Site Management Plan

Hudson River Psychiatric Center Site
Landfill Area 6
Town of Poughkeepsie
Dutchess County, New York

NYSDEC Site Number: # V00657

Hudson Heritage Development, LLC

Poughkeepsie, New York

June 2011

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Revisions to Final Approved Site Management Plan:

Revision #	Submitted Date	Summary of Revision	DEC Approval Date

Project No. 20080291.L4N

FUSS & O'NEILL

CERTIFICATION

I, Craig Lapinski, certify that I am currently a NYS registered professional engineer and that this Site Management Plan was prepared in accordance with all applicable statutes and regulations and in substantial conformance with the DER Technical Guidance for Site Investigation and Remediation (DER-10).

075785	7-12-11	
NYS Professional Engineer #	Date	Signature

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1 Introduction and Description of Remedial Program

1.1 Introduction

This Site Management Plan (SMP) is required as an element of the remedial program at Hudson River Psychiatric Center Site Landfill Area 6 (hereinafter referred to as the "Site") under the New York State (NYS) Voluntary Cleanup Program (VCP) administered by New York State Department of Environmental Conservation (NYSDEC). The SMP provides guidance for managing the Site in accordance with NYSDEC requirements following completion of the remedial activities performed to obtain a Release and Covenant Not to Sue. The Site was remediated in accordance with Voluntary Cleanup Agreement (VCA) # W3-0969-03-07, Site # V00657, which was executed on April 27, 2004.

1.2 General

Hudson Heritage CPCR Ventures, LLC entered into a VCA with the NYSDEC to remediate a portion of a 155.9 acre property located in the town of Poughkeepsie, Dutchess County, New York. This VCA required the Remedial Party, Hudson Heritage CPCR Ventures, LLC, to investigate and remediate contaminated media at the Site. A figure showing the Site location is included as *Figure 1* and a figure showing the Site boundaries of the 2.29-acre area known as Landfill Area 6 (LA6) that is subject to this plan is provided in *Figure 2*. The boundaries of the Site are more fully described in the metes and bounds site description that is part of the Environmental Deed Restriction included in *Appendix A*.

After completion of the remedial work described in the Remedial Action Work Plan, some waste material was left in the subsurface at this Site, which is hereafter referred to as 'remaining waste material.' This SMP was prepared to manage remaining waste material at the Site until the Environmental Deed Restriction is extinguished. All reports associated with the Site can be viewed by contacting the NYSDEC or its successor agency managing environmental issues in New York State.

This SMP was prepared by Fuss & O'Neill of New York, PC, on behalf of Hudson Heritage CPCR Ventures, LLC, in accordance with the requirements in NYSDEC DER-10 Technical Guidance for Site Investigation and Remediation, dated May 2010, and the guidelines provided by NYSDEC. This SMP addresses the means for implementing the Institutional Controls (ICs) and Engineering Controls (ECs) that are required by the Environmental Deed Restriction for the Site. A copy of the Environmental Deed Restriction is included as *Appendix A*. The "Property" described in the Environmental Deed Restriction is the same as the "Site" discussed in this SMP.

1.2.1 Purpose

The Site contains waste material left after completion of the remedial action. Engineering Controls have been incorporated into the Site remedy to control exposure to remaining waste material during the use of the Site to ensure protection of public health and the environment.

An Environmental Deed Restriction granted to the NYSDEC, and recorded with the Dutchess County Clerk, will require compliance with this SMP and all ECs and ICs placed on the Site. The ICs place restrictions on Site use, and mandate operation, maintenance, monitoring and reporting measures for all ECs and ICs. This SMP specifies the methods necessary to maintain compliance with ECs and ICs required by the Environmental Deed Restriction for waste material that remains at the Site. This plan has been approved by the NYSDEC, and compliance with this plan is required by the grantor of the Environmental Deed Restriction and the grantor's successors and assigns. This SMP may only be revised with the approval of the NYSDEC.

This SMP provides a detailed description of all procedures required to manage remaining waste material at the Site after completion of the Remedial Action, including: (1) implementation and management of Engineering and Institutional Controls; (2) media monitoring; (3) operation and maintenance of all treatment, collection, containment, or recovery systems; (4) performance of periodic inspections, certification of results, and submittal of Periodic Review Reports; and (5) defining criteria for termination of treatment system operations.

To address these needs, this SMP includes three plans: (1) an Engineering and Institutional Control Plan for implementation and management of EC/ICs; (2) a Monitoring Plan for implementation of Site Monitoring; (3) an Operation and Maintenance Plan for implementation of remedial collection, containment, treatment, and recovery systems.

This plan also includes a description of Periodic Review Reports for the periodic submittal of data, information, recommendations, and certifications to NYSDEC.

It is important to note that:

- This SMP details the site-specific implementation procedures that are required by the Environmental Deed Restriction. Failure to properly implement the SMP is a violation of the environmental deed restriction, which is grounds for revocation of the Release and Covenant Not to Sue.

- Failure to comply with this SMP is also a violation of Environmental Conservation Law and the VCA (Index # W3-0969-03-07; Site # V00657) for the Site, and thereby subject to applicable penalties.

1.2.2 Revisions

Revisions to this plan will be proposed in writing to the NYSDEC's project manager. In accordance with the Environmental Deed Restriction for the Site, the NYSDEC will provide a notice of approved changes to the SMP, and append these notices to the SMP that is retained in its files.

1.3 Site Background

1.3.1 Site Location and Description

The Site is located in the town of Poughkeepsie, County of Dutchess, New York and is a portion of the parcel identified as Section 6163, Lot 3, and Block 011149 on the Town of Poughkeepsie Tax Map. The Site is an approximately 2.29-acre area, known as Landfill Area 6, bounded by a former driveway and parking lot to the north and west, an unnamed stream to the south, and a former railroad bed to the east (see *Figure 1*). The boundaries of the Site are more fully described in the Metes and Bounds description included in the Environmental Deed Restriction included in *Appendix A*.

1.3.2 Site History

The Site is located on a portion of the former Hudson River Psychiatric Center (HRPC) property which was purchased from the State of New York by Hudson Heritage Development, LLC in 2005. The full HRPC property consisted of approximately 324 acres of land. Hudson Heritage Development, LLC purchased 155.9 acres of the HRPC property. Numerous investigations of the Site and surrounding portions of the HRPC property have been performed by several different consultants. A list of reports generated as a result of these investigations is included in *Section 6.0* of this report.

Wastes were disposed of in various locations on the 324-acre HRPC property for more than 100 years. Wastes located in Landfill Area 6 reportedly consist of municipal waste from the HRPC facility, coal ash from the heating plant, mixed construction debris from the HRPC facility, and potentially some municipal waste from the Town of Poughkeepsie. Air photo interpretation identified that waste deposition in Landfill Area 6 began in the mid-1960s and had apparently ended by 1978 (EA Engineering, 2001).

1.3.3 Geologic Conditions

The Site consists of a former ravine backfilled with solid wastes, with the natural stream re-routed around the ravine's perimeter. Bedrock under the Site consists of minimally-fractured shale and silty-sandstone from the Ordovician age Austin Glen formation. Soils on the Site are generally thin and derived from residual glacial lake deposits or glacial till. Slug testing in wells indicates these soils are generally low-permeability and so would limit groundwater recharge or transmission (Chazen, 2004). Geologic cross sections of the Site (EA Engineering, 2002 & Chazen, July 2004) are included in *Appendix B*.

Chazen reported that a significant downward hydraulic gradient was observed in monitoring wells located upgradient of the Site and a modest downward hydraulic gradient was observed in the geologic formation located downgradient of the Site (Chazen, March 2004).

The overall rate of groundwater movement through the Site is estimated to be low on the basis of limited observed flows of leachate and due to the shallow hydraulic gradient under the center of the Site and to the modest hydraulic conductivity of contributing upgradient overburden and bedrock formations as well as generally thin saturated thickness of the waste (Chazen, March 2004).

The water table at the Site indicates that groundwater migrates generally from north to south across the Site. Groundwater levels are lower in the waste mass than in surrounding native materials, suggesting a more permeable material (Chazen, March 2004). A potentiometric surface map (Chazen, July 2004) is included in *Appendix C*.

1.4 Summary of Remedial Investigation Findings

A Remedial Investigation (RI) was performed to characterize the nature and extent of waste material at the Site. The results of the RI are described in detail in the following reports:

- Remedial Investigation of Area 6 PCB Site at Hudson River Psychiatric Center Poughkeepsie, NY NYDEC ID No. 344063, prepared by Lawler, Matusky & Skelly Engineers, 1996.

- Landfill Characterization Investigation Report Areas 1, 2, 3, 5, 6, 7, and 8 Hudson River Psychiatric Center, Poughkeepsie, NY, prepared by EA Engineering, P.C. et al, January 2001.

- Landfill Closure Investigation Report Landfill Areas 1, 2, 3, 6 and 8 Hudson River Psychiatric Center, Poughkeepsie, NY, prepared by EA Engineering, P.C. et al, July 2002.

- Supplemental Closure Investigation Report, Hudson River Psychiatric Center Landfill Area 6, prepared by The Chazen Companies, March 2004.

- Supplemental Closure Investigation Report – Addendum, Hudson River Psychiatric Center Landfill Area 6, prepared by The Chazen Companies, July 2004.

Generally, the RI determined that wastes located in Landfill Area 6 reportedly consist of municipal waste from the HRPC facility, coal ash from the heating plant, mixed construction debris from the HRPC facility, and potentially some municipal waste from the Town of Poughkeepsie (EA Engineering, 2001). Two areas along the creek bank exhibit soils that have accumulated visible concentrations of leachate precipitate. The two areas total approximately 40 square feet (Chazen, 2004). Below is a summary of Site conditions when the RI was performed in 1996-2004.

1.4.1 Soil

Waste deposited at the Site includes municipal waste, lumber, bricks, coal ash, light gray ash, glass and bottles, pottery, shells, plastic objects, tires, paper, and metal objects including rakes and a lawn chair (EA Engineering, 2001). Test pits were used to identify the general limits and depth of the waste. EA Engineering estimated the landfill volume to be 33,460 cubic yards. Maximum observed waste thickness was 16 feet, extending to below the water table. Test pitting indicated that the cap material consisted of sandy silt between 1 to 5 feet thick.

1.4.2 Groundwater

The EA Engineering reports document the presence of groundwater within the waste mass at the Site, downgradient groundwater samples containing elevated iron, ammonia, color and TDS, VOCs in concentrations less than two times TOGS 1.1.1 class GA standards/guidance values, and leachate discharges to the stream consisting primarily of iron.
On the basis of a limited sampling record, some groundwater quality issues have been identified in upgradient and downgradient wells as summarized below:

- Sodium and chloride exceedances are found in most upgradient and downgradient monitoring wells. These may be related to road de-icing on or near the landfill area and environs.

- Iron, magnesium, and manganese exceedances are found in most upgradient and downgradient monitoring wells. These may be attributed to local geologic formations (e.g., background) and laboratory digestion methods, although iron and manganese leachate seeps confirm some landfill related impacts.

- Dichlorodifluoromethane and benzene were found in one downgradient monitoring well. The VOC concentration was approximately twice TOGS 1.1.1 GA groundwater standards.

- MTBE is present in one upgradient monitoring well in a concentration below TOGS 1.1.1 GA standards.

- Ammonia is present in downgradient overburden monitoring wells, although not in downgradient bedrock wells, in concentrations exceeding TOGS 1.1.1 GA standards.

Chazen's inspection of the culverts indicated that only the 36 inch concrete stream culvert is a reliable water conveyance. The two clay pipes leak water into the landfill. Monitoring data and water level measurements in stream piezometers, 1-inch piezometers, and monitoring wells identify downward gradients in the aquifer and slight upward gradients in the stream bed (Chazen, March 2004). Hydrogeologic data suggests that current leachate discharges are supported by infiltration of storm water into the waste mass through the current capping material and from leaking water conveyance pipes. There is not hydraulic evidence that leachate is supported by aquifer discharges from a regional overburden or bedrock aquifer system. (Chazen, March 2004).

1.4.3 Surface Water/Leachate

Chazen reported sodium exceedances of TOGS 1.1.1 Class D surface water standards in both upstream and downstream samples, iron exceedances in both upstream and downstream samples (with a noted increase in concentration in the downstream sample), and dissolved aluminum exceedances only in the upstream sample. Chazen reported that that the sampling indicates that leachate discharges from Landfill Area 6 increase dissolved iron concentrations in the stream; however, both the upstream and downstream samples exceeded TOGS 1.1.1 Class D surface water standards. Ammonia and turbidity concentrations also increased in the downstream sample compared to the upstream sample, as did color and manganese; but these analyses did not exceed any published guidance or standards (Chazen, 2004).

1.4.4 Sediment

Chazen reported that leachate precipitate did not by itself exceed moderate or severe guidance thresholds for contaminated sediments. Stream sediment data identified concentrations of mercury, arsenic, and lead just above guidance values for moderately contaminated sediments and concentrations of iron exceeded moderate or severe guidance. Chazen reported a marked decrease in sediment concentrations from upstream to downstream, suggesting that impacts are mitigated with distance from leachate emission points, such that the downstream sediments were below moderate impacts guidance values for all metals except arsenic which is close to guidance levels and iron (Chazen, 2004).

1.4.5 Landfill Gases

Landfill gases were investigated by EA Engineering in 2001. Test pitting logs showed little to no putrescible wastes that would produce landfill gases. Twenty two perimeter sampling sites were tested. Elevated explosive gas emissions were noted in two perimeter locations. All other perimeter locations showed no or a low percent of the Lower Explosive Limit (LEL) emissions. Oxygen levels were below atmospheric concentrations in approximately half of the perimeter sampling locations. Low to no VOC emissions were noted (Chazen, 2004).

1.5 Summary of Remedial Actions

The Site was remediated in accordance with the NYSDEC-approved Remedial Action Work Plan dated September 2004, the Addendum to Remedial Action Work Plan dated August 2009, the Interim Remedial Measures (IRM) Work Plan dated March 2008, and the Interim Remedial Measures (IRM) Work Plan Addendum dated July 2008.

The following is a summary of the Remedial Actions performed at the Site:

1. Abandonment by grouting the existing 18" diameter concrete storm sewer pipe located in the northeastern portion of the landfill.

2. Abandonment by plugging the existing 12" diameter clay storm sewer pipe servicing the eastern portion of Ryan Hall.

3. Construction of a swale along the northern perimeter of the landfill to convey storm water from the abandoned 18 inch diameter and 12 inch diameter storm sewer pipes, and intercept storm water from running on to the landfill. The swale discharges to a level spreader that discharges water downgradient of the landfill area.

4. Consolidation of limited quantities of waste from the southeastern corner of LA 6, to the main body of the landfill.

5. Placement of two feet of low permeability cover soil and top soil over contaminated material (waste and leachate impacted soil located in the steep sloped area along the stream bank and the western portion of the landfill where soil cover was thin.)

6. Installation of a demarcation layer consisting of orange construction fencing, over the existing waste where the GCL barrier was to be installed.

7. Installation of a six inch thick gas venting layer over the main body of the landfill, followed by a geosynthetic clay liner (GCL), eight inches of barrier protection soil, and four inches of vegetative support material.

8. Installation of a gas vent located at the high point of the landfill to allow for exhausting accumulated landfill gases.

9. Execution and recording of an Environmental Deed Restriction to restrict land use and prevent future exposure to any contamination remaining at the Site.

10. Development and implementation of this SMP for long term management of remaining contamination as required by the Environmental Deed Restriction which includes plans for: (1) Institutional and Engineering Controls, (2) monitoring, (3) operation and maintenance and (4) reporting.

11. Periodic certification of the institutional and engineering controls listed above.

Remedial activities were performed at the Site between November 2008 and September 2010.

1.5.1 Waste Materials Relocation

Solid waste was removed and relocated from the southeast corner of the Site located adjacent to the former railroad bed on property owned by Dutchess County to within the extents of the GCL cover area. Visible solid waste in this area was relocated to the main body of the landfill, where it was used to level out low lying areas across the landfill area.

Approximately two feet of soil and solid waste was removed from the wetland area located adjacent to the eastern end of the stream. This material was relocated to the main body of the landfill, where it was used to level out low lying areas across the landfill area. The material located in the wetland area was removed to allow for the placement of a low permeability soil cap.

1.5.2 Remaining Waste Material

Solid waste remains below the extents of GCL area as shown on the as-built survey included in *Appendix D*. In the GCL cover area, orange construction fencing was placed over the remaining solid waste to act as a demarcation layer. Six inches of gas venting material was placed on top of the demarcation layer, followed by the GCL, eight inches of barrier protection layer, and four inches of vegetative support material.

The only solid waste that remains outside of the liner limits is located in the area between the stream and the liner area as shown on the as-built survey included in *Appendix D*. This area was the subject of the IRM work. In this area the existing solid waste is covered by an 18 inch layer of low permeability cover soil and 6 inches of vegetative support material.

2 Engineering and Institutional Control Plan

2.1 Introduction

2.1.1 General

Since remaining solid waste exists beneath the Site, Engineering Controls and Institutional Controls (EC/ICs) are required to protect human health and the environment. This Engineering and Institutional Control Plan describes the procedures for the implementation and management of all EC/ICs at the Site. The EC/IC Plan is one component of the SMP and is subject to revision by NYSDEC.

2.1.2 Purpose

This plan provides:

- A description of all EC/ICs on the Site;
- The basic implementation and intended role of each EC/IC;
- A description of the key components of the ICs set forth in the Environmental Deed Restriction;
- A description of the features to be evaluated during each required inspection and periodic review;
- A description of plans and procedures to be followed for implementation of EC/ICs, such as the implementation of the Excavation Work Plan for the proper handling of remaining waste material that may be disturbed during maintenance or redevelopment work on the Site; and
- Any other provisions necessary to identify or establish methods for implementing the EC/ICs required by the Site remedy, as determined by the NYSDEC.

2.2 Engineering Controls

2.2.1 Engineering Control System

Engineering Controls are used to protect human health and the environment from the remaining solid waste at the Site. The engineering controls include cover systems and a storm water diversion system. The engineering controls are permanent controls and the quality and integrity of these systems will be inspected at defined, regular intervals in perpetuity.

Procedures for operating and maintaining the engineering controls are documented in the Operation and Maintenance Plan (*Section 4*). Procedures for monitoring the system are included in the Monitoring Plan (*Section 3*). The Monitoring Plan also addresses severe condition inspections in the event that a severe condition, which may affect controls at the Site, occurs.

2.2.1.1 Cover System

2.2.1.1.1 Geosynthetic Clay Liner Cover System

The geosynthetic clay liner (GCL) cover system is composed of five layers. The landfill surface was graded prior to placement of the cover system to promote surface water run-off. The base layer is a demarcation layer consisting of orange construction fencing placed over the existing material. The demarcation layer is followed by a six inch thick layer of sand that is part of a gas venting system that allows landfill gases to exhaust to the surface through a vent installed at the highest elevation within the landfill area. The gas venting layer is followed by a geosynthetic clay liner that minimizes the direct and indirect infiltration of rain water into the waste material, which minimizes the creation of leachate that otherwise would discharge into the unnamed stream and/or groundwater at the Site. The GCL is followed by a minimum of eight inches of barrier protection layer and four inches of seeded vegetative support material which act as a protective barrier for the GCL. The gas venting layer, barrier protection layer, and vegetative support layer provide a minimum of 18 inches of total cover over the remaining waste material to prevent direct exposure to the remaining waste.

