SAMPLING AND ANALYSIS PLAN
FOR THE SPRING 2011 MONITORING ROUND
TROY MILLS LANDFILL SUPERFUND SITE
CERCLIS ID NHD980520217 / NHDES 198405082
TROY, NEW HAMPSHIRE

PREPARED FOR:
New Hampshire Department of Environmental Services
Waste Management Division, Hazardous Waste Remediation Bureau
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1.0 INTRODUCTION

1.1 SITE DESCRIPTION AND BRIEF HISTORY

The Troy Mills Landfill Superfund Site (Site) is a two-acre former drum disposal area in Troy, New Hampshire (Cheshire County) located about 1.5 miles south of the Center of Troy (refer to **Figure 1**). The two-acre Site is located in the southeastern corner of a 270-acre parcel, which also includes a solid waste landfill. Access to the Site is via the DRED trail (former railroad) and a private gravel pit road off Rockwood Pond Road in Fitzwilliam, New Hampshire.

Troy Mills, Inc. disposed of hazardous substances that were generated at its acrylic fabric manufacturing facility in Troy between 1967 and 1978. An estimated 6,000 to 10,000 55-gallon drums of waste liquid and sludge containing mostly plasticizers such as bis(2-ethylhexyl)phthalate and a petroleum-based solvent known as Varsol™ were disposed of in this area. Other drummed waste included pigments, surplus mixes, and tank residuals of vinyl resins, paint resins, and top coating products. Between 1979 and 2005, several investigations of the Site have occurred. Investigation findings identified volatile organic compounds (VOCs), semi-VOCs, and inorganics in groundwater, leachate, surface soil, surface water, and sediment in and around the drum disposal area.

In September 2003 the Site was listed on the National Priorities List and a time-critical removal action was initiated. Between 2004 and 2005, the United States Environmental Protection Agency (EPA) completed a drum and flammable liquid removal and contaminated soil/sludge removal action; constructed three light non-aqueous phase liquid (LNAPL) interceptor trenches; and constructed a 2-foot-thick permeable soil cap over the excavation area. A subsequent remedial investigation of the Site by EPA identified a plume of groundwater contamination consisting of organic contaminations (alkylbenzenes, chlorinated solvents, phthalates, and toluene). It was concluded that the contaminants of concern were naturally biodegrading and that removal of the buried drums eliminated the primary source of on-going contamination to groundwater.

Pursuant to the September 30, 2005 Record of Decision (ROD) for the Site, the selected remedy for contaminated groundwater, LNAPL, and residual soil contamination included several remedial action components:

- Maintenance of the LNAPL interceptor trenches;
- Maintenance of a permeable soil cap;
- Monitored natural attenuation (MNA) of groundwater contaminants including the monitoring of groundwater, surface water, sediment, leachate, and wetlands;
- Institutional controls; and
- Five year reviews.

The New Hampshire Department of Environmental Services (NHDES) is the lead agency responsible for the implementation of the selected remedy. GZA GeoEnvironmental, Inc. (GZA), on behalf of NHDES, has prepared this Sampling and Analysis Plan (SAP). The SAP describes the establishment of a long-term monitoring component required by the remedy to monitor the effectiveness of the MNA component of the ROD.

The SAP specifically includes the sampling and chemical analysis of groundwater from an existing network of monitoring wells and the sampling and chemical analysis of surface water, sediment, leachate, and wetland soils.

The SAP describes the sampling locations, field measurement procedures and criteria, sampling methods, sample container requirements, preservation, and decontamination procedures. The SAP has been prepared consistent with and references NHDES' Hazardous Waste Remediation Bureau (HWRB) current Master Quality Assurance Project Plan (QAPP) (RFA #08036). HWRB's QAPP describes the chemical-data quality objectives (DQOs), analytical procedures and measurements, including laboratory quality-control protocols necessary to achieve DQOs, and data-assessment procedures for the evaluation and identification of any data limitations.

1.2 SUMMARY OF SITE HYDROGEOLOGY

Based on information collected by others, bedrock underlying the Site is comprised of biotite schist of the Littleton Formation.[1] The biotite schist at the Site is typically dark gray, hard, folded, with high angle foliation and fractures, and quartz veins. Seams of granite, quartz, and pegmatite are also present within the schist. Bedrock fractures were found trending both northeast and northwest.

The overburden primarily consists of a sand unit, ablation till, and lodgment till. The sand layer is typically less than 6 feet in thickness where it remains in place and is mostly saturated in the low area west of the access road. The ablation till is at its thickest beneath the southwestern part of the former drum disposal area, where it is up to 40 feet thick. This unit gradually thins toward Rockwood Brook, where it is less than 10 feet thick, and is very thin to absent near the eastern edge of the former drum disposal area where the bedrock is shallow. The lodgment till is thickest at the bottom of the valley floor near Rockwood Brook, where boring logs indicate a thickness of greater than 35 feet. This till unit thins eastward toward the eastern edge of the former drum disposal area.

Groundwater flow in the shallow overburden has been measured by others to be to the west or northwest, toward Rockwood Brook. The hydraulic gradient is reportedly quite steep to the east of the access road, reflecting the low permeability of the till deposits in which the water table occurs. It has been concluded that the vertical gradients are generally downward or neutral except in areas where groundwater is rising to discharge into a stream or wetland.

1.3 BRIEF SUMMARY OF PREVIOUS INVESTIGATIONS AND CONTAMINANTS-OF-CONCERN

From 1979 to the present, numerous investigations have been conducted and are described in greater detail within the Final Feasibility Study (FS), prepared by Metcalf & Eddy, Inc. (M&E), dated September 2005. GZA has included a summary of the investigation history information provided in the 2005 FS document below.

[1] Final Feasibility Study, Troy Mills Landfill Superfund Site, Troy, New Hampshire, prepared by Metcalf & Eddy, Inc, dated September 2005.

" Under the State hazardous remediation program, consultants to TMI completed a Phase I investigation of the drum disposal area in August 1981, a Phase II in December 1981, a Phase III in July 1982, and entered into a Consent Agreement with NHDES in January of 1985 (Weston, 2003). The Consent Agreement required TMI to submit a Waste Analysis Plan, a Preliminary Risk Assessment, a Remedial Investigation/Feasibility Study, and an engineering design of the selected remedial alternative. The Preliminary Human Health Risk Assessment, completed in March 1986, concluded that a Level 2 Risk Assessment should be conducted since concentrations of VOCs in groundwater showed potentially elevated risk. The RI was initiated in 1987, and the risk assessment was completed in 1991 (Weston, 2003).

Although the risk assessment concluded that risk to human health was negligible, it was later determined that the Site had not been thoroughly characterized. The Phase I Pre-Design study, conducted in 1995, revealed LNAPL in newly-installed wells, a leachate outbreak, and subsequent analyses indicated that concentrations of contaminants in groundwater exceeded the New Hampshire Ambient Groundwater Quality Standards (Weston, 2003). The Pre-Design study recommended a containment remedy and further evaluation of the potential for intrinsic remediation of site groundwater (GEI Consultants, Inc., 1995).

The Phase II Pre-Design report, issued in September 1998, proposed the installation of a hanging slurry wall combined with product collection and a flow-through (intrinsic) treatment gate downgradient of the buried drum area and the leachate outbreak. In addition, the NHDES questioned the conclusion made by the consultant that only a small percentage of the drums remaining in the drum disposal area were still intact and contained liquid. Instead, the NHDES supported a containment-based remedial action, and in April 2000 agreed to a modified version of a containment-based remedial action originally proposed in 1995 with the condition of commitment by TMI to long-term operation, maintenance, and monitoring (Weston, 2003).

In September 2000, TMI requested to defer remediation of the drum disposal area to 2003/2004 due to unfavorable corporate and financial market conditions. In December 2000, NHDES approved the deferral schedule provided in September, based on the remote location of the Site, combined with monitoring data that did not suggest an imminent and substantial threat to public health or the environment. TMI filed for Chapter 11 bankruptcy on November 2, 2001.

At the request of the State, since 2002, the EPA Superfund Technical Assessment and Response Team (START) and Emergency and Rapid Response (ERRS) contractors have conducted removal actions at the Site. Initial activities conducted as part of the removal actions included the construction of LNAPL interceptor trenches downgradient of the drum disposal area, removal of nine 55-gallon drums of hazardous waste solids and non-Resource Conservation Recovery Act (RCRA) regulated materials, installation of a fence along the access road, re-grading of the access road and construction of additional access roads, installation of eight additional monitoring wells and piezometers, installation of sorbent booms at several locations to temporarily contain leachate outbreaks, slug tests on five site monitoring wells, construction of a berm along the access road upgradient of the leachate interceptor trenches to divert storm water runoff, a preliminary assessment and site investigation, and an expanded site investigation.

> Between July and November, 2004 the EPA START and ERRS contractors excavated and removed 7,692 55-gallon drums from the 2-acre drum disposal area. In addition, 29,924 gallons of flammable liquid waste and 26,244 tons of contaminated soil, 3,099 cubic yards of waste sludge, as well as shredded drums have been removed from the Site (EPA, 2004b). Excavated soil was field screened and soil that did not exceed screening standards was used to backfill the excavation. Removal and off-site disposal of additional contaminated soil and placement of a permeable cover, consisting of 2 feet of clean soil, and re-vegetation is occurring during the summer of 2005.
>
> In July 2004, EPA's Superfund Remedial Program retained M&E under the RAC contract to initiate a remedial investigation to determine if any additional remedial actions would be needed after the completion of the removal action. The RI documented the nature and extent of residual contamination and evaluated risks to human health and the environment from any current or expected future exposures to residual contamination. Five additional wells were installed at the Site and groundwater, surface water, soils, and sediments were sampled in December of 2004.
>
> The RI report was completed in July 2005 and documented a plume of groundwater contamination, approximately 8-9 acres in size. Organic contaminants such alkybenzenes, chlorinated solvents, phthalates, and toluene were identified as the primary contaminants-of-concern. The RI concluded that most of the contaminants-of-concern were biodegrading naturally and that by removing the drums, the source was removed..."

The 2005 FS included the establishment of remedial action objectives and preliminary remediation goals; identification and screening of potential treatment and containment technologies, and the development and evaluation of remedial alternatives for the Site. It was concluded by M&E that the primary contaminants posing human health risks and hazards were bis(2-ethylhexyl)phthalate in leachate and various organics and inorganics in groundwater.

The first statutory five-year review was completed by EPA in September 2010 to document the status of the selected remedy relative to it being protective of human health and the environment. The trigger for the five-year review was the initiation of the ROD-specified cleanup actions completed in the fall of 2005. The five-year review documented that the remedy was currently protective of human health and the environment as envisioned by the ROD. However, in order for the remedy to be considered protective over the long term, the following actions were recommended:

- With regard to effectiveness of institutional controls at the Site, report violations and vandalism to the State and the Town for response with appropriate follow-up monitoring and enforcement actions. Repair damaged wells with new locking caps, post warning signs at the inner gate and former drum disposal area, and consider fencing the former drum disposal area to restrict access by all terrain vehicles;
- Conduct a supplemental investigation of the residual LNAPL source area and further evaluate effectiveness of the LNAPL trenches in capturing remaining LNAPL;
- Perform supplemental hydrogeologic studies to confirm hydrostratigraphy and the contaminant of concern fate and transport in groundwater to confirm the effectiveness of the MNA management of migration remedy at the Site and to better forecast time to cleanup; and

- Perform a hydrologic evaluation within the transition zone between groundwater and surface water in the Rockwood Brook Wetland Study area and Rockwood Brook. Review existing data from nearby groundwater monitoring wells relative to appropriate benchmark ecological risk screening values applied to receptor exposures within the ground water – surface water transition zone.

Included as an appendix to the five-year review is GZA's "*June 2009 Through June 2010 Sampling Data Report*" (Data Report) for the Site. This Data Report summarizes the 2009-2010 monitoring activities, data results, and GZA's conclusions and recommendations regarding the findings. Refer to the report text for specific information.

Supplemental investigations are on-going at the time based on the conclusions and recommendations of both the five-year review and the Data Report. Several new wells have been installed as part of the ongoing work and have been incorporated into the Spring 2011 monitoring round (refer to **Table 2** for a summary of sampling rationale). In addition, several operational and maintenance activities (i.e. bladder pump/tubing repairs and/or replacement, protective well casing/roadbox replacement) have taken place between fall 2010 and spring 2011. These activities will be summarized in the annual data report for 2011.

1.4 INTERIM CLEANUP LEVELS AND AMBIENT GROUNDWATER QUALITY STANDARDS

Interim Cleanup levels (ICLs) for contaminants of concern were established in the ROD for groundwater and leachate (refer to **Appendix A**). Groundwater data results will also be compared against New Hampshire Ambient Groundwater Quality Standards (AGQS) included in Env-Or 600. Refer to the table below for a summary of the contaminants of concern and the associated ICLs and AGQS for groundwater and leachate. Refer to the attached **Table 1** for a summary of all test methods including respective laboratory reporting detection limits (RDLs) and action limits being performed on groundwater and other media at the Site.

Contaminant of Concern	ROD ICLs (µg/L)	NH AGQS (µg/L)
Groundwater		
1,4 Dioxane	3	3
Benzene	5	5
Tetrachloroethene	5	5
Trichloroethene	5	5
Vinyl Chloride	2	2
Benzo(a)pyrene	0.2	0.2
benzo(b)fluoranthene	0.05	0.05
bis(2-Ethylhexyl)phthalate	6	-
Dibenzo(a,h)anthracene	0.01	0.005
Pentachlorophenol	1	1
1,2,4-Trimethylbenzene	50	330
1,3,5-Trimethylbenzene	50	330
2-Butanone	170	4,000
P-Isopropyltoluene	50	260
cis-1,2 Dichloroethene	70	70
n-Butylbenzene	50	260
n-Propylbenzene	50	260
Tetrahydrofuran	154	154
Toluene	1,000	1,000
Naphthalene	20	20
Arsenic	10	10

Contaminant of Concern	ROD ICLs (µg/L)	NH AGQS (µg/L)
Boron	620	620
Manganese	300	840
Leachate		
bis(2-Ethylhexyl)phthalate	40	N/A

Notes:
ROD ICLs = Interim Cleanup Levels found in the ROD
AGQS = New Hampshire Ambient Groundwater Quality Standards
(1) Boron will not be analyzed at the present time. Future sampling rounds will consider the analysis of Boron.
(2) Shading indicates reporting detection limit is above the interim cleanup standard. NHDES has acknowledged that the selected method(s) cannot achieve detection limits below the Interim Groundwater Cleanup Level.

Wetland soil analytical results will be compared to Soil Remediation Standards included in Env-Or 600 (see **Table 1**). Surface water and leachate data results will be compared to NHDES Surface Water Quality Regulations (Env-Wq 1700, see **Table 1**). Sediment laboratory analytical data will be compared with historical analytical data relative to long-term trends in sediment quality in addition to published, peer-reviewed screening level contaminant lists included in NHDES' Draft Evaluation of Sediment Quality Guidance Document, dated April 2005, that includes the NOAA 1999 – SQuiRT Tables (NOAA Hazmat Report 99-1). Note that comparison is for screening purposes only as there are no regulatory criteria, site-specific cleanup standards, or remediation goals established for this Site. The results of the screening analysis will be used as a tool to efficiently identify contaminants that may pose a threat to ecological receptors and focus further site activities on those contaminants should they be identified.

Trench water analytical results, if collected, will be compared with historical analytical data relative to long-term trends in trench water quality.

In accordance with the ROD, groundwater and leachate cleanup levels must be met at the completion of the remedial action. Data generated will be reviewed by EPA at least once every 5 years to ensure that results are indicative that the remedy selected for the Site continues to provide adequate protection of human health and the environment. The next five-year review is scheduled for completion in September 2015.

As identified in **Table 1**, some action limits cannot be obtained by the NHDES laboratory using the selected test methods. The data will be included and evaluated in the project reporting deliverables. The evaluation of the data will be qualitative relative to the historical trends of those particular analytes. In the future, as the concentrations of the contaminants-of-concern of various media appear to decline closer to the action limits established, consideration will be given to the need for use of alternative test methods that may be able to achieve lower detection limits where needed.

1.5 DATA QUALITY OBJECTIVES

Based on the preliminary information relating to types of contaminants, environmental media of concern, and potential exposure pathways previously identified, response action objectives (RAOs) were developed by EPA for the Site to mitigate, restore, and/or prevent existing and future potential threats to human health and the environment.[2] Relative to the scope of this SAP,

[2] Region 1 Record of Decision, Troy Mills Landfill Superfund Site, Troy, New Hampshire, dated September 2005.

the RAOs, among other things, included limiting migration of groundwater contaminants beyond the Groundwater Management Zone (GMZ) to downgradient areas, and over time, restoring all Site groundwater to safe drinking water levels.

MNA has been shown to be occurring naturally and is being established at the Site as the primary mechanism to achieve the management of migration RAO. The primary DQOs of MNA include collecting data of known and sufficient quality to accomplish the following:

- Confirm water quality in compliance wells;
- Collect sufficient data to be able to evaluate the effectiveness of MNA at the Site and ensure natural attenuation processes are continuing to degrade the contaminants-of-concern; and
- Collect sufficient data to assess contaminated groundwater impact to leachate seeps, Rockwood Brook surface water and sediment, and wetland soil.

Performance acceptance criteria for all new data generated for this project will be based on principal *Data Quality Indicators* including precision, bias, representativeness, completeness, comparability, and sensitivity. Consistent with the HWRB's QAPP, Section 1.4, for data generated by the NHDES Laboratory the method detection limits (MDLs) and the reporting detection limits (RDLs) established by the NHDES Laboratory have been accepted for use on this project. **Table 1** includes a summary of the test methods being performed by the NHDES laboratory and the associated RDLs. The MDLs have not been included in **Table 1** as all the RDLs are below the action limits established for the Site, with the exception of a few compounds. For those specific compounds identified, as the concentrations of Site contaminants approach the action limits, an evaluation of the need for alternative test methods that could achieve the necessary RDLs will be conducted.

The RDLs established by Absolute Resource Assoc., Inc. (ARA) and Microseeps, Inc (Microseeps) for select analysis described in **Section 3** below are summarized in **Table 1**. The MDLs and RDLs and the acceptance limits for accuracy and precision have been accepted for use on this project. As indicated above, there are a few compounds for which the MDL is above the action limit. For those specific compounds, as the concentrations of Site contaminants approach the action limits, an evaluation of the need for alternative test methods that could achieve the necessary RDLs will be conducted.

Comparability is the extent to which data from one data set can be compared directly to similar or related data sets and/or decision-making standards. Data comparability will be achieved by continuity of laboratory practices, method analysis, sample collection procedures and sample handling. Any deviations from the procedures contained within this SAP shall be approved by the NHDES in advance, following concurrence with EPA.

Completeness is considered to be the percentage of planned data collection that has to be complete in order to be considered sufficient for the intended use. The goal is to achieve a minimum of 90 percent (%) data completeness for analyzed samples.

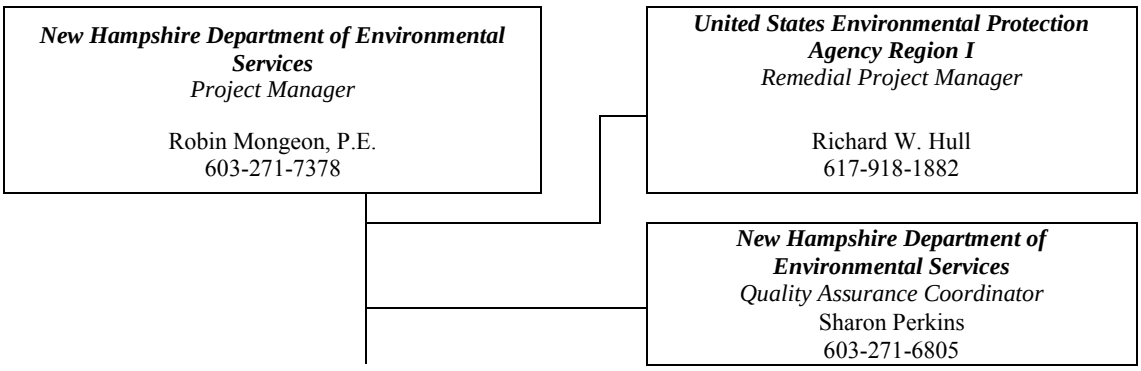
2.0 PROJECT ORGANIZATION AND RESPONSIBILITIES

NHDES and EPA have entered into a Cooperative Agreement to implement the requirements of the September 30, 2005 ROD. NHDES serves as the lead State regulatory agency providing direct oversight for the remedial action at the Site. GZA has been retained by NHDES to provide remedial consulting services for the project.

Within GZA, Mr. Steven R. Lamb will be responsible for the overall contract management and ensuring that established protocols and procedures are adhered to. Mr. Michael Asselin will be responsible for the management of day-to-day activities, staff scheduling, and assuring that the technical objectives are achieved. Ms. Amy Doherty will be the designated Quality Assurance Officer for the project. In this role, Ms. Doherty will oversee all quality assurance (QA) aspects of the project including development of the SAP and data validation reports to confirm that data quality documentation is appropriate and that QA goals have been met.

The following organizational chart illustrates the roles and responsibilities of those individuals involved in the project, and their different organizations.

Project Organizational Chart



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3.0 TASK DESCRIPTIONS - FIELD MONITORING AND SAMPLING PROTOCOL

The following subsections discuss general methodology for performing sampling and analysis as part of the overall field activities including specific sampling procedures and data management requirements that will be implemented during the monitoring program. Field activities will be conducted in accordance with this SAP, unless Site conditions require modifications. Any modifications shall be approved by NHDES in advance, following concurrence with EPA.

Note that specific field equipment required to complete a task, in addition to instrument calibration requirements, are included in GZA's appended standard operating procedures (SOPs) and are referenced as appropriate below.

This SAP discusses the planned semi-annual sampling approach so that the reader will have an understanding of the current semi-annual sampling strategy. Specific GZA SOPs are included in **Appendix B** and referenced herein by individual SOP numbers.

3.1 MULTI-MEDIA SAMPLING AND ANALYSIS

Multi-media sampling at the Site includes semi-annual sampling of groundwater, surface water, and leachate, and annual sampling of sediment and wetland soils (refer to **Table 2**). GZA anticipates that referencing NHDES' current HWRB Master QAPP (RFA #08036) will adequately address regulatory concerns regarding the integrity of laboratory test methods and procedures.

The tables and figure refer to the following sample types to be collected at the Site:

- Groundwater;
- Surface water;
- Sediment;
- Leachate; and
- Wetland Soils.

Figure 1 illustrates all sampling locations at the Site.

Table 2 refers to the selected locations to be sampled, their respective designations, well types, sampling frequency, parameters to be sampled, and the rationale for selecting groundwater wells.

Table 3 refers to specific analytical methods, sample volume, containers, and hold time requirements for the biannual sampling rounds.

Table 4 refers to monitoring well construction information, which includes well diameter, geologic unit the well is screened within, screen interval depth, etc. **Table 4** also provides the estimated depth of the bladder pump in the well. The available historical groundwater level data was reviewed and the bladder pumps were placed sufficiently below the lowest historic level (subject to well depth restrictions) with sufficient water above the pumps to work properly, such that moving the pump in the future will be unlikely.

Table 5 refers to the specific quality control (QC) sampling requirements for the monitoring rounds.

Table 6 is a cross-reference table for groundwater samples that identifies the monitoring well and the specific parameters being analyzed at that well for each round.

All multi-media laboratory samples will be analyzed by NHDES' laboratory with the exception of aqueous carbon dioxide, methane/ethane/ethene, and volatile fatty acids and soil/sediment semi-volatile organic compounds (SVOCs), total organic carbon (TOC), and grain size.

Laboratory analysis of carbon dioxide, methane/ethane/ethene and volatile fatty acids will be subcontracted by GZA to Microseeps. All samples going to Microseeps will be transported using a Microseeps chain-of-custody (COC) (refer to the SOP B-11). The GZA project manager will coordinate sample pick-up/delivery arrangements directly with Microseeps.

Soil/sediment samples for SVOC and TOC analysis will be sent to NHDES laboratory by GZA; however, NHDES will subcontract analysis to ARA. Samples going to NHDES's laboratory (both direct analysis by NHDES laboratory and those going to ARA) will be transported under a NHDES COC (refer to SOP B-11). The GZA project manager will coordinate sample pick-up/delivery arrangements with the NHDES project manager and laboratory.

Sediment samples for grain size analysis will be sent to GZA's in-house laboratory for analysis in accordance with SOP B-6.

The laboratory Turn-Around-Time (TAT) requested for all samples will be the standard business day TAT.

Calibration of the related field equipment will be performed in accordance with the SOP B-4. Decontamination of non-dedicated equipment (i.e., water level meters, bailers) will be completed in accordance with SOP B-10. Investigative Derived Waste generated from decontamination activities will be containerized and disposed of off-site, as appropriate. Purge water will be discharged to the ground surface.

3.1.1 Water Level / LNAPL Thickness Measurements and Well Depth Measurements

Prior to sampling, GZA will obtain a comprehensive round of groundwater level measurements from site monitoring wells included in **Table 2** to assess groundwater flow directions in accordance with SOP B-1. LNAPL thickness will be measured from site monitoring wells included in **Table 2,** any new well found to contain LNAPL, and the remedial trenches in accordance with SOP B-1. Refer to **Figure 1** for the well locations. Care must be taken to collect the measurement from the permanently marked position on the monitoring well PVC or casing, and use the correct measuring reference point at each well location as described in **Table 4**.

The depth to the bottom of the monitoring well should be confirmed in each well included in **Table 4** based on the following:

- If a bladder pump has been installed in a monitoring well, the depth to the bottom of the monitoring well will be confirmed at such time when the bladder pump is removed for repairs or maintenance activities, or if a significant increasing trend in the turbidly values has been observed; and

- In monitoring wells where there has been no bladder pump installed, the depth to the bottom of the monitoring well will be confirmed once every five years, during the sampling event just prior to the 5-year review.

3.1.2 Groundwater Sampling Procedures

Prior to the installation of any new bladder pump in a well, GZA will check for the presence of LNAPL. If LNAPL is detected, its thickness will be recorded, no bladder pump will be installed, and groundwater will not be sampled.

Dedicated stainless steel/Teflon pump assemblies have been previously installed in select wells and include the QED T1250 model for 2-inch diameter monitoring wells and the QED T1300 model for 1.5-inch diameter monitoring wells. Refer to **Table 4** for specific information regarding the pump models used at each well location, the pump length and diameter, and the bladder capacity for each type of pump. In addition select wells that currently have no dedicated pump will be purged and sampled using a non-dedicated QED Sample Pro Bladder pump. These monitoring wells will be purged and sampled using low flow methodology in accordance with SOP B-2. The rationale for sampling groundwater monitoring wells is included in **Table 2**.

If the sampling of groundwater using the bladder pump is precluded by a limited volume of water, following concurrence with NHDES and EPA, the well will be sampled using a stainless steel bottom dispensing bailer in accordance with SOP B-3, if possible.

Refer to **Section 4.2** below and **Table 5** for all required QC sampling including equipment blanks, duplicate samples, etc., with respect to groundwater sampling.

3.1.3 Surface Water and Sediment Sampling Procedures

Field sampling will include the collection of semiannual surface water samples at TRY_SW-1, TRY_SW-3 and TRY_SW-4, as illustrated on **Figure 1**. At one location (TRY_SW-3) a co-located sediment sample (TRY_SEDSW-3) will be collected annually in the fall. The rationale for sampling at TRY_SW-3/TRY_SEDSW-3 is to monitor possible impacts from groundwater migrating from the former drum disposal area to downstream sediment and surface water. The rationale for sampling at TRY_SW-1 is to characterize upstream surface water quality during the sampling event for comparison with downstream surface water quality. The rationale for sampling at TRY_SW-4 is to characterize surface water quality both at the confluence of Rockwood Brook's east and west branches and downgradient of the leachate sampling area. Refer to **Table 2** and **Table 3** for sampling locations and associated analyses.

Surface water and sediment sampling will occur in accordance with SOP B-5.

Refer to **Section 4.2** below and **Table 5** for all required QC sampling including equipment blanks, duplicate samples, etc., with respect to surface water and sediment sampling.

3.1.4 Leachate Sampling Procedures

Field sampling will include the semiannual collection of a leachate sample (TRY_SW-LEACHATE) from the discharge area of the culvert west of the site access road, as illustrated on **Figure 1**. In addition, should flow be observed on the east (uphill) side of the access road at the entrance of the culvert, a second leachate sample will be collected (TRY_SW-LEACH-A).

This area continues to be the only ongoing leachate seep observed since 2006. The rationale for the leachate sample(s) is to monitor for change in leachate composition. Should additional seeps be identified in the future, GZA will consult with NHDES and EPA as to whether or not they should be incorporated into the sampling program.

The leachate sample will be collected as a grab sample in accordance with the SOP B-7. Refer to **Section 4.2** below and **Table 5** for all required QC sampling including equipment blanks, duplicate samples, etc., with respect to leachate sampling.

3.1.5 Wetland Soil Sampling Procedures

Field sampling will include the collection of wetland soil samples at four locations annually in the fall as illustrated on **Figure 1**. The rationale for sampling at the four locations is to monitor possible impact from groundwater migrating from the former drum disposal area to the wetland. The four locations approximately correspond with previous wetland soil sampling locations by M&E in 2004 (designated TRY_WES-01 through TRY_WES-04).

Wetland soil samples will be collected at a depth of 0 to 6 inches beneath the leaf litter in accordance with the SOP B-8. Decontamination of soil sampling equipment will be performed in accordance with the SOP B-10. Refer to **Section 4.2** below and **Table 5** for all required QC sampling including equipment blanks, duplicate samples, etc., with respect to wetland soil sampling.

3.1.6 Determination of Product Recovery Rates

Periodically, the NHDES project manager may request a determination of the LNAPL recovery rates in groundwater monitoring wells and/or remedial trenches. To estimate this, GZA will remove the product to the extent possible and monitor LNAPL recharge in accordance with SOP B-9.

3.2 OTHER PLANNED ACTIVITIES

Specific information regarding Site activities separate from the routine monitoring rounds is summarized in separate work order(s). On-going Site activities since issuance of the 2009-2010 Data Report consist of the following:

- Replacement of kinked sample tubing in TRY_MW-201M and TRY_MW-104D;
- Repair of damaged protective casing/roadboxes at TRY_MW-105D, TRY_M-2 and TRY_MW-501;
- Repair of the damaged bladder pump and kinked tubing at TRY_M-7;

- Replacement of wells TRY_MW-301X, TRY_MW-501X, TRY_MW-508X, and TRY_MW-702SX;
- Installation of new monitoring wells proximate to well TRY_MW-205 (designated as TRY_MW-801, TRY_MW-802, TRY_MW-803, TRY_MW-804, and TRY_MW-805);
- Installation of LNAPL monitoring wells near the trench area (designated as TRY_MW-C1S, TRY_MW-C2S TRY_MW-C3S, TRY_MW-C4S, TRY_MW-C5S, TRY_MW-C6S, TRY_MW-C7S, and TRY_MW-C8S); and
- Re-sampling of TRY_MW-102 for SVOCs to further evaluate Bis(2-ethylhexyl) phthalate results at this location
- Investigation activities to further evaluate the extent LNAPL in the trench area.

GZA notes that these activities will be summarized in a report to NHDES and EPA to be submitted under separate cover.

4.0 QUALITY CONTROL

The following describes the QC steps used to demonstrate reliability and confidence in the monitoring data collected for this project and includes field equipment maintenance and calibration, field QC sample collection, and data verification and validation.

4.1 EQUIPMENT MAINTENANCE AND CALIBRATION

The following tables provide the preventive maintenance steps for the typical equipment anticipated for the types of monitoring and sampling activates addressed by this SAP to ensure proper functioning of field equipment and references the relevant SOPs for the project. Manufacturer's equipment manuals and any manufacturer-provided repair kits will be on-site at all times. Calibration procedures are included in the Appendix referenced below. In addition, all instruments requiring calibration will be calibrated in the GZA office before field activities commence to ensure all of the correct standards are available and that equipment is working properly.

Field Equipment - Preventive Maintenance

INSTRUMENT	ACTIVITY	FREQUENCY	SOP REFERENCE
Electronic Water Level Indicator	Battery Check	Daily	B-1/B-2/B-3
Geotech Oil-Water Interface Probe	Battery Check	Daily	B-1/B-9
QED Model MP-10 Controller	Battery Check	Daily	B-2
YSI 600 XL/XLM Multi-Parameter Water Quality Monitor	Calibration and Calibration Check – pre-sampling event	Once Prior to Sampling Event	B-2/B-4
	Battery check Inspect temperature element Calibration – beginning of day Calibration check – after morning calibration Calibration check – end of day	Daily	

INSTRUMENT	ACTIVITY	FREQUENCY	SOP REFERENCE
Hach 2100 P Turbidity Meter	Calibration and Calibration Check – pre-sampling event	Once Prior to Sampling Event	B-2/B-4
	Battery check Calibration – beginning of day Calibration check – after morning calibration Calibration check – end of day	Daily	

Note: In the case of field equipment failure, backup equipment will be delivered to the Site from GZA's Manchester, New Hampshire office. The YSI and Hach meters are suitable to use on this project as they can meet the calibration requirements included in Appendix B-4. Every reasonable effort shall be made to ensure the low-flow cells, sample tubing, and turbidity meters are shielded from the elements.

The following table provides performance requirements of applicable field equipment; required corrective actions should equipment fail; and references to relevant SOPs for the project.

