil borings and geophysical logging tasks. In addition, projected drawdowns and distance drawdown effects will also be predicted to determine if the aquifer is capable of meeting the long-term well yield objectives.

3.3 SCHEDULE

Upon NYSDEC approval of this Work Plan and the efforts to obtain access are concluded, the activities described above will be initiated. An approximate schedule is provided as Figure 4.

The NYSDEC will be notified at least seven days prior to the proposed initiation of field activities.

4.0 WATER QUALITY TESTING ASSOCIATED WITH PUMPING

4.1 GROUNDWATER QUALITY

One water quality sample will be collected from the test well prior to shut down of the constant rate pumping test. The sample will be collected from a sampling port directly off of the discharge of the test well. A sample will also be collected from each of the monitoring wells located in the immediate vicinity of the pumping well at the end of the recovery period.

The test well sample will be analyzed for the complete list of parameters as listed in the NYSDOH Part 5 regulations for a public drinking water source, in addition to PFCs by USEPA Method 537-1.1 Modified (see section 2.4 for complete list of PFAS/PFCs to be analyzed).

The samples from the monitoring wells will be analyzed for principal organic contaminants (POCs) via EPA Method 502.2, metals, general wet chemistry parameters (e.g., pH, conductivity, TDS, ammonia, TKN, nitrate, bicarbonate, COD, BOD, and sulfate) to be used to evaluate potential pretreatment requirements, and PFCs (see section 2.4).

Sampling procedures will be conducted in accordance with SOP #341, 603, and 605, included in Appendix A. After samples are collected, the samples will be transported to the laboratory following SOPs #105, and 607. All laboratories used for analysis will be NYSDOH-certified for the respective analytical methods specified.

4.2 INTERCONNECTION BETWEEN GROUNDWATER & SURFACE WATER

A Microscopic Particulate Analysis (MPA) test will be performed on the test well water if the test well is located within 1,000 feet of the Hoosic River. The test involves diverting approximately 500 gallons of discharge water, at a rate of 1 gpm, through a water filtration unit for approximately the last 4 hours of the test (see SOP #320). At the end of the test, the filter and water within in the filter housing are submitted to a qualified laboratory for analysis. Prior to, and after the sample for MPA is collected, the discharge will be monitored for pH, temperature and specific conductance.

The MPA test is utilized to generate a risk rating score that indicates the likelihood that the groundwater is under the direct influence of surface water.

5.0 AQUIFER CHARACTERIZATION

In addition to evaluating the potential for expanded production capacity at, and in the vicinity of, the Wysocki Farm Well Field Study Area, this Supplemental Groundwater Source Investigation will assess the:

- recharge source or sources for the aquifer at, and near, the Wysocki Farm Well Field Study Area.
- geologic setting and recharge conditions of the aquifer margins along the valley walls.
- potential presence of PFAS and/or other constituents within the recharge area and its potential to migrate toward any new pumping well.
- lateral and vertical extent of the confining clay unit identified at, and in the vicinity of, the Wysocki Farm Well Field Study Area, with particular focus on:
    - the areal zone between the subject Study Area and the existing Municipal Water Supply Wells for the Village of Hoosick Falls;
    - the areal zone between the subject Study Area and the Hamlet of Hoosick (along Route 7); and
- dynamics of deep-water movement and/or recharge within the above areas of the aquifer.

To complete this assessment, the following data sources will be reviewed and certain additional investigations will be completed. The data sources to be reviewed are:

- Existing hydrogeologic data such as geophysics and boring logs in the southern portion of the Hoosic valley study area (i.e., Arcadis investigation in the southern part of the Wysocki property);
- Existing hydrogeologic data such as aquifer tests and boring logs in the eastern portion of the Hoosic valley study area (i.e., from McCaffrey Street investigation and historic work in the Village well field);
- Additional analysis of the Wysocki aquifer test;
- Additional analysis of USGS data in "Groundwater-Level Analysis of Selected Wells in the Hoosic River Valley Near Hoosick Falls, New York, for Aquifer Framework and Properties"; Open-File Report 2018–1015);
- Hydrogeologic data to be developed from on-going investigations at the John Street, River Road and McCaffrey Street sites; and

The additional investigative activities will entail geophysical surveys, geologic borings and monitoring well installations in key locations as access permits.

Figure 3 depicts three new seismic survey lines proposed to assist in filling potential data gaps related to the physical composition of the aquifer. Lines 1 and 2 are located on properties where the Companies have already secured access, or where access has previously been granted as part of the Arcadis work. Line 3 is intended to provide information along Route 7; however no access to this area has been attempted or obtained.

Along survey Lines 1 and 2, up to three borings will be drilled to bedrock to help characterize the lateral extent of the aquifer and any clay confining unit. Four borings may be installed along Line 3 due to its length, depending on access. The same methods and approaches as previously described in Section 2 will be utilized for these investigations. Final boring locations will be confirmed with NYSDEC before field mobilization.

Each boring will be converted to a shallow monitoring well screened in the upper water bearing zone and sampled per Section 2.4. Additional monitoring will be conducted in conjunction with the pumping tests (Sections 3.1 and 3.2).

6.0 REPORTING

A Data Summary Memorandum will be submitted to NYSDEC at the conclusion of field activities. The memorandum will include the following information:

- Soil boring installation/well installation logs;
- Geophysical survey data;
- Pumping test logs and drawdown data;
- Pumping test analysis;
- Tables summarizing the analytical data for groundwater quantity and quality, including comparisons to appropriate standards, criteria, and guidance;
- Laboratory data usability will be evaluated following procedures for the preparation of a Data Usability Summary Report (DUSR) for all samples collected during the implementation of this Work Plan. The usability evaluation will be performed consistent with the NYSDEC guidance contained in DER-10 Appendix 2B;
- Figures showing the location of the sites investigated, boring and well locations, and location of geophysical surveys; and
- Conclusions and recommendations regarding the potential to install one or more permanent groundwater production wells that could meet the quantity and quality objectives for a new groundwater source for the Village MWS.

The findings of the field investigation activities will be incorporated into the “Municipal Water Supply Study Report for the Village of Hoosick Falls – Final Report”.

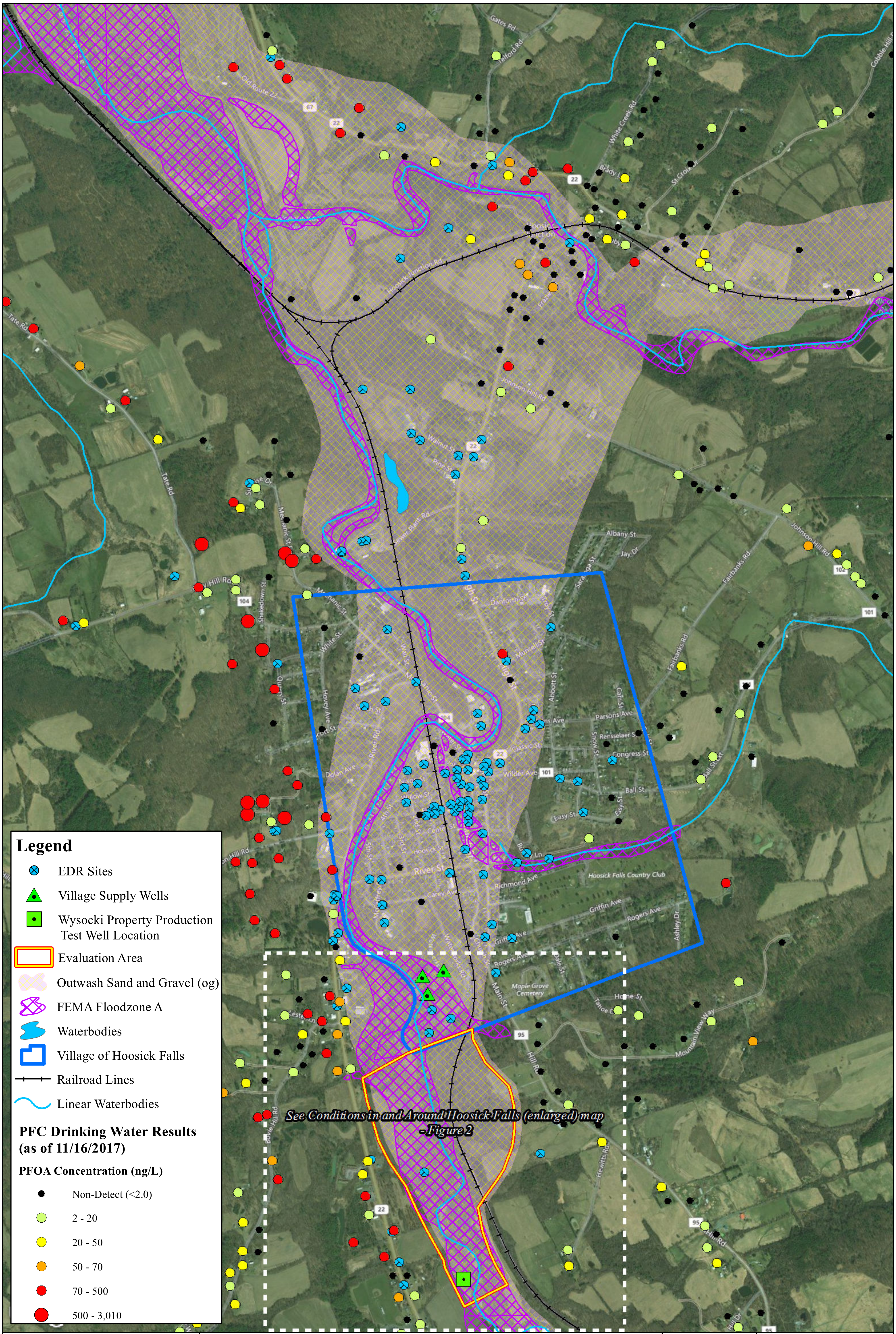
7.0 REFERENCES

New York State Geological Survey. 1987. Hudson Mohawk Sheet. “Surficial Geological Map of New York”, New York State Museum Map & Chart, Number 15.

Potter. 1972. “Stratigraphy and Structure of the Hoosick Falls Area, New York-Vermont, East Central Taconics”. New York State Museum and Science Service Map and Chart Series No. 19.

USGS. 2018. “Groundwater-Level Analysis of Selected Wells in the Hoosic River Valley Near Hoosick Falls, New York, for Aquifer Framework and Properties”. Open-File Report 2018–1015.

FIGURES



CHA
design/construction solutions
III Winners Circle, P.O. Box 5269 • Albany, NY 12205-0269
Main: (518)453-4500 • www.cloughharbour.com

Figure 1 - Conditions in and Around Hoosick Falls

Supplemental Hoosic Valley
Aquifer Groundwater Source Investigation Work Plan

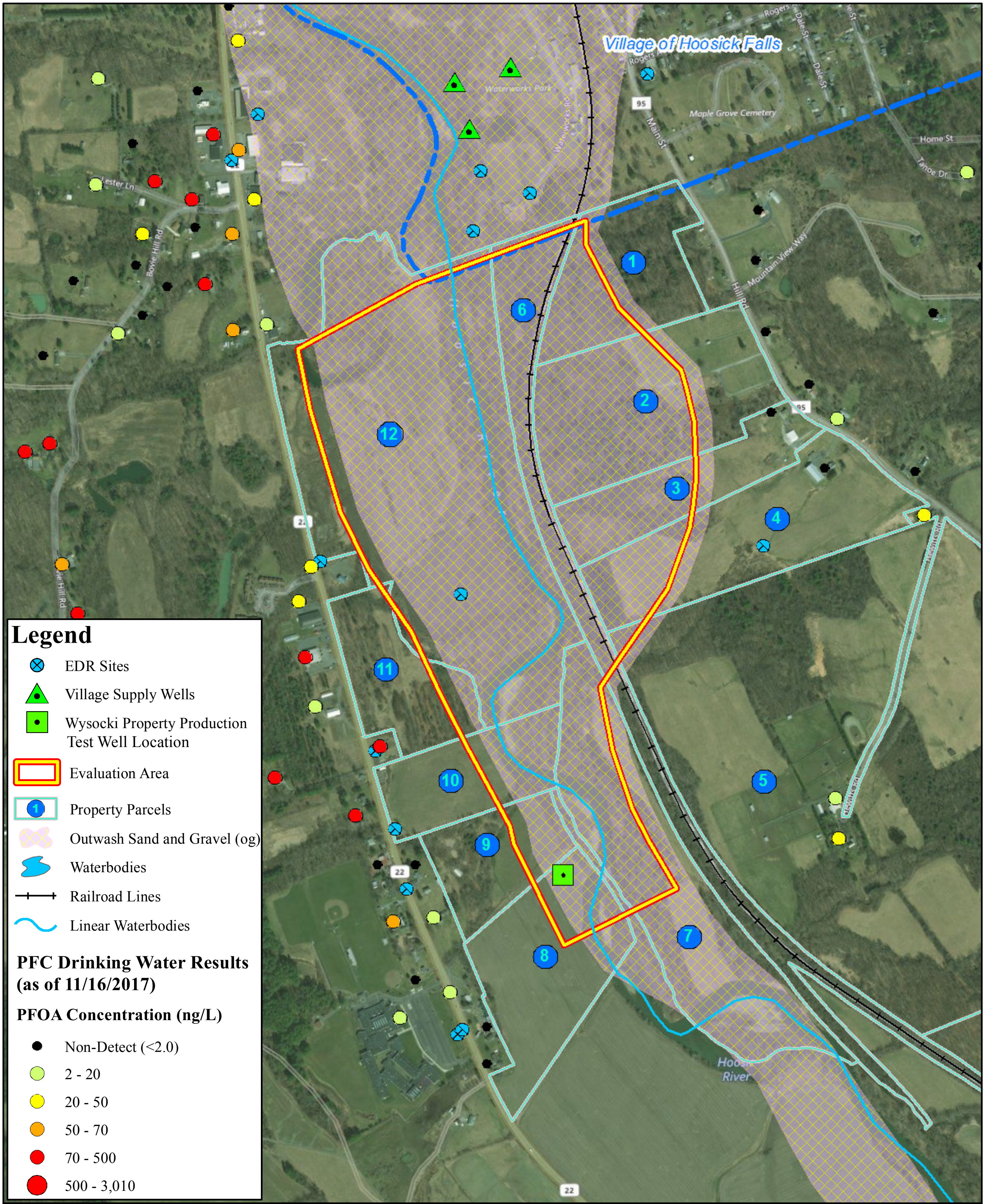
N
W E
S

1 inch = 1,500 feet

Project No. : 32091

July 2018

0 750 1,500
Feet



CHA design/construction solutions
III Winners Circle, P.O. Box 5269 • Albany, NY 12205-0269
Main: (518)453-4500 • www.cloughharbour.com

Figure 2 - Conditions in and Around Hoosick Falls (enlarged)

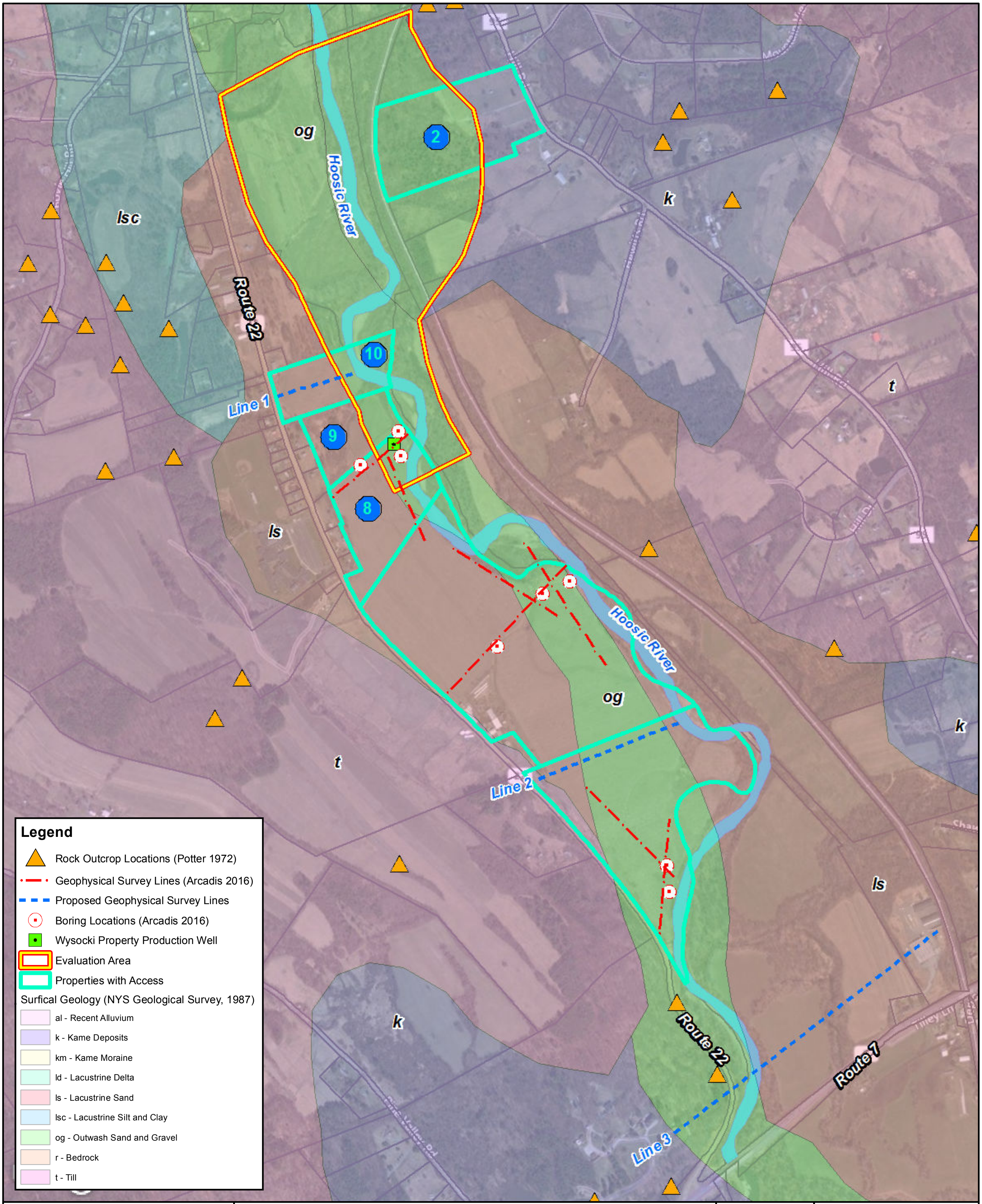
Supplemental Hoosic Valley
Aquifer Groundwater Source Investigation Work Plan

N
W E
S
1 inch = 825 feet

Project No. : 32091

July 2018

0 400 800
Feet



CHA
design/construction solutions
III Winners Circle, P.O. Box 5269 • Albany, NY 12205-0269
Main: (518)453-4500 • www.cloughharbour.com