The GCLs used at the Site were CETCO Bentomat ST and CETCO Bentomat DN. CETCO Bentomat DN was used for all slopes equal or steeper than 3H:1V. CETCO Bentomat ST was used in all other areas. The extent of the GCL cover area is shown on *Figure 2*. As-built details of the GCL and gas vent installations are included on *Figure 3*. The manufacturer's specifications guidelines for CETCO Bentomat ST and CETCO Bentomat DN are included in *Appendix K*.

The Excavation Work Plan that appears in *Appendix E* outlines the procedures required to be implemented in the event the cover system is breached, penetrated, or temporarily removed, and any underlying remaining waste material is disturbed. Procedures for the inspection of this cover are provided in *Section 5.1*.

2.2.1.1.2 Low Permeability Soil Cover

A low permeability soil cover was installed at the northern slope of the stream bank. The low permeability soil cover consisted of 18 inches of low permeability soil and six inches of vegetative support material. Following placement of the cover material the area was hayed and seeded.

2.2.1.2 Storm Water Diversion System

Three storm water lines, two 12 inch diameter clay pipes and one 18 inch diameter concrete pipe, were rerouted to a lined drainage swale installed along the northwest side of the Site. The portions of the storm water lines that were located within the landfill area were abandoned in place and the upstream lines were terminated at new overflow catch basins that were installed northwest of the landfill area. A lined swale was installed along the northern perimeter of the landfill to convey storm water from the overflow catch basins and to minimize surface runoff reaching the landfill area. The swale was lined with a 10 mil PVC liner and anchored in place by burying the edges and placing concrete blocks along the base of the swale. A stone level spreader was installed at the west end of the swale which allows for the discharge of storm water downgradient of the Site. The location of the lined swale and stone level spreader are shown on *Figure 2* and the as-built details are shown on *Figure 3*.

The 18 inch diameter concrete storm sewer pipe located in the northeastern portion of the landfill was abandoned by removing sections of the pipe at the upgradient and downgradient ends of the pipe and filling the remainder of the pipe with concrete grout.

The 12 inch diameter clay storm water pipe servicing the eastern portion of Ryan Hall, which ran through the central portion of the landfill, was abandoned in place by plugging the upgradient end of the pipe with concrete. The pipe had been so plugged with soil and debris that it was not possible to inject concrete into the pipe. The downgradient end of the Site had been buried and was not located.

The 12 inch diameter clay storm water pipe located near the western side of Ryan Hall was abandoned in place by grouting the pipe with concrete grout.

An existing 24 inch diameter steel drainage line was discovered beneath the abandoned rail bed during excavation of the waste material from the southeast corner of the Site. The pipe's outlets had been buried on each end; however, it appears that it had been acting as a conduit, draining water from the east side of rail bed to the stream via subsurface flow. The pipe was extended to the stream using a 24" corrugated HDPE pipe. The pipe discharges to a HDPE flared end outlet with riprap protection up to the edge of the waterline in the stream.

2.3 Institutional Controls

A series of Institutional Controls are required by the RAWP to: (1) implement, maintain and monitor Engineering Control systems; (2) prevent future exposure to remaining waste material by controlling disturbances of the subsurface waste material; and, (3) limit the use and development of the Site to commercial uses only. Adherence to these Institutional Controls on the Site is required by the Environmental Deed Restriction and will be implemented under this Site Management Plan. The Site is a Controlled Property subject to the Environmental Deed Restriction. The Site is also referred to in this section as the "Controlled Property". These Institutional Controls must adhere to the following conditions:

- Compliance with the Environmental Deed Restriction and this SMP must be maintained by the Grantor and the Grantor's successors and assigns.
- All Engineering Controls must be operated and maintained as specified in this SMP.
- All Engineering Controls on the Controlled Property (the Site) must be inspected at a frequency and in a manner defined in the SMP.
- Groundwater, landfill gas, sediment, and leachate monitoring must be performed as defined in this SMP.

- Data and information pertinent to Site Management of the Controlled Property must be reported at the frequency and in a manner defined in this SMP.

Institutional Controls identified in the Environmental Deed Restriction may not be discontinued without an amendment to or extinguishment of the Environmental Deed Restriction.

The Site has a series of Institutional Controls in the form of site restrictions. Adherence to these Institutional Controls is required by the Environmental Deed Restriction included in *Appendix A*. Site restrictions that apply to the Controlled Property are:

- The Controlled Property may only be used for commercial use provided that the long-term Engineering and Institutional Controls included in this SMP are employed.

- The Controlled Property may not be used for a higher level of use, such as unrestricted, residential, or restricted residential use without additional remediation and amendment of the Environmental Deed Restriction, as approved by the NYSDEC.

- All future activities on the Controlled Property that will disturb remaining contaminated material must be conducted in accordance with this SMP.

- The use of the groundwater underlying the Controlled Property is prohibited without treatment rendering it safe for intended use.

- The potential for vapor intrusion must be evaluated for any buildings developed on the Site, and any potential impacts that are identified must be monitored or mitigated.

- Vegetable gardens and farming on the Controlled Property are prohibited.

- The Site owner or remedial party will submit to NYSDEC a written statement that certifies, under penalty of perjury, that: (1) controls employed at the Controlled Property are unchanged from the previous certification or that any changes to the controls were approved by the NYSDEC; and, (2) nothing has occurred that impairs the ability of the controls to protect public health and environment or that constitute a violation or failure to comply with the SMP. NYSDEC retains the right to access such Controlled Property at any time in order to evaluate the continued maintenance of any and all controls. This certification shall be submitted annually, or an alternate period of time that NYSDEC may allow and will be made by an expert that the NYSDEC finds acceptable.

2.3.1 Excavation Work Plan

The Site has been remediated for commercial use. Future intrusive work that will penetrate the cover system, or encounter or disturb the remaining waste material, including any modifications or repairs to the existing cover system, will be performed in compliance with the Excavation Work Plan (EWP) that is attached as *Appendix E*. Work conducted pursuant to the EWP must also be conducted in accordance with the procedures defined in a Health and Safety Plan (HASP) and Community Air Monitoring Plan (CAMP) prepared for the Site. A HASP is attached as *Appendix F* to this SMP that is in current compliance with DER-10, and 29 CFR 1910, 29 CFR 1926, and all other applicable Federal, State and local regulations. Based on future changes to State and federal health and safety requirements, and specific methods employed by future contractors, the HASP and CAMP will be updated and re-submitted with the notification provided in *Section E-1* of the EWP. Intrusive construction work will be performed in compliance with the EWP, HASP, and CAMP, and will be included in the periodic inspection and certification reports submitted under the Site Management Reporting Plan (See *Section 5*).

The Site owner and associated parties preparing the remedial documents submitted to the State, and parties performing this work, are completely responsible for the safe performance of all intrusive work, the structural integrity of excavations, proper disposal of excavation de-water, control of runoff from open excavations into remaining waste material, and for structures that may be affected by excavations (such as building foundations and bridge footings). The Site owner will ensure that site development activities will not interfere with, or otherwise impair or compromise, the engineering controls described in this SMP.

2.3.2 Vapor Intrusion Evaluation

Prior to the construction of any enclosed structures located over areas that contain remaining waste material and the potential for soil vapor intrusion (SVI) has been identified, an SVI evaluation will be performed to determine whether any mitigation measures are necessary to eliminate potential exposure to vapors in the proposed structure. Alternatively, an SVI mitigation system may be installed as an element of the building foundation without first conducting an investigation. This mitigation system will include a vapor barrier and an active sub-slab depressurization system as no sampling was conducted to preclude the need for a system. Alternatively, sampling can be conducted post development / installation to evaluate whether there is a need for an active system, or whether landfill gas monitoring is adequately protective.

Prior to conducting an SVI investigation or installing a mitigation system, a work plan will be developed and submitted to the NYSDEC and NYSDOH for approval. This work plan will be developed in accordance with the most recent NYSDOH "Guidance for Evaluating Vapor Intrusion in the State of New York". Measures to be employed to mitigate potential vapor intrusion will be evaluated, selected, designed, installed, and maintained based on the SVI evaluation, the NYSDOH guidance, and construction details of the proposed structure.

Preliminary (unvalidated) SVI sampling data will be forwarded to the NYSDEC and NYSDOH for initial review and interpretation. Upon validation, the final data will be transmitted to the agencies, along with a recommendation for follow-up action, such as mitigation. SVI sampling results, evaluations, and follow-up actions will also be summarized in the next Periodic Review Report.

2.4 Inspections and Notifications

2.4.1 Inspections

Inspections of remedial components installed at the Site will be conducted at the frequency specified in the SMP Monitoring Plan schedule. A comprehensive Site-wide inspection will be conducted annually, regardless of the frequency of the Periodic Review Report. The inspections will determine and document the following:

- Whether Engineering Controls continue to perform as designed;
- If these controls continue to be protective of human health and the environment;
- Compliance with requirements of this SMP and the Environmental Deed Restriction;
- Achievement of remedial performance criteria;
- Sampling and analysis of appropriate media during monitoring events;
- If Site records are complete and up to date; and
- Changes, or needed changes, to the remedial or monitoring system.

Inspections will be conducted in accordance with the procedures set forth in the Monitoring Plan of this SMP (*Section 3*). The reporting requirements are outlined in the Periodic Review Reporting section of this plan (*Section 5*).

If an emergency, such as a natural disaster or an unforeseen failure of any of the ECs occurs, an inspection of the Site will be conducted within 5 days of the event to verify the effectiveness of the EC/ICs implemented at the Site by a qualified environmental professional as determined by NYSDEC.

2.4.2 Notifications

Notifications will be submitted by the property owner to the NYSDEC as needed for the following reasons:

- 60-day advance notice of any proposed changes in Site use that are required under the terms of the Voluntary Cleanup Agreement (VCA), 6NYCRR Part 375, and/or Environmental Conservation Law.
- 7-day advance notice of any proposed ground-intrusive activities pursuant to the Excavation Work Plan.
- Notice within 48-hours of any damage or defect to the structures that reduces or has the potential to reduce the effectiveness of other Engineering Controls and likewise any action to be taken to mitigate the damage or defect.

- Verbal notice by noon of the following day of any emergency, such as a fire, flood, or earthquake that reduces or has the potential to reduce the effectiveness of Engineering Controls in place at the Site, with written confirmation within 7 days that includes a summary of actions taken, or to be taken, and the potential impact to the environment and the public.

- Follow-up status reports on actions taken to respond to any emergency event requiring ongoing responsive action shall be submitted to the NYSDEC within 45 days and shall describe and document actions taken to restore the effectiveness of the ECs.

Any change in the ownership of the Site or the responsibility for implementing this SMP will include the following notifications:

- At least 60 days prior to the change, the NYSDEC will be notified in writing of the proposed change. This will include a certification that the prospective purchaser has been provided with a copy of Voluntary Cleanup Agreement (VCA), and all approved work plans and reports, including this SMP

- Within 15 days after the transfer of all or part of the Site, the new owner's name, contact representative, and contact information will be confirmed in writing.

2.5 Contingency Plan

The contingency plan includes information that would be useful in emergency situations. Emergencies may include injury to personnel, fire or explosion, environmental release, or serious weather conditions.

2.5.1 Emergency Telephone Numbers

In the event of any environmentally related situation or unplanned occurrence requiring assistance the Owner or Owner's representative(s) should contact the appropriate party from the contact list below. For emergencies, appropriate emergency response personnel should be contacted. Prompt contact should also be made to Fuss & O'Neill of New York, PC. These emergency contact lists must be maintained in an easily accessible location at the Site.

Table 1: Emergency Contact Numbers

Emergency Contact	Phone Number
Medical, Fire, and Police	911
One Call Center (3 day notice required for utility markout)	(800) 272-4480
Poison Control Center	(800) 222-1222
Pollution Toxic Chemical Oil Spills	(800) 424-8802
Hudson Heritage Development, LLC • William Burke	(212) 869-5300 ext 501
Site Manager • Stephen Burke	Office: (845) 473-1976 Cell: (845) 309-2858
Fuss & O'Neill of New York, PC • Joseph Lenahan, PE	(203) 374-3748 ext 3509
St. Francis Hospital	(845) 483-5000

Note: Contact numbers subject to change and should be updated as necessary

2.5.2 Map and Directions to Nearest Health Facility

Site Location: 3532 North Road
Poughkeepsie, NY 12601

Nearest Hospital Name: St. Francis Hospital

Hospital Location: 241 North Road
Poughkeepsie, NY 12601

Hospital Telephone: (845) 483-5000

Directions to the Hospital:

1. Head south (Turn left) on US-9 S/North Road [0.6 mi]
2. Turn left at New York 9G N/Marist Dr [0.2 mi]
3. Turn left at Baker Ave [0.2 mi]
4. Arrive at St. Francis Hospital
   241 North Road
   Poughkeepsie, NY 12601

Total Distance: 1.0 miles
Total Estimated Time: 5 minutes

Map Showing Route from the Site to the Hospital:

2.5.3 Response Procedures

As appropriate, the fire department and other emergency response group will be notified immediately by telephone of the emergency. The emergency telephone number list is found at the beginning of this Contingency Plan (*Table 1*). The list will also be posted prominently at the Site and made readily available to all personnel at all times.

3 Site Monitoring Plan

3.1 Introduction

3.1.1 General

The Monitoring Plan describes the measures for evaluating the performance and effectiveness of the remedy to reduce or mitigate waste material at the Site, the soil cover system, and all affected Site media identified below. Monitoring of other Engineering Controls is described in Chapter 4, Operation, Monitoring and Maintenance Plan. This Monitoring Plan may only be revised with the approval of NYSDEC.

3.1.2 Purpose and Schedule

This Monitoring Plan describes the methods to be used for:

- Sampling and analysis of all appropriate media (e.g., groundwater, landfill gases, sediment);
- Assessing compliance with applicable NYSDEC standards, criteria and guidance, particularly ambient groundwater standards;
- Assessing achievement of the remedial performance criteria;
- Evaluating Site information periodically to confirm that the remedy continues to be effective in protecting public health and the environment; and
- Preparing the necessary reports for the various monitoring activities.

To adequately address these issues, this Monitoring Plan provides information on:

- Sampling locations, protocol, and frequency;
- Information on all designed monitoring systems (e.g., well logs);
- Analytical sampling program requirements;
- Reporting requirements;
- Quality Assurance/Quality Control (QA/QC) requirements;

- Inspection and maintenance requirements for monitoring wells;
- Monitoring well decommissioning procedures; and
- Annual inspection and periodic certification.

Quarterly monitoring of the performance of the remedy will be conducted for the first year. The frequency thereafter will be determined by NYSDEC. Trends in contaminant levels in air, soil, and/or groundwater in the affected areas, will be evaluated to determine if the remedy continues to be effective in achieving remedial goals. Monitoring programs are summarized below in *Table 2* and outlined in detail in *Sections 3.2 and 3.3* below.

Table 2: Monitoring/Inspection Schedule

Monitoring Program	Monitoring Frequency*	Matrix	Analysis
Cover System Monitoring	Quarterly	N/A	N/A
Groundwater Monitoring	Annually	Groundwater	6 NYCRR Part 360-2.11(d)(6) Routine Parameters, TCL SVOCs, & TCL PCBs
Sediment Monitoring	Annually	Sediment	TAL Metals & Total Organic Carbon
Explosive Gas Monitoring	Quarterly	Air	Lower Explosive Limit (LEL)
Site Wide Inspection	Quarterly	N/A	N/A

* The frequency of events will be conducted as specified until otherwise approved by NYSDEC and NYSDOH

3.2 Cover System Monitoring

Exposures to the remaining solid waste will be restricted by cover systems. Cover systems were composed of either a GCL liner system or a low permeability soil cover system. The horizontal extent of each cover system is depicted on the site plan in *Figure 2*.

The cover systems will be inspected quarterly to assess any erosion or other deterioration of the cover systems. An Engineered Control Inspection Form will be completed at each inspection. A sample Engineered Control Inspection Form is included in *Appendix G*. Unscheduled inspections may take place when a suspected failure of the cover system has been reported or an emergency situation occurs that is deemed likely to affect the operation of the system.

3.3 Media Monitoring Program

3.3.1 Groundwater Monitoring

Groundwater monitoring will be performed on a periodic basis to assess the performance of the remedy. Annual sampling will be performed at the overburden monitoring wells MWHR6-20S, MWHR6-21S, MWHR6-22R, and MWHR6-23S. Monitoring well locations are included on *Figure 2*. The samples will be analyzed for routine parameters as listed under 6 NYCRR Part 360-2.11(d)(6), Target Compound List (TCL) semi-volatile organic compounds (SVOCs,) and TCL polychlorinated biphenyls (PCBs). The sampling frequency and the parameters list may be modified with the approval of NYSDEC. The SMP will be modified to reflect changes in sampling plans approved by NYSDEC.

The network of monitoring wells has been installed to monitor both up-gradient and down-gradient groundwater conditions at the Site. Monitoring well construction logs are included in *Appendix H*.

Deliverables for the groundwater monitoring program are specified below.

3.3.1.1 Sampling Protocol

All monitoring well sampling activities will be recorded in a field book and groundwater monitoring field data sheet presented in *Appendix I*. Other observations (e.g., well integrity, etc.) will be noted on the well sampling log. The well sampling log will serve as the inspection form for the groundwater monitoring well network. All sampling of the monitoring wells will be performed using low-flow sampling techniques according to the methods outlined in the Quality Assurance Project Plan (QAPP) included in *Appendix J*.

3.3.1.2 Monitoring Well Repairs, Replacement and Decommissioning

If biofouling or silt accumulation occurs in the on-site and/or off-site monitoring wells, the wells will be physically agitated/surged and redeveloped. Additionally, monitoring wells will be properly decommissioned and replaced if an event renders the wells unusable.

Repairs and/or replacement of wells in the monitoring well network will be performed based on assessments of structural integrity and overall performance.

The NYSDEC will be notified prior to any repair or decommissioning of monitoring wells for the purpose of replacement, and the repair or decommissioning and replacement process will be documented in the subsequent periodic report. Well decommissioning without replacement will be done only with the prior approval of NYSDEC. Well abandonment will be performed in accordance with NYSDEC's "Groundwater Monitoring Well Decommissioning Procedures." Monitoring wells that are decommissioned because they have been rendered unusable will be reinstalled in the nearest available location, unless otherwise approved by the NYSDEC.

3.3.2 Explosive Gas Monitoring Program

Explosive Gas Monitoring will be performed on a periodic basis. Explosive gas will be monitored quarterly using a portable handheld multi-gas meter. Percent methane and percent of lower explosive limit (LEL) will be measured at the landfill cap gas vent as shown on *Figure 2*. The explosive gas monitoring will be recorded in a field book and the methane field data sheet presented in *Appendix I*.

3.3.3 Sediment Monitoring

Sediment monitoring will be performed on a periodic basis to assess the performance of the remedy. Annual sampling will be performed at four locations (SD-01, SD-02, SD-03, and SD-04) along the stream located at the south end of the Site as shown on *Figure 2*. The sediment sample locations correspond to:

- SD-1 – The upstream end of the Site (the discharge point of the stream culvert)
- SD-2 – Along the stream channel in the vicinity of a previously observed seep location
- SD-3 – Along the stream channel downstream from the observed seep area
- SD-4 – Downstream of the Site

The samples will be analyzed for the Target Analyte List (TAL) of metals and for total organic carbon (TOC.) The sampling frequency and the parameters list may be modified with the approval of NYSDEC. The SMP will be modified to reflect changes in sampling plans approved by NYSDEC.

