Unicorn Management Consultants, LLC

REMEDIAL INVESTIGATION WORK PLAN
PHASE I

FORMER GENERAL CABLE FACILITY
1007 ROUTE 346
POWNAL, VERMONT
VTDEC, SMS SITE #87-0129

Prepared for:

AMERICAN FINANCIAL GROUP
One East Fourth Street
Cincinnati, Ohio 45202

Prepared by:

UNICORN MANAGEMENT CONSULTANTS, LLC
52 Federal Road, Suite 2C
Danbury, CT 06810

June 2016

Unicorn Management
Consultants, LLC

DOCUMENT AUTHORIZATION FORM

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AUTHORIZATIONS:

Richard R. Bush **Senior Environmental Geologist**	6/1/16 **Date**
Michael O'Connor **Manager of Environmental Projects**	6/1/16 **Date**
Francisco Trejo **President**	6/1/16 **Date**

Unicorn Management
Consultants, LLC

CERTIFICATION

I, Michael O'Connor, certify that I am currently a Qualified Environmental Professional and that this Phase I Remedial Investigation Work Plan was prepared in accordance with all applicable statutes and regulations and in substantial conformance with the State of Vermont, "Investigation and Remediation of Contaminated Properties Procedures", dated April 2012.

Michael O'Connor
Manager of Environmental Projects

6/1/16
Date

Unicorn Management Consultants, LLC

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APPENDIX

1.0 INTRODUCTION

Unicorn Management Consultants, LLC (UMC), prepared this Phase I Remedial Investigation Work Plan (RIWP) on behalf of American Premier Underwriters, Inc. (APU), to conduct phased remedial investigation (RI) activities related to perfluorinated compounds (PFCs) detected in soil and groundwater at the Former General Cable Facility (Site) located at 1007 Route 346 in Pownal, Vermont. Figure 1 provides a Site Locus Plan. This Phase I RIWP is being submitted to the Vermont Department of Environmental Conservation (VTDEC), Agency of Natural Resources (ANR) in response to a letter correspondence from the VTDEC to APU dated April 19, 2016. The Site is listed with the VTDEC, Waste Management and Prevention Division (WMPD), Sites Management Section (SMS) as site #87-0129.

2.0 SITE DESCRIPTION

Figure 2 is a Site Plan depicting general Site and vicinity features. The Site consists of an approximately 10 acre parcel of land occupied by an approximately 120,000 square foot warehouse and several small auxiliary outbuildings. The Site is owned by Mack Molding Company (MMC) with regional headquarters located in Arlington, Vermont. The Site building consists of a one-story concrete block structure constructed largely on a concrete slab but with sub-floor level spaces in the west-central portion of the building, presumably allowing access to infrastructure associated with historical manufacturing activities (discussed below). The building is serviced with electricity but is not serviced by potable water. An inactive water supply well that formerly serviced the Site is located in an auxiliary building located south of the warehouse, identified as the “well house” on Figure 2. An inactive sewage system is located south of the Site building. A lined retention pond is located in the southern portion of the Site that supplies water to the building’s fire suppression system. Figure 2 indicates the approximate location of the retention pond.

The building and overall Site property is accessed by a paved driveway off of Vermont Route 346. A paved parking area is located south of the Site building and an unpaved parking area is located north of the building. Two loading docks are located at the north end of the Site building and overhead doors at several points allow access to the building interior.

The Site is abutted to the east by Vermont Route 346 with largely undeveloped land beyond that slopes steeply upward with exposed bedrock surfaces and scattered residences. A residential property abuts the Site to the north. A Boston and Maine Railroad right-of-way abuts the Site to the west at the top of an approximately 10 foot high embankment. The northerly flowing Hoosic River lies approximately 150 feet west of the Site building, beyond the railroad right-of-way and at the base of a steep approximately 20 foot high embankment. Based on UMC’s review of Town of Pownal Assessor’s Office maps, a portion of the Site property lies between the railroad right-of way and the Hoosic River as depicted on Figure 2. Agricultural land lies beyond the Hoosic River west of the Site. A parcel of land owned by the Town of Pownal Fire District #2 abuts the Site to the south, occupied by a municipal water supply well that services approximately 450 residences in Pownal. The water supply well is located approximately 1,000 feet south of the Site building as depicted on Figure 2.

The water level in the retention pond referenced above is maintained by rainfall and surface water runoff with overflow directed to a northerly flowing and apparently spring fed small drainage located west of the pond along the southwest edge of the Site property. The drainage in turn directs water to a storm water catch basin and associated culvert that underlies the westerly abutting railroad right-of-way and discharges to the Hoosic River as depicted on Figure 2. Surface water runoff in the northeastern portion of the Site is directed to a south to north-flowing drainage ditch located along the northeast edge of the

Site property. This drainage ditch in turn directs water to a series of catch basins and associated culverts located north and west of the Site building. This portion of the Site storm water system apparently discharges to the catch basin referenced above and discharges to the Hoosic River as depicted on Figure 2.

During an April 25, 2016 inspection of the Site building interior conducted by UMC for the purpose of locating potential PFC source areas, UMC observed an extensive system of floor drains and apparent sumps. However, as of the time of preparation of this Phase I RIWP, the discharge or end points of the system has not been made available to UMC. In addition, UMC observed three former solution tanks, each approximately 30 feet tall and 10 feet in diameter, located in the central portion of the building. MMC personnel indicated that the tanks were used to store solutions of undisclosed composition used in manufacturing processes historically conducted in the building (discussed below). Figure 3 indicates the approximate location of the former solution tanks.

3.0 HISTORICAL SITE USAGE

Based on historical information reviewed by UMC, the Site property consisted of farmland prior to 1948. Warren Wire Company (WWC) purchased the property in 1948 and began construction of the southern-most portion the Site building. WWC reportedly manufactured Teflon-coated wire and continued adding on to the Site building until sale of the facility to the General Cable Company (GCC) in 1963. GCC then continued Teflon-coated wire production and building expansion. Based on an August 12, 1987 letter from GCC representatives to the Compliance Branch, Region 1, of the United States Environmental Protection Agency (USEPA), manufacturing at the Site was discontinued by GCC "on or about November 15, 1986". GCC changed its name to GK Technologies and sold the property to MMC in 1988. No manufacturing is currently being conducted in the Site building or on any portion of the overall Site property. MMC utilizes the Site building solely for the purpose of providing temporary storage of goods manufactured by MMC in their Arlington, Vermont facility.

4.0 HISTORICAL SITE INVESTIGATIONS

4.1 Summary of Historical Petroleum Related Investigations

A release of fuel oil resulting in the discharge of fuel oil to the Hoosic River was reported to the VTDEC ANR by GCC personnel on April 24, 1987, following cessation of manufacturing activities but prior to sale of the Site to MMC. The release resulted in the listing of the Site with the VTDEC, WMPD, SMS as site #87-0129. The release occurred as the result of the failure of a 5,000 gallon capacity underground storage tank (UST) located in a vault with a dirt floor and concrete lined walls inside the Site building. A second 10,000 gallon capacity UST was nested adjacent to the 5,000 gallon UST beneath the concrete floor of the building. The 5,000 gallon UST was subsequently removed and approximately 25 cubic yards of petroleum-impacted soil was excavated and transported off-Site. The 10,000 gallon UST was closed in place by filling with sand. Subsequent to the UST closures, the recovery of light non-aqueous phase liquid (LNAPL) was initiated, a series of monitoring wells was installed (designated as GT-1 through GT-6 and MW-1 through MW-9 on Figure 2), and the quarterly collection of groundwater samples from select wells was initiated. Figure 2 indicates the approximate location of the former Site USTs and the monitoring wells. Note that the MW-designated monitoring wells and RW-designated recovery wells are located on the Site property while the GT-designated wells are located on the westerly abutting and topographically higher railroad right-of-way. The monitoring wells vary from approximately 10 feet to 20 feet in total depth, allowing sampling of the shallow groundwater interval where LNAPL and petroleum-related impacts typically occur.

On behalf of APU and at the request of the VTDEC, UMC is currently conducting quarterly Site groundwater sampling and LNAPL recovery efforts. Based on historically collected groundwater elevation data, Site overburden shallow groundwater flow direction is generally to the west-southwest toward the Hoosic River, likely influenced by a recovery trench historically installed for LNAPL recovery and the network of storm water culverts and drainage lines referenced above. Groundwater levels observed in Site monitoring wells vary seasonally between approximately 3 feet and 16 feet below the ground surface (bgs), generally deeper in the topographically higher GT-designated wells located at the top of the railroad embankment.

4.2 UMC's March 2016 PFOA Investigation

Based on information provided to UMC by the VTDEC, laboratory analysis of a water supply sample collected from the Fire District #2 municipal water supply well referenced above detected the PFC perfluorooctanoic acid (PFOA) at a concentration of 27 parts per trillion (ppt), exceeding the Vermont Department of Health (VTDOH) guidance value for PFOA of 20 ppt. The water supply well is reported to be advanced to a depth of approximately 69 feet bgs, is screened in gravel, and has an average yield of 97 gallons per minute (gpm). Based on a March 31, 2006 e-mail correspondence from the VTDEC to UMC, a well head protection area with a radius of 200 feet is established for the well and the well has a radius of influence of approximately 3,500 feet.

In response to the Fire District #2 municipal water supply well PFOA detection, between March 28 and 30, 2016, UMC collected groundwater samples from select Site monitoring wells and a surface water sample from the retention pond and submitted the samples to ALS Environmental (ALS) for PFC analysis by EPA Method 537 and EPA Method 537 Modified. In addition, UMC conducted four Site soil test borings using a stainless steel hand auger and collected soil samples from the borings at approximate six inch intervals between the ground surface and depths up to approximately 36 inches bgs. UMC also collected a sediment sample from a three foot diameter culvert located west of a small auxiliary outbuilding south of the warehouse, depicted on figures provided to UMC as a "solution tank building". An approximately two inch diameter plastic pipe and shut-off valve was observed in the culvert, apparently emanating from the solution tank building and discharging to the storm water drainage ditch described above and located immediately west of the culvert. The soil and sediment samples were submitted to ALS for PFC analysis by EPA Method 537 Modified. Figure 2 depicts the Site groundwater, surface water, soil, and sediment sample locations.

Figure 2 indicates the concentrations of PFCs detected in Site samples. The VTDOH guidance value for PFOA in water of 20 ppt was exceeded in 12 of the 13 groundwater and surface water samples tested, with concentrations ranging up to 260 ppt in the groundwater sample collected from monitoring well GT-2. In addition, the PFC perfluorooctane sulfonate (PFOS) was detected in seven of the groundwater samples tested in concentrations ranging between 5.3 ppt and 29 ppt. These concentrations do not exceed the VTDOH guidance value for PFOS of 30 ppt. The VTDOH guidance value for PFOA in soil of 0.30 milligrams per kilogram (mg/kg) or 300 nanograms per gram (ng/g) was not exceeded in any of the soil or sediment samples. PFOA detections below the VTDOH guidance value were detected in soils from location PB-4(12-24) at a maximum concentration of 2.5 ng/g. PFOS was detected in soils from location PB-2(6-12) at a maximum concentration of 2.4 ng/g.

5.0 **REMEDIAL INVESTIGATION OBJECTIVES**

UMC prepared this Phase I RIWP consistent with the VTDEC "Investigation and Remediation of Contaminated Properties Procedures", dated April 2012 (IROCPP). Consistent with the IROCPP, the objective of this Phase I RIWP is to conduct an initial assessment of Site overburden hydrogeologic conditions and the horizontal and vertical extent of PFC impacts to Site groundwater using Waterloo Advanced Profiling System (Waterloo^{APS}) technologies (discussed below). Following completion of the Phase I RI activities, UMC will develop a Phase II RIWP that will propose the collection of soil and groundwater samples at specific intervals and the collection of sediment and surface water samples based on analysis of Phase I RI findings. The Phase I and Phase II RI findings will provide an assessment of onsite and offsite PFC sources, sensitive receptors potentially exposed to PFC-impacted media and Site hydrogeologic and contaminant distribution data in support of a conceptual site model (CSM) that describes Site groundwater hydraulics and PFC-impacted groundwater fate and transport.

6.0 REMEDIAL INVESTIGATION ACTIVITIES

6.1 Site/Community Health and Safety

UMC will prepare a Site specific/community health and safety plan (HASP) that will be implemented for the protection of Site workers, the public living and working near the Site, as well as employees or visitors to the Site from exposure to Site contaminants during intrusive activities undertaken during the proposed investigation.

6.2 Site Property Survey

On behalf of APU, UMC will secure the services of a Vermont licensed land surveyor and underground utility locator who will work in tandem to locate overall Site property and building interior physical features. Specifically, under UMC supervision, these sub-contractors will:

- survey the Site property boundaries
- survey the general outline of the Site building exterior and interior walls
- to the extent practicable, survey and assess the discharge end point(s) of the building floor drain system and other features in the building and confirm the discharge end point(s) of the Site storm water collection system

UMC anticipates that the underground utility locator will employ ground penetrating radar (GPR) surveying techniques in conjunction with radio locating, remote camera imaging, or similar to assess the storm water and floor drain system overall layout and discharge end point(s).

6.3 Utility Clearance

The RI activities proposed in this Phase I RIWP involve the advancement of an approximately 1.75-inch-diameter stainless steel probe to the desired depths using a GeoProbe (discussed below). Accordingly, UMC will mark all probe locations with white paint and, as is practicable, with wooden stakes as required by Vermont State Dig Safely One Call (One Call) protocols. The One Call notification will be placed by UMC a minimum of three working days prior to initiating any earthwork. In addition, the independent utility locator selected for completion of activities described above in Section 6.2 will identify on-Site privately owned or historical underground utilities not included as part of the One-Call notification and will clear within a minimum of ten feet the area around each proposed probe location.

To further protect Site workers from potential hazards associated with underground utilities, all probe locations will be cleared using a stainless steel hand auger or air knife to a minimum depth of five feet bgs.

6.4 Waterloo^{APS} Investigation

6.4.1 Waterloo^{APS} Technology

The Waterloo^{APS} technology will be provided by Cascade Technical Services (Cascade) located in Montpelier, Vermont. Application of the technology involves the direct push of a profiling tool or probe at multiple points along transects using a Geoprobe. As the probe is advanced, the technology provides a real-time read-out of the subsurface material index of hydraulic conductivity (I_K). Driving ceases either at pre-determined depths or where the I_K data suggest a good sampling depth. At each sampling depth, physiochemical properties including pH, specific conductance (SC), dissolved oxygen (DO), and oxidation/reduction potential (ORP) are measured and equilibrium values are recorded along with a depth to the potentiometric surface at that depth. The I_K data identifies stratigraphic zones of relatively high permeability that are expected to serve as preferential pathways for groundwater migration and likely control solute PFC fate and transport. In addition, stratigraphic zones of relatively low permeability are identified which potentially contain the majority of PFC mass as a result of diffusive flux into these zones over time and may serve as long-term secondary PFC sources through back diffusion.

Probe advancement is typically stopped within high permeability zones and at the interfaces between high and low permeability zones to allow for groundwater sample collection through the probe. In addition, the depth to the potentiometric surface at each sample depth is measured which, when combined with data from other profiling points, can provide an assessment of the overall Site groundwater horizontal and vertical gradient. The resulting data set is used to generate two or three-dimensional views depicting PFC plume geometry and the variability of PFC concentrations as it correlates with Site geology and hydrogeology. This allows for a targeted approach for the selection of test boring locations and soil sampling intervals and the location of monitoring wells and screened intervals for additional groundwater sampling, ultimately resulting in the development of a more accurate and detailed CSM.

6.4.2 Profiling and Groundwater Sampling Procedures

Cascade will conduct the Waterloo^{APS} profiling under UMC supervision at 40 points including 38 points located on the Site property and 2 points located within the well head protection area established for the Fire District #2 municipal water supply well. Figure 3 depicts the approximate location of the proposed profiling points. The proposed profiling points are collectively oriented along the long axis of the Site property (north to south) and perpendicular to the historically observed shallow groundwater flow direction (east to west toward the Hoosic River).

The location of the profiling points was chosen in part with the objective of assessing groundwater impacts around the perimeter of the property including points PP-1 through PP-5 along the northern (downstream) end and points PP-13 through PP-24 along the southern (upstream) end. In addition, points PP-4 through PP-18 are located along a traverse covering the entire western-most, and presumably hydraulically downgradient property boundary. A second traverse consisting of points PP-25 through PP-30 is located hydraulically upgradient (east) of the Site building. A third traverse consisting of points PP-31 through PP-38 is established inside the building. UMC notes that some profiling points along the traverses were preferentially located proximate to potential areas of concern including the former septic system, water supply well, and solution towers. In addition, some points inside the Site building were preferentially located proximate to floor drains or sumps based on observations during UMC’s April 2016 building inspection. Points along the PP-25 through PP-30 traverse were located within approximately 5 to 10 feet of the Site building to avoid a municipal sewer line that is generally coincident with the eastern property boundary.

Profiling points PP-1, PP-2, and PP-3 are located at the foot of an embankment that slopes upward to the northerly abutting residential property and wraps around the northeastern corner of the property. The embankment is densely wooded with trees and underbrush, and bedrock in the area is likely relatively shallow as evidenced by outcrops immediately west of the property across Route 346. UMC concludes that points PP-1, PP-2, and PP-3 along with points PP-4 and PP-5 effectively cover the downstream northern portion of the property.

Similarly, profiling points PP-13 through PP-24 effectively cover the upstream southern portion of the property south of the building. A concrete pad evident in historical aerial photographs but now covered over with fill material is located south of the building. The pad was encountered approximately six inches below the ground surface during UMC's March 2016 investigation. The pad, retention pond, and a thickly vegetated area south of the pond preclude profiling in that area. However, UMC recognizes that contingent on the results of this phase of investigation, some data gaps may need to be filled.

Based on documented Site and vicinity information, Site stratigraphy is expected to consist of approximately 15 to 20 feet of relatively high transmissivity alluvial sand and gravel, underlain by a low transmissivity lacustrine clay or silty clay of variable thickness which acts as a confining layer to underlying high transmissivity gravelly sand deposited as glacial outwash and/or till to depths up to approximately 70 feet bgs. As-built plans provided to UMC indicate that the Fire District #2 water supply well is approximately 69 feet in total depth with seven feet of stainless steel well screen set in gravel at the well bottom. Based on these data, UMC anticipates that the profiling points will be advanced to total depths of approximately 70 feet bgs.

Groundwater samples will be collected at the desired intervals through a 1.75-inch-diameter stainless steel sampling head with ports fitted with stainless steel screens, which in turn is screwed into direct push rods with an outer diameter 1.75 inches. The ports convey water into a common internal fitting in the tip. Stainless steel tubing with an outside diameter of 1/8 inch is attached to the internal fitting using Swagelok® couplings. As the profiling probe is driven, additional sections of drill rod and stainless steel tubing are added. Non-Teflon-lined high density polyethylene (HDPE) and silicon tubing is attached to the stainless steel tubing and a peristaltic pump at the ground surface. PFC-free water is injected into the formation under pressure from compressed nitrogen as the probe is advanced to purge the probe of formation water from the previous sampling interval, to prevent clogging of the ports and to provide I_K data.

When the probe reaches the desired sampling depth, injection of water ceases, a peristaltic pump is actuated and the interval is purged. Purging continues until the PFC-free injected water is removed, typically marked by a change in water color or turbidity. Purging continues until stabilization criteria for the physicochemical parameters are reached. Typical purge volumes range from 400 mL to 1,000 mL per sample. The purge water will be collected in five gallon buckets and transferred to a 55-gallon drum or other suitable container that will be stored at a secure location of the Site pending characterization and off-Site disposal.