Figure 3 - Aquifer Characterization

Supplemental Hoosic Valley
Aquifer Groundwater Source Investigation Work Plan

N
W E
S

1 inch = 1,250 feet

Project No. : 32091

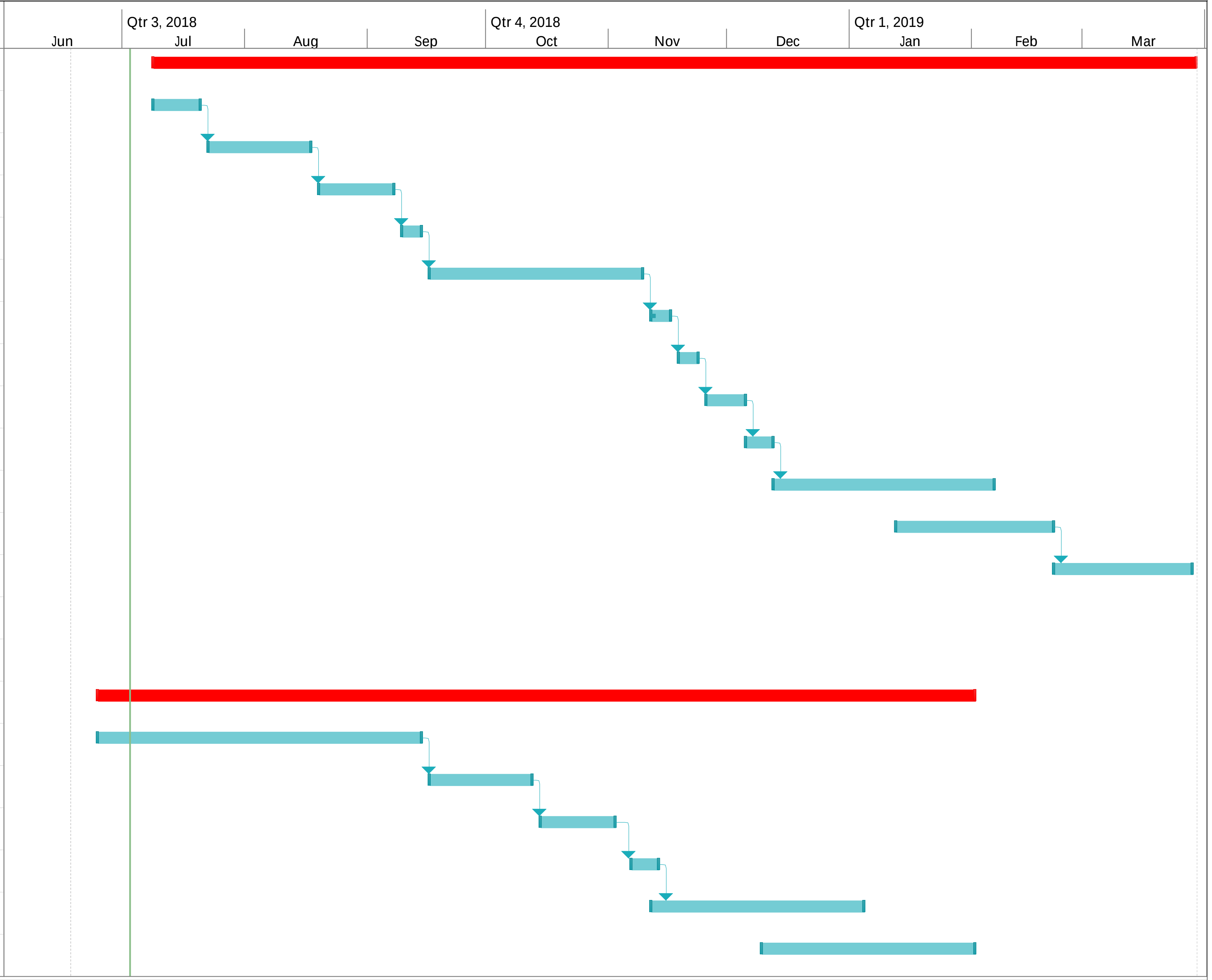
July 2018

0 625 1,250
Feet

Supplemental GW Source Investigation schedule assumes favorable results are obtained at one property
* = Interim Results to be Discussed with NYSDEC

Figure 4 - Project Schedule

ID	Task Mode	Task Name	Duration	Start	Finish
1		Supplemental GW Source Investigation	190 days	Mon 7/9/18	Fri 3/29/19
2		Mobilization	10 days	Mon 7/9/18	Fri 7/20/18
3		Geophysical Survey *	20 days	Mon 7/23/18	Fri 8/17/18
4		Soil Borings/Initial Wells *	15 days	Mon 8/20/18	Fri 9/7/18
5		Initial Water Quality Sampling	5 days	Mon 9/10/18	Fri 9/14/18
6		Laboratory Analysis/DUSR *	40 days	Mon 9/17/18	Fri 11/9/18
7		Additional Well Installation *	5 days	Mon 11/12/18	Fri 11/16/18
8		Install Test Well	5 days	Mon 11/19/18	Fri 11/23/18
9		Conduct Pump Test	8 days	Mon 11/26/18	Wed 12/5/18
10		Additional Water Quality Sampling	5 days	Thu 12/6/18	Wed 12/12/18
11		Laboratory Analysis/DUSR	40 days	Thu 12/13/18	Wed 2/6/19
12		Review and Compile Data	30 days	Sun 1/13/19	Thu 2/21/19
13		Prepare Draft Summary Memorandum *	25 days	Fri 2/22/19	Thu 3/28/19
14					
15					
16		Aquifer Characterization	160 days	Mon 6/25/18	Fri 2/1/19
17		Access Agreements	60 days	Mon 6/25/18	Fri 9/14/18
18		Geophysical Survey	20 days	Mon 9/17/18	Fri 10/12/18
19		Soil Borings/Initial Wells	15 days	Mon 10/15/18	Fri 11/2/18
20		Water Quality Sampling	5 days	Wed 11/7/18	Tue 11/13/18
21		Laboratory Analysis/DUSR	40 days	Mon 11/12/18	Fri 1/4/19
22		Interim Memo *	40 days	Mon 12/10/18	Fri 2/1/19



Date: Tue 7/3/18

Task
Split
Milestone ◆
Summary
Project Summary
Inactive Task
Inactive Milestone ◇
Inactive Summary
Manual Task
Duration-only
Manual Summary Rollup
Manual Summary
Start-only [
Finish-only]
External Tasks
External Milestone ◆
Deadline
Path Successor Milestone Task ◆
Path Successor Summary Task
Path Successor Normal Task
Progress
Manual Progress

APPENDIX A

Standard Operating Procedures

Author: Sarah Newell, Mark Corey
Reviewer: Keith Cowan, Sandy Warner

COMPLETING A CHAIN-OF-CUSTODY RECORD

A. PURPOSE/SCOPE:

This protocol provides a standard operating procedure (SOP) for initiating and maintaining a Chain of Custody (COC) document. A COC is a legal document designed to track persons who are responsible for the preparation of the sample container, sample collection, sample delivery, sample storage, and sample analysis. A COC is an appropriate format to record important data associated with each individual sample. In general, a sample requiring a COC will follow a path as follows:

Sample Collector → Sample Courier/Operator → Sample Custodian

Verification of who has possessed the samples and data and where the samples have been is completed when staff follow chain-of-custody procedures.

B. EQUIPMENT/MATERIALS:

- Chain of Custody form
- Ball-point, permanent pens
- Gallon-Sized Ziploc Bag (to keep COC dry)
- Field Logbook
- Custody seals
- Padlock(s) (optional)

C. PROCEDURE:

1. Once a sample has been determined to require a COC, the Sample Collector must initiate the COC. The Sample Collector must fill in the fields provided on the COC. The words “Chain of Custody” must be located in a conspicuous location at the top of the document.
2. The form is generally a three-page carbon copy document, including a white, yellow and pink sheet. While CHA generally uses COCs provided by the applicable laboratory, it is important to ensure that the COC from each lab contains places for all necessary information.
3. The COC at that time should include the fourteen-digit CHA project number and phase, the project name and location.
4. The Client Information Section must be completed. In most cases the “client” will be CHA Consulting, Inc.
5. The first field of information is the Sample Identification or Sample Identification Number. This identification/number must match the identification/number located on the sample container.
6. An information line for the date, time, phone number, printed name of Sample Collector, signature of Sample Collector, organization name (no acronyms), organization’s full mailing address, and sample description must also be included.
7. Sampling personnel should enter the sample number(s) (which should correspond with a unique number on a sample container [SOP #103] if applicable, and parameters to be analyzed. The “Sample ID” must be included and must match the number on the sample.

COMPLETING A CHAIN-OF-CUSTODY RECORD

8. Subsequent fields must be provided to allow for documentation of information about any subsequent Sample Couriers/Operators or Sample Custodians. These fields must contain the date, time, phone number, printed name of person taking custody of sample, signature of person taking custody of sample and organization name (no acronyms).
9. Field Information - The COC must contain places to enter the following field information: sample number, sampling date, and type of sample. Other field information may be recorded as specified in the field sampling plan or proposal for the project. It is imperative that there be only one sample with a particular sample number per project/study so as to prevent duplicates in Excel files and EQuIS databases.
10. Laboratory Information - Once the sample is delivered to the lab, the laboratory personnel will sign and date the "received by" line located at the bottom of the COC. Other laboratory information may be recorded as specified in the project/study work plan/proposal.
11. Signatures - The COC must contain places for all people who handle the sample to sign his/her name. This is a record of persons who had custody of the sample during all steps of the process from container preparation, sample collection, sample storage and transport, and sample analysis. There should be signature lines to relinquish custody of the sample and to receive custody of the sample.

D. QA/QC REQUIREMENTS:

The Field Team Leader or senior person on the sampling team will review the completed COC form to verify that all fields are properly completed. For purposes of this SOP, signing the form under Collected/Delivered by is considered evidence that the COC form has been checked for accuracy and completeness.

E. SPECIAL CONDITIONS:

Whenever samples are split with a source or government agency, a separate chain of custody form should be completed for the samples and the relinquisher (sampler) and recipient should sign. If a representative is unavailable or refuses to sign for the samples, this can be noted in the “remarks” area of the form. When appropriate, as in the case where the representative is unavailable, the custody record should contain a statement that the samples were delivered to the designated location at the designated time. A copy of the chain of custody form for split samples must be kept with the project file.

Samples may require short term storage in field locations prior to delivery to the laboratory for analyses. The storage may be in vehicles or lodging locations. The samples must be secured to limit access to them. A locked vehicle is considered controlled access. However, simply a locked lodging room is not secure due to potential custodial access. If an unattended lodging room is used for sample storage, the samples must be further secured. This may entail a padlock on the ice chest, samples in an ice chest secured in an inner bag with a custody seal on it, and/or ice chest taped shut with custody seal on the outside of it.

F. REFERENCES:

Sampling Guidelines and Protocols, NYSDEC, http://www.dec.ny.gov/regulations/2636.html
Chain of Custody Protocol is in Appendix 5X.2.

COMPLETING A CHAIN-OF-CUSTODY RECORD

Chain of Custody Procedures for Samples and Data, EPA 50 minute Self Instructional Course:
http://www.epa.gov/apti/coc/

SOP for Chain of Custody, EPA Region 1:
http://www.epa.gov/region6/qa/qadevtools/mod5_sops/misc_docs/r1_chain-of-custody.pdf

G. APPENDICES/FORMS:

CHA COC Form

END OF SOP
Final Check by C. Burns 10/7/15

FIELD DESCRIPTION OF SOILS

A. PURPOSE/SCOPE:

This objective of this SOP is to establish a consistent method for field staff to follow when completing the description of soil samples and entry onto borehole logs. Consistency with description is important because many employees are involved in logging soils, frequently within the same project. Uniformity is critical to allowing meaningful subsurface interpretations using data generated from multiple sources.

This procedure will be used during all field activities when borehole subsurface drilling or surface soil sampling is occurring. These activities should be documented as described herein.

B. EQUIPMENT/MATERIALS:

Some or all of the following equipment is may be required for completing the procedures outlined in this SOP:

- Hand lens
- Field notebook and borehole log forms
- Pencils
- Stiff scraper
- Standard grain size examples
- Squirt bottle with water
- Small clear containers with lids

C. PROCEDURE:

1. CHA utilizes a combination of the USCS and Modified Burmister methods of soil descriptions.
2. The Unified Soil Classification System (USCS) is the most widely used engineering/geotechnical soil classification method. The USCS is based on engineering properties of soil which are effected by grain size, water content, grain size distribution, and compaction. This system is often used for classifying soils encountered in boreholes, test pits, and at the surface. The following properties form the basis of USCS soil classification:
   - Percentage of gravel, sand, and fines;
   - Shape of the grain size distribution curve; and
   - Plasticity and compressibility characteristics.
3. The Modified Burmister Method is used for the verbal description of soil samples. The Modified Burmister classification system is based on grain size and plasticity, but differs from the Unified Soil Classification System in that it includes nomenclature to describe the soil's texture, color, mineralogy, and geological origin.
4. The following step by step procedure will be used for the field classification of soils encountered during subsurface activities (i.e. borehole drilling, trenching, etc.). References to aid in the development of a soil description are included in Appendix A and Appendix B.

A complete soil description should contain the following information in the order indicated.

FIELD DESCRIPTION OF SOILS

- Major grain size component
- Minor grain size component(s) with modifier
- Gradation or Plasticity
- Color
- Soil Moisture
- Density/Consistency
- Soil Structure or Mineralogy (if necessary)
- Evidence of Contamination (odor, staining, etc.)
- USCS symbol

a. Grain Size: There are five major grain sizes: Boulders, Cobbles, Gravel, Sand, and Silt/Clay.

- Boulders are > 8"
- Cobbles are 3" to 8"
- Gravels range in size from 0.2" to 3.0" in diameter and are subdivided into Fine gravel (>0.2" to 0.75") in diameter and Coarse gravel (>0.75" to 3.0")
- Sands range in size from 0.002" to 0.2" and are subdivided into coarse, medium and fine. Standard comparison cards are available for field use.
- Silt and clay are difficult to distinguish in the field. An attempt is made, however, to describe the soil as one of the six following classifications: silt, clayey silt, silt and clay, clay and silt, silty clay, or clay. The field description may be later verified in a lab hydrometer test if required by the project. For field descriptions of silts and clays, the following guidelines should be used:

SILT: --------------------gritty, no threads can be rolled
Clayey SILT:-----------rough to smooth, difficult to roll threads
SILT and CLAY:------rough to smooth, difficult to roll threads
CLAY and SILT:------smooth and dull, threads can be rolled readily
Silty CLAY:------------smooth and shiny, threads can be rolled very readily
CLAY: ------------------very shiny and waxy, threads can be rolled very easily

Grain size descriptions are written with the major grain size component listed first. In order to be considered a major grain size component, the component must constitute greater than 50% of the sample. Major grain size components are written in all capital letters and are underlined. If no grain size component constitutes greater than 50% of the sample, the sample is classified by describing the distribution of the sand component of the sample first (ex. f.m. Sand). Then, the other grain size components are described and the appropriate percentage modifier (see below) is assigned. The reader can then determine the percentage of sand in the sample by subtracting the sum of the modifier percentages from 100%. An example is shown below.

Other grain size components, if present, are listed in order of decreasing percentage.

FIELD DESCRIPTION OF SOILS

The following modifiers are used to indicate the relative proportion of a minor grain size component in the soil:

Estimated amount: Modifier

- < 10 percent: .... Trace
- 10 percent to 20 percent: .... Little
- 20 percent to 35 percent: .... Some
- 35 percent to 50 percent: .... And

Minor grain size components assigned a trace or little modifier are written in lower case letters.

Minor grain size components assigned a “some” or “and” modifier are written with the first letter of the grain size capitalized (ex. f. Sand). When multiple minor grain size components are described with the same modifier, finer grain sizes precede coarser grain sizes.

b. Gradation or Plasticity. Granular soils (i.e., sands or gravels) should be described as well-graded, poorly-graded, uniform, or gap-graded, depending on the gradation of the minus 3-inch fraction. Cohesive soils (i.e., silts and clays) should be described as nonplastic, slightly plastic, moderately plastic, or highly plastic, depending on results of the manual evaluation for plasticity.

c. Color: Common colors and their abbreviations are listed below.

- Orange: ----Or
- Tan: --------Tan
- Black: ------Blk
- Brown: -----Br
- Grey: -------Gr
- Red: --------Red

d. Moisture Content: The moisture content is determined in the field and is described using the following terms:

- Dry: -------------(dab finger in soil, no moisture on finger)
- Moist: -----------(dab finger in soil, moisture on finger)
- Wet:--------------(water visible)
- Saturated: ------(all pore spaces filled)

FIELD DESCRIPTION OF SOILS

e. Density/Consistency: The density or consistency of the soils is classified according to the "N" value of the soil. The "N" value is the sum of the middle two blow counts determined during a standard penetration test (SOP #303). The following classifications are used:

Table 1
Standard Penetration Test for Soil Density

N-Blows/Feet	Relative Density
Cohesionless Soils	
0 - 4	Very loose
5 - 10	Loose
11 - 30	Medium
31 - 50	Dense
>50	Very dense
Cohesive Soils	
0 - 2	Very soft
3 - 4	Soft
5 - 8	Medium
9 - 15	Stiff
16 - 30	Very stiff
>30	Hard

f. Odor (if present): Odor is described from a warm, moist sample. The odor should only be described it is organic or unusual. An organic odor will have distinctive decaying vegetation smell. Unusual odors such as petroleum product, chemical, etc. should be described appropriately.

g. Soil Texture and Structure (if present): Description of particle size distribution, arrangement of particles into aggregates, and their structure. This description includes joints, fissures, slicked sides, mottling, bedding, veins, root holes, debris, organic content, and residual or relict structure (laminations, etc.), as well as other characteristics that may influence the movement or retention of water or contaminants.

h. USCS symbol: A USCS symbol is assigned to each symbol. The USCS recognizes 15 soil groups and uses names and letter symbols to distinguish between these groups.

The coarse grained soils are subdivided into gravels (G) and sands (S). Both the gravel and sand groups are divided into four secondary groups. Fine grained soils are subdivided into silts (M) and clays (C).

FIELD DESCRIPTION OF SOILS

Soils are also classified according to their plasticity and grading. Plastic soils are able to change shape under the influence of applied stress and to retain the shape once the stress is removed. Soils are referred to either low (L) or high (H) plasticity. The grading of a soil sample refers to the particle size distribution of the sample. A well graded (W) sand or gravel has a wide range of particle sizes and substantial amounts of particles sized between the coarsest and finest grains. A poorly graded (P) sand or gravel consists predominately of one size or has a wide range of sizes with some intermediate sizes missing.

Soils which have characteristics of two groups are given boundary classifications using the names that most nearly describe the soil. The two groups are separated by a slash. The same is true when a soil could be well or poorly graded. Again the two groups are separated by a slash.

First and/or second letters	
Symbol	**Definition**
G	gravel
S	sand
M	silt
C	clay
O	organic

Second letter	
Letter	**Definition**
P	poorly graded (uniform particle sizes)
W	well graded (diversified particle sizes)
H	high plasticity
L	low plasticity

Example:

A. Sample with Major Component:

f. SAND, Some Silt, little m.c. sand and f. gravel, trace c. gravel, brown, wet, m. compact, petroleum odor (SM)

B. Sample with No Major Component:
f.m.c. Sand, Some Silt and f. Gravel, brown, moist, v. compact, no evidence of contamination (SM)
(In this sample, the describer classified the sample as containing 30% silt and 30% f. gravel. The percentage of sand would then be determined as: 100%-30%-30%=40%).

D. QA/QC REQUIREMENTS:

Not Applicable

E. SPECIAL CONDITIONS:

Not Applicable

FIELD DESCRIPTION OF SOILS

F. REFERENCES:

Burmister, D.M., Suggested Methods of Test for Identification of Soils.

The Unified Soil Classification System (USCS).

Classification of Soils for Engineering Purposes: Annual Book of ASTM Standards, D 2487-83, 04.08, American Society for Testing and Materials, 1985.

G. APPENDICES/FORMS:

ASTM Criteria for Describing Soils
CHA Legend to Subsurface Logs
CHA Test Boring Log

END OF SOP

Final Check by C. Burns 10/07/15

ASTM CRITERIA FOR DESCRIBING SOIL

Criteria for Describing Angularity of Coarse-Grained Particles

Description	Criteria
Angular	Particles have sharp edges and relatively plane side with unpolished surfaces
Subangular	Particles are similar to angular description but have rounded edges
Subrounded	Particles have nearly plane sides but have well-rounded corners and edges
Rounded	Particles have smoothly curved side and no edges

Criteria for Describing Dilatancy

Description	Criteria
None	No visible change in the specimen.
Slow	Water appears slowly on the surface of the specimen during shaking and does not disappear or disappears slowly upon squeezing.
Rapid	Water appears quickly on the surface of the specimen during shaking and disappears quickly upon squeezing.

Criteria for Describing Toughness

Description	Criteria
Low	Only slight pressure is required to roll the thread near the plastic limit . The thread and the lump are weak and soft.
Medium	Medium pressure is required to roll the thread to near plastic limit. The thread and the lump have medium stiffness.
High	Considerable pressure is required to roll the thread to near the plastic limit. The thread and the lump have very high stiffness.

Criteria for Describing Dry Strength

Description	Criteria
None	The dry specimen crumbles into powder with mere pressure of handling
Low	The dry specimen crumbles into powder with some finger pressure
Medium	The dry specimen breaks into pieces or crumbles with considerable finger pressure
High	The dry specimen cannot be broken with finger pressure. Specimen will break into pieces between thumb and a hard surface.
Very High	The dry specimen cannot be broken between the thumb and shard surface

Criteria for Describing Structure

Description	Criteria
Stratified	Alternating layers of varing material or color with layers at least 6 mm thick; note thickness.
Laminated	Alternating layers of varying materials or color with the layers less than 6 mm thick; note thickness.
Fissured	Breaks along definite planes of fracture with little resistance to fracturing.
Slickensided	Fracture planes appear polished or glossy, sometimes striated.
Blocky	Cohesive soil that can be broken down into small angular lumps which resist further breakdown.
Lensed	Inclusion of small pockets of different soils, such as small lenses of sand scattered through a mass of clay; note thickness.
Homogeneous	Same color and appearance throughout.

CRITERIA FOR DESCRIBING SOIL (Cont.)