Deliverables for the sediment monitoring program are specified below.

3.3.3.1 Sampling Protocol

All sediment sampling activities will be recorded in a field book and sediment monitoring field data sheet presented in *Appendix I*. All sampling sediment will be performed according to the methods outlined in the Quality Assurance Project Plan (QAPP) included in *Appendix J*.

3.4 Site-Wide Inspection

Site-wide inspections will be performed quarterly. Site-wide inspections will also be performed after all severe weather conditions that may affect Engineering Controls or monitoring devices. During these inspections, an inspection form will be completed (*Appendix G*). The form will compile sufficient information to assess the following:

- Verify compliance with all ICs, including Site usage
- Perform an evaluation of the condition and continued effectiveness of ECs

- Record general Site conditions at the time of the inspection
- Document the Site management activities being conducted including, confirmation sampling
- Confirm that Site records are up to date

3.5 Monitoring Quality Assurance/Quality Control

All sampling and analyses will be performed in accordance with the requirements of the Quality Assurance Project Plan (QAPP) prepared for the Site (*Appendix J*). Main Components of the QAPP include:

- QA/QC Objectives for Data Measurement
- Sampling Program:
    - Sample containers will be properly washed, decontaminated, and appropriate preservative will be added (if applicable) prior to their use by the analytical laboratory. Containers with preservative will be tagged as such.
    - Sample holding times will be in accordance with the NYSDEC ASP requirements.
    - Field QC samples (e.g., trip blanks, coded field duplicates, and matrix spike/matrix spike duplicates) will be collected as necessary.
- Sample Tracking and Custody
- Calibration Procedures:
    - All field analytical equipment will be calibrated immediately prior to each day's use or according to the manufacturer's recommendations. Calibration procedures will conform to manufacturer's standard instructions.
    - The laboratory will follow all calibration procedures and schedules as specified in USEPA SW-846 and subsequent updates that apply to the instruments used for the analytical methods.
- Analytical Procedures
- Preparation of a Data Usability Summary Report (DUSR), which will present the results of data validation, including a summary assessment of laboratory data packages, sample preservation and chain of custody procedures, and a summary assessment of precision, accuracy, representativeness, comparability, and completeness for each analytical method.

- Internal QC and Checks
- QA Performance and System Audits
- Preventative Maintenance Procedures and Schedules
- Corrective Action Measures

3.6 Monitoring Reporting Requirements

Forms and any other information generated during regular monitoring events and inspections will be kept on file on-site. All forms, and other relevant reporting formats used during the monitoring/inspection events, will be (1) subject to approval by NYSDEC and (2) submitted at the time of the Periodic Review Report, as specified in the Reporting Plan of this SMP.

All monitoring results will be reported to NYSDEC on a periodic basis in the Periodic Review Report. The report will include, at a minimum:

- Date of event
- Personnel conducting sampling
- Description of the activities performed
- Type of samples collected (e.g., groundwater)
- Copies of all field forms completed (e.g., well sampling logs, chain-of-custody documentation, etc.)
- Sampling results in comparison to appropriate standards/criteria
- A figure illustrating sample type and sampling locations
- Copies of all laboratory data sheets and the required laboratory data deliverables required for all points sampled (to be submitted electronically in the NYSDEC-identified format)
- Any observations, conclusions, or recommendations
- A determination as to whether groundwater conditions have changed since the last reporting event

Data will be reported in the NYSDEC approved electronic data deliverable (EDD) format. Data submitted in the EDD should be submitted on a continuous basis immediately after data validation occurs but in no event more than 90 days after the data has been submitted to the Volunteer or its consultant. A summary of the monitoring program deliverables are summarized in *Table 3* below.

Table 3: Schedule of Monitoring/Inspection Reports

Task	Monitoring Frequency*	Reporting Frequency*
Cover System Monitoring	Quarterly	Annual**
Groundwater Monitoring	Annual	Annual
Sediment Monitoring	Annual	Annual
Explosive Gas Monitoring	Quarterly	Annual***
Site Wide Inspection	Quarterly	Annual**

* The frequency of monitoring and reporting will be conducted as specified until otherwise approved by NYSDEC
**The NYSDEC will be notified of any impacts to the Cover System or other issue discovered during the Cover System Monitoring/Site Wide Inspection that may limit the effectiveness of the engineering controls within seven days of discovery.
*** The NYSDEC will be notified of any exceedance of the Lower Explosive Limit observed during the Explosive Gas Monitoring within seven days of discovery.

4 Operation and Maintenance Plan

4.1 Introduction

Engineering controls in the form of a cover system consisting of a geosynthetic clay liner system and a low-permeability soil cover are utilized at the Site as described in *Section 2.2.1* of this report. Proper maintenance of the cover systems is required in order to maintain the integrity of the engineering controls.

4.2 Maintenance

At a minimum, the cover system will be mowed twice a year, during the month of June and again during September, to prevent trees, shrubs, scrub brush, etc. from establishing. The routine Site Wide Inspection described in *Section 3.4* of this report will monitor for the establishment of trees, shrubs, scrub brush, etc. Additional mowing or trimming events may be required if excessive growth of trees, shrubs, scrub brush, etc are observed during the Site Wide Inspection.

5 Inspections, Reporting, and Certifications

5.1 Site Inspections

5.1.1 Inspection Frequency

All inspections will be conducted at the frequency specified in the schedules provided in *Section 3 - Monitoring Plan* of this SMP. At a minimum, a Site-wide inspection will be conducted annually. Inspections of remedial components will also be conducted when a breakdown of any engineering control has occurred or whenever a severe condition has taken place, such as an erosion or flooding event that may affect the ECs.

5.1.2 Inspection Forms, Sampling Data, and Maintenance Reports

All inspections and monitoring events will be recorded on the appropriate forms for their respective system which are contained in *Appendix G*. Additionally, a general Site-wide inspection form will be completed during the Site-wide inspection. These forms are subject to NYSDEC revision.

All applicable inspection forms and other records, including all media sampling data and system maintenance reports, generated for the Site during the reporting period will be provided in electronic format in the Periodic Review Report.

5.1.3 Evaluation of Records and Reporting

The results of the inspection and Site monitoring data will be evaluated as part of the EC/IC certification to confirm that the:

- EC/ICs are in place, are performing properly, and remain effective
- The Monitoring Plan is being implemented
- The Site remedy continues to be protective of public health and the environment and is performing as designed in the RAWP and FER

5.2 Certification of Engineering and Institutional Controls

After the last inspection of the reporting period, a qualified environmental professional will prepare the following certification:

> For each institutional or engineering control identified for the Site, I certify that all of the following statements are true:
>
> - The inspection of the Site to confirm the effectiveness of the institutional and engineering controls required by the remedial program was performed under my direction;
> - The institutional control and/or engineering control employed at this Site is unchanged from the date the control was put in place, or last approved by the Department;
> - Nothing has occurred that would impair the ability of the control to protect the public health and environment;

- Nothing has occurred that would constitute a violation or failure to comply with any site management plan for this control;
- Access to the Site will continue to be provided to the Department to evaluate the remedy, including access to evaluate the continued maintenance of this control;
- Use of the Site is compliant with the environmental deed restriction;
- The engineering control systems are performing as designed and are effective;
- To the best of my knowledge and belief, the work and conclusions described in this certification are in accordance with the requirements of the Site remedial program; and
- The information presented in this report is accurate and complete.

I certify that all information and statements in this certification form are true. I understand that a false statement made herein is punishable as a Class "A" misdemeanor, pursuant to Section 210.45 of the Penal Law. I, [name], of [business name and address], am certifying as the Owner's Designated Site Representative for the Site.

The signed certification will be included in the Periodic Review Report described below.

5.3 Periodic Review Report

A Periodic Review Report will be submitted to the Department every year, beginning eighteen months after the Release and Covenant Not to Sue is issued. In the event that the Site is subdivided into separate parcels with different ownership, a single Periodic Review Report will be prepared that addresses the Site described in the Metes and Bounds description in *Appendix A*. The report will be prepared in accordance with NYSDEC DER-10 and submitted within 45 days of the end of each certification period. Media sampling results will also be incorporated into the Periodic Review Report. The report will include:

- Identification, assessment and certification of all ECs/ICs required by the remedy for the Site
- Results of the required annual Site inspections and severe condition inspections, if applicable
- All applicable inspection forms and other records generated for the Site during the reporting period in electronic format
- Data summary tables and graphical representations of contaminants of concern by media (groundwater, soil vapor), which include a listing of all compounds analyzed, along with the applicable standards, with all exceedances highlighted. These will include a presentation of past data as part of an evaluation of contaminant concentration trends

- Results of all analyses, copies of all laboratory data sheets, and the required laboratory data deliverables for all samples collected during the reporting period will be submitted electronically in a NYSDEC-approved format

- A Site evaluation, which includes the following:

    - The compliance of the remedy with the requirements of the Site-specific RAWP

    - Any new conclusions or observations regarding Site impacts based on inspections or data generated by the Monitoring Plan for the media being monitored

    - Recommendations regarding any necessary changes to the remedy and/or Monitoring Plan

    - The overall performance and effectiveness of the remedy

The Periodic Review Report will be submitted, in hard-copy format, to the NYSDEC Central Office and Regional Office in which the Site is located, and in electronic format to NYSDEC Central Office, Regional Office and the NYSDOH Bureau of Environmental Exposure Investigation.

5.4 Corrective Measures Plan

If any component of the remedy is found to have failed, or if the periodic certification cannot be provided due to the failure of an institutional or engineering control, a corrective measures plan will be submitted to the NYSDEC for approval. This plan will explain the failure and provide the details and schedule for performing work necessary to correct the failure. Unless an emergency condition exists, no work will be performed pursuant to the corrective measures plan until it is approved by the NYSDEC.

6 References

EA Engineering, P.C. et al, January 2001, Landfill Characterization Investigation Report Areas 1, 2, 3, 5, 6, 7, and 8 Hudson River Psychiatric Center, Poughkeepsie, NY.

EA Engineering, P.C. et al, July 2002, Landfill Closure Investigation Report Landfill Areas 1, 2, 3, 6 and 8 Hudson River Psychiatric Center, Poughkeepsie, NY.

Fuss & O'Neill of New York, PC, August 2009, Remedial Action Work Plan, Hudson River Psychiatric Center Landfill Area 6.

Fuss & O'Neill of New York, PC, July 2008, Addendum to Interim Remedial Measures Work Plan, Hudson River Psychiatric Center Landfill Area 6.

Fuss & O'Neill of New York, PC, March 2011, Draft Final Engineering Report, Hudson River Psychiatric Center Landfill Area 6.

Lawler, Matusky & Skelly Engineers, 1996, Remedial Investigation of Area 6 PCB Site at Hudson River Psychiatric Center Poughkeepsie, NY NYDEC ID No. 344063.

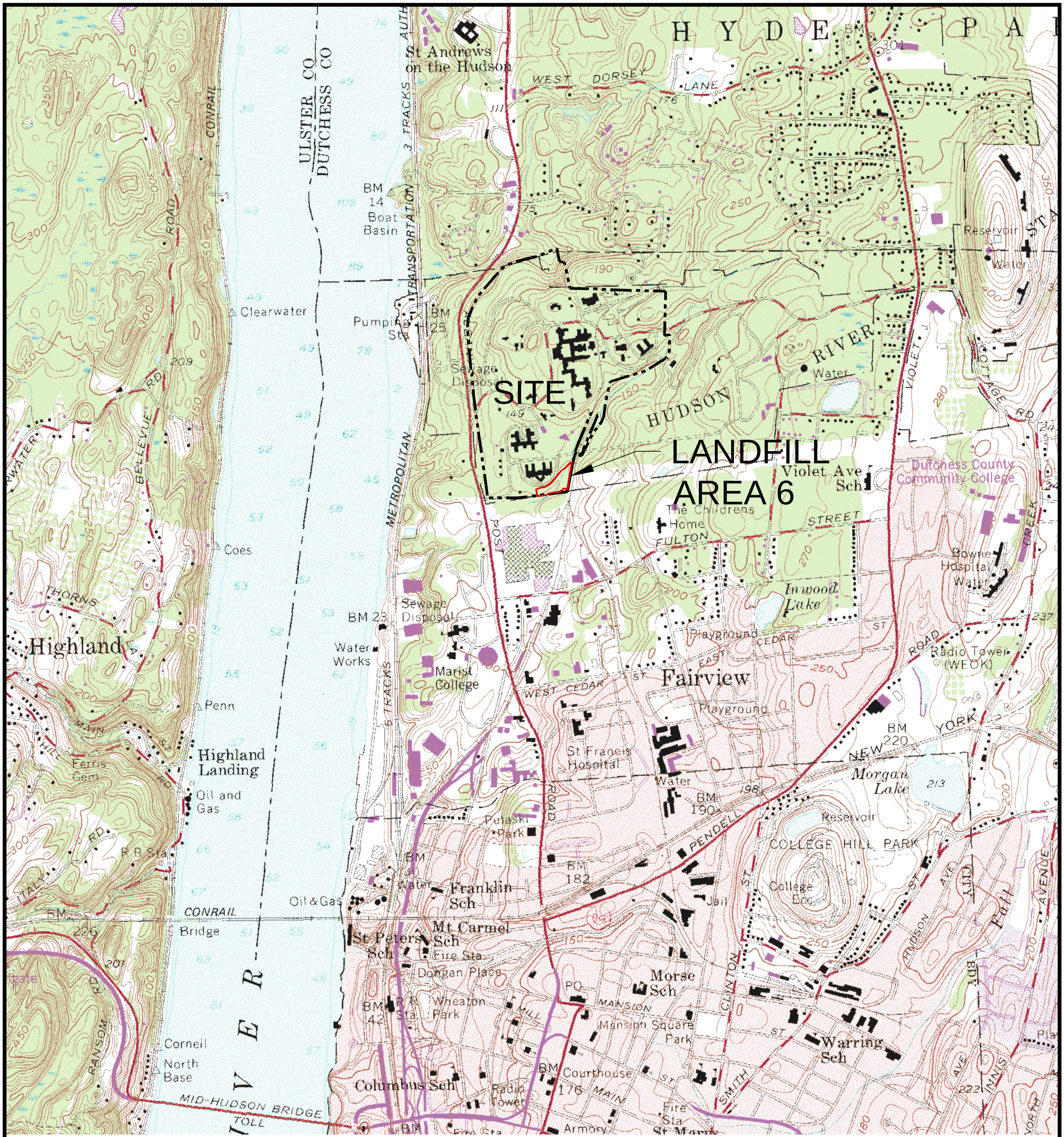
The Chazen Companies, March 2004, Supplemental Closure Investigation Report, Hudson River Psychiatric Center Landfill Area 6.

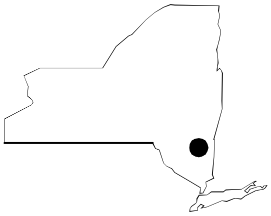
The Chazen Companies, July 2004, Supplemental Closure Investigation Report – Addendum, Hudson River Psychiatric Center Landfill Area 6.

The Chazen Companies, September 2004, Remedial Action Work Plan, Hudson River Psychiatric Center Landfill Area 6.

The Chazen Companies, March 2008, Interim Remedial Measures Work Plan, Hudson River Psychiatric Center Landfill Area 6.

Figures





MAP REFERENCE
THIS MAP WAS PREPARED FROM THE FOLLOWING 7.5 MINUTE USGS MAPS:
POUGHKEEPSIE QUADRANGLE (1957, PHOTOREVISED 1982)

SCALE: HORZ.: 1" = 1000' VERT.: DATUM: HORZ.: VERT.: 0 500 1000 GRAPHIC SCALE	WWW.FandO.COM FUSS & O'NEILL *Disciplines to Deliver* 80 WASHINGTON ST SUITE 301 POUGHKEEPSIE, NY 12601 845.452.6801	HUDSON HERITAGE DEVELOPMENT, LLC LOCATION MAP FORMER HUDSON RIVER PSYCHIATRIC CENTER TOWN OF POUGHKEEPSIE NEW YORK	PROJ. No.: 20080291.L4N DATE: JUNE 2011 FIG. 1

File Path: O:\DWG\P2008\0291\L3N\Civil\Plan\20080291L3N_LOC01.dwg, Layout: Fig 1 FER Thu, Jun 02, 2011 - 1:39 PM User: gtoothill
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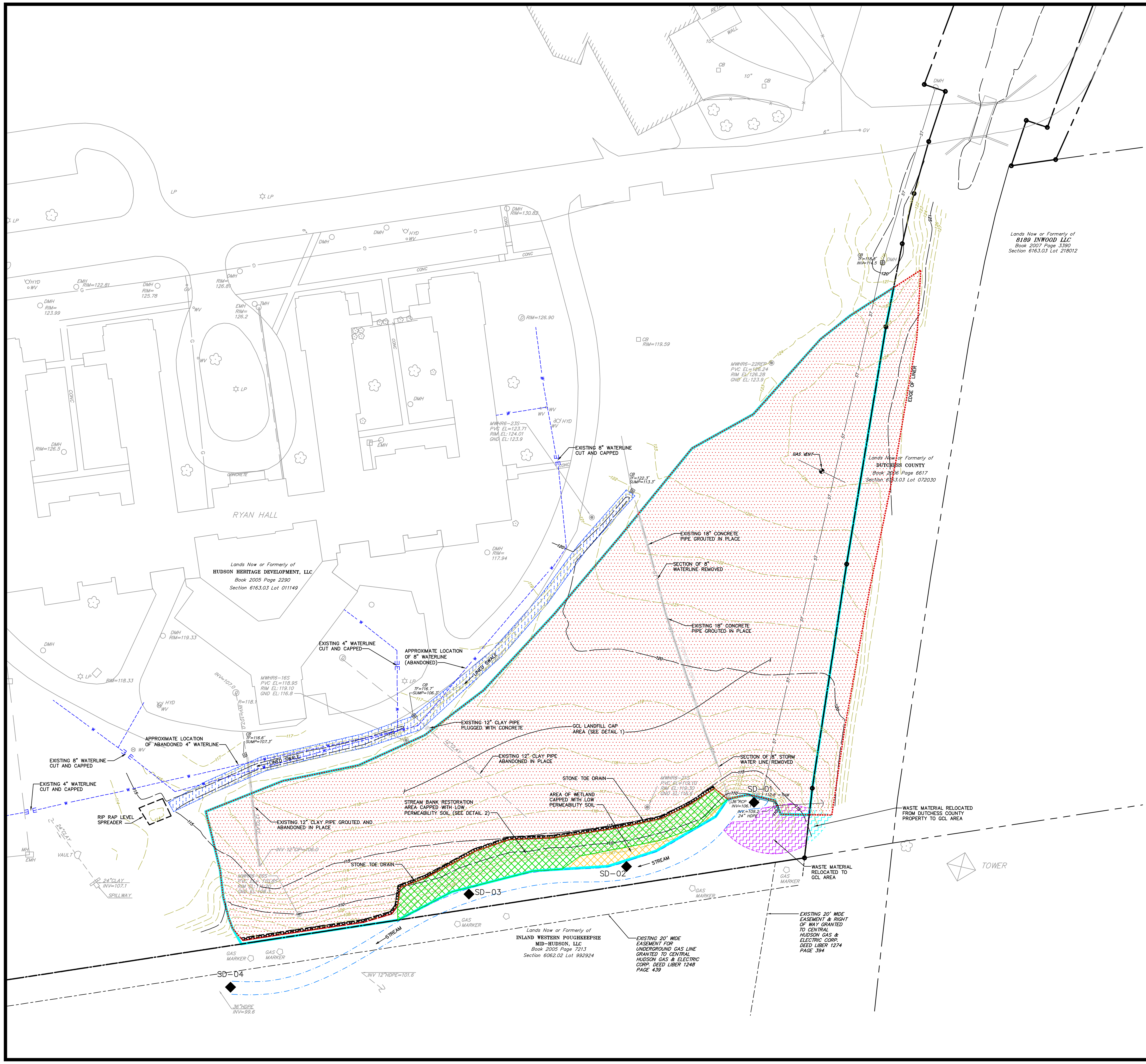

MAP REFERENCES:

1. ELECTRONIC BASE MAP OF OVERALL PROPERTY OF HUDSON HERITAGE DEVELOPMENT, LLC PREPARED BY THE CHAZEN COMPANIES.
2. THIS DRAWING WAS COMPILED IN PART FROM RAW ENTITIES ENTITLED "BOUNDARY AND TOPOGRAPHIC SURVEY OF THE LANDS OF HUDSON HERITAGE DEVELOPMENT, LLC" PREPARED BY AUSFELD & WALDRUFF LAND SURVEYORS, LLP DATED JANUARY 19, 2009.
3. THIS DRAWING WAS COMPILED IN PART FROM RAW ENTITIES ENTITLED "AS-BUILT SURVEY OF HUDSON HERITAGE LANDFILL AREA 6" PREPARED BY AUSFELD & WALDRUFF LAND SURVEYORS, LLP DATED APRIL 14, 2009.
4. THIS DRAWING WAS COMPILED IN PART FROM A DRAWING ENTITLED "AS-BUILT SURVEY OF HUDSON RIVER PSYCHIATRIC CENTER AREA 6 LANDFILL" PREPARED BY AUSFELD & WALDRUFF LAND SURVEYORS, LLP DATED DECEMBER 2, 2010.
5. THIS DRAWING WAS COMPILED IN PART FROM A DRAWING ENTITLED "DEED RESTRICTION AREA HUDSON RIVER PSYCHIATRIC CENTER AREA 6 LANDFILL" PREPARED BY AUSFELD & WALDRUFF LAND SURVEYORS, LLP DATED DECEMBER 2, 2010.