Following purging, a groundwater sample will be collected from the interval consistent with UMC's standard operating procedures (SOPs) and special considerations for sampling of PFC-impacted media (discussed below). Accordingly, UMC personnel will collect the samples in laboratory-supplied sample containers while wearing triple-layered nitrile gloves that are changed between each sampling interval. The containers will be labeled using an indelible ink marker indicating the profiling point and sample depth [i.e. PP-1(15)], the sample time and date, the sampler's initials, and the analyses to be conducted. The sample identification and sampling time will also be recorded in Site-dedicated field notebooks. The samples will be placed in a re-sealable plastic bag which in turn will be placed in a bubble wrap bag and then placed in a cooler on ice. The HDPE and silicon tubing will then be changed and the process will be repeated while advancing the probe to the next sampling interval.

The groundwater samples will generally be collected from intervals of relatively higher permeability (generally 10^{-4} centimeters per second (cm/sec) or higher) and from the interfaces between high and low permeability intervals encountered at each profile point. Accordingly, UMC anticipates that approximately four groundwater samples will be collected at each profiling point including one from the upper-most sand and gravel interval, one from the sand and gravel/silty clay interface, one from a sandy interbed in the silty clay interval, and one from the lower-most gravel interval. Based on this estimate, approximately 160 groundwater samples will be collected from the profiling points.

UMC will pack the collected groundwater samples in coolers on ice along with a laboratory-supplied temperature blank to document sample temperature upon arrival at the laboratory. UMC will arrange for transport of the samples under chain-of-custody to a Vermont-certified analytical laboratory for PFC analysis by EPA Method 527.

Following completion of each profiling point, Cascade will withdraw the profiling probe and drill rod and backfill the open hole to the ground surface using bentonite chips.

6.5 QA/QC Sampling

UMC will collect additional groundwater samples for quality control and quality assurance (QA/QC) purposes. UMC will collected up to 8 duplicate and 8 matrix spike/matrix spike duplicate (MS/MSD) groundwater samples for QA/QC purposes, equating to approximately one duplicate and one MS/MSD sample collected per every 20 groundwater samples collected.

UMC will also collect one aqueous equipment blank sample per working day for QA/QC purposes. The equipment blank samples will be collected by first decontaminating the sampling probe and stainless steel tubing as discussed below. PFC-free water will then be drawn through the assembly using the peristaltic pump and dedicated HDPE and silicon tubing and collected in an appropriate laboratory-supplied container.

In addition, UMC will collect field trip blanks on each day that sampling is being conducted to assess ambient air conditions. One field trip blank will be collected each sampling day proximate to active sampling locations both inside and outside the Site building.

UMC will label the QA/QC samples as described above and pack the samples in coolers on ice along with a laboratory-supplied temperature blank. UMC will arrange for transport of the samples under chain-of-custody to a Vermont-certified analytical laboratory for PFC analysis by EPA Method 527.

6.6 Equipment Decontamination Procedures and Special Considerations

Cascade will decontaminate the drill rod, stainless steel sample tubing, and profiling probe between each profiling point using PFC-free water. Analysis of groundwater samples collected by the VTDEC from a water supply well located on Vermont Route 7 approximately one mile south of the Site did not detected PFCs in concentrations exceeding laboratory detection limits. Therefore, UMC will use water from the well as the source of PFC-free water for sample line purging and for decontamination of profiling equipment between points. UMC will collect a sample of the well water and submit the sample to a Vermont-certified analytical laboratory for PFC analysis prior to use. Cascade will store the water at a secure location on the Site in a pre-cleaned holding tank dedicated solely for PFC-free water storage.

The profiling probe will be decontaminated by submerging the tip in a five-gallon bucket containing PFC-free water and pumping a minimum of one liter of water through the tip using the peristaltic pump. The stainless steel sample tubing and drill rod will be decontaminated by flushing and rinsing each piece with PFC-free water.

UMC notes that sampling of any media for PFCs requires special considerations. These considerations are discussed in UMC's SOP Document Control Number DCN1-44 (SOP DCN1-44), titled "Sampling Perfluorinated Compounds (PFCs), Groundwater, Surface Water, Public and Private Supply Wells, Surface Soil, Subsurface Soil, Stockpile, Sediment". Appendix 1 of this Phase I RIWP contains a copy of UMC's SOP DCN1-44. The sampling of all media for PFCs requires that no potential PFC-containing materials will be used or worn by the sampler during sampling. No materials containing Teflon, Gortex, or other synthetic waterproofing can be utilized while sampling. Appendix A of UMC's SOP DCN1-44 contains a summary of prohibited and acceptable materials for PFC sampling.

Appendix 1 also contains UMC's generic SOPs for completion of activities proposed in this Phase I RIWP and potentially to be proposed in UMC's Phase II RIWP including:

- DCN 1-11r2 titled "Sample Handling"
- DCN 1-12 titled "Calibration of Measuring and Test Equipment"
- DCN 1-16 titled "Measuring Water Levels and Sounding a Well with an Electronic Water Level Meter"
- DCN 1-19 titled "Decontamination of Field Equipment"
- DCN 1-21 titled "Sampling a Monitoring Well"
- DCN 1-26 titled "Soil Boring or Monitoring Well Drilling, Formation Sampling and Borehole Abandonment in Unconsolidated Formations"
- DCN 1-32 titled "Construction, Development and Abandonment of Monitoring Wells in Unconsolidated Formations"
- DCN 1-36 titled "Low Flow purging and Sampling of Monitoring Wells"

The activities proposed in this Phase I RIWP will be conducted in general accordance with UMC's SOPs listed above and with UMC's SOP DCN1-44 that addresses the special considerations to be implemented at PFC-impacted facilities such as the Site. However, UMC notes that deviations from the groundwater sampling and equipment decontamination procedures will be implemented during execution of the proposed Phase I RI activities. Specifically, sample point purging and decontamination of equipment will be conducted using only PFC-free water.

6.7 Monitoring Well Installations and Site Groundwater Elevation Monitoring

Following completion of profiling points PP-1, PP-6, PP-10, PP-15, PP-22, and PP-25, UMC will install monitoring wells proximate to the points to assess shallow and deep groundwater flow direction and gradient in those areas. The final depth of the screened intervals in the wells will be selected following assessment of the profiling point transmissivity data. Based on the overburden stratigraphy anticipated to be encountered at the Site (discussed above in Section 6.4.2), UMC anticipates that two wells will be installed at each location screened in the relatively higher transmissivity shallow and deep stratigraphic intervals.

The monitoring wells will be installed by driving 3.5-inch diameter steel casing and an expendable drive point to the targeted depth using a GeoProbe and direct push methods. Sections of two inch diameter

0.20-inch slotted schedule 40 polyvinyl chloride (PVC) well screen will then be installed in the bottom of the boring with solid schedule 40 PVC riser pipe extending above the top of the screen to approximately 3.5 feet above the ground surface. Based on historical groundwater elevations observed in MW-designated monitoring wells, the shallow stratigraphic interval wells will be screened between depths of 5 and 15 feet bgs. Five foot sections of well screen will be set at the bottom of the deeper stratigraphic interval wells with targeted depths anticipated to be approximately 70 feet bgs.

The boring annulus around the well screen will be backfilled with a #10 to 20 silica sand pack to a level approximately two feet above the top of the well screen. The remaining boring annulus will then be backfilled with bentonite chips to a level approximately 6-inches bgs and topped off with silica sand. Locking J-plugs will be installed in the riser pipe and a protective steel standpipe and locking cover will be installed over the wells, set in concrete at a depth of at least 3 feet bgs.

Following completion of each monitoring well, the casing will be steam cleaned using PFC-free water and the wells will be developed by purging each well of groundwater and fine materials produced during installation. The developing process will consist of using a surge block to agitate the well to mobilize the fine materials and inertial pump, submersible pump, or ventura system to evacuate the water. Each well will be developed until the water runs clear or until no further change in groundwater turbidity is visually observed and a minimum of three well volumes of groundwater has been purged. The purged water and water generated during steam cleaning will be containerized in 55-gallon drums that will be stored at a secure Site location pending characterization and off-Site disposal.

UMC will measure the groundwater level in the newly installed wells and in the existing MW and GT-series monitoring wells on a daily basis. These data, when correlated with hydraulic head measurements collected at other profiling points, will allow an assessment of overall Site shallow and deep groundwater flow direction and gradient both horizontally and vertically.

6.8 Profiling Point and Monitoring Well Surveying

Following completion of the profiling points and monitoring well installations, the horizontal location and vertical elevation of the ground surface at each profiling point as well as the elevation of the PVC casing at each of the newly installed monitoring wells will be surveyed by a Vermont-licensed land surveyor under UMC supervision. The survey will be conducted relative to a benchmark established during an historical surveying event on the top the concrete pad supporting the northeast corner of the water tower located east of the Site building, having an elevation of 533.56 feet above mean sea level (amsl).

6.9 Investigation Derived Waste Disposal

Employment of the Waterloo^{APS} technology will not generate drill cuttings. Waste water generated during sample point purging and equipment decontamination will be transferred to 55-gallon drums or a dedicated holding tank stored in a secure location on the Site. Following completion of the proposed Phase I RI activities, UMC will collect a sample of the waste water and submit the sample for PFC and other analyses as necessary and dispose of the water off-Site consistent with VTDEC requirements.

6.10 Data Analysis and Report Preparation

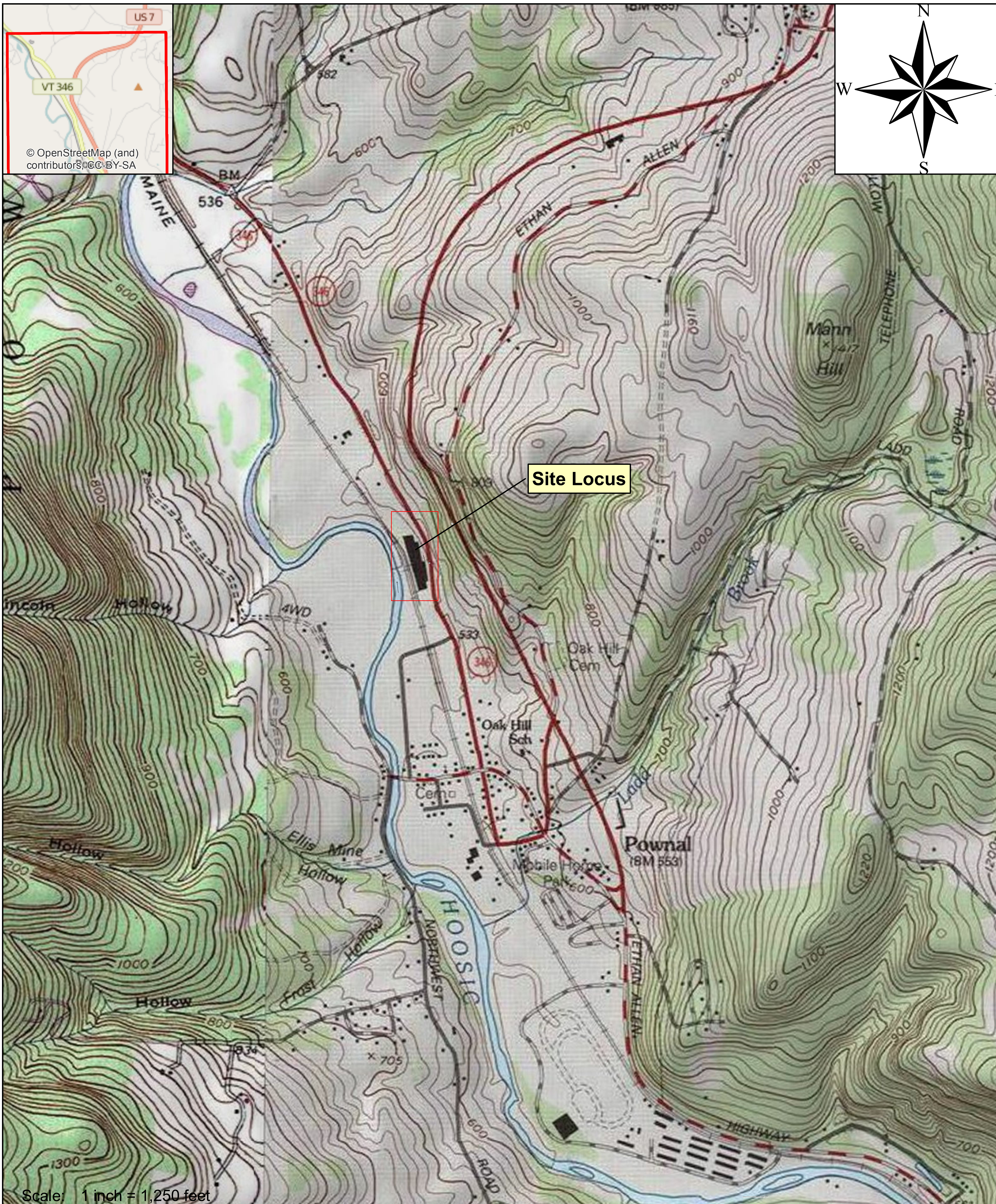
UMC will summarize the completed Phase I RIWP activities in a Phase I Remedial Investigation Report (Phase I RIR) for submittal to the VTDEC. The report will include discussion and tabulations of the groundwater sample analytical results and observed Site hydrogeologic conditions. In addition, the report will include figures depicting shallow Site groundwater flow direction and gradient and, as appropriate, groundwater flow direction and gradient in observed deeper groundwater intervals.

The Phase I RIR will also contain cross sections, plan view maps or interpolated three dimensional views depicting PFC plume geometry and the variability of PFC concentrations as it correlates with Site geology and hydrogeology. These figures will be used to provide a visual representation of Site groundwater hydraulics and PFC-impacted groundwater fate and transport in support of a CSM.

Based on Phase I RI findings, UMC will develop a Phase II RIWP that will be appended to the Phase I RIR and will likely propose:

- the advancement of test borings at select locations and the collection of soil samples from select intervals in the borings;
- the installation of monitoring wells at select locations screened at select intervals for the collection of additional ground water samples; and,
- the collection of sediment and surface water samples.

FIGURES



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Site Locus Plan
Remedial Investigation Workplan
Former General Cable Facility
Pownal, Vermont
VTDEC, SMS Site #87-0129

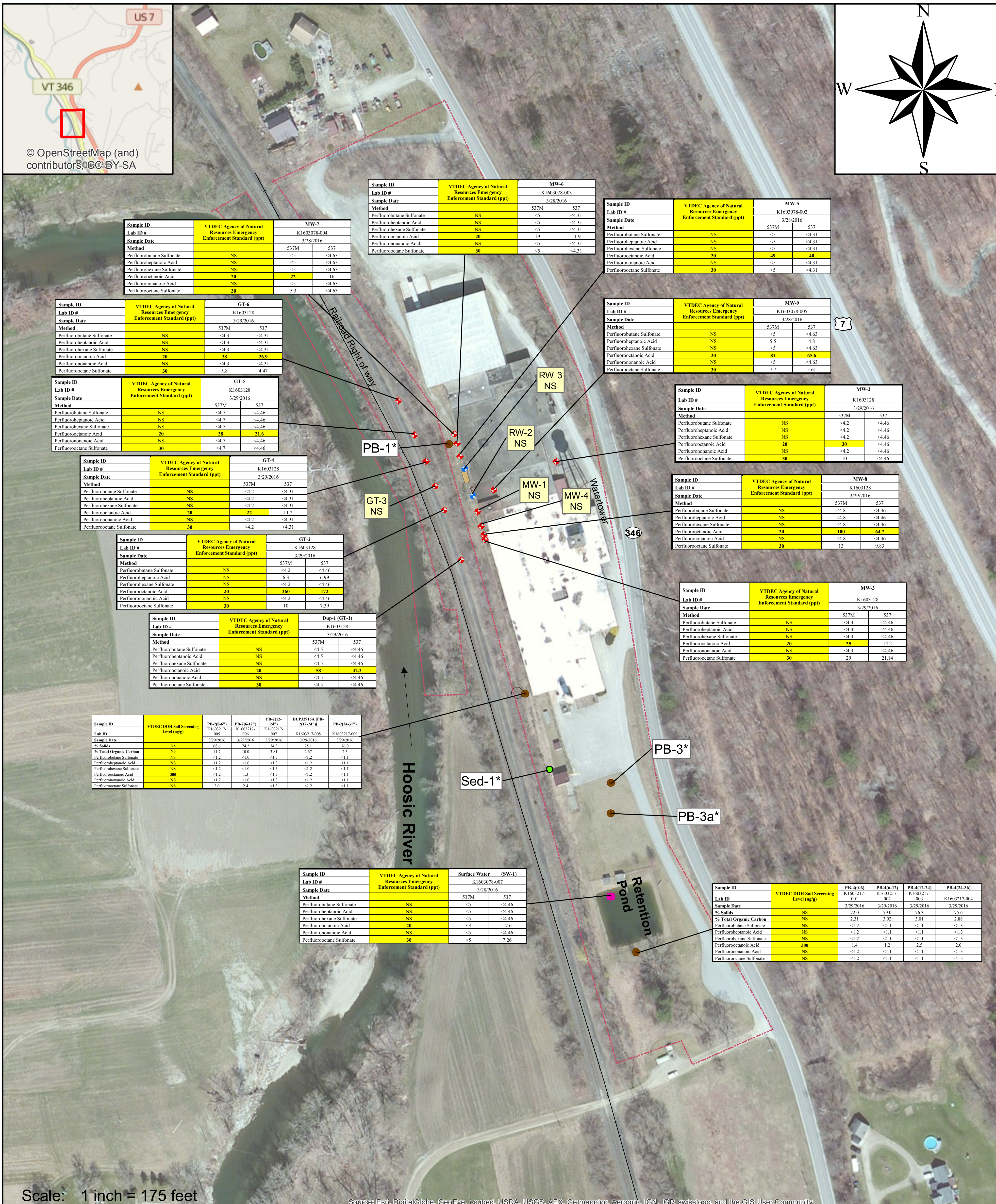
Legend

Site Locus

Figure 1

Project Name: Pownal, VT	
Project #: 2010	Author: RTM
Created: 6/9/15	Revised: 4/21/16
File: Pownal_PFOA_Result	

Topographic Map Source- ESRI ARCGIS USA Topo Map



Sample ID	VTDEC Agency of Natural Resources Emergency Enforcement Standard (ppt)	MW-6	
Lab ID #		K1603078-003	
Sample Date		3/28/2016	
Method		537M	537
Perfluorobutane Sulfonate	NS	<5	<4.31
Perfluoroheptanoic Acid	NS	<5	<4.31
Perfluorohexane Sulfonate	NS	<5	<4.31
Perfluorooctanoic Acid	**20**	19	11.9
Perfluorononanoic Acid	NS	<5	<4.31
Perfluorooctane Sulfonate	**30**	<5	<4.31

Sample ID	VTDEC Agency of Natural Resources Emergency Enforcement Standard (ppt)	MW-5	
Lab ID #		K1603078-002	
Sample Date		3/28/2016	
Method		537M	537
Perfluorobutane Sulfonate	NS	<5	<4.31
Perfluoroheptanoic Acid	NS	<5	<4.31
Perfluorohexane Sulfonate	NS	<5	<4.31
Perfluorooctanoic Acid	**20**	**49**	**40**
Perfluorononanoic Acid	NS	<5	<4.31
Perfluorooctane Sulfonate	**30**	<5	<4.31

Sample ID	VTDEC Agency of Natural Resources Emergency Enforcement Standard (ppt)	MW-7	
Lab ID #		K1603078-004	
Sample Date		3/28/2016	
Method		537M	537
Perfluorobutane Sulfonate	NS	<5	<4.63
Perfluoroheptanoic Acid	NS	<5	<4.63
Perfluorohexane Sulfonate	NS	<5	<4.63
Perfluorooctanoic Acid	**20**	**22**	16
Perfluorononanoic Acid	NS	<5	<4.63
Perfluorooctane Sulfonate	**30**	5.3	<4.63