Field Equipment - Calibration and Corrective Action

Instrument	Calibration Frequency/1	Calibration Standards	The Acceptance Criteria for the Daily Calibration Checks/2	Corrective Action	SOP Reference
YSI 600 XL / XLM					
1.) Dissolved Oxygen and temperature	Daily Calibration at the beginning of each day Calibration Check at the beginning of the day after calibration Calibration Check at the end of the day/1	Calibrate to 100% water saturated air and use 0 mg/L DO check	0 to 0.5 mg/L for the 0 mg/L DO	**Daily Calibration** – Recalibrate appropriate standards. If value(s) are still outside the acceptance criteria, replace with a different unit. **Morning Calibration Check** – If outside the criteria during the morning check, replace the appropriate calibration standards and recalibrate/check. If recalibration is unsuccessful, replace the unit. **End of the day Calibration Check** – If outside the criteria at the end of the day, the data will be qualified by GZA.	B-4
2.) Oxygen Reduction Potential		Zobel solution (calibration and check)	+/- 5%		B-4
3.) Specific Conductance		Calibrate to 1,413 µS/cm and use 718 µS/cm to check	+/- 5%		B-4
4.) pH		Calibrate to pH 4, 7, and 10 and use pH 7 to check	+/- 5%		B-4
Hach 2100 P Turbidity Meter		Calibrate to <0.1, 20, 100, and 800 NTUs and use 20 NTUs to check (use StablCal Formazin Primary Turbidity Standards)	+/- 5%		B-4

Note: /1 Each instrument requiring calibration by GZA must be calibrated in the office prior to field event to ensure proper The equipment can meet the QA criteria.
/2 The morning and end-of-the-day checks are a check of the instrument against the calibration standards and is in "measurement" mode. This is not recalibration but rather a check.

4.2 FIELD QUALITY CONTROL

The following provides a general description of the field QC sampling that will occur for the project. Refer to **Table 5** that includes a summary of QC samples to be collected.

Field Quality Control Requirements

QC Sample	Frequency	Acceptance Criteria	Corrective Action
Duplicate	1 duplicate per batch 20 samples; per matrix; per parameter	Duplicate concentrations are within +/- 30% for aqueous samples and 50% for solid samples	Flag in project report
VOC Trip Blank (separate trip blanks required for aqueous and solid VOCs and 1,4 Dioxane)	1 per cooler containing VOC samples	No contaminants are detected	Flag in project reports
Equipment Blank	• If dedicated equipment used, an initial equipment blank is required. No additional equipment blanks are required (refer to **Table 5**). • If non-dedicated equipment (other than the water level meter and oil water interface probe) is used, once per sampling event during equipment use duration; per equipment type (refer to **Table 5**). • Specific to the water level meter and oil / water interface probe – one equipment blank of the oil / water interface probe will be collected per sampling event. The blank will be collected after use in well TRY_MW-201S which contains LNAPL and is worst case (refer to **Table 5**).	No contaminants are detected	Flag in project reports

Notes:

- Duplicate samples are not intended to be blind duplicate samples. They will be designated with a "DUP" after the well designation (i.e., TRY_M-2 DUP).
- Trip blanks will be prepared by NHDES' laboratory and maintained at all times with the sample containers. The trip blank(s) will be designated "TRIP BLANK."
- Equipment blank samples will be designated as "EQUIP BLANK." Note that a comment is required on the COC indicating what the equipment blank is for (i.e., water level meter / oil water interface probe blank, a silastic tubing blank, a bladder pump blank). See **Table 5**.

4.3 DATA VERIFICATION AND VALIDATION

Data review, which includes a GZA in-house examination to ensure data have been recorded, transmitted, and processed correctly and data verification, which includes the evaluation of completeness, correctness, and conformance/compliance of a specific data set will be performed by GZA's Project Manager at the end of each sampling event.

Field water quality data collected/measured will be reviewed in the field by the GZA QA Officer daily for all matrices. Review will generally consist of the following: (1) review of calibration data and end of the day check; and (2) review of raw data and field notes for outliers or inconsistencies that may indicate a problem with the equipment or sampling procedure.

All laboratory data generated by the NHDES laboratory will be reviewed by NHDES personnel and will not require third party validation. NHDES laboratory will evaluate Field Quality Control samples for all samples analyzed by the NHDES laboratory and ARA, and will flag any data that does not meet the acceptance criteria under Field Quality Control Requirements listed in Section 4.2 above.

Analytical data reports generated by NHDES' laboratory report will consist of the following:

- Data Qualifier Description Page;
- Sample Summary Page: includes laboratory identifications (IDs), Corresponding Client Sample IDs, Matrix, Date/Time Collected and Date Received;
- Analytical Report Comments and Qualifiers Page; and
- Analytical Results Pages: Method Citation, results, units, RDL, prep date, analyzed date, CAS# Regulatory Limit if applicable, and Qualifier Code.

Analytical data reports generated by ARA for soil and sediment SVOCs and TOC data will consist of the following:

- Data Completeness;
- Preservation and Technical Holding Times;
- Blanks;
- Surrogate Compounds;
- Matrix Spike (MS)/Matrix Spike Duplicates (MSD);
- Field Duplicates;
- Laboratory Control Sample; and
- Compound Quantitation.

Analytical data reports generated by Microseeps for carbon dioxide, methane/ethane/ethene, and volatile fatty acids data will consist of the following:

- Data Qualifiers;
- Analytical Results Pages: Lab project number, Client project name, client project number, Matrix, Lab sample number, sampled date and time, received date, Method Number, results, units, Practical Quantitation Limits (PQLs), analysis date and personnel initials, and Qualifier Codes; and

- QC Pages: prep methods; analysis methods; and results, units, true spike concentrations, RDLs, % recovery, control limits, for method blanks, LCS, LCSD, MS and MSD samples.

Data validation requirements for the project will be evaluated at each 5-year review.

4.4 QUALITY ASSURANCE FIELD AUDITS

GZA QA field audits shall be conducted by the GZA QA Officer during monitoring events and will include observation of all sampling related activities including equipment calibration, multi-media sampling, QC sampling, and decontamination activities to ensure that all procedures and techniques are conducted in accordance with this SAP and the current HWRB QAPP.

Field audits will be performed during the sampling round as scheduled by NHDES and EPA. Additional, field audits will be conducted as necessary such as if the field team is changed or the SOPs for the project change significantly. If corrective action is needed, additional field audits will be conducted to ensure all procedures and techniques used at the Site are conducted in accordance with this SAP and the HWRB's QAPP.

The results of the GZA field audit which result in corrective actions will be reported to the NHDES project manager and the NHDES QA Coordinator verbally and noted in the field log book. Audit findings and corrective actions will be discussed with the NHDES project manager and the NHDES QA Coordinator to resolve the findings and corrective actions to the satisfaction of NHDES.

5.0 DOCUMENTATION

5.1 FIELD DATA MANAGEMENT

In accordance with HWRB's Master QAPP, field personnel shall use field logbooks and/or pre-printed field worksheets to accurately document all field activities: on-site conditions; field measurements; sample collection information; field instrument and calibration information; and other pertinent site-related information during monitoring activities. All information shall be recorded in permanent black ink.

A permanently bound field logbook (per person) with individually numbered pages is maintained for field sampling information not recorded on field forms (calibration sheets, low flow purge forms, COCs, etc.). All entries into the field logbook are made with permanent black ink, and corrections are made using a single line through the error with the initials and date of the individual who made the correction. The unused bottom portion of each page shall be lined-out, initialed, and dated. The field notes in general shall include a description of field conditions that includes, as a minimum:

- Site location
- Date, start, and finish times of the work and weather conditions;
- Name and initials of person making entry;
- Names of other personnel present, if any;

- Names of visitors, if any;
- Purpose and summary of proposed work effort;
- Details of any deviation from the field operations plan or standard operating procedures, including who authorized the deviation;
- Field observations;
- Location, description and unique identifier for all photographs taken in association with the field activity; and
- Any other pertinent information.

Field forms to be completed in the field include the daily calibration forms, low flow purge forms, ferrous iron and nitrate field screening forms, and the surface water/sediment quality field form. Refer to the appropriate SOPs for a copy of the individual field forms and the specific information required for each form.

GZA's Project Manager will be responsible for ensuring that the field files are entered into the project record. Information recorded in other Site documents other than the field logbooks (e.g., sampling logs, calibration sheets, COCs) will not be repeated in logbooks except in summary form, as necessary.

5.2 CHAIN-OF-CUSTODY PROCEDURES

Samples shall remain in the sample collector's view at all times, unless locked in a vehicle or other secure place in accordance with SOP B-11. It is the sampler's responsibility to ensure that the samples are not tampered with prior to their delivery to the analytical lab. The GZA QA Officer will review the COCs at the end of each day to ensure all data has been entered properly. The COC form shall be completed to provide documentation tracing sample possession and handling from the time of collection through delivery to the analytical lab, and shall accompany the samples at all times. The COC is a legal document that may be used for litigation purposes.

5.3 TECHNICAL PROJECT REPORTS

The NHDES laboratory, ARA, and Microseeps will provide the analytical data reports along with a copy of the pertinent QC data. All field logs, field forms, etc., will be provided by GZA's Project Manager. GZA will prepare project technical reports at least annually (unless directed otherwise by NHDES) that document the findings of Site sampling work. The specific scope of the reports will be determined by NHDES; however, typically these reports will include the following:

- Summary of sampling activities;
- Copies of all field sampling sheets/forms and appropriate field logbook pages;
- A list of equipment used, including make and models (and serial number if available);
- All calibration information including calibration standards used lots numbers, expiration dates, calibration checks etc.;
- A copy of the laboratory report and applicable data validation reports;

- Data summary tables of the compounds detected at each sampling location, highlighting any compounds that exceed cleanup goals;
- Data summary tables showing the history of the compounds detected at each sampling location, highlighting any compounds that exceed cleanup goals with graphs of the same;
- A table of the groundwater levels and elevations at each well, including past data;
- Site map;
- Groundwater Potentiometric Surface Map;
- Isoconcentration Contour Maps for Site COCs;
- Recommendations for any further remedial action;
- QA/QC information (refer to **Section 5.3.1** below)
- Recommendations for future modifications to the current monitoring program or to the SAP, if appropriate.

5.3.1 Quality Assurance/Quality Control Section of Report

Each technical report should include general statements summarizing whether or not the quality control criteria in this SAP and HWRB's QAPP were met in the field and in the laboratory. The report will include a discussion of any QA/QC problems and how they were resolved. GZA will note anything unusual that is anticipated to affect the quality or usability of the data.

Examples for situations where the QA criteria were not met which would be included within a technical report:

- How does that affect the usability of the data?
- Can we use the data? If not, why not?
- Was any corrective action needed and what, if any, measures were taken?
- What changes are recommended for the future?

Examples of possible issues to be included within a technical report:

- Were contaminants found in the equipment blanks?
- Were any samples broken in transport to the lab?
- Did the lab report any difficulties, issues?
- Were the sample tags mixed up in the field if the results look abnormal?

TABLES

TABLE 1 - SUMMARY OF ANALYTICAL TEST METHODS AND LABORATORY REPORTING LIMITS / DETECTION LIMITS AND REGULATORY ACTION LIMITS

Troy Mills Landfill Superfund Site

Troy, New Hampshire

Test Methods / Analytes	GROUNDWATER Laboratory Reporting Detection Limits (RDLs)	Ambient Groundwater Quality Standards (AGQS)	ROD Interim Groundwater Cleanup Levels
VOCs by EPA Method 8260B (ug/L)			
Vinyl Chloride	2	2	2
cis-1,2-Dichloroethene	2	100	70
2-Butanone(MEK)	10	4,000	170
Tetrahydrofuran(THF)	10	154	154
benzene	2	5	5
Trichloroethene	2	5	5
Toluene	2	1,000	1000
Tetrachloroethene	2	5	5
n-Propylbenzene	2	260	50
1,3,5-Trimethylbenzene	2	330	50
1,2,4-Trimethylbenzene	2	330	50
p-Isopropyltoluene	2	260	50
n-Butylbenzene	2	260	50
Naphthalene	2	20	20
1,4 Dioxane by EPA Method 522 (ug/L)	0.2	3	3
SVOCs by EPA Method 8270C (ug/L)			
Naphthalene	10	20	20
Pentachlorophenol	20	1	1
Bis-(2-ethylhexyl)phthalate	5	---	6
Benzo(b)fluoranthene	10	0.05	0.05
Benzo(a)pyrene	10	0.20	0.2
Dibenzo(a,h)anthracene	10	0.01	0.01
Metals by EPA Method 200.7/200.8 (mg/L)			
Lead	0.0010	0.015	---
Silver	0.0050	0.1	---
Arsenic	0.0010	0.01	0.01
Barium	0.0050	2	---
Cadmium	0.0020	0.005	---
Chromium	0.0050	0.1	---
Selenium	0.0050	0.05	---
Mercury (245.1)	0.0005	0.002	---
Iron	0.050	---	---
Manganese	0.010	0.84	0.3
Alkalinity by EPA SM 2320B (mg/L)	1.0	---	---
Nitrate LACHAT 10-107-04-1-C (mg/L)	0.05	10	0.05
Nitrite LACHAT 10-107-04-1-C (mg/L)	0.05	1	0.05
Nitrate & Nitrite LACHAT 10-107-04-1-C (mg/L)	0.05	---	0.05
Total Organic Carbon by EPA 415.3 (mg/L)	0.5	---	0.5
Chloride by Lachat 10-117-07-1-B (mg/L)	3.0	---	---
Sulfate by Lachat 10-511-00-1-A (mg/L)	1.0	500	---
Carbon Dioxide Microseeps SOP-AM20GAx (mg/L)	5	---	---
Methane by Microseeps SOP-AM20GAx (mg/L)	0.1	---	---
Ethane by Microseeps SOP-AM20GAx (mg/L)	0.025	---	---
Ethene by Microseeps SOP-AM20GAx (mg/L)	0.025	---	---
Volatile Fatty Acids by AM21G (mg/L)			
Acetic Acid	1	---	---
Propionic Acid	1	---	---
Butyric Acid	1	---	---
Pyruvic Acid	10	---	---
Lactic Acid	25	---	---

Notes:

1. RDL information for Carbon Dioxide, methane, ethane, ethene and Volatile Fatty Acids was provided by Microseeps, Inc. All other RDL information was provided by NHDES laboratory.
2. Microseeps AM20GAx SOP is based on RSKSOP-175, which uses Henry's Law and satisfies EPA requirements.
3. "---" indicates no standard was available for the analyte.
4. Blue Shaded cells indicate those parameters for which the laboratory can't achieve the action limit for an analyte.

TABLE 1 - SUMMARY OF ANALYTICAL TEST METHODS AND LABORATORY REPORTING LIMITS / DETECTION LIMITS AND REGULATORY ACTION LIMITS

Troy Mills Landfill Superfund Site
Troy, New Hampshire

Test Methods / Analytes	LEACHATE Laboratory Reporting Detection Limits (RDLs)	Ambient Groundwater Quality Standards (AGQS)	Surface Water Quality Criteria (Env-Wq 1700)	ROD Interim Leachate Cleanup Levels
VOCs by EPA Method 8260B (uGu/L)				
Vinyl Chloride	2	2	---	---
cis-1,2-Dichloroethene	2	100	11600*	---
2-Butanone(MEK)	10	4,000	---	---
Tetrahydrofuran(THF)	10	154	---	---
benzene	2	5	5300	---
Trichloroethene	2	5	21900	---
Toluene	2	1,000	---	---
Tetrachloroethene	2	5	890	---
n-Propylbenzene	2	260	---	---
1,3,5-Trimethylbenzene	2	330	---	---
1,2,4-Trimethylbenzene	2	330	---	---
p-Isopropyltoluene	2	260	---	---
n-Butylbenzene	2	260	---	---
Naphthalene	2	20	620	---
SVOCs by EPA Method 8270C (ug/L)				
Naphthalene	10	20	620	---
Pentachlorophenol	20	1	4.05	---
Bis-(2-ethylhexyl)phthalate	5	---	3	40
Benzo(b)fluoranthene	10	0.05	---	---
Benzo(a)pyrene	10	0.20	---	---
Dibenzo(a,h)anthracene	10	0.01	---	---
Metals by EPA Method 200.7/200.8 (mg/L)				
Manganese	0.010	0.84	---	---
Hardness	3.0	---	---	---

Notes:

1. All other RDL information was provided by NHDES laboratory.
2. Surface Water Quality Criteria (SWQC) standards assume the Protection of Aquatic Life in Freshwaters with chronic criteria. If a chronic criteria standard has not been established, GZA used the Freshwater Acute Criteria.
3. "---" indicates no standard was available for the analyte.
4. Blue Shaded cells indicate those parameters for which the laboratory can't achieve the action limit for an analyte.
5. " * " indicates that the compound shown has two or more isomers. The sum of the concentrations of each isomer shall meet the SWQC.

TABLE 1 - SUMMARY OF ANALYTICAL TEST METHODS AND LABORATORY REPORTING LIMITS / DETECTION LIMITS AND REGULATORY ACTION LIMITS

Troy Mills Landfill Superfund Site
Troy, New Hampshire

Test Methods / Analytes	Surface Water Laboratory Reporting Detection Limits (RDLs)	Surface Water Quality Criteria (Env-Wq 1700)
VOCs by EPA Method 8260B (ug/L)		
Vinyl Chloride	2	---
cis-1,2-Dichloroethene	2	11600*
2-Butanone(MEK)	10	---
Tetrahydrofuran(THF)	10	---
benzene	2	5300
Trichloroethene	2	21900
Toluene	2	---
Tetrachloroethene	2	890
n-Propylbenzene	2	---
1,3,5-Trimethylbenzene	2	---
1,2,4-Trimethylbenzene	2	---
p-Isopropyltoluene	2	---
n-Butylbenzene	2	---
Naphthalene	2	620
SVOCs by EPA Method 8270C (ug/L)		
Naphthalene	10	620
Pentachlorophenol	20	4.05
Bis-(2-ethylhexyl)phthalate	5	3
Benzo(b)fluoranthene	10	---
Benzo(a)pyrene	10	---
Dibenzo(a,h)anthracene	10	---
Metals by EPA Method 200.7 (mg/L)		
Manganese	0.010	---
Hardness	3.0	

Notes:

1. There are no ROD Interim Cleanup Goals established for surface water.
2. Surface Water Quality Criteria (SWQC) standards assume the Protection of Aquatic Life in Freshwaters with chronic criteria. If a chronic criteria standard has not been established, GZA used the Freshwater Acute Criteria.
3. " * " indicates that the compound shown has two or more isomers. The sum of the concentrations of each isomer shall meet the SWQC.
4. RDL information was provided by NHDES laboratory.
5. "---" indicates no standard was available for the analyte.
6. Blue Shaded cells indicate those parameters for which the laboratory can't achieve the action limit for an analyte.

TABLE 1 - SUMMARY OF ANALYTICAL TEST METHODS AND LABORATORY REPORTING LIMITS / DETECTION LIMITS AND REGULATORY ACTION LIMITS

Troy Mills Landfill Superfund Site

Troy, New Hampshire

Test Methods / Analytes	WETLAND SOIL Laboratory Reporting Detection Limits (RDLs)	Soil Remediation Standards Env- Or 600 (Dry Weight)
SVOCs by EPA Method 8270C (ug/kg wet)		
Naphthalene	50	5,000
Pentachlorophenol	1000	3,000
Bis(2-ethylhexyl)phthalate	500	---
Benzo(b)fluoranthene	50	700
Benzo(a)pyrene	50	700
Dibenzo(a,h)anthracene	50	700
Metals by EPA Method 200.7/200.8 (mg/kg wet)		
Lead	0.25	400
Silver	2.5	89
Arsenic	0.25	11
Barium	1.25	1,000
Cadmium	2.5	33
Chromium	1.25	1,000
Selenium	1.25	180
Mercury (245.1)	0.04	6
Iron	12.5	---
Manganese	2.5	5,200
Total Organic Carbon by Method SW846 9060 (mg/kg)	500	---

Notes:

1. There are no ROD Interim Cleanup Goals established for wetland soil.
2. "---" indicates no information available for that compound.
3. RDL Information for Semivolatile Organic Compounds (SVOCs) and Total Organic Carbon (TOC) was provided by Absolute Resource Assoc.,Inc (ARA), Metals RDL information was provided by NHDES laboratory. ARA Subs out TOCs to ALS Laboratory Group, 34 Dogwood Lane, Middletown, PA
4. Laboratory reporting in dry weight for all wetland soil data results.

TABLE 1 - SUMMARY OF ANALYTICAL TEST METHODS AND LABORATORY REPORTING LIMITS / DETECTION LIMITS AND REGULATORY ACTION LIMITS

Troy Mills Landfill Superfund Site

Troy, New Hampshire

Test Methods / Analytes	SEDIMENT Laboratory Reporting Detection Limits (RDLs)	SQuiRT TEC[/5] (Dry Weight)
VOCs by EPA Method 8260B (ug/kg wet)		
Vinyl Chloride	100	*n/a*
cis-1,2-Dichloroethene	100	*n/a*
2-Butanone(MEK)	500	*n/a*
Tetrahydrofuran(THF)	500	*n/a*
benzene	100	*n/a*
Trichloroethene	100	*n/a*
Toluene	100	*n/a*
Tetrachloroethene	100	*n/a*
n-Propylbenzene	100	*n/a*
1,3,5-Trimethylbenzene	100	*n/a*
1,2,4-Trimethylbenzene	100	*n/a*
p-Isopropyltoluene	100	*n/a*
n-Butylbenzene	100	*n/a*
Naphthalene	100	176
SVOCs by EPA Method 8270C (ug/kg)		
Naphthalene	50	176
Pentachlorophenol	1000	*n/a*
Bis(2-ethylhexyl)phthalate	500	*n/a*
Benzo(b)fluoranthene	50	*n/a*
Benzo(a)pyrene	50	150
Dibenzo(a,h)anthracene	50	33
Metals by EPA Method 200.7/200.8 (mg/kg wet)		
Lead	0.25	35.8
Silver	2.5	*n/a*
Arsenic	0.25	9.79
Barium	1.25	*n/a*
Cadmium	2.5	0.99
Chromium	1.25	43.4
Selenium	1.25	*n/a*
Mercury (245.1)	0.04	0.180
Iron	12.5	*n/a*
Manganese	2.5	*n/a*
Total Organic Carbon by Method SW846 9060 (mg/kg)	500	*n/a*

Notes:

1. There are no ROD Interim Cleanup Goals established for sediment.
2. "---" indicates no information available for that compound.
3. RDL Information for Semivolatile Organic Compounds (SVOCs) and Total Organic Carbon (TOC) was provided by Absolute Resource Assoc.,Inc (ARA), Metals RDL information was provided by NHDES laboratory. ARA subs out the TOC analysis to ALS Laboratory Group, 34 Dogwood Lane, Middletown, PA
4. Laboratory reporting in dry weight for all sediment data results.
5. Buchman, M.F., 2008. NOAA Screening Quick Reference Tables, NOAA OR&R Report 08-1, Seattle WA, Office of Response and Restoration Division, National Oceanic and Atmospheric Administration. "TEC" is Threshold Effect Concentration, which is consensus-based and incorporates the Ontario Ministry of the Environment lowest-observed effect levels (LELs) (Persaud et al 1993) as well as data from up to five other sediment quality guidelines (when available), including:
   - threshold effects levels (TELs) (Smith et al. 1996),
   - effects range-low (ER-L) values (Long and Morgan 1991),
   - threshold effect levels for Hyalella azteca in 28 day tests (TEL-HA28) (U.S.EPA 1996a; Ingersoll et al. 1996),
   - minimal effect thresholds (MET) from EC and MENVIQ (1992), and
   - chronic equilibrium partitioning thresholds (SQAL) (Bolton et al. 1985; Zarba 1992; U.S.EPA 1997a).
6. Blue Shaded cells indicate those parameters for which the laboratory can't achieve the action limit for an analyte.

TABLE 2 - MULTI-MEDIA SAMPLING PLAN
Spring 2011 Sampling Round
Troy Mills Landfill Superfund Site
Troy, New Hampshire

SAMPLE LOCATION AND DESIGNATION	MEDIA TYPE	WELL TYPE	SAMPLE METHOD	SAMPLING FREQUENCY	PARAMETERS	SAMPLING RATIONALE
Wells With Water Level Measurements Only						
TRY_P-1	Groundwater	unknown	n/a	Semiannual	Wells currently being monitored for Water Level Only	Groundwater Flow Directions
TRY_M-3		Overburden				No impacts detected for VOCs and SVOCs in October 2005, June 2006, December 2006, and June 2008 samples.
TRY_M-5		unknown				Groundwater Flow Directions
TRY_M-6		unknown				
TRY_M-7D		Deep Bedrock				No detections in June 2008.
TRY_MW-108		Deep Bedrock				Near northern compliance boundary. Characterization of deep bedrock aquifer flow
TRY_MW-201D		Overburden				Groundwater Flow Directions
TRY_MW-202S		Overburden				
TRY_MW-202D		unknown				
TRY_MW-502		Overburden				
TRY_MW-504		unknown				
TRY_MW-505		Overburden				Sidegradient of former drum disposal area, and near southern compliance boundary. In December 2006 sample, no VOCs or SVOCs detected, and no detected metals concentrations exceeded standards.
TRY_MW-506		unknown				Groundwater Flow Directions
TRY_MW-507		Overburden				
TRY_MW-603		Bedrock				Shallow bedrock and upgradient of former drum disposal area.
Wells With Product Thickness Measurements Only						
TRY_MW-C1S	Groundwater	Overburden	n/a	Semiannual	No analytical samples collected. Product thickness measurements only	Monitor LNAPL thickness
TRY_MW-C2S		Overburden				
TRY_MW-C3S		Overburden				
TRY_MW-C4S		Overburden				
TRY_MW-C5S		Overburden				
TRY_MW-C6S		Overburden				
TRY_MW-C7S		Overburden				
TRY_MW-C8S		Overburden				
TRY_MW-201S		Overburden				

TABLE 2 - MULTI-MEDIA SAMPLING PLAN
Spring 2011 Sampling Round
Troy Mills Landfill Superfund Site
Troy, New Hampshire

SAMPLE LOCATION AND DESIGNATION	MEDIA TYPE	WELL TYPE	SAMPLE METHOD	SAMPLING FREQUENCY	PARAMETERS	SAMPLING RATIONALE
Wells Currently Sampled That Have Screen Lengths Greater than 10 feet						
TRY_M-1	Groundwater	Overburden	Bladder Pump	Semiannual	**I. Water level measurements** are collected at each well being sampled **II. Semiannual Laboratory Analyses**: VOCs; SVOCs; Manganese; and Lab MNA (Nitrate/Nitrite, Alkalinity, Chloride, Sulfate, TOC, Carbon Dioxide, & Methane/Ethane/Ethene) ***Exceptions*** : 1.) ***no lab MNA*** at TRY_MW-105S, TRY_MW-105D, TRY_MW-702S, and TRY_MW-702D 2.) ***modified lab MNA*** at TRY_MW-104S and TRY_MW-104D - only Alkalinity, Chloride, and Sulfate at these two locations **III. Semiannual Field Measurements for wells being sampled via bladder pump**: Dissolved Oxygen, temperature, Oxygen Reduction Potential, specific conductance, pH, and turbidity **IV. Fall Round Prior to 5-Year Review:** all wells additionally sampled for VFA and Arsenic. 1,4 Dioxane will also be sampled at wells TRY_M-7, TRY_MW-201M, TRY_MW-105S, TRY_MW-105D, TRY_MW-702SX, and TRY_MW-702D (plus any additional wells where 1,4-Dioxane was detected, from Section V below) **Exceptions:** ***No VFA*** at TRY_MW-105S, TRY_MW-105D, TRY_MW-702SX, TRY_MW-702D, TRY_MW-104S, and TRY_MW-104D **V. For Any New Well Being Sampled for the first time:** Additional parameters to be sampled for include RCRA 8 and Fe (in addition to Mn) and 1,4 Dioxane. After the initial round, metals analysis will consist of Mn only and 1,4 Dioxane will only be analyzed in the fall, prior to the 5-year review if 1,4 Dioxane is detected	Monitoring contaminants migrating from the Lower Drum Area
TRY_M-2		Overburden				Downgradient of former drum removal area, and within area of groundwater impact. Monitor groundwater quality changes and natural attenuation. VOCs dropped from analyte list as this well has been free of VOCs.
TRY_MW-101		Predominantly Overburden				In former drum disposal area. Monitor groundwater quality changes and natural attenuation.
TRY_MW-102		Predominantly Overburden				Sidegradient of former drum disposal area. Low level concentrations detected below standards for one VOC and one SVOC in October 2005 and December 2006 samples.
TRY_MW-104S		Overburden				Downgradient of former drum disposal area and within wetland. Low level detects below standards for five VOCs and no SVOCs in October 2005 and December 2006 samples. Manganese was the only metal exceeding standard in same samples.
TRY_MW-104D		Overburden				Same location and aquifer as MW104S. No impacts above detection limits for VOCs and SVOCs in October 2005 and December 2006. Will sample 1-4 Dioxane only during the fall round prior to the 5-year review.
TRY_MW-105S		Overburden				Groundwater Management Zone sentinel monitoring well
TRY_MW-105D		Deep Bedrock				Groundwater Management Zone sentinel monitoring well
TRY_MW-201P		Overburden				Monitoring contaminants migrating from the Lower Drum Area
TRY_MW-202P		Overburden				Monitoring contaminants migrating from the Lower Drum Area
TRY_MW-601S		Overburden				Former drum disposal area. Monitor groundwater quality changes and natural attenuation.
TRY_MW-602S		Overburden				Former drum disposal area. Monitor groundwater quality changes and natural attenuation.
TRY_MW-701		Deep Bedrock				Near eastern compliance boundary and bedrock background.
TRY_MW-702D		Deep Bedrock				Groundwater Management Zone sentinel monitoring well
Wells Currently Sampled With Screen Lengths Equal to or Less than 10 feet						
TRY_M-7	Groundwater	Overburden	Bladder Pump	Semiannual		Near northwestern compliance boundary. Low level chlorinated SVOCs, VOCs, and 1,4-dioxane have been detected in samples from this well since December 2004.
TRY_MW-201M		Overburden				Downgradient of former drum removal area, and within area of groundwater impact. Monitor groundwater quality changes and natural attenuation.
TRY_MW-204		Overburden				Former drum disposal area. Monitor groundwater quality changes and natural attenuation.
TRY_MW-205		Overburden				Solid waste area, and area of groundwater impact adjacent to former drum disposal area. Monitor groundwater quality changes and natural attenuation.

TABLE 2 - MULTI-MEDIA SAMPLING PLAN
Spring 2011 Sampling Round
Troy Mills Landfill Superfund Site
Troy, New Hampshire

SAMPLE LOCATION AND DESIGNATION	MEDIA TYPE	WELL TYPE	SAMPLE METHOD	SAMPLING FREQUENCY	PARAMETERS	SAMPLING RATIONALE
TRY_MW-301X	Groundwater	Overburden	Bladder Pump	Semiannual	**I. Water level measurements** are collected at each well being sampled **II. Semiannual Laboratory Analyses**: VOCs; SVOCs; Manganese; and Lab MNA (Nitrate/Nitrite, Alkalinity, Chloride, Sulfate, TOC, Carbon Dioxide, & Methane/Ethane/Ethene) ***Exceptions*** : 1.) ***no lab MNA*** at TRY_MW-105S, TRY_MW-105D, TRY_MW-702S, and TRY_MW-702D 2.) ***modified lab MNA*** at TRY_MW-104S and TRY_MW-104D - only Alkalinity, Chloride, and Sulfate at these two locations **III. Semiannual Field Measurements for wells being sampled via bladder pump**: Dissolved Oxygen, temperature, Oxygen Reduction Potential, specific conductance, pH, and turbidity **IV. Fall Round Prior to 5-Year Review:** all wells additionally sampled for VFA and Arsenic. 1,4 Dioxane will also be sampled at wells TRY_M-7, TRY_MW-201M, TRY_MW-105S, TRY_MW-105D, TRY_MW-702S, and TRY_MW-702D **Exceptions:** 1.) ***no VFA*** at TRY_MW-105S, TRY_MW-105D, TRY_MW-702S, TRY_MW-702D, TRY_MW-104S, and TRY_MW-104D **V. For Any New Well Being Sampled for the first time:** Additional parameters to be sampled for include RCRA 8 and Fe (in addition to Mn) and 1,4 Dioxane. After the initial round, metals analysis will consist of Mn only and 1,4 Dioxane will only be analyzed in the fall, prior to the 5-year review if 1,4 Dioxane is detected	Solid waste area, and near/sidegradient of drum disposal area. Low level detects below standards for six VOCs in October 2005 and December 2006. Bis (2-ethyl hexyl)phthalate detected (12 ug/L) above standards (6 ug/L) in December 2006. Arsenic, lead, and manganese exceeded standards in December 2006 sample. Monitor groundwater quality changes and natural attenuation.
TRY_MW-501X		Overburden				Downgradient of former drum removal area, and within area of groundwater impact. Monitor groundwater quality and natural attenuation.
TRY_MW-508X		Overburden				Background monitoring well.
TRY_MW-601D*		Overburden				Former drum disposal area. Monitor groundwater quality changes and natural attenuation.
TRY_MW-602B		Bedrock				Former drum disposal area. Monitor groundwater quality changes and natural attenuation.
TRY_MW-702SX		Overburden				Groundwater Management Zone sentinel monitoring well
TRY_MW-801		Overburden				Investigation around TRY_MW-205 due to the observed high level of methane, trimethylbenzenes, and bis(2-ethylhexyl phthalate)
TRY_MW-802		Overburden				Investigation around TRY_MW-205 due to the observed high level of methane, trimethylbenzenes, and bis(2-ethylhexyl phthalate)
TRY_MW-803		Overburden				Investigation around TRY_MW-205 due to the observed high level of methane, trimethylbenzenes, and bis(2-ethylhexyl phthalate)
TRY_MW-804		Overburden				Investigation around TRY_MW-205 due to the observed high level of methane, trimethylbenzenes, and bis(2-ethylhexyl phthalate)
TRY_MW-805		Overburden				Investigation around TRY_MW-205 due to the observed high level of methane, trimethylbenzenes, and bis(2-ethylhexyl phthalate)

TABLE 2 - MULTI-MEDIA SAMPLING PLAN
Spring 2011 Sampling Round
Troy Mills Landfill Superfund Site
Troy, New Hampshire

SAMPLE LOCATION AND DESIGNATION	MEDIA TYPE	WELL TYPE	SAMPLE METHOD	SAMPLING FREQUENCY	PARAMETERS	SAMPLING RATIONALE
TRY_SW-LEACHATE	Leachate	n/a	Sample Container	Semiannual	VOCs, SVOCs, Mn, hardness	See the Sampling and Analysis Plan for rationale
TRY_SW-LEACH-A						
TRY_SW-1	Surface Water	n/a	Sample Container	Semiannual	VOCs, SVOCs, Mn, hardness.	
TRY_SW-3						
TRY_SW-4						
TRY_TRENCH-A	Trench Water	n/a	n/a	Semiannual	No analytical samples collected. LNAPL thickness measurements only	
TRY_TRENCH-C						
TRY_TRENCH-B						
TRY_SEDSW-3	Sediment	n/a	Ponar Dredge	Fall round only	VOCs, SVOCs/%solid, 10 Metals, TOC, & Grain Size	
TRY_WES-01	Wetland Soil	n/a	Hand Auger	Fall round only	SVOCs, 10 Metals, & TOC	
TRY_WES-02						
TRY_WES-03						
TRY_WES-04						

Notes:

1. "VOCs" consist of the New Hampshire Department of Environmental Services (NHDES) full list of volatile organic compounds analyzed by EPA Method 8260B.
2. "1,4 Dioxane" is analyzed by EPA Method 522.
3. "SVOCs" consist of semi-volatile organic compounds analyzed by EPA Method 8270C, including acid- and base/neutral-extractables.
4. "10 metals" consist of Arsenic, Barium, Cadmium, Chromium, Lead, Selenium & Silver, Manganese, and Iron by EPA Method 200.7 / 200.8 and Mercury by Cold Vapor Method 245.1
5. "MNA - Lab" parameters consists of Nitrate/Nitrite, CO2, alkalinity, chloride, methane/ethane/ethene, sulfate and total organic carbon.
6. "MNA - Field" parameters consist of dissolved oxygen, temperature, Oxygen Reduction Potential (ORP), specific conductance, pH, and turbidity.
7. "VFA" parameters consist of Volatile Fatty Acids and is only sampled once in the fall round just prior to the 5-year review.
8. Semiannually - typically May and October of each year.
9. Refer to **Table 6** - Groundwater Sampling Cross-Reference Table for a summary of individual parameters being sampled for at each well location.
10. The replacement wells (TRY_MW-301X, TRY_MW-501X, TRY_MW-508X and TRY_MW-702SX) are considered new wells.
11. "*" These wells have at least 2 consecutive rounds of having insufficient recharge. Do not attempt to do low flow again, use the Insufficient Recharge Procedure in the Low Flow SOP instead..