REFERENCE MAPS:

4. NON-FILED MAP ENTITLED "DORMITORY AUTHORITY OF THE STATE OF NEW YORK, NEW YORK STATE OFFICE OF MENTAL HEALTH, HUDSON RIVER PSYCHIATRIC CENTER, TOWNS OF POUGHKEEPSIE & HYDE PARK, DUTCHESS COUNTY, NEW YORK, BOUNDARY MAP" SHEETS 1 AND 2 PREPARED BY HAWK ENGINEERING , P.C. AND DATED NOVEMBER 20, 1996.
5. NON-FILED MAP ENTITLED "BOUNDARY MAP, HUDSON RIVER STATE HOSPITAL, DEPARTMENT OF MENTAL HYGIENE" PREPARED BY M.N. SINACORI, DIST. ENGINEER, DIST. 8 AND DATED JULY 17, 1964.
6. NON-FILED MAP ENTITLED "MAP OF SURVEY OF LANDS TO BE ACQUIRED BY HUDSON HERITAGE, LLC," DATED MAY 7 2003, PREPARED BE THE CHAZEN COMPANIES.
7. STREAM LOCATION, WETLANDS, TEST PITS AND LIMIT OF LANDFILL SHOWN HEREON FROM A MAP ENTITLED "TOPOGRAPHIC SURVEY-LANDFILL AREA NO. 6, HUDSON RIVER PSYCHIATRIC CENTER", DATED AUGUST 2000, BY PAGGI, MARTIN AND DEL BENE.
8. MAP ENTITLED "MID-HUDSON CENTER, 3 LOT SUBDIVISION" PREPARED BY CHAZEN ENGINEERING & LAND SURVEYING CO., P.C. AND FILED WITH THE DUTCHESS COUNTY CLERK'S OFFICE ON AUGUST 26, 1998 AS FILED MAP No.10650.
9. "SUBDIVISION PLAN & SURVEY MAP OF THE LANDS OF MICHAEL J. SUYDAM, ANN SUYDAM, SHELDON STEIN & DONNA STEIN" PREPARED BY RAYMOND KIHLMIRE, DATED OCTOBER 2, 1987 AND FILED IN THE DUTCHESS COUNTY CLERKS OFFICE AS MAP 8668.
10. "CHERRY LANE ESTATES-4 LOT SUBDIVISION PLAT" PREPARED BY LINK LAND SURVEYORS P.C., DATED APRIL 8, 2002 AND FILED IN THE DUTCHESS COUNTY CLERKS OFFICE AS MAP 11531.
11. "SUBDIVISION PLAT PREPARED FOR WINDSOR COURT" PREPARED BY PAGGI & MARTIN ENGINEERING, DATED NOVEMBER 1987 AND FILED IN THE DUTCHESS COUNTY CLERKS OFFICE AS MAP 8301.
12. "STATE HOSPITAL S.H. NO. 9003" MAP NO. 70-T, PARCEL NOS. 75, 78 & 79 SHEET 1-5 OF 5, PREPARED BY THE NEW YORK STATE DEPARTMENT OF PUBLIC WORKS, ON FILE AT DISTRICT OFFICE NO. 8, POUGHKEEPSIE, N.Y.

PLAN REFERENCE NOTE:
LAYOUT AND INFORMATION TAKEN FROM THE PLANS ENTITLED "AREA 6 LANDFILL CLOSURE AT THE HUDSON RIVER PSYCHIATRIC CENTER" PREPARED BY THE CHAZEN COMPANIES LAST REVISED SEPTEMBER 30, 2004.

LEGEND

- DEED RESTRICTION AREA
- STORMWATER LINE
- WATER LINE
- CONTOUR LINE – 1' INTERVAL
- CONTOUR LINE – 10' INTERVAL
- GROUTED FORMER STORMWATER LINE
- PROPERTY LINE
- ADJACENT PROPERTY LINE
- STREAM BOUNDARY
- CATCH BASIN
- MONITORING WELL
- LANDFILL GAS VENT
- SD-04 SEDIMENT SAMPLING LOCATION
- LINED SWALE (IRM)
- GEOSYTHETIC CLAY LINER (GCL) LANDFILL CAP AREA (RAWP)
- LOW PERMEABILITY SOIL CAP (IRM)
- RELOCATED SOIL TO GCL AREA AND LOW PERMEABILITY SOIL CAP (RAWP)
- WASTE MATERIAL RELOCATED TO GCL AREA (IRM)
- WASTE MATERIAL RELOCATED FROM DUTCHESS COUNTY PROPERTY TO GCL AREA (RAWP)
- STONE TOE DRAIN

No.	DATE	DESCRIPTION	BY
1.			

REVISIONS

PROJ. MANAGER: JEL
CHIEF DESIGNER: GAT
REVIEWED BY: CL
DATE

SEAL

SEAL

IT IS A VIOLATION OF NEW YORK STATE EDUCATION LAW FOR ANY PERSON, UNLESS HE IS ACTING UNDER THE DIRECTION OF A LICENSED PROFESSIONAL ENGINEER, TO ALTER THIS DOCUMENT IN ANY WAY. IF THIS DOCUMENT IS ALTERED, THE ALTERING ENGINEER SHALL AFFIX TO THE ITEM HIS SEAL AND THE NOTATION "ALTERED BY" FOLLOWED BY HIS SIGNATURE, THE DATE OF SUCH ALTERATION, AND A SPECIFIC DESCRIPTION OF THE ALTERATION.

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HORZ.:
VERT.:
0 20 0 40
GRAPHIC SCALE

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HUDSON HERITAGE DEVELOPMENT, LLC
IRM & RAWP AS-BUILT PLAN
FORMER HUDSON RIVER PSYCHIATRIC CENTER
TOWN OF POUGHKEEPSIE DUTCHESS COUNTY, NEW YORK

PROJ. No.: 20080291.L3N
DATE: JUNE 2011

FIGURE 2

File Path: O:\DWG\P2008\0291\L3N\Civil\Plan\20080291L3N_STP02.dwg, Layout: FIGURE 2 Thu, Jun 02, 2011 - 1:49 PM User: gtoothill
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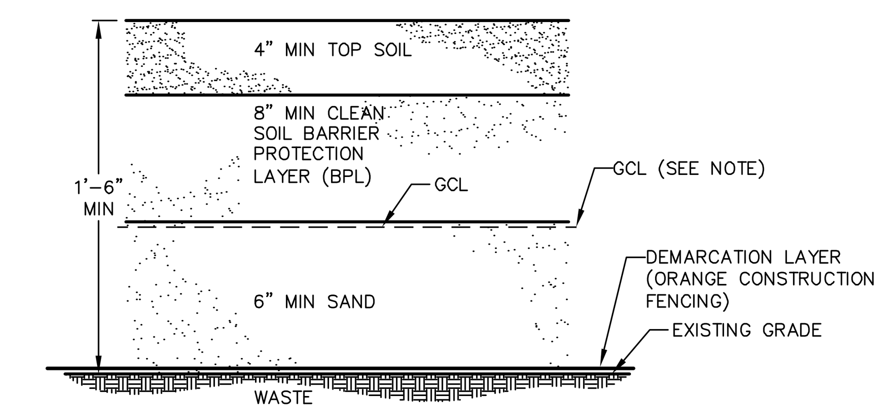
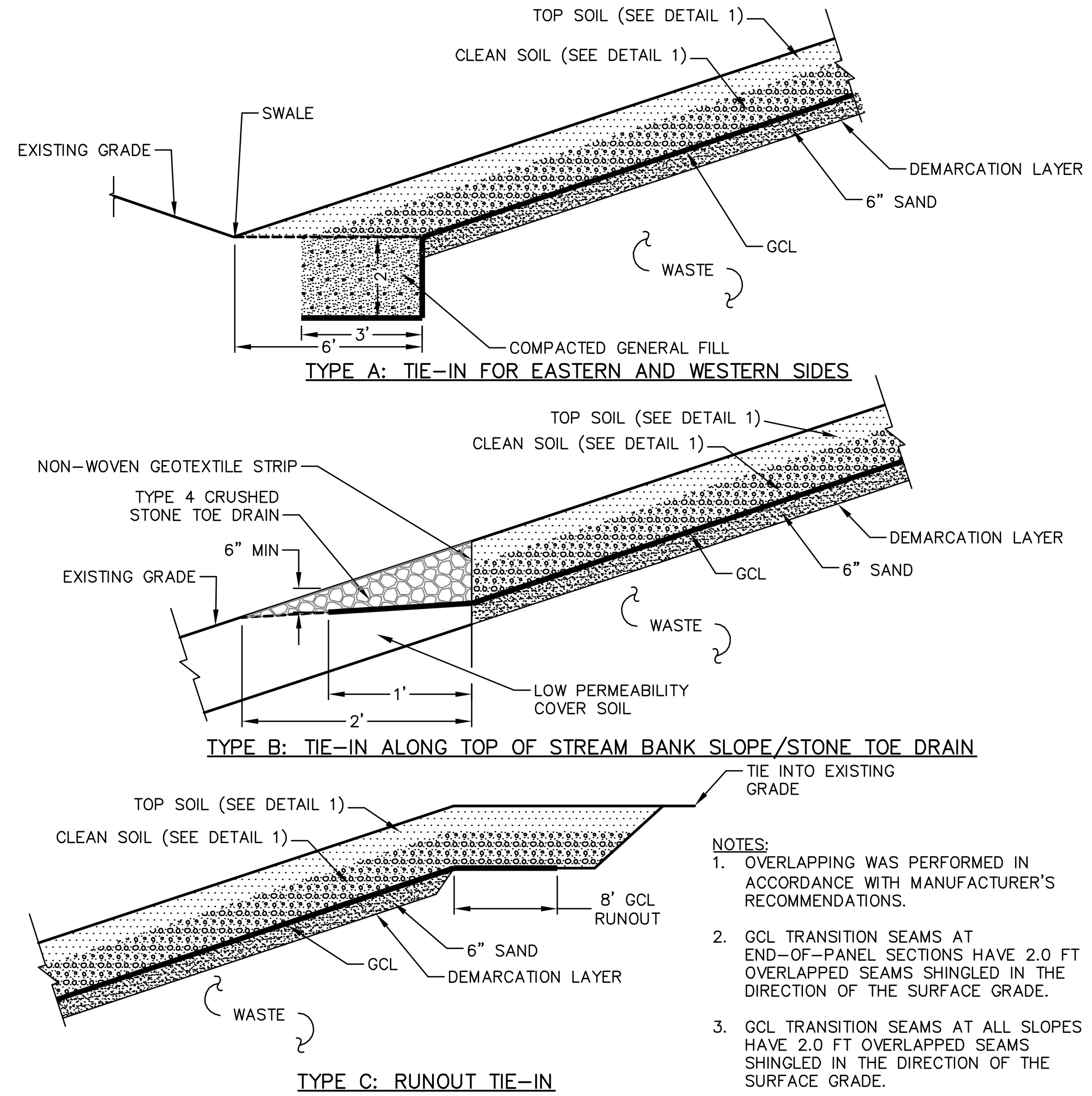


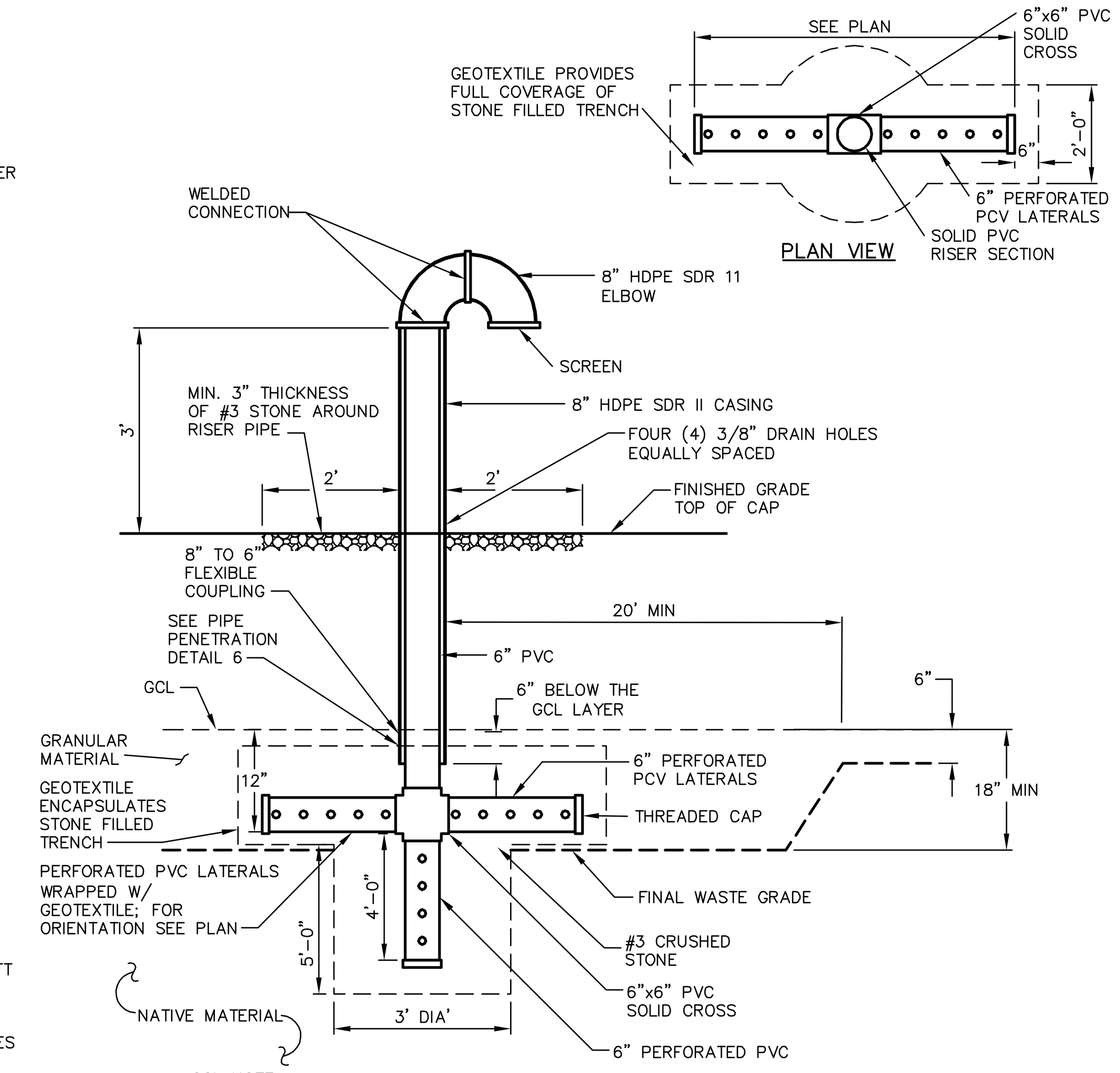
GCL NOTES:
1. CETCO BENTOMAT DN USED ON ALL SLOPES EQUAL OR STEEPER THAN 3:1
2. CETCO BENTOMAT ST USED ON ALL OTHER SLOPES

① LANDFILL CAP SECTION
NOT TO SCALE



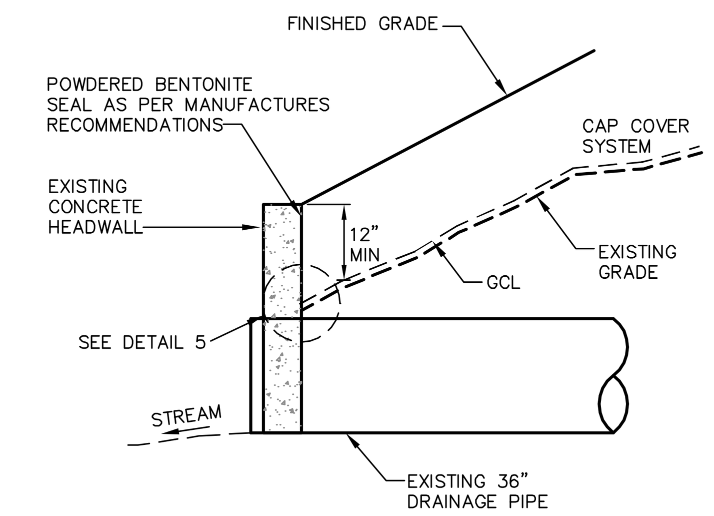
NOTES:
1. OVERLAPPING WAS PERFORMED IN ACCORDANCE WITH MANUFACTURER'S RECOMMENDATIONS.
2. GCL TRANSITION SEAMS AT END-OF-PANEL SECTIONS HAVE 2.0 FT OVERLAPPED SEAMS SHINGLED IN THE DIRECTION OF THE SURFACE GRADE.
3. GCL TRANSITION SEAMS AT ALL SLOPES HAVE 2.0 FT OVERLAPPED SEAMS SHINGLED IN THE DIRECTION OF THE SURFACE GRADE.