Sample ID	VTDEC Agency of Natural Resources Emergency Enforcement Standard (ppt)	GT-6	
Lab ID #		K1603128	
Sample Date		3/29/2016	
Method		537M	537
Perfluorobutane Sulfonate	NS	<4.3	<4.31
Perfluoroheptanoic Acid	NS	<4.3	<4.31
Perfluorohexane Sulfonate	NS	<4.3	<4.31
Perfluorooctanoic Acid	**20**	**38**	**26.9**
Perfluorononanoic Acid	NS	<4.3	<4.31
Perfluorooctane Sulfonate	**30**	5.8	4.47

Sample ID	VTDEC Agency of Natural Resources Emergency Enforcement Standard (ppt)	MW-9	
Lab ID #		K1603078-005	
Sample Date		3/28/2016	
Method		537M	537
Perfluorobutane Sulfonate	NS	<5	<4.63
Perfluoroheptanoic Acid	NS	5.5	4.8
Perfluorohexane Sulfonate	NS	<5	<4.63
Perfluorooctanoic Acid	**20**	**81**	**65.6**
Perfluorononanoic Acid	NS	<5	<4.63
Perfluorooctane Sulfonate	**30**	7.7	5.61

Sample ID	VTDEC Agency of Natural Resources Emergency Enforcement Standard (ppt)	GT-5	
Lab ID #		K1603128	
Sample Date		3/29/2016	
Method		537M	537
Perfluorobutane Sulfonate	NS	<4.7	<4.46
Perfluoroheptanoic Acid	NS	<4.7	<4.46
Perfluorohexane Sulfonate	NS	<4.7	<4.46
Perfluorooctanoic Acid	**20**	**38**	**21.6**
Perfluorononanoic Acid	NS	<4.7	<4.46
Perfluorooctane Sulfonate	**30**	<4.7	<4.46

Sample ID	VTDEC Agency of Natural Resources Emergency Enforcement Standard (ppt)	MW-2	
Lab ID #		K1603128	
Sample Date		3/29/2016	
Method		537M	537
Perfluorobutane Sulfonate	NS	<4.2	<4.46
Perfluoroheptanoic Acid	NS	<4.2	<4.46
Perfluorohexane Sulfonate	NS	<4.2	<4.46
Perfluorooctanoic Acid	**20**	**30**	<4.46
Perfluorononanoic Acid	NS	<4.2	<4.46
Perfluorooctane Sulfonate	**30**	10	<4.46

Sample ID	VTDEC Agency of Natural Resources Emergency Enforcement Standard (ppt)	GT-4	
Lab ID #		K1603128	
Sample Date		3/29/2016	
Method		537M	537
Perfluorobutane Sulfonate	NS	<4.2	<4.31
Perfluoroheptanoic Acid	NS	<4.2	<4.31
Perfluorohexane Sulfonate	NS	<4.2	<4.31
Perfluorooctanoic Acid	**20**	**22**	11.2
Perfluorononanoic Acid	NS	<4.2	<4.31
Perfluorooctane Sulfonate	**30**	<4.2	<4.31

Sample ID	VTDEC Agency of Natural Resources Emergency Enforcement Standard (ppt)	MW-8	
Lab ID #		K1603128	
Sample Date		3/29/2016	
Method		537M	537
Perfluorobutane Sulfonate	NS	<4.8	<4.46
Perfluoroheptanoic Acid	NS	<4.8	<4.46
Perfluorohexane Sulfonate	NS	<4.8	<4.46
Perfluorooctanoic Acid	**20**	**100**	**64.7**
Perfluorononanoic Acid	NS	<4.8	<4.46
Perfluorooctane Sulfonate	**30**	13	9.83

Sample ID	VTDEC Agency of Natural Resources Emergency Enforcement Standard (ppt)	GT-2	
Lab ID #		K1603128	
Sample Date		3/29/2016	
Method		537M	537
Perfluorobutane Sulfonate	NS	<4.2	<4.46
Perfluoroheptanoic Acid	NS	6.3	6.99
Perfluorohexane Sulfonate	NS	<4.2	<4.46
Perfluorooctanoic Acid	**20**	**260**	**172**
Perfluorononanoic Acid	NS	<4.2	<4.46
Perfluorooctane Sulfonate	**30**	10	7.39

Sample ID	VTDEC Agency of Natural Resources Emergency Enforcement Standard (ppt)	MW-3	
Lab ID #		K1603128	
Sample Date		3/29/2016	
Method		537M	537
Perfluorobutane Sulfonate	NS	<4.3	<4.46
Perfluoroheptanoic Acid	NS	<4.3	<4.46
Perfluorohexane Sulfonate	NS	<4.3	<4.46
Perfluorooctanoic Acid	**20**	**25**	14.2
Perfluorononanoic Acid	NS	<4.3	<4.46
Perfluorooctane Sulfonate	**30**	29	21.14

Sample ID	VTDEC Agency of Natural Resources Emergency Enforcement Standard (ppt)	Dup-1 (GT-1)	
Lab ID #		K1603128	
Sample Date		3/29/2016	
Method		537M	537
Perfluorobutane Sulfonate	NS	<4.5	<4.46
Perfluoroheptanoic Acid	NS	<4.5	<4.46
Perfluorohexane Sulfonate	NS	<4.5	<4.46
Perfluorooctanoic Acid	**20**	**58**	**42.2**
Perfluorononanoic Acid	NS	<4.5	<4.46
Perfluorooctane Sulfonate	**30**	<4.5	<4.46

Sample ID	VTDEC DOH Soil Screening Level (ng/g)	PB-2(0-6")	PB-2(6-12")	PB-2(12-24")	DUP32916A [PB-2(12-24")]	PB-2(24-31")
Lab ID		K1603217-005	K1603217-006	K1603217-007	K1603217-008	K1603217-009
Sample Date		3/29/2016	3/29/2016	3/29/2016	3/29/2016	3/29/2016
% Solids	NS	68.6	74.2	74.3	75.1	76.0
% Total Organic Carbon	NS	11.7	10.0	3.81	2.67	2.3
Perfluorobutane Sulfonate	NS	<1.2	<1.0	<1.3	<1.2	<1.1
Perfluoroheptanoic Acid	NS	<1.2	<1.0	<1.3	<1.2	<1.1
Perfluorohexane Sulfonate	NS	<1.2	<1.0	<1.3	<1.2	<1.1
Perfluorooctanoic Acid	**300**	<1.2	1.3	<1.3	<1.2	<1.1
Perfluorononanoic Acid	NS	<1.2	<1.0	<1.3	<1.2	<1.1
Perfluorooctane Sulfonate	NS	2.0	2.4	<1.3	<1.2	<1.1

Sample ID	VTDEC Agency of Natural Resources Emergency Enforcement Standard (ppt)	Surface Water (SW-1)	
Lab ID #		K1603078-007	
Sample Date		3/28/2016	
Method		537M	537
Perfluorobutane Sulfonate	NS	<5	<4.46
Perfluoroheptanoic Acid	NS	<5	<4.46
Perfluorohexane Sulfonate	NS	<5	<4.46
Perfluorooctanoic Acid	**20**	3.4	17.6
Perfluorononanoic Acid	NS	<5	<4.46
Perfluorooctane Sulfonate	**30**	<5	7.26

Sample ID	VTDEC DOH Soil Screening Level (ng/g)	PB-4(0-6)	PB-4(6-12)	PB-4(12-24)	PB-4(24-36)
Lab ID		K1603217-001	K1603217-002	K1603217-003	K1603217-004
Sample Date		3/29/2016	3/29/2016	3/29/2016	3/29/2016
% Solids	NS	72.0	79.0	76.3	75.6
% Total Organic Carbon	NS	2.31	3.92	3.01	2.88
Perfluorobutane Sulfonate	NS	<1.2	<1.1	<1.1	<1.3
Perfluoroheptanoic Acid	NS	<1.2	<1.1	<1.1	<1.3
Perfluorohexane Sulfonate	NS	<1.2	<1.1	<1.1	<1.3
Perfluorooctanoic Acid	**300**	1.4	1.2	2.5	2.0
Perfluorononanoic Acid	NS	<1.2	<1.1	<1.1	<1.3
Perfluorooctane Sulfonate	NS	<1.2	<1.1	<1.1	<1.3

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Pownal PFC Final Lab Results for Groundwater, Surface Water, and Soil Samples (3/28/16 & 3/29/16)
Immediate Response Investigation Report
Former General Cable Facility
Pownal, Vermont
VTDEC, SMS Site #87-0129

Figure 2

Project Name:	Pownal, VT		
Project #:	2010	Author:	RTM
Created:	6/9/15	Revised:	5/8/16
File:	Figure3_Results		

* Next to the ID indicates all depths of the boring were non-detect for PFC's/

All water concentrations are in parts per trillion. Yellow concentrations exceed the Vermont Standard for the given compound.

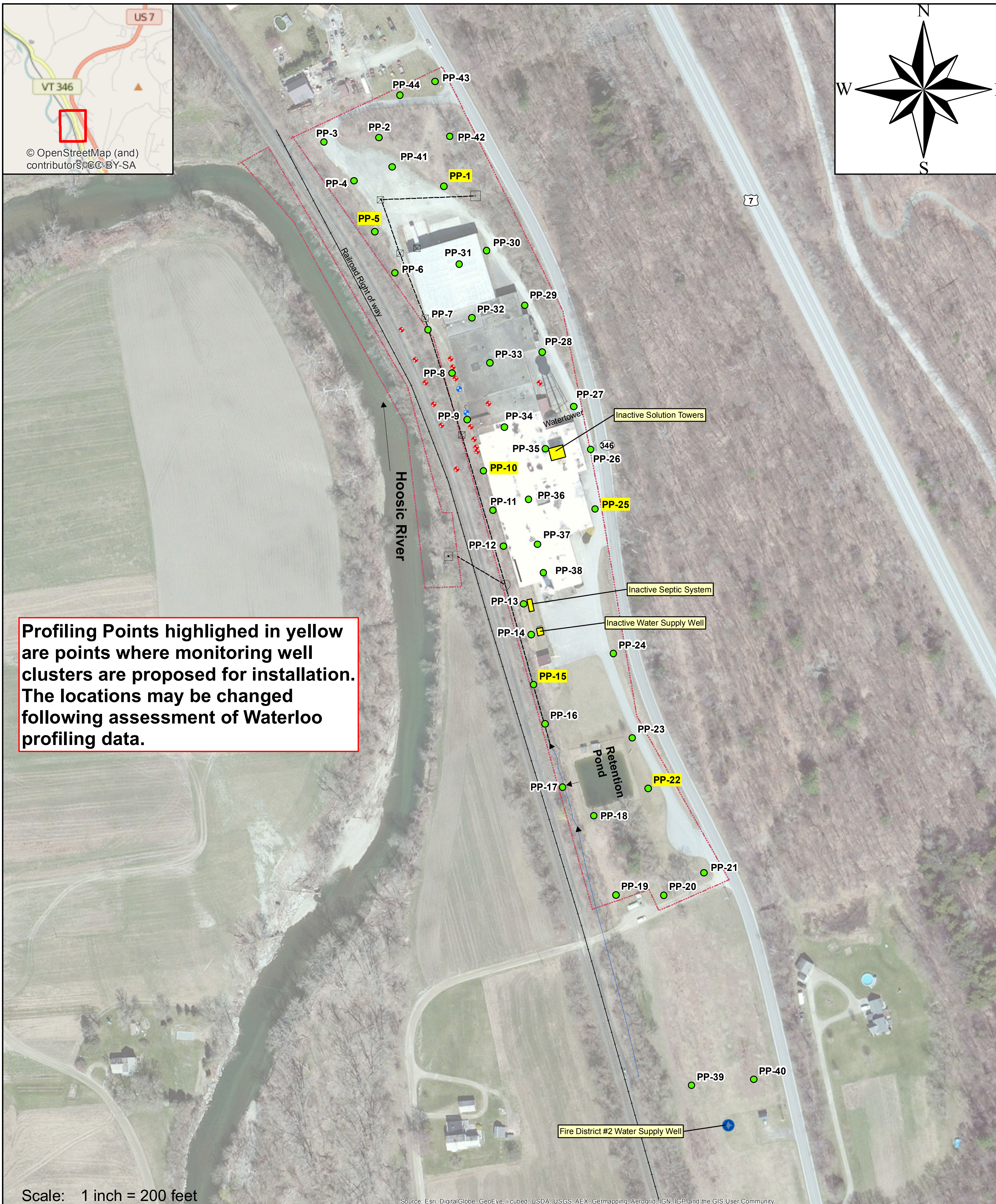
All soil concentrations are in parts per billion.

DUP= Duplicate Sample

NS= Not Sampled

Legend

- Sediment Location- 2016
- Surface Water Sample- 2016
- Soil Borings- 2016
- Monitoring Well
- Recovery Well
- Catch Basin
- Site Boundaries



Unicorn Management Consultants, LLC

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Danbury, CT
06810
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Figure 3

Project Name:	Pownal, VT
Project #: 2010	Author: RTM
Created: 6/9/15	Revised: 6/1/16
File:	Figure3_proposed

Proposed Profiling Locations
Remedial Investigation Workplan
Former General Cable Facility
Pownal, Vermont
VTDEC, SMS Site #87-0129

Legend

- Proposed Profiling Points- 2016
- Pownal Municipal Well
- Current Monitoring Well
- Current Recovery Well
- Storm Water structure recieving storm runoff
- Storm Water outfall to Hoosic River
- Catch Basin
- Catch Basin/Storm Water structure with steel manhole
- Drainage Ditch/Stream
- Underground Storm Water line and flow pathway
- Site Boundaries

APPENDIX 1

UMC SOPs

ENVIRONMENTAL SERVICES
STANDARD OPERATING PROCEDURE

SAMPLE HANDLING

PROJECT NUMBER: 0001		**DOCUMENT CONTROL NUMBER: 0001-011R2**	
APPROVALS			
Title-Signature-Date			
REV NO.	PREPARED BY	DIRECTOR REVIEW	PRESIDENT
0			
1			
2			
3			
4			
5			
6			
7			
8			
9			
10			
11			
12			

1.0 PURPOSE

The purpose of this Standard Operating Procedure (SOP) is to establish guidelines for sample handling that will aid in achieving consistent methods of data collection. This SOP is designed to ensure that once samples are collected, they are preserved, packed and delivered in a manner that maintains sample integrity. While the following procedures are appropriate for most sampling events, applicable local, state and Federal sample handling protocols and guidelines must be reviewed and considered. If necessary, modifications to the SOP can be addressed on a site-specific basis. Any modification must be clearly stated in the project planning documents (e.g., work plan, field sampling plan, site specific SOP) prepared for the site; these documents will always take precedence over this SOP.

2.0 CONSIDERATIONS

2.1 Sample Containers

Prior to the sampling event, consideration must be given to the type and number of containers that will be used to store and transport the samples. The sample matrix, the analytical method, the laboratory's quality assurance/quality control (QA/QC) requirements, potentially present contaminants and local, state or Federal regulatory requirements factor into the selection of a sample container. Typically, the contracted laboratory will select and provide the appropriate number and type of sample containers based upon the analytical methods and scope of work requested. Prior to sampling, make sure that the laboratory is clear on the scope of work and the objectives of the project. When performing non-routine sampling, it is also recommended that the sampling crew request instructions from the laboratory regarding the volume of sample required (e.g., matrix spike analyses for soil may require extra samples), the proper technique for filling and preserving the sample containers and the type and number of containers supplied per analytical parameter.

As a general guide, the attached table provides a list of common analytical parameters with corresponding sample containers as specified by USEPA Test Methods for Evaluating Solid Waste, Physical/Chemical Methods, SW-846 (EPA/530-SW-846.3-1). Sample container selection is usually based upon some combination of the following criteria:

a. Reactivity of Container Material with Sample

For sampling potentially hazardous material, glass is the recommended container type because it is chemically inert to most substances. Plastic containers are not recommended for most hazardous wastes because the potential exists for contaminants to adsorb to the surface of the plastic or for the plasticizer to leach into the sample. Species of metals will adhere to the sides of glass containers in an aqueous matrix; therefore, plastic bottles (e.g., nalgene) must be used. If metals analyses are to be performed along with other analyses, then a separate plastic bottle must be used. In the case of a strong alkali waste or hydrofluoric solution, plastic containers may be more suitable because glass containers may be etched by these compounds and create adsorptive locations on the surface of the container.

b. Volume of the Container

The volume of sample to be collected will be dictated by the analytical method and the sample matrix. Individual laboratories may provide larger volume containers or request multiple containers for a sample to ensure sufficient sample for duplicates or other QA/QC checks. Wide mouth containers are recommended to facilitate transfer of the sample from the sampler into the container without spillage or sample disturbance. Aqueous samples analyzed for volatile organic compounds (VOCs) must be placed in 40-milliliter (ml) glass vials with polytetrafluoroethylene (PTFE) (e.g., Teflon™) septum. Non-aqueous samples for VOC analysis should be collected in either En-Core® or similar sampling devises for shipment to the laboratory. Alternatively, non-aqueous samples may be collected and preserved according to EPA Method 5035 (see attached).

c. Color of Container

Whenever possible, amber glass containers should be used to prevent photodegradation of the sample, except when samples are being collected for metals analyses. If amber containers are not available, then containers holding the samples should be protected from light.

d. Container Closures

Container closures (i.e., caps and lids) must screw on and off the containers and form a leak-proof seal. Container caps must not be removed until the container is ready to be filled with the sample and the container cap must be replaced immediately after filling. Container caps should be constructed of a material that is inert with respect to the sampled material, such as PTFE. Alternately, the caps may be separated from the sample by a closure liner that is inert to the sample material. If soil or sediment samples are being collected, the threads of the container must be wiped clean.

e. Decontamination of Sample Containers

Sample containers should be laboratory pre-cleaned, preferably by the laboratory performing the analysis. (The cleaning procedure will be dictated by the specific analysis to be performed on the sample.) Sample containers should be examined upon receipt and before use to ensure that each appears clean. Do not mistake any preservative that was already deposited in the sample container by the laboratory for unwanted residue. Sample bottles received from a laboratory should not be field cleaned. If there is any question regarding the integrity of the bottle, the laboratory should be contacted and the bottle(s) replaced.

f. Sample Bottle Storage and Transportation

Care should always be taken to avoid contamination of the sample bottles. Sample shuttles or coolers and sample bottles must be stored and transported in clean environments. Sample bottles and clean sample equipment should never be stored near solvents, gasoline or other equipment that is a potential source of cross contamination. When under chain of custody, sample bottles should either be custody sealed in a cooler or shuttle that is secured inside a locked vehicle or other designated secure area, or in the presence of authorized personnel.

2.2 Sample Filtering

Aqueous samples collected for dissolved metals analyses may require filtering to remove suspended sediment from the sample. Filtering must be performed prior to preserving the sample (in accordance with UMC DCN 0001-029). If the sample container received from the laboratory contains preservative, then an interim container must be used to transport the sample from the collection point to the filtering apparatus. To ensure that interim containers are contaminant free, they should be supplied by the laboratory.

2.3 Decontamination of Sampling Equipment

Refer to the SOP for the Decontamination of Field Equipment (UMC DCN 0001-019) for guidance on decontamination of re-usable sampling equipment.

2.4 Quality Assurance/Quality Control Samples

QA/QC samples are intended to provide control over the proper collection and subsequent review and interpretation of analytical data. Refer to the SOPs for Collection of Quality Control Samples (UMC DCN 0001-018) and Field Record Keeping (UMC DCN 0001-017) for detailed guidance concerning these procedures.