TABLE 3 –MEDIA, ANALYSIS, TEST METHODS, CONTAINERS/ SAMPLE VOLUME, PRESERVATION, AND HOLD TIME

Spring 2011 Sampling Round

Troy Mills Landfill Superfund Site, Troy New Hampshire

PARAMETER	MATRIX	NUMBER OF SAMPLES (including field QC[1 and 2])	ANALYTICAL METHOD	SAP SOP[3]	CONTAINERS (size and type)	PRESERVATION REQUIREMENTS[4]	MAXIMUM HOLDING TIME
GROUNDWATER							
VOCs	Groundwater	29 field samples; 2 duplicates; 4 equipment blanks; trip blanks	8260B	B-2/3	3- 40mL VOA[1]	HCl, 4°C +/-2°C	14 days
1,4 Dioxane		13 field samples; 1 duplicate; 3 equipment blanks; trip blanks; 1 MS/MSD	522	B-2/3	1 - 1L Amber	$NaHSO_4$, 4 °C +/-2°C	28 days to extract, 28 days to analyze
		1,4-Dioxane Note: For every 10 samples, the lab requires two 1-liter amber sample bottles be collected for QA. For any sampling event where 1,4-Dioxane is sampled at all locations, the lab requires a minimum of TWO sets of two 1-liter amber bottles.					
SVOCs		29 field samples; 3 duplicates; 4 equipment blanks; 1 MS/MSD	8270C	B-2/3	2 - 1L Amber	4°C +/-2°C	7 days to extract, 40 days to analyze
		SVOC Note: For every 10 samples, the lab requires four 1-liter SVOC sample bottles be collected for QA. For the entire sampling event, the lab requires a minimum of TWO sets of four 1-liter amber bottles. One set is required to be from groundwater; the remaining sets can be from another aqueous media.					
Total Mn		16 field samples; 1 duplicate; 2 equipment blank	200.7	B-2/3	1- 500mL plastic	HNO_3, 4°C +/-2°C	6 months
10 Metals (RCRA 8, Fe, & Mn)		13 field samples; 1 duplicate; 2 equipment blank	200.7/200.8	B-2/3	1- 500mL plastic	HNO_3, 4°C +/-2°C	6 months
Alkalinity		25 field samples; 2 duplicates	SM 2320B	B-2/3	1 – 500mL plastic	4°C +/-2°C	14 days
Chloride		25 field samples; 2 duplicates	Lachat 10-117-07-1-B	B-2/3			28 days
Sulfate		25 field samples; 2 duplicates	Lachat 10-511-00-1-A	B-2/3			28 days
Nitrate/Nitrite		23 field samples; 2 duplicates	Lachat 10-107-04-1-C	B-2/3			**48 hours ***
Total Organic Carbon		23 field samples; 2 duplicates	SM 5310B	B-2/3	3 - 40mL amber VOA	H_3PO_4, 4°C +/-2°C	28 days
Carbon Dioxide Methane/Ethane/Ethene		23 field samples; 2 duplicates	Microseeps SOP-AM20GAx[(5)], revision 11, 10/12/2010; SOP-PM 01C, revision 6, 10/20/2009	B-2/3	2 - 40mL VOA	benzalkonium chloride, 4°C +/-2°C	14 days
Volatile Fatty Acids (VFA)		0 field samples	AM21G	B-2/3	2- 40mL VOA	4°C +/-2°C	21 days

TABLE 3 –MEDIA, ANALYSIS, TEST METHODS, CONTAINERS/ SAMPLE VOLUME, PRESERVATION, AND HOLD TIME

Spring 2011 Sampling Round

Troy Mills Landfill Superfund Site, Troy New Hampshire

PARAMETER	MATRIX	NUMBER OF SAMPLES (including field QC[1 and 2])	ANALYTICAL METHOD	SAP SOP[3]	CONTAINERS (size and type)	PRESERVATION REQUIREMENTS[4]	MAXIMUM HOLDING TIME
LEACHATE							
VOCs	Leachate	2 field samples; 1 duplicate; trip blanks	8260B	B-7	3- 40mL VOA	HCl, 4°C +/-2°C	14 days
SVOCs		2 field samples; 1 duplicate; 1 MS/MSD	8270C	B-7	2 - 1L Amber	4°C +/-2°C	7 days to extract, 40 days to analyze
Total Mn & Hardness		2 field samples; 1 duplicate	200.7	B-7	1- 500mL plastic	HNO_3, 4°C +/-2°C	6 months
SURFACE WATER							
VOCs	Surface Water	3 field samples; 1 duplicate; trip blanks	8260B	B-5	3- 40mL VOA	HCl, 4°C +/-2°C	14 days
SVOCs		3 field samples; 1 duplicate; 1 MS/MSD	8270C	B-5	2 - 1L Amber	4°C +/-2°C	7 days to extract, 40 days to analyze
Total Mn & Hardness		3 field samples; 1 duplicate	200.7	B-5	1- 500mL plastic	HNO_3, 4°C +/-2°C	6 months
SEDIMENT							
VOCs (dry weight determined in SVOC sample)	Sediments (solid sample)	0 field samples	8260B	B-5	1- 40mL VOA	Methanol, 4°C +/-2°C	14 days
SVOCs / dry weight		0 field samples	8270C	B-5	1- 4oz glass	4°C +/-2°C	7 days to extract, 40 days to analyze
Total RCRA Metals, Fe, & Mn		0 field samples	200.7, 200.8, and 245.1 (mercury)	B-5	8 oz. plastic	4°C +/-2°C	6 months with the exception of mercury which is 28 days
Total Organic Carbon		0 field samples	SW846 9060	B-5	1- 4oz glass	4°C +/-2°C	14 days
Grain Size		0 field samples	GZA SOP – C6B – Grain Size Analysis, ASTM D-422	B-5/B-6	Minimum of 500-grams, glass jar	None	none

TABLE 3 –MEDIA, ANALYSIS, TEST METHODS, CONTAINERS/ SAMPLE VOLUME, PRESERVATION, AND HOLD TIME

Spring 2011 Sampling Round

Troy Mills Landfill Superfund Site, Troy New Hampshire

PARAMETER	MATRIX	NUMBER OF SAMPLES (including field QC/1 and 2)	ANALYTICAL METHOD	SAP SOP/3	CONTAINERS (size and type)	PRESERVATION REQUIREMENTS/4	MAXIMUM HOLDING TIME
WETLAND SOIL							
SVOCs	Wetland Soil (solid)	0 field samples	8270C	C-10	1- 4oz glass	4°C +/-2°C	7 days to extract, 40 days to analyze
Total RCRA Metals, Fe, & Mn		0 field samples	200.7, 200.8, and 245.1 (mercury)	C-10	8 oz. plastic	4°C +/-2°C	6 months with the exception of mercury which is 28 days
Total Organic Carbon		0 field samples	SW846 9060	C-10	1- 4oz glass	4°C +/-2°C	14 days
DI WATER EQUIPMENT BLANK							
VOCs	DI Water	1 equipment blank, trip blank	8260B	n/a	3- 40mL VOA	HCl, 4°C +/-2°C	14 days
1,4 Dioxane		1 equipment blank	522	n/a	1 - 1L Amber	$NaHSO_4$, 4 °C +/-2°C	28 days to extract, 28 days to analyze
SVOCs		1 equipment blank	8270C	n/a	2 - 1L Amber	4°C +/-2°C	7 days to extract, 40 days to analyze
Total RCRA Metals, Fe, & Mn		1 equipment blank	200.7	n/a	1- 500mL plastic	HNO_3, 4°C +/-2°C	6 months

Notes:

*** Nitrate samples must be delivered to the laboratory by 2 pm on Fridays.**

1. Trip blanks will be included with each cooler containing VOC samples. Trip blanks will include HCL-preserved blanks for aqueous VOC samples (2 VOA Vials), and methanol preserved blanks for solid samples (1 VOA Vial) as needed. There will be one temperature blank per cooler.
2. Refer specifically to **Table 5** for equipment blank details as well as other QC sampling requirements. If dedicated sampling equipment is used (i.e., bladder pumps), an initial equipment blank is required. No additional equipment blanks are required for dedicated equipment. If non-dedicated sampling equipment is used, one equipment blank per sampling event will be required.
3. The sampling SOP appendix is referenced for the appropriate media.
4. Note that the pH requirement for parameters requiring acidification is less than 2 units (except for 1,4-Dioxane which is less than 4 pH units).
5. Microseeps AM20GAx SOP is based on RSKSOP-175, which uses Henry's Law and satisfies EPA requirements.
6. Refer to **Table 6** - Groundwater Sampling Cross-Reference Table for a summary of individual parameters being sampled for at each well location.
7. "n/a" indicates that there is no standard operating procedure associated with collection of the DI water equipment blank. The laboratory provided DI water is decanted directly from the original container to the appropriate sample containers in most to least volatile sample bottle order.

TABLE 4 - WELL CONSTRUCTION INFORMATION
Spring 2011 Sampling Round
Troy Mills Landfill
Troy, New Hampshire

Monitoring Well Designation	**Well Type (2-in, 1.5-in etc)**	**Reference Measuring Point**	**Height of Stickup of Measuring Point** (ft)	**Bladder Pump Model**	**Bladder Length in feet (L) / Diameter in inches (D) / & Capacity in mg/L (C)**	**Screened Geologic Unit**	**Screen Interval** (ft, referenced to measuring point)	**Depth to Well Bottom*** (ft, referenced to measuring point)	**Historic Low Water Level** (ft, referenced to measuring point)	**Recommended Depth of Bladder Pump Intake** (ft, referenced to measuring point)	**Pump Intake Distance from Top of Screen** (ft, referenced to measuring point)	**Distance Between Pump Intake and Bottom of Well** (ft, referenced to measuring point)
Wells With Water Level Measurements Only												
TRY_P-1	2-in PVC	PVC	1.74	---	---	Overburden	---	16.82	13.67	---	---	---
TRY_M-3	1 1/2-in PVC	PVC	0.95	---	---	Overburden	7.5-31.4	31.4	6.8	14.5	7.0	16.9
TRY_M-5	1 1/2-in PVC	PVC	2.25	---	---	Bedrock	---	22.4	16.5	---	---	---
TRY_M-6	2-in PVC	Casing	1.99	---	---	Overburden	---	17.33	10.6	---	---	---
TRY_M-7D	1 1/2-in PVC	PVC	1.49	---	---	Deep Bedrock	50.8-80.8	81.36	6.1	74.0	23.2	6.8
TRY_MW-108	1 1/2-in PVC	Casing	3.25	---	---	Deep Bedrock	84.3-134.3**	142.35	36.02	Obstruction in Well	---	---
TRY_MW-201D	2-in PVC	PVC	1.98	---	---	Overburden	---	54.76	10.68	---	---	---
TRY_MW-202S	2-in PVC	PVC	1.64	---	---	Overburden	6.6 to 13.6	14.13	11.18	---	---	---
TRY_MW-202D	2-in PVC	Casing	1.84	---	---	Overburden	---	65.23	10.43	---	---	---
TRY_MW-502	2-in PVC	PVC	2.47	---	---	Overburden	---	18.6	15.13	---	---	---
TRY_MW-504	2-in PVC	PVC	2.50	---	---	Overburden	---	11.85	7.51	---	---	---
TRY_MW-505	2-in PVC	PVC	2.56	---	---	Overburden	6.6-16.6**	16.78	7.81	---	---	---
TRY_MW-506	2-in PVC	PVC	3.19	---	---	Overburden	---	17.32	13.24	---	---	---
TRY_MW-507	2-in PVC	PVC	2.74	---	---	Overburden	8-13**	13.04	9.15	---	---	---
TRY_MW-603	2-in PVC	PVC	2.16	---	---	Bedrock	5.2-15.2**	15.7	9.22	---	---	---
Wells With LNAPL Thickness Measurements Only												
TRY_MW-C1S	2-in PVC	PVC	3.27	---	---	Overburden	5.0-15.0	15.0	---	---	---	---
TRY_MW-C2S	2-in PVC	PVC	1.75	---	---	Overburden	7.2-17.2	17.2	---	---	---	---
TRY_MW-C3S	2-in PVC	PVC	3.1	---	---	Overburden	7.8-17.8	17.8	---	---	---	---
TRY_MW-C4S	2-in PVC	PVC	2.64	---	---	Overburden	6.7-16.7	16.7	---	---	---	---
TRY_MW-C5S	2-in PVC	PVC	3	---	---	Overburden	5.0-15.0	15.0	---	---	---	---
TRY_MW-C6S	2-in PVC	PVC	1.79	---	---	Overburden	5.2-15.2	15.2	---	---	---	---
TRY_MW-C7S	2-in PVC	PVC	2.03	---	---	Overburden	5.0-15.0	15.0	---	---	---	---
TRY_MW-C8S	2-in PVC	PVC	2.48	---	---	Overburden	8.1-18.1	18.1	---	---	---	---
TRY_MW-201S	1 1/2-in PVC	PVC	2.24	---	---	Overburden	8.2-18.2	18.2	---	---	---	---
Wells Currently Sampled That Have Screen Lengths Greater than 10 feet												
TRY_M-1	1 1/2-in PVC	PVC	0.64	QED T1300	3.8-ft L, 1-in D, 220-mL C	Overburden	8.3-67.3**	67.3**	8.76	55.0	46.7	12.3
TRY_M-2	1 1/2-in PVC	PVC	0.75	QED T1300	3.8-ft L, 1-in D, 220-mL C	Overburden	7.5-43.9	43.9	5.54	16.5	9.0	27.4
TRY_MW-101	1 1/2-in PVC	Casing	1.18	QED T1300	3.8-ft L, 1-in D, 220-mL C	Predominantly Overburden	32-82	82	29.81	50.0	18.0	32.0
TRY_MW-102	2-in PVC	Casing	2.89	QED Sample Pro	1.2-ft L, 1.75 in D, 100-mL C	Predominantly Overburden	21.2-36.2**	36.2**	23.65	34.0	13.0	2.2
TRY_MW-104S	2-in PVC	PVC	2.17	QED T1250	1.2-ft L, 1.5-in D, 100-mL C	Overburden	5-17**/6	17.7**/6	4.20	15.5	10.5	1.5
TRY_MW-104D	2-in PVC	PVC	2.48	QED T1250	1.2-ft L, 1.5-in D, 100-mL C	Overburden	37.1-52.1**	52.1**	4.18	48.0	10.9	4.1
TRY_MW-105S	2-in PVC	PVC	---	QED Sample Pro	1.2-ft L, 1.75 in D, 100-mL C	Overburden	6.5-19.5**	21.08	10.96	17.5	11.0	3.6
TRY_MW-105D	2-in PVC	PVC	1.89	QED Sample Pro	1.2-ft L, 1.75 in D, 100-mL C	Deep Bedrock	48.5-88.2**	87.92	11.52	68.0	19.5	20.2
TRY_MW-201P	4-in PVC	Casing	2.07	QED Sample Pro	1.2-ft L, 1.75 in D, 100-mL C	Overburden	6.5-56.5**	53.7	8.02	26.5	20.0	30.0
TRY_MW-202P	4-in PVC	PVC	1.96	QED Sample Pro	1.2-ft L, 1.75 in D, 100-mL C	Overburden	4.9-59.9**	61.55	9.97	52.5	47.6	7.4
TRY_MW-601S	2-in PVC	PVC	2.69	QED T1250	1.2-ft L, 1.5-in D, 100-mL C	Overburden	14.3-29.3	29.3	21.57	27.8	13.5	1.5
TRY_MW-602S	2-in PVC	PVC	2.30	QED T1250	1.2-ft L, 1.5-in D, 100-mL C	Overburden	21-36	36	24.22	34.4	13.4	1.6
TRY_MW-701	2-in PVC	PVC	3.18	QED T1250	1.2-ft L, 1.5-in D, 100-mL C	Deep Bedrock	18.3-78.3	78.3	10.70	48.3	30.0	30.0
TRY_MW-702D	2-in PVC	PVC	2.44	QED Sample Pro	1.2-ft L, 1.75 in D, 100-mL C	Deep Bedrock	19.4-46.4**/6	46.4**/6	6.51	33.0	13.6	13.4

TABLE 4 - WELL CONSTRUCTION INFORMATION
Spring 2011 Sampling Round
Troy Mills Landfill
Troy, New Hampshire

Monitoring Well Designation	**Well Type (2-in, 1.5-in etc)**	**Reference Measuring Point**	**Height of Stickup of Measuring Point** (ft)	**Bladder Pump Model**	**Bladder Length in feet (L) / Diameter in inches (D) / & Capacity in mg/L (C)**	**Screened Geologic Unit**	**Screen Interval** (ft, referenced to measuring point)	**Depth to Well Bottom*** (ft, referenced to measuring point)	**Historic Low Water Level** (ft, referenced to measuring point)	**Recommended Depth of Bladder Pump Intake** (ft, referenced to measuring point)	**Pump Intake Distance from Top of Screen** (ft, referenced to measuring point)	**Distance Between Pump Intake and Bottom of Well** (ft, referenced to measuring point)
Wells Currently Sampled With Screen Lengths Equal to or Less than 10 feet												
TRY_M-7	1 1/2-in PVC	PVC	1.61	QED T1300	3.8-ft L, 1-in D, 220-mL C	Overburden	7.8-17.3	17.3	8.71	15.8	8.0	1.5
TRY_MW-201M	1 1/2-in PVC	PVC	2.81	QED T1300	3.8-ft L, 1-in D, 220-mL C	Overburden	26.6-36.6	36.6	10.50	34.6	8.0	2.0
TRY_MW-204	2-in PVC	PVC	2.6	QED T1250	1.2-ft L, 1.5-in D, 100-mL C	Overburden	22.8-32.8	32.8	20.69	31.3	8.5	1.5
TRY_MW-205	2-in PVC	PVC	2.07	QED T1250	1.2-ft L, 1.5-in D, 100-mL C	Overburden	29.1-39.1	39.1	31.06	37.6	8.5	1.5
TRY_MW-301X	2-in PVC	PVC	2.42	QED Sample Pro	1.2-ft L, 1.75 in D, 100-mL C	Overburden	42.5-52.5	52.5	---	47.5	5.0	5.0
TRY_MW-501X	2-in PVC	PVC	2.02	QED Sample Pro	1.2-ft L, 1.75 in D, 100-mL C	Overburden	2.0-12.0	12.02	---	7.0	5.0	5.0
TRY_MW-508X	2-in PVC	PVC	2.9	QED Sample Pro	1.2-ft L, 1.75 in D, 100-mL C	Overburden	4.7-9.7	9.7	---	7.2	2.5	2.5
TRY_MW-601D	2-in PVC	PVC	2.23	QED T1250	1.2-ft L, 1.5-in D, 100-mL C	Overburden	52.1-62.1	62.1	22.81	57.1	5.0	5.0
TRY_MW-602B	2-in PVC	PVC	2.12	QED T1250	1.2-ft L, 1.5-in D, 100-mL C	Bedrock	37.5-47.5	47.5	20.61	42.5	5.0	5.0
TRY_MW-702SX	2-in PVC	PVC	3.9	QED Sample Pro	1.2-ft L, 1.75 in D, 100-mL C	Overburden	5.4-15.4	15.4	---	10.4	5.0	5.0
TRY_MW-801	2-in PVC	PVC	2.25	QED Sample Pro	1.2-ft L, 1.75 in D, 100-mL C	Overburden	36.4-46.4	46.4	---	41.4	5.0	5.0
TRY_MW-802	2-in PVC	PVC	2.1	QED Sample Pro	1.2-ft L, 1.75 in D, 100-mL C	Overburden	25.6-35.6	35.6	---	30.6	5.0	5.0
TRY_MW-803	2-in PVC	PVC	2.15	QED Sample Pro	1.2-ft L, 1.75 in D, 100-mL C	Overburden	22.3-32.3	32.3	---	27.3	5.0	5.0
TRY_MW-804	2-in PVC	PVC	2.32	QED Sample Pro	1.2-ft L, 1.75 in D, 100-mL C	Overburden	26.0-36.0	36.0	---	31.0	5.0	5.0
TRY_MW-805	2-in PVC	PVC	2.37	QED Sample Pro	1.2-ft L, 1.75 in D, 100-mL C	Overburden	32.4-42.4	42.4	---	29.4	5.0	5.0

Notes:
1. "ft bgs" indicates depth in feet below ground surface.
2. "**" indicates downhole information was not verified during the October 8, 2008 camera survey.
3. Historic "low" water level is based on water level data compiled from December 2006, May and December 2007 and June/July 2009 water level measurements. The historic low water level refers to the lowest recorded water level measuremen through 20094. "-" indicates that data was not obtained.
5. "---" = GZA included every known monitoring point within the above table. The information for numerous locations have been left blank as GZA does not have the data for those monitoring locations.
6. GZA notes that there appears to be a minor discrepancy between the historical information regarding the bottom of screen/well and that which was measured in July 2008 by GZA in two wells (TRY_MW-702D & TRY_MW-104S). Both sets of information are included in this table.
7. The distance between pump intake and bottom of the well is calculated using the Depth to Well Bottom information.
8. "*" Depth to Well Bottom are field measured unless otherwise noted.

TABLE 5 – SUMMARY OF QUALITY ASSURANCE SAMPLES TO BE COLLECTED
Spring 2011 Sampling Round
Troy Mills Landfill Superfund Site
Troy, New Hampshire

SAMPLING MEDIA	SAMPLING FREQUENCY	ASSOCIATED SAMPLING EQUIPMENT	SAMPLE ID	DESIGNATED NOTE TO BE USED ON CHAIN-OF-CUSTODY	ANALYSES
EQUIPMENT BLANK SAMPLES					
Lab provided DI Water (collected prior to sampling)	Semiannually	DI Water	EQUIP BLANK	"DI Water"	VOCs, 1,4-Dioxane, SVOCs, & 10 Metals,
Groundwater (collected from bailer after sampling/decon)	Semiannually	Bailer (if used)	EQUIP BLANK	"Bailer"	VOCs, SVOCs, & Mn
Groundwater (collected prior to sampling)	Semiannually	New Bladder Pumps (if purchased)	EQUIP BLANK	"QED 1250/1300 Bladder Pump"	VOCs, 1,4-Dioxane, SVOCs, & 10 Metals
Groundwater (collected prior to sampling)	Semiannually	QED Sample Pro Bladder Pump (if used)	EQUIP BLANK	"QED Sample Pro"	VOCs, 1,4-Dioxane, SVOCs, & 10 Metals
Groundwater (collected after TRY_MW-201S)	Semiannually	Oil-Water Interface Probe	EQUIP BLANK	"Oil /Water Probe"	VOCs, 1,4-Dioxane, SVOCs, & Mn
Sediment (collected after sampling/decon)	Annually (Fall Round)	Petite Ponar Dredge and sampling tools (i.e. bowl/spoon) used to collect sediment samples	EQUIP BLANK	"Ponar Dredge & Equipment"	VOCs, SVOCs, & 10 Metals
Wetland Soil (collected after sampling/decon)	Annually (Fall Round)	Hand Auger and sampling tools (i.e. bowl/spoon) used to collect Wetland Soil samples	EQUIP BLANK	"Hand Auger & Equipment"	SVOCs, & 10 Metals
DUPLICATE SAMPLES					
Groundwater	Spring 2011 only	Bladder Pump	TRY_MW-102 DUP	*N/A*	SVOCs only
	Semiannually	Bladder Pump	TRY_MW-205 DUP	*N/A*	VOCs, SVOCs, Mn, & MNA -Lab
		Bladder Pump	TRY_MW-804 DUP	*N/A*	VOCs, 1,4-Dioxane, SVOCs, 10 Metals, & MNA -Lab
Surface Water	Semiannually	*N/A*	TRY_SW-3 DUP	*N/A*	VOCs, SVOCs, Mn, & Hardness
Leachate	Semiannually	*N/A*	TRY_SW-LEACHATE DUP	*N/A*	VOCs, SVOCs, Mn & Hardness
Sediment	Annually (Fall Round)	*N/A*	TRY_SEDSW-3 DUP	*N/A*	VOCs, SVOCs/% solid, 10 Metals, & TOC
Wetland Soil	Annually (Fall Round)	*N/A*	TRY_WES-03 DUP	*N/A*	SVOCs, 10 Metals, TOC
LABORATORY MS/MSD SAMPLES					
Groundwater	Round before the five year review and when new wells are added.	*N/A*	TRY_MW-702SX	"MS/MSD"	1,4-Dioxane
Groundwater	Semiannually	*N/A*	TRY_MW-104S	"MS/MSD"	SVOCs
Surface Water	Semiannually	*N/A*	TRY_SW-1	"MS/MSD"	SVOCs
Leachate	Semiannually	*N/A*	TRY_SW-LEACHATE	"MS/MSD"	SVOCs
TRIP BLANK/TEMPERATURE BLANK SAMPLES					
Aqueous VOCs (1 per cooler with aqueous VOCs samples)	Semiannually	*N/A*	TRIP BLANK	*Identify all Sample IDs associated with Trip Blank in notes section of COC*	VOCs
Solid VOCs (1 per cooler with solid VOC samples)	Annually (Fall Round)	*N/A*	TRIP BLANK	*Identify all Sample IDs associated with Trip Blank in notes section of COC*	VOCs
Temperature Blank (1 per cooler)	Semiannually	*N/A*	TEMP BLANK	*Include in notes section of COC that a temperature blank has been included in the cooler*	Temperature

TABLE 5 – SUMMARY OF QUALITY ASSURANCE SAMPLES TO BE COLLECTED
Spring 2011 Sampling Round
Troy Mills Landfill Superfund Site
Troy, New Hampshire

Notes*:*
1. "VOCs" consist of the New Hampshire Department of Environmental Services (NHDES) full list of volatile organic compounds analyzed by EPA Method 8260B.
2. 1,4 Dioxane is analyzed by EPA Method 522.
3. "SVOCs" consist of semi-volatile organic compounds analyzed by EPA Method 8270C, including acid- and base/neutral-extractables.
4. "10 metals" consist of Arsenic, Barium, Cadmium, Chromium, Lead, Selenium & Silver, Manganese, and Iron by EPA Method 200.7 / 200.8 and Mercury by Cold Vapor Method 245.1
5. "MNA - Lab" parameters consists of nitrate/nitrite, alkalinity, chloride, sulfate, CO_2, methane/ethane/ethene, and total organic carbon.
6. "MNA - Field" parameters consist of dissolved oxygen/temperature, Oxygen Reduction Potential (ORP), specific conductance, pH, and turbidity.
7. "VFA" parameters consist of Volatile Fatty Acids.
8. Wells TRY_MW-105S, TRY_MW-105D, TRY_MW-702S, and TRY_MW-702D are sentry wells and will be sampled for 1,4 Dioxane in the fall round prior to the five year review until such time that 1,4 dioxane is no longer a contaminant of concern at the Site.
9. Refer to **Table 6 -** Groundwater Sampling Cross-Reference Table for a summary of individual parameters being sampled for at each well location.

TABLE 6 - GROUNDWATER SAMPLING CROSS-REFERENCE TABLE
Spring 2011 Sampling Round
Troy Mills Landfill Superfund Site
Troy, New Hampshire

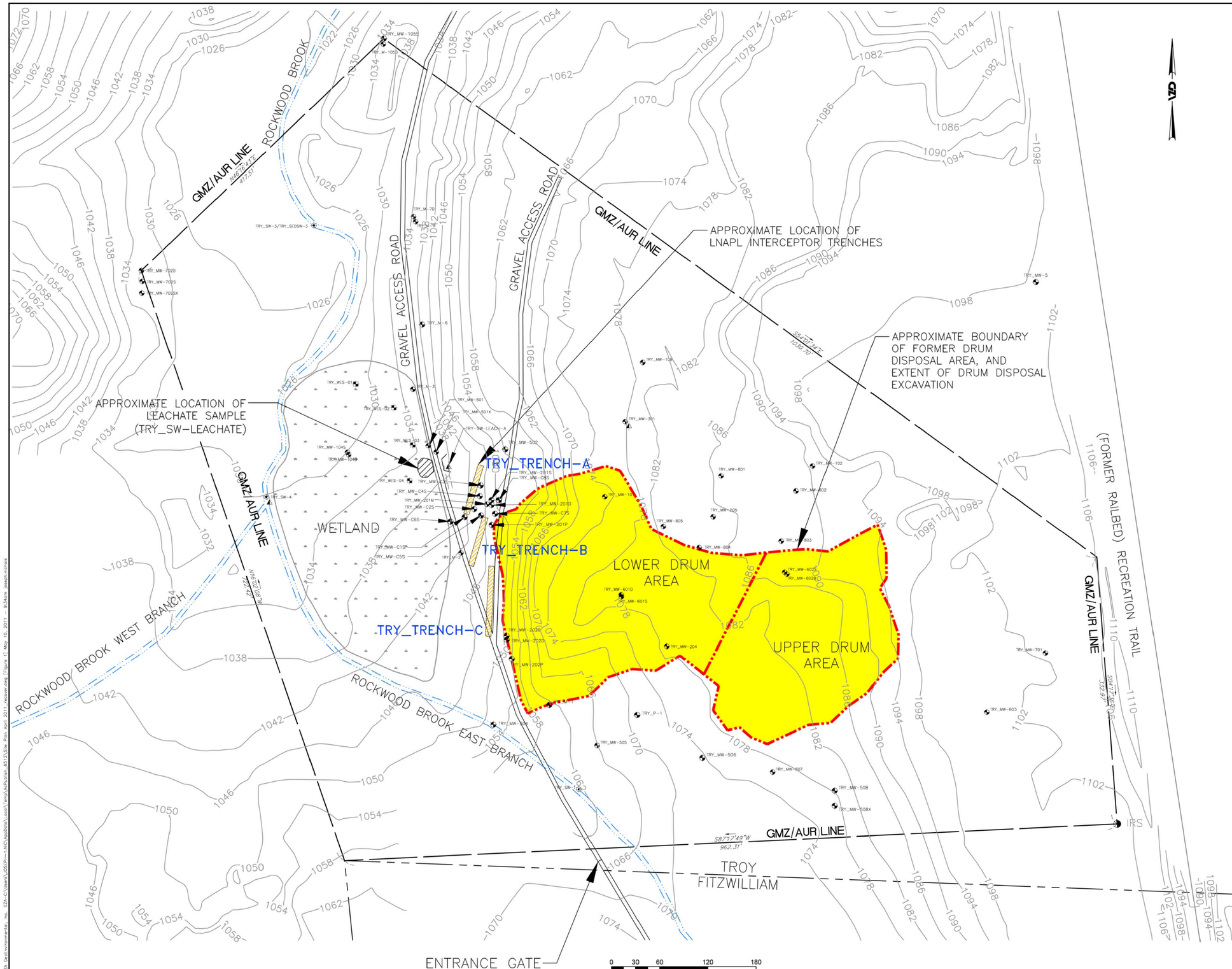
Well ID	Sampling Methodology (refer to Table 2)	QC Sampling (refer to Table 5)	Parameters to Be Sampled (refer to Table 3)	SAP Parameter Guidance
TRY_M-1	Bladder Pump		VOCs; SVOCs; 1,4 Dioxane; 10 Metals; MNA - Lab; MNA - Field	**I. Water level measurements** are collected at each well being sampled **II. Semiannual Laboratory Analyses**: VOCs; SVOCs; Manganese; and Lab MNA (Nitrate/Nitrite, Alkalinity, Chloride, Sulfate, TOC, Carbon Dioxide, & Methane/Ethane/Ethene) ***Exceptions*** : 1.) ***no lab MNA*** at TRY_MW-105S, TRY_MW-105D, TRY_MW-702S, and TRY_MW-702D 2.) ***modified lab MNA*** at TRY_MW-104S and TRY_MW-104D - only Alkalinity, Chloride, and Sulfate at these two locations **III. Semiannual Field Measurements for wells being sampled via bladder pump**: dissolved oxygen, temperature, oxygen reduction potential, specific conductance, pH, and turbidity **IV. Fall Round Prior to 5-Year Review:** all wells additionally sampled for VFA and Arsenic. 1,4 Dioxane will also be sampled at wells TRY_M-7, TRY_MW-201M, TRY_MW-105S, TRY_MW-105D, TRY_MW-702SX, and TRY_MW-702D **Exceptions:** 1.) ***no VFA*** at TRY_MW-105S, TRY_MW-105D, TRY_MW-702S, TRY_MW-702D, TRY_MW-104S, and TRY_MW-104D **V. For Any New Well Being Sampled for the first time:** Additional parameters to be sampled for include RCRA 8 and Fe (in addition to Mn) and 1,4 Dioxane. After the initial round, metals analysis will consist of Mn only and 1,4 Dioxane will only be analyzed in the fall, prior to the 5-year review if 1,4 Dioxane is detected
TRY_M-2	Bladder Pump		VOCs; SVOCs; Manganese; MNA - Lab; MNA - Field	
TRY_MW-101	Bladder Pump		VOCs; SVOCs; Manganese; MNA - Lab; MNA - Field	
TRY_MW-102	Bladder Pump	Duplicate SVOCs only	VOCs; SVOCs; 1,4 Dioxane; 10 Metals; MNA - Lab; MNA - Field	
TRY_MW-104S	Bladder Pump	MS/MSD SVOCs	VOCs; SVOCs; Manganese; Modified Lab MNA (Alkalinity, Chloride, Sulfate); MNA - Field	
TRY_MW-104D	Bladder Pump		VOCs; SVOCs; Manganese; Modified Lab MNA (Alkalinity, Chloride, Sulfate); MNA - Field	
TRY_MW-105S	Bladder Pump		VOCs; SVOCs; Manganese; MNA - Field	
TRY_MW-105D	Bladder Pump		VOCs; SVOCs; Manganese; MNA - Field	
TRY_MW-201P	Bladder Pump		VOCs; SVOCs; 1,4 Dioxane; 10 Metals; MNA - Lab; MNA - Field	
TRY_MW-202P	Bladder Pump		VOCs; SVOCs; 1,4 Dioxane; 10 Metals; MNA - Lab; MNA - Field	
TRY_MW-601S	Bladder Pump		VOCs; SVOCs; Manganese; MNA - Lab; MNA - Field	
TRY_MW-602S	Bladder Pump		VOCs; SVOCs; Manganese; MNA - Lab; MNA - Field	
TRY_MW-701	Bladder Pump		VOCs; SVOCs; Manganese; MNA - Lab; MNA - Field	
TRY_MW-702D	Bladder Pump		VOCs; SVOCs; Manganese; MNA - Field	
TRY_M-7	Bladder Pump		VOCs; SVOCs; Manganese; MNA - Lab; MNA - Field	
TRY_MW-201M	Bladder Pump		VOCs; SVOCs; Manganese; MNA - Lab; MNA - Field	
TRY_MW-204	Bladder Pump		VOCs; SVOCs; Manganese; MNA - Lab; MNA - Field	
TRY_MW-205	Bladder Pump	Duplicate	VOCs; SVOCs; Manganese; MNA - Lab; MNA - Field	
TRY_MW-301X	Bladder Pump		VOCs; SVOCs; 1,4 Dioxane; 10 Metals; MNA - Lab; MNA - Field	
TRY_MW-501X	Bladder Pump		VOCs; SVOCs; 1,4 Dioxane; 10 Metals; MNA - Lab; MNA - Field	
TRY_MW-508X	Bladder Pump		VOCs; SVOCs; 1,4 Dioxane; 10 Metals; MNA - Lab; MNA - Field	
TRY_MW-601D*	Bladder Pump Insufficient Recharge		VOCs; SVOCs; Manganese; MNA - Lab; MNA - Field	
TRY_MW-602B	Bladder Pump		VOCs; SVOCs; Manganese; MNA - Lab; MNA - Field	
TRY_MW-702SX	Bladder Pump	MS/MSD 1,4-Dioxane	VOCs; SVOCs; 1,4 Dioxane; 10 Metals; MNA - Field	
TRY_MW-801	Bladder Pump		VOCs; SVOCs; 1,4 Dioxane; 10 Metals; MNA - Lab; MNA - Field	
TRY_MW-802	Bladder Pump		VOCs; SVOCs; 1,4 Dioxane; 10 Metals; MNA - Lab; MNA - Field	
TRY_MW-803	Bladder Pump		VOCs; SVOCs; 1,4 Dioxane; 10 Metals; MNA - Lab; MNA - Field	
TRY_MW-804	Bladder Pump	Duplicate	VOCs; SVOCs; 1,4 Dioxane; 10 Metals; MNA - Lab; MNA - Field	
TRY_MW-805	Bladder Pump		VOCs; SVOCs; 1,4 Dioxane; 10 Metals; MNA - Lab; MNA - Field	