Criteria for Describing the Reaction with HCl

Description	Criteria
None	No visible reaction
Weak	Some reaction, with bubbles forming slowly
Strong	Violent reaction, with bubbles forming immediately

Criteria for Describing Consistency

Description	Criteria
Very Soft	Thumb will penetrate soil more than 1 inch (25 mm)
Soft	Thumb will penetrate soil about 1 inch (25 mm)
Firm	Thumb will indent soil about 1/4 inch (6 mm)
Hard	Thumb will not indent soil but readily indented with thumbnail
Very Hard	Thumbnail will not indent soil

Criteria for Describing Cementation

Description	Criteria
Weak	Crumbles or breaks with handling or little finger pressure
Moderate	Crumbles or breaks with considerable finger pressure
Strong	Will not crumble or break with finger pressure

Criteria for Describing Particle Shape

The particle shape shall be described as follows where length, width, and thickness refer to greatest, intermediate, and least dimensions of a particle, respectively (see page 104).

Flat	Particles with width/thickness ratio > 3
Elongated	Particles with length/width ratio > 3
Flat and Elongated	Particles meet criteria for both flat and elongated

Criteria for Describing Plasticity

Description	Criteria
Nonplastic	A 1/8 inch (3 mm) thread cannot be rolled at any water content.
Low	The thread can barely be rolled and the lump cannot be formed when drier than the plastic limit.
Medium	The thread is easy to roll and not much time is required to reach the plastic limit. The thread cannot be rolled after reaching the plastic limit. The lump crumbles when drier than the plastic limit.
High	It takes considerable time rolling and kneading to reach the plastic limit. The thread can be rerolled several times after reaching the plastic limit. The lump can be formed without crumbling when drier than the plastic limit.

Identification of Inorganic Fine-Grained Soils from Manual Tests

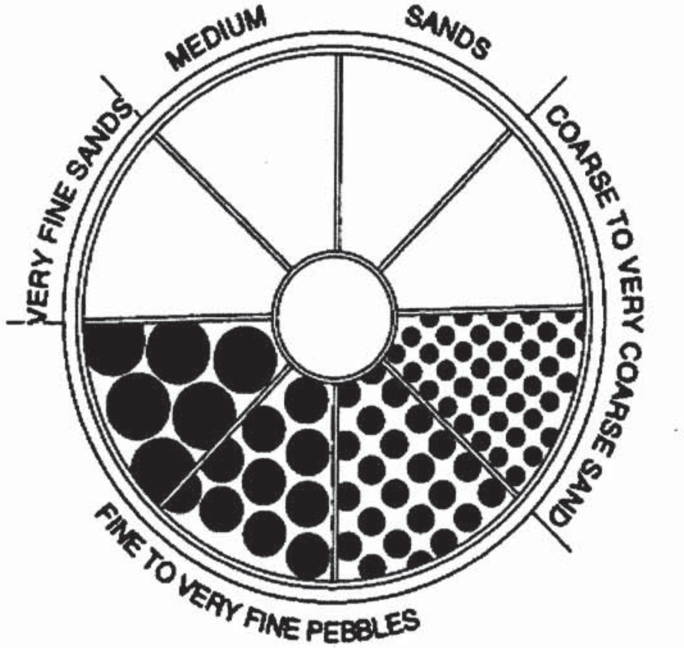
Soil Symbol	Dry Strength	Dilatancy	Toughness
ML	None to low	Slow to rapid	Low or thread cannot be formed
CL	Medium to high	None to slow	Medium
MH	Low to medium	None to slow	Low to medium
CH	High to very high	None	High

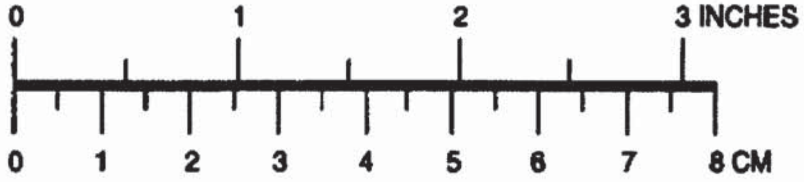
Criteria for Describing Moisture Condition

Description	Criteria
Dry	Absence of moisture, dusty, dry to the touch
Moist	Damp but no visible water
Wet	Visible free water, usually soil is below water table

SEDIMENT PARTICLE SIZE AND SHAPE ESTIMATES

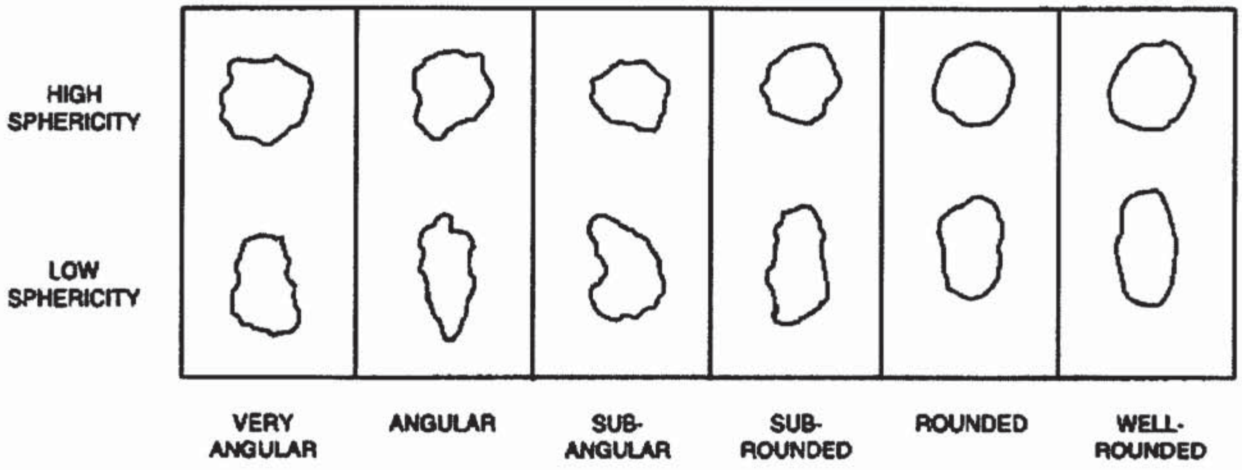
GRAPH FOR DETERMINING SIZE OF SEDIMENTARY PARTICLES





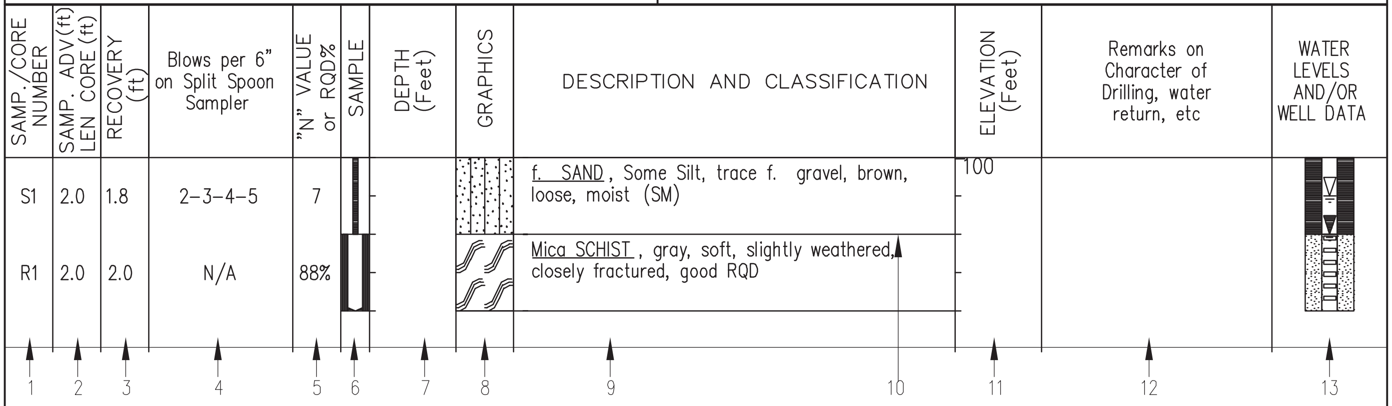
COBBLES RANGE FROM 6.4 TO 25.6 cm (~2.5 TO 10.1 INCHES)
BOULDERS ARE LARGER THAN 25.6 cm (>10.1 INCHES)

SEDIMENT PARTICLE SHAPES



CHA

LEGEND TO SUBSURFACE LOGS



Subsurface Logs present material classifications, test data, and observations from subsurface investigations at the subject site as reported by the inspecting geologist or engineer. In some cases, the classifications may be made based on laboratory test data when available. It should be noted that the investigation procedures only recover a small portion of the subsurface materials at the site. Therefore, actual conditions between borings and sampled intervals may differ from those presented on the Subsurface Logs. The information presented on the logs provide a basis for an evaluation of the subsurface conditions and may indicate the need for additional exploration. Any evaluation of the conditions reported on the logs must be performed by Professional Engineers or Geologists.

1. SAMP./CORE NUMBER – Samples are numbered for identification on containers, laboratory reports or in text reports.

2. SAMP.ADV/LEN.CORE – Length of sampler advance or length of coring run measured in feet.

3. RECOVERY – Amount of sample actually recovered after withdrawing sampler or core barrel from bore hole measured in feet.

4. SAMPLE BLOWS/6" – Unless otherwise noted, blow counts represent values obtained by driving a 2.0" (O.D.), 1-3/8" (I.D.) split spoon sampler into the subsurface strata with a 140 pound weight falling 30" as per ASTM International D1586. After an initial penetration of 6" to seat the sampler into undisturbed material, the sampler is then driven an additional 2 or 3 six inch increments. Refusal is defined as a resistance greater than 50 blows per 6" of penetration.

5. "N" Value or RQD % – "N" VALUE – The sum of the second and third sample blow increments is generally termed the Standard Penetration Test (SPT) "N" value. Refusal (R) is defined as a resistance greater than 50 blows for 6 inches of penetration. CORE RQD – Core Rock Quality Designation, RQD, is defined as the summed length of all pieces of core equal to or longer than 4 inches divided by the total length of the coring run. Fresh, irregular breaks distinguishable as being caused by drilling or recovery operations are ignored and the pieces are counted as intact lengths. RQD values are valid only for cores obtained with NX size core barrels.

6. SAMPLE – Graphical presentation of sample type and advance or core run length. See Table 1.

7. DEPTH – Depth as measured from the ground surface in feet.

8. GRAPHICS – Graphical presentation of subsurface materials. See Table 4. Dual soil classification and rock graphics may vary and are not shown on Table 4.

9. DESCRIPTION AND CLASSIFICATION – SOIL – Recovered samples are visually classified in the field by the supervising geologist or engineer unless otherwise noted. Particle size and plasticity classification is based on field observations, and using the Unified Soil Classification System (USCS). See Table 4. USCS symbols are presented in parentheses following the soil description. Where necessary, dual symbols may be used for combinations of soil types. Relative proportions, by weight and/or plasticity, are described in general accordance with "Suggested Methods of Test for Identification of Soils" by D.M. Burmister, ASTM Special Publication 479, 6-1970. See Table 2. Soil density or consistency description is based on the penetration resistance. See Table 3. Soil moisture description is based on the observed wetness of the soil recovered being dry, moist, wet, or saturated. Water introduced into the boring during drilling may affect the moisture content of the materials. Other geologic terms may also be used to further describe the subsurface materials. ROCK – Rock core descriptions are based on the inspector's observations and may be examined and described in greater detail by the project engineer or geologist. Terms used in the description of rock core are presented in Table 5.

10. DIVISION LINES – Division lines between deposits are based on field observations and changes in recovered material. Solid lines depict contacts between two deposits of different geologic depositional environment of known elevation. Dashed lines represent estimated elevation of contacts between two deposits of different geologic depositional environment. Dotted lines depict transitions of deposits within the same depositional environment, such as grain size or density.

11. ELEVATION – Elevation of strata changes in feet.

12. REMARKS – Miscellaneous observations.

13. WATER LEVELS & WELL DATA – Hollow water level symbol, if present, represents level at which first saturated sample or water level was encountered. Solid water level symbol, if present, depicts the most probable static water elevation at the time of drilling or as measured in an installed observation well at a later date. Subsurface water conditions are influenced by factors such as precipitation, stratigraphic composition, and drilling/coring methods. Conditions at other times may differ from those described on the logs. For graphical presentation of observation/monitoring well construction, see Table 6. Elevations of changes in construction are noted at the bottom of each section.

CHA

LEGEND TO SUBSURFACE LOGS

TABLE 1
TYPICAL SAMPLE TYPES

SPLIT SPOON
(1 3/8" I.D.)

NX SIZE
ROCK CORE

SHELBY TUBE
"UNDISTURBED"

AUGER SAMPLE

TABLE 2
SAMPLE MATERIAL PROPORTIONS

ADJECTIVE	PERCENTAGE OF SAMPLE
"and"	35% – 50%
"some"	20% – 35%
"little"	10% – 20%
"trace"	< 10%

Standard split spoon samples may not recover particles with any dimension larger than 1 3/8". Therefore, reported gravel percentages may not reflect actual conditions.

TABLE 3
DENSITY/CONSISTENCY

GRANULAR SOILS		COHESIVE SOILS	
Blows/ft.	Density	Blows/ft.	Consistency
< 5	Very Loose	< 2	Very Soft
5–10	Loose	2–4	Soft
11–30	Med. Compact	5–8	Med. Stiff
31–50	Compact	9–15	Stiff
> 50	Very Compact	16–30	Very Stiff
		> 30	Hard

TABLE 4
USCS CLASSIFICATION, PARTICLE SIZE, & GRAPHICS

MAJOR PARTICLE SIZE DIVISION		USCS SYMBOL	GRAPHIC SYMBOL	GENERAL DESCRIPTION
COARSE GRAINED SOILS	GRAVEL Coarse: 3"–3/4" Fine: 3/4"–#4 Classification based on > 50% being gravel	GW	▨	Well graded gravels, gravel & sand mix.
		GP	▨	Poorly graded gravels, gravel & sand mix.
		GM	▨	Gravel, sand and silt mix.
		GC	▨	Gravel, sand and clay mix.
	SAND Coarse: #4–#10 Med.: #10–#40 Fine: #40–#200 Classification based on > 50% being sand	SW	▨	Well graded sand, sand & gravel mix.
		SP	▨	Poorly graded sand, sand & gravel mix.
		SM	▨	Sand and silt mix.
		SC	▨	Sand and clay mix.
FINE GRAINED SOILS	SILT & CLAY Classification based on > 50% passing #200 sieve.	ML	▨	Inorganic silt, low plasticity.
		CL	▨	Inorganic clay, low plasticity.
		OL	▨	Organic silt/clay, low plasticity.
		MH	▨	Inorganic silt, high plasticity.
		CH	▨	Inorganic clay, high plasticity.
		OH	▨	Organic silt/clay, high plasticity.
ORGANIC SOILS		Pt	▨	Peat and other highly organic soils.
FILL		Fill	▨	Miscellaneous fill materials.

TABLE 5
ROCK CLASSIFICATION TERMS

HARDNESS:

Very Soft	Carves
Soft	Grooves with knife
Med. Hard	Scratched easily with knife
Hard	Scatched with difficulty
Very Hard	Cannot be scratched with knife

WEATHERING:

Fresh	Slight or no staining of fractures, little or no discoloration, few fractures.
Slightly	Fractures stained, discoloration may extend into rock 1", some soil in fractures.
Moderately	Significant portions of rock stained and discolored, soil in fractures, loss of strength.
Highly	Entire rock discolored and dull except quartz grains, severe loss of strength.
Complete	Weathered to a residual soil.

BEDDING:

Massive	> 40"
Thick	12' – 40"
Medium	4" – 12"
Thin	< 4"

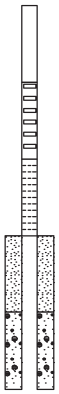
FRACTURE SPACING:

Massive/V. Wide	> 6'
Thick/Wide	2' – 6'
Med./Med.	8" – 24"
Thin/Close	2 1/2" – 8"
V. Thin/V. Close	< 2 1/2"

RQD:

Excellent	> 90%
Good	76% – 90%
Fair	51% – 75%
Poor	25% – 50%
V. Poor	< 25%

TABLE 6
WELL CONSTRUCTION



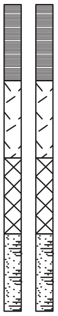
SOLID PVC PIPE

SCREENED PVC PIPE

STAINLESS STEEL
SCREENED PIPE

FINE GRAINED
WASHED SAND

WASHED SAND



BENTONITE PLUG

AIR ENTRAINED
CEMENT

NATURAL SOIL/
ROCK FILL

BENTONITE/
CEMENT GROUT

File: O:_GEOPUBLIC\LOG LEGENDS\USCS\LL-ENG-USCS.DWG Saved: 9/27/2012 2:51:06 PM PLotted: 9/27/2012 3:01:26 PM User: Gray, Timmolyn

Authors: Sarah Newell and Mark Corey
Reviewer: Keith Cowan

BOREHOLE INSTALLATION AND SAMPLING

A. PURPOSE/SCOPE:

The following SOP presents a description of the methods generally employed for the installation of boreholes and the collection of subsurface soil samples. Boreholes are typically advanced to define geologic conditions; allow the installation of monitoring wells and piezometers; and allow the collection of subsurface soil samples (generally above the water table) for chemical analysis. Although several manual methods are available for the collection of subsurface soils samples (e.g. hand augers, post-hole augers [see SOP #305 and SOP #307]), the most common method used by CHA to advance boreholes is a drill rig equipped with hollow-stem augers (HSA) or direct-push technology (DPT). Representative samples are most often collected utilizing split-spoon samplers or Macrocore technology.

The purpose of drilling test borings is typically to characterize the lateral and vertical extent of contamination in the unsaturated zone. The test borings may also be used to allow the installation of ground water monitoring wells. Test borings may also be used to determine the subsurface characteristics for the purpose of geotechnical investigations.

B. EQUIPMENT/MATERIALS:

Drilling will be performed by a licensed drilling firm under the direction of CHA staff. The drilling field crew will consist of a driller, a driller's assistant, and a CHA field geologist/engineer. The field geologist/engineer will supervise drilling operations and conduct the geologic logging of the boreholes. A list of typical equipment needed for installation of monitoring wells at the site is summarized in the table included in SOP #309.

C. PROCEDURE:

1. Subcontractor Responsible for Utility Clearance - Subcontractor shall take all reasonable precautions, including contacting the appropriate utility organizations (USPFO, Dig Safe, etc.), in order to verify there are no buried utilities at the test boring and test pit locations.
2. The drilling rig and sampling equipment may be required to be decontaminated by steam-cleaning (high pressure, hot water) prior to drilling and in between borings, depending on the job requirements
3. The borings will be drilled with direct push technology (DPT), hollow-stem augers, flush joint casing, open hole or any combination depending on the type of information needed, geologic conditions, and other limitations that may be imposed due to contamination or state or federal guidelines. The boring shall be advanced to match the sampling interval (continuous or standard sampling).
4. Drilling progress and information about the formations encountered shall be recorded by the geologist on the field boring log. The information should include total depth drilled, depths and thickness of strata, problems with borehole advancement, fill materials encountered, and water levels.

BOREHOLE INSTALLATION AND SAMPLING

Hollow Stem Auger/Flush Joint Driven Casing

a. At the chosen depth interval, drive a clean, standard, 24-inch long, 2-inch O.D. split-spoon sampler into the soil a distance of 24 inches using a 140 lb hammer, free falling 30 inches. Record the number of blows required to drive the sampler every 6 inches on the field boring log. Discontinue driving the sampler if 100 blows have been applied and the sampler has not been driven 6 inches. If 6 inches of penetration has been achieved, discontinue driving the sampler after 50 blows has failed to penetrate fully any of the remaining 6 inch intervals. The first six inches seats the spoon, the next 12 inches represents the Standard Penetration Resistance, and the last six inches is driven to insure sample recovery.

b. Retrieve the sampler from the borehole and place it on a clean, flat surface. Open the sampler and immediately scan the sample with an air monitoring instrument (e.g., HNu or OVA) if appropriate to the purpose of the investigation. Record instrument readings on the field boring log.

Direct Push Technology

a. The DPT is hydraulically powered and mounted in a customized four-wheel drive vehicle. Position the base of the sampling device on the ground over the sampling location and hydraulically raise the vehicle on the base. As the weight of the vehicle is transferred to the probe, the probe is pushed into the ground.

b. Soil samples will be collected with a Macrocore (or equivalent). The sample tube is pushed and/or vibrated to a specified depth. The interior plug of the sample tube is then removed by inserting small-diameter threaded rods. Drive the sample tube an additional foot to collect the soil sample. Withdraw the probe sections and sample tube.

Shelby Tube Sampling

a. Further, describe and record the following properties of the sample: Sample length recovered, presence of any slough in sampler, basic soil type (e.g., sand, gravel, clay), structure, texture, sorting, grain size, grain shape, degree of saturation, competency, color, odor, staining, and presence of foreign material(s). Refer to SOP#301, Field Description of Soils.

b. After the soil within the sampler has been described, it will be placed in sealed sample jars directly from the sampling device.

c. If appropriate to the investigation, the air space surrounding the borehole shall be scanned with a FID or PID and Explosimeter during all drilling activities to determine the presence or absence of volatile organic compounds. Results of this air monitoring shall be recorded on the Geologic Field Log. Activities shall proceed according to the site HSP if the presence of volatile organic compounds is indicated.