2.5 Sample Preservation Requirements

Certain analytical methods require that the sample be preserved in order to stabilize and maintain sample integrity. Many laboratories provide pre-preserved bottles as a matter of convenience and to help ensure that samples will be preserved immediately upon collection. Care must be exercised not to overfill sample bottles containing preservatives to prevent the sample and preservative from spilling, thereby diluting the preservative.

When samples are preserved in the field, special care must be taken. The transportation and handling of concentrated acids in the field requires additional preparation and adherence to appropriate preservation procedures. All preservation acids used in the field should be trace-metal or higher grade.

2.6 Sample Labels

Sample labels should be provided with the sample containers, but this should be verified with the laboratory. If desired, labels may be pre-printed by computer with blank spaces provided for variable information collected in the field. If necessary, masking tape may be used for labels in the field, but this practice should be avoided. Sample containers should always be labeled prior to opening the container to avoid cross contamination and problems associated with marking wet or dirty paper. Indelible ink markers should be used for labeling and labels.

At a minimum, sample containers will be labeled with the following information:

- site name;
- project number;
- initials of sampler;
- sample identification code;
- analytical method;
- date and time of collection; and
- preservative added (if applicable).

These are common sample identification codes that may be used on sample labels.

1. Sample type (medium) abbreviation may be as presented below.

ground water sample	=	GW
surface water sample	=	SW
sediment sample	=	SED
solid waste sample	=	WASTE
waste water sample	=	WW
chip sample	=	CHIP
wipe sample	=	WIPE

soil sample	=	SOIL
influent sample	=	INF
effluent sample	=	EFF
air sample	=	AIR
dust sample	=	DUST

2. Sample location abbreviation may use the identifier system established for the site. Examples of sample location abbreviations are presented below.

soil boring	=	"SB-" followed by the designated number of the boring
monitoring well	=	"MW-" followed by the designated number of the well
surface water	=	"SW-" followed by the designated number of the sampling location
surface soil	=	"SS-" followed by the designated number of the sampling location
sediment	=	"SD-" followed by the designated number of the sampling location
discharge outfall	=	"OF-" followed by the designated number of the outfall location
air	=	"AS-" followed by the designated number of the air station

3. Where applicable, depth intervals may be designated in feet or tenths of a foot (e.g., 0.5-1.0 ft).

4. Analytical parameter designations are commonly abbreviated as presented below.

volatile organic compound	=	VOC
semivolatile organic compound	=	SVOC
polychlorinated biphenyl	=	PCB
pesticide	=	PEST
metals	=	METAL
non-metallic inorganic	=	INO
geotechnical	=	GA

5. Quality control qualifiers commonly are abbreviated as presented below.

field replicate	=	R
trip or travel blank	=	TB
field or rinsate blank	=	FB
matrix spike and matrix spike duplicate	=	MS/MSD

For example, the designation "SOIL/SB-10/12-14/VOC" would indicate that the sample was a soil sample collected at Soil Boring SB-10, that it was collected at a depth interval of 12 to 14 feet below land surface, and it was selected to be analyzed for volatile organic compounds. A sample designated "GW/MW-10/R/SVOC" would indicate a replicate sample of ground water collected from Monitoring Well MW-10 and selected to be analyzed for semivolatile organic compounds.

Occasionally, the contracted laboratory supplies preprinted or bar-coded labels on the sample containers. These labels are acceptable; however, care must be exercised to ensure that coded-alike containers are not confused with other similar containers. The sampler should initial and record the time and date on each container in a blank portion of the label or on a separately attached label.

2.7 Sample Packing

All sample labels should be checked for accuracy and the caps checked for tightness. Any irregularities concerning the condition of the samples or containers should be noted on the chain-of-custody form. The bottles must be carefully packed to prevent breakage during transport. If there are any samples known or suspected to be highly contaminated, they should be packaged individually to prevent cross-contamination. Sufficient ice should be placed in the cooler to maintain the temperature at 4 degrees Celsius (˚C) until delivery to the laboratory. Consult the work plan to determine if a particular cooling agent is specified for preservation (e.g., the United States Environmental Protection Agency does not condone the use of blue packs because they claim that the samples will not hold at 4˚C.) The chain-of-custody form should be properly completed, placed in a "zip-loc" bag and placed in the cooler. One copy must be maintained for the project file. The cooler should be sealed with strapping tape and a cooler-custody seal. The cooler drains should be taped shut to prevent leakage. The custody seal number should be noted in the field book or on the chain-of-custody form.

2.8 Chain-of-Custody Forms

Most contracted laboratories have their own Chain-of-Custody (COC) forms. If appropriate, use of the laboratory supplied COC forms is preferred because it reduces the chance of miscommunication between the samplers and the receiving laboratory. Otherwise, the Field Team Leader (FTL) is responsible for obtaining appropriate blank COC forms from the PM for use during the sampling event.

2.8.1 Prior to initiation of field activities, the FTL is responsible for ensuring that an ample supply of COC forms are onsite to cover all of the scheduled sampling, including extra blank forms for contingency purposes.

2.8.2 The FTL reviews and familiarizes himself with the COC form and contacts the issuing laboratory for clarification of any questions concerning proper completion of the COC form.

2.8.3 Pre-completion of the COC form and sample bottle labels is limited to site generic information, e.g., site name and address, and UMC project number.

2.8.4 The format of various COC forms will differ; however, the following information must be included on all COC forms accompanying samples collected by UMC: UMC project number; UMC project name; UMC's name address and telephone number and contact person; unique sample identification numbers; sample matrix; date and time samples were collected; volume, type, and quantity of sample containers; preservatives; and analyses requested. Reference methods must be specified when appropriate, e.g., *VOCs+15 (via 624)*. Special instructions and considerations should be noted in the comment section, e.g., *sample bottle not full, run TPH first*.

2.8.5 The FTL or his/her designee completes the COC form as soon as practicable after collection of the samples. Note: sample bottle labels must be completed at the time of sample collection and prior to collection of the next sample.

2.8.6 If sample custody is directly relinquished, e.g., laboratory pickup at the project site, the FTL or his/her designee: 1) signs, dates, and notes the time of the transfer; 2) gives the COC to the receiver to sign, date, and note the time; 3) takes the COC back from the receiver and reviews for completeness rectifying any deficiencies; and 4) gives the completed COC back to the receiver, retaining the appropriate carbon copy for the project files. If the COC form does not have carbon copies, a photocopy or handwritten duplicate with appropriate signatures must be made (**no exceptions**).

2.8.7 If sample custody is indirectly relinquished, e.g., express mailed to the receiving laboratory, the FTL or his/her designee: 1) signs, dates, and notes the time of the transfer; 2) places the completed COC form into the sample shuttle retaining the appropriate carbon copy; 3) completes the express mail slip and retains the appropriate carbon copy; and 4) attaches the retained copies of the COC form and express mail slip together for the project file. If the COC form does not have carbon copies, a photocopy or handwritten duplicate with appropriate signatures must be made (**no exceptions**).

2.9 Sample Delivery

Samples should be delivered to the laboratory within 24 hours of collection. If samples are shipped prior to or on a weekend or holiday, the laboratory should be contacted to confirm that someone will be available to accept delivery. Check the work plan to determine whether a shorter delivery time is imperative.

3.0 EQUIPMENT AND MATERIALS

3.1 General Equipment

a. Sample bottles of proper size and type
b. Cooler with ice (wet or blue pack)
c. Field notebook, appropriate field form(s), chain-of-custody form(s), custody seals
d. Black pen and indelible marker
e. Packing tape and "zip-loc" bags
f. Overnight shipping forms and laboratory address
g. Health and Safety plan (HASP)
h. Work plan/scope of work
i. Pertinent SOPs for specified tasks and their respective equipment and materials
j. Container labels
k. Ice bath (cold water and ice in a small, leak-proof cooler)

3.2 Preservatives

Preservatives for specific samples/analytes, as specified by the laboratory. Preservatives must be stored in secure spill-proof glass containers with their content, concentration, and date of preparation and expiration clearly labeled. Most preservatives are hazardous chemicals and must arrive with an MSDS. The MSDS must be brought to the field during the sampling event.

3.3 Miscellaneous Equipment (if appropriate)

a. graduated pipettes
b. pipette bulbs

c. Litmus paper
d. glass stirring rods
e. filtering equipment

3.4 Personal Protective Equipment

a. protective goggles
b. disposable gloves
c. protective clothing (e.g., Tyvek™)
d. portable water supply for immediate flushing of spillage, if appropriate
e. shovel and container for immediate containerization of spillage-impacted soil, if appropriate

4.0 PROCEDURE

4.1 Examine all bottles and verify that they are clean and of the proper type, number and volume capacity for the sampling to be conducted.

4.2 Label bottles carefully and clearly with the appropriate information as described in Section 2.6.

4.3 Collect samples in the proper manner. Samples shall be collected in the following order:

a) Volatile organic compounds (VOCs)
b) Purgeable organic compounds (POC)
c) Purgeable organic halogens (POX)
d) Total organic halogens (TOX)
e) Total organic carbon (TOC)
f) Base neutrals/acid extractables (BNA)
g) TPHC/Oil & Grease
h) PCB/Pesticides
i) Total Metals
j) Dissolved Metals
k) Phenols
l) Cyanide
m) Sulfate and chloride
n) Turbidity
o) Nitrate and ammonia
p) Preserved inorganics
q) Radionuclides
r) Non-preserved inorganics
s) Bacteria

4.4 Chemically preserve samples as required. Field preservation should be done immediately.

4.5 Seal containers carefully.

4.6 Conduct QC sampling as required.

4.7 Each sample container should be individually sealed in a "zip-loc" bag and placed into a cooler with ice to bring the ambient temperature down to the internal temperature of the shipping cooler (approximately 4˚C). Samples should not be allowed to warm up prior to packing them into the laboratory cooler for shipping.

4.8 Arrange containers in front of assigned coolers. Organize and carefully pack all samples in cooler immediately after collection. Pack samples so that breakage will not occur. There must be a cushion of padding (e.g., bubble wrap or vermiculite) or sufficient ice between each sample container and between the containers and the top, bottom and sides of the shuttle.

4.9 Complete and place the chain-of-custody form in the cooler after all samples have been collected. Maintain one copy for the project file. If the cooler is to be transferred several times prior to shipment to the laboratory, it may be easier to tape the chain of custody form to the exterior of the sealed cooler. When exceptionally hazardous samples are known or suspected to be present, this should be identified on the chain-of-custody record as a courtesy to the laboratory personnel. Any other irregularities should also be noted.

4.10 Add additional ice as necessary to ensure that it will last until receipt by the laboratory.

4.11 Seal the cooler with packing or strapping tape (make several complete revolutions) and a custody seal covered with clear tape (if available). Record the number of the custody seal in the field notebook and on the field form. If samples are shipped in the mail they should be properly labeled and comply with shipping regulations. Maintain the shipping bill along with the chain-of-custody form for the project files and call the laboratory the next day to confirm receipt.

4.12 Unless specified otherwise in the superceding site-specific work plan or field sampling plan, this SOP shall govern the manner in which sample handling is performed by UMC personnel. However, if field conditions or other factors dictate the need, reasonable deviation from the SOP is acceptable. Any departure from the SOP must be documented in the site-specific field notebook or project file, along with an explanation as to why the deviation was necessary.

Attachment

ANALYSIS--AQUEOUS	CONTAINER	PRESERVATIVE
ORGANIC CHEMISTRY:		
Volatile Organic Compounds	3 x 40 ml VOA Vial	HCL,pH <2, 4ºC
Semi-Volatile Organic Compounds	2 x 1L glass amber	4ºC
Organochlorine Pest/PCBS	2 x 1L glass amber	4ºC
Organophosphorous Pesticides	2 x 1L glass amber	4ºC
Chlorinated Herbicides	2 x 1L glass amber	4ºC
EDB/DBCP	3 x 40 ml VOA Vial	4ºC
Total Petroleum Hydrocarbons - TEH (Diesel, Kerosine. Paint Thinner)	2 x 1L glass amber	4ºC
Total Petroleum Hydrocarbons + BTXE - TVH (Gasoline, Jet Fuel)	3 x 40 ml VOA Vial	HCL,pH <2, 4ºC
METALS:		
ICP Metals	1 x 250 ml Plastic	HNO3,pH <2
GFAA Metals	1 x 250 ml Plastic	HNO3,pH <2
Mercury	1 x 250 ml Plastic	HNO3,pH <2
ICP, GFAA and Mercury	1 x 1L Plastic	HNO3, pH <2
Lead, Copper (Drinking Water)	1 x 250 ml Plastic	HNO3,pH <2
GENERAL CHEMISTRY:		
Alkalinity	1 x 250 ml Plastic	4ºC
Anions	1 x 250 ml Plastic	4ºC
Ammonia	1 x 250 ml Plastic	H2SO4, pH <2, 4ºC
Cyanide	1 x 250 ml Plastic	NaOH,pH >12, 4ºC
Hardness	1 x 250 ml Plastic	HNO3,pH < 2, 4ºC
Sulfide	1 x 500 ml Plastic	NaOH + Zn Acetate pH >9,4ºC
Total Kjeldahl Nitrogen (TKN)	1 x 250 ml Plastic	H2SO4,pH <2, 4ºC
Total Organic Carbon (TOC)	2 x 40 ml VOA Vial or Plastic	HCL,pH <2, 4ºC
Total Phosphorous	1 x 250 ml Plastic	H2SO4,pH <2, 4ºC
Total Dissolved Solids (TDS)	1 x 250 ml Plastic	4ºC
Total Solids	1 x 250 ml Plastic	4ºC
Total Suspended Solids (TSS)	1 x 250 ml Plastic	4ºC
Total Volatile Solids (TVS)	1 x 250 ml Plastic	4ºC

ANALYSIS--SOILS	CONTAINER	PRESERVATIVE
ORGANIC CHEMISTRY:		
Volatile Organic Compounds	1 x 4 oz. Glass Jar	4ºC
Semi-Volatile Organic Compounds	1 x 4 oz. Glass Jar	4ºC
Organochlorine Pest/PCBs	1 x 4 oz. Glass Jar	4ºC
Organophosphorous Pesticides	1 x 4 oz. Glass Jar	4ºC
Chlorinated Herbicides	1 x 4 oz. Glass Jar	4ºC
EDB/DBCP	1 x 4 oz. Glass Jar	4ºC
Total Petroleum Hydrocarbons - TEH (Diesel, Kerosine. Paint Thinner)	1 x 4 oz. Glass Jar	4ºC
Total Petroleum Hydrocarbons + BTXE - TVH (Gasoline, Jet Fuel)	1 x 4 oz. Glass Jar	4ºC
METALS:		
Metals (all)	1 x 4 oz. Glass Jar	4ºC

UMC

ENVIRONMENTAL SERVICES
STANDARD OPERATING PROCEDURE

CALIBRATION OF MEASURING AND TEST EQUIPMENT

PROJECT NUMBER: 0001		**DOCUMENT CONTROL NUMBER: 0001-012**	
APPROVALS			
Title-Signature-Date			
REV NO.	PREPARED BY	DIRECTOR REVIEW	PRESIDENT
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1.0 PURPOSE

The purpose of this Standard Operating Procedure (SOP) is to establish guidelines for calibration of measuring and testing equipment used by Unicorn Management Consultants, LLC.

2.0 RESPONSIBILITY

2.1 The Equipment Manager is responsible for preparing and periodically reviewing equipment logs, and for providing properly calibrated equipment to field team leaders.

2.2 Field Team Leaders are responsible for familiarizing themselves with the equipment logs for each piece of equipment that has been issued to them, for completing the logs and for ensuring that any necessary calibration is conducted according to the manufacturers' directions.

2.3 The President is responsible for assigning an Equipment Manager.

3.0 PROCEDURE FOR UMC-OWNED EQUIPMENT

3.1 The Equipment Manager will review all available manufacturers' information regarding calibration and be familiar will the calibration requirements for each piece of equipment.

3.2 The Equipment Manager will establish an equipment log for each piece of equipment owned by UMC. This log will outline the frequency and mechanism of calibration for the piece of equipment and will direct users to complete the log including details related to use, operability, calibration, and problems.

3.3 The Equipment Manager will ensure that all equipment is calibrated according to the manufacturers' instructions prior to supplying the equipment to a Field Team Leader.

3.4 Field Team Leaders will request equipment from the Equipment Manager. The Equipment Manager will provide the equipment and the equipment log. Prior to using the equipment, the Field Team Leader will thoroughly review the log and calibrate the equipment if needed.

3.5 The Field Team Leader will ensure that the equipment is calibrated as directed in the equipment log and will ensure that the equipment and the log is returned to the Equipment Manager.

3.6 The Equipment Manager will review the equipment log when it is returned and ready the equipment for use if needed (by having it inspected, repaired or calibrated, etc.). Any of these actions will be noted in the equipment log.

4.0 PROCEDURE FOR RENTED EQUIPMENT

4.1 The Field Team Leader that has arranged for the equipment rental will review all available manufacturers' information regarding calibration and be familiar will the calibration requirements for each piece of rented equipment.

4.2 Prior to using the equipment, the Field Team Leader will thoroughly inspect the equipment to ensure it is in good working order and calibrate the equipment if needed.

4.3 The Field Team Leader will note any adjustments made, operational problems noted and/or calibrations conducted in the field notebook.

4.4 The Field Team Leader will contact the supplier directly if the equipment is not operating properly or if there are questions about the frequency or method of calibration.

ENVIRONMENTAL SERVICES
STANDARD OPERATING PROCEDURE

MEASURING WATER LEVELS AND SOUNDING A WELL WITH AN ELECTRONIC INDICATOR

PROJECT NUMBER: 0001		DOCUMENT CONTROL NUMBER: 0001-016	
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1.0 PURPOSE

This Standard Operating Procedure (SOP) establishes the guidelines for using an electronic water-level indicator (EWLI) in the field to accurately and uniformly determine the depth to water (DTW) below an established (surveyed) measuring point (MP). The information obtained by using a EWLI can be utilized to construct groundwater elevation maps and determine the direction of groundwater flow.

2.0 EQUIPMENT

Required equipment includes:

- EWLI;
- Alconox™ detergent or equivalent;
- distilled/deionized water;
- measuring tape or ruler;
- paper towels;
- black-ink pen; and
- field log book.

3.0 DECONTAMINATION

The EWLI must be cleaned before initial use and before each well measurement in the field to avoid cross contamination of the wells. At a minimum, the probe and any section of the tape introduced into the well is to be wiped with a dedicated paper towel and rinsed with distilled/deionized water. An EWLI should not be used in any well suspected or confirmed as containing non-aqueous phase liquids. However, if free product such as oil is encountered in the well, then the WLI should be cleaned by wiping the probe with paper, cloth or an absorbent pad, and scrubbing with a non-phosphate, laboratory grade detergent then rinsing with copious amounts of distilled/deionized water; this procedure should be repeated until the sampling personnel are certain that complete and thorough decontamination of the EWLI has been achieved.

4.0 CALIBRATION

Before going into the field, the EWLI should be checked to ensure that it is in proper working condition. Turn the unit "on" and check the batteries; immerse the probe in a bucket of potable water to be sure that the indication system (beepers, lights, or both) is working correctly. Check the tape for kinks, stretching, or abrasions in the protective covering over the wiring.

5.0 PROCEDURE

5.1 Note that the same device and method should be used to complete a round of measurements to ensure precision and consistency. Make sure that you know and understand the gradations of the tape. Tapes divided into feet and inches are easily confused with those divided into feet and tenths of feet.

5.2 Decontaminate the probe and the tape in accordance with the SOP for Decontamination of Field Equipment (UMC DCN 0001-019).

5.3 If available, consult previous groundwater and total depth measurements for the well(s) to obtain an idea of the expected range of depth to groundwater.

5.4 Locate the well, and remove the well cap. Note that monitoring of head space in the well with a PID or other instrument may be required. In addition, it may be necessary to wait for several minutes for the water level in the well to equilibrate if the well is sealed air tight.