Notes:
1. "VOCs" consist of the New Hampshire Department of Environmental Services (NHDES) full list of volatile organic compounds analyzed by EPA Method 8260B.
2. 1,4 Dioxane is analyzed by EPA Method 522.
3. "SVOCs" consist of semi-volatile organic compounds analyzed by EPA Method 8270C, including acid- and base/neutral-extractables.
4. "10 metals" consist of Arsenic, Barium, Cadmium, Chromium, Lead, Selenium & Silver, Manganese, and Iron by EPA Method 200.7 / 200.8 and Mercury by Cold Vapor Method 245.1
5. "MNA - Lab" parameters consists of nitrate/nitrite, alkalinity, chloride, sulfate, CO_2, methane/ethane/ethene, and total organic carbon.
6. "MNA - Field" parameters consist of dissolved oxygen/temperature, Oxygen Reduction Potential (ORP), specific conductance, pH, and turbidity.
7. "VFA" parameters consist of Volatile Fatty Acids.
8. Wells TRY_MW-105S, TRY_MW-105D, TRY_MW-702S, and TRY_MW-702D are sentry wells and will be sampled for 1,4 Dioxane in the fall round prior to the five year review until such time that 1,4 dioxane is below the AGQS.
9. "*" These wells have at least 2 consecutive rounds of having insufficient recharge. Do not attempt to do low flow again, use the Insufficient Recharge Procedure in the Low Flow SOP instead.

FIGURE

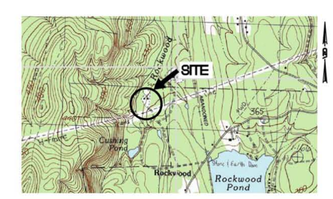
NOTES:

1. BASE PLAN IS FROM FIGURE 2.2 OF THE REPORT BY METCALF & EDDY, INC. ENTITLED "FINAL REMEDIAL INVESTIGATION, VOLUME I, TROY MILLS LANDFILL SUPERFUND SITE, TROY, NEW HAMPSHIRE", DATED SEPTEMBER 2005, AND PREPARED FOR THE UNITED STATES ENVIRONMENTAL PROTECTION AGENCY.
2. GROUND SURFACE CONTOURS ARE FROM THE BASE PLAN. THE METHOD OF PREPARATION BY OTHERS IS UNKNOWN. EPA GRADING CHANGED GROUND SURFACE CONTOURS SHOWN IN VICINITY OF LOWER AND UPPER DRUM AREA.
3. THE GROUNDWATER MANAGEMENT ZONE (GMZ)/ACTIVITY AND USE RESTRICTION (AUR) LINE IS FROM "GROUNDWATER MANAGEMENT ZONE & ACTIVITY AND USE RESTRICTION PLAN, TROY MILLS LANDFILL, TROY, NEW HAMPSHIRE", PREPARED BY TF MORAN, INC., DATED DECEMBER 18, 2006, REVISED JANUARY 17, 2007 AND MARCH 19, 2007.
4. UPPER AND LOWER DRUM AREAS, AND SURROUNDING AREAS WERE COVERED BY CLEAN FILL AND GRADED BY EPA.



LEGEND

- GMZ/AUR BOUNDARY
- GROUND SURFACE CONTOUR
- FORMER RAILBED
- SURFACE WATER
- TRY_MW-102 MONITORING WELL
- TRY_WES-01 WETLAND SOIL SAMPLE LOCATION
- TRY_SW-1 SURFACE WATER AND/OR SEDIMENT SAMPLE LOCATION
- LEACHATE SAMPLE LOCATION
- IRS IRON ROD SET
- TRY-SW-4 PERMANENTLY INSTALLED STAFF GAUGE



LOCUS PLAN
SCALE: 1" = 2,000'

NO.	ISSUE/DESCRIPTION	BY	DATE

TROY MILLS LANDFILL
SUPERFUND SITE

TROY, NEW HAMPSHIRE

SITE PLAN AND
EXPLORATION LOCATION PLAN

PREPARED BY:
GZA GeoEnvironmental, Inc.
Engineers and Scientists
380 HARVEY ROAD
MANCHESTER, NEW HAMPSHIRE 03103
(603) 623-3600

PREPARED FOR:

PROJ MGR: MBA	REVIEWED BY: SRL	CHECKED BY: MBA	FIGURE
DESIGNED BY: ATD	DRAWN BY: JPN	SCALE: 1" = 60'	1
DATE APRIL 2011	PROJECT NO. 04.0024466.61	REVISION NO.	SHEET NO.

© 2008 GZA GeoEnvironmental, Inc. GZA: C:\Users\JOEPH~1\AppData\Local\Temp\AcPublish_6572\Site Plan April 2011_recover.dwg | Figure 1 | May 10, 2011 - 8:34am joseph.vienna

APPENDIX A

EPA'S RECORD OF DECISION GROUNDWATER
AND LEACHATE CLEANUP LEVELS
AND NHDES AGQS

Table L-1

Interim Groundwater Cleanup Levels

Carcinogenic Chemical of Concern	Cancer Classification	Interim Cleanup Level (ug/L)	Basis	RME Risk
1,4-Dioxane	B2	3	GW-1	1E-06
Benzene	A	5	MCL	7E-06
Tetrachloroethene	not available*	5	MCL	7E-05
Trichloroethene	B1*	5	MCL	6E-05
Vinyl Chloride	A	2	MCL	2E-04
Benzo(a)pyrene	B2	0.2	MCL	3E-05
Benzo(b)fluoranthene	B2	0.05	AGQS	6E-07
bis(2-Ethylhexyl)phthalate	B2	6	MCL	3E-06
Dibenzo(a,h)anthracene	B2	0.01	PQL	1E-06
Pentachlorophenol	B2	1	MCL	2E-06
Arsenic	A	10	MCL	3E-04
Non-Carcinogenic Chemical of Concern	**Target Endpoint**	**Interim Cleanup Level (ug/L)**	**Basis**	**RME Hazard Quotient**
1,2,4-Trimethylbenzene	General Toxicity/ Liver/Kidney	50	AGQS	1
1,3,5-Trimethylbenzene	General Toxicity/ Liver/Kidney	50	AGQS	1
2-Butanone	Developmental	170	AGQS	0.03
4-Isopropyltoluene	Kidney	50	AGQS	0.1
Benzene	Immune System	5	MCL	0.2
cis-1,2-Dichloroethene	Blood	70	MCL	0.7
n-Butylbenzene	Blood	50	AGQS	5
n-Propylbenzene	Blood	50	AGQS	4
Tetrachloroethene	Liver	5	MCL	0.07
Tetrahydrofuran	not available	154	AGQS	Not available
Toluene	Liver/Kidney	1,000	MCL	1
Trichloroethene	Liver	5	MCL	0.02
Vinyl Chloride	Liver	2	MCL	0.07
bis(2-Ethylhexyl)phthalate	Liver	6	MCL	0.06
Naphthalene	General Toxicity	20	AGQS	0.8
Pentachlorophenol	Liver/Kidney	1	MCL	0.003
Arsenic	Skin	10	MCL	3
Boron	Developmental	620	AGQS	0.3
Manganese	CNS	300	Advisory	1

Key

AGQS – New Hampshire Ambient Groundwater Quality Standards - 2/24/99.

ug/L = micrograms per liter (equivalent to parts per billion).

* = The cancer classifications for tetrachloroethene and trichloroethene are under review by EPA.

GW-1 = New Hampshire Department of Environmental Services Method 1 Groundwater Standards (RCMP, 3/31/05). Note that recent updates have been made to the NHDES GW-1 standards. It is anticipated that the AGQS concentrations presented will be made equivalent to the GW-1 standards. However, GW-1 standards have only been selected as the PRG when there is no AGQS available.

The AGQS for dibenzo(a,h)anthracene is 0.005 ug/L; however the interim groundwater cleanup levels has been set at 0.01 ug/L based on the practical quantification limit (PQL) for this chemical. During five-year reviews, the PQL for this chemical will be revisited to determine if analytical detection limits in the range of the AGQS are achievable. If so, the interim groundwater cleanup level for this chemical will be revised to match the AGQS.

Table L-1 Interim Groundwater Cleanup Levels
Tetrahydrofuran was included on the above table as it was found in groundwater at levels that exceed an AGQS. However, as an RfD was not available, an RME hazard quotient could not be calculated. MCL = Maximum Contaminant Level. MCLG = Maximum Contaminant Level Goal Advisory = Health Advisory on Manganese (EPA-822-R-04-003; January 2004). CNS = Central Nervous System. PQL = Practical Quantification Limit.

As noted above, at the time that Interim Groundwater Cleanup Levels identified in the ROD, newly promulgated ARARs, and modified ARARs, which require higher standards for the remedy to remain protective have been achieved, a risk assessment shall be performed on the residual groundwater contamination to determine whether the remedy is protective at the points of compliance. This risk assessment of the residual groundwater contamination shall follow EPA procedures and will assess the cumulative carcinogenic and non-carcinogenic risks posed by ingestion and dermal absorption of groundwater and inhalation of VOCs from domestic water usage. At this Site, Interim Cleanup Levels must be met throughout the contaminated groundwater plume that extends from the former drum disposal area west-northwest into the adjacent Rockwood Brook wetland area. Compliance will be demonstrated by attainment of interim cleanup levels, or alternative protective levels as determined above, in all monitoring wells and area supply wells currently associated with the Site plume. EPA has estimated that the Interim Groundwater Cleanup Levels will be reached within 30 years after completion of the source control component.

Leachate Cleanup Levels

Without the maintenance of the LNAPL interceptor trenches at the Site, leachate migrating from the Site contains levels of contaminants that pose a potential future risk to young child and/or adult recreational users at the Site. Leachate PRGs based on RME human health risks were established. Risk estimates were calculated based on existing data and exposure parameters contained in the RI, FS, and risk assessment reports. Cleanup levels for chemicals of concern in leachate exhibiting an unacceptable cancer risk and/or hazard index have been have been established such that they are protective of human health. Leachate cleanup levels for known and suspect carcinogenic chemicals of concern (Classes A, B, and C compounds) have been set at a 10-6 excess cancer risk level considering exposures via dermal contact. Cleanup levels for chemicals of concern in leachate having non-carcinogenic effects were derived for the same exposure pathway(s) and correspond to an acceptable exposure level to which the human population (including sensitive subgroups) may be exposed without adverse affect during a lifetime or part of a lifetime, incorporating an adequate margin of safety (hazard quotient = 1).

Table L-2 summarizes the cleanup levels for carcinogenic and non-carcinogenic chemicals of concern in LNAPL-contaminated leachate protective of direct contact.

Table L-2

Leachate Cleanup Levels for the Protection of Recreational Dermal Contact Exposures

Carcinogenic Chemical of Concern	Cancer Classification	Interim Cleanup Level (ug/L)	Basis	RME Risk
bis(2-Ethylhexyl)phthalate	B2	40	Risk	1E-06
Non-Carcinogenic Chemical of Concern	**Target Endpoint**	**Interim Cleanup Level (u/L)**	**Basis**	**RME Hazard Quotient**
bis(2-Ethylhexyl)phthalate	Liver	40	Risk	0.01

Key
HQ = Hazard Quotient.
ug/L = micrograms per liter (equivalent to parts per billion).

These leachate cleanup levels must be met at the completion of the remedial action at the point of compliance generally described as where leachate enters the adjacent Rockwood Brook wetlands. In addition, the leachate levels must be met without the maintenance of the LNAPL interceptor trenches. If the trenches must be maintained in order for cleanup levels to be met, this will not be considered compliance. The cleanup levels are consistent with ARARs for the leachate, attain EPA's risk management goals for remedial action, and are protective of human health.

M. STATUTORY DETERMINATIONS

The remedial action selected for implementation at the Troy Mills Landfill Site is consistent with CERCLA and, to the extent practicable, the NCP. The selected remedy is protective of human health and the environment, will comply with ARARs and is cost effective. In addition, the selected remedy utilizes permanent solutions and alternate treatment technologies or resource recovery technologies to the maximum extent practicable.

Based on the recent completion of a drum removal action by EPA's Removal Program, which eliminated the primary source of Site contamination; the remote location of the Site; the lack of current human health risks; and the relatively low levels of remaining contamination present, EPA concluded that it was impracticable to remove and treat the chemicals of concern in a cost-effective manner at the Site. Thus, the selected remedy does not satisfy the statutory preference for treatment as a principal element of the remedy.

1. The Selected Remedy is Protective of Human Health and the Environment

The remedy at this Site will adequately protect human health and the environment by eliminating, reducing or controlling exposures to human and environmental receptors through treatment, engineering controls and institutional controls. More specifically, the remedy will: 1) restore groundwater to drinking water standards through monitored natural attenuation;

APPENDIX B

GZA STANDARD OPERATING PROCEDURES

WATER LEVEL / LNAPL THICKNESS MEASUREMENTS

PURPOSE

This Standard Operating Procedure (SOP) *Water Level / LNAPL Thickness Measurements* is to establish guidelines for the manual determination of both the depth to water and the thickness of Light Non-Aqueous Phase Liquid (LNAPL) in monitoring wells at the Troy Mills Landfill Superfund Site in Troy, New Hampshire.

In general, water-level measurements are used to construct water table or potentiometric surface maps and to determine flow direction as well as other aquifer characteristics. Therefore, a synoptic water level measurement round should be performed in the shortest possible time (preferably within a 24-hour period) before any purging and sampling activities begin.

The synoptic water level round shall also include the brook stage measurement at surface water sampling location TRY_SW-4, where a permanent stream gage has been mounted.

Any modifications to this SOP shall be approved by NHDES in consultation with the EPA in advance, documented in the site logbook, and presented in the final report.

EQUIPMENT AND MATERIALS

- Site-specific plan and boring logs;
- Field book;
- Water level / LNAPL field forms (see attached);
- Electronic water level meter and/or Oil Water Interface Probe of appropriate lengths (i.e., 100 ft, 200 ft, and 300 ft, and measures in increments of 0.01 feet);
- Gate keys/well keys and other applicable field equipment to open wells/manhole covers;
- Indelible black-ink pen (Sharpie);
- Personal protective clothing and gear; and
- Decontamination supplies in accordance with the SOP.

GENERAL INFORMATION

All monitoring wells should be locked at all times, or within a secure locked area, to ensure the integrity of the well.

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If water level measurements are being completed for the first time following well installation (or if it does not already exist), a survey mark/physical notch should be placed on the top of the riser or casing as a reference point for future groundwater level measurements. If the top of the riser or casing is not flat, make the reference point the highest point. The measurement reference point should be documented in the site logbook.

All field personnel must be made aware of the measurement reference point (top of casing [TOC] or top of PVC pipe [TOPVC]) being used in order to ensure the collection of comparable data.

Before measurements are made, water levels in monitoring wells should be allowed to stabilize for a minimum of 24 hours after well construction and development. In low yield situations, recovery of water levels to equilibrium may take longer. All measurements should be made to an accuracy of 0.01 feet.

All equipment shall be decontaminated prior to use in accordance with the decontamination SOP.

SURFACE WATER LEVEL MEASUREMENT

The synoptic water level round shall also include the brook stage measurement (height of water column in the brook) at surface water sampling location TRY_SW-4, where a permanent stream gage has been mounted midstream. Refer to the Site Map, **Figure 1**. The stage measurement should be taken to the nearest one hundredth of a foot and recorded on the Water Level Field Measurement Form and later recorded on the Surface Water Field Form (included in SOP C-7). Additional measurements will be collected concurrent with the sampling of groundwater well cluster TRY_MW-104 and again when TRY_SW-4 is sampled. Additional measurements may be collected on an as needed basis during the monitoring event.

WATER LEVEL MEASUREMENT PROCEDURES

Care should be taken to minimize water column disturbance. Use the following procedures to collect water level measurements:

1. Open the well and monitor the headspace with the appropriate air monitoring instrument to determine the presence of volatile organic compounds (if applicable).

2. Lower the electronic water level meter probe and measuring tape into the well until the water surface is reached as indicated by a tone or meter deflection. Record the distance from the reference point to water surface.

3. Record the distance from the water surface (to 0.01 feet), as determined by the audio signal or tone, to the reference measuring point (i.e., top of PVC riser or casing) and record on the field measurement form (see Synoptic Water Level Measurement Form). In addition, note the reference point used (top of PVC riser or casing).

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4. For any well not previously sampled by GZA, remove the tubing from the well and measure the length of all downhole tubing to verify the tubing intake. Inspect the tubing for integrity. Record length of downhole tubing and observations on the Synoptic Water Level Measurement Form. Replace tubing and secure to the tubing in the well.

5. The depth to the bottom of the monitoring well should be confirmed in each well included on **Table 4** and recorded on the Synoptic Water Level Measurement Form based on the following:

   a. If a bladder pump has been installed in a monitoring well, the depth to the bottom of the monitoring well will be confirmed at such time when the bladder pump is removed for repairs or maintenance activities, or if a significant increasing trend in the turbidly values has been observed; and

   b. In monitoring wells where there has been no bladder pump installed, the depth to the bottom of the monitoring well will be confirmed once every five years, during the sampling event just prior to the 5-year review.

6. In field book/field sheet, note if the lock was damaged or missing and any physical changes to well condition, such as erosion or cracks in protective concrete pad, roadbox, standpipe, etc.

7. Remove all downhole equipment used for the water level measurement, and replace well cap and locking steel caps.

8. Decontaminate all the equipment entering the well(s) in accordance with the decontamination SOP.

LNAPL THICKNESS MEASUREMENT PROCEDURES (WELLS/TRENCH MANHOLES)

Care should be taken to minimize water column disturbance. Use the following procedures to collect LNAPL thickness measurements:

1. Open the well/trench manhole cover and monitor the headspace with the appropriate air monitoring instrument to determine the presence of VOCs (if applicable).

2. Lower the Oil Water Interface Probe and measuring tape into the well/trench manhole until the LNAPL surface is reached as indicated by a solid audio tone. Record the distance from the reference point to the LNAPL surface on the LNAPL Thickness Measurement Form.

3. Continue to lower the probe and measuring tape into the well / trench manhole until the LNAPL/water interface is reached as indicated by a beeping audio tone. Record the distance from the reference point to LNAPL/water interface on the LNAPL Thickness Measurement Form.

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4. Calculate the thickness by taking the difference between the two measurements and record on the LNAPL Thickness Measurement Form.

5. If there is no measureable LNAPL thickness; however, globules are observed on the water surface or on the probe tip, record the thickness as "Trace".

6. In field book/field sheet, note if the lock was damaged or missing and any physical changes to well condition, such as erosion or cracks in protective concrete pad, roadbox, standpipe, etc.

7. Remove all downhole equipment used for the LNAPL thickness measurement, and replace well cap and locking steel caps/trench manhole cover.

8. Decontaminate all the equipment entering the well(s) in accordance with the decontamination SOP.

RECORDS AND DOCUMENTATION

All water level/ LNAPL thickness information should be recorded on the attached Water Level Measurement and LNAPL Thickness Measurement Forms

APPLICABLE REFERENCES AND STANDARDS

United States Environmental Protection Agency – Environmental Response Team Standard Operating Procedures "Water Level Measurement" SOP #2043 Revision 0.1, February 11, 2000. USEPA Contract 68-C4-0022

Water Level Measurement Procedure included in the current Hazardous Waste Remediation Bureau Master QAPP, EPA RFA#08036.

ATTACHMENTS

Water Level Measurement Form
LNAPL Thickness Measurement Form

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Water Level Measurement Form
Troy Mills Landfill Superfund Site
Troy, New Hampshire

Date:_____

Field Engineer:_____

Monitoring Well Designation	**Well Type** (2-in, 1.5-in etc)	**Measuring Point**	**Reported Depth to Well Bottom** (ft, referenced to measuring point)	**Measured Depth To Water** (ft, referenced to measuring point)	**Measured Depth to Well Bottom** (ft, referenced to measuring point, only if specified in SAP)	**Comments**
Wells With Water Level Measurements Only						
TRY_P-1	2-in PVC	PVC	---			
TRY_M-3	1 1/2-in PVC	PVC	31.4			
TRY_M-5	1 1/2-in PVC	PVC	---			
TRY_M-6	2-in PVC	Casing	---			
TRY_M-7D	1 1/2-in PVC	PVC	80.8			
TRY_MW-108	1 1/2-in PVC	Casing	---			
TRY_MW-201D	2-in PVC	PVC	---			
TRY_MW-202S	2-in PVC	PVC	13.6			
TRY_MW-202D	2-in PVC	Casing	---			
TRY_MW-502	2-in PVC	PVC	---			
TRY_MW-504	2-in PVC	PVC	---			
TRY_MW-505	2-in PVC	PVC	---			
TRY_MW-506	2-in PVC	PVC	---			
TRY_MW-507	2-in PVC	PVC	13.0**			
TRY_MW-603	2-in PVC	PVC	5.2-15.2			
Wells Currently Sampled That Have Screen Lengths Greater than 10 feet						
TRY_M-1	1 1/2-in PVC	PVC	---			
TRY_M-2	1 1/2-in PVC	PVC	43.9			
TRY_MW-101	1 1/2-in PVC	Casing	82			
TRY_MW-102	2-in PVC	Casing	---			
TRY_MW-104S	2-in PVC	PVC	17.7**/3			
TRY_MW-104D	2-in PVC	PVC	53.1			
TRY_MW-105S	2-in PVC	PVC	9.5			
TRY_MW-105D	2-in PVC	PVC	88.2			
TRY_MW-201P	4-in PVC	Casing	---			
TRY_MW-202P	4-in PVC	PVC	---			

Water Level Measurement Form
Troy Mills Landfill Superfund Site
Troy, New Hampshire

Date:_____

Field Engineer:_____

Monitoring Well Designation	Well Type (2-in, 1.5-in etc)	Measuring Point	Reported Depth to Well Bottom (ft, referenced to measuring point)	Measured Depth To Water (ft, referenced to measuring point)	Measured Depth to Well Bottom (ft, referenced to measuring point, only if specified in SAP)	Comments
Wells Currently Sampled That Have Screen Lengths Greater than 10 feet, continued						
TRY_MW-601S	2-in PVC	PVC	29.3			
TRY_MW-602S	2-in PVC	PVC	36			
TRY_MW-701	2-in PVC	PVC	78.3			
TRY_MW-702D	2-in PVC	PVC	47.2**[/3]			
Wells Currently Sampled With Screen Lengths Equal to or Less than 10 feet						
TRY_M-7	1 1/2-in PVC	PVC	17.3			
TRY_MW-201M	1 1/2-in PVC	PVC	36.6			
TRY_MW-204	2-in PVC	PVC	32.8			
TRY_MW-205	2-in PVC	PVC	39.1			
TRY_MW-301X	2-in PVC	PVC	42.8			
TRY_MW-501X	2-in PVC	PVC	12			
TRY_MW-508X	2-in PVC	Casing	13.9			
TRY_MW-601D	2-in PVC	PVC	62.1			
TRY_MW-602B	2-in PVC	PVC	47.5			
TRY_MW-702SX	2-in PVC	PVC	8.7**[/3]			
TRY_MW-801	2-in PVC	PVC	45 [7]			
TRY_MW-802	2-in PVC	PVC	33.5 [7]			
TRY_MW-803	2-in PVC	PVC	30 [7]			
TRY_MW-804	2-in PVC	PVC	34 [7]			
TRY_MW-805	2-in PVC	PVC	---			
Surface Water Location						
TRY_SW-4	NA	NA	NA		NA	

Notes:

1. "-" indicates that data was not obtained.
2. "---" = GZA included every known monitoring point within the above table. The information for numerous locations have been left blank as GZA does not have the data for those monitoring locations at this time.
3. GZA notes that there appears to be a minor discrepancy between the historical information regarding the bottom of screen/well and that which was measured in July 2008 by GZA in three wells (TRY_MW-702S, TRY_MW-702D, & TRY_MW-104S).
4. "**" indicates downhole information was not verified during the October 8, 2008 camera Survey.
5. NA = not applicable
6. The depth of water measurement at TRY_SW-4 is reference to the permanently installed stream gage at that location
7. For the 800 series wells, depth to bottom information is reported as below ground surface until the stickup height is known (before the next sampling round) then it will be reported as PVC.

LNAPL Thickness Measurement Form
Troy Mills Landfill Superfund Site
Troy, New Hampshire

Date:_____

Field Engineer:_____

Monitoring Well Designation	**Well Type** (2-in, 1.5-in etc)	**Measuring Point**	**Reported Depth to Well Bottom** (ft, referenced to measuring point)	**Measured LNAPL Surface** (ft, referenced to measuring point)	**Measured Depth To LNAPL/Water Interface** (ft, referenced to measuring point)	**LNAPL Thickness** (feet)	**Measured Depth to Well Bottom** (ft, referenced to measuring point, only if specified in SAP)	**Comments**
Remedial Trenches								
Trench A	n/a	manhole rim	n/a					
Trench B	n/a	manhole rim	n/a					
Trench C	n/a	manhole rim	n/a					
Wells With LNAPL Thickness Measurements Only								
TRY_MW-C1S	2-in PVC	PVC	15.0					
TRY_MW-C2S	2-in PVC	PVC	17.2					
TRY_MW-C3S	2-in PVC	PVC	17.8					
TRY_MW-C4S	2-in PVC	PVC	16.7					
TRY_MW-C5S	2-in PVC	PVC	15.0					
TRY_MW-C6S	2-in PVC	PVC	15.2					
TRY_MW-C7S	2-in PVC	PVC	15.0					
TRY_MW-C8S	2-in PVC	PVC	18.1					
TRY_MW-201S	1 1/2-in PVC	PVC	18.2					

Notes:

1. "-" indicates that data was not obtained.

GROUNDWATER WELL SAMPLING – LOW FLOW USING A BLADDER PUMP

SCOPE AND APPLICATION

This Standard Operating Procedure (SOP) *Groundwater Sampling – Low flow Using A Bladder Pump,* provides a general framework for collecting groundwater samples at the Troy Mills Landfill Superfund Site in Troy, New Hampshire that are indicative of total mobile organic and inorganic loads (dissolved and colloidal sized fractions) transported through the subsurface under ambient flow conditions with minimal physical and chemical alterations from sampling operations. This is accomplished by: low pumping rates, negligible water level draw down and stabilization of water quality parameters; emphasizing the need to minimize hydraulic stress at the well-aquifer interface.

This SOP was developed using the "Low Flow Groundwater Purging and Sampling SOP" included in the current NHDES Hazardous Waste Remediation Bureau (HWRB) Master Quality Assurance Project Plan (Master QAPP), EPA RFA#08036 and is considered generally consistent with EPA's "Groundwater Sampling EPA Region 1 "Low Stress (Low-flow) Purging and Sampling Procedure For the Collection of Ground Water Samples From Monitoring Wells," Revision 2, July 30, 1996, Revised January 19, 2010. This SOP will help ensure that the project's data quality objectives (DQOs) are met under certain low-flow conditions. Any modifications to this SOP shall be approved by NHDES in consultation with EPA in advance, documented in the site logbook, and presented in the final report.

This procedure is primarily designed for monitoring wells with an inside diameter that can accommodate a positive lift pump (1.5-inches or greater) with a screen length or open interval ten feet or less and with a water level above the top of the screen or open interval (Hereafter, the "screen or open interval" will be referred to only as "screen interval").

In low permeability formations or poorly installed monitoring wells it may not be possible to collect groundwater samples using the standard low flow procedure. In such instances, refer to the "Monitoring Wells That Have Insufficient Recharge" section for instruction for sampling the well. If the low flow procedure has been attempted unsuccessfully at a well for two consecutive rounds, confer with the field team leader and proceed to the "Monitoring Wells That Have Insufficient Recharge" section without further attempt to use the standard low flow procedure. These wells shall be identified on **Table 2** and **Table 6**. Wells where this occurs should be considered for replacement in the future.

Low flow indicator parameters include: pH, turbidity, specific conductance, temperature, dissolved oxygen (DO) and oxygen reducing potential (ORP). All measurements must be obtained using a "flow-through-cell", except for turbidity. Turbidity must be taken at a point before the flow-through-cell and from an instrument separate from the flow-through-cell apparatus (refer to the attached schematic). A three-way stop cock attached to the tubing before the flow-through-cell will be used for this purpose. Transparent flow-through-cells with a cell

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capacity of 250 ml or less are required. The transparency allows field personnel to watch for air bubbles and particulate build-up within the cell, which may affect indicator field parameter values measured within the cell. The flow-through-cell must be designed in a way that prevents air bubble entrapment in the cell. When the pump is turned off or cycling on/off water in the cell must not drain out. Monitoring probes must be submerged in water at all times.

A small volume cell (250 ml or less) facilitates rapid turnover of water in the cell between measurements of the indicator field parameters. The pump's flow rate must be able to "turn over" at least one flow-through-cell volume between measurements (for a 250 mL flow-through-cell with a flow rate of 50 mL/min., the monitoring frequency would be every five minutes; for a 500 mL flow-through-cell at the same flow rate, it would be every ten minutes). If the cell volume cannot be replaced in the proper interval, (e.g. five minute for a 250 ml flow through cell) then the time between measurements must be increased accordingly.

This procedure does not address the collection of water or free product samples from wells containing free phase light non-aqueous phase liquid (LNAPL). Prior to the installation of any new dedicated bladder pumps, GZA will check for the presence of LNAPL in the planned monitoring wells. If LNAPL is detected, its thickness will be recorded and the bladder pump will not be installed. Wells with LNAPL will not be sampled. The recharge rate of the LNAPL in the well may be determined after consultation with the GZA project manager following an approved SOP in the Sampling and Analysis Plan (SAP).

USE OF TERMS

Field duplicates: Field duplicates are collected to determine precision of sampling procedure. For this procedure, collect duplicate for each analyte group in consecutive order (volatile organic compound [VOC] original, VOC duplicate, SVOC original, SVOC duplicate, etc.).

Matrix Spike/Matrix Spike Duplicates: Used by the laboratory in its quality assurance program. Refer to **Table 3** in the SAP for the sample volume to be collected.

Trip blank (VOCs): Trip blank is a sample of analyte-free water taken to the sampling site and returned to the laboratory. The trip blanks (one pair) are added to each sample cooler that contains VOC samples.