5. Upon completion of the test boring, all drill cuttings shall either be placed back in the borehole or will be drummed based on potential contaminants encountered.
6. Note the locations of the borings on a site map and/or mark the locations of the boreholes with a labeled wooden stake.

BOREHOLE INSTALLATION AND SAMPLING

D. QA/QC REQUIREMENTS:

Follow QA/QC requirements for field documentation.

E. SPECIAL CONDITIONS:

1. Drilling Subcontract - The Field Team Leader must be familiar with the scope, fee, schedule, and all the terms and conditions of the drilling subcontract. When contractual issues or questions arise during the fieldwork, the Field Team Leader should communicate with the Project Manager and with the owner/client as appropriate.
2. Abandoned Borehole - If the contractor is not able to finish the drilling or has to abandon the borehole due to loss of tools, accidents or any unforeseeable circumstances, the contractor should remove the casings or drive pipes already in the hole and refill it with native soil cuttings, sand, grout, or as approved by the Engineer. All materials extracted from the hole, after refilling it will be managed as investigation derived material and will be disposed of accordingly. Typically, another borehole will be attempted in the area of the initial borehole attempt.
3. Subcontractor/Driller Standby Time - Document any conditions that may result in driller/subcontractor standby time. Such conditions may include adverse weather conditions, lack of access to the property, utilities not marked out, etc. Standby time may result in additional costs from our subcontractor that may not be planned for or approved. Communicate any conditions that may result in standby time to the CHA Project Manager as soon as possible.

F. REFERENCES:

ASTM Standard D 1586

Drilling Subcontract Scope, Schedule, Fee, Terms, and Conditions

NYSDEC DER-10, May 2010 (or current version)

CHA's Legend to Subsurface Logs

G. APPENDICES/FORMS:

Boring Log Form

END OF SOP
Final Check by C. Burns 10/07/15

Author: C. Burns
Reviewer: S. Benson

MONITORING WELL INSTALLATION

A. PURPOSE/SCOPE:

The following standard operating procedure (SOP) presents a description of the methods generally employed for the installation of monitoring wells. Monitoring well installation creates access for collection of groundwater samples which are used to define the lateral and vertical extent of groundwater contamination, to determine the elevation and fluctuations in the water table, as an observation point during pump tests, to aid in determining the hydraulic conductivity of screened soil layers, and to establish a background level for the local groundwater chemistry. Wells are also installed for the purpose of environmental remediation projects and include air-sparging wells, soil vapor extraction wells, and groundwater recovery wells.

The most commonly used drilling methods are hollow-stem auger, mud rotary, and air rotary. The procedures described below are intended to provide access to groundwater with minimum disturbance to the aquifer. Additionally, the procedures are intended to prevent cross-contamination between aquifers.

B. EQUIPMENT/MATERIALS:

Drilling will be performed by a licensed drilling firm under the direction of CHA. The drilling field crew will consist of, at a minimum, a driller, a driller's assistant, and a CHA field geologist/engineer. The field geologist/engineer will supervise drilling operations and conduct the geologic logging of the boreholes. A list of typical equipment needed for installation of monitoring wells is included below.

a. Heavy Equipment

- Drill rig
- Water truck (if needed)
- Grout mixer
- Steam cleaner
- Generator for steam cleaner

b. Sampling Tools

- 2-Inch I.D split-barrel samplers or 3-Inch I.D. thin-walled sampling tubes

c. Well Casing Materials

- Varies with job requirements

d. Other Well Construction Materials

- Type I Portland cement
- Bentonite pellets
- Washed sand of various grain sizes depending on screen or geologic conditions

e. Miscellaneous Equipment/Materials

- Bore brush
- 55-Gallon drums
- Stainless steel tape (100 feet)
- Tremie pipe
- Shovels

MONITORING WELL INSTALLATION

C. METHODS:

1. Hollow Stem Auger

Wells can be installed in unconsolidated formations using hollow-stem augers. The augers are advanced by rotation and the drill cuttings are brought to the surface by travelling up the outside of the auger flights in a screw-like manner. Upon reaching the planned well depth, the casing and screen are placed inside the hollow-stem augers and the flights are individually removed while the annual space around the well is filled with filter pack and grout.

Outside diameters of hollow-stem augers generally range from 6 ¼ inches to 22-inches with corresponding inner diameters ranging from 2 ¼ inches to 13 inches. Auger lengths are usually 5 feet which allows easy handling. Soil samples can be collected using split spoons or Shelby tubes, which can be used inside the augers.

Advantages of hollow-stem auger drilling include:
- allowing the well to be installed inside the hollow stem of the auger, which prevents the borehole from collapsing and representative soil samples can be easily obtained using split-spoon samples
- relatively fast and inexpensive
- well development is usually less difficult than with wells drilled by the mud rotary method

Disadvantages of hollow-stem auger drilling include:
- very slow or impossible to use in coarse materials such as cobble or boulders
- cannot be used in consolidated formations
- generally limited to depths of approximately 100 feet in order to be efficient

2. Air Rotary

The air rotary method uses air as the drilling fluid. Air is forced down the drill rods by an air compressor, escapes out of the bit and returns to the surface in the annual space between the borehole wall and the drill string. Cuttings are moved out of the hole by the ascending air and collect around the rig. The bit is pneumatically driven rapidly against the rock in short strokes while the drilling string slowly rotates. The air supply must be filtered to prevent introduction of contamination into the borehole.

The advantages of air rotary drilling include:
- fast, more than 100 feet of borehole advancement a day is possible
- preliminary estimates of well yields and water levels are often possible
- no drilling fluid to plug the borehole

The disadvantages of air rotary drilling include:
- generally cannot be used in unconsolidated formations
- in contaminated zones, the use of high-pressure air may pose a significant hazard to the drill crew because of transport of contaminated material up the hole
- introduction of air to the groundwater could reduce concentration of volatile organic compounds.

MONITORING WELL INSTALLATION

D. PROCEDURE:

Wells Installed in Unconfined Aquifers

Refer to SOP #303 for drilling procedures used to advance boreholes.

The following procedure describes construction of a monitoring well using 2-inch diameter water-tight flush threaded PVC well casing and screen. The slot size of the screen will be determined depending on the data required and the type of soil screened. Filter pack sand size used will be dependent on the screen slot size and various state and federal regulations.

It should be noted however, that the diameter and type of well casing material may differ according to different specific applications.

1. Well casing and screens should be new and brought to the site enclosed in plastic. Contact of casing or screen with the ground prior to installation shall be avoided. Plastic sheeting (e.g., visqueen) shall be placed on the ground and used as a cover to protect stockpiled materials from contamination.
2. If monitoring for contaminants less dense than water, drilling will proceed to a depth of several feet below the water table. The well will be screened across the water table, using approximately ten feet of screen.
3. If monitoring for contaminants more dense than water, drilling will proceed until the first confining surface (e.g., clay layer, top of bedrock, etc.) is encountered. In these situations, ten feet of screen will be placed immediately above the confining surface.
4. A sand pack composed of washed sand will be tremmied in the annular space of each monitoring well. The filter pack will be placed at 6 inches below the bottom of the well screen to two feet or 20 percent of the screen length, whichever is greater, above the well screen.
5. A bentonite seal at least 3 feet thick will be placed on top of the filter pack. The preferred method of placing bentonite is by the tremie method, however the bentonite may be poured in boreholes less than 50 feet in depth.
6. The remaining annulus to the ground surface will be filled with a cement-bentonite grout using a tremie pipe. Depending on local requirements, a certain amount of setting time for the bentonite seal may be required before the bentonite/cement grout is placed.
7. The wells shall extend three feet above grade. A four to six inch diameter protective steel surface casing shall be installed over the completed well and will be surrounding by a three-foot square concrete pad extending below the frost line. The pad should be shaped to shed rainwater and the protective casing should be fitted with a lockable water-tight cap. Weep holes should be drilled at the base of the protective steel casing and a vent hole must be drilled at the top of the PVC casing to allow water levels to respond to barometric changes and prevent explosive gas buildup. The annular space of the protective casing should be filled with gravel or coarse sand.
8. In cases where wells must be installed in high traffic areas, the protective steel casing may be replaced with a manhole which is mounted flush with surface grade. The protective casing will be grouted in place and fitted with bolts and rubber gaskets. The well top will be fitted with a locking cap.

9. The drilling rig and sampling equipment may be required to be decontaminated by steam-cleaning (high pressure, hot water) prior to drilling and in between borings depending on the job requirements.
10. Drilling progress and information about the formations encountered shall be recorded by the geologist on the field boring log. The information should include:
    - Borehole Depth
    - Well Screen Depth
    - Filter Pack Interval
    - Seal Interval
    - Grout Interval
    - Surface Cap Detail
    - Well Material
    - Well Riser and Screen Length
    - Well Diameter
    - Filter Pack Material
    - Date Installed

<u>Wells Installed in Confined Aquifers</u>

Wells installed in confined aquifers must penetrate a confining layer. That confining layer may be a clay lens in more porous unconsolidated materials or unfractured bedrock in consolidated materials.

1. Drill to the top of the confining surface. Grout the steel casing in place. After the grout has set, proceed drilling until the desired depth is reached.
2. If drilling proceeds through more than one confining layer, repeat the process described above, except the first aquifer will be cased off with a wider casing and the second aquifer will be cased off with narrower diameter casing, etc.
3. A well will then be constructed and installed in this borehole in the same manner as described in the steps for an unconfined aquifer.
4. When install a well in fractured bedrock, it may be possible to leave the open borehole as is, depending upon the competency of the rock.

E. QA/QC REQUIREMENTS:

Instruments used during groundwater sampling should be calibrated at the beginning of each day. If a measurement falls outside the calibration range, the instrument should be recalibrated so the measurements fall within the calibration range. The calibration should be checked at the end of each day to verify the instruments remained in calibration.

MONITORING WELL INSTALLATION

F. SPECIAL CONDITIONS:

We have seen cases where settlement causes the PVC riser to extend above the steel casing over time. Drillers often "rest" the cap of the outer protective casing on the PVC riser (or on an attached gripper plug) when pouring the concrete surface pad. This provides no room for settlement since the PVC is at, or near the top of the steel casing cap. When completing the well installation, recommend that the driller use a block or spacer on top of the riser to provide separation from the cap of the steel casing. Once the concrete for the pad and casing has set, the spacer can be removed.

G. REFERENCES:

New Jersey Department of Environmental Protection (August 2005), *Field Sampling Procedures Manual*, Chap. 6, retrieved January 5, 2009 from http://www.nj.gov/dep/srp/guidance/fspm/.

United States Environmental Protection Agency (March 13, 1996), *Monitor Well Installation*, retrieved March 18, 2009, from http://www.dem.ri.gov/pubs/sops/wmsr2048.pdf

H. APPENDICES/FORMS:

Monitoring Well Construction Log

END OF SOP

Final Check by C. Burns 10/07/15 (Revised Title 5-30-17)

WELL DEVELOPMENT

A. PURPOSE/SCOPE:

Prior to the collection of hydraulic or groundwater quality data, a monitoring well must be developed. Well development is necessary to remove drilling fluid and construction residues remaining in the borehole or surrounding aquifer, restore the hydraulic properties of the formation immediately surrounding the screened interval, and sort the filter pack material to allow groundwater to freely flow into the monitoring well.

Well development can be accomplished using bailing, overpumping, mechanical surging, and air-lift methods. The best methods involve surging water flow back and forth through the well screen to sort the filter pack materials. These methods include bailing, pumping/overpumping/backwashing, and surging with a surge block, or a combination of these methods. Pumping alone will tend to cause particles moving toward the well to form blockages that restrict subsequent particle movement.

Mechanical surging forces water to flow into and out of a screen by operating a plunger up and down in the casing, similar to a piston in a cylinder. The tool normally used is called a surge block, surge plunger, or swab. Silt and sediment loosened by the surging is removed by either a bailer or pump. The combination of mechanical surging and pumping are generally used in 2 to 4-inch diameter monitoring wells.

Compressed air can also be used to develop wells in consolidated and unconsolidated formations. Most air rotary drilling rigs have sufficient air capacity to develop 6-inch to 12-inch diameter wells. Airlift methods may introduce air into the aquifer surrounding the monitoring well, potentially altering groundwater quality, particularly for volatile organics.

Overpumping/backwashing creates an increase in the flow velocity of the water to the well, creating a rapid and effective migration of particulates toward the well. Where there is no backflow-prevention valve installed, the pump can be alternately started and stopped, allowing the column of groundwater that is initially picked up by the pump to be alternately dropped and raised up in a surging action (backwashing).

Bailing is an effective development technique in relatively clean, permeable formations where water flows freely into the well. The bailer is dropped until it strikes the surface of the water, producing an outward surge of water. As the bailer fills and is rapidly withdrawn, the particulate matter outside the well flows into the well. Subsequent bailing removes the particulate matter.

B. EQUIPMENT/MATERIALS:

- Surge block
- Inertial or submersible pump
- Bailer
- Air compressor and air line
- Well development log

WELL DEVELOPMENT

C. PROCEDURE:

1. Mechanical Surging and Pumping

   a. Before starting to surge, the well should be evacuated to ensure water will flow into it.

   b. Lower the surge block into the well until it is 10 to 15 feet beneath the static water level, but above the well screen. The water column will effectively transmit the action of the surge block to the screen section. The initial surging motion should be relatively gentle, allowing any material blocking the screen to break up, go into suspension, and move into the well.

   c. As water begins to move easily both into and out of the screen, the surging tool is usually lowered progressively downward through the entire length of the screen. As the block is lowered, the force of the surging movement is increased.

   d. Continue surging for approximately 20 minutes, then pull the block from the well. A pump or bailer may be used to remove the sediment out of the well. Pumping should continue for approximately 20 minutes.

   e. Continue alternating the surging and pumping action until little or no sand or fines can be pulled into the well. The turbidity of the final discharge water should be below 50 NTU.

2. Airlift Development

   a. Place the airline into the water at a shallow depth. Initially, the airlift should be operated to pump fluids at a reduced rate from the well. Once a constant flow rate from the well has been established, the airline is lowered to within five feet of the bottom of the screen, assuming that sufficient pressure is available to overcome the static head. Development can also start near the top of the screen, depending on the preference of the driller.

   b. A surging action is created by injecting air into the well to lift the water to the surface. As the water reaches the top of the casing, the air supply is shut off, allowing the aerated water column to fall (this procedure is called "rawhiding"). This tends to drive the water outward through the well screen openings.

   c. After surging the well for a period of 20 to 30 minutes, the air should be applied in a continuous manner so that the water is expelled from the casing. The airline should be lowered to the bottom of the well so that accumulated sediment will be expelled. Surging and lifting cycles are repeated until the water is relatively free of sand and fine particles. The turbidity of the final discharge water should be below 50 NTU.

3. Overpumping / Backwashing

   a. Place the pump in the well and lower until it is 10 to 15 feet beneath the static water level.

   b. Pump the groundwater from the well at a rate that substantially exceeds the rate that the formation can deliver the water.

   c. Alternately start and stop the pump to allow the column of water that is initially picked up by the pump to be alternately dropped and raised up in a surging action.

   d. After surging the well for a period of 20-30 minutes, the pump should be lowered to the bottom of the well and operated in a continuous matter so that accumulated sediment will be expelled.

WELL DEVELOPMENT

   e. Surging and lifting cycles are repeated until the water is relatively free of sand and fine particles. The turbidity of the final discharge water should be below 50 NTU.

4. Bailing
   a. Drop the bailer so it is allowed to fall freely through the monitoring well until it strikes the surface of the water.
   b. After the bailer fills with groundwater, rapidly withdraw it from the monitoring well.
   c. Subsequent bailing will remove the sand and other particulate matter from the well.
   d. Bailing should be continued until the turbidity of the final discharge water is below 50 NTU.
   e. QA/QC REQUIREMENTS:

If an air compressor is used to develop the wells, make sure a filter is present on the compressor. Otherwise, oil from the compressor will be present in the airstream that enters the well.

D. SPECIAL CONDITIONS:

The surge block should be operated with care in cases where excessive sand will be introduced through the well screen to prevent the tool from becoming sand locked.

Air development procedures should begin by determining that groundwater can flow freely into the screen. Application of too much air volume in the borehole when the formation is clogged can result in a collapsed screen.

E. REFERENCES:

New Jersey Department of Environmental Protection (August 2005), *Field Sampling Procedures Manual*, Chap. 6, retrieved January 5, 2009 from http://www.nj.gov/dep/srp/guidance/fspm/.

F. APPENDICES/FORMS:

Well Development Log

END OF SOP

Final Check by C. Burns 10/07/15

Author: Sarah Johnston
Reviewer: Keith Cowan

MEASUREMENT OF WATER LEVEL/ FREE PRODUCT THICKNESS

A. PURPOSE/SCOPE:

Measurements of static groundwater levels are used to determine the general elevation of groundwater, to evaluate horizontal and vertical hydraulic gradients, and to calculate the volume of water to be purged from a well prior to sampling. Seasonal fluctuations of the water table can also be assessed when water levels are monitored over the long term. Individual measurements of free product thickness are used to evaluate the presence of free product and also to determine the lateral extent of free product contamination in an unconfined aquifer.

B. EQUIPMENT/MATERIALS:

- Electronic water level meter
- Clear polyethylene or Teflon bailer (for free product measurement only)
- Oil/water interface meter (for free product measurement only)
- Field data sheets
- Well keys if necessary
- Decontamination supplies

C. PROCEDURE:

1. Identify and inspect the well. Determine if the well cap and lock are present and in good working order. Note any defects in the well casing or surface seal in field notes.
2. If it is known that free product is not present in the well, the electronic water level indicator may be used to measure the depth to water according to the meter instructions.
    a. Every well should have an established measuring point on the inner well casing that is clearly marked and used during each monitoring event. Measure the depth to the water from the established reference point to the nearest 0.01 foot. For any site, all measurements should be made during the same day, prior to any purging activities that will affect water levels (see Section J, Special Conditions).
    b. If it is unknown whether free product is present in a well, collect a water level measurement as per Step A above. Then lower a dedicated clear bailer into the well until liquid is encountered, being careful not to fully submerge the bailer. Remove the bailer from the well and measure the thickness of the free product, if present, using a tape measure or ruler. Record the measurement to the nearest 0.01 foot.
    c. If free product is known to exist in a well, the use of an oil/water interface meter is recommended. The meter incorporates both optical and conductivity sensors to determine if the probe is in product or water, respectively. The probe typically emits two different types of signals; one for free product and one for water. Slowly lower the probe until the first signal indicates the interface between air and free product has been reached. Then continue to lower the probe until the second signal indicates the interface between free product and water. The water/product interface measurement is actually best taken while moving the probe back up from the water toward the floating product interface, as this minimizes the effects of product coating the conductivity probe.

MEASUREMENT OF WATER LEVEL/ FREE PRODUCT THICKNESS

Repeat the measurements and record all measurements to the nearest 0.01 foot. In the event that an oil/water interface probe is not available, free product measurements may be collected using a clear bailer as described in Step B above.

3. Record all data on the field data sheet or log book. This includes all measured depths and notation of the measuring point on the well casing (i.e., top of inner PVC casing, top of steel protective casing, etc.). Water level measurements are eventually used to calculate water elevations above mean sea level using the surveyed elevations of each well.
4. Decontaminate the probe after each use according to the complete procedures in SOP #501, Small Equipment Decontamination. Field decontamination procedures generally include removal of gross contamination by scraping/brushing and rinsing, followed by a wash with Alconox® to remove all visible contamination, and a re-rinse with potable water to remove the detergent. The water level meter probe and the entire length of tape subject to contamination should be decontaminated. The meter should be decontaminated between each well. Field staff should also consult the site specific work plan for any specialized decontamination requirements.

D. QA/QC REQUIREMENTS:

Not Applicable

E. SPECIAL CONDITIONS:

When measuring water levels in multiple wells on a site, all measurements should be collected in as short of time as possible to minimize the effects of daily fluctuations in water levels. This is particularly important in areas where groundwater levels may be tidally-influenced. Other possible causes of fluctuations include precipitation events, changes in barometric pressure, pumping of nearby wells, and changes in river stage or flow in unlined ditches. If any of these conditions are observed they should be recorded in field notes.

For newly installed wells or piezometers, a period of 24 hours should be allowed prior to measurement so water levels stabilize following development. Additionally, any well with a cap capable of producing an air tight seal on the casing may contain a vacuum or pressurized zone that can measurably affect water levels. In this instance, water level measurements should be repeated until the level has stabilized following cap removal.