5.5 Turn the EWLI on, and press the test button (if present) to confirm that the unit is working.

5.6 Lower the probe slowly into the well until an audible and/or visual signal is obtained; making sure that the tape hangs freely under its own weight and is not binding or twisting in the well.

5.7 Slowly pull the tape back out of the well until the signal stops and then lower it again until the signal just starts. The probe detector is now at the air-water interface.

5.8 While keeping the probe detector at the air-water interface, move the tape so that it is adjacent to and touching the measuring point. The measuring point should be a permanent marking point on the inner casing or outer casing/curb box if the inner casing is greatly recessed. If no permanent mark is available, measure from the highest point on the casing or if the casing is level, from the north side and mark this point with a permanent marker. Make note of this in the field notebook.

5.9 Read to the smallest unit (usually 1/100') marking on the tape when it touches the measuring point. This is the depth to water (DTW). Note that the tape is read from bottom to top.

5.10 Take the DTW again to check for accuracy. Repeat until satisfied that the DTW measurement is accurate. Record the DTW measurement in the field notebook.

5.11 To measure total depth (TD) of the well, turn the EWLI off and slowly allow the probe to descend in the water column until it meets resistance.

5.12 Gently jiggle the probe to determine that it is at the bottom of the well and not caught up in the column. Note the feel of the bottom, *e.g.*, hard (no sediment), or very soft (fine sediment).

5.13 When you are satisfied that the probe is at the bottom of the well, measure the TD of the well by reading to the smallest unit (usually 1/100') the marking on the tape where it touches the measuring point. This is the approximate TD of the well. This is an approximate measurement because the ELWI tape is calibrated from the location of the detector which is usually not at the bottom of the prob. The TD measurement can be corrected if required by adding the distance from the detector to the bottom of the probe.

5.14 At sites lacking historical data or where there is reason to suspect that water levels fluctuate due to nearby pumping, tidal effects or other causes, it is advisable to collect a second water-level measurement from the earliest (first) well measured during the round. Comparison of the two measurements will determine if water levels have changed significantly during the course of the measuring round.

5.15 Before leaving the site, check all recorded field measurements against previously existing data for inaccuracies. Discrepancies can indicate equipment or procedure problems during measurement collection. Re-measure those wells where an error is suspected.

ENVIRONMENTAL SERVICES
STANDARD OPERATING PROCEDURE

DECONTAMINATION OF FIELD EQUIPMENT

PROJECT NUMBER: 0001		**DOCUMENT CONTROL NUMBER: 0001-019**	
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1.0 PURPOSE

The purpose of this standard operating procedure (SOP) is to establish the guidelines for decontamination of field equipment potentially exposed to contamination. The objective of decontamination is to ensure that all equipment is decontaminated, *i.e.*, free of potential contaminants: 1) prior to being brought onsite to avoid the introduction of potential contaminants to the site; 2) between sampling events and activities onsite to eliminate the potential for cross contamination; and 3) prior to the removal of equipment from the site to prevent the transportation of potentially contaminated equipment offsite.

The following SOP is a guideline and represents the minimal decontamination procedures which should be followed. In determining decontamination procedures on a site-specific basis, state and Federal regulatory and agency requirements and guidance must be considered.

2.0 PROCEDURE FOR HEAVY EQUIPMENT

Equipment and machinery such as drill rigs, auger flights, augers, drill rods, well casing, samplers, tools, heavy machinery or any other items that can potentially come in contact with contaminated materials and/or the sampling matrix should be decontaminated prior to and after each use, *i.e.*, use only decontaminated equipment. Drilling rigs and associated items should be properly decontaminated by the contractor before arrival on site and should also be decontaminated on-site before first use. Heavy equipment can be steam cleaned or manually scrubbed.

2.1 Steam generators and power washers use potable water to provide a high pressure medium to remove visible debris. They are also easy to handle and generate relatively small volumes of wash solution. Potential disadvantages include: (1) the need for a fixed or portable power source and water supply, (2) reliability, and (3) they may not be practical for use on small pieces of equipment or for one day sampling events.

2.2 Manual scrubbing involves using a non-phosphate, laboratory-grade glassware detergent solution, followed by a thorough water rinse. This method can be as effective as a steam generator but is labor intensive and generates large volumes of wash and rinse solutions.

2.3 Drilling equipment utilized in the presence of thick sticky oils, *e.g.*, PCBs, may need special decontamination procedures before steam cleaning or scrubbing.

2.4 Wash rinsate may have to be contained, sampled and disposed of in a proper manner depending on the type of contaminants encountered and Federal, state and local procedures.

3.0 GENERAL PROCEDURE FOR SAMPLING EQUIPMENT

3.1 Decontaminate equipment prior to beginning sampling events and after each individual sample is collected.

3.2 Establish a location for a decontamination station away from any potential sources of cross contamination. The decontamination station must not contaminate an otherwise clean area. Decontamination should be performed over a container and the residual liquid material must be properly disposed.

3.3 Don disposable gloves and other required protective gear to avoid cross contamination; change gloves as needed.

3.4 Disassemble sampling devices and scrub with a brush in a non-phosphate, laboratory-grade detergent and tap water solution to remove visual or gross contamination.

3.5 Rinse with generous amounts of tap water.

3.6 Rinse with distilled or de-ionized water.

3.7 Place clean equipment on a clean plastic sheet to dry.

3.8 Reassemble the cleaned equipment as necessary.

4.0 SPECIAL CONSIDERATIONS FOR AQUEOUS SAMPLING EQUIPMENT

Wherever possible, disposable bailers or laboratory-decontaminated stainless-steel bailers will be used for sampling. This is advantageous because bailer decontamination takes place in a controlled environment and reduces the risk of cross contamination of the wells to be sampled. However, if the need arises, the procedures presented in Section 3 should be used to decontaminate aqueous sampling equipment.

5.0 SPECIAL CONSIDERATIONS FOR SUBMERSIBLE PUMPS

Submersible pumps and wire leads must be cleaned and flushed prior to and between each use according to the following protocol.

5.1 Wash pump casing, hose and cable using laboratory-grade glassware detergent plus tap water;

5.2 tap water rinse;

5.3 wash pump internals by running the pump in a bucket of soapy water*;

5.4 flush potable water through the pump until all soap is removed;

5.5 distilled or de-ionized water rinse;

5.6 Place decontaminated pump and wires on clean polyethylene sheeting.

* Some pumps, for example the Grundfos™ two-inch diameter submersible pumps, have a recessed screw at the bottom of the pump which must be removed and the cavity rinsed out with distilled or de-ionized water and then filled with distilled or de-ionized water.

6.0 DECONTAMINATION FLUIDS

UMC's policy is to not use chemicals, such as acetone, methanol and nitric acid during decontamination in the field because their use introduces potentially hazardous chemicals at the site which: 1) may be deleterious to the environment; 2) cause unnecessary exposure of the field personnel to hazardous substances; 3) confuse interpretation of chemical analytical data; and 4) require off site disposal of wash waters which otherwise could be discharged on-site. However, this policy may be superceded by regulatory or agency requirements.

UMC

ENVIRONMENTAL SERVICES
STANDARD OPERATING PROCEDURE

SAMPLING A MONITORING WELL

PROJECT NUMBER: 0001		**DOCUMENT CONTROL NUMBER: 0001-021**	
APPROVALS			
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1.0 PURPOSE

The purpose of this standard operating procedure (SOP) is to establish the guidelines for the sampling of ground-water monitoring wells for total and dissolved constituents. As part of the SOP for the sampling of ground-water monitoring wells, sample collection equipment and devices must be considered, and equipment decontamination and pre-sampling procedures (e.g., measuring water levels, sounding wells, and purging wells) must be implemented. Sampling objectives must be firmly established in the work plan before considering the above.

The following SOP is stringent in that it is largely adapted from the New Jersey Department of Environmental Protection and Energy's (NJDEPE) *Field Sampling Procedures Manual, May 1992*. However, in determining well sampling procedures on a site-specific basis, state and Federal regulatory and agency requirements and guidance must be considered. Decontamination procedures must be in compliance with state and/or Federal protocols in order that regulatory agency scrutiny of the procedures and data collected do not result in non-acceptance (invalidation) of the work undertaken and data collected.

2.0 EQUIPMENT AND MATERIALS

2.1 In order to sample ground water from monitoring wells, specific equipment and materials are required. The equipment and materials list may include, but is not necessarily limited to, the following:

a. bailers (Teflon™, stainless steel, or polyethylene);
b. pumps (centrifugal, peristaltic, bladder, electric submersible, bilge, hand-operated diaphragm, etc.);
c. appropriate discharge hose;
d. appropriate discharge tubing (e.g., polypropylene, Teflon, etc.) if using a peristaltic pump;
e. appropriate compressed gas if using bladder-type or gas-displacement device;
f. portable generator and gasoline or alternate power supply and electrical cord if using an electric submersible pump;
g. non-absorbent cord (e.g., polypropylene, etc.);
h. plastic sheeting;
i. applicable field forms (e.g., groundwater sampling field worksheet, groundwater pumping field worksheet, well inspection worksheet, etc.) and field notebook;
j. well location and site map;
k. stop watch, digital watch with second increments, or watch with a second hand;
l. well keys;
m. black pen and water-proof marker;
n. tools (e.g., pipe wrenches, screwdrivers, hammer, pliers, flashlight, pen knife, etc.);
o. appropriate health and safety equipment, as specified in the site health and safety plan (HASP);
p. pH meter(s) and buffers or multi-meter;
q. conductivity meter(s) and standards or multi-meter;
r. dissolved Oxygen (DO) meter or multi-meter;
s. thermometer(s) or multi-meter;
t. extra batteries (for meters, thermometers, flashlight, etc.);

u. filtration apparatus, filters, pre-filters;

v. plasticware (e.g., pre measured buckets, beakers, flasks, funnels);

w. disposable gloves; and

x. reference copies of site sampling and analysis plan (SAP) and HASP.

3.0 EQUIPMENT DECONTAMINATION

For each sampling event, all field measurement and sampling equipment that will enter a well must be cleaned (refer to UMC Program Document 3-6) prior to its entry into the well.

4.0 CALIBRATION OF FIELD ANALYSIS EQUIPMENT

Calibrate field analysis equipment (e.g., thermometers, pH, conductivity and dissolved oxygen meters, etc.) before use or as required in the manufacturer's manual for the instrument. Refer to the SOP for field analysis for measuring temperature, ph, dissolved oxygen and turbidity of water samples (UMC Program Document 3-9) and other applicable SOPs as appropriate. Document, initial and date the calibration procedures on the appropriate field form, and in the field notebook.

5.0 PROCEDURE

5.1 Purge the well prior to sampling (refer to UMC Program Document 3-10). The well should be pumped or bailed in accordance with the workplan.

5.2 If well has been pumped to near dryness, the well should be allowed to recover to a volume sufficient for sampling. In general, sampling should take place within two hours of purging; however, for wells with slow recharge, the two hour limit may be exceeded to allow for sufficient recovery of the water volume.

5.3 Record the physical appearance of the purge water (i.e., color, turbidity, odor, etc.) on the appropriate field form. Note any changes that occur during the purging.

5.4 If a bailer is used to collect the sample, then:

a. Flush the decontaminated bailer three times with distilled/deionized water.

b. Tie dedicated non-absorbent cord (polypropylene) to the bailer with a secure knot and then tie the free end of the bailer cord to the protective casing or, if possible, some nearby structure to prevent losing the bailer and cord down the well.

c. Lower the bailer slowly down the well and into the water column to minimize the disturbance of the water surface. If a bottom filled bailer is used, then do not submerge the top of the bailer; however, if a top filling bailer is used, then submerge the bailer several feet below the water surface.

5.5 If a pump is used to collect the sample, then use the same pump used to purge the well. If need be, reduce the discharge rate to facilitate filling sample containers and to avoid problems that can occur while filling sample containers. Alternately, the purge pump can be removed and a thoroughly decontaminated bailer can be used to collect the sample.

5.6 When sampling, remove the cap from each container, pour in the sample and replace and secure the cap immediately. Fill VOC containers first, to minimize loss of volatiles from the water sample.

5.7 Fill each appropriate, pre-labeled sample container carefully and cautiously to prevent: 1) agitating or creating turbulence; 2) breaking the container; 3) entry of, or contact with, any other medium; and 4) spilling/splashing the sample and exposing the sampling team to contaminated water. Immediately place the filled sample container in an ice-filled (wet ice or blue pack) cooler for storage.

5.8 If VOCs are being tested for, then,"top off" containers and tightly seal with Teflon™-lined septums held in place by open-top screw caps to prevent volatilization. Ensure that there are no bubbles by turning the container upside down and tapping it gently.

5.9 Filter water samples collected for dissolved metals analysis prior to preservation to remove the suspended sediment from the sample (see UMC Program Document 3-19 for procedure). In the event that the regulatory agency wants unfiltered samples for metals analysis, a second set of filtered samples should also be collected. Because unfiltered samples indicate total metals (dissolved and suspended), they may not be representative of aquifer conditions because ground water does not transport sediment (except in some rare cases). Thus, the results for dissolved metals in ground water should be based on filtered samples, even if both filtered and unfiltered sets are presented in a report.

5.10 Add any necessary preservative(s) to the appropriate container(s) prior to, or after (preferred), the collection of the sample, unless the appropriate preservative(s) have already been added by the laboratory before shipment.

5.11 As required, record the start and end time for sampling and the sampling method (e.g., bailer or pump). Measure and record pH, dissolved oxygen, temperature, and specific conductivity, if required.

5.12 Complete all necessary field worksheets and chain-of-custody forms. Secure the cooler with sufficient packing tape and a custody seal.

ENVIRONMENTAL SERVICES
STANDARD OPERATING PROCEDURE

SOIL BORING OR MONITORING WELL DRILLING, FORMATION SAMPLING AND BOREHOLE ABANDONMENT IN UNCONSOLIDATED FORMATIONS

PROJECT NUMBER: 0001		DOCUMENT CONTROL NUMBER: 0001-026	
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Title-Signature-Date			
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1.0 PURPOSE

The purpose of this Standard Operating Procedure (SOP) is to describe the considerations and procedures, and to establish the guidelines for drilling (soil borings, wells, or piezometers) and formation sampling activities in unconsolidated formations. There are several drilling techniques available which may include hollow-stem auger, cable tool, hydraulic rotary, cased-hole rotary, and air rotary. Formation (sediment/soil) sample collection include disturbed (drill cuttings), intact (split spoon), and undisturbed (Shelby-tube or Denison-core). Borehole abandonment (closure) procedures will also be addressed in this SOP.

The objective of drilling is to collect accurate subsurface information and to prepare a borehole for potential completion as a well or piezometer. Consequently, the lithologic data is the all important, most essential information that can be collected. The lithologic data characterizes subsurface conditions, describes hydrogeologic coefficients qualitatively and/or quantitatively, and identifies optimum locations for screen zones if wells are constructed.

Data can be obtained through the physical examination and testing of formation samples, as well as knowledge regarding groundwater levels. Thus, drill fluid mix, fluid loss, rate of drilling, lengths of split spoon and Shelby-tube/Denison-core recovery, etc. must be monitored by the on-site hydrogeologic or geologist.

2.0 DRILLING TECHNIQUE SELECTION

Verify that the drilling technique is the one specified in the investigation work plan, and that the drilling equipment mobilized by the driller is in good condition and proper working order. Do not permit the driller to use a drilling rig that appears to be substandard, in disrepair, etc., and /or is questionable as to whether or not the rig has the capabilities to accomplish the goals of the drilling program. The drilling rig must be capable of:

a. Penetration of all anticipated subsurface materials and formations at a desired rate, and construction of a borehole of desired diameter (for the anticipated well, if applicable, including the placement of a gravel or sand pack through a tremie pipe and necessary formation seeking material such as bentonite or cement).

b. Identification of lithology for development of a geologic log of all unconsolidated formations and materials penetrated, including physical characteristics and visual description of color, grain sizes, sorting and mineralogy.

c. Collection of samples of aquifer fluids during the drilling process and prior to well construction, while at the same time minimizing potential for cross contamination. The method used should prevent cross contamination between surface soils and groundwater or between different hydrogeologic units.

d. Collection of intact and/or undisturbed soil samples from the center line or sidewall of the borehole. This objective requires the drilling to be halted while soil samples are taken from the bottom of side of the incomplete borehole.

e. Completing the process of converting a borehole into a well (monitoring or observation) or piezometer during the initial construction process (i.e., constructing a well or piezometer as the borehole is drilled, or constructing a well or piezometer in the borehole immediately after the drilling tools are removed).

f. Implementation of geophysical borehole logging (when applicable and possible) to enable more accurate vertical and horizontal extrapolation of borehole data relating to the lithology of the hydrogeologic system.

g. Completion of a well or piezometer, if applicable, in the borehole following a time lapse for interpretation of geologic or geophysical data from the borehole.

3.0 DRILLING TECHNIQUE-DESCRIPTION

3.1 Hollow-stem auger; this drilling method is rapid and extremely effective in most cohesive sediments but less so in loose sandy material. Penetration may be up to 150 feet below land surface (bls) depending on the size of the rig, drilling conditions, and the diameter of the auger flight; however depths up to 250 feet bls have been achieved under compatible conditions. A major advantage of this technique is that normally no fluids are introduced into the formation. If the auger flights can be moved and the integrity of the borehole maintained, then electrical and radiation (e.g., gamma, neutron, etc.) geophysical logs can be run. If the auger flights must remain in the borehole, then only radiation geophysical logs can be run. Casing, screen and sampling devices can then be lowered through the hollow stem by removing the drilling rod and plug positioned at the bottom of the auger flights, and gravel packing and cementing can be accomplished within the hollow stem. However, this can be difficult especially below the water table. Auger flight outside diameters (OD) range from 5 inches (in.) to 12 in. The diameter of a well that can be constructed inside the hollow stem is limited however, to about 4 in.

3.2 Cable Tool (Percussion) - This drilling method is slow because the borehole is advanced by lifting and dropping a heavy string of drilling tools. Cuttings accumulate in the drill casing and are removed by a sand bailer. A steel casing is driven in as the hole is deepened. Cable Tool rigs can be used in unconsolidated sediment and bedrock to depths of hundreds of thousands of feet and often employ telescoping techniques for drilling deep boreholes. Electrical geophysical logs cannot be run through the steel cased borehole, but radiation logs (e.g., gamma, neutron, etc.) can be run. Well casing and screen can be installed within the cased borehole after which the outer casing is pulled back (removed). Because the boring is cased as it is being drilled, cross contamination between various depths is practically eliminated. The method provides an excellent means to collect good, representative formation samples.

3.3 Hydraulic rotary - The drilling method uses a rotating bit to drill (advance) the borehole. Drill cuttings are removed using a recirculating drilling fluid (mud/water or bentonite/water slurry). Although setting up the drilling equipment is slow, the drilling process is reasonably fast. In the mud-rotary method, drilling mud forms a cake on the borehole wall which prevents excessive loss of fluid to the formation being drilled. The hydrostatic pressure combined with the weight and density of the mud slurry keeps the hole open, and removes the drill cuttings. This allows the drill rods to be removed from the borehole and geophysical logs (electric and radiation) to be run in the open borehole.

In reverse hydraulic rotary drilling, the drilling fluid moves downward through annular space and upward inside the drill pipe. If the drilling fluid does not contain mud, then sufficient water flow is required as makeup water because the borehole wall is not sealed; therefore, significant water flow can occur to the formation being drilled. The borehole is held open by hydrostatic pressure only. A serious obstacle to the drilling method occurs when the static water level is less than 15 feet below land surface because of insufficient hydrostatic head difference between the borehole and the water table. However, the problems of excessive water loss and shallow depths to water may be overcome by using mud as the drilling fluid.