② COVER TIE-IN
NOT TO SCALE

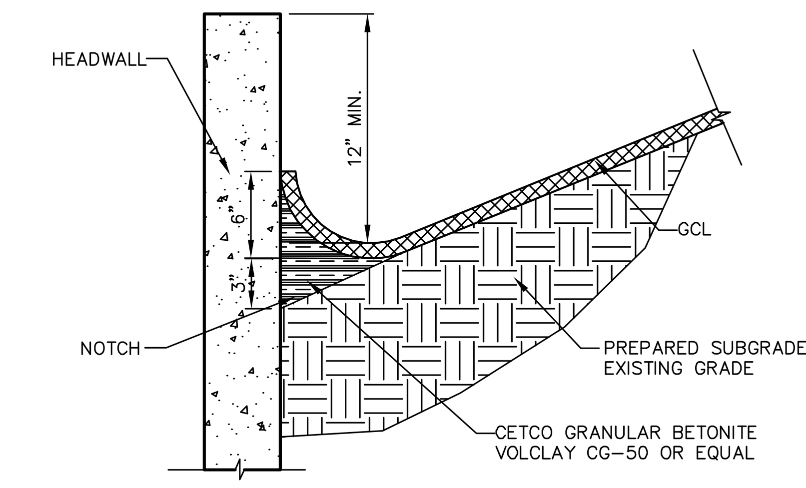


GCL NOTE:
1. SEE CAP SECTIONS FOR DETAILED EARTH LAYERING INFORMATION FOR REMAINDER OF CAP.
2. THE ABOVE CAP SECTION IS SPECIFIC TO THE LOCATION WHERE THE GAS VENT RISER PENETRATES THE LINER. SAND LAYER ABOVE THE WASTE GRADE TRANSITIONS FROM 6 IN. OF THICKNESS TO A 18" MINIMUM THICKNESS FOR THE EXTENTS OF THE THE LATERAL VENT PIPE.

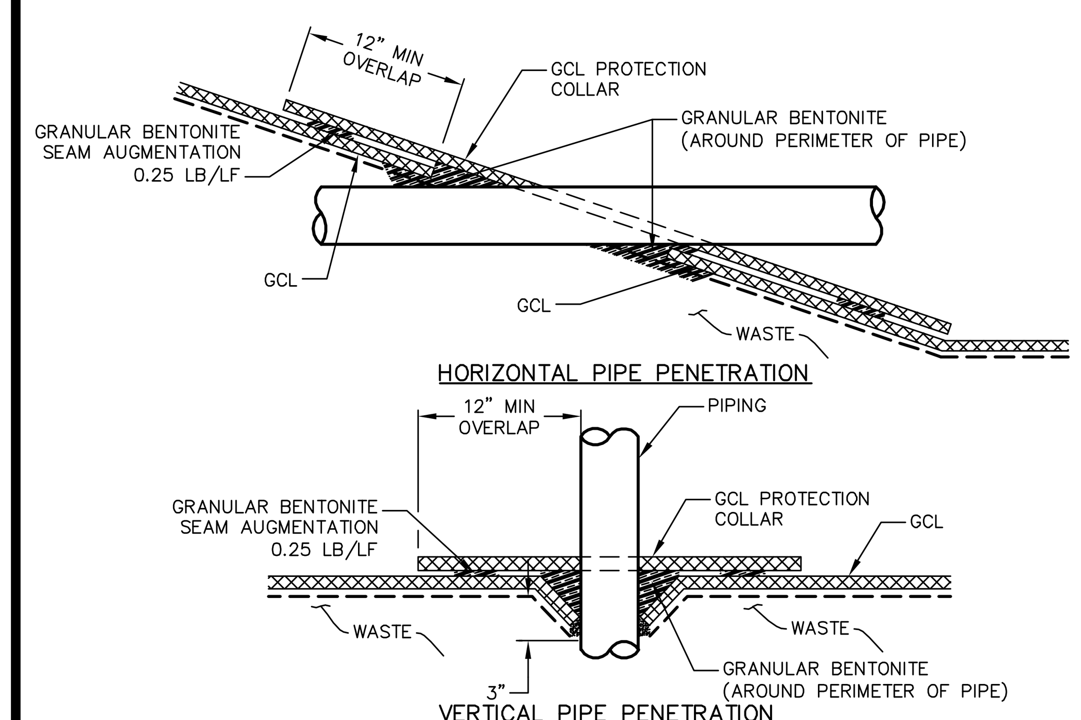
③ GAS VENT RISER
NOT TO SCALE



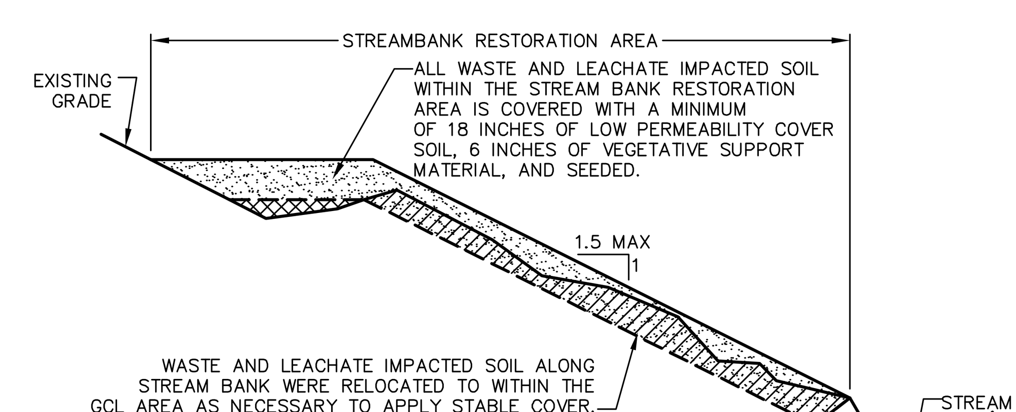
④ HEADWALL TIE-IN
NOT TO SCALE



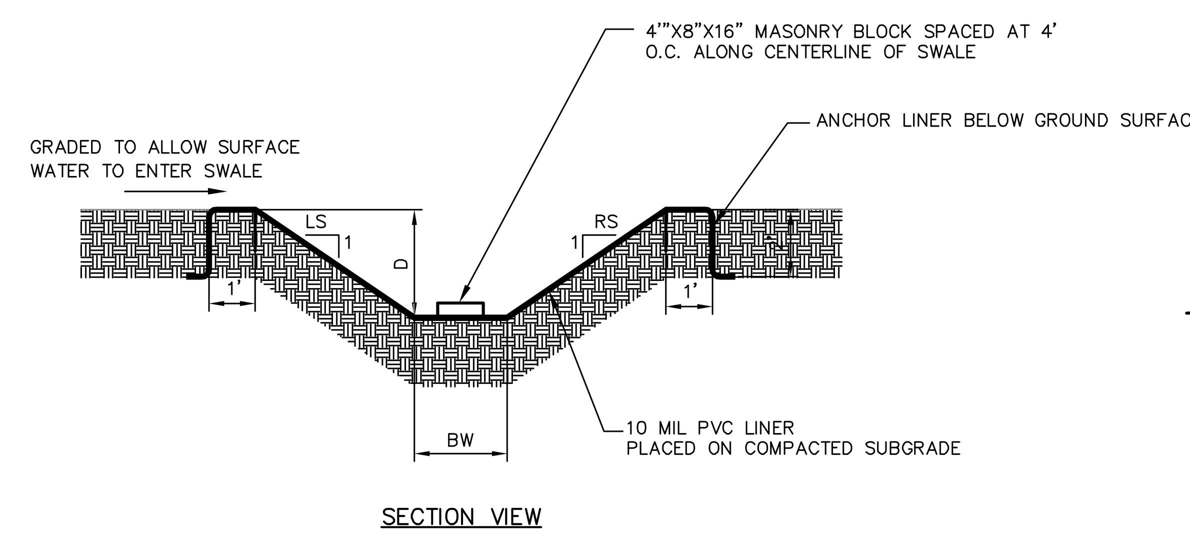
⑤ GCL SEAL AT HEADWALL STRUCTURE
NOT TO SCALE



⑥ PIPE PENETRATION AND GCL TIE-IN
NOT TO SCALE

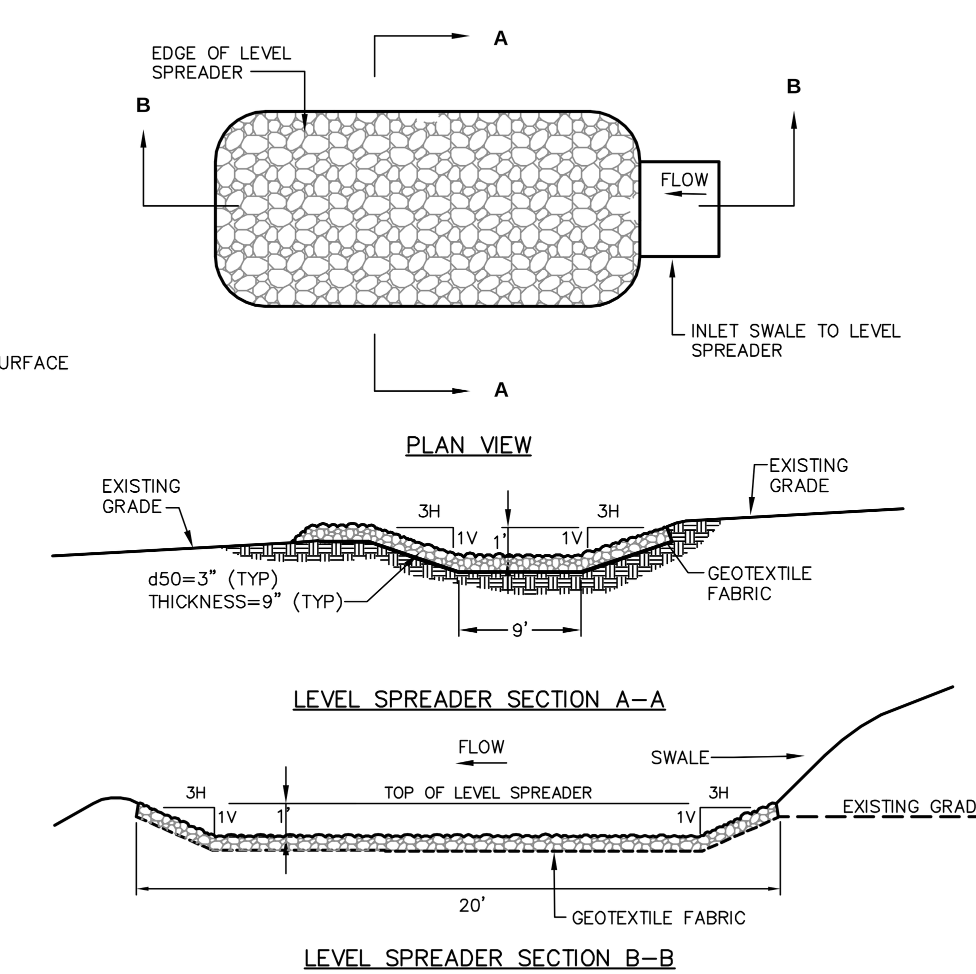


⑦ STREAM BANK RESTORATION
NOT TO SCALE



SWALE	D (FT)	LS (FT)	RS (FT)	BW (FT)
A	1.5'(MIN)	2	2	3
B	1.5'(MIN)	2	2	2

⑧ LINED CHANNEL DETAIL
NOT TO SCALE



⑨ LEVEL SPREADER DETAIL
NOT TO SCALE

No.	DATE	DESCRIPTION	BY
1.			

REVISIONS

PROJ. MANAGER: JEL
CHIEF DESIGNER: GAT
REVIEWED BY: CL
DATE

SEAL

SEAL

SCALE:
HORZ.: AS SHOWN
VERT.:
DATUM:
HORZ.:
VERT.:
40 20 0 40
GRAPHIC SCALE

WWW.FandO.COM
FUSS & O'NEILL
Disciplines to Deliver
80 WASHINGTON ST SUITE 301 POUGHKEEPSIE, NY 12601 845.452.6801

HUDSON HERITAGE DEVELOPMENT, LLC
IRM & RAWP AS-BUILT DETAILS
FORMER HUDSON RIVER PSYCHIATRIC CENTER
TOWN OF POUGHKEEPSIE DUTCHESS COUNTY, NEW YORK

PROJ. No.: 20080291.L3N
DATE: JUNE 2011

FIGURE 3

File Path: O:\DWG\P2008\0291\L3N\Civil\Plan\20080291L3N_STP02.dwg, Layout: FIGURE 3 Thu, Jun 02, 2011 - 1:50 PM User: gtoothill
CTB: F&O 2008 MONO
LMAN: N/A
MS VIEW: N/A
UCS: N/A

Appendix A

Environmental Deed Restriction

DECLARATION of COVENANTS and RESTRICTIONS

THIS COVENANT is made the 23rd day of March, 2011, by Hudson Heritage Development, LLC, a limited liability company organized and existing under the laws of the State of New York, having an office for the transaction of business at c/o CPC Resources, Inc., 28 E. 28th Street, New York, N.Y.10016.

WHEREAS, the Hudson River Psychiatric Center Site is the subject of a Voluntary Cleanup Agreement executed by Hudson Heritage CPCR Ventures, LLC as part of the New York State Department of Environmental Conservation's (the "Department's") Voluntary Cleanup Program, namely a portion of that parcel of real property located on 373 North Road in the Town of Poughkeepsie, County of Dutchess, State of New York, which is part of lands conveyed by New York State Urban Development Corporation D/B/A Empire State Development Corporation, a New York Public Benefit Corporation, to Hudson Heritage Development, LLC by deed dated March 15, 2005 and recorded in the Dutchess County Clerk's Office as Document #02-2005-2290, and being more particularly described in Appendix "A," attached to this declaration and made a part hereof, and hereinafter referred to as "the Property"; and

WHEREAS, the Department approved a remedy to eliminate or mitigate all significant threats to the environment presented by the contamination disposed at the Property and such remedy requires that the Property be subject to restrictive covenants.

NOW, THEREFORE, Hudson Heritage Development, LLC, for itself and its successors and/or assigns, covenants that:

First, the Property subject to the Declaration of Covenants and Restrictions is as shown on a map attached to this declaration as Appendix "B" and made a part hereof.

Second, unless prior written approval by the Department or, if the Department shall no longer exist, any New York State agency or agencies subsequently created to protect the environment of the State and the health of the State's citizens, hereinafter referred to as "the Relevant Agency," is first obtained, where contamination remains at the Property subject to the provisions of the Site Management Plan ("SMP"), there shall be no construction, use or occupancy of the Property that results in the disturbance or excavation of the Property which threatens the integrity of the engineering controls or which results in unacceptable human exposure to contaminated soils.

Third, the owner of the Property shall not disturb, remove, or otherwise interfere with the installation, use, operation, and maintenance of engineering controls required for the remedy, which are described in the SMP, unless in each instance the owner first obtains a written waiver of such prohibition from the Department or Relevant Agency.

Fourth, the owner of the Property shall prohibit the Property from ever being used for purposes other than for Commercial or Industrial use, as defined in 6 NYCRR 375-1.8(g)(2)(iii) and 6 NYCRR 375-1.8(g)(2)(iv) respectively, excluding day care, child care or medical care uses, without the express written waiver of such prohibition by the Relevant Agency.

Fifth, the owner of the Property shall prohibit the use of the groundwater underlying the Property without treatment rendering it safe for drinking water or industrial purposes, as appropriate, unless the user first obtains permission to do so from the Department or Relevant Agency.

Sixth, the owner of the Property shall provide a periodic certification, prepared and submitted by a professional engineer or environmental professional acceptable to the Department or Relevant Agency, which will certify that the institutional and engineering controls put in place are unchanged from the previous certification, comply with the SMP, and have not been impaired.

Seventh, the owner of the Property shall continue in full force and effect any institutional and engineering controls required for the remedy and maintain such controls, unless the owner first obtains permission to discontinue such controls from the Department or Relevant Agency, in compliance with the approved SMP, which is incorporated and made enforceable hereto, subject to modifications as approved by the Department or Relevant Agency.

Eighth, this Declaration is and shall be deemed a covenant that shall run with the land and shall be binding upon all future owners of the Property, and shall provide that the owner and its successors and assigns consent to enforcement by the Department or Relevant Agency of the prohibitions and restrictions that the Voluntary Cleanup Agreement requires to be recorded, and hereby covenant not to contest the authority of the Relevant Agency to seek enforcement.

Ninth, any deed of conveyance of the Property, or any portion thereof, shall recite, unless the Department or Relevant Agency has consented to the termination of such covenants and restrictions, that said conveyance is subject to this Declaration of Covenants and Restrictions.

IN WITNESS WHEREOF, the undersigned has executed this instrument the day written below.

Hudson Heritage Development, LLC

By: Richard A. Kumro
Its: Vice President

STATE OF NEW YORK)
) ss:
COUNTY OF NEW YORK)

On the 23rd day of March, in the year 2011, before me, the undersigned, personally appeared Richard A. Kumro, personally known to me or proved to me on the basis of satisfactory evidence to be the individual(s) whose name is (are) subscribed to the within instrument and acknowledged to me that he/she/they executed the same in his/her/their capacity(ies), and that by his/her/their signature(s) on the instrument, the individual(s), or the person upon behalf of which the individual(s) acted, executed the instrument.