F. REFERENCES:

U.S. EPA Environmental Response Team, 2000: Standard Operating Procedures, SOP #2043, Manual Water Level Measurements

G. APPENDICES/FORMS:

Field Data Sheets

END OF SOP
Final Check by C. Burns 10/07/15

LOW-FLOW GROUNDWATER PURGING/SAMPLING

A. PURPOSE/SCOPE:

Low-flow purging is purging using a pumping mechanism that produces low-flow rates [less than 1 liter per minute (lpm) or less than 0.26 gallon per minute (gpm)] that cause minimal drawdown of the static water table and usually employs a flow cell in which geochemical parameters are continuously monitored. These parameters may include dissolved oxygen content, oxidation-reduction potential (redox), conductivity, turbidity, and pH.

The intent of this sampling protocol is to collect a representative sample from the monitored groundwater zone. A representative sample may be obtained when all the monitored chemical parameters have stabilized, thus qualitatively demonstrating that the groundwater being purged is in equilibrium (refer to Table 3). Samples are collected directly from the pumping mechanism with minimum disturbance to the aquifer groundwater. The low-flow/low volume purging method (purging to parameter stability) tends to isolate the interval being sampled, which provides more accurate water quality measurements and reduces the volume of purge water generated. This method has an advantage in that it can limit vertical mixing and volatilization of volatile organic compounds in solution within the well casing or borehole as compared to high-flow purging and sampling.

An overview of this methodology is presented in Puls and Barcelona, 1996. Low-flow purging and sampling is appropriate for collection of groundwater samples for all groundwater contaminants, including inorganic compounds, metals, pesticides, PCBs, volatile and semi-volatile organic compounds (VOCs and SVOCs), other organic compounds, radiochemical and microbiological constituents. This method is not applicable to the collection LNAPL or DNAPL.

B. EQUIPMENT/MATERIALS:

- Inertial pump
- Submersible pump
- Disposable bailers
- Generator
- Sample bottles
- Bailing twine and rope
- Field analyses meters
- Sampling gloves
- Water level meters
- Filtration system
- 2-Inch grundfos rediflow pump and controller
- Well sampling forms

Depending on the purging method to be used, there are specific equipment limitations. Table 1 provides a description of the various methodologies and their applicability. The proper selection of sampling devices or pumps is critical to the quality and representation of the sampling results. The following table provides a summary of the acceptable sampling methods for the various compounds of concern.

Table 1
Acceptable Sampling Methods for Compounds of Concern

Method	**VOCs**	**Semi-VOCs**	**Metals and Inorganics**	**Petroleum Hydrocarbons**		**General Chemistry**
				C3-C16	**C16+**	
Peristaltic Pump	X	1	3	X	1	2
Centrifugal Pump	2	3	3	2	2	3
Submersible Impeller Pump (w/ controller)	2	3	3	2	3	3
Bailer	2	2	2	2	2	2
Bladder Pump	**3**	**3**	**3**	**3**	**3**	**3**
DPIS	3	3	2	2	2	2
Diffusion Sampler	2	2	X	2	2	X

1 - Not recommended, better methods exist
2 - Useful with limitations
3 - Recommended method
X – Unacceptable
Note: Centrifugal pump - assumed at a low-flow rate (no greater than 1 Lpm)

C. PROCEDURE:

1. The wells will be sampled in order from the least contaminated well to the most contaminated well.
2. Using a decontaminated measurement probe, determine the water level in the well; then calculate the fluid volume in the casing.
3. Setting up the Pump:
    a. Dedicated Systems

    Installation of any device into a well disturbs the stratification typically exhibited in a well due to laminar flow of groundwater in the well. Insertion also potentially mobilizes suspended solids in the water column due to disturbance of settled and solids in the casing and agitation of water in the filter pack. Dedicated systems result in lower initial turbidity values and lower purge volumes to achieve stabilized indicator parameter readings, and should be considered when a well will be sampled multiple times.

    b. Portable Systems

    If portable systems are used, they must be placed carefully into the well and lowered into the screen zone as slowly as possible to avoid disturbance of the groundwater resulting in non-equilibrium conditions. As a result, longer purge times and greater purge volumes may be necessary to achieve indicator parameter stabilization. In general, this may require that after installation, the portable pump should remain in place for a minimum of 1-2 hours to allow settling of solids and re-establishment of horizontal flow through the screen zone. If initial turbidity readings are excessive (>50 NTU), pumping should cease and the well should rest for another 1-2 hours before initiating pumping again. In wells set in very fine-grained formations, longer waiting periods may be required.

LOW-FLOW GROUNDWATER PURGING/SAMPLING

4. The flow rate used during purging must be low enough to avoid increasing the water turbidity. The following measures should be taken to determine the appropriate flow rate:
    a. The flow rate shall be determined for each well, based on the hydraulic performance of the well.
    b. The flow must be adjusted to obtain stabilization of the water level in the well as quickly as possible.
    c. The maximum flow rate used should not exceed 1 liter per minute (0.26 gpm).
    d. Once established, this rate should be reproduced with each subsequent sampling event.
    e. If a significant change in initial water level occurs between events, it may be necessary to re-establish the optimum flow rate at each sampling event.
5. Water Level Monitoring:
    a. Should not fluctuate more than 0.1 meters (~4 inches).
6. Measurement of indicator parameters (Dissolved oxygen content, redox potential, specific conductance, temperature and pH) is required. Continuous monitoring of water quality indicator parameters is used to determine when purging is competed and sampling should begin. Stabilized values, based on selected criteria listed in Table 2 should be met prior to sampling. The use of an in-line flow cell (closed) system is recommended for measuring indicator parameters, except for turbidity.

   For turbidity measurement, a separate field nephalometer should be used. Indicator parameter collection is more important when low-flow purging is used compared to the high-flow purging method. Generally, measurements are taken every 3 to 5 minutes and water chemistry parameters are considered to be stable when they are within the following ranges for three (3) consecutive readings:

Table 2
Stability Criteria for Low-Flow Purging

Constituent	**Criteria**
Dissolved Oxygen Content (DO)	± 10%
Oxidation-Reduction Potential (redox)	± 10 mv
Specific Conductance	± 03% of reading
pH	± 0.1 units
Turbidity	± 10%
Temperature	NA

Turbidity should be below 50 NTU, if possible. If sample turbidity can not be reduced below 50 NTU, a field filtered sample shall be collected for metals analysis in addition to an unfiltered sample. Record these readings on the well sampling log.

7. The order in which samples are to be collected is as follows:
    - Volatile Organic Compounds (VOCs)
    - Semi-Volatile Organic Compounds (SVOCs)

LOW-FLOW GROUNDWATER PURGING/SAMPLING

- Purgeable organic carbon (POC)
- Purgeable organic halogens (POX)
- Total organic carbon (TOC)
- Total organic halogens (TOX)
- Extractable organics
- Total metals
- Dissolved metals
- Phenols
- Cyanide
- Sulfate and chloride
- Turbidity
- Nitrate and ammonia
- Radionuclides

8. When collecting aliquots for analysis of volatile organic compounds, make absolutely certain that there are no bubbles adhering to the walls or the top of the VOA container.
9. Add appropriate preservatives to samples as described in SOP #605.
10. Label the sample containers with all necessary information and complete all chain-of-custody documents and seals.
11. Place the properly labeled and sealed sample bottles in a cooler with ice and maintain at 4oC for the duration of the sampling and transportation period. Do not allow samples to freeze.

D. QA/QC REQUIREMENTS:

To the extent possible, all samples should be collected using the same type of equipment and in the same manner to ensure comparability of data.

E. SPECIAL CONDITIONS:

Because the methodology requires that disturbance to the water column in the well be minimized, the same pumping device used for purging should be used for sampling.

Sample collection will be performed utilizing either an inertial pump system or disposable bailer. If the inertial pump system is used, samples will be obtained through the dedicated polyethylene tubing while maintaining a low-flow. Should disposable bailers be utilized, the sampling will be performed as follows:

Attach a new bailer line to the disposable bailer equipped with a single check valve. Check the operation of the check valve assembly to confirm free operation. Lower the single check valve bailer slowly into the well until it contacts the water surface. Then lower the bailer just below the water surface with a minimum of disturbance. When filled with groundwater, slowly raise the bailer to the surface. Discharge the first bailer to the ground. Tip the bailer to allow the water to slowly discharge from the top and to flow gently down the inside of the sample bottle with minimum entry turbulence and aeration.

LOW-FLOW GROUNDWATER PURGING/SAMPLING

Step 4 (*samples collected*) can be replaced if purging and sampling is being performed with a Grundfos Rediflow pump. In this case, after well purging was completed, the discharge rate for the pump would be reduced to approximately 40 ml/minute. Sampling can then proceed as described above.

F. REFERENCES:

Low-Flow (Minimal Drawdown) Ground-Water Samp*ling Procedures"* by Robert Puls and Michael J. Barcelona dated April 1996.

G. APPENDICES/FORMS:

Well Sampling Forms

END OF SOP
Final Check by C. Burns 11/4/15

SAMPLE COLLECTION FOR MICROPARTICULATE ANALYSIS

A. PURPOSE/SCOPE:

The objective of this standard operating procedure (SOP) is to ensure proper sample collection of microparticulate analysis (MPA) from potable wells which are located in the vicinity of surface water bodies. Parasites such as giardiasis are commonly present in surface water and can present a threat to drinking water quality if groundwater is under the direct influence of surface water bodies in endemic areas. The EPA Consensus Method for Determining Groundwater Under the Direct Influence of Surface Water Using Microscope Particulate Analysis (EPA 910-9-92-029, Oct 1992) uses identification and counts of various bioindicators (e.g., microorganisms and plant debris) to generate a risk rating score that indicates the likelihood that the groundwater is under the direct influence of surface water.

MPA testing is typically commenced towards the last several hours of a 72-hour pump test with the well pumped at its rated capacity to ensure that the well is in hydraulic connection with nearby, associated surface water bodies. Discharge water is diverted from the subject drinking water well through a water filtration over an 8 to 24 hour period. At the end of the test, the filter and water within the filter housing are submitted to a qualified laboratory for analysis, whereupon results are reviewed and a risk rating score is generated.

B. EQUIPMENT AND MATERIALS:

- Site Map and Work Plan
- Well keys and site access permission
- 5-gallon bucket or beaker
- Field parameter monitoring instruments for pH, oxidation reduction potential (ORP), dissolved oxygen (DO), turbidity, specific conductance, and temperature
- Pressure regulator (Watts IR56) and pressure gauge
- Water meter
- Flow control valve rated at 1.0 gallons per minute (gpm)
- Inlet and discharge hoses
- The following laboratory-provided sampling equipment:
    - Ten-inch cartridge filter housing (Model LT10 or equivalent)
    - Ten-inch 1µm polypropylene, yarn wound (string), nominal porosity cartridge filter (Carborundum honeycomb filter tube)
    - Sample bags and labels
    - Shipping container/cooler
    - Field data worksheets
    - Sample collection instructions

SAMPLE COLLECTION FOR MICROPARTICULATE ANALYSIS

C. PROCEDURE:

The typical procedures for conducting MPA testing following EPA's Consensus Method are outlined below. Please refer to instructions provided by the laboratory for any additional details regarding equipment set-up and sample collection.

General Considerations

1. Testing is conducted 8 to 24 hour period prior to the end of a 72-hour pump test. Refer to SOP # 323 as appropriate.
2. The sample should be collected closest to the well head, prior entering to distribution, storage tanks, and any treatment systems.
3. All screens/ aerators, strainers and hose attachments must be removed before sampling. These attachments tend to aerate the water that may cause bacteria and organics to be lost.
4. Rinse a clean, 5-gallon bucket or beaker with the well water to be sampled. Obtain pre-sampling water quality measurements using water quality instrument, including pH, conductivity, turbidity, DO, and ORP.
5. Assemble the sampling equipment (refer to figure in Appendix and any additional instructions provided by the laboratory), ensuring that units are assembled in the correct direction of water flow.
6. Prior to installing filter, clean the sampling unit and flush with source sample water for approximately 3 – 5 minutes.
7. Insert filter into housing wearing nitrile gloves, following any laboratory procedures to limit any cross contamination, then position equipment into upright position. Ensure washers are in place and tighten any fittings.
8. Begin the test by partially opening the sample control valve. Expel any air present by inverting the unit, as needed, and return to upright position when air has been removed. Turn control valve to complete open position.
9. Ensure the pressure gauge reads at 10 pounds per square inch (psi). Adjust fittings on the regulator as needed.
10. Adjust flow rate to 1.0 gpm and record meter reading and time.
11. Divert at least 500 gallons of sample water (recommended 1,000 gallons) through the filter over an 8 - 24 hour period.
12. If possible, obtain additional water quality measurements (pH, conductivity, turbidity, DO, and ORP) while sampling, noting if conditions rapidly change.
13. After sufficient sample is collected, turn off the sampling tap, record the time, pressure meter reading, and flow meter reading. Disconnect the sampling apparatus and pour residual water out of the filter canister, leaving approximately 100 – 200 milliliters (mL) behind for water sample collection.

14. Collect a water sample by turning the unit upside down and allowing water to drain into the laboratory-provided sampling bag, ensuring that the filter remains intact in the housing in the process. After donning nitrile gloves, open the filter housing to remove the filter and place into the same bag containing the sample water.
15. Label the laboratory-provided sample bag with the proper sample ID, time of collection, job number, parameters to be analyzed, and the sampler's initials.
16. Place filled sample bag in upright position in cooler and use sufficient ice to maintain a temperature of 4°C while samples are transport to laboratory. Do not allow the sample to freeze. Complete a chain-of-custody form (SOP #105) in addition to any data sheets provided by the laboratory. Ship or transport samples, chain-of-custody, and any data sheets to laboratory.
17. The holding time (beginning after completion of sample collection) for MPA is 48 hours and samples must be run by the laboratory within 96 hours.

D. QA/QC REQUIREMENTS:

When possible, the samples should be collected using the same type of equipment and in the same manner to ensure comparability of data if more than one sample is obtained.

Instruments used during sampling should be calibrated at the beginning of each day or prior to use on that day. If a measurement falls outside the calibration range, the instrument should be recalibrated so the measurements fall within the calibration range. The calibration should be checked at the end of each day to verify the instruments remained in calibration.

E. SPECIAL CONDITIONS:

Notify the local and/or state Department of Health prior to conducting sampling and follow any additional directives, as applicable.

If the well has been disinfected (i.e., chlorination) prior to conducting sampling, contact the laboratory in advance, as additional procedures may be necessary to employ during sampling. If the sample is chlorinated, it is advisable to add 50 ml of 1 % sodium thiosulfate to the bag and shake before bringing the sample back to the laboratory.

F. REFERENCES:

United States Environmental Protection Agency, 1992, Consensus Method for Determining Groundwater Under the Direct Influence of Surface Water Using Microscope Particulate Analysis, retrieved May 29, 2018 from https://nepis.epa.gov/Exe/ZyPDF.cgi/P100C58D.PDF?Dockey=P100C58D.PDF

Washington State Department of Health, 2003, Guidance Document: Potential GWI Sources – Microscope Particulate Analysis, retrieved May 29, 2018 from https://www.doh.wa.gov/Portals/1/Documents/Pubs/331-231.pdf

SAMPLE COLLECTION FOR MICROPARTICULATE ANALYSIS

G. APPENDICES/FORMS:

Typical MPA Water Sampling Device Schematic (taken from EPA's C*onsensus Method for Determining Groundwater Under the Direct Influence of Surface Water Using Microscope Particulate Analysis* (MPA), 1992)

END OF SOP

Final Check by C. Burns 5/31/18

STEP DRAWDOWN AND CONSTANT RATE PUMP TESTS

A. PURPOSE/SCOPE:

Step drawdown and constant rate pump tests are used to gather data about the yield of a well and the hydraulic properties of an aquifer, respectively. These tests are sometimes referred to as aquifer tests. The typical purpose of an aquifer test is to determine the tested aquifer's performance capability and to quantify the hydraulic parameters including storativity and transmissivity. An aquifer test may also be conducted to determine the potential effects of pumping on surrounding wells, or to determine the degree to which two or more aquifers are hydraulically connected. In addition, the procedures for hydrogeologic formation testing can also be used to determine well performance characteristics. Two different types of pumping tests are described below: step drawdown tests and constant rate pump tests.

B. EQUIPMENT/MATERIALS:

- Site map and Work Plan
- Well keys and site access permission
- Appropriate length electronic water level meter(s) (may require rental)
- Water pressure transducers/ data loggers
- Laptop with appropriate software and adaptors if using data loggers
- Stopwatch and watch
- Barometer
- Flashlight/spotlights for nighttime measurements if necessary
- Water Level Measurement Equipment and Supply Checklist.

C. PROCEDURE:

The procedures for both step drawdown tests and constant rate pump tests are outlined below. A step test may be performed alone to determine well performance, but should be performed in advance of a constant rate pump test to determine the optimal pumping rate for that test.

Step Drawdown Pump Test:

1. This SOP assumes a test well has already been installed. Consideration to the site-specific hydrogeologic setting (e.g., unconfined or confined and unconsolidated or bedrock) must be given with regard to well diameter and screen setting for the test well.

2. This SOP also assumes that the test well has been fully developed with a target turbidity of 5 NTUs or less prior to the start of a pump test.

3. Water levels in the pumping wells and observation wells should be monitored at regular time intervals for at least 24 hours prior to the start of the pump test.

4. All persons involved in the test should synchronize their watches prior to starting the test, or the use of cell phone clocks is also useful for this purpose.

5. The pump test will begin at a rate that is dependent on the estimated well yield, based either on driller estimates or other previous yield information. The test will continue at the first rate for one hour. Drawdown in the well will be measured every half a minute for the first ten minutes, every minute from 10 to 15 minutes, and every 5 minutes from 15 to 60 minutes, as shown on the Step Test Log.

STEP DRAWDOWN AND CONSTANT RATE PUMP TESTS

After one hour, the pumping rate will be increased an appropriate increment, dependent on the well performance during the first step (typical steps are increments of 10 gpm up to 100 gpm). The water levels will again be measured at the time intervals listed above. The procedure described above will be repeated until the well cannot support the pumping rate or the maximum pumping rate of the pump is reached.

6. Following the conclusion of the final step, water level measurements will be taken for the recovery period of the test immediately following pump shut-down. Water level measurements will be taken at the same frequency as described in Step 5 for at least 8 hours or until the 90% of the total drawdown measured in the well has recovered.

Pump Testing:

1. This SOP assumes one or more observation wells have already been installed.
2. In an unconfined aquifer, observation wells should be spaced no more than 100 to 300 feet from the pumping well. In a confined aquifer, observation wells should be installed 300 to 700 feet from the pumping well.
3. Observation wells should be installed and screened at the same depth of the pumping wells. Wells with screens fully penetrating the saturated zone are preferred.
4. If working in a setting with potential anisotropic flow (e.g., fractured rock with strong fracture orientation, consider placement for the observation wells along the preferential strike of the fracture zones.
5. The discharge outlet for the pumping well should be placed far enough away to prevent the re-introduction of water back into the aquifer (i.e., recycling). The discharge should also be constructed in such a manner to prevent erosion at the end of the discharge pipe.
6. There are various methods to confirm the discharge rate including use of a weir, flume, or flowmeter at the discharge point. Any method selected shall be capable of direct flow measurements in gallons per minute. The discharge rate should be monitored throughout the pump test to confirm pumping is occurring a constant rate.
7. If working in a remote area and using a generator to power the pump, supplies of fuel for the generator should be on hand and provisions to prevent spills should also be implemented.
8. The weather for 2 to 3 days prior to the start of the pump test should be monitored with particular attention to precipitation and barometric pressure as changes in either parameter may impact pump test results.
9. Install pressure transducers/data loggers in each observation well and the test well and set for data recording.
10. Whether collecting depth to water measurements by hand or whether using pressure transducers with data loggers, the frequency of data collection should be as follows:

STEP DRAWDOWN AND CONSTANT RATE PUMP TESTS

Type of Well	Time Since Pumping Started (Minutes)	Time Intervals between Measurements (Minutes)
Test Wells	0 to 10	0.5
	10 to 15	1
	15 to 60	5
	60 to 300	30
	300 to 1440	60
Observation Wells	0 60 60	2
	60 to 120	5
	120 to 300	30
	300 to 1440	60

Note data loggers connected to pressure transducers can collect data much more frequently.

11. Following recovery from the Step Test, the Constant Rate Pump Test can begin.
12. The pumping rate should remain constant throughout the test.
13. Generally the length of a pump test should be 24 hours in a confined aquifer and 72 hours in an unconfined aquifer for optimal interpretation of the pump test data. Different durations may be required by various regulatory agencies. The test shall not be terminated until six (6) hours of stabilized drawdown has been measured.
14. Following the conclusion of pumping, water level measurements will be collected during recovery period at the same frequency as described for the Step Drawdown test for at least 8 hours or until the 90% of the total drawdown measured in the well has recovered.
15. Following completion of the pump test and recovery, interpretation of the data can be begin (not covered in this SOP).