In mud-rotary drilling, the drilling fluid (mud) moves downward through the drill pipe and then upward through the annular space. Therefore, the borehole is held open by hydrostatic pressure and the mud cake lining the wall of the borehole. The mud-rotary method can be used to construct moderate to deep wells in unconsolidated material, while the reverse rotary technique can be used to construct moderate to deep wells in unconsolidated materials. The principal disadvantage may be difficulty in removing mud cake from the formation at the screened zone. Excessive well development may be required to remove the mud cake.

3.4 Cased-Hole Rotary - Several new rotary drilling techniques have been developed in which a steel casing is advanced with an air rotary or mud rotary drill. This technique is highly desirable for use in exploratory drilling at monitoring sites in because water and soil samples may be collected under conditions which preclude contamination from shallower depths. Furthermore, this technique is extremely effective in boulder or cavernous zones which would inhibit or preclude drilling using other techniques. Drilling results are comparable to cable-tool drilling but with greatly enhanced speeds. In all the cased hole techniques, the main benefit is that the only portion of the borehole which is open, is at the bottom of the drill casing; thus, no soil or water from shallower depths can move down and impact the depth drilled and/or sampled. Electrical geophysical logs cannot be run through the steel cased borehole, however, radiation logs (e.g., gamma, neutron, etc.) can be run.

Presently, there are three cased-hole rotary techniques which include:

a. The drill-through casing hammer technique in which the casing is advanced by percussion with a hammer or vibratory driver similar to the method used in a borehole drilled by the air rotary method. The casing hammer can also pull out the casing (air drilling only).

b. The Odex™ Drilling System (European System) which "pulls" the casing using a fixture attached to an air hammer type drill bit (air drilling only).

c. The Barber™ Drilling System in which drilling is done with a top-head drive and a rotary table that spins casing into the ground. Casing can be fitted with a carbide "shoe" to cut boulders and an air hammer can be used above the bit. Air or mud rotary can be used to lift cuttings.

Two potential problems may be encountered using the cased hole rotary technique: 1) "sand heave" when drilling stops (which can be quickly drilled or bailed out) and 2) possible aeration of water in the cased borehole if volatiles are being tested (which can be overcome by pumping or bailing the standing water out before sampling). The minimum drill casing diameter is 6 inches and depth is limited to approximately 450 feet.

3.5 Air-Rotary - This drilling method uses a rotating bit to drill, and high velocity compressed air remove cuttings from the borehole. A pneumonic down-hole hammer is often used to add percussion to the rotary drilling action. This drilling method is very fast and, although it is most suitable for penetrating hard bedrock, it can be used in unconsolidated formations. The borehole may be cased or uncased depending on geologic conditions. If an open borehole is drilled, then electrical and radiation (e.g., gamma, neutron, etc.) geophysical logs can be run. If a cased borehole is drilled, then only radiation geophysical logs can be run.

Four potential problems may be encountered when using the air-rotary technique.

a. When a prolific aquifer is tapped, the compressed air may be able to lift the water to the surface.

b. Aeration of water in the borehole (and unfinished well) immediately prior to sampling can interfere with a number of organic and inorganic water quality parameters.

c. Low yield water entry zones may not be identified because the air pressure prevents water from entering the borehole. Care should be taken to prevent overdrilling of the borehole.

d. Air rotary drilling can include the migration of volatile organics to the surface or adjacent structures causing potential aesthetic or health and safety concerns.

If the air rotary technique is used then the following special procedures will be implemented.

a. An air line oil filter will be required and changed per manufacturer's recommendations during operation with documentation of this maintenance on an appropriate field form and in the field notebook. More frequent oil filter changes will be made if oil is visibly detected in the filtered air.

b. The use of any additive will be prohibited, except approved water (e.g., potable water) for dust collector and cuttings removal.

4.0 DECONTAMINATION

Drilling equipment decontamination procedures are outlined in the field equipment decontamination SOP (UMC DCN 0001-019). Proper decontamination in accordance with regulatory guidelines must be clearly documented in the field notebook.

5.0 PROCEDURE FOR DRILLING

5.1 Document all drilling related activities (e.g., starting, stopping, footage, problems, decontamination, etc.) on the daily log form and in the field notebook. Record dates and times and activities, and names of UMC personnel providing oversight.

5.2 Monitor and record drill fluid mix, speed of rotation, pressure on the drill fluid, rate of drilling, and length of drill rods or casing in the borehole.

5.3 Confirm that the drill rods and core barrels are straight, or discontinue drilling.

5.4 Pay particular attention to the advancement of the boring because differences in the rate of drilling may be indicative of differences in subsurface geologic conditions (e.g., sand and gravel versus clay).

5.5 Maintain a continuous dialogue with the driller to track and keep informed of all drilling activities (e.g., speed of the drill and drilling pressure, difficult and easy drilling conditions etc.).

5.6 Collect formation samples as described below in Section 6.0. Sample jars must be labeled appropriately (e.g., project number and name, site location, boring number, date, sample interval, and initials of UMC personnel collecting samples.

5.7 Record geologic information in the geologic log form and in the field notebook (including blow count).

5.8 Samples should be handled in accordance with UMC's Standard Operating Procedure for Sample Handling (UMC DCN 0001-011). Handle and ship split spoon sample jars carefully to avoid breakage and handle and ship tubes or cores carefully to prevent disturbance.

6.0 PROCEDURE FOR FORMATION SAMPLING

6.1 Intact information will be implemented using split spoon samplers (which are driven), Shelby-tube samplers (which are pushed), or Denison-core samplers (which are rotated) depending on the drilling technique employed. Formation samples will be retained in suitable size (e.g., 1 pint or 0.5 pint) jars for physical description and potential physical and chemical analysis. The appropriate labeled jars and tubes will be stored in a safe place to avoid breakage, agitation and freezing. Intact formation samples will be collected as described in the work plan at specified intervals (e.g., at 5 foot increments below land surface) and at each major change in subsurface materials. Hydrogeologic information will be recorded on a geologic log form and in the field notebook. Detailed descriptions of the type (s) of intact sample (s) collected, sampling intervals and conditions, and objective(s) of the sample collection will be provided in the work plan.

6.2 Disturbed formation samples (drill cuttings) will be examined continuously throughout the entire depth of the borehole. If applicable to the study and/or stated in the work plan, borehole cuttings will be collected from the circulating auger flights which lift cuttings to land surface (hollow-stem auger technique), from the sand bailer (cable-tool technique), from the recalculating drilling fluid (mudflume) which transports cuttings to land surface (mud rotary and related techniques), or from the compressed air used to carry cuttings to land surface (air rotary and related techniques). Formation samples will be retained in (air rotary and related techniques). Formation samples will be retained in appropriate size (e.g., 1-pint or 0.5-pint), properly labeled jars and stored in a safe place to avoid breakage, agitation and freezing. Hydrogeologic data will be recorded on a geologic log form and in the field notebook.

6.3 The soil cores from the wells drilled at the site are used for lithologic identification. The first 18 inches of soil for each borehole will be collected intact using a split spoon sampler, Shelby-tube sampler, or Denison-core sampler. Split spoon samples may be collected continuously from the boreholes for cluster wells; single wells and/or piezometer boreholes may be split-spooned throughout drilling or at specified intervals or changes in lithology. The conditions for sampling will be specified in the work plan.

6.4 Before collecting and retaining soil and/or sediments collected with the split spoon sampler, the top several inches will be removed from the sampler and discarded to eliminate any sediment that may have caved into the bottom of the borehole.

6.5 Sediment sampling equipment such as split spoon samplers, spatulas, etc. (but not including Shelby-tube or Denison-core samplers, which area not re-usable) will be decontaminated by steam cleaning and/or a non-phosphate, laboratory grade and distilled/deionized wash followed by a distilled/deionized rinse. (Refer to the SOP for Decontamination of Field Equipment, UMC DCN 0001-019, for a detailed description of minimum and special decontamination procedures). Decontamination of sediment sampling equipment will take place prior to the collection of the first sample and following the collection of each subsequent sample.

7.0 BOREHOLE ABANDONMENT or CLOSURE

7.1 Upon the completion of the investigation, a determination will be made as whether to maintain the borehole (for a well or piezometer) or to close it (i.e., abandon and seal it). If the client and UMC agree to abandon the borehole, then the state will be notified and a request will be presented for borehole abandonment. Upon state approval to seal the borehole, appropriate borehole abandonment forms will be completed, if required. Following state approval, the abandonment of any borehole (or boring) will be in accordance with local, state and/or Federal regulations.

7.2 For each abandoned borehole, the procedure will be documented on an appropriate field form or in the study notebook. Documentation may include, where appropriate, the following:

a. borehole designation;

b. location with respect to the placement borehole, if replaced (e.g., 30 ft north and 40 ft west borehole B-1). Allocation sketch should be prepared;

c. open depth to prior grouting and any other relevant circumstances (e.g., formation collapse);

d. drill casing left in the borehole by depth, size and composition;

e. copy of the geologic log;

f. a revised program of the abandoned borehole using a supplement geologic log form;

g. additional items left in hole by depth, description and composition (e.g., lost tools, bailers, etc.);

h. description and daily quantities of grout used to compensate for settlement

i. date of grouting;

j. level of water or mud prior to grouting and the date and time measured;

k. any other state or local well abandonment reporting requirements.

ENVIRONMENTAL SERVICES
STANDARD OPERATING PROCEDURE

CONSTRUCTION, DEVELOPMENT, AND ABANDONMENT OF MONITORING WELLS IN UNCONSOLIDATED FORMATIONS

PROJECT NUMBER: 0001		DOCUMENT CONTROL NUMBER: 0001-032	
APPROVALS			
Title-Signature-Date			
REV NO.	PREPARED BY	DIRECTOR REVIEW	PRESIDENT
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1.0 PURPOSE

This Standard Operating Procedure (SOP) establishes and standardizes the methods and procedures for construction of groundwater monitoring or observation wells in unconsolidated (e.g., gravel, sand, silt and clay) formations. Well development and well abandonment (closure) procedures are also addressed.

2.0 CONSIDERATIONS

The United States Environmental Protection Agency (USEPA), the United States Geological Survey (USGS), and state regulatory agency procedures will be reviewed and considered in conjunction with the experience of UMC to determine appropriate site-specific well construction and abandonment procedures. Discussions will be held with appropriate agencies to resolve conflicting procedures and finalize well construction or abandonment methods. The well construction plan and, if necessary, abandonment will be detailed in the work plan.

Monitoring wells will be completed in unconsolidated formations for the purposes of measuring groundwater levels and collecting groundwater samples. Groundwater level data will be used to calculate groundwater elevations which will be used to construct water-level elevation and groundwater flow direction maps to illustrate head and flow relationships. Groundwater samples will be used to quantify water quality conditions.

Observation wells will be completed in unconsolidated formations for the purpose of collecting water level data from aquifer tests. Slug tests, step-drawdown tests, and constant-rate pumping tests (refer to the respective SOPs) may be conducted to qualitatively characterize flow system hydraulic parameters and/or intra-aquifer and inter-aquifer hydraulic connection.

3.0 PROCEDURE FOR WELL CONSTRUCTION

Prior to beginning field activities, the on-site geologists shall familiarize themselves with well installation and construction details provided in the work plan. The work plan shall specify the following: purpose and expected use of the wells; well locations and desired depths/screened intervals; acceptable drilling/boring methods; acceptable or required well casing type, e.g., PVC or stainless steel, and size (nominal diameter); screen length, diameter, type (material and fabrication method), and slot size; well pack type and size; grout type; seal type; cement mixture; type of surface completion, and acceptable development methods.

In general, unless otherwise specified in the work plan, wells will be a minimum of 2 inches nominal diameter to accommodate most water sampling and water level measuring devices. Larger diameter monitoring wells (4 inches, 6 inches or greater) may be needed to accommodate pumps, floats or sensors. All casings, fittings, and screens will be new material. The inside diameter of the well (screen and riser/blank/casing) shall be constant and not restricted by fittings or couplings. No PVC glues or resins shall be used.

Installation of each unconsolidated well will begin immediately after borehole completion and geophysical logging (if conducted). Once well installation has begun, no breaks in the process will be made until the well has been completed and secured against unauthorized access. In cases of unscheduled delays, such as personal injury, equipment breakdowns or sudden inclement weather, installation will be resumed as soon as practical. The geologist will record all monitoring well installation and construction details on a well construction diagram and in the field notebook (see UMC DCN 0001-017).

When conditions (total well depth, screen length, depth to water) allow, wells constructed in unconsolidated formations will be installed as described below. Conditions may require modification of specified material thicknesses and heights; extreme caution shall be used to ensure that such modifications do not compromise the integrity of the well.

1) The depth and diameter of the boring is measured and recorded and checked to see if it is in accordance with the work plan and is appropriate for the purpose of the well given field observations, e.g., depth to water and formation characteristics.

2) The appropriate length screen and casing are determined, assembled (fitted with bottom cap), and lowered into the borehole to the appropriate depth

3) The geologist calculates the volume per foot of annulus using the following formula;

$$\mathbf{p[(r_b)^2-(r_w)^2] = ft^3/\text{linear foot of annulus}}$$

Where:

r_b **= Boring Radius (ft)**

r_w **= Well Radius (ft)**

This value should be referenced by the geologist to compare theoretical volumes of material (gravel sand, bentonite, grout, cement) required to construct the well with actual quantities of materials used. Large discrepancies between theoretical and actual quantities may indicate problems with the well, e.g., use of less material than calculated may indicate bridging of material in the annulus.

4) A gravel pack (quartz sand or pea gravel) will be filled in around the screen from one foot below the bottom of the screen to several feet above the screen (0.5 feet minimum) to filter out fines from the overlying bentonite seal and grout. The size of the uniformly graded gravel pack will be selected based on the grain size of the formation material in the screened interval and the slot size of the screen. Care shall be taken to avoid bridging of well pack materials in the annulus of the well; this may require the use of a tremie pipe.

5) A 1 foot to 3 foot layer of clean, fine grained silica sand may be placed above the selected gravel pack. Again, care shall be taken to avoid bridging of the pack materials in the annulus of the well; this may require the use of a tremie pipe.

6) Several feet (0.5 ft minimum) of bentonite powder or pellets will be placed on top of the sand or gravel layer to seal the top of the gravel packed screen zone. The bentonite should be introduced very slowly to prevent bridging.

7) The remainder of the annulus will be grouted to within a few feet of land surface. For very deep wells, i.e., greater than 100 ft, constructed of PVC, the grout should be emplaced in lifts to prevent damage to the casing from heat of curing and/or the weight of the grout.

8) The well will be surface completed in accordance with the work plan. Surface completion usually includes either a locking steel protective casing or a curb box set over the well and cemented in place. The cement at the surface is formed in a manner to prevent water from ponding at the top of the well or directly entering the well. In high traffic areas, bollards may be installed to prevent vehicular damage.

9) Each well will be properly identified with the appropriate information, e.g., local well number and state permit number (if applicable), as specified in the work plan and as required by applicable regulations. The top of the inner well casing will serve as the Measuring Point for groundwater level measurements. The measuring point

will be surveyed to the nearest 0.01 foot relative to a common datum (e.g., mean sea level) by a professional, state licensed surveyor as defined in the work plan.

10) If required, well clusters will be constructed. A well cluster is defined as a group of two or more wells, located adjacent to or very near each other, which penetrate different depths of the aquifer or formation. Each well is screened at a different depth to obtain data defining the vertical distribution of water levels and quality in the aquifer or formation. In the event that a well cluster is drilled, then one large-diameter (e.g., 6 inch, 8 inch, 10 inch, etc.) borehole may be drilled and each well in the cluster will be individually cased within that one borehole; however, the preferred method is to drill individual boreholes for each well in the cluster. The shortest well in the cluster should be advanced first.

11) A boring log/well construction diagram will be completed for each well. The boring log will include a description of the surface soils and subsurface materials encountered. The well diagram will show the screened interval and casing placement and materials used to fill the annular space between the well casing and borehole.

The following information, if applicable, will be included on the well log.

- Project number;
- Date and initials of individual documenting the well information;
- Date and time of construction;
- Well location, local number and permit number;
- Borehole diameter and well depth;
- Casing material, screen material, screen slot size and length;
- Gravel pack type and size (depths from__to__);
- Sand pack type and size (depths from__to__);
- Bentonite pellets (depths from__to__);
- Grout (depths from__to__);
- Ground surface and measuring point elevations;
- Well height above or depth below land surface; and
- Depth where groundwater was encountered.

4.0 PROCEDURE FOR WELL DEVELOPMENT

A monitoring well must be properly developed before it can be used for water quality sampling, measuring water levels, or aquifer testing. Well development is the process of removing fine-grained materials (sands, silts and clays) from the formation around the screen, the well pack, and the well itself. Well development continues until the well responds to water level changes in the formation (i.e., a good hydraulic connection is established between the well and formation) and the well produces clear, sediment free water to the extent practical. The geologist should check for relative clarity by eye or with a turbid meter to determine whether development is complete. The work plan should provide a standard to determine when development is complete. Well development procedures will be recorded on the well construction diagram and in the field notebook.

A variety of well development methods are available. The method used will depend upon: the drilling technique used; formation texture; size, types, and placement of well construction materials; and regulatory considerations. Acceptable development methods should be specified in the work plan. The following well development methods are commonly used:

- Bailing;
- Pumping (centrifugal, submersible, or air);

- Backwashing;
- Surging (mechanical);
- Jetting; and
- A combination of the above.

Dispersing agents, acids, disinfectants or other additives will not be used during development nor will they be introduced into the well at any other time unless specifically stipulated in the work plan. During development, water will be removed from the entire column of water standing in the well by periodically lowering and raising the pump intake or depth of the bailer. Well development will include the rinsing of the interior well casing above the water column in the well using only water from that well.

5.0 PROCEDURE FOR WELL ABANDONMENT

Because wells interrupt the natural stratigraphy and are potential contaminant pathways, they must be properly abandoned when they no longer serve a purpose, or have questionable integrity due to damage, or when they interfere with construction or other site activities. Upon the completion of the investigation, a determination will be made whether to maintain the well or to close it (i.e., abandon and seal it). If the client and UMC agree to abandon the well, then the state or other appropriate agency will be notified and a request will be presented for well abandonment. After obtaining required approvals, the appropriate well abandonment forms will be completed as required, and abandonment of the well will commence in accordance with local, state and/or Federal regulations. Usually the well will be abandoned by grouting with concrete, or bentonite pellets. Components of the well may also be removed from the ground prior to grouting.

For each abandoned well, the procedure will be documented on an appropriate field form and in the field notebook. Documentation may include, where appropriate, the following.

- Well designation;
- Location with respect to the replacement well, if replaced (e.g., 30 ft north and 40 ft west of monitoring well MW-1). A location sketch should be prepared;
- Open depth prior to grouting and any other relevant circumstances (e.g., formation collapse);
- Well casing left in the borehole by depth, size and composition;
- A copy of the geologic log;
- A revised diagram of the abandoned well using the well construction log form;
- Additional items left in hole by depth, description and composition (e.g., lost tools, bailers, etc.);
- A description and daily quantities of grout used to compensate for settlement;
- The date of grouting;
- The level of water prior to grouting and the date and time measured;
- The remaining casing, size and composition above or below ground surface reported in depths or heights from ground surface;
- Any other state or local well abandonment reporting requirements.

ENVIRONMENTAL SERVICES
STANDARD OPERATING PROCEDURE

LOW FLOW PURGING AND SAMPLING OF MONITORING WELLS

PROJECT NUMBER: 0001		DOCUMENT CONTROL NUMBER: 0001-036	
APPROVALS			
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REV NO.	PREPARED BY	DIRECTOR REVIEW	PRESIDENT
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1.0 PURPOSE

The purpose of this standard operating procedure (SOP) is to provide the general methodology for the low-flow/low stress purging and sampling of groundwater monitoring wells. These procedures may be superceded by project, client, regulatory, or site specific procedures established in a sampling and analysis plan (SAP), Quality Assurance Project Plan (QAPP) or other project document. Project or site specific procedures take precedence over the generic procedures set forth here.