Claudia A. Gilchriest
Notary Public State of New York

CLAUDIA A. GILCHRIEST
Notary Public, State of New York
No. 01GI6126232
Qualified in Kings County
Commission Expires May 2, 2013

Appendix A

Ausfeld & Waldruff Land Surveyors LLP
514 State Street, Schenectady, New York 12305
Phone: (518) 346-1595 Fax: (518) 770-1655
www.awlsllp.com

LEGAL DESCRIPTION

Deed Restriction Parcel
Hudson Heritage Development
Containing 2.29 Acres
Area 6 Landfill

All that piece or parcel of land situate in the Town of Poughkeepsie, County of Dutchess and the State of New York, bounded and described as follows:

Beginning at a point located along the division line between the lands now or formerly of Dutchess County (Book 2006, Page 6617) on the east and the lands now or formerly of Hudson Heritage Development, LLC (Book 2005, Page 2290) on the west, said point being located North 06°20'10" East, 33.28 feet from the intersection formed by said division line with the northeast corner of the lands now or formerly of Inland Western Poughkeepsie Mid-Hudson (Book 2005, Page 7213); thence from said point of beginning and through the aforesaid lands of Hudson Heritage Development, LLC the following ten courses: 1) North 89°10'16" West, 21.93 feet to a point; 2) North 22°25'09" West, 11.62 feet to a point; 3) North 77°49'27" West, 20.94 feet to a point; 4) South 77°51'28" West, 16.41 feet to a point; 5) South 33°56'31" West, 16.18 feet to a point; 6) South 59°56'01" West, 52.61 feet to a point;7) South 72°24'19" West, 39.08 feet to a point: 8) South 86°27'34" West, 57.49 feet to a point; 9) South 75°36'54" West, 64.11 feet to a point; 10) South 62°26'21" West, 47.01 feet to a point located along the division line between the aforesaid lands of Hudson Heritage Development, LLC on the north and the aforesaid lands of Inland Western Poughkeepsie Mid-Hudson, LLC on the south; thence in a westerly direction and along said division line, South 81°18'31" West, 121.39 feet to a point; thence through the aforesaid lands of Hudson Heritage Development, LLC, the following sixteen courses: 1) North 29°30'41" West, 13.86 feet to a point; 2) North 20°06'10" West, 8.67 feet to a point; 3) N14°41'46" West, 16.02 feet to a point; 4) North 06°51'40" West, 21.58 feet to a point; 5) North 13°44'11" West, 45.85 feet to a point; 6) North 68°23'33" East, 63.66 feet to a point; 7) North 78°19'40" East, 59.16 feet to a point; 8) North 65°33'37" East, 55.90 feet to a point; 9) North 52°41'08" East, 56.77 feet to a point; 10) North 42°52'21" East, 79.21 feet to a point; 11) North 40°16'02" East, 78.12 feet to a point; 12) North 39°15'01" East, 87.92 feet to a point; 13) North 61°00'40" East, 53.74 feet to a point; 14) North 41°49'00" East, 77.16 feet to a point; 15) North 51°32'58" East, 28.82 feet to a point and 16) North 57°08'22" East, 40.09 feet to a point; thence in a southerly direction and along the first mentioned division line, the following four course: 1) South 11°06'53" West, 30.62 feet to a point; 2) South

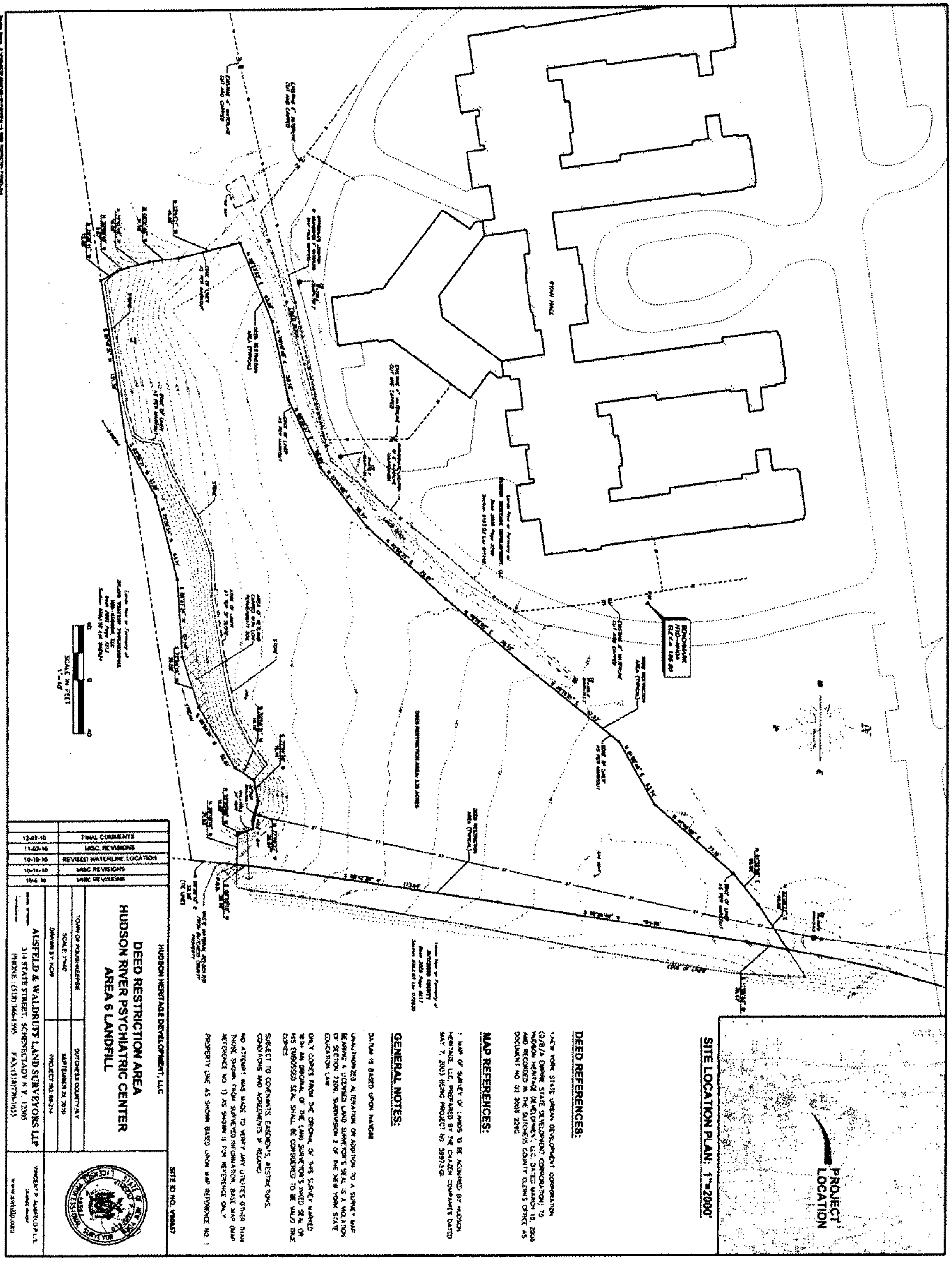
09°24'40" West, 184.58 feet to a point; 3) South 08°42'36" West, 173.98 feet to a point and 4) South 06°20'10" West, 20.46 feet to the point or place of beginning.

Containing in all 2.29 acres of land being more or less

STATE OF NEW YORK VINCENT P. AUSFELD ... LICENSED ... SURVEYOR

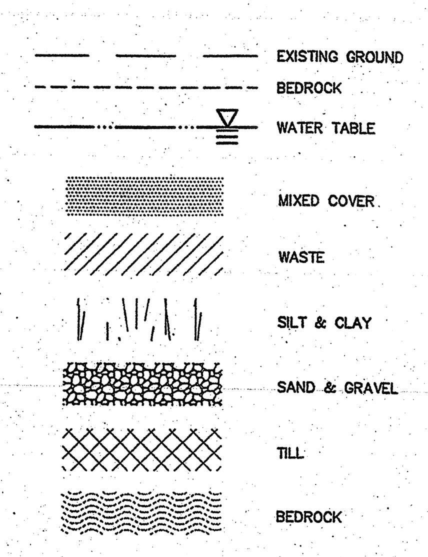
September 29, 2010 Vincent P. Ausfeld P.L.S.
Revised 12-21-10
Z:\PROJECTS\2008\08-214\deed restriction LD 2.29 ac.doc

Appendix B


SITE LOCATION PLAN: 1"=2000'
PROJECT LOCATION
DEED REFERENCES:
MAP REFERENCES:
GENERAL NOTES:
HUDSON HERITAGE DEVELOPMENT, LLC
DEED RESTRICTION AREA
HUDSON RIVER PSYCHIATRIC CENTER
AREA 6 LANDFILL
ALSFELD & WALDRUFF LAND SURVEYORS LLP
FINAL COMMENTS
MISC. REVISIONS
REVISED WATERLINE LOCATION
RYAN HALL

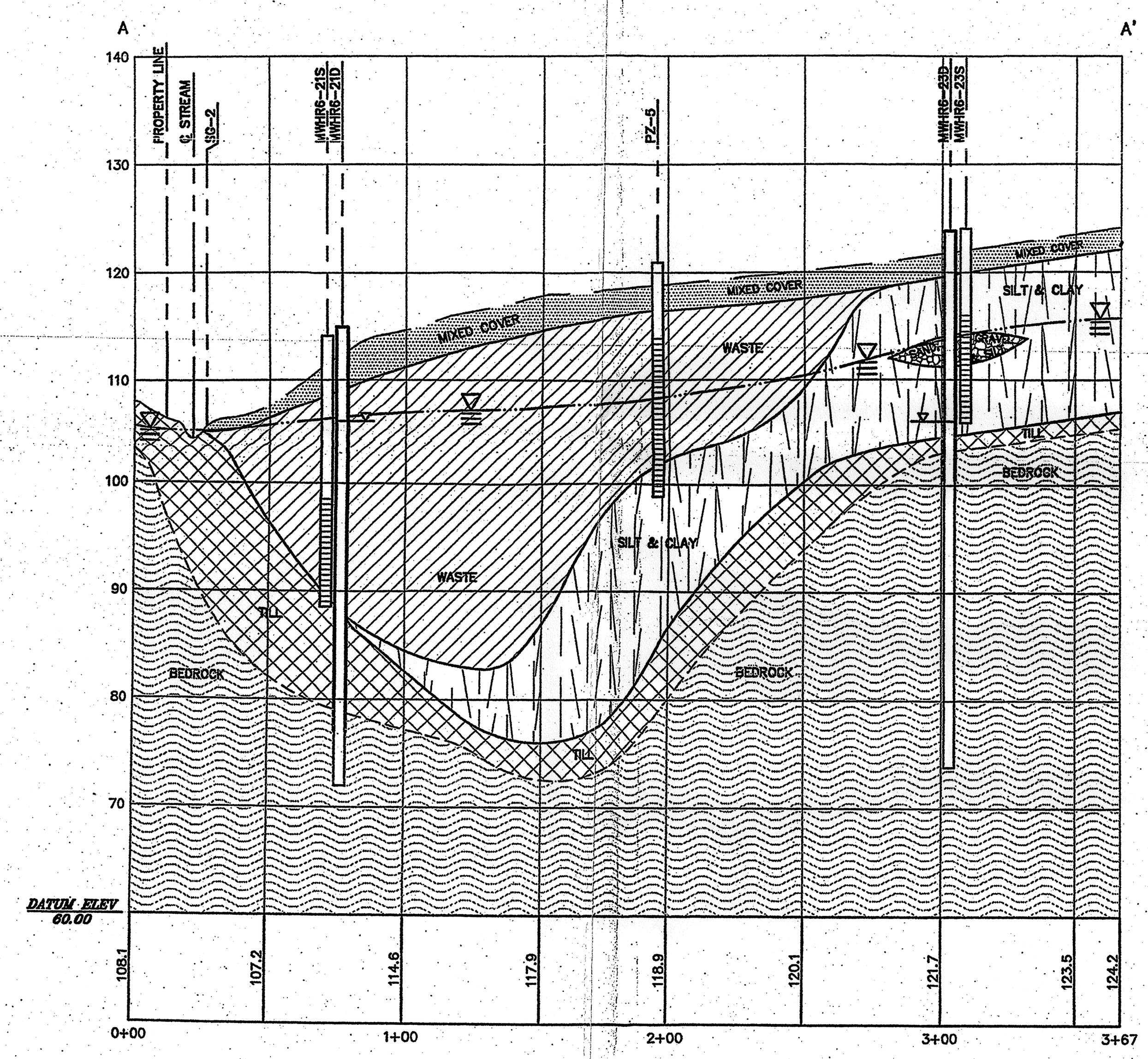
Appendix B

Geologic Cross Section

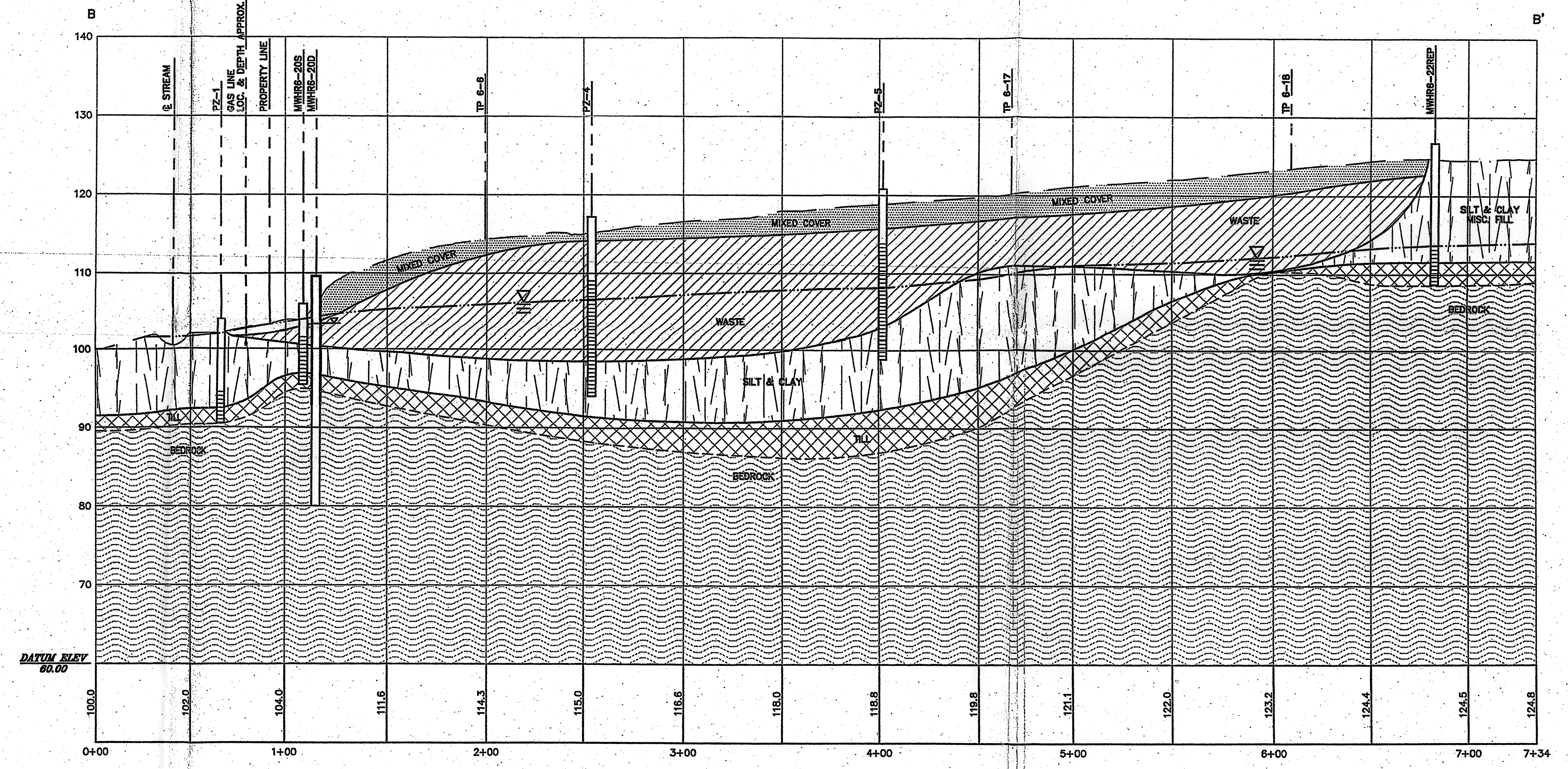


NOTE:

1. WELL DIMENSIONS NOT TO SCALE.
2. ALL BOUNDARIES INFERRED BASED ON FINDINGS FORM FIELD INVESTIGATION, HISTORICAL TOPOGRAPHIC MAPS , AND INFORMATION FROM "LANDFILL CLOSURE INVESTIGATION REPORT" BY EA ENGINEERING.



1 FIG 4 **CROSS SECTION A-A' PERPENDICULAR TO FORMER VALLEY CENTERLINE**
SCALE: HORIZONTAL 1"=40'
VERTICAL 1"=10'



2 FIG 4 **CROSS SECTION B-B' ALONG FORMER VALLEY CENTERLINE**
SCALE: HORIZONTAL 1"=40'
VERTICAL 1"=10'

THE Chazen COMPANIES
Engineers/Surveyors
Planners
Environmental Scientists

CHAZEN ENGINEERING & LAND SURVEYING CO., P.C.

Dutchess County Office: 21 Fox Street, Poughkeepsie, New York 12601, Phone: (845) 454-3980
Capital District Office: 20 Gurley Avenue, Troy, New York 12182, Phone: (518) 235-8050
Orange County Office: 263 Route 17K, Newburgh, New York 12550, Phone: (845) 567-1133
North Country Office: 110 Glen Street, Glens Falls, New York 12801, Phone: (518) 812-0513

rev.	date	description

HUDSON RIVER PSYCHIATRIC CENTER–LANDFILL AREA 6 CLOSURE INVESTIGATION

CROSS SECTIONS

TOWN OF POUGHKEEPSIE, DUTCHESS COUNTY, NEW YORK

drawn	checked
DWP	
date 10/14/03	scale AS SHOWN
project no. 40307.00	
sheet no. Figure 5	

Drawing Name: X:\4\40300-40400\40307.00 (HRPC-Hydrogeo)\ENG\DWG\Figures\Figure 4 -PROFILES LANDFILL Area 6.dwg
Xrefs Attached: X-PROFILE LANDFILL Area 6

LEGEND

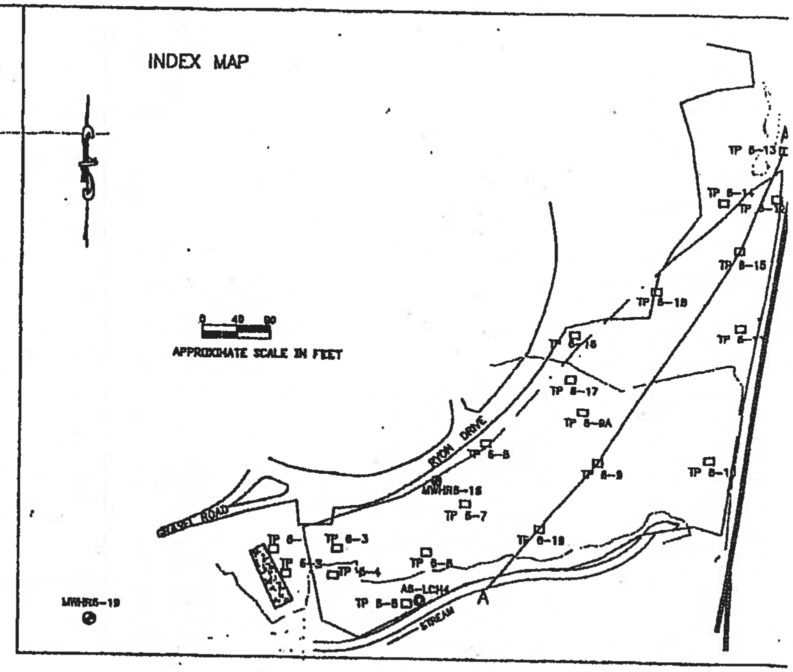
6-9 — Test pit ID, Ground surface

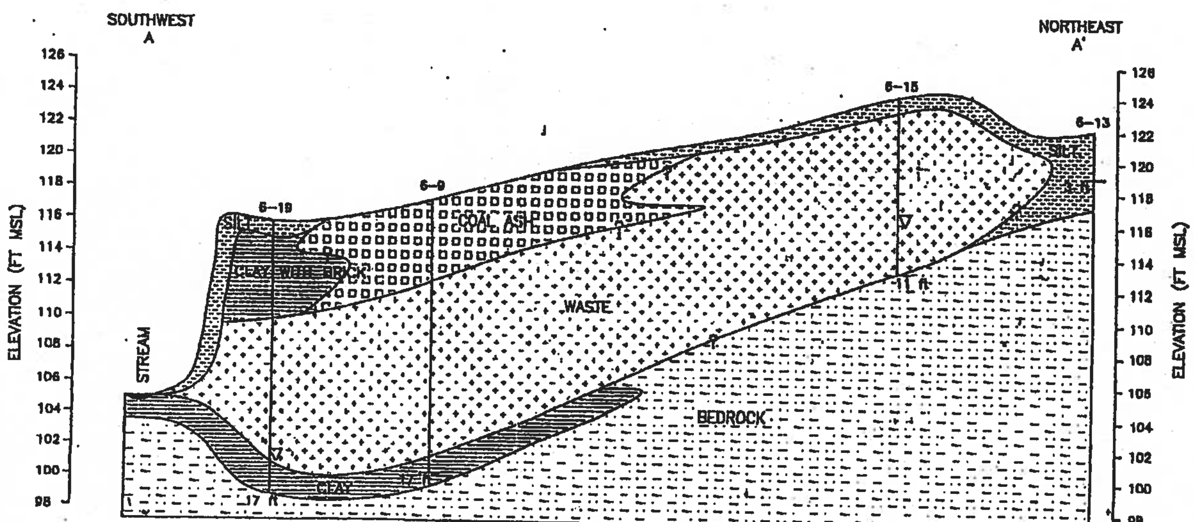
▽ — Depth to water table

17 ft — Total depth of test pit (ft below ground surface)