D. QA/QC REQUIREMENTS:

During the pump test, the data should be reviewed for abrupt changes in drawdown, either an increase or decrease. These changes could signal that a recharge boundary or a discharge boundary has been encountered.

E. SPECIAL CONDITIONS:

This SOP does not provide procedures conducting a pump test from a well with contamination. Additional procedures must be implemented if contaminated groundwater will be pumped.

F. REFERENCES:

Groundwater and Wells, 1989, F. Driscoll, editor.

STEP DRAWDOWN AND CONSTANT RATE PUMP TESTS

G. APPENDICES/FORMS:

Pump Test Forms:
- Step Test
- Pump Test
- Recovery Log
- Weather Log

END OF SOP
Final Check by C. Burns 12/7/15

Author: Amy Bredes
Reviewer: Scott Smith/Chris Burns

SAMPLING PERFLUOROALKYL SUBSTANCES (PFASs) and PERFLUORINATED COMPOUNDS (PFCS)

A. PURPOSE/SCOPE:

The objective of this SOP is to ensure proper and uncontaminated collection of Perfluoroalkyl Substances (PFASs) and other Perfluorinated Compounds (PFCs). PFASs and PFCs are large groups of manufactured compounds used as surfactants in industrial applications, applied to many household products for grease, water, and stain resistance, and heavily used in Aqueous Film Forming Foams (AFFF) which are often used in firefighting. Although there are no federal regulations currently requiring remedial action for these chemicals, many states are adopting rules and regulation regarding these compounds. As rules continue to develop for these contaminants permitted and non-permitted equipment, materials, and procedure are subject to change. The complete list of compounds in this group testable by current methodology (EPA Method 537) is shown in Table 1.

Note: This SOP has been developed assuming that there are no elevated concentrations of more toxic chemicals present at the site warranting additional personal protective equipment. However, prior to commencing sampling activities, the sampler should consider all potential contaminants at the site and determine if additional protocols are necessary.

Table 1
List of PFAS and PFCs Accurately Measured by EPA Method 537

Analyte	Acronym	Chemical Abstract Services Registry Number (CASRN)
N-ethyl perfluorooctanesulfonamidoacetic acid	NEtFOSAA	–
N-methyl perfluorooctanesulfonamidoacetic acid	NMeFOSAA	–
Perfluorobutanesulfonic acid	PFBS	375-73-5
Perfluorodecanoic acid	PFDA	335-76-2
Perfluorododecanoic acid	PFDoA	307-55-1
Perfluoroheptanoic acid	PFHpA	375-85-9
Perfluorohexanesulfonic acid	PFHxS	355-46-4
Perfluorohexanoic acid	PFHxA	307-24-4
Perfluorononanoic acid	PFNA	375-95-1
Perfluorooctanesulfonic acid	PFOS	1763-23-1
Perfluorooctanoic acid	PFOA	335-67-1
Perfluorotetradecanoic acid	PFTA	376-06-7
Perfluorotridecanoic acid	PFTrDA	72629-94-8
Perfluoroundecanoic acid	PFUnA	2058-94-8

Due to the prevalence of these chemicals in common goods, it is imperative that field personnel are conscious of potential cross contamination. This contamination can be from field equipment, field clothing and PPE, sample containers, decontamination, and food.

B. EQUIPMENT/MATERIALS:

Field equipment, field clothing, PPE, sample containers, and any other items used or present on site made of or containing the following materials **ARE NOT PERMITTED**:

- Low Density Polyethylene (LDPE) – pumps and tubing Only [permitted for sample containers]
- Aluminum foil
- Glass
- Polytetrafluoroethylene (PTFE) / Teflon™
- Waterproofed clothing or boots
- Clothing containing PTFE material (i.e. GORE-TEX®)
- New clothing (clothing not washed a minimum of 6 times) or clothing washed with fabric softeners
- Polypropylene coated coveralls and PVC boot covers completely covering personnel's street clothes is an acceptable alternative.
- Tyvek® material
- Waterproof/treated paper or field books
- Plastic clipboards, binders, or spiral hard cover notebooks
- Post-it notes or other adhesives
- Sharpies or other permanent markers
- Paint pens, marking paint, etc.
- Most repellents, sunscreens, moisturizers, cosmetics, or other related products
- Decon 90

A complete list of what is and is not permitted can be found in the Appendix A. This list should be given to personnel well in advance of sampling to ensure compliance.

Materials such as Teflon™ or PTFE may be found in common sampling equipment. It is important that field personnel examine and assess existing equipment to avoid accidental contamination. The following materials are **ALWAYS PERMITTED** in sampling equipment:

- Stainless steel
- High density polyethylene (HDPE)
- PVC
- Silicone
- Acetate
- Polypropylene
- Loose paper on aluminum clipboards
- Ballpoint pens

There are changes necessary in a number of the CHA's SOPs when sampling for PFASs and PFCs. The change relate to the sampling equipment and supplies used and are as follows for each SOP as referenced:

Borehole Installation and Sampling (SOP #303/309)

- If using hollow stem augers/split spoons or similar, they must be carbon steel and not coated.
- If collecting a soil or sediment core sample (e.g. Geoprobe®), it must be collected directly from single-use PVC liners that must not be decontaminated or reused at different locations.

Soil Sampling with a Hand Auger (SOP #305)

- A stainless steel hand auger without any coatings must be used when sampling.
- Scoops and spatula used must be stainless steel.

Well Development (SOP #311)

- Do not use bailers, unless entirely made of PVC or stainless steel. Teflon in any part of the bailer is not acceptable.
- Do not use bladder pumps, most bladders are made of Teflon. Only bladder pumps with a bladder made of natural rubber are acceptable.
- Other pump types are typically okay, but should still be examined for Teflon or other prohibited materials.

Conventional Groundwater Sampling (SOP #315) / Low-Flow Groundwater Purging/ Sampling (SOP #317) / Residential Well Sampling (SOP #319)

- Bailers should not be used unless entirely made of PVC or stainless steel. Teflon is not acceptable. Single use disposable polyethylene or silicone materials are also acceptable.
- Tubing can only be made of HDPE or silicone.
- Do not use bladder pumps, most bladders are made of Teflon. Only bladder pumps with a bladder made of natural rubber are acceptable.
- Other pump types are typically okay, but should still be examined for Teflon or other prohibited materials.

Surface Soil Sampling (SOP #405)

- A stainless steel spoon and bowl should be used. Cover the bowl with a stainless steel lid where possible between the addition of each aliquot. Do NOT cover the bowl with aluminum foil.

Small Equipment Decontamination (SOP #501)

- Water used for decontamination on site should be laboratory certified “PFAS-free” water.

Field Handling, Packaging, and Shipping (SOP #607)

- Plastic bags must be polyethylene.
- Only ice from water should be used, not chemical (blue) ice.
- These equipment changes can be applied to other SOPs if PFASs and/or PFCs are being sampled. If equipment is not specifically mentioned, refer to the list of materials that are always permitted. If the materials are not mentioned DO NOT use that sampling equipment.

SAMPLING PERFLUOROALKYL SUBSTANCES (PFASs) and PERFLUORINATED COMPOUNDS (PFCS)

C. PROCEDURE:

Standard operating procedures for sampling as outlined in a number of CHA's SOPs should be followed, but with the specific changes listed below for the specific SOPs referenced, if being used:

Borehole Installation and Sampling (SOP #303/309)

- When drilling the well use PFAS-free drilling fluids.
- Don't use detergent to decon drilling equipment with the exception of Alconox and Liquinox. Scrub with equipment a plastic brush to remove heavy soiling and rinse thoroughly in tap water. Use a steam cleaner or a triple-rinse of PFOA-free water as the final step. If large quantities of PFOA-free water are not available from the lab, additional QA/QC sampling may be required to verify the source as a potential source of cross-contamination.
- , then triple-rinse in distilled or deionized water.
- Collect a representative water sample used during drilling activities.
- If using an auger, it must be carbon steel and un-coated.

Conventional Groundwater Sampling (SOP #315) / Low-Flow Groundwater Purging/ Sampling (SOP #317) / Residential Well Sampling (SOP #319)

- Collect samples from the pump discharge tubing only. Never collect a water sample that has passed through a flow through cell or similar.
- When sampling prioritize drinking water, followed by surface water, followed by groundwater.
- When sampling groundwater; start with the upgradient well(s), then the furthest downgradient of the interpreted or known source, then wells downgradient to the source, and lastly the wells closest to the interpreted or known source.
- When sampling residential wells, any plumber's sealing tape should be noted, as these typically contain PFCs.
- Prior to sample collection, field personnel must wash their hands and wear a new set of nitrile gloves.
- PFAS/PFC samples should be taken first, prior to collecting samples for any other parameters into any other containers. Field personnel should avoid contact with any other type of sample container or package materials.
- When samples are collected and capped, place the sample bottle(s) in an individual sealed plastic bag (i.e. Ziploc®) separate from all other sample parameter bottles, and place in a shipping container packed only with ice made from frozen water.
- After collecting PFOA samples conduct the "Shaker Test:" A small portion of the sample (~10-25 ml) should be shaken by the sample collector on site. If foaming is noted within the sample, this should be documented when samples are submitted for analysis.

Surface Water Sampling (SOP #401)

- Surface water must be collected by inserting a capped sampling container with the opening pointing down to avoid the collection of surface films.
- Where conditions permit, sampling devices should be rinsed with site medium to be sampled prior to collection of the sample.

Surface Soil Sampling (SOP #405)

- PFAS/PFC samples should be taken first, prior to collecting samples for any other parameters into any other containers. Field personnel should avoid contact with any other type of sample container or package materials.

Large Equipment Decontamination (SOP #503)

- Don’t use detergent to decon drilling equipment, scrub with a plastic brush and rinse thoroughly in tap water, then triple-rinse in distilled or deionized water.

Field Handling, Packaging, and Shipping (SOP #607)

- Ice should be double bagged and secured to avoid meltwater from contacting sample containers, and/or samples should be in an individual sealed plastic bag.

D. QA/QC REQUIREMENTS:

A variety of blanks should be collected to trace the sources of any artificially introduced contamination. Rinsate or equipment blanks, field blanks, and trip or travel blanks should all be collected during the sampling event. Rinsate or equipment blanks and field blanks should be collected once per day per matrix or once per 20 samples per matrix, whichever comes first. One trip blank is required per cooler.

Samples should be immediately placed in a cooler maintained at 4 ± 2^{o} Celsius.

E. SPECIAL CONDITIONS:

In the event of wet weather field personnel must avoid using personal waterproof or water-resistant rain gear. Instead a gazebo tent that is only touched or moved prior to or after sampling activities should be used.

No food or drink is permitted on-site, except for bottled water and hydration drinks, such as Gatorade. These drinks should only be consumed in the staging area. When field personnel require a break to eat or drink, they should remove their gloves and coveralls and move away from the sampling location, preferably downwind. When finished eating, field personnel should clean up and put their coveralls back on and don a new pair of gloves prior to returning to the work area.

Visitors to the site are asked to remain at least 30 feet from sampling areas.

If laboratory results are received and the combined concentration PFOA and PFOS was between 50 and 70 parts per trillion (ppt), consider contacting the laboratory to ensure that the analytical results reported are based on the more comprehensive technique from EPA Method 537 for measuring PFOA.

F. REFERENCES:

Chiang, D., Ph.D., P.E., Davis, K., Ph.D., Bogdan, D., Ph.D., Aucoin, M., & Woodward, D. (n.d.). PFAS Sampling. AECOM.

Shoemaker, J. A., Grimmet, P. E., & Boutin, B. K. (2009). Method 537. Determination of Selected Perfluorinated Alkyl Acids in Drinking Water by Solid Phase Extraction and Liquid Chromatography/Tandem Mass Spectrometry (LC/MS/MS) (EPA/600/R-08/092) (USA, EPA, Office of Research and Development). Cincinnati, OH: U.S. Environmental Protection Agency.

G. APPENDICES/FORMS:

Appendix A - PFAS/PFC Sampling – Acceptable and Prohibited Items

END OF SOP

APPENDIX A – SOP 341
PFAS/PFC SAMPLING – ACCEPTABLE AND PROHIBITED ITEMS

PROHIBITED	ACCEPTABLE
Field Equipment	
Teflon containing materials	High-Density Polyethylene (HDPE) Materials
Low density polyethylene (LDPE) materials	Acetate Liners
Fluoropolymer tubing, valves and other parts in pumps	Silicon Tubing
Sharpies (acceptable by EPA) and other markers	Ball point pens
Waterproof field books, Post-it Notes, and any adhesive paper produces	Loose paper (non-waterproof)
Plastic clipboards, binders, or spiral hard cover notebooks	Aluminum field clipboards or with Masonite
Chemical (blue) ice packs	Regular Ice
Field Clothing and PPE	
New cotton clothing or synthetic water resistant, waterproof, or stain-treated clothing, clothing containing GORE-TEX	Well-laundered clothing made of natural fibers (preferably cotton)
Clothing laundered using fabric softener	No fabric softener
Boots containing GORE-TEX or treated for water resistance	Boots made with polyurethane and PVC
Tyvek	Cotton clothing or Polypropylene coated coveralls
No cosmetics, moisturizers, hand cream, or other related products as part of personal cleaning/showering routine on the morning of sampling	**Sunscreens** – Alba Organics Natural Sunscree, Yes to Cucumbers, Aubrey Organics, Jason Natural Sun Block, Kiss my Face, Baby sunscreens that are “free” or “natural” **Insect Repellents** – Jason Natural Quit Bugging Me, Repel Lemon Eucalyptus Insect Repellant, Herabl Armor, California Baby Natural Bug Spray, BabyGanics **Sunscreen and Insect Repellant** – Avon Skin So Soft Bug Guard Plus – SPF 30 Lotion
Sample Containers	
LDPE or glass containers	HDPE or polypropylene
PTFE or Teflon-lines caps	Unlined polypropylene caps
Equipment Decontamination	
Decon 90	Alconox and/or Liquinox
Water from an on-site well	Laboratory certified “PFAS-free” water
Food Considerations	
All food and drink, with exceptions noted	Bottled water and hydration fluids to be brought and consumed only in the staging areas. Eating should take place away from the sampling location, wash hands well after handling, wear powderless nitrile gloves

SMALL EQUIPMENT DECONTAMINATION

A. PURPOSE/SCOPE:

Proper decontamination of small equipment prevents cross-contamination of samples, introduction of contaminants to clean sites, and the mixture of incompatible substances. Equipment decontamination also assures the health and safety of all equipment users. Procedures for decontamination procedures vary depending on the matrix sampled, level of contamination, type of contaminants, and the target analytes of the sampling event. The procedure outlined in this SOP is a general procedure for field/ warehouse decontamination of equipment associated with water, soil and other surficial sampling activities.

Decontamination should be performed before sampling work commences and after each sampling event. Decontaminated equipment should be protected from contact with surroundings during storage and transport, and should be handled as little as possible before its use and always with disposable gloves. Note that all waste generated by decontamination procedures including liquids, solids, rags, gloves, etc., will be collected and disposed of properly according to the procedures outlined in SOP #507.

B. EQUIPMENT/MATERIALS:

- Alconox®
- Tap water
- Distilled and deionized water
- 10% Nitric acid rinse
- Acetone (or other pesticide grade organic solvent)
- 1-Gallon pressure spray bottles
- Long-handled brushes
- 5-Gallon plastic buckets

C. PROCEDURE:

Note that if it is logistically impractical/ impossible to complete all steps listed below at the field site, Steps 1-4 should be performed prior to transport of equipment to a facility where all steps can be completed if required. All field decontamination should take place over a container and liquids should be properly disposed of.

1. Disassemble equipment as necessary.
2. Remove gross contamination from equipment by scraping, brushing and rinsing with tap water
3. Wash with Alconox® or other laboratory grade detergent to remove all visible particulate matter and residual oils and grease.
4. Rinse with tap water to remove detergent.
5. Rinse with distilled and deionized water.
6. Field personnel will use a new pair of outer gloves before handling sample equipment after it is cleaned.
7. If equipment will not be used immediately, wrap in aluminum foil (unless sampling for metals analysis) or seal in plastic bags (unless sampling for organics analysis) and store.
8. Record the date and method of decontamination on foil/bag and equipment log.

SMALL EQUIPMENT DECONTAMINATION

D. QA/QC REQUIREMENTS:

When necessary, field equipment rinsate blanks will be collected by pouring analyte-free water over decontaminated equipment and submitting them to the lab with the other blanks and samples. These blanks are used to assess the quality of equipment decontamination.

E. SPECIAL CONDITIONS:

Reusable PPE such as respirators, chemical-resistant overboots and gloves shall also undergo the equipment decontamination sequence. See SOP #505 for related information on Personnel decontamination.

If acetone is a known or expected contaminant another solvent may be substituted. Note that methanol cannot be used for decontamination when sampling gasoline or its by-products.

Additional decontamination procedures may be required for particular contaminants or when samples are to be analyzed at very low concentrations. Identify methods as needed but see for example Wilde, 2004.

F. REFERENCES:

New Jersey Department of Environmental Protection, August 2005. *Field Sampling Procedures Manual*.

USEPA, 1994. Sampling Equipment Decontamination. Environmental Response Team SOP #2006, Revision #0.0. Edison, NJ. http://www.ert.org.

USEPA, 1996. *Environmental Investigations Standard Operating Procedures and Quality Assurance Manual*. Region 4, Science and Ecosystem Support Division. Athens, GA. http://www.epa.gov/region04/sesd/eisopqam/eisopqam.html

Wilde, F.D., ed., 2004. *Cleaning of Equipment for water sampling (ver. 2.0)*: U.S. Geological Survey Techniques of Water-Resources Investigations, book 9, chap. A3, April, accessed January 5, 2009 at http://pubs.water.usgs.gov/twri9A3/

G. APPENDICES/FORMS:

Not Applicable

END OF SOP
Final Check by C. Burns 10/27/15

LARGE EQUIPMENT DECONTAMINATION

A. PURPOSE/SCOPE:

Decontamination of large equipment (drilling rigs, backhoe excavators, bulldozers, etc.) is necessary to prevent cross-contamination between sampling points and to prevent the removal of contaminants from a hazardous waste site.

B. EQUIPMENT/MATERIALS:

- Steam cleaner
- Generator
- Decontamination pad or supplies to construct a temporary pad
- Centrifugal pump
- Discharge hose
- 55-Gallon drums
- Alconox®
- Hexane
- Potable water source

C. PROCEDURE:

1. Drilling rigs and excavation equipment and materials should arrive on-site in a clean condition, free of oil, grease, and debris. Inspect rigs for any fluid leaks.
2. Unless otherwise approved, all decontamination of large equipment will take place on a decontamination pad designed to collect all rinsate generated during cleaning. Temporary pads should be lined with a water-impermeable material with no seams, and if possible, constructed on a level, paved surface. Pads should be constructed so as to facilitate the collection of wastewater, with a sump in one corner or side, or with one corner generally lower than others. Where appropriate, side shields should be placed around the decon pad to prevent overspray.
3. Steam clean the drill rig/ excavator, tools, drill bits, buckets, etc. prior to the start of work. Smaller equipment and tools should be elevated on saw horses to avoid any splashing. After steam cleaning, the equipment should be inspected for residues such as machine oil. If residues are observed, the equipment should be steam cleaned until such residues are removed. Steam cleaning procedures can be supplemented with manual scrubbing with Alconox® where necessary to remove contamination.
4. In the event that equipment is contaminated with heavy oils or products that cannot be removed by the standard decontamination procedures outlined above, the following modifications will be made. First, wipe all excess oil/tar from the equipment with a paper towel or clean rag. Second, with a paper towel or clean rag that has been soaked in hexane, wipe any residual contamination off the equipment. When equipment is relatively free of gross oil or tar contamination, proceed with the usual decontamination procedure.
5. At the completion of the project, or when required, all rinsate generated from decontamination activities shall be pumped from the decontamination pad to 55-gallon drums for disposal.

LARGE EQUIPMENT DECONTAMINATION

D. QA/QC REQUIREMENTS:

Equipment field blanks may be required depending on job specifics.

E. SPECIAL CONDITIONS:

Not Applicable

F. REFERENCES:

New Jersey Department of Environmental Protection, 2005. *Field Sampling Procedures Manual. August*.

USEPA, 1996. *Environmental Investigations Standard Operating Procedures and Quality Assurance Manual*. Region 4, Science and Ecosystem Support Division. Athens, GA. http://www.epa.gov/region04/sesd/eisopqam/eisopqam.html

G. APPENDICES/FORMS:

Not Applicable

END OF SOP
Final Check by C. Burns 10/22/15

Author: Meghan Platt, P.E.
Reviewer: Scott Smith, P.E.