This SOP was developed using the USEPA's Groundwater Issue Paper EPA/540/S-95/504, *Low-Flow (Minimal Drawdown) Groundwater Sampling Procedure* (April 1996) and USEPA Region 2 *Low Stress Groundwater Sampling Protocol* (March 1998), and the EPA Ground Water Forum Issue Paper EPA/542/S-02-001 *Ground-Water Sampling Guidelines for Superfund and RCRA Project Managers* (May 2002).

2.0 EQUIPMENT AND MATERIALS

The equipment and materials required may include, but is not necessarily limited to, the following:

- Electronic water-level indicator (WLI) or steel tape and chalk, with 0.01 foot increments. Electronic oil/water interface probe (EIP) for measuring non-aqueous phase liquid (NAPL), if needed.
- Photoionization Detector (PID) or Flame Ionization Detector (FID).
- Water-quality indicator parameter meters:
    - Multi-Parameter meter with flow-through-cell to monitor pH, ORP, dissolved oxygen (DO), specific conductivity, and temperature. The flow-through-cell should be a closed cell with the inlet located near the bottom and the outlet near the top.
    - Turbidity meter.
- Sampling pump - adjustable rate submersible or bladder pumps. Adjustable rate, peristaltic pump can be used when the depth to water is 20 feet or less.
- Compressed gas cylinder or compressor if using bladder pump or air-activated piston.
- Power Source: If a combustion engine generator is used, it must be placed downwind of the sampling area.
- Tubing - Teflon® or Teflon® lined polyethylene tubing is used when sampling for organic compounds. Polyethylene tubing can be used when sampling inorganics. Pharmed™ , silicone or Teflon flexible tubing for peristaltic pump.
- Flow measurement supplies: graduated cylinder and a stop watch.
- Decontamination Supplies – distilled or deionized water, non-phosphate soap, methanol, brushes, pressure sprayers, spray bottles, buckets or decontamination tubes for pumps.
- Sample bottles (and preservation supplies if bottles are not pre-preserved).
- Sample labels
- Chain-of-custody forms.
- Field Sampling Plan and/or Quality Assurance Project Plan.
- Well construction data
- Water quality data from previous sampling events.
- Well keys
- Map of well locations.
- Field notebook, groundwater sampling logs and calculator. A field data sheet (low flow groundwater sampling data collection sheet) is provided in the attachment.
- 0.45 micron in-line disposable filters (if filtered samples are needed).
- Polyethylene sheeting to place on ground around the well head.
- Personal protective equipment specified in the site Health and Safety Plan.
- Air monitoring equipment as specified in the Site Health and Safety Plan.

- Tool box - All needed tools for all site equipment used.
- A 55-gallon drum or container to collect the purged water.
- Portable rain-shelter (e.g. tarp and guy-lines or ice-fishing tent)

3.0 CALIBRATION OF FIELD ANALYSIS EQUIPMENT

Calibrate field analysis equipment (e.g., PID/FID, multi-parameter and turbidity meters, etc.) before use or as required in the manufacturer's manual for the instrument. Summarize the calibration procedures in the field notebook.

4.0 PROCEDURE

1. Start at wells with the least impacted groundwater and proceed to the monitoring wells with more impacted groundwater. Record location, time, date and appropriate information in the field notebook and on the field data sheet (see attached low flow groundwater sampling data collection sheet).

2. Check the condition of the monitoring well for damage or evidence of tampering and record observations in the field notebook.

3. Unlock well head. Monitor the headspace of the unopened monitoring well at the rim of the casing for volatile organic compounds (VOCs) with a PID or FID, and record in the field notebook and on the field data sheet.

4. Remove inner casing cap and monitor the headspace of the monitoring well at the rim of the casing for VOCs and record in the field notebook. If the monitoring well has a history of elevated headspace readings, ensure that the sampling is conducted in accordance with the Site Health and Safety Plan.

5. Lay out polyethylene sheeting around the well to minimize contamination of sampling/purging equipment from contact with the ground surface. Place monitoring, purging and sampling equipment on the sheeting.

6. Measure the water level depth to nearest 0.01 feet with a WLI or EIP (refer to the SOP for measuring water levels, UMC DCN 0001-016) and record in the field notebook and on the field data sheet. **NOTE: If the presence of separate phase petroleum hydrocarbons (SPPH) is suspected or unknown, the depth to water measurement should be made with an EIP. <u>Do not sample groundwater in the well if EIP indicates that SPPH are present in the well</u>.**

7. Check the available well information or field information for the total depth of the monitoring well. Use the information from the depth of water in step six and the total depth of the monitoring well to calculate the mid-point of the saturated screen length and the volume of the water in the monitoring well. Record information in the field notebook and on the field data sheet. **<u>NOTE: avoid sounding well to determine depth to bottom less than 48-hours prior to sampling.</u>**

Purging and Sampling Activities

8. **Non-dedicated system -** Carefully measure the length of tubing needed to place the pump intake at a pre-determined location within the screen interval. Mark the point at the top of the tubing that corresponds with the depth to the desired pump intake:
   - at a previously defined depth noted in SAP or QAPP;
   - at the approximate mid-point of the saturated screen; or
   - if less than 4-feet of water in the well, no less than 1.0-foot below the top of the water column (avoid placing intake within 2.0-feet of bottom of the well).

   Connect tubing to pump and slowly lower into the monitoring well until the mark at the top of the tubing aligns with the measuring point at the top of the well casing. Secure the safety cable, electrical lines and/or tubing at the well head. Record pump intake depth in the field notebook and on the field data sheet.

   Dedicated system - Pump has already been installed. Measure length of tubing needed to connect the permanently installed down-well tubing to equipment at the well head. Refer to the available monitoring well information and record the depth of the pump intake in the field notebook and on the field data sheet.

9. Re-measure the water level to nearest 0.01-foot and record information on the field data sheet, leave water level indicator probe in the monitoring well.

10. Connect the discharge line from the pump to a "T"-fitting/3-way valve. Connect one branch of the "T" fitting to the flow-through cell. The second branch of the "T" connection is used for turbidity measurements and sample collection. Direct the discharge line from the flow-through cell to a container to collect the purge water during the purging and sampling of the monitoring well.

11. Start pumping the well at a low flow rate (0.2 to 0.5 liters per minute). Check water level. Maintain a steady flow rate while keeping a drawdown of 0.3-feet or less. If drawdown is greater than 0.3 feet, lower the pumping rate while maintaining pump suction and preventing entrainment of air in the tubing. Record each adjustment made to the pumping rate and the water level measured immediately after each adjustment.

12. Measure the discharge rate of the pump with a graduated cylinder and a stop watch. Measure the water level and record both flow rate and water level on the field data sheet. Monitor and record water level and pumping rate every three to five minutes during purging.

13. Monitor and record the water-quality indicator parameters every three to five minutes beginning after a minimum of one tubing volume (including the volume of water in the pump and flow cell) has been purged. The flow cell must not contain any air or gas bubbles when monitoring water-quality indicator parameters. Sample collection can take place when three successive readings of the water quality indicator parameters vary by less than or equal to the following:

    temperature ± 10 %
    pH ± 0.1 pH units;
    Specific conductance ± 3% Siemens/centimeter (S/cm);
    oxidation-reduction potential (ORP) ± 10 millivolts (mV);
    turbidity ± 10 % nephelometric turbidity units (NTU) (if >10 NTUs);
    dissolved oxygen ± 0.3 milligrams per liter (mg/L) or ± 10% whichever is less; and
    drawdown ± 0.03 feet

If one or more indicator parameters fail to stabilize after 4 hours, contact field team leader or project manager to determine which one of the following four actions should be taken:

a) Continue purging in an attempt to achieve stabilization;

b) Discontinue purging, collect samples, and document attempts to reach stabilization in the l field notebook and on the field data sheet;

c) Secure the well, purge and collect samples the next day (preferred by EPA Region 2); or

d) Discontinue purging, do not collect samples, and document attempts to reach stabilization in the field notebook and on the field data sheet.

14. If a stabilized drawdown in the well can't be maintained at 0.3 feet or less and drawdown is approaching the pump intake (or when drawdown exceeds 2-feet), close the three-way valve and turn the pump off for 15 minutes to allow for recovery (a check valve is required if the pump is shut off). Pumping the well dry should be avoided to the extent possible in all cases. If drawdown cannot be stabilized at the minimum pumping rate, contact field team leader or project manager to determine which of the following three actions should be taken:
    - If two tubing volumes (including the volume of water in the pump and flow cell) have been removed during purging then sampling should commence as soon as the volume in the well has recovered sufficiently to allow collection of samples. Record this information in the field notebook and in the comments section of field data sheet;
    - Continue purging water until three to six well volumes have been removed prior to sampling. Record this information in the field notebook and in the comments section of field data sheet; or
    - Lower depth of pump intake and continue purging water until three to six well volumes have been removed prior to sampling. Record this information in the field notebook and in the comments section of field data sheet.

15. Maintain the same pumping rate or reduce slightly for sampling. Adjust 3-way valve to re-route water away from the flow-through-cell so that the samples are collected directly into sample containers from the pump's discharge tubing (refer to SOP for sample handling UMC DCN 0001-011). For samples collected for dissolved gases or VOC analyses, the pump's tubing needs to be completely full of groundwater. If turbidity is greater then 10 NTUs, a filtered metal (dissolved) sample also should be collected using a 0.45-micron in-line filter fitted to the end of the discharge tubing. The in-line filter must be pre-rinsed following manufacturer's recommendations and if there are no recommendations for rinsing, by passing 0.5 to 1 liter of groundwater from the monitoring well through the filter prior to collecting samples.

16. **Non-dedicated system -** Remove the pump from the monitoring well and dispose of the tubing if it is non-dedicated.
    Dedicated system - Disconnect the tubing that extends from the permanently installed down-well tubing to equipment at the wellhead and discard after use.

17. Before locking the monitoring well, measure and record the well depth to nearest 0.01 feet (refer to the SOP for measuring water levels, UMC DCN 0001-016). If desired, measure and record the depth of any DNAPLs using an EIP while measuring total well depth.

18. After collection of the samples, the tubing, unless permanently installed, must be properly discarded or dedicated to the well for resampling by hanging the tubing inside the well.

19. Close and lock the well.

20. Decontaminate equipment that has come in contact with groundwater in accordance with Section 5.0 below prior to using in another well.

5.0 EQUIPMENT DECONTAMINATION

For each sampling event, all field measurement and sampling equipment must be cleaned prior to its entry into the well (refer to SOP for decontaminating field equipment UMC DCN 0001-019). Low flow sampling pumps require specialized decontamination procedures that are described below. Centrifugal pumps have two sets of decontaminating procedures; "daily decontamination" that is performed prior to the start of the sampling day, and "between-well decontamination" that is performed after each well is sampled. Bladder pumps have only one set of decontaminating procedures that is performed prior to sampling each well.

Centrifugal Pump – Daily Decontamination:

A. Pre-rinse: Operate pump in a deep basin of potable water for 5 minutes and flush other equipment with potable water for 5 minutes.
B. Wash: Operate pump in a deep basin containing a non-phosphate detergent solution, such as Alconox, for 5 minutes and flush other equipment with fresh detergent solution for 5 minutes. Use the detergent sparingly.
C. Rinse: Operate pump in a deep basin of potable water for 5 minutes and flush other equipment with potable water for 5 minutes.
D. Disassemble pump.
E. Wash pump parts: Place the disassembled parts of the pump into a deep basin containing a non-phosphate detergent solution. Scrub all pump parts with a test tube brush.
F. Rinse pump parts with potable water.
G. Rinse the following pump parts with distilled/ deionized water: inlet screen, the shaft, the suction interconnector, the motor lead assembly, and the stator housing.
H. Place impeller assembly in a large glass beaker and rinse with 1% nitric acid (HNO3).
I. Rinse impeller assembly with potable water.
J. Place impeller assembly in a large glass bleaker and rinse with methanol.
K. Rinse impeller assembly with distilled/deionized water and re-assemble pump

Centrifugal Pump – Between Well Decontamination:

A. Pre-rinse: Operate pump in a deep basin of potable water for 5 minutes and flush other equipment with potable water for 5 minutes.
B. Wash: Operate pump in a deep basin containing a non-phosphate detergent solution, such as Alconox, for 5 minutes and flush other equipment with fresh detergent solution for 5 minutes. Use the detergent sparingly.
C. Rinse: Operate pump in a deep basin of potable water for 5 minutes and flush other equipment with potable water for 5 minutes.
D. Final Rinse: Operate pump in a deep basin of distilled/deionized water to pump out 1 to 2 gallons of this final rinse water.

Bladder Pump Decontamination:

A. Disassemble pump.
B. Wash pump parts: Place the pump body and disassembled parts into a deep basin containing a non-phosphate detergent solution. Scrub all parts of the pump with a test tube brush.
C. Rinse pump parts with potable water.
D. Rinse the pump parts with distilled/ deionized water.
E. Install new bladder, or the bladder dedicated to the well to be sampled, and re-assemble pump.
F. Wash: Operate pump in a deep basin containing a non-phosphate detergent solution, such as Alconox, for 5 minutes. Use the detergent sparingly.
G. Rinse: Operate pump in a deep basin of potable water for 5 minutes.

6.0 FIELD LOG BOOK

A field log book must be kept each time ground water monitoring activities are conducted in the field (refer to SOP for Field Record Keeping UMC DCN 0001-017). The field log book should document the following:

- Well identification number and physical condition.
- Well depth, and measurement technique.
- Static water level depth, date, time, and measurement technique.
- Presence and thickness of immiscible liquid layers and detection method.
- Collection method for immiscible liquid layers.
- Pumping rate, drawdown, indicator parameters values, and clock time, at three to five minute intervals; calculate or measure total volume pumped.
- Well sampling sequence and time of sample collection.
- Types of sample bottles used and sample identification numbers.
- Preservatives used.
- Parameters requested for analysis.
- Field observations of sampling event.
- Name of sample collector{s) .
- Weather conditions.
- QA/QC data for field instruments.

7.0 REFERENCES

Puls, R.W. and M.J. Barcelona, 1996, Low-Flow (Minimal Drawdown) Groundwater Sampling Procedures, EPA/540/S-95/504.

UMC, Decontamination of Field Equipment SOP, UMC DCN 0001-019, October 7, 2002

UMC, Field Record Keeping SOP, UMC DCN 0001-017, October 3, 2002

UMC, Measuring Water Levels and Sounding a Well SOP, UMC DCN 0001-016, October 3, 2002

UMC, Sample Handling SOP, UMC DCN 0001-011, November 5, 2002

U.S. Environmental Protection Agency Region 2, 1998, Ground Water Sampling Procedure Low Stress (Low Flow) Purging and Sampling, GW Sampling SOP Final, March 16, 1998

U.S. EPA, 1993, RCRA Ground-Water Monitoring: Draft Technical Guidance, EPA/530-R-93-001.

UMC

ENVIRONMENTAL SERVICES
STANDARD OPERATING PROCEDURE

SAMPLING PERFLUORINATED COMPOUNDS (PFCS)
GROUNDWATER, SURFACE WATER, PUBLIC AND PRIVATE SUPPLY WELLS
SURFACE SOIL, SUBSURFACE SOIL, STOCKPILE, SEDIMENT

PROJECT NUMBER: 2010		**DOCUMENT CONTROL NUMBER: DCN1-44**	
APPROVALS			
Title-Signature-Date			
REV NO.	PREPARED BY	DIRECTOR REVIEW	PRESIDENT
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1.0 **PURPOSE**

The purpose of this standard operating procedure (SOP) is to provide the general methodology for the sample collection of PFCs, a class of more than 24 synthetic compounds, from groundwater, surface water, public service wells, private service wells, surface soil, subsurface soil, stockpile, and sediment sample locations. These procedures may be superseded by project, client, regulatory, or site specific procedures established in a sampling and analysis plan (SAP), Quality Assurance Project Plan (QAPP) or other project document. Project or site specific procedures take precedence over the generic procedures set forth here.

This SOP was developed based in part upon the following references:

- Sampling and Analysis Plan for the Pownal Tannery Site, Pownal Vermont prepared by Weston Solutions, Inc. for the USEPA, Region I, Superfund Technical Assessment and Response Team IV (START), March 2016 (as provided to Unicorn Management Consultants, LLC [UMC] by the Vermont Department of Environmental Conservation [VTDEC] on March 25, 2016).
- Work Scope (Revised 3/15/16), Surface Soil Sampling, Village of North Bennington, VT, prepared by C.T. Male Associates, D.P.C., (as provided to UMC by the VTDEC on March 25, 2016).
- Perfluorinated Compound Sampling Plan, Former ChemFab, North Bennington, VT prepared by Weston & Sampson Engineers, Inc., on behalf of the VTDEC, February 2016.
- Low Stress (Low Flow) Purging and Sampling Procedure for the Collection of Groundwater Samples from Monitoring Wells, U.S. Environmental Protection Agency (USEPA), Region I, EPASOP-GW-01, Revision 3, dated July 30, 1996, revised January 19, 2010.

2.0 **PROHIBITED AND ACCEPTABLE MATERIALS FOR COLLECTING PFC SAMPLES**

The sampler will assure that no potential PFC-containing materials are utilized during sampling. No materials containing Teflon, Gortex, or other waterproofing can be utilized while sampling. Please take extra care to assure that clothing, storage containers, and sampling equipment do not contain potential PFCs. Appendix A of this SOP contains a summary of prohibited and acceptable materials for PFC sampling.

3.0 **CALIBRATION OF FIELD ANALYSIS EQUIPMENT**

Calibrate field analysis equipment (e.g., PID/FID, multi-parameter and turbidity meters, etc.) before use or as required in the manufacturer's manual for the instrument. Summarize the calibration procedures in the field notebook or on applicable field sheets.

4.0 **PREPARING THE FIELD TRIP BLANK**

A field trip blank is needed to represent ambient air conditions (e.g., indoor, outdoor, change of property, etc.) during sampling regardless of matrix being sampled. A separate field trip blank is required to be collected for each different ambient air location on the same date and proximate time as the PFC samples being collected.

Prior to handling the field trip blank bottles, each sampling team member will don at least three pairs (layers) of Nitrile gloves. The cooler containing the PFC sampling containers will be opened and the full bottle labeled "field trip blank" and the empty bottle marked "field trip blank" will be located.

Label the sample container(s) with appropriate information such as: client name, site location, sample identification (location, etc.) date, time of collection, and sampler's initials.

Once sample bottles have been labeled, remove each bottle cap. This is done best with one person holding the bottles firmly and another person uncapping both bottles and maintaining the caps upright. Then the contents of the full “field trip blank” bottle will be dispensed into the empty “field trip blank” bottle. Both bottles will be recapped and the field trip blank bottle will be placed into a resealable (Ziploc-type) bag before proceeding. The bottle will be placed in the sample cooler in a location away from the sampling point. The outer pair of Nitrile gloves will then be doffed.

5.0 **AQUEOUS SAMPLE COLLECTION FOR PFCS**

This SOP establishes generic procedures for collecting groundwater, surface water, and supply well aqueous sample. These procedures may be superseded by project, client, regulatory, or site specific procedures established in a SAP or other project document. Project or site specific procedures take precedence over the generic procedures set forth here.

5.1 AQUEOUS SAMPLE COLLECTION

When possible, aqueous samples should be collected from locations/wells that are the least impacted followed by locations/wells with potentially greater impacts. Prior to sample collection, record location, time, date, and appropriate information in the field notebook and on the field data sheet.