Temperature blank: A temperature blank is added to each sample cooler. The blank is measured prior to shipment and upon receipt at the laboratory to assess whether the samples were properly cooled during transit.

Equipment blank: The equipment blank shall include the pump and the pump's tubing. If tubing is dedicated to the well, the equipment blank need only include the pump in subsequent sampling rounds. If the pump and tubing are dedicated to the well, the equipment blank is collected prior to its placement in the well. If the pump and tubing will be used to sample multiple wells, the equipment blank is normally collected after sampling from contaminated wells and not after background wells.

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Potentiometric Surface: The level to which water rises in a well constructed in a confined aquifer. In an unconfined aquifer, the potentiometric surface is the water table.

BACKGROUND FOR IMPLEMENTATION

Prior to conducting the sampling event, information regarding well construction, development, and water level records for each well to be sampled should be obtained and reviewed to determine the appropriate pump to be used, the location of the intake, and the potential groundwater recharge rate of the well. If this information is not available, a reconnaissance should be made prior to the actual sampling event to determine well depth, water level, length of screen, etc., and performance of a pump test to determine the recharge rate of the well. Additionally, wells that have not been sampled should be redeveloped prior to conducting the actual sampling event, if possible.

It is expected that the monitoring well screen, or open interval has been properly located (both laterally and vertically) to intercept existing contaminant plume(s) or along flow paths of potential contaminant migration. Problems with inappropriate monitoring well placement or faulty/improper well installation cannot be overcome by even the best water sampling procedures. This SOP presumes that the analytes of interest are moving (or will potentially move) primarily through the more permeable zones intercepted by the screen interval.

Proper well construction, development and operation and maintenance cannot be overemphasized. The use of installation techniques that are appropriate to the hydrogeologic setting of the site often prevent "problem well" situations from occurring. During well development, or redevelopment, tests should be conducted to determine the hydraulic characteristics of the monitoring well. The data can then be used to set the purging/sampling rate, and provide a baseline for evaluating changes in well performance and the potential need for well rehabilitation. Note: if this installation data or well history (construction and sampling) is not available or discoverable, for all wells to be sampled, efforts to build a sampling history should commence with the next sampling event.

The pump intake should be located within the screen interval and at a depth that will remain under water at all times. It is recommended that the intake depth and pumping rate remain the same for all sampling events. The mid-point or the lowest historical midpoint of the saturated screen length is often used as the location of the pump intake.

Significant chemical or permeability contrast(s) within the screen may require additional field work (e.g. interval sampling and/or borehole geophysics) to determine the optimum vertical location(s) for the pump/tubing intake, and appropriate pumping rate(s) for purging and sampling more localized target zone(s). Primary flow zones (high(er) permeability and/or high(er) chemical concentrations) should be identified in wells with screen lengths longer than 10 feet, or in wells with open boreholes in bedrock. Targeting these zones for water sampling will help ensure that the low stress procedure will not underestimate contaminant concentrations. (Refer to **Table 4** in the SAP for well construction details and intake depths).

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Stabilization of indicator field parameters is used to indicate that conditions are suitable for sample collection. Achievement of turbidity levels of less than 5 NTU, and stable drawdown of less than 0.3 feet, while desirable, are not mandatory. Sample collection may still take place provided the indicator field parameter criteria in this procedure are met.

A goal of this procedure is to emphasize the need for consistency in deploying and operating equipment while purging and sampling monitoring wells during each sampling event. This will help minimize sampling variability.

Cold weather considerations must be factored into a low-flow sampling plan. It is recommended that low-flow sampling be conducted when the air temperature is above 32°F (0°C). If the procedure is used below 32°F, special precautions will need to be taken to prevent the groundwater from freezing in the equipment. Because sampling during freezing temperatures may adversely impact the data quality objectives, the need for water sample collection during months when these conditions are likely to occur should be evaluated during site planning and special sampling measures may need to be developed. Ice formation in the flow-through-cell will cause the monitoring probes to act erratically. A transparent flow-through-cell is required to observe if ice is forming in the cell. If ice starts to form on the other pieces of the sampling equipment, additional problems may occur.

The use of dedicated sampling equipment is recommended as it promotes consistency in the sampling; may reduce sampling bias by having the pump's intake at a constant depth; and can streamline sampling activities, significantly reducing the time needed to complete each sampling event, thereby reducing the overall field costs.

HEALTH and SAFETY

When working on-site, comply with all applicable OSHA requirements and the site's health/safety procedures. All proper personal protection clothing and equipment are to be worn. Some samples may contain biological and chemical hazards. These samples should be handled with suitable protection to skin, eyes, etc.

PRECAUTIONS

The following precautions needs to be considered when planning to collect groundwater samples when the below conditions occur.

If the groundwater degasses during purging of the monitoring well, dissolved gases and VOCs will be lost. When this happens, the groundwater data for dissolved gases (e.g., methane, ethene, ethane, dissolved oxygen, etc.) and VOCs will need to be qualified. Some conditions that can promote degassing are changes in aperture along the sampling tubing, and squeezing/pinching the pump's tubing which results in a pressure change.

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When collecting the samples for dissolved gases and VOCs analyses, avoid aerating the groundwater in the pump's tubing. This can cause loss of the dissolved gases and VOCs in the groundwater. Having the tubing completely filled prior to sampling will avoid this problem.

Direct sun light and hot ambient air temperatures may cause the groundwater in the tubing and flow-through-cell to heat up. This may cause the groundwater to degas which will result in loss of VOCs and dissolved gases. When sampling under these conditions, shade the equipment from the sunlight (e.g., umbrella, tent, etc.). If possible, sampling on hot days, or during the hottest time of the day, should be avoided. The tubing exiting the monitoring well should be kept as short as possible to avoid the sun light or ambient air from heating up the groundwater.

Condensation (fogging) of Turbidity Vial: Condensation may occur on the outside of the sample cell when measuring a cold sample in a warm, humid environment. Condensation interferes with turbidity measurement, so all moisture must be thoroughly wiped off the sample cell before measurement. If fogging recurs, let the sample warm slightly by standing at ambient temperature or immersing in a container of ambient temperature water for a short period. After warming, gently invert the sample cell to thoroughly mix the contents before measurement.

Thermal currents in the monitoring well may cause vertical mixing of water in the well bore. When the air temperature is colder than the groundwater temperature, it can cool the top of the water column. Colder water which is denser than warm water sinks to the bottom of the well and the warmer water at the bottom of the well rises, setting up a convection cell. "During low-flow sampling, the pumped water may be a mixture of convecting water from within the well casing and aquifer water moving inward through the screen. This mixing of water during low-flow sampling can substantially increase equilibration times, can cause false stabilization of indicator parameters, can give false indication of redox state, and can provide biological data that are not representative of the aquifer conditions" (Vroblesky 2007).

Interferences may result from using contaminated equipment, cleaning materials, sample containers, or uncontrolled ambient/surrounding air conditions (e.g., truck/vehicle exhaust nearby). Cross contamination problems can be eliminated or minimized through the use of dedicated sampling equipment and/or proper planning to avoid ambient air interferences. Clean and decontaminate all sampling equipment prior to use. All sampling equipment needs to be routinely checked to be free from contaminants and equipment blanks collected to ensure that the equipment is free of contaminants. Check the previous equipment blank data for the site (if they exists) to determine if the previous cleaning procedure removed the contaminants. If contaminants were detected and they are a concern, then a more vigorous cleaning procedure will be needed.

PERSONNEL QUALIFICATIONS

All field samplers working at sites containing hazardous waste must meet the requirements of the OSHA regulations. Federal regulations require the sampler to take the 40 hour OSHA health and safety training course and a yearly 8 hour refresher course prior to engaging in any field activities on Superfund Sites.

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The field samplers must be trained prior to the use of the sampling equipment, field instruments, and procedures. Training is to be conducted by an experienced sampler before initiating any sampling procedure.

The entire sampling team needs to read, and be familiar with, the site Health and Safety Plan, the SAP, all relevant SOPs, and the HWRB Master QAPP (including the most recent amendments) before going onsite for the sampling event. It is recommended that field sampling leader attest to the understanding of these site documents and that it is recorded.

EQUIPMENT AND MATERIALS

- Informational materials for sampling event: A copy of the current approved site-specific Health and Safety Plan, site-specific SAP, HWRB Master QAPP, monitoring well construction data, location map(s), field data from prior sampling events, manuals for sampling, diagram(s) to show how the equipment should be set up, and the monitoring instrument's operation, maintenance, and calibration manuals, should be brought to the site.
- Appropriate health and safety gear.
- Site and well keys.
- Electronic water level indicator capable of measuring to one-hundredth of a foot (0.01') accuracy.
- Interface probe capable of measuring to one-hundredth of a foot (0.01') accuracy to check on the presence of free phase liquids (LNAPL).
- Non-contact gas stainless steel bladder pump and operation manual, stainless steel/Teflon bladders (e.g. QED Sample Pro, T1250, and T1300 with a minimum bladder sample capacity of 100 mL; bladder pump repair kits (for T1250 pumps) and replacement bladders for the Sample Pro.

  The size, capacity of the pump, and placement in the well shall be selected to maximize the filling of the pump's bladder. For the proper operation, the bladder pump will need a minimum amount of water above the pump; consult the manufacturer for the recommended submergence. The pump's recommended submergence value should be determined during the planning stage, since it may influence well construction and placement of dedicated pumps where water-level fluctuations are significant.

  For the collection of VOCs and dissolved gases: The bladder's capacity shall be 100 ml (large enough to fill a VOA vial in one discharge) and the pump settings (refill and discharge rates) shall be set so that one pulse will deliver a water volume that is sufficient to fill a 40 mL VOC vial.
- QED bladder pump controller (Model MP-10) capable of adjusting flow to 50 ml/minute, with a manual control option and operation manual.

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- Compressed gas source (Also see "Special Notes" section at end of this SOP): Compressed nitrogen stored in a tank with a gas regulator for 150/200 pounds per square inch (PSI) to a maximum of 400 PSI and the appropriate gas lines with quick disconnect fittings.

  Acceptable alternative method: Compressor (minimum 100 PSI) and marine battery, plus spare marine battery. **NHDES prefers that gasoline powered equipment is not used if at all possible**. If a gasoline-powered source (e.g. generator) is used, it must be located downwind and at a safe distance from the well (at least 30 feet) so that the exhaust fumes do not contaminate the samples.
- Teflon sample tubing (sized for bladder pump) – quantity enough to dedicate to each well and to accommodate connection from the well to the multi-parameter meter, and the T-valve for collecting samples for the turbidity meter.
- Teflon air tubing (sized for bladder pump) - quantity enough to dedicate to each well and to accommodate connection from the bladder pump to the MP-10 controller and the compressed gas source.
- YSI 600XL/XLM Multiparameter unit with a 250 ml or less transparent flow cell, capable of measuring pH (units), ORP in mV, DO in mg/L (100% saturation for calibration), specific conductance in µS/cm and temperature (˚C).
- Hach 2100 P Turbidity Meter and equipment operation manuals.
- Appropriate calibration solutions for the YSI and Hach meters including: 0 mg/L DO for DO; Zobell solution for ORP; two different specific conductance standards to calibrate and check calibration (e.g. 718 and 1,413 µS/cm); 4, 7, & 10 units pH; and < 0.1, 20, 100 and 800 NTUs for turbidity. Extra DO membranes in case of breakage.
- Small wet sponge or paper towel for DO 100% saturation calibration.
- A three way stop cock to divert sample flow (before the multi-parameter meter) to collect turbidity samples.
- Plumbing fittings including clips for holding tubing and water level meter in place within the well casing and prevent pinching of tubing. Plumbing fittings for extending the well sample and air tubing in the well must be either Teflon or stainless steel. Crimping tool for the plumbing fittings.
- Flow measurement supplies: graduated cylinder sized according to the flow rate (250 ml max), measured in 10 ml increments, stop watch, and graduated bucket for purge water.
- Appropriate keys for well-cap locks, spare locks, and bolt cutters.
- Logbook, pencil/pen/sharpies, sharp knife (locking blade), calculator, and engineering scale.
- Field-data sheets, sample labels, and chain-of-custody records.
- Sample containers and spare containers, preserved as necessary, provided by the laboratory.

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- Loose ice and a sample cooler/shipping containers, and packing materials.
- Clear tape – Place clear tape over sample container labels before sampling if it has not been done prior to going into the field in the event the labels are not water proof labels. Alternative – use plastic water proof labels.
- Onsite Tools - (to include at least: bolt cutters, spare well locks, screwdrivers, pliers, hacksaw, duct tape, hammer, flashlight, adjustable wrench), socket set, well key (the well key is to be carried by the sampler).
- Decontamination equipment and supplies in accordance with the Decontamination **SOP B-10** in the SAP
- Appropriate size buckets and lids as specified in the in work plan for containerization of liquids.
- Ziploc® plastic bags and trash bags to containerize solid waste.
- Tap water / Deionized Water (DI) / distilled water, as necessary.
- Protective gloves (examples: rubber, plastic, or latex).
- Flagging/spray paint as needed to demark well locations, if needed.
- Necessary tent /canopy for protection of the equipment from the weather elements.
- Equipment protection paraphernalia (tent /canopy) to:
    - Adequately shade equipment and tubing to prevent temperature variations in the readings, bubbles forming in the tubing, and to prevent the acid preservative in the sample containers from volatilizing;
    - Protect both personnel and equipment from other elements including rain, wind; etcetera.
    - Keep the sampling equipment from freezing in the winter.
    - Keep monitoring and sampling equipment off the ground (e.g. table, bucket or polyethylene sheeting).

EQUIPMENT/INSTRUMENT CALIBRATION

1. In general, all instrumentation necessary for field monitoring and health and safety purposes shall be maintained, tested, and inspected according to the manufacturer's instructions prior to the sampling event. This will ensure that the equipment/instruments are working properly before they are used in the field. The manufacturer's instruction manuals for field equipment shall be on site during each sampling event.
2. All instruments will be successfully calibrated and documented once by the sampling team prior to the sampling event to ensure that the equipment is working properly. **IMPORTANT –** ***Refer to the Calibration SOP B--4 of the SAP for specific calibration information and procedures.***

3. The instruments shall be calibrated at the beginning of each sampling day at the Site using the appropriate solutions. If cold weather conditions exist that may impact successful calibration, consider indoor calibration at hotel/office/site trailer (if heated). The calibration will be checked in the run mode after the morning calibration has been completed to ensure that the calibration was successful. If the field measurement falls outside the calibration range, the instrument must be re-calibrated so that all measurements fall within the calibration range. All calibration data shall be recorded on the calibration log.

   The calibration will be checked at the end of the day in the run mode to verify the accuracy of the instrument readings throughout the day. If a calibration check at the end of the day is not within the acceptable range for that parameter, the data collected that day for that parameter shall be qualified in its use and that information indicated on the calibration log and on the sampling worksheet(s) where that instrument was used that day. In addition, should any erratic or suspect readings occur between calibrations, the instrument shall be recalibrated in order to ensure that representative measurements are obtained.

   If the field instruments are being used to monitor the natural attenuation parameters then a calibration check at mid-day is highly recommended to ensure that the instruments did not drift out of calibration.

   Note: during the day, if the instrument reads zero or a negative number for dissolved oxygen, pH, specific conductance, or turbidity (negative value only); this indicates that the instrument drifted out of calibration or the instrument is malfunctioning. If this situation occurs the data from this instrument will need to be qualified or rejected, and the instrument must be recalibrated before use.

   Failure to calibrate or perform proper maintenance on the sampling equipment and measurement instruments (e.g., multi-parameter meter, etc.) can result in faulty data being collected.

PRELIMINARY PROCEDURES INCLUDING WATER LEVEL MEASUREMENTS

1. The pump's bladder capacity should be optimized to ensure a VOC sample can be collected in one bladder cycle or in the "pause-hold-sample" mode of the MP-10. As a result, a minimum bladder capacity of 100 ml is required to ensure that 40 ml can be obtained to fill the VOC vial.

   The dedicated bladder pump intake within each well should be located at the midpoint of the saturated well screen length based on historical groundwater low unless otherwise specified on **Table 4**.

   The pump intake needs to be kept at least 1 to 2 feet above the bottom of the well to avoid disturbing any sediment on the bottom of the well. <u>If the water level in the well is less than 2 feet, a sample will not be collected</u>.

   Great care must be taken during pump installation and sampling to minimize the disturbance of particulates that can greatly extend the purge time by increasing turbidity.

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2. Check well for security (damage, evidence of tampering, missing lock, etc.) and record pertinent observations (include photograph as warranted). Note any physical changes to well condition, such as erosion or cracks in protective concrete pad, road box or standpipe. If a lock is found to be damaged, replace with a new lock. Wells shall be locked at all times when not being sampled.

3. A synoptic water level measurement round should be performed (in the shortest possible time) before any purging and sampling activities begin. A synoptic water level measurement round is necessary to construct potentiometric surface map(s) for the sampling event. It is recommended that water levels (to 0.01 feet) be measured at least one day prior to well sampling activities, if possible, in order to allow for re-settlement of any particulates in the water column. This is especially important for those wells that have not been recently sampled because sediment buildup in the well may require the well to be redeveloped. All measurements must be taken from the established and permanently marked referenced point (refer to the **Table 4**).

   If the well casing does not have an established reference point (usually a V-cut or indelible mark in the well casing), make one. Describe its location and record the date of the mark in the logbook (consider a photographic record as well). All water level measurements must be recorded relative to this reference point and the altitude of this point should be determined using techniques that are appropriate to the site's DQOs.

   The synoptic water level round shall also include the brook stage measurement at surface water sampling location TRY_SW-4, where a permanent stream gage has been mounted. The stage measurement should be taken to the nearest one hundredth of a foot and recorded on the Water Level Field Measurement Form (included with **SOP B-1**) as well as the Surface Water Field Form (included in **SOP B-5**). Additional measurements will be collected concurrent with the sampling of groundwater well cluster TRY_MW-104 and again when TRY_SW-4 is sampled. Additional measurements may be collected on an as needed basis during the monitoring event.

4. The depth to the bottom of the monitoring well should be confirmed in each well included on **Table 4** based on the following:

   - If a bladder pump has been installed in a monitoring well, the depth to the bottom of the monitoring well will be confirmed at such time when the bladder pump is removed for repairs or maintenance activities, or if a significant increasing trend in the turbidly values has been observed; and
   - In monitoring wells where the bladder pump hasn't been installed yet, the depth to the bottom of the monitoring well will be confirmed once every five years, during the sampling event just prior to the 5-year review.
   - If measurement of total well depth is to be collected and is not made the day before, it should not be measured until after sampling of the well is complete.

5. Set up equipment according to the attached Low Flow Sampling Diagram. Be sure to tilt the low flow cell with the outflow connection facing upward to eliminate and prevent air bubbles.

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6. Be sure all sampling equipment is properly protected from the weather.
7. Lay out sheet of clean polyethylene for monitoring and sampling equipment, unless equipment is elevated above the ground (e.g., on a table, bucket, etc.).

WELL PURGING AND SAMPLING PROCEDURES

1. A water level indicator should be carefully lowered to the top of groundwater. Measure and record the water level (to 0.01 feet) before any disturbance to the well. Care should be taken to minimize suspension of any particulates attached to the sides.
2. Activate the gas source, which activates the pneumatic controller (MP-10).
3. If available, check flow rates, drawdown and pump setting information from previous sampling events for each well. Duplicate, to the extent practicable, the PSI, refill and discharge settings (use final pump dial setting information) and flow rates from previous events. For wells that are routinely sampled, refer to the ***prior Low Flow Well Purging Field Water Quality Measurement Forms*** to determine the initial settings to reach stabilization of the water level as quickly as possible. This is only a guide and the sampler will need to "fine tune" the operating conditions since the recharge rate of groundwater may vary.

   If changes are made in the settings used during previous sampling events, for either portable or dedicated pumps, record new values on the historical table and the field log/sampling worksheet and explain reasons for the changes.
4. From the time the pump starts purging and until the time the samples are collected, the purged water is discharged into a graduated bucket to determine the total volume of groundwater purged. This information is recorded on the purge form.
5. Select the appropriate pressure/cycle setting for the MP-10 controller. The PSI setting should be close to the PSI needed to lift water the depth of the pump intake, plus 10-20 feet, to maximize the discharge volume from the bladder. However, be careful not to set the PSI setting too high resulting in a sample stream that shoots out of the tubing during sampling and/or damage to the bladder. Once final PSI selection is made, lock flow throttle in place.

   The water flow out of the bladder pump during sampling needs to be a laminar flow without air bubbles. If air bubbles are observed they can usually be removed by elevating the discharge tube and pump to allow the air to continue rising until discharged with the water. In the event that it is difficult to remove the captured air bubbles in the sample tubing, use the "pause-hold-sample" mode to flush the air bubbles out of the sample tubing.
6. Prevent sample and air tubing from crimping and avoid the use of constriction devices on the tubing to decrease the flow rate because the constrictor will cause a pressure difference in the water column. This will cause the groundwater to degas and result in a loss of VOCs and dissolved gasses in the groundwater samples. All tubing needs to maintain open condition.

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7. Start with a cycle setting of one cycle per minute, a discharge setting of 20 seconds and a refill setting of 40 seconds unless otherwise indicated on the historical flow sheets. The purge rate should be close to the well recharge rate so that the water level in the well doesn't decrease during purging.

   If excessive turbidity or flow is anticipated or encountered with the pump startup, divert the water through the three way stopcock, as if you were taking a turbidity sample, until it clears in order to minimize particulate buildup in the cell (this is a judgment call made by the sampler). Make sure that the discharge water is going into the graduated bucket as part of the final purge volume.

8. Adjust pump discharge and refill rates (followed by PSI if required) until there is little or no water level drawdown. Keep the refill setting higher than the discharge setting and make sure that the refill setting is greater than 10 seconds. Try to reserve the use of the PSI setting to keep the flow of discharge water laminar. As adjustments are being made, continue to check the water level. Once final PSI selection is made, lock flow throttle in place.

   Concentrate on the bladder pump flow rate and water level stabilization in the beginning of the well purging effort. For new wells being sampled, in general, the water level is expected to be stabilized within the first fifteen minutes of purging.

9. Recording of the indicator parameters is not mandatory during this initial time period when attempts are being made to stabilize the water level; however make sure the purge water is still being collected in the graduated bucket as part of the total purge volume.

   Make a notation on the field form "NR" for "no reading" at times when only partial data is being collected (i.e. water level only) during this initial stage of stabilizing the water level. Note that if you observe minimum fluctuation of the indicator parameters during this initial period go ahead and begin recording data as it may limit the total volume purged. Measure purge volume of a cycle with a 250 ml graduated cylinder or smaller size.

10. During pump start-up, drawdown may exceed the 0.3 feet target and then "recover" somewhat as pump flow adjustments are made. If the initial water level is above the top of the screen do not allow the water level to fall below the top of the well screen. If the drawdown has exceeded 0.3 feet and stabilizes, continue purging until the indicator parameters stabilize.

    If the water level continues to drop with the MP-10 controller settings at one cycle per minute and a discharge setting of one second, or if the flow rate for a stabilized groundwater level is below 50 ml per minute, the well will be considered to have insufficient recharge for low flow sampling. Discontinue sampling at that location and return once the well has sufficiently recharged and there is ample water to purge one tubing volume of water and collect all samples (this may be the next day). Refer to the "*Monitoring Wells That Have Insufficient Recharge*" section below for instructions as to how to sample the well. Sufficient

11. After the water level appears stabilized, if the normal discharge volume from a pump cycle is less than 70 ml, place the controller in the "pause-hold-sample mode" to confirm that a discharge volume of 70 ml or greater can be collected. The "pause-hold-sample mode" will empty the bladder. Note that if the discharge volume is 70 ml or greater, there is no need to perform this check as you will be sampling directly from the pump cycle.

    In the event the "pause-hold-sample mode" volume is less than 70 ml, attempt to change operating conditions to increase the "pause sample mode" volume. If attempts are unsuccessful, call the GZA project manager to discuss the issue. (Note: the need to fill the VOAs with one discharge volume of water is a NHDES requirement and an EPA recommendation.)

12. Begin recording the indicator field parameters. When recording pH and dissolved oxygen data, only use one decimal place (round off to nearest tenth place number). When recording specific conductance, temperature, turbidity, and ORP data, record only whole numbers (round off to the nearest whole number). When turbidity data is less than 5 NTU, data should be recorded as "< 5". When DO data is less than 0.5 mg/L, data should be recorded as "< 0.5".

13. Initially monitor and record the water level (during discharge cycle of the bladder pump), draw down, PSI (pressure), pumping rate (discharge/refill of pump), any adjustments, and the indicator parameters (pH, turbidity, specific conductance, temperature, dissolved oxygen and oxygen reduction potential) <u>every ten minutes</u> until the indicator parameters begin to stabilize (the turbidity sample is collected from the three-way stop cock located prior to the low flow cell).

    If the flow rate for a stabilized groundwater level changes to below 50 ml per minute, the well will be considered to have insufficient recharge. Discontinue sampling and refer to the "*Monitoring Wells That Have Insufficient Recharge*" section below for instructions.

    Once it appears that the indicator parameters have begun to stabilize record the data every 5 minutes. If the well has a history of not stabilizing within the two hour time limit, data collection every 15 minutes is acceptable during the first hour followed by data collection every 10 minutes for the second hour. If the well begins to stabilize more quickly, then record data every 5 minutes.

    If the cell needs to be cleaned during purging operations, continue pumping and disconnect cell for cleaning, then reconnect after cleaning and continue monitoring activities. Record start and stop times for cleaning and give a brief description of cleaning activities.

14. In the event that flow from the bladder pump appears to be a water/air mixture during purging/sampling operations, pull the bladder pump and either check and tighten the tubing and fitting connections. If the flow from the bladder pump still appears to be a water/air mixture, pumping should be discontinued without taking a sample. This may signal that turbulent flow is occurring, the water level in the well is at the pump intake level, or the bladder has been damaged. If possible, lower the pump further into the water so the pump unit is fully submerged (if it is not fully submerged) and continue

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stabilization step operations. If the pump is lowered, the sampler needs to record the reason for lowering the pump and the new pump's depth on the field form(s). This new depth should be maintained as the fixed pumping depth for all subsequent monitoring events.

15. The well is considered ready for sample collection once the water level and the indicator parameters have stabilized and the purge volume requirement has been met, or two hours of purge time has elapsed. Stabilization is considered to be achieved when three consecutive readings at five-minute intervals are within the following limits:

- Temperature =/< 3%
- Specific Conductivity =/< 3% (shall be reported in uS/cm)
- Dissolved Oxygen (DO) =/< 10% for values greater than 0.5 mg/L. If three consecutive DO values are less than 0.5 mg/L, consider the values as stabilized.
- pH =/< 0.1 unit
- ORP =/< 10 millivolts
- Turbidity =/< 10% for values greater than 5 NTU (rounded to a whole number, values between 5 and 10 will be considered stable within +/- 1 NTU). If three consecutive turbidity values are less than 5 NTU, consider the values as stabilized.

16. The final purge volume must be greater than the stabilized drawdown volume plus the pump's tubing volume. If parameter stabilization has been achieved but the purge volume criteria has not been met, pumping must be continued until the combined volume (stabilized drawdown plus tubing volume) has been purged from the well or the two hour limit has been reached.

    Purge volume calculations should utilize stabilized drawdown value, not the initial drawdown. Calculate the volume of water between the initial water level and the stabilized water level. Add the volume of the water which occupies the pump's tubing to this calculation. This combined volume of water needs to be purged from the well before samples are collected. Purge volume calculations must be documented on the field form.

17. If all the indicator field parameters have not stabilized within 2 hours of purging, collect the samples and record the following information on the field worksheet: indicate that two-hour purge limit was reached, note the specific conditions that were not achieved, which parameters were not stabilized, the final set of readings, and the total purge volume.

18. Samples for laboratory analyses must be collected before the flow cell and three way stop cock. This will be done by disconnecting the flow cell and three-way stop cock after reaching stabilization. Collection of the sample is directly from the tubing.

19. When collecting VOCs, if the discharge water volume is 70 ml per discharge or greater, the sampler may sample directly from the pump discharge. In the event the discharge water volume is less than 70 ml per discharge, the water samples will need to be collected through the "pause-hold-sample" function of the QED MP-10 controller.

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20. Remove the cap from the sample container and place it on the plastic sheet or in a location where it won't become contaminated.

21. The priority order in which samples should be collected from each well is as follows, refer to **Table 2** and **Table 6** in the SAP for specific information:

    a. Base neutral/acid extractables;

    b. VOCs (see special notes);

    c. Total manganese or 10 metals, if the 10 metals have not been previously tested for at the sampling location (RCRA 8, Mn, & Fe);

    d. 1,4 Dioxane (as applicable);

    e. MNA Parameters:

        1) Methane/ethane/ethene/carbon dioxide (see special notes);

        2) Sulfate; Chloride; Nitrate/Nitrite, Alkalinity;

        3) Total organic carbon; and

        4) Volatile fatty acids (if applicable).

22. All sample containers should be filled by allowing the discharge to flow gently down the inside of the container with minimal turbulence. Cap sample containers securely after filling each bottle. Sample containers should be wiped dry.

23. Field duplicate samples should be collected by filling a separate container for each analysis immediately following the actual field sample collection and should be in the same priority order as indicated above. Duplicate samples are not intended to be blind duplicate samples. They should be designated with a "DUP" after the well designation (i.e. TRY_M-2 DUP) as indicated in the SAP. Refer to **Table 5** and **Table 6** in the SAP for specific QC sampling requirements.

24. Field matrix spike/matrix spike duplicate (MS/MSD) samples should be collected by filling a separate container for SVOC analysis immediately following the actual field sample collection and duplicate sample if required at this location. Refer to **Table 5** for specific QC sampling requirements and appropriate COC notations required for MS/MSD samples.

25. After collection of the samples, place samples in loose ice within the cooler, deactivate the gas source and disconnect equipment as needed. Tubing should be secured to the inside of the well.

26. Secure the well with the locking cap.

27. All non-dedicated equipment (water level meter) must be decontaminated following the Decontamination **SOP B-10** in the SAP.

28. If equipment blank is required for a bladder pump setup, decontaminate the bladder pump in accordance with the procedures included in **SOP B-10**. Fill the PVC chamber (4-foot PVC riser with end cap to provide well scenario for pump) with DI water. Lower pump

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setup including pump and appropriate Teflon tubing into the PVC chamber. Activate bladder pump and purge one tubing volume of water through the setup. Collect an equipment blank sample by filling the appropriate bottles. Refer to **Table 5** for specific QC sampling requirements and appropriate COC notations required for samples. Continuously add DI water to the PVC chamber until all the bottles have been filled.

MONITORING WELLS THAT HAVE INSUFFICIENT RECHARGE

This procedure is to be used if the well has insufficient recharge and stabilized drawdown cannot be achieved. Well purging is not required prior to taking samples under theses conditions.

If the low flow procedure was attempted unsuccessfully during the current monitoring round, ensure that the well has recharged sufficiently and there is ample water to remove one tubing volume of water and collect all the samples before continuing with this procedure. Apply the last control settings used before purging was discontinued.

1. Measure the water level. Carefully lower a water level indicator to the top of groundwater, measure and record the water level (to 0.01 feet) before any disturbance to the well. Care should be taken to minimize suspension of any particulates attached to the sides.
2. Prior to sample collection, purge one discharge line volume. The purge volume is equal to $h * 3.14(r/12)^2 * 7.48$ gal/ft^3

   One purge volume is equal to (h) * (f) where:
   h = length of tubing
   f = the volume in gal/foot

   Then convert gallons to milliliters (1 gallon = 3785 mL) so that the purge volume can be accurately measured using a graduated cylinder.

Tubing Diameter (inches)	¼ - inch (0.25) OD **(0.17 in ID)***	3/8 - inch (0.375) OD **(0.25 in ID)***	1/2 - inch (0.50) OD **(0.375 in ID)***	5/8 - inch (0.625) OD **(0.50 in ID)***
Volume (gal/foot)	0.0012	0.0026	0.0057	0.0102
Volume (ml/foot)	4.5	9.7	21.7	38.6

3. Remove the cap from the sample container and place it on the plastic sheet or in a location where it won't become contaminated.
4. Following purging of the discharge line, immediately begin collecting groundwater samples with the following parameter priority:
   a. Base neutral/acid extractables;
   b. VOCs (see special notes);

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c. Total manganese or 10 metals, if the 10 metals have not been previously tested for at the sampling location (RCRA 8, Mn, & Fe);

d. 1,4 Dioxane (as applicable);

e. MNA Parameters:

1) Methane/ethane/ethene/carbon dioxide (see special notes);

2) Sulfate; Chloride; Nitrate/Nitrite, Alkalinity;

3) Total organic carbon; and

4) Volatile fatty acids (if applicable).

5. The water samples will need to be collected through the "pause-hold-sample" function of the QED MP-10 controller.

6. All sample containers should be filled by allowing the discharge to flow gently down the inside of the container with minimal turbulence. Cap sample containers securely after filling each bottle.

7. After collection of the samples, place samples in loose ice within the cooler, deactivate the gas source, and disconnect equipment as needed. Tubing should be secured to the inside of the well. All non-dedicated equipment (water level meter) must be decontaminated following GZA's decontamination procedures included in the appropriate SOP.

8. Wells where this occurs will be considered for replacement in the future.

RECORDS AND DOCUMENTATION

A field log must be kept each time ground water monitoring activities are conducted in the field. The attached Low Flow Well Purging Field Water Quality Measurement Form is the approved form for use by staff for low flow sampling. Fill out the form completely. The field log/sampling worksheet should document (at a minimum) the following in ink:

- Job name;
- Well identification, condition of well;
- Name of sample collector(s):
- Date;
- Well depth;
- Screen length (if known);
- Static water level;
- Pump settings (PSI, refill and discharge rates, cycle setting). If settings are modified from the previous round, explain reasons for the changes on the worksheet.

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- Pump rate, or flow rate including units;
- Any adjustments made (including adjustments in flow rates, etc.);
- Time of all measurements;
- All measurement readings of indicator parameters;
- Water level at the specified pumping rate (water levels are measured from the specified measuring point indicated on **Table 4**);
- Drawdown and cumulative drawdown, in feet;
- Total purge volume;
- Time of sample collection (start, and end);
- Sampler's signature;
- Laboratory analyses requested; and
- Notation of which indicator parameters did not stabilize after two hours of purging (if any).