SAMPLE CONTAINERS, VOLUMES, PRESERVATIONS AND HOLDING TIMES

A. PURPOSE/SCOPE:

The following standard operating procedure (SOP) presents general guidelines for sample containers, volumes, preservations and holding times associated with air, water and soil/sediment samples. Field personnel are responsible for ensuring that state-specific standards/guidelines/regulations are followed, where applicable.

Improper preserving, storing and handling of air, water and soil/sediment samples are critical if the integrity of the samples are to be maintained. Samples collected in the field may undergo biological, chemical or physical changes following removal from their environment. In order to minimize those changes, many samples must have preservatives in the form of strong acids or bases added prior to delivery to the laboratory. If samples are to be collected as part of a government program, the governing agency typically must be notified 30 days prior to sample collection.

B. EQUIPMENT/MATERIALS:

Pre-cleaned sample containers along with associated preservations within the sample containers will be provided to CHA from the analytical laboratory. The field geologist/engineer will provide the necessary personal protective equipment to place samples collected within the appropriate sample containers per SOPs 300 through 417. However, if field preservation is required the following equipment and materials shall be obtained:

- Hydrochloric (HCl) Acid Reagent A.S.C. 38%
- Nitric (HNO3) Acid Reagent A.S.C. 71%
- Sodium Hydroxide (NaOH) 97%
- 10 mL glass pipettes
- Narrow range (0-3 and 12-14) pH paper
- Nitrile gloves

C. PROCEDURE:

1. Review Table 1 which details typical parameters of interest at environmental sites and the associated methods, preservation, container type, holding time and required sample volume.
2. Obtain pre-cleaned and pre-preserved sample containers from the laboratory. If pre-preserved sample containers were provided skip to Step 7; if not proceed to Step 3.
3. Put on a clean pair of nitrile gloves.
4. In a clean, non-dusty environment, remove the cap of the sample container.
5. Using a clean, 10 mL glass pipette draw the required amount of acid or base and insert into the sample container.
6. Volatile Organic Compounds – 2 mL of HCl acid (water samples).
7. Total and Dissolved Metals (including mercury) – 5 mL Nitric acid (water samples).
8. Cyanide – 15-20 Sodium Hydroxide pellets (water samples).

SAMPLE CONTAINERS, VOLUMES, PRESERVATIONS AND HOLDING TIMES

9. Chemical Oxygen Demand, Oil and Grease, Organic Carbon, Phenolics, Total Dissolved Phosphorous, Hydrolyzable Phosphorus, Ammonia, Nitrate and Nitrite – 5 mL Sulfuric acid (water samples).
10. Immediately replace and tighten the sample container cap.
11. Collect sample using equipment and procedures outlined in other SOPs as appropriate. The volume of the sample collected shall be sufficient to conduct the analysis required, as well as associated quality assurance/quality control samples (QA/QC). QA/QC samples shall be collected in accordance with SOP 605.
12. Place samples immediately in the pre-preserved sample containers.
13. Chill all samples to 4ºC from sample collection until laboratory analysis.
14. Package and ship samples per SOP #607.

D. QA/QC REQUIREMENTS:

This section includes QA/QC requirements associated with sample containers, volumes, preservations, and holding times. The following general requirements apply to this SOP:

1. All data must be documented on field data sheets or within site logbooks.
2. All instrumentation must be operated in accordance with operating instructions as supplied by the manufacturer, unless otherwise specified in the work plan.
3. Equipment checkout and calibration activities must occur prior to sampling/operation, and must be documented.
4. QA/QC samples shall be collected in accordance with SOP 605.

The following procedure shall be conducted to provide a QA/QC check of water (aqueous) samples to ensure the samples were preserved to the proper pH prior to shipping for laboratory analysis.

Volatile Organic Compounds:

1. Collect one additional VOA vial at every third aqueous sampling location.
2. Fill the extra vial with the sample.
3. Using the extra VOA vial, remove the cap and using a clean, 10 mL glass pipette extract approximately 1 mL of water.
4. Place two drops of the water on a 1-inch strip of 0-3 range pH paper.
5. Compare pH strip's color while wet with that of the color key included on the pH paper container.
6. If pH is not less than 2, add additional HCL to the remaining 3 VOA vials prior to collecting the sample.
7. Discard the vial used to check the pH.

SAMPLE CONTAINERS, VOLUMES, PRESERVATIONS AND HOLDING TIMES

Total and Dissolved Metals, Mercury, Ammonia, Nitrate plus Nitrite, Total Dissolved Phosphorus, COD, Oil & Grease, Organic Carbon, Phenolics

1. Collect sample and tightly reseal the cap.
2. Agitate the sample by gently shaking the sample bottle to mix the acid and water.
3. Remove the cap and using a clean, 10 mL glass pipette extract approximately 1 mL of sample.
4. Place approximately two drops of sample on a 1 inch strip of 0-3 range pH paper.
5. Compare pH strip's color while wet with that of the color key included on the pH paper container.
6. If pH is not less than 2, add appropriate additional Sulfuric Acid to the sample using a clean pipette.
7. Recheck sample using steps 2 through 6 until sample pH is less than 2.

Cyanide

1. Collect sample and tightly reseal the cap.
2. Agitate the sample by gently shaking the sample bottle until the NaOH pellets are dissolved.
3. Remove the cap and using a clean 10 mL glass pipette extract approximately 1 mL of sample.
4. Place approximately two drops of sample on a 1-inch strip of 12-14 range pH paper.
5. Compare pH strip's color while wet with that of the color key included on the pH paper container.
6. If pH is not greater than 12, add additional NaOH to the sample using standard procedures.
7. Recheck sample using steps 2 through 6 until sample pH is greater than 12.

E. SPECIAL CONDITIONS:

Not Applicable

F. REFERENCES:

Alpha Analytical Aqueous and Soil/Solid Reference Guides.

G. APPENDICES/FORMS:

Table 1 Laboratory Analysis: Summarizing parameters, methods, preservations, container type, holding times and minimum sample volumes are included as an attachment to this SOP.

END OF SOP
Final Check by C. Burns 10/27/15

Table 1

Laboratory Analysis	EPA Method	Standard Method and/or SW846 Method	Preservation	Container	Holding Time	Minimum Volume
WATER						
Acid Soluble & Insoluble Sulfide	-----	9030B	Cool to 4 deg C No Headspace	P or G	7 Days	8 oz.
Acidity as CaCO3	305.1	2310B	Cool to 4 deg C	P or G	14 Days	100 mL
Alkalinity	-----	2320B	Cool to 4 deg C	P or G	14 Days	100 mL
Alkalinity as CaCO3	310.1	2320B	Cool to 4 deg C	P or G	14 Days	100 mL
Ammonia	350.2/.3	4500-NH3 B,E	Cool to 4 deg C, H2SO4 to pH<2	P or G	28 Days	400 mL
Aromatic Hydrocarbons	602	8021B	1:1 HCl to pH <2, Cool to 4 deg C 0.008% Na2S2O3 if residual chlorine present	G, Vial screw cap with center hole Teflon- faced silicone septum	14 Days	40 mL
Biochemical Oxygen Demand	405.1	5210B	Cool to 4 deg C	P or G	48 Hrs.	500 mL
Bromide	300	-----	None	P or G	28 Days	250 mL
Calcium	-----	3120B	HNO3 to pH<2	P or G	6 Months	100 mL
Calcium- Hardness	200.7	3111B	HNO3 to pH<2	P or G	6 Months	100 mL
Carbamates	531.1	-----	Cool to 4 deg C, 0.08% Na2S2O3 if residual chlorine present	G, screw cap Teflon faced silicone septum	14 Days	100 mL mL
Carbonaceous BOD	-----	5210B	Cool to 4 deg C	P or G	48 Hrs.	1000 mL
Chloride	300	4500-CL D 4110	Cool to 4 deg C	P or G	28 Days	100 mL
Chloride, Residual Disinfectant	-----	4500Cl-G	Cool to 4 deg C	P or G	Analyze Immediately	200 mL
COD	410.4	5220D	H2S04 to pH<2, Cool to 4 deg C	P	28 days	250 mL
Color	-----	2120B	Cool to 4 deg C	P or G	24 Hrs	100 mL
Conductivity	-----	2510B	Cool to 4 deg C	P or G	28 Days	100 mL
Cyanide	335.4	4500-CN C&E	Cool to 4 deg C NaOH pH>12	P or G	14 Days	250 mL
Cyanide	335.2	9010B, 9012A, 9014	Cool to 4 deg C, NaOH to pH>12 0.6 g ascorbic acid if residual chlorine present	P or G	Sulfide absent, 14 days; sulfide present 24 Hrs	250 mL
Cyanide, Amenable	335.1					
Dioxin	-----	8280A	Cool to 4 deg C 0.008% Na2S2O3 if residual chlorine present	G, Amber Teflon-lined screw cap	7 days until extraction 40 days after extraction	1000 mL
DRO	-----	8015B	Cool to 4 deg C 0.008% Na2S2O3 if residual chlorine present	G, Amber Teflon-lined screw cap	7 days until extraction 40 days after extraction	1000 mL
Escherichia Coli	-----	9222B	0.008% Na2S203 if residual chlorine present 0.3 mL/125 mL 15% EDTA if > 0.01 mg/L heavy metals	Sterile P or G	30 Hrs. for Drinking Water 6 Hrs. for Waste Water	125 mL
Extractable Org. Compounds			Cool to 4 deg C, Store in dark	G, Amber Teflon-lined screw cap	*7 days	4000 mL

Table 1

Laboratory Analysis	EPA Method	Standard Method and/or SW846 Method	Preservation	Container	Holding Time	Minimum Volume
Fecal Coliform	-----	9222B or D	0.008% $Na_2S_2O_3$ if residual chlorine present 0.3 mL/125 mL 15% EDTA if > 0.01 mg/L heavy metals	Sterile P or G	30 Hrs. for Drinking Water 6 Hrs. for Waste Water	125 mL
Fecal Streptococci	-----	9230C	Cool to 4 deg C 0.008% $Na_2S_2O_3$ if residual chlorine present	Sterile P or G	30 Hrs. for Drinking Water 6 Hrs. for Waste Water	125 mL
Fluoride	300	4500 F-B,C S	Cool to 4 deg C	P or G	28 Days	300 mL
Foaming Agents (MBAS)	-----	5540C	Cool to 4 deg C	P or G	48 Hrs	250 mL
Gases	-----	3810	Cool to 4 deg C 0.008% $Na_2S_2O_3$ if residual chlorine present 1:1 HCl to pH <2	G, Vial screw cap with center hole Teflon- faced silicone septum	7 days without HCl 14 days with HCl	40 mL
GRO	-----	8015B	1:1 HCl to pH <2, Cool to 4 deg C 0.008% $Na_2S_2O_3$ if residual chlorine present	G, Vial screw cap with center hole Teflon- faced silicone septum	7 days w/o HCl 14 days w/HCl	40 mL
Hardness			HNO_3 to pH<2	P	6 months	1000 mL
Heterotrophic Plate Count	-----	9215B	Cool to 4 deg C 0.008% $Na_2S_2O_3$ if residual chlorine present	Sterile P or G	30 Hrs. for Drinking Water 6 Hrs. for Waste Water	125 mL
Hexavalent Chromium	7196A	3500Cr-D	Cool to 4 deg C	P	24 hours	500 mL
HPLC (Explosive)	------	8330	Cool to 4 deg C	G, Amber Teflon-lined screw cap	7 days until extraction 40 days after extraction	1000mL
HPLC (Explosive)	------	8310	Cool to 4 deg C	G, Amber Teflon-lined screw cap		1000mL
Mercury	-----	7470A	Cool to 4 deg C	P or G	28 Days	8 oz.
Metals	200.7	-----	HNO_3 to pH<2	P	6 Months	100 mL
Nitrate	300	-----	Cool to 4 deg C	P or G	48 Hrs.	100 mL
Nitrate (Chlorinated)	353.2	4500-NO3 F	Cool to 4 deg C	P or G	48 Hrs	250 mL
Nitrate (Non- chlorinated)	353.2	4500-NO3 F	H_2SO_4 to pH<2, Cool to 4 deg C	P or G	14 Days	250 mL
Nitrite	300, 353.2, 354.1	4500-NO3 D	Cool to 4 deg C	P or G	48 Hrs	100 mL
Odor	-----	2150B	Cool to 4 deg C	G only	24 Hrs	200 mL
Oil and Grease		1664	HCl to pH<2, Cool to 4 deg C	G, Amber Teflon-lined screw cap	28 days	1000 mL
Organic Nitrogen	351.1	-----	Cool to 4 deg C, H_2SO_4 to pH<2	G	28 Days	500 mL

Table 1

Laboratory Analysis	EPA Method	Standard Method and/or SW846 Method	Preservation	Container	Holding Time	Minimum Volume
Organochlorine Pesticides/PCB	608	8081A,8082	Cool to 4 deg C 0.008% Na2S2O3 if residual chlorine present If aldrin is to be determined bind to pH 5-9.	G, Amber Teflon-lined screw cap	7 days until extraction 40 days after extraction	1000 mL
Ortho Phosphate	300	4500 P-E	Cool to 4 deg C	P or G	48 Hrs	50 mL
Orthophosphate	365.2	-----	Filter immediately, Cool to 4 deg C	P or G	48 Hrs.	50 mL
pH, Hydrogen ion	-----	4500-H-B	Cool to 4 deg C	P or G	Analyze Immediately	25 mL
Phenols	420.1	9065, 510ABC	Cool to 4 deg C, H2SO4 to pH<2	G	28 Days	500 mL
Pseudomanas Aeruginosa	-----	9213E	Cool to 4 deg C 0.008% Na2S2O3 if residual chlorine present	Sterile P or G	30 Hrs. for Drinking Water 6 Hrs. for Waste Water	125 mL
Purgeable Halocarbons	601	8021B	Cool to 4 deg C 0.008% Na2S2O3 if residual chlorine present	G, Vial screw cap with center hole Teflon- faced silicone septum	14 Days	40 mL
Radiological	-----	-----	HNO3 to pH<2	P or G	6 Months	100 mL
Residue- Settleable (SS)	160.5	-----	Cool to 4 deg C	P or G	48 Hrs.	1000 mL
Residue-filtered (TDS)	160.1	-----	Cool to 4 deg C	P or G	7 Days	100 mL
Residue-non- filtered (TSS)	160.2	-----	Cool to 4 deg C	P or G	7 Days	100 mL
Residue-Total Volatile Solids	160.4	2540 E	Cool to 4 deg C	P or G	7 Days	100 mL
Salinity	-----	2520 C	Cool to 4 deg C	G	28 Days	100 mL
Semivolatile Organic Compounds (Unregulated)	525.2	-----	If residual chlorine is present, add 40-50 mg Sodium Thiosulfate. If not chlorinated, add 6N HCl to pH<2 Cool to 4 deg C	G, Amber Teflon-lined screw cap	7 Days for extraction, 30 after extraction	1000 mL
Semivolatile Organics	625	8270C	Cool to 4 deg C 0.008% Na2S2O3 if residual chlorine present	G, Amber Teflon-lined screw cap	7 days for extraction 40 days after extraction	1000 mL
Silica	200.7	-----	Cool to 4 deg C	P only	7 Days	50 mL
Specific Conductance	120.1	-----	Cool to 4 deg C	P or G	28 Days	100 mL
Sulfate	300	4500-SO4	Cool to 4 deg C	P or G	28 Days	50 mL
Sulfate	375.4	-----	Cool to 4 deg C	P or G	28 Days	50 mL
Sulfide	376.2	9030 B, 4500S2-AD	Cool to 4 deg C, add zinc plus NaOH to pH>9	P or G	7 Days	50 mL
Sulfite (SO3)	377.1	-----	None Required	G, Bottle and Top	Analyze immediately	50 mL
Surfactants (MBAS)	425.1	-----	Cool to 4 deg C	P or G	48 Hrs.	250 mL

Table 1

Laboratory Analysis	EPA Method	Standard Method and/or SW846 Method	Preservation	Container	Holding Time	Minimum Volume
TDS			Cool to 4 deg C	P	7 days	500 mL
Temperature	-----	2550B	None	P or G	Analyze Immediately	1000 mL
Temperature	170.1	-----	None Required	G, Bottle and Top	Analyze immediately	1000 mL
Total Kjeldahl Nitrogen	353.3/.1	4500Norg-C	H2S04 to pH<2 , Cool to 4 deg C	P	28 days	250 mL
Total Coliform	-----	9221D	0.008% Na2S203 if residual chlorine present 0.3 mL/125 mL 15% EDTA if > 0.01 mg/L heavy metals	Sterile P or G	30 Hrs. for Drinking Water 6 Hrs. for Waste Water	125 mL
Total Dissolved Solids	160.1	2540C	Cool to 4 deg C	P or G	7 Days	100 mL
Total Hardness	130.2 , 200.7	-----	HNO3 to pH<2 H2SO4 to pH<2	P or G	6 Months	100 mL
Total Kjeldahl Nitrogen	351.3	-----	H2SO4 to pH<2	P or G	28 Days	500 mL
Total Metals	200.7 200.8	6010B, 6020, 7000A	HNO3 to pH<2	P	6 months (Hg 28 days)	500 mL
Total Organic Carbon (TOC)	415.1	9060, 5310C	H2SO4 to pH<2, Cool to 4 deg C	G, Amber Teflon-lined screw cap	28 days	80 mL
Total Organic Halides		5320B	1N H2SO4 to pH<2	P or G	28 Days	50 mL
Total Phosphorus	365.2	-----	Cool to 4 deg C, H2SO4 to pH<2	G	28 Days	50 mL
Total Recoverable Oil & Grease	413.1,166 4A	-----	Cool to 4 deg C, HCL or H2SO4 to pH<2	G	Petroleum Based 3 Days; Non-Petroleum Based 24 hours	1000 mL
Total-Residue (TS)	160.3	2540B	Cool to 4 deg C	P or G	7 Days	100 mL
Turbidity	180.1	2130B	Cool to 4 deg C	P or G	48 Hrs	100 mL
Volatile Organics	624	8260B	1:1 HCl to pH <2, Cool to 4 deg C 0.008% Na2S2O3 if residual chlorine present	G, Vial screw cap with center hole Teflon-faced silicone septum	7 days w/o HCl 14 days w/HCl	40 mL
Volatiles (Regulated)	524.2	-----	Cool to 4 deg C HCl to pH<2	G, Vial screw cap with center hole Teflon-faced silicone septum	14 Days	60-120 mL
SOIL						
Acid Soluble & Insoluble Sulfide	-----	9030B	Cool to 4 deg C, no headspace	P or G	7 Days	8 oz.
Amenable Cyanide	-----	9213	Cool to 4 deg C	P or G	14 Days	4 oz.
Bromide	-----	9211	Cool to 4 deg C	P or G	28 Days	8 oz.
Cation - Exchange Capacity	-----	9080, 9081	None	P	-----	8 oz.
Chloride	-----	9212, 9056, 9253	None	P or G	28 Days	8 oz.
Chlorinated Herbicides	-----	8151A	Cool to 4 deg C	G, wide mouth, teflon liner	14 Days	8 oz.
Corrosivity pH Waste>20% water	-----	9040B	Cool to 4 deg C	P	Analyze Immediately	4 oz.

Table 1

Laboratory Analysis	EPA Method	Standard Method and/or SW846 Method	Preservation	Container	Holding Time	Minimum Volume
Corrosivity Toward Steel	-----	1110	Cool to 4 deg C	P	14 Days	4 oz.
Cyanide		9010B, 4500CN	Cool to 4 deg C	G, Amber	14 Days	4 oz
Dioxin	-----	8280A	Cool to 4 deg C	G	14 Days	8 oz.
DRO	-----	8015B	Cool to 4 deg C	G, Amber	14 Days	4 oz.
Extractable Organic Compounds			Cool to 4 deg C, Store in dark	G	14 days	8 oz
Extractable Sulfide	-----	9031	Cool to 4 deg C, fill top of sample with 2N Zinc Acetate until moistened	P or G	7 Days	8 oz.
Fluoride	-----	9214	None	P	28 Days	8 oz.
Gases	-----	3810	Cool to 4 deg C	G, Amber	14 Days	8 oz.
Grain Size			N/A	G	N/A	8 oz
GRO	-----	8015B	Cool to 4 deg C, check state regulations for proper preservative. NJ (methanol), PA (encore samplers) NY (cool to 4 deg C).	G, Amber VOA vial	14 Days	15 Grams
HPLC (PAH)	------	8310	Cool to 4 deg C	G, Amber Teflon-lined screw cap	14 days until extraction 40 days after extraction	4 oz.
Ignitability	-----	1010	None	P or G	None	8 oz.
Ignitability of Solids		1030	None	P or G	None	8 oz.
Mercury	245.1	7471A	Cool to 4 deg C	G, Amber	28 Days	4 oz.
Metals	-----	6010B, 6020, 7000A	Cool to 4 deg C	G, Amber	6 Months	8 oz.
Moisture Content			Store in airtight jar 3-30 deg C	G	N/A	8 oz
Nitrate	-----	9210	Cool to 4 deg C	P or G	48 Hrs	8 oz.
Oil & Grease (Sludge, Sludge- Hem)	-----	9071B	Cool to 4 deg C	G	28 Days	8 oz.
Organochlorine	-----	8081A	Cool to 4 deg C	P or G	14 Days	8 oz.
Paint Filter Liquids Test	-----	9095A	Cool to 4 deg C	P or G	-----	8 oz.
PCBs	-----	8082	Cool to 4 deg C	G, Amber Teflon-lined screw cap	14 Days	4 oz.
pH	-----	9045C	Cool to 4 deg C	G, Amber	Analyze Immediately	4 oz.
pH, Soil and Waste	-----	9045A	Cool to 4 deg C	G	Analyze Immediately	8 oz.
Phenol	-----	9065, 9066, 9067	Cool to 4 deg C	G, Amber	28 Days	4 oz.
Radiological	-----	-----	Cool to 4 deg C	G	6 Months	8 oz.
Reactivity Cyanide	-----	SW-846 7.3.3.2	Cool to 4 deg C	P	14 Days	8 oz.
Reactivity Sulfide	-----	SW-846 7.3.4.2	Cool to 4 deg C	P	14 Days	8 oz.
Semivolatile Organics	-----	8270C	Cool to 4 deg C	G, Amber	14 Days	8 oz.