SOIL DESCRIPTION

- SILT: Tan to dark brown silt
- COAL ASH: Black coal ash with tan to brown sandy silt
- CLAY WITH BRICK: Tan gray silty clay with a little brick
- WASTE: Glass, metal, paper, wood with some silt, and construction debris with tan gray silt and clay
- CLAY: Gray to brown clay with silt
- BEDROCK: Gray to tan siltstone





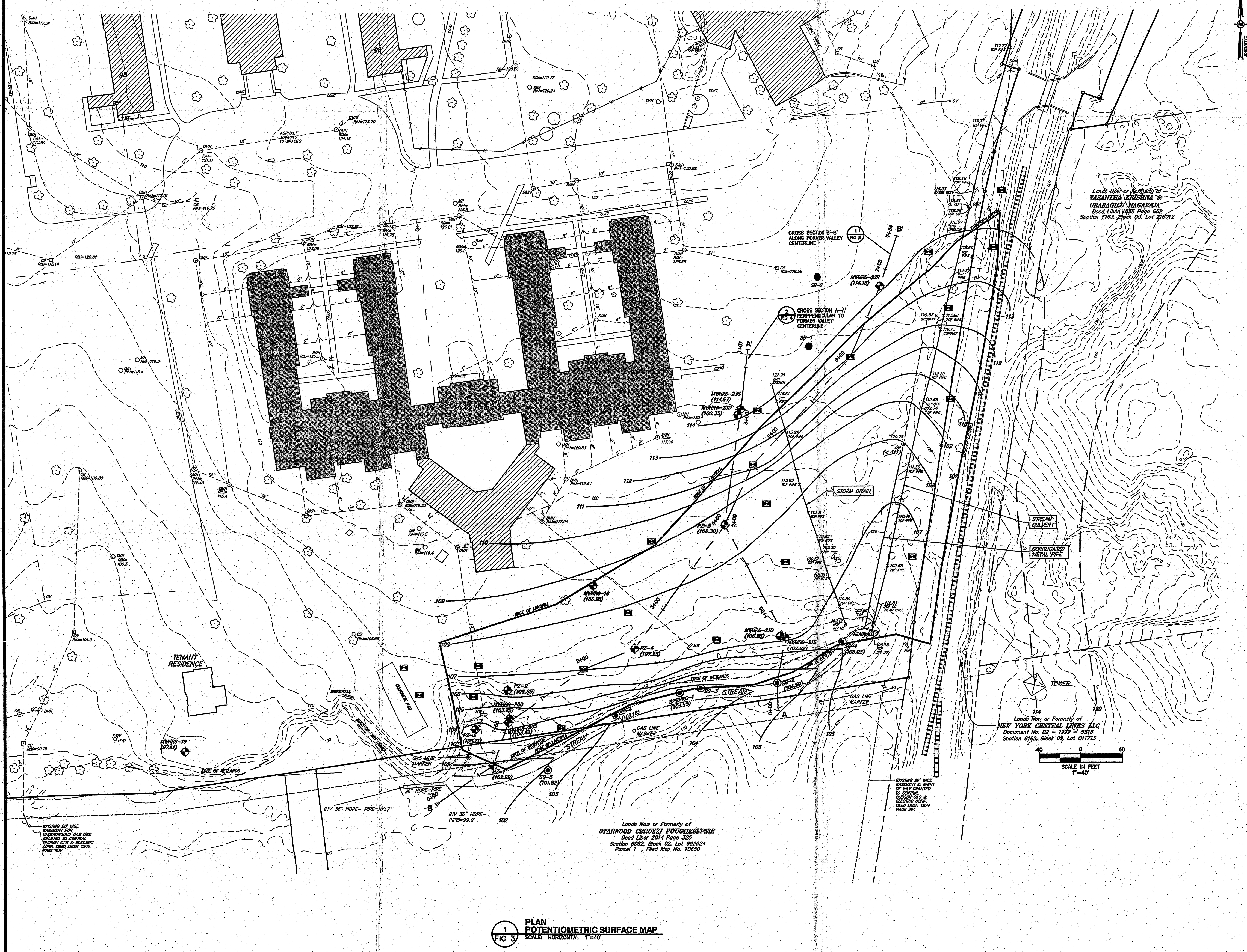
APPROXIMATE SCALE IN FEET
0 40 80
VERTICAL EXAGGERATION = 10X

NOTES:
1. CROSS-SECTION BASED ON SURVEY DATA PROVIDED BY PAGGI, MARTIN AND DEL BENE, LLP
2. SOIL AND BEDROCK CONTACTS ARE INFERRED BELOW AND BETWEEN TEST PIT LOCATIONS

EA ENGINEERING, P.C. AND ITS AFFILIATE EA ENGINEERING, SCIENCE, AND TECHNOLOGY	PROJECT MGR: DM	DATE: 26 JAN 2001	PROJECT NO: 61317.05	FILE NAME: FIG13.DWG	HUDSON RIVER PSYCHIATRIC CENTER, POUGHKEEPSIE, NEW YORK
	CHECKED BY: KD	DRAWN BY: JG	DASNY PROJECT NO.: 59995	SCALE: AS SHOWN	FIGURE 13 CROSS-SECTION OF LANDFILL AREA 6

Appendix C

Potentiometric Surface Map



1 FIG 3 PLAN
POTENTIOMETRIC SURFACE MAP
SCALE: HORIZONTAL 1"=40'

LEGEND:

Symbol	Description
	NO PHYSICAL BOUNDS
	ADJACENT PROPERTY LINE
	NYSDEC WETLANDS LINE
	NYSDEC 100' BUFFER LINE
	ACOE WETLANDS LINE
110	EXISTING MAJOR CONTOUR
	EXISTING MINOR CONTOUR
X 108.7	EXISTING SPOT GRADE
	EXISTING RETAINING WALL
	EXISTING SWALE
	EXISTING DRAINAGE LINE
CB	EXISTING CATCH BASIN
DMH	EXISTING DRAINAGE MANHOLE
CB	EXISTING CATCH BASIN
HW	EXISTING HEADWALL
ES	EXISTING END SECTION
	EXISTING TREE LINE
	EXISTING TREE/SHRUB
	EDGE OF LANDFILL
SB-1	SOIL BORING LOCATION
SG-6 (101.82)	STAFF GAUGE LOCATION (WATER EL.)
PZ-1 (102.29)	PIEZOMETER LOCATION (WATER EL.)
MWHR-230 (106.25)	MONITORING WELL LOCATION (WATER EL.)
	EA ENGINEERING TEST PIT LOCATION
108	WATER TABLE CONTOUR (FEET)

NOTE:

WATER ELEVATIONS CALCULATED FROM WATER LEVEL MEASUREMENTS TAKEN ON 10/23/03 (TABLE 2).

WATER TABLE CONTOURS DASHED WHERE INFERRED.

THE Chazen COMPANIES
Engineers/Surveyors
Planners
Environmental Scientists

CHAZEN ENGINEERING & LAND SURVEYING CO., P.C.

Dutchess County Office: 21 Fox Street, Poughkeepsie, New York 12601, Phone: (845) 454-3980
Capital District Office: 20 Gurley Avenue, Troy, New York 12182, Phone: (518) 235-8050
Orange County Office: 263 Route 17K, Newburgh, New York 12550, Phone: (845) 567-1133
North Country Office: 110 Glen Street, Glens Falls, New York 12801, Phone: (518) 812-0513

rev.	date	description

HUDSON RIVER PSYCHIATRIC CENTER–LANDFILL AREA 6 CLOSURE INVESTIGATION

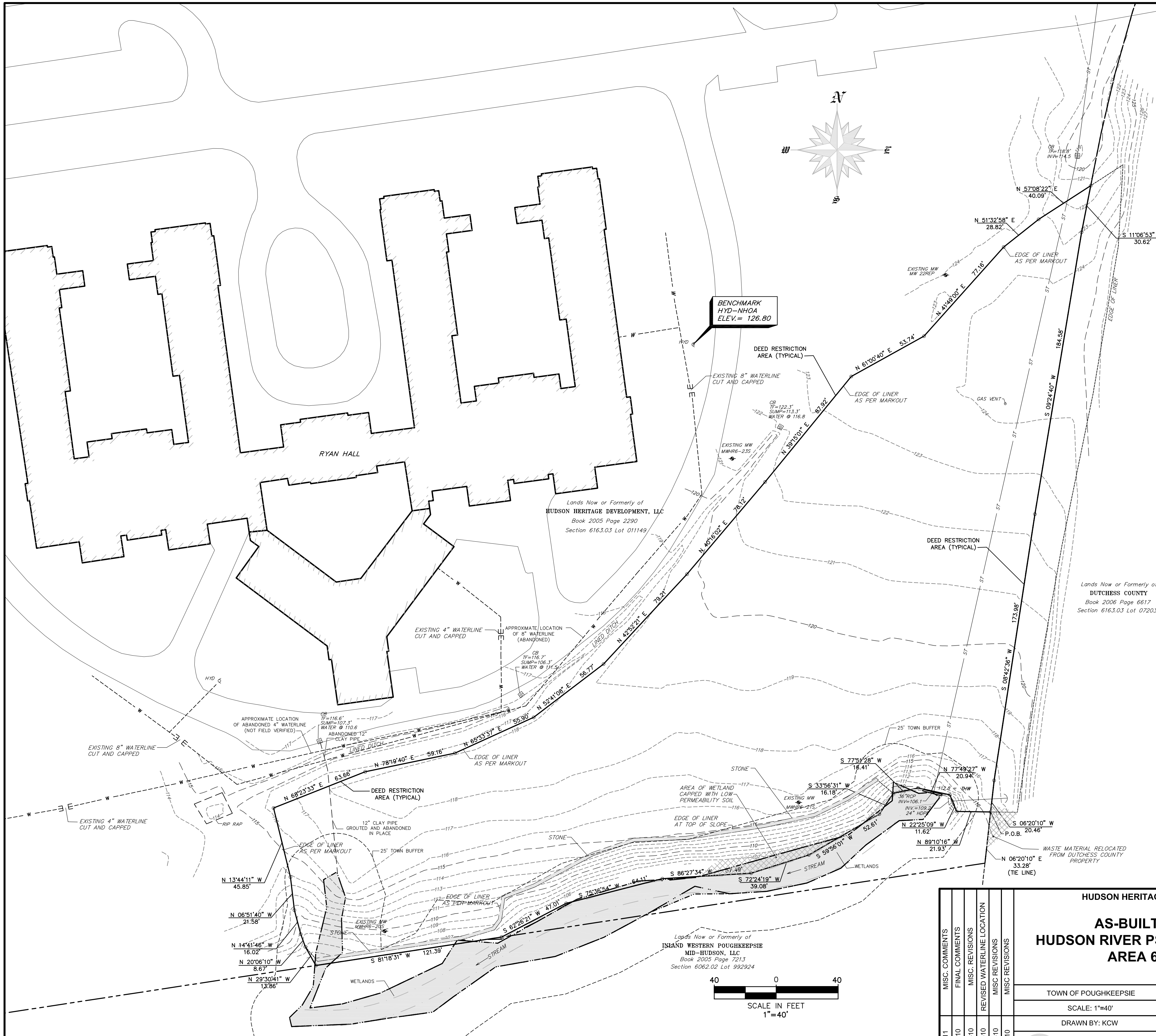
POTENTIOMETRIC SURFACE MAP

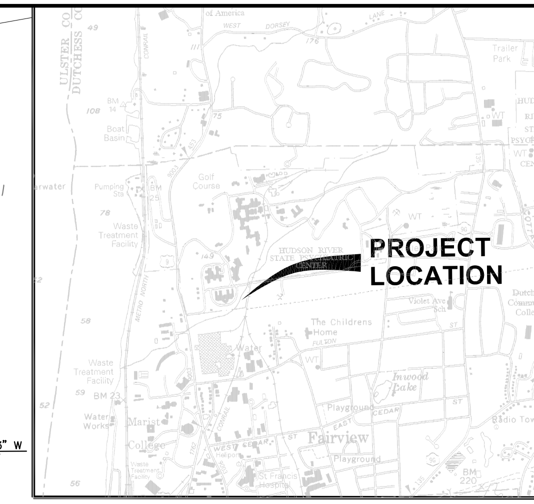
TOWN OF POUGHKEEPSIE, DUTCHESS COUNTY, NEW YORK

drawn	checked
DWP	
date 10/14/03	scale 1"=40'
project no. 40307	
sheet no. Figure 4	

Appendix D

As-Built Survey





SITE LOCATION PLAN: 1"=2000'

DEED REFERENCES:

1.NEW YORK STATE URBAN DEVELOPMENT CORPORATION (D/B/A EMPIRE STATE DEVELOPMENT CORPORATION) TO HUDSON HERITAGE DEVELOPMENT, LLC, DATED MARCH 15, 2005 AND RECORDED IN THE DUTCHESS COUNTY CLERKS OFFICE AS DOCUMENT NO. 02 2005 2290.

MAP REFERENCES:

1. MAP OF SURVEY OF LANDS TO BE ACQUIRED BY HUDSON HERITAGE, LLC, PREPARED BY THE CHAZEN COMPANIES DATED MAY 7, 2003 BEING PROJECT NO. 59973.01

GENERAL NOTES:

DATUM IS BASED UPON NAVD88.

UNAUTHORIZED ALTERATION OR ADDITION TO A SURVEY MAP BEARING A LICENSED LAND SURVEYOR'S SEAL IS A VIOLATION OF SECTION 7209, SUBDIVISION 2 OF THE NEW YORK STATE EDUCATION LAW.

ONLY COPIES FROM THE ORIGINAL OF THIS SURVEY MARKED WITH AN ORIGINAL OF THE LAND SURVEYOR'S INKED SEAL OR HIS EMBOSSED SEAL SHALL BE CONSIDERED TO BE VALID TRUE COPIES .

SUBJECT TO COVENANTS, EASEMENTS, RESTRICTIONS, CONDITIONS AND AGREEMENTS OF RECORD.

NO ATTEMPT WAS MADE TO VERIFY ANY UTILITIES OTHER THAN THOSE SHOWN FROM SURVEYED INFORMATION. BASE MAP (MAP REFERENCE NO. 1) AS SHOWN IS FOR REFERENCE ONLY.

PROPERTY LINE AS SHOWN BASED UPON MAP REFERENCE NO. 1

SITE ID NO. V00657

7-11-11	MISC. COMMENTS
12-02-10	FINAL COMMENTS
11-02-10	MISC. REVISIONS
10-19-10	REVISED WATERLINE LOCATION
10-14-10	MISC REVISIONS
10-6-10	MISC REVISIONS

HUDSON HERITAGE DEVELOPMENT, LLC

AS-BUILT SURVEY OF HUDSON RIVER PSYCHIATRIC CENTER AREA 6 LANDFILL

TOWN OF POUGHKEEPSIE	DUTCHESS COUNTY,N.Y.
SCALE: 1"=40'	SEPTEMBER 29, 2010
DRAWN BY: KCW	PROJECT NO: 08-214

AUSFELD & WALDRUFF LAND SURVEYORS LLP
514 STATE STREET, SCHENECTADY N.Y. 12305
PHONE : (518) 346-1595 FAX:(518)770-1655

STATE OF NEW YORK · VINCENT P. AUSFELD · 49597 · LICENSED PROFESSIONAL SURVEYOR

VINCENT P. AUSFELD P.L.S.
LICENSE #049597
www.awlsllp.com

Drawing Name: Z:\PROJECTS\2008\08-214\DWG\LF-6 FINAL AS-BUILT.dwg
Xref's Attached:
Date Printed: Jul 11, 2011, 3:03pm

Appendix E

Excavation Work Plan

E EXCAVATION WORK PLAN

E-1 Notification

At least 15 days prior to the start of any activity that is anticipated to encounter remaining waste material, the Site owner or their representative will notify the Department. Currently, this notification will be made to:

Regional Hazardous Waste Remediation Engineer
NYS Department of Environmental Conservation Region 3
21 South Putt Corners Road
New Paltz, NY 12561-1696

This notification will include:

- A detailed description of the work to be performed, including the location and areal extent, plans for Site re-grading, intrusive elements or utilities to be installed below the soil cover, estimated volumes of contaminated soil to be excavated and any work that may impact an engineering control

- A summary of environmental conditions anticipated in the work areas, including the nature and concentration levels of contaminants of concern, potential presence of grossly contaminated media, and plans for any pre-construction sampling

- A schedule for the work, detailing the start and completion of all intrusive work

- A summary of the applicable components of this Excavation Work Plan (EWP)

- A statement that the work will be performed in compliance with this EWP and 29 CFR 1910.120

- A copy of the contractor's health and safety plan, in electronic format, if it differs from the Health and Safety Plan (HASP) provided in *Appendix F* of this document

- Identification of disposal facilities for potential waste streams

- Identification of sources of any anticipated backfill, along with all required chemical testing results

E-2 Soil Screening Methods

Visual, olfactory and instrument-based soil screening will be performed by a qualified environmental professional during all remedial and development excavations into known or potentially contaminated material (remaining waste material). Soil screening will be performed regardless of when the invasive work is done and will include all excavation and invasive work performed during development, such as excavations for foundations and utility work, after issuance of the Release and Covenant Not to Sue.

Soils will be segregated based on previous environmental data and screening results into material that requires off-site disposal, material that requires testing, material that can be returned to the subsurface, and material that can be used as cover soil.

E-3 Stockpile Methods

Soils excavated from potentially contaminated areas may be temporarily stockpiled. Separate stockpiles will initially be made based on the constituents of concern from the excavated areas. Waste characterization will be performed of the stockpiled soil for off-site disposal. Stockpiled soils will be removed from the Site in a timely manner. All excavated concrete and pavement to be removed from the Site will be temporarily consolidated. The stockpiles will include the following:

- Two layers of 6 mil plastic sheeting will be placed on the ground surface.

- The stockpiles will be surrounded with silt fence or with non-impacted excavated soil, imported fill, hay bales, or other material suitable for constructing a berm to contain runoff.

- Dust suppression measures will be provided as necessary to prevent fugitive dust generation.