Refer to GZA's **SOP B-11** *Chain-of-Custody, Sample Packaging and Shipment Procedures* in the SAP for additional documentation requirements.

If a calibration check at the end of the day is not within the acceptable range for any parameter(s), the data collected that day for that parameter shall be qualified in its use. A note must be added to the worksheet to indicate the qualification and the values for that parameter highlighted. (Example note: "The afternoon calibration check for ORP was not within the acceptable range; therefore, these ORP values can only be used for determining stabilization and not as representative of actual ORP values of the water being sampled.")

SPECIAL NOTES

When using compressed gas as the compressed air source, be sure to transport tanks upright and properly secured. Always remove regulator and install the protective cover over the cylinder valve to prevent damage to the valve which could result in rapid pressure release, when transporting tanks or moving tank to a new sampling location. When using a tank for the first time, connect the regulator valve and shut the regulator valve off, then open the tank valve all the way and then close the tank valve (this seats the valve seal properly). The regulator valve shall use a PSI gauge that is 150 PSI (minimum) to 400 PSI (maximum).

Special Considerations for Volatile Organic Compound Sampling

The proper collection of a sample for volatile-organic compounds requires minimal disturbance of the sample to limit volatilization and therefore a minimal loss of volatiles from the sample. The following VOC procedures should be followed:

1. Open the vial, set cap in a protected place, and collect the sample. When collecting duplicates, collect both samples at the same time.
2. Do not rinse the vial or excessively overflow it.
3. Do not collect the initial 10 ml (approximate) of sample or the last 10 ml (approximate) of sample of the sample discharge volume. The beginning and end of the sample discharge volume has been in contact with air.
4. Be sure the sample flow is laminar and there are no air bubbles in the sample flow.
5. There should be a convex meniscus on the top of the vial. You can use the cap to create the convex meniscus for VOC samples, if needed.

   For methane/ethane/ethene and carbon dioxide, do not use the sample bottle cap to top off the sample vials. Small bubbles are considered normal for these pre-preserved containers.

6. Check that the cap has not been contaminated (splashed) and carefully cap the vial.
7. Place the cap directly over the top and screw down firmly. Do not over-tighten and break the cap.
8. Invert the vial and tap gently. If an air bubble appears, uncap and attempt to add a small volume of sample to achieve the convex meniscus without excessively overfilling the vial. If there this has to be repeated more than twice, discard the sample and begin again with a new container and preservative. It is imperative that no entrapped air is in the sample vial.
9. Immediately place the vial in the protective foam sleeve (if available) and place into the cooler.

APPLICABLE STANDARDS AND REFERENCES

United States Environmental Protection Agency – Environmental Response Team Standard Operating Procedures "Groundwater Well Sampling" SOP #2007 Revision 0.0, January 26, 1995.

Low Flow Groundwater Purging and Sampling Procedure included in the current Hazardous Waste Remediation Bureau Master QAPP, EPA RFA#08036.

EPA's "Groundwater Sampling EPA Region 1 "Low Stress Purging and Sampling Procedure For the Collection of Ground Water Samples From Monitoring Wells", dated July 30, 1996, as revised January 19, 2010.

ATTACHMENTS

Low Flow Well Purging Field Water Quality Measurement Form
Equipment Setup Diagram

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LOW FLOW WELL PURGING FIELD WATER QUALITY MEASUREMENT FORM

Troy Landfill Superfund Site, Troy, New Hampshire

Date : _____ Well ID : _____

Weather Conditions : _____

Field Personnel: _____

Purging Device (pump type): _____

Reference Measuring Point (Top of PVC/Top of Casing): _____ (See Table 4)

Screen Interval (ft, ref. to measuring point): _____ (See Table 4)

Purging Start Time : _____ (24 hour cycle)

Sample Time: _____ (24 hour cycle)

Initial Water Level (ft, ref. to measuring point): _____

Pump Intake (ft, ref. to measuring point): _____

Head Above Pump Intake (ft, ref. measuring point): _____

Pump Speed @ Stabilization (minimal or no Drawdown), mL/min: _____

Total Purge Volume (gallons): _____

Indicator Parameter Stabilization: **yes** OR **no** (circle one) Time: _____

Two Hour Time Limit Reached ? **yes** OR **no** (circle one) _____

Time at Sample Completion: _____ (24 hour cycle)

Clock Time	Water Level	Drawdown	Cumulative Drawdown	Cycle Setting	Bladder Refill Time	Bladder Discharge Time	Pressure	Purge Rate	Temp. +/- 3%	Spec. Cond. +/- 3%	pH +/- 0.1	ORP +/-10	DO +/- 10% if > 0.5	Turbidity +/- 10% if > 5	Comments/Adjustments
(24 HR)	(ft)	(ft)	(ft)	1-4	setting	setting	(PSI)	(ml/min)	(ºC)	(µS/cm)	units	(mV)	(mg/L)	(NTU)	

Notes: 1. All depths in feet below the referenced measuring point, unless specified.

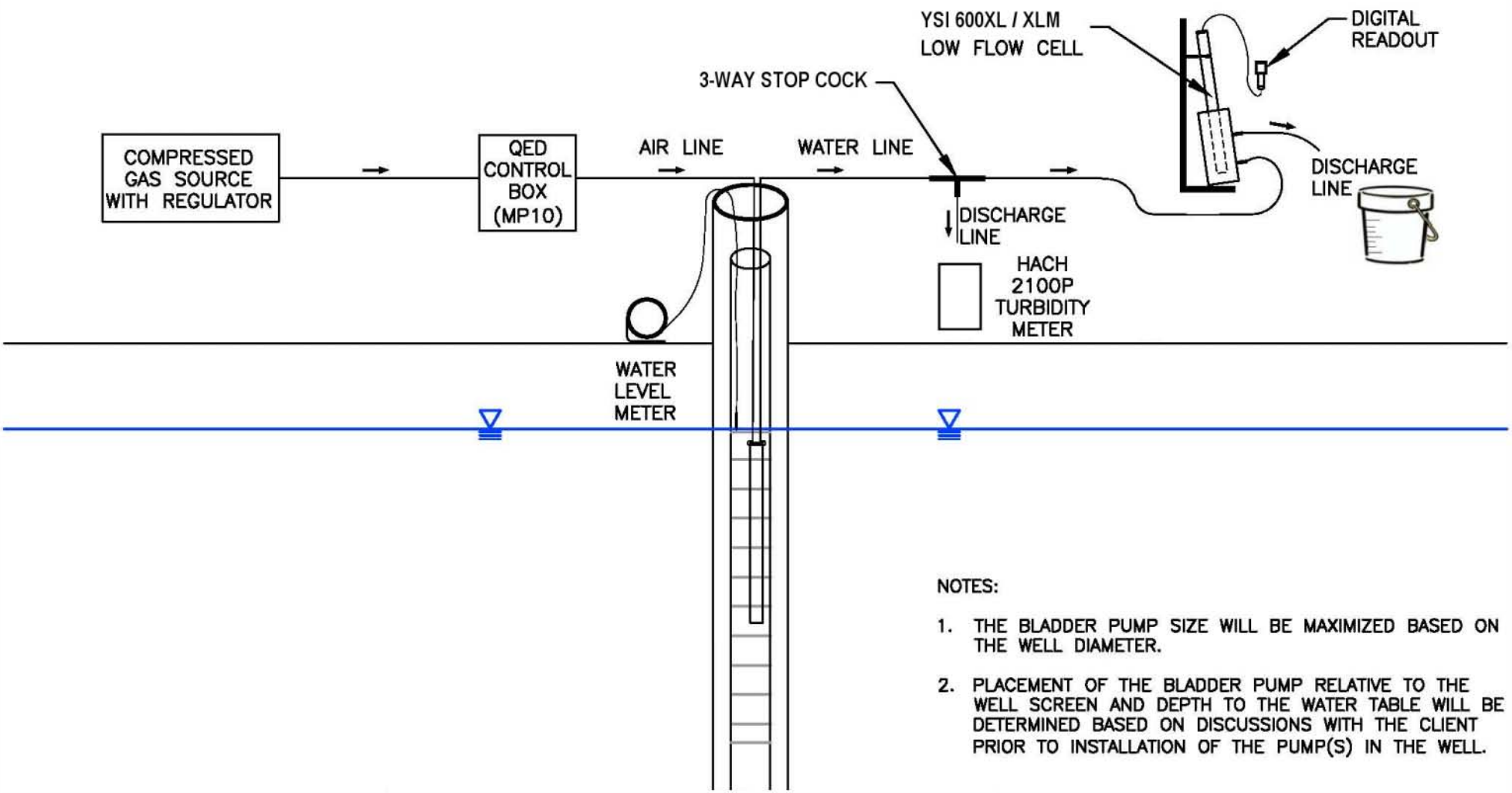
2. When recording pH and dissolved oxygen data, only use one decimal place. When recording specific conductance, temperature, turbidity, and ORP data, record only whole numbers. When turbidity data is less than 5 NTU, data should be recorded as "< 5" or "less than 5". When DO data is less than 0.5 mg/L, data should be recorded as "<0.5" or "less than 0.5".

3. "NR" indicates no reading taken.

_____

Sampler's Signature

SCHEMATIC OF THE LOW FLOW SET UP USING A BLADDER PUMP WITH COMPRESSED GAS SOURCE



NOTES:

1. THE BLADDER PUMP SIZE WILL BE MAXIMIZED BASED ON THE WELL DIAMETER.
2. PLACEMENT OF THE BLADDER PUMP RELATIVE TO THE WELL SCREEN AND DEPTH TO THE WATER TABLE WILL BE DETERMINED BASED ON DISCUSSIONS WITH THE CLIENT PRIOR TO INSTALLATION OF THE PUMP(S) IN THE WELL.

GROUNDWATER WELL SAMPLING - BAILERS

PURPOSE

This Standard Operating Procedure (SOP) *Groundwater Well Sampling - Bailers,* is designed to provide general reference information on purging and sampling of groundwater wells (other than using low flow techniques). The SOP was prepared consistent with and references NHDES Hazardous Waste Remediation Bureau's (HWRB) current Master Quality Assurance Project Plan (QAPP), EPA RFA#08036.

At the Troy Landfill Superfund Site, wells which contain little water will be sampled using a stainless steel or Teflon, bottom filling/bottom dispensing bailer. The bailer will be decontaminated prior to use in accordance with SOP B-10.

This SOP is primarily concerned with the collection of samples from the saturated zone of the subsurface. Every effort must be made to ensure that the sample is representative of the particular zone of groundwater being sampled. These procedures are designed to be used in conjunction with analyses for the most common types of groundwater contaminants (e.g., volatile and semivolatile organic compounds, and metals).

The procedures discussed herein may be varied or changed as required, dependent upon site conditions or equipment limitations. In all instances, the procedures employed should be approved by DES with Environmental Protection Agency (EPA) concurrence, the GZA project manager, documented in the site logbook, and presented in the final report.

EQUIPMENT AND MATERIALS

The following is a list of equipment and material commonly used for the collection of groundwater samples:

- Water-level indicator;
- Clean, portable stainless steel or Teflon, bottom filling/bottom dispensing bailer of appropriate size and construction material,
- Nylon line and suspension rings if needed,
- Appropriate keys for well-cap locks, spare locks, and bolt cutters;
- Logbook, pencil/pen/sharpies, sharp knife (locking blade), calculator, camera, and engineering scale;
- Sample labels, chain-of-custody records and custody seals;
- Sample containers including spare containers, preserved as necessary;
- Toolbox (to include at least: bolt cutters, spare well locks, screwdrivers, pliers, hacksaw, hammer, flashlight, adjustable wrench), socket set, duct tape, well key;

- Appropriate health and safety gear and an approved site-specific Health and Safety Plan;
- Plastic sheeting;
- Self-sealing plastic bags and trash bags to containerize solid waste;
- DI (de-ionized) water;
- Decontamination equipment and supplies in accordance with GZA's SOP B-10; and
- Loose ice and a sample cooler.

PROCEDURES

SECTION I - WELL PURGING PROCEDURES

This sampling procedure does not require that the well be purged prior to sampling. The groundwater sample will be collected without purging, utilizing a "bottom discharge" type bailer.

SECTION II - WELL SAMPLING PROCEDURES

This section includes well sampling methods employed by GZA to sample a groundwater monitoring well using a bailer. A stainless steel bottom filling/bottom dispensing bailer is required. The bailer is equipped with a check with valve at the bottom of the bailer, which allows water to enter from the bottom as the bailer is lowered, and then prevents its release as the bailer is raised. The following describes the general well sampling procedure.

1. Decontaminate bailer before use and between use at different wells in accordance with SOP B-10.
2. Before collecting a groundwater sample, a water level measurement must be obtained. Care should be taken to minimize water column disturbance. Use the following procedures to collect water level measurements:
    - If possible, and when applicable, start at those wells that are least contaminated and proceed to those wells that are most contaminated.
    - Lower water level meter and graduated measuring tape/cable into the well to the water surface.
    - Record the distance from the water surface (to 0.01 feet), as determined by the audio signal or tone, to the reference measuring point (i.e., top of PVC riser or casing) and record in the field book/field sheet. In addition, note the reference point used (top of PVC riser or casing).
    - Record the distance to the bottom of the well (to 0.01 feet) in wells being sampled using a bailer once every 5 years, during the sampling event just prior to the 5-year review.

- In field book/field sheet, note any physical changes to well condition, such as erosion or cracks in protective concrete pad, road box, standpipe, variation in total depth of well, etc.

3. Using the water level and well construction information included on the attached **Table 4** of the SAP, determine the mid point of the saturated screen (sample location).

4. Prior to sampling, the bailer shall be rinsed with a small amount of water from the well to be sampled. During the rinse procedure the bailer does not need to be fully submerged, nor should it be submerged beyond the sample location calculated in #3 above (middle of the saturated screen). To obtain rinse water, slowly lower the bailer, being careful not to drop the bailer into the water, causing turbulence and possible loss of volatile organic compounds (VOCs). Tip bailer enough so that the entire inside of the bailer has been rinsed with groundwater, and pour/dispense out the top. Note: In the event that there is an insufficient volume of water in the well to fill all sample bottles, do not rinse the bailer prior to sampling.

5. Allow the bailer to fill and then slowly and gently retrieve the bailer from the well avoiding contact with the casing, so as not to knock flakes of rust or other foreign materials into the bailer. When pulling the bailer out, ensure that the line either falls onto a clean area of plastic sheeting or never touches the ground.

6. Discharge the rinse water collected from the bailer to the ground. The bailer is then considered "rinsed" and is ready to be used for sample collection.

7. To prevent cross contamination using non-dedicated equipment (i.e., bailer and water level meter), sample the least contaminated wells first and the more contaminated wells last. If the degree of contamination is unknown, sample the upgradient wells first and the downgradient wells last.

8. To collect a groundwater sample repeat the above step. Groundwater will be discharged into the sample containers.

9. The priority order in which samples should be collected from each well is as follows (if appropriate, refer to **Table 2**):

   a. Base neutral/acid extractables;

   b. VOCs (see special notes);

   c. Total manganese or 10 metals, if the 10 metals have not been previously tested for at the sampling location (RCRA 8, Mn, & Fe);

   d. 1,4 Dioxane (as applicable)

   e. MNA Parameters:

      1) Methane/ethane/ethene/carbon dioxide (see special notes);

      2) Sulfate; Chloride; Nitrate/Nitrite, Alkalinity;

      3) Total organic carbon; and

      4) Volatile fatty acids (if applicable).

10. Remove the cap from the appropriate sample container and place it on the plastic sheet or in a location where it won't become contaminated.
11. Begin slowly discharging from the bottom of the bailer using the release devise for the bailer. All sample containers should be filled by allowing the discharge to flow gently down the inside of the container with minimal turbulence.
12. Continue to remove water from the well until sufficient volume has been obtained to fill all sample containers according to the priority order identified above.
13. Cap sample containers tightly and place sample container in the sample cooler.
14. If a field duplicate sample is required, the duplicate sample should be collected by filling a separate container for each analysis immediately following the actual field sample collection and should be in the same priority order as indicated above. Duplicate samples are not intended to be blind duplicate samples. They should be designated with a "DUP" after the well designation (i.e., TRY_M-2 DUP) as indicated in the SAP. Refer to **Table 5** included in the SAP for specific QC sampling requirements.
15. If a field matrix spike/matrix spike duplicate (MS/MSD) sample is required, the MS/MSD sample should be collected by filling a separate container for SVOC analysis immediately following the actual field sample collection and duplicate sample if required at this location. Refer to **Table 5** included in the SAP for specific QC sampling requirements and appropriate COC notations required for MS/MSD samples.
16. If the bailer is dedicated and will remain in the well, it should be suspended as close to the top of the well as possible and above the water column if possible.
17. Replace the well cap and secure the well.
18. Log all samples in the field book and ensure all samples are appropriately labeled.
19. Package samples and complete necessary paperwork.
20. The bailer and water level meter (and all other non-dedicated equipment) must be decontaminated following GZA's decontamination procedures included in SOP B-10 of the SAP.
21. If an equipment blank is required for the bailer, decontaminate the bailer in accordance with the procedures included in SOP B-10. Fill the bailer with DI water and rinse the bailer once. Once rinsed, collect an equipment blank sample by filling the bailer with DI water and then slowly discharging the Rinsate from the bottom of the bailer using the release devise for the bailer. Refill the bailer with DI water as needed to fill all the appropriate containers. Refer to **Table 5** included in the SAP for specific QC sampling requirements and appropriate COC notations required for samples.

RECORDS AND DOCUMENTATION

Refer to SOP B-11 *Chain-of-Custody, Sample Packaging and Shipment Procedures* for documentation requirements.

SPECIAL NOTES

Special Considerations for VOC Sampling

The proper collection of a sample for volatile-organic compounds requires minimal disturbance of the sample to limit volatilization and, therefore, a minimal loss of volatiles from the sample. The following VOC procedures should be followed:

1. Open the vial, set cap in a protected place, and collect the sample. When collecting duplicates, collect both samples at the same time.
2. Do not rinse the vial or excessively overflow it.
3. There should be a convex meniscus on the top of the vial. You can use the cap to create the convex meniscus for VOC samples, if needed.

   For methane/ethane/ethene and carbon dioxide, do not use the sample bottle cap to top off the sample vials. Small bubbles are considered normal for these pre-preserved containers.

4. Check that the cap has not been contaminated (splashed) and carefully cap the vial.
5. Place the cap directly over the top and screw down firmly. Do not over-tighten and break the cap.
6. Invert the vial and tap gently. If an air bubble appears, uncap and attempt to add a small volume of sample to achieve the convex meniscus without excessively overfilling the vial. If there this has to be repeated more than twice, discard the sample and begin again with a new container and preservative. It is imperative that no entrapped air is in the sample vial.
7. Immediately place the vial in the protective foam sleeve (if available) and place into the cooler.

APPLICABLE STANDARDS AND REFERENCES

United States Environmental Protection Agency – Environmental Response Team Standard Operating Procedures "Groundwater Well Sampling" SOP #2007 Revision 0.0, January 26, 1995.

Bailer Sampling Procedure included in current Hazardous Waste Remediation Bureau Master QAPP, EPA RFA#08036.

CALIBRATION OF YSI 600 XL/XLM/HACH 2100P TURBIDIMETER PROCEDURES

PURPOSE

This Standard Operating Procedure (SOP) *Calibration of YSI 600 XL/XLM/Hach 2100P Turbidimenter Procedure,* provides a general framework for calibrating field instruments used to measure water quality parameters for groundwater and surface water at the Troy Mills Landfill Superfund Site in Troy, New Hampshire. Water quality parameters include temperature, pH, dissolved oxygen (DO), specific conductance, Oxidation Reduction Potential (ORP) and turbidity.

This SOP is written for instruments that measure temperature, pH, dissolved oxygen, specific conductance, turbidity, and/or oxidation/reduction potential [ORP] and the probe readings for pH, dissolved oxygen, and specific conductance are automatically corrected for temperature; such as the YSI Models 600XL/XLM. pH meters must be calibrated using three pH standards (4, 7 and 10 pH units). Turbidity must be taken with a separate meter (such as the Hach 2100P Turbidity meter).

This SOP was developed using the "Calibration of Field Instruments SOP" included in the current NHDES Hazardous Waste Remediation Bureau (HWRB) Master Quality Assurance Project Plan (Master QAPP), EPA RFA#08036. Any modifications to this SOP shall be approved by NHDES in consultation with EPA in advance, documented in the site logbook, and presented in the final report.

All field instruments must be calibrated once in the office prior to the sampling event to ensure that the units are working properly.

HEALTH AND SAFETY WARNINGS

Read all labels on the standards and note any warnings on the labels. Wear appropriate personal protection equipment (e.g., gloves, eye shields, etc.) when handling the standards. If necessary, consult the Material Safety Data Sheets (MSDS) for additional safety information on the chemicals in the standards

CALIBRATION ACCEPTANCE CRITERIA

The instruments shall be calibrated at the beginning of each sampling day at the Site prior to sample collection. The calibration shall then be checked immediately following the calibration to ensure the instrument was calibrated properly. If the morning calibration check is not within the acceptable range for that parameter, the instrument shall be recalibrated using all the standards for that parameter and the calibration shall be checked again. See individual parameters for specific instructions. If problems with the instrument continue, backup instruments shall be calibrated and used in place of the inoperable unit.

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The calibration shall be checked again at the end of the day of use to ensure that the instruments have remained in calibration throughout the day. In addition, should any erratic or illogical readings occur between calibrations, the instrument shall be recalibrated in order to ensure that representative measurements are obtained. All calibration and check values shall be documented on the calibration log maintained by each user (see attached log).

If a calibration check at the end of the day is not within the acceptable range for that parameter, the data collected that day for that parameter shall be qualified in its use. This qualification shall be documented on the calibration log and the field sheets/logs for the appropriate sampling locations. For example: pH measurements are collected as part of the low flow sampling procedure. If the afternoon pH calibration check was not within the acceptable range that day, the pH data collected by that instrument on that day would be qualified as useful only for determining stabilization and not as representative pH measurements of the water being sampled. That qualification would then be documented on the calibration log and the sampling sheet / log book for each of those locations.

COLD WEATHER CONDITIONS

Given the temperature sensitivity of the calibration solutions in very cold weather conditions, the NHDES project manager may approve performing the morning calibration and calibration check in the office just prior to going into the field and the end of the day calibration check upon returning to the office. Careful thought must be given before approval. On one hand this may avoid delays and budget increases due to cold weather calibration issues in the field. On the other hand, not being able to check the calibration or re-calibrate in the field may result in the qualification or loss of data if there are problems with the equipment that day. In each case, this deviation to the normal procedure must be approved by the NHDES project manager in advance. If approved, it must be documented on each Calibration Log and in all Site sampling reports (e.g. Annual Report, etc) that the calibration and checks for that day were performed off-site due to very cold weather conditions, including where they were performed and that it was approved in advance by the NHDES project manager. See page two of the attached Calibration Log.

EQUIPMENT AND MATERIALS

The following is a list of equipment and materials commonly used during calibration:

- Multi-meter sonde and handheld meter (such as the YSI 600XL/XLM)
- Calibration solutions:
  - "Zero" (0) mg/L DO check standard,
  - pH buffers 4, 7 and 10 (plus additional pH 4 for overnight storage of YSI probes),
  - Two standards for specific conductance, one for calibration and one for checking the calibration: 1,413 micro Siemens per centimeter [µS/cm]) and 718 µS/cm, and
  - Zobell Solution for ORP;

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- Small wet sponge or paper towel for DO 100% saturation calibration;
- Separate Turbidimeter (such as the Hach 2100P Turbidity meter) w/calibration standards (NTU <0.1, 20, 100, 800);
- Calibration cup with cap;
- Cooler (for storage of calibration solutions);
- Distilled water;
- Paper towels;
- Kimwipes;
- NIST certified thermometer, degrees Celsius (if the vendor has not verified the accuracy of the instrument temperature sensor);
- Ring stand with clamp; and
- Calibration log.

GENERAL INFORMATION

In general, all instrumentation necessary for field monitoring and health and safety purposes shall be maintained, calibrated, tested and inspected according to the manufacturer's instructions. It is assumed that most of this equipment will be rented and is not owned by the contractor. Any reference made to a vendor applies to the owner/renter of the equipment.

Prior to calibration, all instrument probes must be cleaned in accordance with the manufacturer's instructions, preferably by the vendor if the unit is rented. Failure to perform this proper maintenance step can lead to erratic measurements. The vendor is required to provide written documentation (which will be included in sampling reports) that indicates the equipment was cleaned, by who and dated.

Calibration standard values, check results, temperature and barometer checks, and maintenance for each piece of equipment shall be documented on the calibration logs and included in reports as requested by the NHDES project manager. This information includes dates, personnel, calibration standards expiration dates, etc. A calibration log is provided at the end of this SOP.

This SOP requires that the manufacturer's instruction manuals (including the instrument specifications) accompany the instruments into the field.

Turn on the instrument and allow it to warm up according to the manufactures instructions.
Program the multi-probe instrument so that the following parameters to be measured will be displayed: temperature in ˚C; pH, dissolved oxygen (DO) in % for calibration and mg/L for measurements; specific conductance in µS/cm; and ORP in mV.

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All calibration solutions shall be placed into the calibration cup to calibrate the instrument and to check the calibration. The probes shall not be put directly into the bottles of calibration solutions from the vendor. The volume of the calibration solutions must be sufficient to cover both the probe and temperature sensor. See manufacturer's instructions for additional information.

While calibrating or measuring, make sure there are no air bubbles lodged between the probe and the probe guard.

Mark the "date opened" on each new bottle of calibration solution. Record the lot number and expiration date on the calibration log.

All calibration solutions shall be stored in the dark and stored at cool/stable temperatures. Storage of calibration solutions in an insulated cooler kept in the shade will help to maintain calibration solution integrity.

CALIBRATION PROCEDURES

TEMPERATURE (not to be done in the field)

For instrument probes that rely on the temperature sensor, each temperature sensor must be checked for accuracy against a thermometer that is traceable to the National Institute of Standards and Technology (NIST) prior to the sampling event. A temperature check is required once a year for each instrument at a minimum.

This procedure is not to be done in the field.

The temperature check shall be performed prior to the field event, preferably via the vendor if the unit is rented. If the check is not performed by the vendor it must be performed by field personal prior to using the unit. Verification and documentation, including accuracy, dates and personnel, of this procedure is required. The documentation shall be recorded on the calibration log and included in any sampling reports.

<u>Temperature Sensory Accuracy Procedure</u>

1. Allow a container filled with water to come to room temperature.

2. Place a NIST thermometer and the instrument's temperature sensor into the water and wait for both temperature readings to stabilize.

3. Compare the two measurements. The instrument's temperature sensor must agree with the reference thermometer measurement within the accuracy of the sensor (typically ±0.15°C or ±0.2°C). Check the manual that came with the instrument. If the measurements do not agree, the instrument may not be working properly and the vendor/manufacturer needs to be consulted and the unit replaced.

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DISSOLVED OXYGEN

Dissolved oxygen (DO) content in water is measured using a membrane electrode.

The DO probe's membrane and electrolyte solution shall be replaced prior to the sampling event and replaced as needed thereafter. Failure to perform this step may lead to erratic measurements. If the vendor changes the membrane and electrolyte solution they must send the appropriate documentation with each unit. If there is no documentation with the unit, the field personnel will have to replace the membrane and electrolyte solution before the sampling event begins. Documentation shall be noted on the calibration log.

DO Calibration/Calibration Check Procedure

1. Gently dry the temperature sensor according to manufacturer's instructions and inspect the DO membrane for air bubbles and nicks.
2. Place a wet sponge or a wet paper towel on the bottom of the DO calibration container to create a 100 percent water-saturated air environment.
3. Loosely fit the DO probe into the calibration container to prevent the escape of moisture evaporating from the sponge or paper towel while maintaining ambient pressure (see manufacturer's instructions on attaching the calibration container to the instrument). Do not allow the probe to come in contact with the wet sponge or paper towel.
4. Allow the confined air to become saturated with water vapor (saturation occurs in approximately 10 to 15 minutes). During this time, turn on the instrument to allow the DO probe to warm-up according the manufactures directions. Make sure that both the DO reading and the temperature have stabilized before starting the calibration sequence.
5. Select calibration mode; then select "DO %".
6. Enter the local barometric pressure (usually in mm of mercury) for the sampling location into the instrument using an on-site hand held barometer, unless the instrument already has a temperature-compensated barometer.
7. Record the barometric pressure on the calibration log.
8. The instrument should indicate that the calibration is in progress. Observe the readings for percent dissolved oxygen and temperature. When they show no significant change for approximately 30 seconds press enter. After calibration, the instrument should display dissolved oxygen in mg/L (% DO is only used for calibration).
9. Record the initial DO reading in mg/L and temperature reading in ˚C on the calibration log immediately after calibration.
10. To check the calibration (in the run mode), remove the probe from the container and place it into a 0.0 (zero) mg/L DO standard. Do not put the DO probe back into the storage cup (w/sponge), prior to performing the zero check.

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11. Wait until the "mg/L DO" and temperature readings have stabilized. Record the zero mg/L DO reading on the calibration log. The instrument must read 0 to 0.5 mg/L DO. If the instrument cannot reach this value, it will be necessary to clean the probe, and change the membrane and electrolyte solution. If this is unsuccessful, use a new 0.0 mg/L DO standard. If these measures are still unsuccessful, consult the manufacturer/vendor or replace the unit.
12. Remove probe from the zero DO standard, rinse with distilled water, and gently blot dry.

pH (electrometric)

The pH of a sample is determined electrometrically using a glass electrode. Three standards are needed for the calibration: 4, 7 and 10.

<u>pH Calibration/Calibration Check Procedure</u>

1. Allow the buffered standards to equilibrate to the ambient temperature.
2. Fill calibration containers with the buffered standards so each standard will cover the pH probe and temperature sensor.
3. Remove probe from its storage container, rinse with distilled water, and gently blot dry with a Kimwipe. Use caution during drying that the dissolved oxygen probe membrane is not disturbed.
4. Select the calibration mode for a three point pH calibration.
5. Immerse probe into the initial standard, pH 7. Enter the buffered standard value (pH 7) into instrument. Wait until temperature and pH readings stabilize. If the readings do not change within 30 seconds, press enter to accept the calibration.
6. Remove probe from the initial standard, rinse with distilled water, and gently blot dry.
7. Immerse probe into the second standard (pH 4). Repeat step 5.
8. Remove probe from the second standard, rinse with distilled water, and gently blot dry.
9. Immerse probe in third buffered standard (pH-10) and repeat step 5.
10. Remove probe from the third standard, rinse with distilled water, and gently blot dry.
11. To check the calibration, select monitoring/run mode and immerse the probe into the pH 7 buffer solution. Wait for the temperature and pH readings to stabilize. Record the pH value on the calibration log. The value must be pH 7 +/-5% (pH 6.65-7.35). If the calibration check failed re-calibrate the instrument using fresh standards for all three values and check it again. If re-calibration fails, clean the pH probe, consult the manufacture/vendor or replace the unit.
12. Remove probe from the pH 7 check standard, rinse with distilled water, and gently blot dry.

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SPECIFIC CONDUCTANCE

Conductivity is used to measure the ability of an aqueous solution to carry an electrical current. Specific conductance is the conductivity value corrected to 25°C. When monitoring ground water, surface water or pore water use the specific conductance readings and record in µS/cm.

Most instruments are calibrated against a single standard which is near, (above or below) the specific conductance of the environmental samples. A second standard is used to check the linearity of the instrument in the range of measurements. Specific conductivity standards concentrations are generally dependent on expected field conditions and availability. However, there have been some issues with the stability of some of the standards in the field. Unless specified in a site specific SAP, NHDES and EPA have agreed that specific conductivity is, in general, a non critical measurement and it is more important to use standards that are stable in the field even though they maybe above or below the actual field conditions.

The following standards have been field tested, are readily available from most vendors, and are acceptable for use by NHDES and EPA: a 1413 µS/cm standard and a 718 µS/cm standard. It is acceptable to use either one of the standards to calibrate and the other to check the calibration. In general, the 1413 µS/cm standard will be used to calibrate and a 718 µS/cm standard to check the calibration.

<u>Specific Conductance Calibration/Calibration Check Procedure</u>

1. Allow the calibration standards to equilibrate to the ambient temperature.
2. Remove the probe from its storage container, rinse the probe with a small amount of the higher value (1413 µS/cm) specific conductance standard (discard the rinsate), and place the probe into the standard. Be sure that the temperature sensor and the probe's vent hole are immersed in the standard. Gently move the sonde up and down to dislodge any air bubbles from the conductivity cell.
3. Allow at least one minute for temperature equilibrium before proceeding.
4. Select the calibration mode for specific conductance. Enter the calibration value of the standard being used (1413 µS/cm). Allow the temperature and specific conductance to stabilize. If the reading does not change within 30 seconds, press enter to accept the calibration.
5. To check the calibration, select the monitoring/run mode. Remove the probe from the higher standard, rinse the probe with distilled water and then a small amount of the second, lower standard (discard the rinsate), and place the probe into the second, lower (718 µS/cm) standard. The second standard will serve to verify the linearity of the instrument. Read the specific conductance value from the instrument. Record the value on the calibration log**,** and compare the value to the standard. The value must be +/-5%. (682-754 µS/cm for the 718 µS/cm standard). If not, recalibrate using new standards and check again. If the re-calibration does not correct the problem, clean the probe, consult the manufacturer/vendor or replace the unit.

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6. Remove probe from the specific conductance check standard, rinse with distilled water, and gently blot dry.

OXIDATION/REDUCTION POTENTIAL (ORP)

The oxidation/reduction potential is the electrometric difference measured in a solution between an inert indicator electrode and a suitable reference electrode. The electrometric difference is measured in millivolts and is temperature dependent. A Zobell solution is required to calibrate ORP. Read the warning on the label before use.

ORP Calibration/Calibration Check Procedure

1. Allow the Zobell solution calibration standard to equilibrate to ambient temperature.
2. Remove the probe from its storage container, rinse the probe with distilled water, gently blot dry with a Kimwipe and place it into the standard.
3. Select monitoring/run mode.
4. Wait for the probe temperature to stabilize, and then read the temperature. Record the temperature reading on the calibration log.
5. Look up the millivolt (mV) value at this temperature from the temperature / millivolt chart found below and on the calibration log. These values have been rounded to the nearest whole number. Record this value on the calibration log.