Table 1

Laboratory Analysis	EPA Method	Standard Method and/or SW846 Method	Preservation	Container	Holding Time	Minimum Volume
Sulfate	-----	9035, 9036, 9038	Cool to 4 deg C	P or G	28 Days	8 oz.
Sulfides	-----	9215	Cool to 4 deg C	P or G	7 Days	8 oz.
TCLP Metals	-----	1311, 6010B, 6020, 7000A, 7470A	Cool to 4 deg C	G, Amber	180 Days (Hg 28 days)	8 oz
TCLP Herbicides	-----	1311	Cool to 4 deg C	G, Amber	14 Days	8 oz.
TCLP Pesticides	-----	1311	Cool to 4 deg C	G, Amber	14 Days	8 oz.
TCLP Semivolatile Organics	-----	1311, 8270C, 8081A, 8151A	Cool to 4 deg C	G, Amber Teflon Lined	14 Days	8 oz.
TCLP Volatile Organics	-----	1311, 8260B	Cool to 4 deg C	G, Amber VOA Vial Teflon Lined	14 Days	8 oz.
Temperature	-----	2550	-----	P	Analyze Immediately	4 oz.
TOC		Lloyd Kahn Method	Cool to 4 deg C	G, Amber	14 days	4 oz.
Total Coliform	-----	9131	Cool to 4 deg C	Sterile, P or G	6 Hrs	4 oz.
Total Coliform	-----	9132	Cool to 4 deg C	Sterile, P or G	6 Hrs	4 oz.
Total Cyanide	-----	9013	Cool to 4 deg C	P or G	14 Days	8 oz.
Volatile Organic Compounds	-----	8260B	Cool to 4 deg C Check individual state regulations for proper preservative. NJ (methanol), PA (encore samplers), NY (cool to 4 deg C)	G, wide mouth, teflon liner	14 Days	4 oz.
Volatile Organic Compounds	-----	8021		G, wide mouth, teflon liner	14 Days	4 oz.
CLP Sampling and Holding Time Information						
Cyanide (aqueous)	ILM04.1		NaOH to pH>12, Cool to 4 deg C	P	12 Days VTSR	1000ml
Cyanide**	ILM04.1		Cool to 4 deg C	G		8 oz
Mercury (aqueous)	ILM04.1		HNO3 to pH<2, Cool to 4 deg C	P	26 Days VTSR	1000ml
Mercury (solid/soils)	ILM04.1		Cool to 4 deg C	G		8 oz
Metals (aqueous)	ILM04.1		HNO3 to pH<2, Cool to 4 deg C	P	180 Days VTSR	1000ml
Metals (solid/soils)	ILM04.1		Cool to 4 deg C	G		8 oz
PCBs (aqueous)	OLM04.2		Na2S203, Cool to 4 deg C	G	See Note 7	1000ml
PCBs (solid/soils)	OLM04.2		Cool to 4 deg C	G	See Note 6	8 oz
Pesticides (aqueous)	OLM04.2		Na2S203, Cool to 4 deg C	G	See Note 7	1000ml
Pesticides (solid/soils)	OLM04.2		Cool to 4 deg C	G	See Note 6	8 oz
Semivolatile Organic Compounds (aqueous)	OMLO4.2		Cool to 4 deg C	G	See Note 8	1000ml
Semivolatile Organic Compounds (solid/soils)	OLM04.2		Cool to 4 deg C	G	See Note 6	8 oz
Volatile Organic Compounds (aqueous)	OLM04.2		HCL pH < 2, Cool to 4 deg C	G	W/preservative: 10 days VTSR; W/O: 7 days VTSR	40ml
Volatile Organic Compounds (solid/soils)	OLM04.2		Cool to 4 deg C	G	10 Days VTSR	4 oz

Table 1

Laboratory Analysis	EPA Method	Standard Method and/or SW846 Method	Preservation	Container	Holding Time	Minimum Volume

Notes:

1. P - Plastic.
2. G - Glass.
3. Minimum volume is the minimum volume required by the laboratory to conduct the analysis. The laboratory will likely require additional sample volume.
4. * Extraction within seven (7) days of collection; analysis within 40 days of extraction.
5. **When chlorine is present ascorbic acid is used to remove the interference (0.6 g ascorbic acid).
6. VTSR - Validated time of sample receipt.
7. Ten (10) days from VTSR for extraction and 40 days following extraction.
8. Five (5) days from VTSR for extration 14 days after extraction.
9. Five (5) days from VTSR for extraction 40 days after extraction.
10. Holding times are from the time of sample collection unless otherwise noted.

QUALITY ASSURANCE/QUALITY CONTROL SAMPLES

A. PURPOSE/SCOPE:

This standard operating procedure explains the purpose and correct usage of Quality Assurance/Quality Control (QA/QC) samples. QA/QC samples are intended to validate the results of sample analysis by providing the means to determine the influence of outside factors on the sample and analysis. There are several types of QA/QC samples in use to ensure the best practices are being followed by both the laboratory preforming the analysis and the sampling team in the field. This is a general procedure for the use of QA/QC samples. Also refer to any guidelines provided by the laboratory.

B. EQUIPMENT/MATERIALS:

QA/QC samples require the following materials:

- Sample containers:
  They should be the same containers in number and type of preservative as the containers for the samples for which QA/QC samples are being taken.
- Analyte-free water
- Any laboratory supplied QA/QC materials.

C. PROCEDURE:

The following are types of QA/QC samples.

1. Duplicate Sample

A duplicate sample is a sample that is collected concurrently with the routine samples. It consists of an additional set of sample containers to be analyzed for the same parameters as the routine samples. It is taken at a sample point of the samplers choosing and at the same time as the routine sample for that sample point is taken. It is labeled and included on the Chain of Custody (COC) Form (see SOP 105) with a name unknown to the laboratory.

Example:

- Sample Point ID is **MW-1**
- Duplicate Sample ID is **CHA-1**

The duplicate sample is submitted as a ‘blind’ sample to the laboratory. The purpose of a duplicate sample is to allow the sampler to determine the precision of laboratory analysis. The results of the duplicate sample are compared with the results of the concurrent routine sample by the sampler. These results should be within the margin of error for the test being performed.

One duplicate sample should be taken for every twenty (20) routine samples. For example if 16 samples points were sampled, there would be 1 duplicate sample taken at one of the sample points for a total of 17 sample sets submitted to the lab.

2. Field Blank

The Field Blank sample is a type of QA/QC sample used to account for possible external contamination of the routine samples, usually by exposure to the air from being on site. It consists of an additional set of sample containers to be analyzed for the same parameters as the routine samples. It is common to only conduct a Field Blank for volatile organic compound (VOC) parameters even when sampling to additional parameters. This is because VOCs are more likely to be present in the atmosphere at the site then a parameter like metals. However a Field Blank can be conducted for any parameter.

The containers are prepared prior to sampling by filling the containers with analyte-free water. The containers are then transported with the routine sample containers to the site. Once at the site the containers are placed in a location representative of the site conditions and their caps are removed. At the end of the sampling event the caps are then replaced. The sample is labeled and included on the COC as **Field Blank** or **FB**.

If any results are positive for the Field Blank it can be assumed that the routine samples have also been exposed to a similar amount of contaminant and that contaminant is probably present in the atmosphere at the site.

One Field Blank should be taken as required for each day of sampling at the site. They are only used for the collection of aqueous samples.

3. Equipment Blank

An Equipment Blank is a QA/QC sample designed to measure the effectiveness of the decontamination of field equipment. It consists of an additional set of sample containers being analyzed for the same parameters as the routine samples.

An Equipment Blank is collected by pouring analyte-free water directly over/on/into the decontaminated sampling equipment coming into contact with the samples being collected. The water is then collected in the sample containers. Once the containers are filled they are capped and sent to the lab with the other routine samples. The sample is labeled and included on the COC as **Equipment Blank** or **EQ Blank**.

A positive result for the analysis of the Equipment Blank could signal inadequate decontamination of the equipment which may result in cross-contaminated samples and thus suspect results.

One Equipment Blank should be taken for every twenty (20) routine samples collected. The Equipment Blank is not necessary when using dedicated sampling equipment or sampling equipment that is disposed of between each sample point.

4. Matrix Spike/Matrix Spike Duplicate Sample

The Matrix Spike/Matrix Spike Duplicate (MS/MSD) Sample is a quality control system used by the laboratory to check the accuracy of their instruments. It consists of a set of two (2) samples taken at a sample point concurrently with the routine sample for a total of three (3) sets of containers for that sample point. Therefore, the MS/MSD samples should be collected from sample points with sufficient sample volume (e.g., monitoring wells that have low recharge are not good candidates). They are labeled and included on the COC as ‘Sample ID’ MS and ‘Sample ID MSD’.

Example:

- Sample Point ID is **MW-1**
- Matrix Spike would be **MW-1 MS**
- Matrix Spike Duplicate would be **MW-1 MSD**

QUALITY ASSURANCE/QUALITY CONTROL SAMPLES

The MS/MSD samples are submitted to the laboratory with the routine samples. Once at the laboratory they will have a known amount of an analyte added, known as the spike. The sample will then be run as a routine sample. Once the results are received they are compared to the results of the routine sample (MW-1 results are compared to MW-1 MS results). There should be a difference in the amount of analyte detected between the samples that should be within the margin of error of the amount of analyte spike that was added to the MS sample. This process is repeated for the MSD sample. This process is an internal review of results for the laboratory to determine the accuracy of their instruments.

One MS/MSD set should be taken for every twenty (20) samples (including Duplicate Samples and Field or Equipment Blank Samples). For example if 12 samples are taken, there should also be a set of MS/MSD samples taken for a total of 14 sample sets submitted to the lab. If 20 samples will be taken, only one set of MS/MSD samples needs to be submitted (total number of samples being 22).

The following QA/QC samples are used for only specific analyses or functions.

5. <u>Trip Blank</u>

A Trip Blank is a form of QA/QC that is utilized to account for possible exposure to an external source of VOCs during storage and transport of the sample containers and samples to and from the laboratory. It consists of a VOC sample container prepared by the laboratory and filled with analyte-free water. Trip Blanks are only required when aqueous samples are being collected for VOC analysis, all other parameters do not need one.

The Trip Blank is placed in the cooler with the sample containers when they are sent form the lab to the client. The Trip Blanks will remain in the cooler with the sample containers at all times. When the samples are collected they are placed in the cooler and put on ice with the Trip Blanks for shipment to the lab. At no time should the Trip Blanks be opened or removed from the coolers containing VOC samples. The Trip Blank should be labeled and included on the COC as **Trip Blank** or **TB**.

Each cooler that contains samples for VOC analysis must have a Trip Blank. It is good practice to combine all VOC containers from a site into one cooler to minimize the number of Trip Blanks required. For example if there are five coolers of samples, place all the VOC containers into one cooler and the remaining containers in the other four coolers. Thus only the VOC cooler requires a Trip Blank, which saves on the cost of analysis.

A positive result on the Trip Blank for a VOC could indicate the samples had been exposed during transportation which can have an effect on the results of the routine samples.

Different laboratories have different practices concerning their Trip Blanks. For example some laboratories will include just one VOA vial as their trip blank while others will utilize multiple vials for theirs. The extra vials are often included only as a backup in the event one of the Trip Blank vials is broken during transport, and will not be analyzed unless necessary.

D. <u>QA/QC REQUIREMENTS:</u>

Not Applicable

QUALITY ASSURANCE/QUALITY CONTROL SAMPLES

E. SPECIAL CONDITIONS:

Temperature Blanks are a type of QA/QC that fall outside of the umbrella of QA/QC Samples.

A Temperature Blank is a container provided by the lab and is used to obtain the temperature of the cooler upon receipt at the lab, usually with an infrared thermometer. It is generally a ~125 mL plastic bottle filled with tap water.

- The Temperature Blank should be left in the cooler during sampling. When the cooler is being prepared for shipment, place the Temperature Blank in the center of the cooler next to the sample containers. There is no need to open the container; it is filled with tap water and therefore harmless unless otherwise noted on the container.
- It should be noted that not all laboratories require a Temperature Blank. There is no cost associated with the Temperature Blanks in the coolers.

F. REFERENCES:

United States Environmental Protection Agency (July 2007), *Samplers Guide, Contract Laboratory Program Guidance for Field Samplers*, Section 3.4, retrieved April 6, 2009, from http://www.epa.gov/superfund/programs/clp/download/sampler/clp_sampler_guidance.pdf

United States Environmental Protection Agency (May 2002), *Ground-Water Sampling Guidelines for Superfund and RCRA Project Managers*, Page 34, retrieved December 15, 2010, from http://www.epa.gov/tio/tsp/download/gw_sampling_guide.pdf

G. APPENDICES/FORMS:

Not Applicable

END OF SOP

Final Check by C. Burns 10/27/15

Author: Will Pierce
Reviewer: Chris Burns

FIELD HANDLING, PACKAGING, AND SHIPPING

A. PURPOSE/SCOPE:

This procedure describes proper methods for the handling, packaging, and shipping of samples from the field to the laboratory. When preparing samples for transportation to the laboratory it is important to maintain the integrity of the samples in order to obtain the most accurate results possible and to prevent possible contamination of other samples or the package itself. These procedures generally apply to samples collected in the field, any state or federal regulations or guidelines applying to the shipment of hazardous samples must be followed. In addition any guidelines provided by the laboratory should be consulted.

These procedures refer to the shipment of soil, sediment or water samples. For the shipment of air canisters refer to section J: Special Conditions.

B. EQUIPMENT/MATERIALS:

The following materials are required to adequately package samples

- Appropriately sized coolers that can accommodate samples and ice
- Plastic bags (i.e. garbage bags) large enough to contain all samples and ice
- Zip lock bags
- Ice sufficient to keep samples cool. DO NOT USE DRY ICE
- Bubble wrap or similar padding material
- Bubble bags or a similar padding material for any glassware
- Packing tape. Do not use duct tape inside coolers as it can contain volatile chemicals which could contaminate samples
- Custody seals and/or tamper-evident tape
- Appropriate labels (including ‘UP’ Arrows, Ice labels, Regulatory Compliance Labels (49 CFR 173.4), Shipping bills/labels).

C. PROCEDURE:

Once the samples have been collected, properly labeled and documented (See SOP’s #103 and #105) the following steps should be followed to pack and ship the samples.

For aqueous, sediment, soil or other solid samples:

1. Prepare the cooler for shipment
   - Seal and/or plug the cooler drain if present.
   - Place a layer of bubble wrap or other cushioning material on the bottom of the cooler.
   - Use a large plastic bag (liner) to line the cooler. It should fill the cooler with little void space between bag and cooler walls, if not use a smaller cooler or additional cushioning material. Double bag the cooler if using thin plastic bags. Place a thin layer of ice in the bottom of the liner.
2. Prepare the sample containers
   - Ensure all caps and lids are securely attached.
   - Check that all labels have been properly filled out and attached
   - Check that the samples are properly noted on the Chain-of-Custody (COC) and on any applicable field sheets.
   - Place sample containers into zip lock bags if they are being used.

FIELD HANDLING, PACKAGING, AND SHIPPING

3. If the sample is in a glass container place that container in a bubble bag or other cushioning material (bubble wrap roll, foam block, etc.) and secure it with tape. Try to avoid having glass in direct contact with ice as this can lead to the glass breaking (because the ice does melt).

4. Place samples in the cooler inside the liner.

   - All containers should be upright in cooler inside the bag liners.
   - Try to place glass containers towards the middle of the cooler.
   - Do not overfill the cooler. Try to keep weight below 60 lbs. to allow for easier maneuvering of the cooler.
   - Add a Trip Blank and a Temperature Blank if required. Include the Trip Blank on the COC. Place the Temperature Blank in the center of the cooler.

5. Add more ice, making sure that all containers are covered. The samples should arrive at the laboratory at 4° Celsius (+/- 2° C).

6. When all samples are in the cooler, or the cooler is full, gather the bags and tie or twist the loose ends to contain the ice and samples. Use packing tape, and a Custody seal if desired, to seal the bag liner.

7. Place another layer of bubble wrap or cushioning material on top of the bag for further protection and insulation of the samples. Make sure any void space in the cooler is filled to prevent the samples from shifting during transportation.

8. Put the COC along with any other required documentation inside a sealed zip lock bag and place it in the cooler.

9. Seal the cooler.

   - Place a signed and dated Custody seal on the cooler (if being used). The seal should extend from the top of the cooler, across the seam between the lid and the front, and down the front of the cooler. Tape over the custody seal using a length of tape continuously around the cooler. The seal should be placed such that it will be broken if the cooler is opened.
   - Using packing tape, tape around the cooler from front to back crossing both the top and the bottom of the cooler, use a continuous length of tape to help maintain integrity. Tape the cooler in at least two locations (i.e. left and right sides to create two bands of tape encircling the cooler.)

10. Place all required labels on the cooler. These can include ‘UP’ directional arrows, Wet Ice labels and regulatory labels (49 CFR 173.4). Tape them down as needed.

11. Fill out and affix the necessary shipping labels to the lid of the cooler.

12. All samples should be shipped overnight to the laboratory.

13. Alert the laboratory that the samples are en route. This is especially important for samples being delivered on a Saturday or around a holiday as the laboratory may be closed or have different hours. It is good practice to coordinate with the lab ahead of sampling to determine when the lab will receive samples.

FIELD HANDLING, PACKAGING, AND SHIPPING

For air samples:

1. Remove any regulators or valves from the canister.
2. Replace the canister and associated equipment in the container they were received in.
3. Place the COC in a zip lock bag with any required documentation and seal the bag. Put the COC into the container.
4. Add any necessary padding materials to fill void space and ensure the canister is protected and cannot shift during transport.
5. Seal the cooler with Custody Seals and packing tape.
6. Affix the necessary labels and shipping bills to the container.
7. Alert the laboratory that the samples are en route.

D. QA/QC REQUIREMENTS:

If aqueous samples for Volatile Organic Compound (VOC) analysis are being shipped use a Trip Blank (See SOP#605).

Some laboratories require Temperature Blanks (See SOP# 605) in each cooler of samples.

E. SPECIAL CONDITIONS:

These procedures apply to environmental samples only. An environmental sample usually consists of possibly contaminated water, soil, or sediment or air to be analyzed. In order to comply with regulations (ex. 49 CFR 173), no more the 30 mL of a product may be shipped in any one container inside the cooler (For example you can ship 3 containers with 20 mL of an oil to be tested, but not 2 containers with 40 mL of oil in them). Consult state and federal regulatory agencies and the laboratory receiving the samples if you are unsure of the regulations on the samples being taken.

F. REFERENCES:

United States Environmental Protection Agency (June 2010), *Sample Collection Information Document*, Section 5, retrieved August 31, 2012 from http://www.epa.gov/sam/sample_collection_information_document_SAM_companion.pdf

United States Environmental Protection Agency (July 2007), *Samplers Guide, Contract Laboratory Program Guidance for Field Samplers,* Section 3.4, retrieved April 6, 2009 from http://www.epa.gov/superfund/programs/clp/download/sampler/clp_sampler_guidance.pdf

Tennessee Valley Authority, *Standard Operating Procedure For: Sample Labeling, Packing, and Shipping* (July 2010), retrieved August 31, 2012 from http://www.tva.gov/kingston/sap/

G. APPENDICIES/FORMS:

Not Applicable

END OF SOP

Final Check by C. Burns 10/27/15