5.2 GROUNDWATER SAMPLE COLLECTION FOR PFCS

5.2.1 GROUNDWATER SAMPLING EQUIPMENT AND MATERIALS

The equipment and materials required for groundwater sample collection may include, but is not limited to, the following:

- Electronic water-level indicator (WLI) or steel tape and chalk, with 0.01 foot increments. Electronic oil/water interface probe (EIP) for measuring non-aqueous phase liquid (NAPL), if needed.
- Water-quality indicator parameter meter(s):
  - Multi-Parameter meter with flow-through-cell to monitor pH, oxygen reduction potential (ORP), dissolved oxygen (DO), specific conductivity, turbidity, and temperature. The flow-through-cell should be a clear, closed cell with the inlet located near the bottom and the outlet near the top.
  - Turbidity meter if not included in multi-parameter meter above.
- Sampling pump - adjustable rate submersible or stainless steel pumps. Adjustable rate, peristaltic pump can be used when the depth to water is 25 feet or less.
- Power Source: Batteries or if a combustion engine generator is used, it must be placed downwind of the sampling area.
- Tubing – when possible high density polyethylene tubing (HDPE) is used when sampling for PFCs. Silicone flexible tubing may be used within a peristaltic pump.
- Flow measurement supplies: graduated cylinder, or other volumetric measuring device, and a stop watch.

- Decontamination Supplies – Laboratory prepared PFC free rinse water, distilled or deionized water, non-phosphate soap (such as Alconox), isopropyl alcohol, brushes, pressure sprayers, spray bottles, buckets or decontamination tubes for pumps.
- Sample bottles (and preservation supplies if bottles are not pre-preserved).
- Sample labels
- Chain-of-custody forms.
- Field Sampling Plan and/or Quality Assurance Project Plan.
- Well construction data
- Water quality data from previous sampling events.
- Well keys
- Map of well locations.
- Field notebook, groundwater sampling logs and calculator. A field data sheet (low flow groundwater sampling data collection sheet) is provided in the attachment. Do not use waterproof paper for PFC sampling.
- 0.45 micron in-line disposable filters (if filtered samples are needed).
- Personal protective equipment as specified in the Site Health and Safety Plan (if necessary).
- Air monitoring equipment as specified in the Site Health and Safety Plan (if necessary).
- Tool box - All needed tools for all site equipment used.
- A 55-gallon drum or container to collect the purged water (if necessary).
- Portable rain-shelter (e.g. tarp and guy-lines or ice-fishing tent).

5.2.2 GENERAL GROUNWATER SAMPLE COLLECTION CONSIDERATIONS

If sampling from monitoring wells is required, check the condition of the well for damage or evidence of tampering and record observations in the field notebook. As required, monitor the headspace of the unopened monitoring well at the rim of the outer casing for volatile organic compounds (VOCs) with a PID or FID, and record in the field notebook and on the field data sheet. Remove inner casing cap and monitor the headspace of the monitoring well at the rim of the casing for VOCs and record in the field notebook.

Prior to sampling monitoring wells, measure the water level depth to nearest 0.01 foot with a WLI or EIP (refer to the UMC SOP for measuring water levels, UMC DCN 0001-016) and record in the field notebook and on the field data sheet. If the presence of non-aqueous phase liquid (NAPL) is suspected or unknown, the depth to water measurement should be made with an EIP. Do not sample groundwater in the well if EIP indicates that NAPL is present in the well unless specified on the SAP. Check the available well information or field information for the total depth of the monitoring well. Use the depth to water measurement and the total depth of the monitoring well to calculate the mid-point of the saturated screen length and the volume of the water in the monitoring well. Avoid sounding well to determine depth to bottom less than 48-hours prior to sampling.

5.2.3 SAMPLING GROUNDWATER WITH PERISTALTIC PUMPS FOR PFCS

Adjustable rate peristaltic pumps may be used when the top of the water table is less than 25 feet below the ground surface to collect groundwater samples for PFC analysis.

Once the mid-point of the saturated screen length has been calculated, HDPE tubing will be measured and lowered slowly (to minimize disturbance) into the well to the midpoint of the saturated zone to be sampled. If possible, the tubing will be placed at least two feet above the bottom of the well to minimize disturbing any particulates at the bottom of the well. The HDPE tubing will be connected to the silicon tubing located within the peristaltic pump.

Prior to activating the pump, a water level meter will be lowered into the well to the top of the water column and will remain in the well to record drawdown of the water column during purging and well stabilization.

Once the water level meter is secured down-well, verify that the pump is set to its lowest pumping rate, then activate the pump and slowly increase the pumping rate until groundwater discharge occurs. Monitor the drawdown of the water column in the well and adjust the flow rate of the pump as necessary until the drawdown is less than 0.3 feet.

Allow the well to purge until the water clarity improves then connect the discharge tubing to the flow through cell and water quality multi-parameter meter using silicon tubing. During well purging, record water quality parameters in 5-minute intervals over a 45-minute minimum purge time on dedicated field sheets (see Appendix B). Well stabilization is considered to be achieved once the minimum purge time has been met and three consecutive water quality parameter readings are within the following limits:

- Turbidity (10% for values greater than 1NTU)
- Temperature (3%)
- pH (0.1 Unit)
- ORP (10 millivolts)
- Specific Conductance (3%)
- DO (10%)

Once the well is stabilized, groundwater sampling may begin. First, prior to collecting a groundwater sample the pump is turned off and disconnected from the flow through cell. The pump is then restarted and groundwater is allowed to flow for approximately one minute before sample collection.

For groundwater sampling, adjust the flow rate to approximately 200-300 milliliters per minute. Label the laboratory supplied, certified pre-cleaned, containers using an indelible ink (Sharpie). Wearing a minimum of two layers of Nitrile gloves, fill the sample bottles nearly to the top, secure caps on bottles, and gently agitate the bottles in an up and down manner to allow the preservative to dissolve. The filled sample bottles will be returned to a resealable bag.

All relevant information and observations pertaining to the sample location including an inventory of potential PFC containing items in the area nearby the sampling point, if any, will be recorded in the field book and/or on the field sheets, and the sampling location will be photo-documented.

After sampling location observations and information are recorded, the tubing can be removed from the well and peristaltic pump and discarded. Note that the silicon tubing associated with the peristaltic pump must be changed between sampling locations. A final water level will be recorded prior to removal of the water level meter from the well.

The samples will be recorded on a chain-of-custody, prepared for shipment, and transported to an offsite laboratory for analysis in accordance with UMC's Sample Handling SOP.

5.2.4 SAMPLING GROUNDWATER WITH SUBMERSIBLE PUMPS FOR PFCS

For deep overburden or bedrock wells (>25 feet), UMC will utilize a stainless steel submersible pump to minimize the introduction of PFCs during sample collection. Once the mid-point of the saturated screen length has been calculated, secure tubing to the pump, and lower the pump slowly (to minimize disturbance) into the well to the midpoint of the saturated zone to be sampled. If possible, place the pump at least two feet above the bottom of the well to minimize disturbing any particulates at the bottom of the well. The water level meter will remain in the well at the top of the water column to monitor drawdown after the pump is started.

Once the water level meter and pump are secured down-well, verify that the pump is set to its lowest pumping rate, then activate the pump and slowly increase the pumping rate until groundwater discharge occurs. Monitor the drawdown of the water column in the well and adjust the flow rate of the pump as necessary until the drawdown is less than 0.3 feet.

Allow the well to purge until the water clarity improves then connect the pump's discharge tubing to the water quality multi-parameter meter flow through cell using silicon tubing. During well purging, record water quality parameters in 5-minute intervals over a 45-minute minimum purge time on dedicated field sheets (Appendix B). Well stabilization is considered to be achieved once the minimum purge time has been met and three consecutive water quality parameter readings are within the following limits:

- Turbidity (10% for values greater than 1NTU)
- Temperature (3%)
- pH (0.1 Unit)
- ORP (10 millivolts)
- Specific Conductance (3%)
- DO (10%)

Once the well is stabilized, groundwater sampling may begin. For groundwater sampling, adjust the flow rate to approximately 200-300 milliliters per minute. Label the laboratory supplied, certified pre-cleaned, containers using indelible ink (Sharpie). Wearing a minimum of two layers of Nitrile gloves, fill the sample bottles nearly to the top, secure caps on bottles, and gently agitate the bottles in an up and down manner to allow the preservative to dissolve. The filled sample bottles will be returned to a resealable bag.

All relevant information and observations pertaining to the sample location including an inventory of potential PFC containing items in the area nearby the sampling point, if any, will be recorded in the field book and/or on the field sheets, and the sampling location will be photo-documented.

After sampling location observations and information are recorded, a final water level will be recorded prior to removal of the water level meter and pump from the well.

The samples will be recorded on a chain-of-custody, prepared for shipment, and transported to an offsite laboratory for analysis in accordance with UMC's Sample Handling SOP.

5.3 SURFACE WATER SAMPLING FOR PFCS

Each sampling team member will don at least three pairs (layers) of Nitrile gloves. Label the laboratory supplied, certified pre-cleaned, containers using indelible ink (Sharpie). Surface water samples will be collected directly from the surface water source using a non-preserved, laboratory supplied, container (suitable for analysis of PFCs). Care will be taken to minimize the collection of sediment.

Once the surface water sample is within the non-preserved laboratory supplied container, it will be transferred into a preserved laboratory supplied container, as necessary. Wearing a minimum of two layers of Nitrile gloves, fill the sample bottles nearly to the top, secure caps on bottles, and gently agitate the bottles in an up and down manner to allow the preservative to dissolve. The filled sample bottles will be placed into a resealable bag. Discard the empty sampling container (non-preserved) used to acquire the surface water sample.

All relevant information and observations pertaining to the sample location including an inventory of potential PFC containing items in the area nearby the sampling point, if any, will be recorded in the field book and/or on the field sheets, and the sampling location will be photo-documented.

The samples will be recorded on a chain-of-custody, prepared for shipment, and transported to an offsite laboratory for analysis in accordance with UMC's Sample Handling SOP.

5.4 SAMPLING PRIVATE AND PUBLIC SUPPLY WELLS FOR PFCS

Supply well samples should be collected before any treatment systems or softeners. If present any screens, aerators or deviators will be removed from the selected sampling tap. The cold water tap will be turned on and allowed to flow at approximately 2 to 3 gallons per minute for at least 10 minutes. The flow on the tap will be adjusted to ensure a slow, constant flow of less than ½ gallon per minute.

Label the laboratory supplied, certified pre-cleaned, containers using indelible ink (Sharpie). Wearing a minimum of two layers of Nitrile gloves, fill the sample bottles nearly to the top, secure caps on bottles, and gently agitate the bottles in an up and down manner to allow the preservative to dissolve. The filled sample bottles will be placed into a resealable bag.

All relevant information and observations pertaining to the sample location including an inventory of potential PFC containing items in the area nearby the sampling point, if any, will be recorded in the field book and/or on the field sheets, and the sampling location will be photo-documented.

The samples will be recorded on a chain-of-custody, prepared for shipment, and transported to an offsite laboratory for analysis in accordance with UMC's Sample Handling SOP.

6.0 **SOIL SAMPLE COLLECTION FOR PFCS**

This SOP establishes generic procedures for collecting soil and sediment samples for PFC analysis. These procedures are generally consistent with previously established UMC SOPs (e.g., UMC DCN 0001-027 titled Collecting Surface and Soil Samples and Installing Monitoring Wells); modified for the collection of surface, subsurface, stockpiled soil, and sediment PFC samples. These procedures may be superseded by project, client, regulatory, or site specific procedures established in a SAP or other project document. Project or site specific procedures take precedence over the generic procedures set forth here.

6.1 SOIL SAMPLING CONSIDERATIONS

Soil and sediment samples can be collected from the surface, or at depth. Commonly, surface sampling refers to the collection of samples at a 0-6 inch depth; the minimum and maximum depth of surface samples must be defined in the SAP. Surface samples can be collected directly by sampling personnel with, for example, stainless steel trowels or scoops. Subsurface samples may be collected directly, *e.g.*, on an excavation face, or indirectly by bringing the soil to the sampling personnel with a hand auger, split-spoon sampler, a thin-walled tube sampler, with a back hoe, or other excavation equipment.

The SAP should specify sampling locations. The locations can be selected on a bias or randomly (simple, stratified, or systematic). The SAP should indicate the type of sampling (random or biased) and the rationale behind the selection of the sampling points. This will allow sampling personnel to make field modifications to the SAP which are consistent with the purpose of the sampling.

Either grab or composite samples can be taken dependent upon the SAP and specific analytical method requirements. A grab sample is collected from one specific sample site. A composite sample is comprised of sample fractions collected at more than one sampling point. A commonly used application of composite samples is characterizing stockpiled soils and sediment for treatment or waste disposal. To avoid off-gassing of contaminants, care must be exercised when composite samples are to be analyzed for VOCs.

6.2 SOIL SAMPLE COLLECTION EQUIPMENT AND MATERIALS

Sample collection methods, materials, and Quality Assurance/Quality Control (QA/QC) requirements should be specified in the SAP. The SOP for Collecting Quality Control Samples (DCN 0001-018) should be referenced regarding the collection of quality control samples. Equipment and materials required for proper collection of soil samples includes, but is not limited to, the following:

- A detailed SAP;
- Field notebook, maps, boring log, and field data sheets maps;
- Decontamination supplies including: non-phosphate laboratory grade detergent, buckets, brushes, potable water, distilled water, PFC-Free rinse water, regulatory-required reagents, aluminum foil, and plastic sheeting, garbage bags - Refer to the SOP for Decontamination of Field Equipment (DCN 0001-019) for detailed procedures.
- SAP specified sampling device(s), *e.g.*, split-spoon sampler, thin-walled tube sampler, stainless steel hand auger, or stainless steel trowel;
- Stainless steel spoons, spatulas, scrapers, probes and other small tools;
- Stainless steel mixing bowl;
- Disposable sampling gloves (Nitrile gloves);
- Laboratory-supplied and cleaned sample containers;
- Sample labels, Chain-of-Custody/Analytical Request Forms, custody seals;
- Sample Shuttle/cooler and ice;
- Zip-lock bags (or similar) and packing material;
- Indelible marker (sharpie like);
- Tape measure;
- Paper Towels;
- Masking and packing tape;
- Overnight (express) mail forms.

6.3 SOIL SAMPLE COLLECTION PROCEDURES

Prior to initiating soil sample collection, determine the size and number of sample containers needed and prepare preservatives if required. Label the sample container(s) with appropriate information such as: client name, site location, sample identification (location, depth, etc.) date and time of collection, and sampler's initials. Determine the type and quantity of sampling equipment required. Ensure that all sampling equipment has been thoroughly cleaned according to the SOP for Decontamination of Field Equipment (DCN 0001-019) and prepare decontamination equipment and materials if reusable sample equipment is to be used. In cases where it is not known which type of sampling equipment will work best, several types of systems and devices should be on hand and available.

Once the soil sample location is identified in accordance with the SAP, secure a piece of six foot by six foot plastic sheeting over the sampling location and remove a one foot by one foot opening in the center of the plastic sheeting. Remove vegetation, humus, or other ground surface cover to expose the top of ground surface.

For indirectly collected subsurface samples, the boring must be advanced with thoroughly cleaned equipment to the top of the desired sampling interval. A pre-cleaned sampling device should then be advanced through the sampling horizon (after removal of the boring tool if required). When the sampling tool is also the boring device, e.g., bucket auger, the device should be withdrawn and cleaned prior to advancement through the sampling horizon; or, preferably, another pre-cleaned device should be used to collect the sample.

Using disposable gloves (triple layered for PFC sample collection) and a pre-cleaned, stainless steel spatula, spoon, scoop or other approved device, collect the sample directly or extract the sample from the sampler, and place the sample in a laboratory-supplied pre-cleaned sample container or stainless steel bowl (if homogenizing is required). Samples to be analyzed for VOCs must be collected prior to other constituents, utilizing no headspace sampling techniques, and handling should be kept to a minimum. For directly collected samples, if possible, remove an inch of soil before collecting the sample so that the collected soil has not been directly exposed to the atmosphere. For indirectly collected samples, collect the soil or sediment towards the middle or bottom of the sampler because soil at the ends of the sampler may not be representative of the depth interval being sampled. Immediately after collection the sample should be cooled to 4°C and placed in a cooler/sample shuttle. See the SOP for Sample Handling (DCN 0001-011) for proper sample handling and documentation.

Using the remaining portion of the soil from the sampler, record at minimum the following soil observations: color, odor, moisture, texture, density, consistency, organic content, layering, grain size, etc. Samples may be screened with portable instrumentation such as a PID. These results should also be recorded in the field notebook or on the appropriate field data forms.

Discard any gloves, foil, plastic, etc. in an appropriate manner that is consistent with site conditions. Sampling equipment will be decontaminated between each sampling interval. All reusable sampling equipment must be thoroughly cleaned in accordance with the UMC SOP for Decontamination of Field Equipment (DCN 0001-019). Equipment decontamination fluids that have potentially been impacted by PFCs must be changed between sampling intervals and locations.

All relevant information and observations pertaining to the sample location including an inventory of potential PFC containing items in the area nearby the sampling point, if any, will be recorded in the field book and/or on the field sheets, and the sampling location will be photo-documented.

The samples will be recorded on a chain-of-custody, prepared for shipment, and transported to an offsite laboratory for analysis in accordance with UMC's Sample Handling SOP.

7.0 DECONTAMINATION PROCEDURES FOR PFC IMPACTED EQUIPMENT

General decontamination procedures are described in UMC SOP for Decontamination of Field Equipment (DCN 0001-019). Specific consideration is needed when sampling for PFCs using submersible pumps or any other pieces of equipment used during the sample collection of PFCs which may come in contact with potentially PFC impacted water or soil. Specifically, the decontamination of potentially PFC-impacted equipment will be conducted as follows:

Flush the equipment with potable water
Flush with Alconox and water wash solution
Flush with distilled/deionized water to remove all the Alconox solution
Flush with isopropyl alcohol
Flush with distilled/deionized water
Flush with PFC-free water (laboratory supplied and certified)
Allow the equipment to air dry

Equipment decontamination fluids that have potentially been impacted by PFCs must be changed between sampling intervals and locations.

Summary of Prohibited and Acceptable Materials for Collecting Perfluorinated Compound Samples

Prohibited Items	Acceptable Items
Field Equipment	
Teflon® containing materials	High-density polyethylene (HDPE)
Storage of samples in containers made of LDPE materials	Acetate liners
Teflon® tubing	Silicon tubing
Waterproof field books	Loose paper (non-waterproof)
Plastic clipboards, binders, or spiral hard cover notebooks	Aluminum field clipboards or with Masonite
	Sharpies®, pens
Post-It Notes	
Chemical (blue) ice packs	Regular ice
Field Clothing and Personal Protective Equipment (PPE)	
New clothing or water resistant, waterproof, or stain-treated clothing, clothing containing Gore-Tex™	Well-laundered clothing, defined as clothing that has been washed 6 or more times after purchase, made of synthetic or natural fibers (preferable cotton)
Clothing laundered using fabric softener	No fabric softener
Boots containing Gore-Tex™	Boots made with polyurethane and polyvinyl chloride (PVC)
Tyvek®	Cotton Clothing
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 Sunscreen, 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, Herbal 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
Teflon®-lined caps	Lined or unlined HDPE or polypropylene caps
Rain Events	
Waterproof or resistant rain gear	Gazebo tent that is only touched or moved prior to and following sampling activities
Equipment Decontamination	
Decon 90	Alconox® and/or Liquinox®
Water from an on-site well	Potable water from municipal drinking water supply
Food Considerations	
All food and drink, with exceptions noted on the right	Bottled water and hydration drinks (i.e. Gatorade® and Powerade®) to be brought and consumed only in the staging area

Source: PFC Release Determination at Multiple BRAC Bases, Final Quality Project Plan, July 2014.