Zobell Solution mV Values Based on Temperature for ORP Calibration
Calibration Check Range Values (+/- 5%)

Temp. ºC	ORP Zobell Solution mV Value	Calibration Check Range Values +/- 5%	Temp. ºC	ORP Zobell Solution mV Value	Calibration Check Range Values +/- 5%	Temp. ºC	ORP Zobell Solution mV Value	Calibration Check Range Values +/- 5%
-3	**267**	254-280	10	**251**	238-264	23	**234**	222-246
-2	**266**	253-279	11	**249**	237-261	24	**232**	220-244
-1	**265**	252-278	12	**248**	236-260	25	**231**	219-243
0	**264**	251-277	13	**247**	235-259	26	**230**	219-242
1	**262**	249-275	14	**245**	233-257	27	**228**	217-239
2	**261**	248-274	15	**244**	232-256	28	**227**	216-238
3	**260**	247-273	16	**243**	231-255	29	**226**	215-237
4	**258**	245-271	17	**241**	229-253	30	**225**	214-236
5	**257**	244-270	18	**240**	228-252	31	**223**	212-234
6	**256**	243-269	19	**239**	227-251	32	**222**	211-233
7	**254**	241-267	20	**238**	226-250	33	**221**	210-232
8	**253**	240-266	21	**236**	224-248	34	**219**	208-230
9	**252**	239-265	22	**235**	223-247	35	**218**	207-229

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6. Select the calibration mode for ORP. Enter the temperature-corrected ORP value into the instrument. Once the temperature and ORP values stabilize, press enter to accept the calibration.
7. To check the calibration, select the monitoring/run mode. Immerse the probe in the Zobell solution, read the ORP on the instrument. Record the check value on the calibration log**,** and compare the value to the ORP value of the standard in step 5. The instrument value must be +/- 5% of the calibration value. See the chart above for the check range. If it is not within +/- 5%, recalibrate using a new Zobell solution. If the re-calibration is not successful, consult the manufacture/vendor or replace the unit.
8. Remove the probe from the ORP check standard, rinse with distilled water, and gently blot dry.

TURBIDITY

The turbidity method is based upon a comparison of intensity of light scattered by a sample under defined conditions with the intensity of light scattered by a standard reference suspension. A turbidimeter is a nephelometer with a visible light source for illuminating the sample and one or more photo-electric detectors placed ninety degrees to the path of the light source.

The HWRB low flow procedure requires that the turbidity meter shall have a calibration range from 0.00 to 800 (1000) NTUs.

Some instruments will only accept one standard. For these instruments, additional standards will serve as check points. Turbidity standards concentrations are dependent on expected field conditions. The standards used to calibrate and serve as check points must be within the range expected during that sampling event.

Condensation (fogging):
Condensation may occur on the outside of the sample cell when measuring a cold sample in a warm, humid environment. Condensation interferes with turbidity measurement, so all moisture must be thoroughly wiped off the sample cell before measurement. If fogging recurs, let the sample warm slightly by standing at ambient temperature or immersing in a container of ambient temperature water for a short period. After warming, gently invert the sample cell to thoroughly mix the contents before measurement.

This procedure is based on the use of the Hach 2100P Turbidimeter and the commercially available StablCal® Formazin Primary Turbidity Standards, which is preferred; however, an approved equivalent meter may be used, and the standards may be prepared using Formazin according to the EPA analytical Method 180.1.

Calibration/Calibration Check Procedures for the Hach 2100P Turbidity Meter

1. Use the commercially available StablCal® Formazin Primary Turbidity Standards.

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2. Before performing the calibration procedure, make sure the cells are not scratched. If the cell is scratched, the standard must be replaced.
3. Allow the calibration standards to equilibrate at the ambient temperature.
4. Turn on the meter.
5. The meter should be in the Auto Range. "Auto Rng" and 0.00 NTUs should show on the display. If not press the range key until it is in the auto range and reading to two (2) decimal points (e.g.. 0.00)
6. Gently invert the standards to thoroughly mix the contents. (**DO NOT SHAKE**)
7. Wipe the standards with a soft, lint free cloth or Kimwipe to make sure the outside surfaces are dry, free from fingerprints and dust.
8. Insert the standard into the cell compartment by aligning the orientation mark on the cell with the mark on the front of the cell compartment.
9. Insert the first (blank) standard, <0.1 NTU, into the cell compartment and close the lid.
10. Press **CAL.** The "CAL" and "S0**"** icons will be displayed (the "0" will flash).
11. Press **READ.** The instrument will count down from 60 to 0, read the blank and use it to calculate a correction factor for the second, 20 NTU standard. The display will automatically increment to the next standard. The display will now show "S1" (with the 1 flashing) and "20 NTU", the value of the second standard. Remove the <0.1 NTU standard from the compartment.
12. Insert the second, 20 NTU, standard into the cell compartment and close the lid.
13. Press **READ.** The instrument will count down from 60 to 0, measure the turbidity and store the value. The display will automatically increment to the next standard with the display showing "S2" (with the 2 flashing) and "100 NTU", the value of the third standard. Remove the 20 NTU standard from the compartment.
14. Insert the third, 100 NTU, standard into the cell compartment and close the lid.
15. Press **READ.** The instrument will count down from 60 to 0, measure the turbidity and store the value. The display will automatically increment to the next standard. The display will show the "S3" (with the 3 flashing) and the 800 NTU standard, the value of the fourth standard. Remove the 100 NTU standard from the compartment.
16. Insert the fourth and last, 800 NTU, standard into the cell compartment and close the lid.
17. Press **READ.** The instrument will count down from 60 to 0, measure the turbidity and store the value. Then the display will increment back to the S0 display. Remove the 800 NTU standard from the compartment and close the lid.
18. Press **CAL** to accept the calibration. The instrument will return to the measurement mode automatically.
19. To check the calibration (in run mode), insert the 20 NTU standard into the cell compartment and close the lid.

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20. Press **READ.** The meter will display a lamp symbol (which looks like a light bulb) indicating that the reading is in progress. The lamp turns off and the measurement value is displayed. Record the turbidity reading on the calibration log. The calibration check must be +/- 5% (19-21 NTUs). If not, recalibrate using all standards. If re-calibration is unsuccessful, use new standards, consult the manufacture/vendor or replace the unit.
21. Remove the 20 NTU check standard from the compartment and close the lid.

OVERNIGHT STORAGE OF THE YSI INSTRUMENT

For overnight storage of the YSI, fill the calibration cup with a pH 4 solution, place the probes into the calibration cup and seal tightly.

DATA MANAGEMENT AND RECORDS MANAGEMENT

All calibration information must be documented on the attached calibration log, including the instrument manufacturer, model number and identification number; standards used to calibrate the instruments (including source, lot numbers and expiration dates); date; personnel; the instrument readings, barometer reading, DO membrane inspection, changed DO membrane and solution, etcetera. Each daily calibration log shall be dated and signed by the user.

REFERENCES

Calibration of Field Instruments SOP included in the current Hazardous Waste Remediation Bureau Master QAPP, EPA RFA#08036.

Hach Model 2100P Portable Turbidity Instruction Manual

ATTACHMENTS

Calibration Log

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TROY LANDFILL INSTRUMENT CALIBRATION / MAINTENANCE LOG

Date: **Time:** Field Personnel:

Meter: (circle one) YSI: Model 600XL, Model 600XLM **Multimeter Serial Number:**

Rental Company:

Probe Pre-cleaned Certification Provided By: Personnel **Date:**

Temperature Calibration: Personnel: **Date:**

Manufactures Accuracy Range of Sensor (e.g. +/- 0.2˚C): **Temperature check results:**

Beginning of Day Instrument Calibration

Multimeter Calibration	Value of Standard	Check as Completed	Lot #	Expiration Date	Comments
DO (% saturation)	100%				Allow time for stabilization per manufacture
DO mg/L reading					Record these values immediately after calibration
DO Temp. (˚C) reading					
pH 1st Standard	7				
2nd Standard	4				
3rd Standard	10				
Specific Conductance (µS/cm)	1413				Higher standard is used to calibrate
ORP using Zobell Solution					See Chart on Page 2 for ORP Zobell Solution mV Value Based on Temperature
Zobell Solution _____ ˚C					

Additional Information for Dissolved Oxygen Calibration

Barometric Pressure of Meter or Hand Held Barometer : _____ mm Hg [BP inches _____ x 25.4 + BP _____ mm Hg]

Dissolved Oxygen Charge (YSI Meters): _____ (Acceptable Range: 25 to 75) You MUST change the membrane if charge is out of range.

Inspected DO membrane for nicks or bubbles (check as completed) _____ **Personnel:**_____

Changed Dissolved Oxygen Membrane and Electrolyte Solution (circle one) **YES or NO**

HACH 2100P Turbidimeter Calibration	Value of Standard	Check as Completed	Lot #	Expiration Date	Comments
Turbidity 1st Standard (blank)	<0.1 NTU				Calibrate w/ StablCal® Formazin Primary Turbidity Standards
2nd Standard	20 NTU				
3rd Standard	100 NTU				
4th Standard	800 NTU				

HACH Serial Number: **Rental Company:**

Post A.M. Calibration Check

Date: **Time:** **Personnel:**

Calibration Check	Value of Standard	Check Results	Acceptable Range	Within Range (yes/no)	Lot #	Expiration Date	Comments
Zero DO check (mg/l)	0		0 to 0.5 mg/L				
pH 7 check	7		+/- 5%				Range 6.65 - 7.35 pH
Specific Conductance (µS/cm) Higher standard used for check	718		+/- 5%				Range 682 - 754 µS/cm (718)
ORP check - Zobell (mV)			+/- 5%				See Chart on Page 2 for ORP Zobell Solution mV Value Based on Temperature
Zobell Solution _____ ˚C							
Turbidity 2nd Standard (NTU)	20		+/- 5%				Range 19.0 - 21.0 NTU

Notes: 1) NWS = National Weather Service
2) If the post calibration check is not within the acceptable range the meter must be recalibrated.
3) All calibration checks must be made in the run mode, not the calibration mode.
4) If the lot numbers and expiration dates are the same as the initial calibration place a check mark ✓ in the appropriate box.

Calibration & Post Calibration Check Performed by: _____(Print)_____ (Sign)

END OF DAY INSTRUMENT CALIBRATION CHECK

Calibration Check	Value of Standard	Check Results	Acceptable Range	Within Range (yes/no)	Lot #	Expiration Date	Comments
Date: **Time:**		**Personnel:**					
Zero DO check (mg/l)	**0**		**0 to 0.5 mg/L**				
pH 7 check	**7**		**+/- 5%**				**Range 6.65 - 7.35 pH**
Specific Conductance **(µS/cm)** Higher standard used for check	**718**		**+/- 5%**				**Range 682 - 754 µS/cm (718)**
ORP check - Zobell (mV)			**+/- 5%**				**See Chart below for ORP Zobell Solution mV Value Based on Temperature**
Zobell Solution _____ ˚C							
Turbidity 2nd Standard (NTU)	**20**		**+/- 5%**				**Range 19.0 - 21.0 NTU**

Notes:

1) If the end of the day calibration check is not within the acceptable range the data collected that day for that parameter shall be qualified in it's use.

2) All calibration checks must be made in the run mode, not the calibration mode.

3) If the lot numbers and expiration dates are the same as the initial calibration place a check mark ✓ in the appropriate box.

Cold Weather Conditions:
If the calibration/calibration check was performed off-site (e.g. in the office, etc) due to cold weather conditions, check (√) here:_____
Was prior approval given by the NHDES Project Manager? (Circle one) Yes or No

Where off-site was the calibration/calibration check performed? _____

Calibration Check by _____ _____
Print Name Signature

List wells sampled using this equipment on this day if data needs to be qualified

_____
_____
_____
_____
_____
_____
_____
_____
_____

Zobell Solution mV Value Based on Temperature for ORP Calibration
Calibration Check Range Values (+/- 5%)

Temp. ºC	ORP Zobell Solution mV Value	Calibration Check Range Values +/- 5%	Temp. ºC	ORP Zobell Solution mV Value	Calibration Check Range Values +/- 5%	Temp. ºC	ORP Zobell Solution mV Value	Calibration Check Range Values +/- 5%
-3	**267**	254-280	10	**251**	238-264	23	**234**	222-246
-2	**266**	253-279	11	**249**	237-261	24	**232**	220-244
-1	**265**	252-278	12	**248**	236-260	25	**231**	219-243
0	**264**	251-277	13	**247**	235-259	26	**230**	219-242
1	**262**	249-275	14	**245**	233-257	27	**228**	217-239
2	**261**	248-274	15	**244**	232-256	28	**227**	216-238
3	**260**	247-273	16	**243**	231-255	29	**226**	215-237
4	**258**	245-271	17	**241**	229-253	30	**225**	214-236
5	**257**	244-270	18	**240**	228-252	31	**223**	212-234
6	**256**	243-269	19	**239**	227-251	32	**222**	211-233
7	**254**	241-267	20	**238**	226-250	33	**221**	210-232
8	**253**	240-266	21	**236**	224-248	34	**219**	208-230
9	**252**	239-265	22	**235**	223-247	35	**218**	207-229

SAMPLE COLLECTION – SURFACE WATER AND STREAM SEDIMENTS

PART I – SURFACE WATER

PURPOSE

To obtain surface water samples for analyses that are representative of environmental conditions at the location sampled at the Troy Mills Landfill Superfund Site in Troy, New Hampshire.

EQUIPMENT AND MATERIALS

- Waders, appropriate PPE;
- Appropriate sample containers, prepreserved as necessary;
- Wide-mouth glass sample containers for in-stream sample collection, pre-cleaned by laboratory (one per sample location plus extra);
- Pole and strapping as necessary to collect samples from locations with limited access;
- YSI 600XL or XLM Multiparameter Unit with a probe guard to take in-situ readings and Hach 2100 P Turbidity Meter; and
- Appropriate calibration solutions for the YSI and Hach meters including; 0 mg/L (for DO check), Zobel ORP, 718 µS/cm and 1,413 µS/cm specific conductance, 7, 4, 10 units pH, and <0.1, 20, 100, and 800 NTUs for turbidity.
- Digital camera

PRELIMINARY PROCEDURES

1. In general, all instrumentation necessary for field monitoring and health and safety purposes shall be maintained, tested, and inspected according to the manufacturer's instructions. The manufacturer's instruction manuals for field equipment shall be kept on-site with the equipment.
2. All instruments will be successfully calibrated once by the sampling team prior to the sampling event.
3. Instruments will be calibrated at the beginning of each sampling day at the site and will be checked (in the run mode) in the morning and again at the end of the day. Instrument calibration will be performed additional times during the sampling day if instrument readings appear to be significantly different than previously observed. **IMPORTANT – *Refer to the Calibration SOP B-4 of the SAP for specific calibration information and procedures.***

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4. Surface water and sediment sampling will occur congruent to the groundwater sampling event. Based on weather reports, the sampling team will select the driest period during the Site sampling events to sample stream-related media.

5. An initial brook stage measurement (height of water column in the brook from a permanent location at TRY_SW-4) shall be collected from the permanently mounted stream gage located midstream, just downstream of the SW-4 location during the synoptic water level form (refer to SOP B-1). Transfer the data from the Water Level Measurement Field Form to Surface Water Field Form.

   Two additional brook stage measurements at TRY_SW-4 stream gage station shall be collected including: (1) just prior to the sampling the TRY_MW-104 cluster well, and (2) just prior to the sampling of surface water at TRY_SW-4. The stage measurement should be taken to the nearest one hundredth of a foot. Record this information on the Surface Water Field Form (see attached). If significant changes in flow conditions are observed by the field team, discuss with the GZA Senior Project Manager if surface water sampling should be completed.

6. The following additional information will be included on the Surface Water Field Form (see attached):
   - Past 7 days of local meteorological data showing a minimum of daily precipitation totals and barometric pressure;
   - General physical description of the samples and sampling locations; and notes concerning digital photographs.

7. Digital photographs shall be taken at each sampling location, upstream and downstream from the same position. Consistency should be maintained between sampling rounds.

PROCEDURE

This methodology will be utilized for sampling surface water at the Troy Mills Landfill Superfund Site. Each of the three sampling locations (TRY_SW-3, TRY_SW-4, and TRY_SW-1) are permanently marked in the field so that sampling points are consistent for each round. Refer to the Site Map, **Figure 1**. The following procedures shall be used to collect a surface water sample from each location:

1. Prepare sampling equipment and bottles on a clean sheet of polyethylene near the sample location.

2. Sampling occurs sequentially from downstream (TRY_SW-3) to upstream (TRY_SW-1). Each sampling location is entered from the downgradient side. Laboratory samples are collected followed by in-situ field screening parameters using the YSI meter and turbidity using the Hach meter. If there is a co-located sediment location (TRY_SW-3/TRY_SED SW-3), surface water samples are collected, then in-situ field screening parameters, followed lastly by the sediment sample (Part II below).

3. Samples are collected from the shore providing the safest access to the marked sample

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location. If no safe access is available, attach the sample collection container to a pole with strapping or tape and collect the samples. Note that due to ground conditions around TRY_SW-1 and TRY_SW-4 at various times of the year, samples may be collected from either side of the stream. Sample from whichever side has appropriate flow and can be accessed most safely.

4. A new dedicated, glass (laboratory pre-cleaned), wide-mouth sampling container will be used at each sample location. Rinse the sample container downstream of the sampling location once. The sample will be collected from just below the surface of the water. Make sure that the sample is free of floating debris and/or surface skim. Using the sample container, fill the sample containers from most to least volatile (VOCs, SVOCs, and manganese/hardness).

5. If field duplicate samples are required, duplicate samples should be collected by filling a separate container for each analysis immediately following the actual field sample collection and should be in the same priority order as indicated above. Duplicate samples are not intended to be blind duplicate samples. They should be designated with a "DUP" (i.e. TRY_SW-3 DUP) after the sample ID as indicated in the SAP. Refer to **Table 5** included in the SAP for specific QC sampling requirements.

6. If field matrix spike/matrix spike duplicate (MS/MSD) samples are required, MS/MSD samples should be collected by filling a separate container for SVOC analysis immediately following the actual field sample collection and duplicate sample if required at this location. Refer to **Table 5** included in the SAP for specific QC sampling requirements and appropriate COC notations required for MS/MSD samples.

7. Cap and seal the sample containers.

8. Label, preserve, and store the sample in accordance with appropriate protocols.

9. With the probe guard on the YSI instrument, rinse the probes in the brook downstream of the sampling location.

10. Immerse the probes into the water, immediately upstream of any disturbance caused by accessing the sample location, making sure it is deep enough to cover the probes and probe guard. It is important that there are no air bubbles on/in the electrode. To dislodge any bubbles, gently move the electrode through the water before recording the measurement. If the sample location is not accessible, a pole and strapping may be used to hold the probes in place for stabilization and readings.

11. Allow a minimum of two minutes for the readings to stabilize.

12. Once the readings have stabilized, record the pH (unit), Specific Conductivity (µS/cm), Temperature (°C), ORP (millivolts) and DO (mg/L) on the Field Data Sheet.

13. Rinse out a turbidity vial downstream of the sampling location.

14. Collect an aliquot of water for the Hach and analyze the sample for turbidity. Record the NTU value on the surface water sampling sheet.

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PART II – STREAM SEDIMENT SAMPLES

PURPOSE

To obtain sediment samples underlying water bodies to describe the physical characteristics and to investigate contamination in the sediments at the Troy Mills Landfill Superfund Site in Troy, New Hampshire.

MATERIALS AND EQUIPMENT

- Waders, appropriate PPE;
- Appropriate sample containers (pre-preserved as necessary) along with disposable syringes and stainless steel scoops to collect the VOC samples;
- Disposable syringes for siphoning surface water off top of sediment sample;
- Pre-decontaminated Petite (6 inches by 6 inches) Ponar Dredge;
- A tripod stand to hold the Ponar dredge while excess water is being removed;
- Stainless steel laboratory spoon;
- Stainless steel mixing bowl; and
- Decontamination supplies, as described in the SOP included in Appendix B-10.
- Digital camera

PROCEDURE

This methodology will be utilized at Troy for the co-located sample location (TRY_SW-3 / TRY_SEDSW_3). The sample should be collected from the most safely accessible shore of the surface water body near the permanently marked sample location. The sediment sample is collected after the surface water sample has been collected. The following procedure is to be used for sediment sample collection using a Ponar dredge, assuming that the depth of water is no more than 3 feet deep. Should the depth of water be greater than three feet no sample will be collected. Inform the GZA project Manager of the conditions and note in the log book.

1. Pre-decontaminate the Ponar dredge in accordance with GZA's SOP B-10.
2. Set up the tripod to hold the dredge once is full.
3. Attach a dedicated nylon rope to the hook provided on top of the dredge.
4. Arrange the Ponar dredge sampler in the open position, setting the trip bar so the sampler remains open when lifted from the top.
5. Carefully clear away all surface debris (leaves, twigs, etc.) for a 1-foot radius around the sampling location, taking care not to greatly disturb fine sediments.

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6. Slowly lower the sampler to a point just above the sediment (about 2 inches)
7. Drop the sampler sharply into the sediment, then pull sharply up on the line, thus releasing the trip bar and closing the dredge.
8. Raise the sampler to the surface and slowly decant any free liquid through the screens on top of the dredge. Be careful to retain fine sediments.
9. Suspend the dredge on the tripod.
10. Open the dredge and using a syringe, siphon off, to the extent possible while minimizing the disturbance of any fines, any existing standing water in the Ponar dredge.
11. Collect a VOC sample right from the dredge (using the methanol preserved VOA vials and disposable syringe). Note that VOC sample collection will be conducted in accordance with NHDES' SOP "Preservation of VOCs in Soil Samples" included in the current NHDES' Hazardous Waste Remediation Bureau (HWRB) Master Quality Assurance Project Plan (Master QAPP). Using the disposable syringe, the proper volume of soil is added to the container until the volume in the VOA vial reaches the pre-marked line established by the NHDES laboratory. A separate dry weight sample will not be necessary as long as the dry weight analysis is added to the analysis for the SVOC container.

    Using the syringe method to extract the VOC sample assumes that the water content does not prevent sample collection. If the water content and/or sediment characteristics are such that a sample can't be obtained using a syringe, a stainless steel spoon will be used to transfer sediment from the Ponar dredge to the VOC sample vial.
12. Transfer the remaining sediment to a pre-decontaminated stainless steel mixing bowl. Continue to collect additional sediment from areas adjacent to the original sample location until sufficient material has been gained to fill the remaining sample containers in the priority listed below. Thoroughly mix sediment to obtain a homogeneous sample, and then transfer to the appropriate sample containers.
13. Following VOCs sample collection, the sample containers should be filled in the following priority order:
    - Base neutral/acid extractables (and percent solids);
    - Total metals;
    - Total Organic Carbon, and
    - Grain Size.
14. If a field duplicate sample is required, fill a separate container for each analysis immediately following the actual field sample collection and it should be in the same priority order as indicated above. Note that the VOC sample shall be collected directly from the dredge, prior to sample mixing. Duplicate samples are not intended to be blind duplicate samples. They should be designated with a "DUP" after the sample designation (i.e., TRY_SEDSW_3 DUP) as indicated in the SAP. Refer to **Table 5** included in the SAP for specific QC sampling requirements.

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15. Decontaminate the Ponar dredge in accordance with GZA's SOP B-10.
16. If an equipment blank is required for sediment sampling equipment, following sample collection and after equipment decontamination, gently pour DI water over the Ponar dredge, stainless steel bowl, and mixing spoon used to collect the sediment sample. Collect the rinsate that flows off the equipment into the appropriate sample containers. Refer to **Table 5** included in the SAP for specific QC sampling requirements.

RECORDS AND DOCUMENTATION

All data and sampling information will be recorded as specified in the SAP.

SPECIAL NOTES

None.

APPLICABLE REFERENCES AND STANDARDS

deVera, E.R.; Simmons, B.P.; Stephens, R.D.; and Storm, D.L., "Samplers and Sampling Procedures for Hazardous Waste Streams," EPA-600/2-80-018, January 1980.

U.S. Environmental Protection Agency, "Procedures for Groundwater Monitoring at Solid Waste Disposal Facilities. EPA-530/SW-611, August 1977.

Ford, J.J.; Turina, P.J.; and Seely, D.E., "Characterization of Hazardous Waste Sites - A Methods Manual, Volume II, Available Sampling Methods, EPA 600/X-83-018, March 1983.

"Preservation of VOCs in Soil Samples", included in the current HWRB Master QAPP, EPA RFA#08036

ATTACHMENTS

Surface Water Field Form

Date:

Field Personnel:

SURFACE WATER FIELD FORM
Troy Mills Landfill Superfund Site

WEATHER CONDITIONS

CURRENT		Weather Station Location Used For Historical data:							
Barometric Pressure (in mm/hg)		PAST 7 DAYs							
Storm (heavy rain)		Date							
Rain (Steady Rain)		Barometric Pressure (in mm/hg)							
Showers (Intermittent)		Estimated Rainfall (in)							
Cloud Cover (%)		Comments							
Clear/Sunny									
Comments									

STREAM / SAMPLING LOCATION CHARACTERIZATION

Provide Physical Description of Sampling Locations At The Time of Sampling	Sample Location:
	Photograph #
	Sample Location:
	Photograph #
	Sample Location:
	Photograph #
	Sample Location:
	Photograph #

IN SITU SURFACE WATER QUALITY DATA

Minimum 2 minute parameter stabilization period met (Y/N)?

Sample Location ID	Temperature (ºC)	Specific Conductivity (µS/cm)	pH units	ORP/Eh (mV)	DO (mg/L)	Turbidity (NTU)	Sample Time	Comments
TRY_SW-1								
TRY_SW-3								
TRY_SW-4								

TRY_SW-4 STREAM-STAGE MEASUREMENT (FT)

Initial Synoptic Stream-Stage (from Water Level Measurement Form)	**Date:**		**DTW (ft):**		**Comments:**	
Stream-stage when sampling TRY_MW-104S/D cluster	**Date:**		**DTW (ft):**		**Comments:**	
Stream-stage when sampling surface water TRY_SW-4	**Date:**		**DTW (ft):**		**Comments:**	

Notes: 1. Surface Water Quality Parameters are collected using the YSI 600XL/XLM and Hach 2100 P units as described in GZA's SOP C-7. Both units are calibrated in accordance with GZA's SOP C-4.
2. "NR" indicates no reading

GZA GeoEnvironmental, Inc. **SOP GT-1.0**

Standard Operating Procedure for the GRAIN SIZE ANALYSIS

ASTM TEST METHOD D-422

Copy # 1

Date: 8/99 *Reviewed by Lab Supervisor:* MJM *Date:* 9-1-99

Revision #: *Reviewed by QA Officer:* [illegible] *Date:* 2/14/00

1. Scope and Application

This test method covers the quantitative determination of the distribution of particle size in soils. Soils larger than the 75um (#200 sieve) which consist of sand and gravel sizes are determined by the sieving, and the particle sizes smaller than 75um (#200 sieve) are determined by a sedimentation process using the hydrometer.

2. Method Summary

2.1 Method Overview

During sample preparation ASTM Test method D421-85 is used as a guide for dry preparation of samples. Remove soil samples from sample containers, spread out on plastic sheeting, labeled and a small representative portion is removed for percent solids. Samples then air dry with the aid of fans, for a period of not less than 16hrs. After drying samples are then gravel sieved to remove all particles greater than 4.75um (#4 sieve). A representative portion of - #4 sieve is taken and used for the hydrometer portion of test. In addition another portion of - #4 sieve is used to determine the hygroscopic moisture. Hydrometer readings are recorded in the conventional manner (typically 7-10 readings over 22-26 hr. time interval along with several temperature readings). After completion of hydrometer analysis sample is washed through #200 sieve and all retained material is put in oven to dry for sieve analysis of sand sized particles. This data will be used to determine the calculated percent finer for all sieve and hydrometer readings. Particle sizes ranging from coarse gravel (>19.0mm) to clay sized particles (<2micron). Calculations are predicated on hygroscopic moisture, percent solids and assumed specific gravity (Gs for hydrometer portion only).

2.2 Related Standard Operating Procedures

- GT-2.0 Percent Solids SOP
- SA-3.0 Balance Calibration

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3. Sample Preservation, Containers, Handling, and Storage

Preservation: Non-Applicable

Containers: Jars, Glass or Plastic (4-32oz), Plastic Sample Bags (5 gallon), 5 gallon buckets

Storage: Samples are stored in Laboratory until project is complete, data is sent, and no additional testing required

4. Interference and Potential Problems:

- Sample size is sometimes compromised due to limited amount of material to perform analysis.
- Organic matter can float causing inaccurate Hydrometer readings.
- 1000ml Cylinders can crack (glass) during hydrometer portion of test.
- Error in recording of weights during any step of this analysis.
- Error in calculating data.

5. Definitions

- **Gradation** - The proportions by mass of soil or fragmented rock distributed in specified particle-size ranges.
- **Grain Size Analysis** - The process of determining grain-size distribution.
- **Gravel** - Rounded or semi-rounded particles of rock that will pass a 3 in. (76.2 mm) and be retained on a No. 4 (4.75μm) U.S. standard sieve.
- **Sand** - Particles of rock that will pass the No. 4 (4.75μm) U.S. standard sieve.
- **Silt** - Material passing the no. 200 (75 μm) U.S. standard sieve that is non-plastic or very slightly plastic and that exhibits little or no strength when air-dried.
- **Clay** - Fine-grained soil or the fine grained portion of soil that can be made to exhibit plasticity (putty-like properties) within a range of water contents, and that exhibits considerable strength when air-dry. The term has been used to designate the percentage finer than 0.002mm.
- **Organic** - Soil with a high organic content. (In general, organic soils are very compressible and have poor load sustaining properties.

6. Equipment and Apparatus

- Electric fans (for Sample drying)
- 5 gallon carboys & Squirt bottles (for DI or Demineralized Water)

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- Balance sensitive to 0.01 grams.
- Mixer and dispersion cup
- 1000ml Cylinder for hydrometer analysis
- Thermometer accurate to 1.0 F
- Oven with temperature range of 110± 5°C.
- Sieves (2in,1in,3/4in,1/2in,#4,#10,#20,#40,#60,#100&#200 mesh)
- Hydrometer bulb (ASTM soil test hydrometer 151H)
- Clock with capability to read to seconds
- Spatulas and soil pans for mixing and sieving of soil
- Sieve Shaker for thorough sieving of sand sized particles
- Stirring rod for agitation of sample in hydrometer analysis

7. Reagents:

- Sodium Metaphosphate as dispersing agent,
- distilled and/or demineralized water,
- alconox and dish soaps as cleaning agents for apparatus

8. Health and Safety Issues

Safety glasses, Long pants, socks, gloves and lab coats must be worn when handling samples with known contaminants.

The Laboratory Manager ensures that health and safety procedures are discussed with each new employee by the H&S representative prior to beginning work in the laboratory.

The chemical hygiene plan and the Hazardous Materials Handling and Disposal SOP should be reviewed by each employee. Copies of both plans are kept in the laboratory.

Use caution when dealing with any heated oven zones. Wear heat protection gloves.

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9. Procedures

9.1 **Login:**

Samples are logged in as follows:

- Each sample is given a unique laboratory identification number.
- This number must be sequential beginning with number one.
- In the case of ongoing project refer to next Lab No. in numerical sequence.
- Last Lab No. can be found in log book in laboratory.
- This log must be updated each time a new sample is logged in.

9.2 **Identify Sample for Testing:**
Check soils laboratory testing assignment sheet.

9.3 **Sieve or Sieve Hydrometer:** is assigned if an X is marked under Sieve-200% (for sieve) or Sieve-200% and Hyd-2m% for Sieve Hydrometer.

9.4 **Sample Wet Preparation:**

- Take entire sample record weight under "total sample wet weight"
- Sieve sample through a nest of gravel sieves (3in,2in,1in,3/4in,1/2in, #4sieve).
- Record cumulative weight retained on each sieve.
- Take a representative portion of -#4 sieve (approximately 250-500 grams) and place in a pre weighed pan and record weight (wet weight of soil & container)
- Oven-dry for hygroscopic moisture.

9.5 **Hydrometer Test:**

- Take approximately 50gms (Clay) to 100gms (Sandy) of -#4sieve material and combine in a 250mls container with 125 mls of 4% dispersing agent (Metaphosphate).
- Allow this solution to soak for not less than 16hrs.
- After soaking period is complete decant solution into stir cup using distilled water in squirt bottle , place cup into stirrer and allow to stir for at least one minute.
- Take squirt bottle with DI water and decant into a 1000. cylinder and fill remainder of cylinder with DI until 1000 mls is in cylinder.
- Agitate with stirring rod for one minute in an up-down and stirring fashion to get all material into suspension.
- After agitation, start clock, take hydrometer bulb and start to record settlement versus time specified on raw data sheet (1,2,4,8,16,32,64,120,...aprox.1400 minutes).
- During this phase of tests also record as many temperature readings as feasible coinciding with settlement readings.
- After final hydrometer reading is recorded re-agitate sample and wash through a 200 sieve.
- Take all retained material and place in a pan , put pan in oven to dry.
- After drying has occurred sieve through sand sized sieves and record weight in same manner as wash sieve.

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9.6 **Wash Sieve:**

- Remove sample from oven, record weight (Dry weight of soil & container)
- Wash through a 200 sieve to remove any fine (Silt or Clay) fraction.
- Return to oven and allow to dry not less than 2 hours
- Take out of oven and pour sample into tared pan and record weight (pre-sieve weight).
- Take sample and pour into top of stacked sand sieves (#10,#20,#40,#60,100,#200) put into sieve shaker
- Shake for two minutes.
- Record cumulative weight of material passing #200 to sample and record weight (post sieve).
- Check pre-sieve weight divided by post sieve weight (must be within 5%) to insure proper recovery of soil is recorded.
- Using information contained from hygroscopic moisture calculate total sample dry weight, split sample dry weight, and percent finer by weight

9.7 **Status Check on Data:**

Status is obtained from the soils laboratory testing assignment sheet as follows:

- Test assigned is clearly designated with an X in appropriate column (Step 9.3).
- If one quarter of X is shaded, sample has been prepared
- If one half of X is shaded, sample has been run,
- If three quarters of X is shaded, test has been calculated,
- Finally if entire X is shaded in pencil, test has been Reduced and Reviewed and can be sent as final data.

9.8 **Data Reduction:** All data upon conclusion of test is then inputed into computer program (written and verified by GZA personnel) and computer generated plots are to be furnished along with raw data to lab director or supervisor for data review.

9.9 **Data Review:**

Data Review is done as follows:

- Check calculation for hygroscopic moisture.
- Check calculation for total sample dry weight.
- Check calculation for split sample dry weight.
- Check calculation for dry weight of soil in cylinder.
- Check Gs (specific gravity).
- Check at least one but not limited to one Hydrometer reading.
- After 5.6.1 through 5.6.6 have been verified, cross examine Job Name, sample Identification, soil classification and any other pertinent information on computer plots versus login identification to insure final data is furnished correctly.

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9.10 **Data Report:**

Final data is sent as follows:

- Plotted results of % finer versus grain diameter (mm)
- Tabulated results, if required
- % Solids, if required
- Summary data sheet, if required

10. Calculations - Calculations for percent solids, hygroscopic moisture, total sample dry weight, split sample dry weight, particle size retained and finer by weight (both sieve and hydrometer portion) and dry weight of soil in suspension.

10.1 Formula

10.1.1 Percent Solids (PS):

PS= (Dry weight of soil & pan-pan weight)/(wet weight of soil & pan-pan weight) x 100.

10.1.2 Hygroscopic moisture (HM):

HM= (Wet weight of soil & pan - Dry weight of soil & pan)/ (Dry weight of soil & pan-pan weight) x 100

10.1.3 Total Sample Dry Weight (TSDW):

TSDW= (Total sample wet weight - weight retained on #4 sieve)/ $1+\left(\frac{HM}{100}\right)$ (Weight retained on # 4 sieve)

10.1.4 Split Sample Dry Weight (Sieve Analysis Only) (SSDW):

SSDW = (Dry weight of soil & pan-pan weight)

10.1.4.1 Split Sample Dry Weight (Sieve & Hydrometer) (SSDW):

SSDW= (Weight of wet soil in hydrometer)/ (1+HM)

10.1.5 Dry Weight of Soil in Suspension (DWSS):

DWSS= (SSDW - weight of soil retained on #200 sieve)

10.1.6 Total Weight of Gravel Retained in Percent (TWGR):

TWGR= (weight of gravel retained on sieve)/(TSDW) x 100

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10.1.7 Total Weight of Gravel Finer in Percent (TWGF):

$$TWGF = 1 - \left(\frac{TWGR}{100}\right) \times 100$$

10.1.8 Split (sand portion)Sample Weight Retained in Percent (SSWR):

$$SSWR = \left(\frac{weight\ retained\ on\ sieve}{SSDW}\right) \times 100$$

10.1.9 Split (sand portion) Sample Weight Finer in Percent (SSWF):

$$SSWF = 1 - \left(\frac{SSWR}{100}\right) \times 100$$

10.1.10 Total Sample Sand & Gravel Finer by Weight in Percent (TSSGFW):

$$TSSGFW = \left(\frac{SSWF}{100}\right) \times TWGF$$

10.1.11 Hydrometer Weight Retained in Percent (HWR):

$$HWR = \left[\left(\frac{GS}{1 - GS} \right) \times 100 \div DWSS \right] \times (\text{Hydrometer Reading} - \text{Control Reading})$$

(Note: Control Reading = 4% Dispersing Agent in 1000 mls Distilled Water)

10.1.12 Entire Sample Weight Finer in Percent (ESWF):

$$ESWF = \left(\frac{TSSGFW}{100} \right) \times HWR$$

10.1.13 Diameter Size of Fine Particles (silt or clay) (DSFP):

$$DSFP = K\sqrt{L/T}$$

where K= constant depending on the temperature of the suspension and specific gravity of the soil particles.
T= time in minutes.
L= distance from the surface of the suspension to the level at which the density of the suspension is being measured, cm. This distance is known as effective depth.

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10.2 Verification of calculations

- Calculations are verified via cross reference of hand calculation versus computer generated results.

11. Calibration

- Oven temperature is recorded daily and calibrated every four months (SOP SA-Draft)
- Thermometers are calibrated quarterly, cross measuring temperature with thermometer of higher degree of accuracy (SOP SA-13).
- Balances are checked daily with S class weights and kept in Log Book in lab by Scale (SOP SA 3.0).
- Sieves are calibrated bi-annually (SOP SA-Draft)
- Hydrometers are calibrated annually (SOP SA-Draft)

12. QC Limits

Non-Applicable

13. Corrective Action Procedures

Corrective actions are taken as follows:

13.1.1 Any suspect or questionable data during test is to be reported to Supervisor immediately on finding.

13.1.2 Supervisor will review data and check any calculations for error.

13.1.3 If there is a calculation error that is made, correction will be noted and test will continue.

13.1.4 If there is a procedural error whether it be in Sieving, Menisus Correction or Recording of invalid weight, Supervisor will re-trace procedural steps of sample in question. If error is recovered and corrected test will continue.

13.1.5 If error can not be retrieved, then Supervisor instructs technician to retrieve any unused portion of Sample.

13.1.6 When unused sample is retrieved Supervisor determines if there is enough material and is so instructs technician to re-run entire test. If there is not enough material to re-run test Supervisor relays that information to Project Manager or Client, at this stage it is determined whether more sample can be obtained to run analysis or test is canceled.

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13.1.7 Supervisor or lab technician appointed by Supervisor, must weigh and calculate all oven-dried samples every morning. This is a routine check of testing to determine any errors in recording of weights during test.

13.1.8 When an error occurs during 13.1.7 the following measure is taken: first re-weigh sample & container and check against recorded weight. If weight doesn't check then re-record new weight and re-calculate to see if new data correlates with all other data. If weight checks, then remove oven-dried material and weigh container and repeat prior step. If correction is made test can continue or be reduced and reviewed. If correction is not made then refer to 13.1.6 for corrective action.

13.1.9 Oven-dried samples are not disposed of until Supervisor has checked all data calculations and determines data is valid.

13.1.10 During data review if there are any errors or questionable data Lab Director notifies Supervisor and Supervisor retrieves test sample. If checking test sample by weighing or sieving corrects error than test is reduced again and sent through for review. If checking test sample does not correct mistake then refer to 13.1.6.

13.1.11 Any corrections made to data sheet are done by putting a line through error and recording new data and initialing by individual. If more than one mistake is made and there is no room on data sheet to put correction, a line will be placed through error, a new data sheet will be stapled to original data and a brief explanation as to why sheet is stapled and then new data recorded on stapled sheet and initialed by individual.

13.1.12 Any changes deviance's or unusual measures taken during recording of data shall have an asterisk placed next to unusual data and a brief yet detailed description of what data represents and why its represented in this manner followed by initials of individual taking these actions.

14. Document Description and Example Forms

14.1 See attached Forms

15. Miscellaneous Notes

15.1 Hydrometer portion of analysis is performed on #4 Sieve

15.2 Stirring rod (Army Corps Manual Appendix V Figure 7 page V-16) was used to agitate soil in cylinder during hydrometer analysis.

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16. References

16.1 ASTM D421 - Dry Preparation of Soil Samples for Particle Size Analysis and Determination of Soil Constants

16.2 ASTM D422 - Particle Size Analysis of Soils

16.3 Army Corps Manual EM1110 Appendix V - Combined Analysis

16.4 AASHTO-R18 - Establishing and Implementing A Quality System for Construction and Materials Testing Laboratory

17. Confidentiality Statement

- **This SOP document has been developed and copyrighted by GZA. It is intended for internal (GZA) personnel and government agencies specifically. In addition, the document is not to be released externally for any other purpose without consent of GZA.**

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SAMPLE COLLECTION – LEACHATE

PURPOSE

To obtain leachate samples for analyses that are representative of environmental conditions at the location sampled at the Troy Mills Landfill Superfund Site in Troy, New Hampshire.

EQUIPMENT AND MATERIALS

- Waders, appropriate personal protective equipment (PPE);
- Wide-mouth glass sample container for sample collection, pre-cleaned by laboratory;
- Pole and strapping as necessary to collect the sample;
- Appropriate sample containers (pre-preserved as necessary);
- Extra glass sampling container(s);
- Digital camera

PROCEDURES

Field sampling of leachate will include the semiannual collection of a leachate sample (TRY_SW-LEACHATE) from the discharge area of the culvert west of the site access road, as illustrated on **Figure 1** included in the SAP. In addition, should flow be observed on the east (uphill) side of the access road at the entrance of the culvert, a second leachate sample will be collected (TRY_SW-LEACH-A). The leachate sampling location is permanently marked in the field so that sampling points are consistent for each round.

This area continues to be the only ongoing leachate seep observed since 2006. Should additional seeps be identified in the future, GZA will consult with NHDES and EPA as to whether or not they should be incorporated into the sampling program.

The following methodology will be utilized to collect a leachate samples where minimum sample agitation is required and the sampling depth is typically 1 foot or less:

- Digital photographs shall be taken at each sampling location from the same position(s). Consistency should be maintained between sampling rounds. Note in log book the photo number and directional information for each photo.
- Prepare sampling equipment and bottles on a clean sheet of polyethylene near the sample location.
- For the TRY_SW-LEACHATE sample, the sample should be collected from the shore inside the boom for safety. If no safe access is available, attach the sample collection container to a pole with strapping or tape and collect the samples.

- Use extreme care in lowering the container into the water being careful not to disturb sediments. Using the sample container, fill the sample containers based on the following priority order:
  - Volatile organic compounds (VOCs);
  - Base neutral/acid extractables; and
  - Total manganese and hardness;
- If field duplicate samples are required, duplicate samples should be collected by filling a separate container for each analysis immediately following the actual field sample collection and should be in the same priority order as indicated above. Duplicate samples are not intended to be blind duplicate samples. They should be designated with a "DUP" after the sample designation (i.e. TRY_SW-LEACHATE) as indicated in the SAP. Refer to **Table 5** included in the SAP for specific QC sampling requirements.
- If field matrix spike/matrix spike duplicate (MS/MSD) samples are required, MS/MSD samples should be collected by filling a separate container for SVOC analysis immediately following the actual field sample collection and duplicate sample if required at this location. Refer to **Table 5** included in the SAP for specific QC sampling requirements and appropriate COC notations required for MS/MSD samples.
- Cap and seal the sample containers.
- Label, preserve, and store the sample in accordance with appropriate protocols.

RECORDS AND DOCUMENTATION

All data and sampling information will be recorded as specified in the Sampling and Analysis Plan.

SPECIAL NOTES

None.

APPLICABLE STANDARDS AND REFERENCES

Ford, P.J.; Turina, P.J.; and Seely, D.E., "Characterization of Hazardous Waste Sites - A Methods Manual," Volume II - Available Sampling Methods, EPA 600/S-83-018, 1983.

SAMPLE COLLECTION – WETLAND SOIL

PURPOSE

Surface soil samples are collected to determine the physical characteristics of the material or levels of contamination in near-saturated or saturated wetland soils at the Troy Mills Landfill Superfund Site in Troy, New Hampshire.

EQUIPMENT AND MATERIALS

- Appropriate sample containers (pre-preserved as necessary);
- T-handle auger;
- Stainless bowl(s);
- Stainless steel trowel
- Stainless steel shovel;
- Disposable syringes; and
- Decontamination Supplies, as described in Appendix B-10.
- Digital camera

PROCEDURES

This methodology will be utilized to collect surface / shallow soil samples at designated wetland soil locations (TRY_WES-01, TRY_WES-02, TRY_WES-03, and TRY_WES-04) to a maximum depth of 6-inches deep at the Troy Mills Landfill Superfund Site. The sample locations are in areas where the soils are saturated but there is no standing water above the soil and are permanently marked in the field so that sampling points are consistent for each round. Areas where there is a dense pine mat will be avoided. The following procedures shall be used to collect a wetland soil sample:

1. Note that the physical sample location should be located within a five foot radius of the permanently marked sample location. This will allow the field sampler flexibility in case debris, ponded water, or other condition exists at the permanent sample marker.
2. Clear away all surface debris (leaves, twigs, etc.) for a 1-foot radius around the planned sampling location.
3. Using a pre-decontaminated auger, auger a hole to the desired sampling depth of 6 inches. Carefully withdraw the auger to prevent cave-in of the borehole sidewalls. A pre-decontaminated stainless steel shovel may also be used when appropriate.
4. Transfer soil to a pre-decontaminated stainless steel mixing bowl. Continue to collect

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additional soil until sufficient material has been gained to fill the remaining sample containers. If additional soil is needed, collect the additional soil from a location next to the original sampling location so the soil at the desired depth of 6 inches can be collected. Thoroughly mix soil to obtain a homogeneous sample, and then transfer to the appropriate sample containers using a pre-decontaminated steel soil trowel.

5. The sample containers should be filled in the following priority order:
   - Base neutral/acid extractables (and percent solids);
   - Total metals; and
   - Total Organic Carbon.

6. If a field duplicate sample is required, fill a separate container for each analysis immediately following the actual field sample collection and it should be in the same priority order as indicated above. Duplicate samples are not intended to be blind duplicate samples. They should be designated with a "DUP" after the sample designation (i.e. TRY_WES-01) as indicated in the SAP. Refer to **Table 5** included in the SAP for specific QC sampling requirements.

7. Decontaminate the hand auger and/or stainless steel shovel, stainless steel bowl and mixing spoons in accordance with GZA's SOP B-10.

8. If an equipment blank is required for soil sampling equipment, following sample collection and after equipment decontamination, gently pour DI water over the auger, stainless steel bowl, and mixing spoon used to collect the soil sample. Collect the rinsate that flows off the equipment into the appropriate sample containers. Refer to Table 5 included in the SAP for specific QC sampling requirements.

9. Digital photographs shall be taken at each sampling location from different positions and recorded in the field log book. Consistency should be maintained between sampling rounds.

If the sample location(s) are identified at the time of the sampling event to have <u>standing water (1 foot or less) above the wetland soil locations</u>, the following procedure is to be followed:

- Using a pre-decontaminated auger, auger a hole to the desired sampling depth of 6 inches. Carefully withdraw the auger to prevent cave-in of the borehole sidewalls;
- Surface water should be decanted from the sample prior to transfer using a syringe; care should be taken to retain the fine sediment fraction during this procedure; and
- Follow the steps above to collect the soil samples.

If the depth of <u>standing water above the sample location(s) is greater than 1 foot</u>, GZA will not collect the sample.

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RECORDS AND DOCUMENTATION

All data and sampling information will be recorded as specified in the SAP.

APPLICABLE STANDARDS AND REFERENCES

Dunlap, W.J.; McNabb, J.F.,; Scalf, M.R.; and Crosby, R.L., "Sampling for Organic Chemicals and Microorganisms in the Subsurface," EPA-600/2-77-16, August 1977.

U.S. Environmental Protection Agency, "Characterization of Hazardous Waste Sites - A Methods Manual, Volume II - Available Sampling Methods, EPA 600/X-83-018, March 1983.

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DETERMINATION OF LNAPL RECHARGE

PURPOSE

This methodology shall be used to recover Light Non-aqueous Phase Liquid (LNAPL) from groundwater monitoring wells and remedial trenches with LNAPL at the Troy Mills Landfill Superfund Site and determine the LNAPL recharge rate at the request of the New Hampshire Department of Environmental Services (NHDES). As of June 2008, TRY_TRENCH B and well TRY_MW-201S have been identified as containing LNAPL.

EQUIPMENT AND MATERIALS

- Oil Water Interface Probe;
- Peristaltic pump with tubing,
- 5-gallon bucket with cover;
- Retrieval cable / rope;
- Decontamination supplies, as specified in GZA's SOP B-10; and
- PVC bailers (back-up option).

PRELIMINARY PROCEDURES

- Check monitoring well and trenches for security/damage and record observations; and
- Remove lid from 55-gallon steel drum.

RECOVERY PROCEDURES

Note that **the initial LNAPL thickness measurements/product recovery shall take place at the beginning of the sampling event *to allow for periodic measurements of LNAPL throughout the duration of the sampling event*,** as needed.

1. Groundwater Monitoring Wells

   - Measure the thickness of the LNAPL layer to the nearest one-hundredth of a foot (0.01') using the Oil Water Interface Probe. Record the thickness and time and date of the measurement.
   - Pump the LNAPL out of the well by using a peristaltic pump and discharging product into a 55-gallon drum. Continue to pump product until no measurable LNAPL is observed within the well and no LNAPL layer is observed in the discharge.

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- Measure the thickness of the LNAPL layer to the nearest 0.01' using the Oil Water Interface Probe every hour for the first four hours followed by every day until the end of the field event or the original LNAPL thickness has been reached. Record the LNAPL thickness and elapsed time since product recovery.
- If the peristaltic pump approach doesn't work, contact the GZA Senior Project Manager and consult with NHDES/U.S. Environmental Protection Agency (EPA).
- Determine the theoretical recharge rate of the LNAPL.
- Close drum and label for contents.
- Decontaminate the Oil Water Interface Probe in accordance with GZA's SOP B-10.

2. Trenches

- Note: This test can only be performed if the large sorbent socks currently in the trenches are removed prior to a sampling event.
- Measure the thickness of the LNAPL layer to the nearest 0.01' using the Oil Water Interface Probe. Record the thickness and time and date of the measurement.
- Tie a retrieval cable or rope to several sorbent socks.
- Insert the sorbent socks into the trench to the current depth of the LNAPL per the manufacturer's instructions.
- Retrieve sorbent socks and place in 55-gallon drum.
- Repeat the first four bullets until no measurable LNAPL is observed within the trench. Record the date and time when no measurable LNAPL is achieved.
- In the event that LNAPL recharge is keeping up with LNAPL removal by the sorbent socks, try pumping the LNAPL out by using a peristaltic pump.
- Periodically measure the thickness of the LNAPL layer to the nearest 0.01' using the Oil Water Interface Probe throughout the remainder of the sampling program (every other day until the end of the field event or the original LNAPL thickness has been reached). Record the LNAPL thickness and elapsed time since product recovery. If a peristaltic pump was required to remove the LNAPL, measure the LNAPL thickness every hour for the first four hours followed by every other day until the end of the field event or the original LNAPL thickness has been reached.
- Determine the theoretical recharge rate of the LNAPL.
- Close drum and label for contents.
- Decontaminate the Oil Water Interface Probe in accordance with GZA's SOP B-10.

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RECORDS AND DOCUMENTATION

All data and sampling information will be recorded as specified in the SAP.

SPECIAL NOTES

None.

APPLICABLE STANDARDS AND REFERENCES

None.

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SAMPLING EQUIPMENT DECONTAMINATION PROCEDURE

PURPOSE

This Standard Operating Procedure (SOP) *Sampling Equipment Decontamination Procedure* is designed to provide a procedure for preventing, minimizing, or limiting cross-contamination of environmental samples at the Troy Mills Landfill Superfund Site in Troy, New Hampshire. This SOP focuses on small equipment decontamination (e.g., split spoons, hand augers, water level meters, oil water interface probes, sediment dredge tools, etc.) which combines both physical and chemical removal steps. Removing or neutralizing contaminants from equipment not only minimizes the likelihood of sample cross contamination, but reduces or eliminates transfer of contaminants to clean areas and prevents the mixing of incompatible substances.

Gross contamination can be removed by physical decontamination procedures. These abrasive and non-abrasive methods used by GZA typically include the use of brushes and high and low pressure water cleaning. The first step, a soap and water wash, removes all visible particulate matter and residual oils and grease. The second step involves a distilled/deionized water rinse to remove the detergent. Next, a pesticide-grade hexanes rinse/wipe is performed for trace semi-volatile organics removal followed a pesticide-grade isopropanol rinse to remove trace volatile organics. Isopropanol must evaporate completely prior to a final distilled/deionized water rinse.

Note: Field staff need to check with the principal-in-charge (PIC) and/or the project manager (PM) before conducting field work to confirm the actual field procedure to be followed and to discuss and document any deviations to GZA's standard operating procedure (SOP).

EQUIPMENT AND MATERIALS

The following is a list of equipment and material commonly used for decontamination:

- Non-phosphate detergent (alconox);
- Selected solvent rinses (pesticide-grade isopropanol and pesticide-grade hexane) with spray bottles;
- Distilled or deionized water;
- Long and short handled brushes and bottle brushes (that can fit within the bailer);
- Drop cloth/plastic sheeting;
- Paper towels;
- Plastic / stainless steel tubs or buckets;
- Pressurized sprayers;
- Aluminum foil;

- Ziploc® plastic bags; and
- Appropriate personal protective equipment (i.e., safety glasses appropriate gloves, boots).

DECONTAMINATION PROCEDURES

The decontamination line is setup so that the first station is used to clean the most contaminated item. It progresses to the last station where the least contaminated item is cleaned. The spread of contaminants is further reduced by separating each decontamination station by a minimum of 3 feet. Ideally, the contamination should decrease as the equipment progresses from one station to another farther along in the line.

The decontamination procedure is summarized as follows:

1. Physical removal - non-phosphate detergent wash;
2. Distilled/deionized water rinse;
3. Solvent rinse bath (pesticide-grade hexanes);
4. Solvent rinse wipe (pesticide-grade hexanes);
5. Solvent rinse (pesticide-grade isopropanol);
6. Air dry;
7. Distilled/deionized water rinse; and
8. Secure clean equipment.

Note: The decontamination procedure for water level meters and oil/interface probes shall include special handling of the portion of the water level meter and oil interface probe that has been utilized in level measurement. Rather than rolling the dirty tape back on to the reel, the tape shall be removed from the well by hand and placed in a clean 5-gallon plastic bucket for transportation to the decontamination station. The tape and the bucket will be decontaminated as outlined in the decontamination procedure.

<u>Physical Removal</u>
Fill a wash basin or a large bucket with non-phosphate detergent and tap water. Scrub equipment with soap and water using bottle and/or bristle brushes. For such equipment as bailers, ensure that the interior space is scrubbed with bottle brushes. Wash soap off of equipment with distilled/deionized water from a low-pressure sprayer. Repeat as many times as necessary.

Sensitive equipment which is not waterproof should be wiped down with a damp cloth.

Solvent Bath/Wipe - Hexanes
Rinse sampling equipment by thoroughly submerging contaminated equipment in hexanes contained in a 5-gallon bucket or other appropriate container (solvent bath). Next, carefully wipe the equipment down (inside/outside, as appropriate) with a paper towel saturated with hexane (solvent wipe). Allow hexanes to evaporate.

Solvent Sprayer - Isopropanol
Rinse sampling equipment with pesticide-grade isopropanol. Begin spraying (inside and outside) at one end of the equipment allowing the solvent to drip to the other end into a 5-gallon bucket. Rinse sampling equipment with distilled/deionized water with a low-pressure sprayer.

Clean Equipment Drop
Lay clean equipment on plastic sheeting. Once air dried, wrap sampling equipment with aluminum foil, plastic, or other protective material.

IDW (Investigative Derived Waste) Disposal
Solid Waste – Place all solid waste materials generated from the decontamination area (i.e., gloves and plastic sheeting, etc.) in an approved container.

Liquid Waste – Place used soap water and solvent liquid wastes into 5-gallon plastic containers and store with lid on. Return decontamination solids/fluid containers to office and contact appropriate office personnel to arrange for disposal.

RECORDS AND DOCUMENTATION

General decontamination procedures should be documented in the field log book.

SPECIAL NOTES

All field activities must be carried out in accordance with a site-specific Health and Safety Plan. MSDS' are required to be on site when using decontamination acid and/or solvent solutions.

APPLICABLE STANDARDS AND REFERENCES

United States Environmental Protection Agency – Environmental Response Team Standard Operating Procedures "Sampling Equipment Decontamination" SOP #2006 Revision 0.0, August 11, 1994.

Decontamination SOP in the current NHDES Hazardous Waste Remediation Bureau (HWRB) Master Quality Assurance Project Plan (HWRB Master QAPP), EPA RFA#08036

CHAIN-OF-CUSTODY, SAMPLE PACKAGING AND SHIPMENT PROCEDURES

PURPOSE

This Standard Operating Procedure (SOP) *Chain-of-Custody, Sample Packaging and Shipment Procedures* has been established to provide for sample integrity in addition to proper sample labeling and completion of Chain-of-Custody (COC) forms; and proper sample packaging and shipment for the Troy Mills Landfill Superfund Site (Troy).

A COC is a legal document designed to track persons who are responsible for the preparation of the sample container, sample collection, sample delivery, sample storage, and sample analysis. The field sampler is personally responsible for the care and custody of the samples until they are transferred or properly dispatched. As few people as possible should handle the samples. A sample including empty sample containers, samples and coolers are under a person's custody if it meets the following requirements:

- It is in the person's possession;
- It is in the person's view, after being in the person's possession;
- It was in the person's possession and it was placed in a secured location; or
- It is in a designated secure area.

******Never leave samples including un-used sample containers unattended unless they are secured in a locked vehicle or building for which no one else has access******

All samples submitted to a laboratory shall be accompanied by a properly completed COC form, be packaged and shipped as appropriate. Always check with the selected laboratory-specific requirements regarding COCs.

For the Troy project, all samples will be delivered to the New Hampshire Department of Environmental Services (NHDES) laboratory by GZA and/or NHDES courier with the exception of volatile fatty acids (VFA), carbon dioxide, and methane/ethane/ethane. These samples will be shipped directly to Microseeps Inc. by GZA. Examples COCs for each laboratory are attached.

EQUIPMENT AND MATERIALS

The following is a list of equipment and material commonly used for labeling, packaging and shipping samples:

- COC forms/seals;
- bubble wrap or air cushions;
- re-sealable plastic bags;

- permanent waterproof ink marker;
- black ink pen;
- loose ice;
- shipping coolers;
- sample labels;
- packing ; and
- tape.

CUSTODY PROCEDURES

1. The field sampler will review the Sampling and Analysis Plan (SAP) provided by the project manager for specific COC record-keeping requirements. Note the following key COC related items:
   - Quality Assurance/Quality Control (QA/QC) data package requirements (i.e., level A, B, or C) for project-specific data validation needs;
   - Laboratory reporting options required (i.e., preliminary results requested or electronic deliverable options needed);
   - Turn-around-time required (standard or rush);
   - Special laboratory requirements required (i.e., lower detection limits);
   - Short hold time issues; and
   - Sample volume issues.
2. The field sampler will label all sample bottles with the following: sample ID, sampler name, date and time sample was collected, laboratory analysis and test method requested, preservative used, Site name/location, and GZA project number. Sample tags should be filled out using waterproof ink for each sample. *Note: No additional labels should be used for soil VOA samples as these are pre-weight by the laboratory. GZA field staff should use the pre-provided label already on the container.*
3. Prior to leaving the site, the field sampler will verify that all pertinent data is on both the sample label and the COC form. Check for errors on the label and COC form.
4. The unique laboratory COCs (example NHDES, and Microseeps COCs are attached) will be filled out and include the following: unique sample ID, time and date of collection, matrix type (i.e., soil, groundwater, surface water), laboratory test and method requested, the preservative used, the number of containers, and any special notes. The COC should also include any QA/QC samples and associated information (i.e., duplicate, trip blank, temperature blank, and equipment blanks).

   Either one of the field samplers or the onsite QA Officer will prepare the COCs. The names and phone numbers of all the field samplers and the QA Officer must be listed on the COC.

5. When transferring the possession of samples, the individuals relinquishing and receiving will sign, date, and note the time on the record. This record documents transfer of custody of samples from the sampler to another person, to a mobile laboratory, to the permanent laboratory, or to/from a secure storage area.

   Only one of the field samplers signs the first "relinquished by" line. The person who receives the samples at the laboratory signs the COC last in the "received by" line. In case there are additional steps in the process requiring another person or persons to take custody of the sample, the form has additional lines for signatures. All signatures must be in ballpoint pen and are followed by a date and time that the COC was signed. The line at the bottom of the page is provided for personnel from the laboratory to sign for receiving the sample. If the samples are taken to the lab via courier the sampler will relinquish the samples to "NHDES Laboratory via courier."

   Note: No erroneous information may be erased on the COC. Errors must be lined out and initialed, and the correction written in.

6. If the samples are shipped by public courier (i.e., Federal Express, UPS, etc.) the airbill generally serves as the chain-of-custody record for that portion of the trip and will be retained by the field sampler (and provided to the project manager) as part of the permanent documentation.

7. The project manager and/or QC officer will review the COC to evaluate completeness; holding time or sample volume issues that may impact the validity of the results.

SAMPLE PACKAGING PROCEDURES

Sample containers are generally packaged in insulated coolers for shipment or pickup by the laboratory courier. Appropriate packing materials include bubble wrap and air cushions. Sample containers are packed tightly so minimize movement during shipment that may cause breakage.

1. To eliminate the chance of breakage during shipment, approximately 1 inch of inert material shall be placed in the bottom of the cooler.

2. Include a temperature bank and any necessary trip blanks in loose ice in each cooler prior to sample collection.

3. Place each sample container, or sample site set of containers that have been bubble wrapped tightly inside a plastic bag and seal, as a precaution against cross-contamination due to leakage or brakeage.

4. Place all containers in an upright position into the loose ice in the cooler and place all glass containers in such a way that they do not come into contact with each other during shipment.

5. After samples have been packed, **loose ice** will be added to the cooler to ensure temperature preservative is achieved (temperature 4 +/-2 degrees Celsius).

6. Include a completed COC in a sealed Ziploc® bag within each cooler being shipped to or picked up by the laboratory.

7. Coolers being shipped (not couriered) will be secured with strapping tape in at least two locations for shipment to the laboratory and include a custody seal.
8. Prior to any cooler being shipped that contains environmental samples, **you are required to evaluate if the samples/sample containers being shipped are considered hazardous**. Consult appropriate trained office personnel for proper packaging and labeling requirements.

SAMPLE PICKUP/SHIPPING PROCEDURES

Samples will be properly packaged for shipment, and a separate signed COC record will be enclosed in each sample cooler if more than one is used. Shipping containers will be secured with strapping tape and a custody seal in at least two locations for shipment to the laboratory. When samples are transported via courier, strapping tape and custody seals are not required.

Samples will be transported to the NHDES laboratory in such a manner as to preserve their integrity and will be delivered at least every other day and if possible, no samples should be held over the weekend. Samples requiring shipment to Microseeps shall be sent next-day delivery by Federal Express or an equivalent overnight carrier. The receiving laboratory shall be given advance notice by the field sampler no later than 48 hours before sample shipment.

If Friday sampling is unavoidable and Saturday delivery is not possible, samples shall be properly stored (custody and sample preservation must be maintained) over the weekend in GZA's office sample refrigerator. The building is locked when GZA personnel are not present to prevent unauthorized access. If prompt shipping and laboratory receipt of samples cannot be guaranteed, the samplers will be responsible for proper storage of samples until adequate transportation arrangements can be made or sample collection schedules can be modified by the Project Manager. If holding times would be exceeded by storing the samples, alternative arrangements must be made by the Project Manager for sample collection and shipment or pickup.

DOCUMENTATION

The original COC record will accompany the cooler and a copy will be retained by the sampler for return to the project manager.

APPLICABLE STANDARDS AND REFERENCES

Chain of Custody Sample Handling & Shipping Procedure included in the current Hazardous Waste Remediation Bureau Master QAPP, EPA RFA#08036.

ATTACHMENTS

Example COCs (2) for NHDES and Microseeps

NH DES LABORATORY SERVICES LOGIN AND CUSTODY SHEET

(Laboratory Policy: Samples not meeting method requirements will be analyzed at the discretion of the NH DES Laboratory.)

LAB ACCOUNT (Billing) #04-0000307 **One Stop (PROJECT) ID# SUPERFND** **DES Site Number 198405082** **Temp. ^{0}C. _____**

Description: Troy Mills Landfill Superfund Site **Town: Troy NH**

Comments:

RCRA 8 = As, Ba, Cd, Cr, Pb, Hg, Se, Ag

NHDES Contact: Sharon Perkins (603) 271-6805
GZA Contact: Michael Asselin (603) 232-8739
Collected By & Phone#:
Stefanie Lamb (603)-493-1548
Amy Doherty (603) 361-4222
Tanya Justham (603) 493-1548
Heidi Rizza (603) 361-0177

Sample Location /ID	Date/Time Sampled	# of Containers	Matrix	8260B	1,4-Dioxane	8270	Mn	RCRA 8 & Fe, Mn	Nitrate/ Nitrite, Alkalinity, Chloride, & Sulfate	TOC	Harness	Comment	Lab ID # (For Lab Use Only)

Preservation: Aqueous VOCs – HCL/4°C +/-2°C; Solid VOCs – Methanol/4°C +/-2°C; 1,4-Dioxane- $NaHSO_4$ 4°C +/-2°C; Metals/Hardness – HNO3; TOC – H3PO4, - 4°C +/-2°C; Alkalinity/Chloride/ Sulfate/Nitrate/Nitrite - 4°C +/-2°C; sediment/soil TOC - 4°C +/-2°C; _____ ☐ Temperature Blank Included in Cooler

Relinquished By_____Date and Time_____Received By_____Matrix: A= Air; S= Soil; SED = Sediments; AQ= Aqueous; O = Other

Relinquished By_____Date and Time_____Received By_____

Relinquished By_____Date and Time_____ **Received For Laboratory By_____**

Page _____ of _____ Data Reviewed By_____ Date_____

Section No.: 22.0
Revision No.: 5 (HWRB)
Date: 11-2-06
Page 1 of 1

Microseeps Lab. Proj. # _____

CHAIN - OF - CUSTODY RECORD

Microseeps COC cont. # _____

Phone: (412) 826-5245 Microseeps, Inc. - 220 William Pitt Way - Pittsburgh, PA 15238 Fax No. : (412) 826-3433

Company : _____

Co. Address : _____

Phone # : _____ Fax # : _____

Proj. Manager : _____

Proj. Name/Number : _____

Sampler's signature : _____

Cooler Temp.

Parameters Requested

Results to : _____

Invoice to : _____

Sample ID	Sample Description	Sample Type Water	Vapor	Solid	Date	Time	# bottles												Remarks :

Relinquished by :	Company :	Date :	Time :	Received by :	Company :	Date :	Time :
Relinquished by :	Company :	Date :	Time :	Received by :	Company :	Date :	Time :
Relinquished by :	Company :	Date :	Time :	Received by :	Company :	Date :	Time :

WHITE COPY : Accompany Samples YELLOW COPY : Laboratory File PINK COPY : Submitter