- Stockpiles will be covered with plastic on a daily basis to prevent infiltration of precipitation. The cover will be secured in place with sandbags, stones, or similar weights as warranted. Stockpiles will be routinely inspected and damaged tarp covers will be promptly replaced.

- The stockpiles will be maintained and inspected at minimum once each week and after every storm event for damage, erosion and sediment controls, and other signs of wear. Repairs to damaged controls will be made immediately. Results of inspections will be recorded in a logbook and maintained at the Site and available for inspection by the NYSDEC.

E-4 Materials Excavation and Load Out

A qualified environmental professional or person under their supervision will oversee all invasive work and the excavation and load-out of all potentially contaminated excavated material.

The owner of the property and its contractors are solely responsible for safe execution of all invasive and other work performed under this Plan.

The presence of utilities and easements on the Site will be investigated by the qualified environmental professional. It will be determined whether a risk or impediment to the planned work under this SMP is posed by utilities or easements on the Site.

Loaded vehicles leaving the Site will be appropriately lined, tarped, securely covered, manifested, and placarded in accordance with appropriate Federal, State, local, and NYSDOT requirements (and all other applicable transportation requirements).

A truck wash will be operated on-site for significant excavation activities. The qualified environmental professional will be responsible for ensuring that all outbound trucks that have come into contact with impacted material will be washed at the truck wash before leaving the Site until the activities performed under this section are complete.

Locations where vehicles enter or exit the Site shall be inspected daily for evidence of off-site soil tracking.

The qualified environmental professional will be responsible for ensuring that all egress points for truck and equipment transport from the Site are clean of dirt and other materials derived from the Site during intrusive excavation activities. Cleaning of the adjacent streets will be performed as needed to maintain a clean condition with respect to Site-derived materials.

E-5 Off-Site Materials Transport

All transport of materials will be performed by licensed haulers in accordance with appropriate local, State, and Federal regulations, including 6 NYCRR Part 364. Haulers will be appropriately licensed and trucks properly placarded.

Material transported by trucks exiting the Site will be secured with tight-fitting covers. Loose-fitting canvas-type truck covers will be prohibited. If loads contain wet material capable of producing free liquid, truck liners will be used.

All trucks that have come into contact with contaminated material will be washed prior to leaving the Site. Truck wash waters will be collected and disposed of off-site in an appropriate manner.

Truck transport routes are as follows: West on Winslow Gate Road to US Route 9. All trucks loaded with Site materials will exit the vicinity of the Site using only these approved truck routes. These are the most appropriate routes and take into account: (a) limiting transport through residential areas and past sensitive sites; (b) prohibiting off-site queuing of trucks entering the facility; (c) limiting total distance to major highways; (d) promoting safety in access to highways; and (e) overall safety in transport.

Trucks will be prohibited from stopping and idling in the neighborhood outside the project Site.

Egress points for truck and equipment transport from the Site will be kept clean of dirt and other materials during Site remediation and development.

Queuing of trucks will be performed on-site in order to minimize off-site disturbance. Off-site queuing will be prohibited.

E-6 Off-Site Materials Disposal

All soil/fill/solid waste excavated and removed from the Site will be treated as contaminated and regulated material and will be transported and disposed in accordance with all local, State (including 6NYCRR Part 360) and Federal regulations. If disposal of soil/fill from this Site is proposed for unregulated off-site disposal (e.g. clean soil removed for development purposes), a formal request with an associated plan will be made to the NYSDEC. Unregulated off-site management of materials from this Site will not occur without formal NYSDEC approval.

Off-site disposal locations for excavated soils will be identified in the pre-excavation notification. This will include estimated quantities and a breakdown by class of disposal facility (e.g. hazardous waste disposal facility, solid waste landfill, petroleum treatment facility, C/D recycling facility, etc.), if appropriate. Actual disposal quantities and associated documentation will be reported to the NYSDEC in the Periodic Review Report. This documentation will include: waste profiles, test results, facility acceptance letters, manifests, bills of lading and facility receipts.

Non-hazardous historic fill and contaminated soils taken off-site will be handled, at minimum, as a Municipal Solid Waste per 6NYCRR Part 360-1.2. Material that does not meet Track 1 unrestricted SCOs is prohibited from being taken to a New York State recycling facility (6NYCRR Part 360-16 Registration Facility).

E-7 Materials Reuse On-Site

Soils excavated in potentially contaminated areas will be temporarily stockpiled for characterization at an appropriate location within the Site. Material exceeding the Table 375-6.8 (b) Unrestricted Use standard may only be reused in areas covered by an environmental easement limiting the use in that area to commercial use. In addition, material exceeding the lower of the protection of groundwater or the protection of public health soil cleanup objectives for commercial use found in Subpart 375-6(b) may not be used to function as the cover material in an engineering control. Material exceeding the Table 375-6.8 (b) commercial use standards shall not be reused anywhere on the Site and must be disposed of as described in *Section E-6* of this plan or placed below an engineered control.

Materials that will be re-used on-site will be sampled at a rate of one composite sample per 500 cubic yards of material from each source area and will be analyzed for TAL metals, TCL SVOCs, TCL pesticides, and TCL PCBs. In addition one grab sample will be collected per 500 cubic yards of material from each source area and will be analyzed for TCL VOCs. If more than 1,000 cubic yards of soil are excavated from a given soil source area and both samples of the first 1,000 cubic yards meet conditions set forth in 375-6.7(d), the sample collection frequency will be reduced to one sample for every 2,500 cubic yards of additional soils from the same source, up to 5,000 cubic yards. For material sources greater than 5,000 cubic yards, sampling frequency may be reduced to one sample per 5,000 cubic yards, provided all earlier samples met the conditions set forth in 375-6.7(d).

The Remedial Engineer or a qualified environmental professional under his/her supervision will ensure that procedures defined for materials reuse in this SMP are followed and that unacceptable material does not remain on-site. Contaminated on-site material, including historic fill and contaminated soil, that is acceptable for re-use on-site will be placed below a demarcation layer or impervious surface, and will not be reused within a cover soil layer, within landscaping berms, or as backfill for subsurface utility lines.

If demolition material proposed for re-use on-site is suspected to include asbestos containing material (ACM) then the demolition material will be sampled for asbestos and the results will be reported to the NYSDEC for acceptance. Concrete crushing or processing on-site will not be performed without prior NYSDEC approval. Organic matter (e.g. wood, roots, stumps, etc.) or other solid waste derived from clearing and grubbing of the Site will not be reused on-site.

E-8 Fluids Management

All liquids to be removed from the Site, including excavation dewatering and groundwater monitoring well purge and development waters, will be handled, transported and disposed in accordance with applicable local, State, and Federal regulations. Dewatering, purge and development fluids will not be recharged back to the land surface or subsurface of the Site, but will be managed off-site.

Discharge of water generated during large-scale construction activities to surface waters (e.g. a local pond, stream or river) will be performed under a State Pollutant Discharge Elimination System (SPDES) permit.

E-9 Cover System Restoration

After the completion of soil removal and any other invasive activities the cover system will be restored in a manner that complies with the Remedial Action Work Plan (RAWP.) The demarcation layer, consisting of orange snow fencing material or equivalent material will be replaced to provide a visual reference to the top of the 'Remaining Waste Material Zone', the zone that requires adherence to special conditions for disturbance of remaining contaminated soils defined in this Site Management Plan.

If the GCL is damaged or punctured for installation of utilities or structures, it may be possible to repair it by cutting a patch to fit over the damaged area. The patch shall be obtained from a new GCL roll and shall be cut to size such that a minimum overlap of 24 inches is achieved around all of the damaged area. Granular bentonite or bentonite mastic should be applied around the damaged area prior to placement of the patch. An adhesive shall be used to affix the patch in place so that it is not displaced during cover placement.

Any damage to the gas vent will be repaired to restore the vent to its original condition as shown on the as-built detail included on *Figure 3*.

If the type of cover system changes from that which exists prior to the excavation (e.g., a soil cover is replaced by asphalt), this will constitute a modification of the cover element of the remedy and the upper surface of the 'Remaining Waste Material.' A figure showing the modified surface will be included in the subsequent Periodic Review Report and in any updates to the Site Management Plan.

E-10 Backfill from Off-Site Sources

All materials proposed for import onto the Site will be approved by the qualified environmental professional and will be in compliance with provisions in this SMP prior to receipt at the Site. Material from industrial sites, spill sites, or other environmental remediation sites or potentially contaminated sites will not be imported to the Site.

All imported soils will meet the backfill and cover soil quality standards established in 6 NYCRR 375-6.7(d). Soils that meet 'exempt' fill requirements under 6 NYCRR Part 360, but do not meet backfill or cover soil objectives for this Site, will not be imported onto the Site without prior approval by NYSDEC. Solid waste will not be imported onto the Site.

All imported soils will meet NYSDEC approved backfill or cover soil quality objectives for this Site. These NYSDEC approved backfill or cover soil quality objectives are the lower of the protection of groundwater or the protection of public health soil cleanup objectives for restricted residential use found in 6 NYCRR Subpart 375-6, Table 375-6(b). Sample of the backfill material will be analyzed for TAL metals, total cyanide, TCL VOCs, TCL SVOCs, TCL pesticides, and TCL PCBs according to the schedule included below in *Table E-1*.

Table E-1: Soil Sampling Schedule for Soil Imported to or Exported From a Site

<table>
<tr><th>Contaminant</th><th>VOCs</th><th colspan="2">SVOCs, Inorganics & PCBs/Pesticides</th></tr>
<tr><th>Soil Quantity (cubic yards)</th><th>Discrete Samples</th><th>Composite</th><th>Discrete Samples/Composite</th></tr>
<tr><td>0-50</td><td>1</td><td>1</td><td rowspan="8">3-5 discrete samples from different locations in the fill being provided will comprise a composite sample for analysis</td></tr>
<tr><td>50-100</td><td>2</td><td>1</td></tr>
<tr><td>100-200</td><td>3</td><td>1</td></tr>
<tr><td>200-300</td><td>4</td><td>1</td></tr>
<tr><td>300-400</td><td>4</td><td>2</td></tr>
<tr><td>400-500</td><td>5</td><td>2</td></tr>
<tr><td>500-800</td><td>6</td><td>2</td></tr>
<tr><td>800-1000</td><td>7</td><td>2</td></tr>
<tr><td>1000</td><td colspan="3">Add an additional 2 VOC and 1 composite for each additional 1000 cubic yards or consult with NYSDEC</td></tr>
</table>

Non-compliant soils will not be imported onto the Site without prior approval by NYSDEC. Nothing in the approved SMP or its approval by NYSDEC should be construed as an approval for this purpose.

Soils that meet 'exempt' fill requirements under 6 NYCRR Part 360, but do not meet backfill or cover soil objectives for this Site, will not be imported onto the Site without prior approval by NYSDEC.

Trucks entering the Site with imported soils will be securely covered with tight fitting covers. Imported soils will be stockpiled separately from excavated materials and covered to prevent dust releases.

E-11 Storm Water Pollution Prevention

A Storm Water Pollution Prevention Plan (SWPPP) that conforms to the requirements of NYSDEC Division of Water guidelines and NYS regulations will be prepared for any future construction activity exceeding one acre in area.

Prior to starting future invasive site work activities, erosion and sedimentation (E&S) controls will be installed as deemed necessary around the downgradient perimeter of the work areas and soil management areas. E&S controls are intended, to the extent practicable, to limit the potential for impacted sediments to be transported from the Site.

Barriers and hay bale checks will be installed and inspected once a week and after every storm event. Results of inspections will be recorded in a logbook and maintained at the Site and available for inspection by NYSDEC. All necessary repairs shall be made immediately.

Accumulated sediments will be removed as required to keep the barrier and hay bale check functional.

All undercutting or erosion of the silt fence toe anchor shall be repaired immediately with appropriate backfill materials.

Manufacturer's recommendations will be followed for replacing silt fencing damaged due to weathering.

Erosion and sediment control measures identified in the SMP shall be observed to ensure that they are operating correctly. Where discharge locations or points are accessible, they shall be inspected to ascertain whether erosion control measures are effective in preventing significant impacts to receiving waters.

E-12 Contingency Plan

If underground tanks or other previously unidentified contaminant sources are found during post-remedial subsurface excavations or development related construction, excavation activities will be suspended until sufficient equipment is mobilized to address the condition.

Sampling will be performed on product, sediment and surrounding soils, etc. as necessary to determine the nature of the material and proper disposal method. Chemical analysis will be performed for a full list of analytes (TAL metals, TCL volatiles and semi-volatiles, TCL pesticides and PCBs), unless the site history and previous sampling results provide a sufficient justification to limit the list of analytes. In this case, a reduced list of analytes will be proposed to the NYSDEC for approval prior to sampling.

Identification of unknown or unexpected contaminated media identified by screening during invasive site work will be promptly communicated by phone to NYSDEC's Project Manager. Reportable quantities of petroleum product will also be reported to the NYSDEC spills hotline. These findings will be also included in the periodic reports prepared pursuant to *Section 5* of the SMP.

E-13 Community Air Monitoring Plan

Continuous monitoring will be required for all ground intrusive activities and during the demolition of contaminated or potentially contaminated structures. Ground intrusive activities include, but are not limited to, soil/waste excavation and handling, test pitting or trenching, and the installation of soil borings or monitoring wells.

Periodic monitoring for VOCs will be required during non-intrusive activities such as the collection of soil and sediment samples or the collection of groundwater samples from existing monitoring wells. "Periodic" monitoring during sample collection might reasonably consist of taking a reading upon arrival at a sample location, monitoring while opening a well cap or overturning soil, monitoring during well baling/purging, and taking a reading prior to leaving a sample location. In some instances, depending upon the proximity of potentially exposed individuals, continuous monitoring may be required during sampling activities. Examples of such situations include groundwater sampling at wells on the curb of a busy urban street, in the midst of a public park, or adjacent to a school or residence.

VOC Monitoring, Response Levels, and Actions

Volatile organic compounds (VOCs) must be monitored at the downwind perimeter of the immediate work area (i.e., the exclusion zone) on a continuous basis or as otherwise specified. Upwind concentrations should be measured at the start of each workday and periodically thereafter to establish background conditions, particularly if wind direction changes. The monitoring work should be performed using equipment appropriate to measure the types of contaminants known or suspected to be present. The equipment should be calibrated at least daily for the contaminant(s) of concern or for an appropriate surrogate. The equipment should be capable of calculating 15-minute running average concentrations, which will be compared to the levels specified below.

1. If the ambient air concentration of total organic vapors at the downwind perimeter of the work area or exclusion zone exceeds 5 parts per million (ppm) above background for the 15-minute average, work activities must be temporarily halted and monitoring continued. If the total organic vapor level readily decreases (per instantaneous readings) below 5 ppm over background, work activities can resume with continued monitoring.

2. If total organic vapor levels at the downwind perimeter of the work area or exclusion zone persist at levels in excess of 5 ppm over background but less than 25 ppm, work activities must be halted, the source of vapors identified, corrective actions taken to abate emissions, and

monitoring continued. After these steps, work activities can resume provided that the total organic vapor level 200 feet downwind of the exclusion zone or half the distance to the nearest potential receptor or residential/commercial structure, whichever is less - but in no case less than 20 feet, is below 5 ppm over background for the 15-minute average.

3. If the organic vapor level is above 25 ppm at the perimeter of the work area, activities must be shutdown.

4. All 15-minute readings must be recorded and be available for State (DEC and NYSDOH) personnel to review. Instantaneous readings, if any, used for decision purposes should also be recorded.

Particulate Monitoring, Response Levels, and Actions

Particulate concentrations should be monitored continuously at the upwind and downwind perimeters of the exclusion zone at temporary particulate monitoring stations. The particulate monitoring should be performed using real-time monitoring equipment capable of measuring particulate matter less than 10 micrometers in size (PM-10) and capable of integrating over a period of 15 minutes (or less) for comparison to the airborne particulate action level. The equipment must be equipped with an audible alarm to indicate exceedance of the action level. In addition, fugitive dust migration should be visually assessed during all work activities.

1. If the downwind PM-10 particulate level is 100 micrograms per cubic meter ($\mu g/m^3$) greater than background (upwind perimeter) for the 15-minute period or if airborne dust is observed leaving the work area, then dust suppression techniques must be employed. Work may continue with dust suppression techniques provided that downwind PM-10 particulate levels do not exceed 150 $\mu g/m^3$ above the upwind level and provided that no visible dust is migrating from the work area.

2. If, after implementation of dust suppression techniques, downwind PM-10 particulate levels are greater than 150 $\mu g/m^3$ above the upwind level, work must be stopped and a re-evaluation of activities initiated. Work can resume provided that dust suppression measures and other controls are successful in reducing the downwind PM-10 particulate concentration to within 150 $\mu g/m^3$ of the upwind level and in preventing visible dust migration.

3. All readings must be recorded and be available for State (NYSDEC and NYSDOH) and County Health personnel to review.

E-14 Odor Control Plan

This odor control plan will be followed, as necessary, during excavation activities to control emissions of nuisance odors off-site and on-site. If nuisance odors are identified at the Site boundary, or if odor complaints are received, work will be halted and the source of odors will be identified and corrected. Work will not resume until nuisance odors have been abated. NYSDEC and NYSDOH will be notified of all odor events and of any other complaints about the project. Implementation of all odor controls, including the halt of work, is the responsibility of the property owner's Remediation Engineer, and any measures that are implemented will be discussed in the Periodic Review Report.

All necessary means will be employed to prevent on- and off-site nuisances. At a minimum, these measures will include:

1) Limiting the area of open excavations and size of soil stockpiles;

2) Shrouding open excavations with tarps and other covers; and

3) Using foams to cover exposed odorous soils.

If odors develop and cannot be otherwise controlled, additional means to eliminate odor nuisances will include:

1) Direct load-out of soils to trucks for off-site disposal;

2) Use of chemical odorants in spray or misting systems; and

3) Use of staff to monitor odors in surrounding neighborhoods.

If nuisance odors develop during intrusive work that cannot be corrected, or where the control of nuisance odors cannot otherwise be achieved due to on-site conditions or close proximity to sensitive receptors, odor control will be achieved by sheltering the excavation and handling areas in a temporary containment structure equipped with appropriate air venting/filtering systems.

E-15 Dust Control Plan

This dust control plan will be followed, as necessary, during excavation activities to control dust during invasive on-site work.
As necessary, the following dust suppression measures will be employed during excavation work at the Site:

- Dust suppression will be achieved though the use of a dedicated on-site water truck for road wetting. The truck will be equipped with a water cannon or sprayer capable of spraying water directly onto off-road areas including excavations and stockpiles.

- Clearing and grubbing of larger sites will be done in stages to limit the area of exposed, unvegetated soils vulnerable to dust production.

- Gravel will be used on roadways to provide a clean and dust-free road surface.

- On-site roads will be limited in total area to minimize the area required for water truck sprinkling.

Appendix F

Health and Safety Plan

Site Health & Safety Plan

Remedial Action Work Plan
Hudson River Psychiatric Center
Landfill Area 6
Town of Poughkeepsie
Dutchess County, New York

Hudson Heritage Development, LLC
Poughkeepsie, New York

May 2009
Revised August 3, 2009

FUSS & O'NEILL
Disciplines to Deliver

Fuss & O'Neill of New York, PC
80 Washington Street, Suite 301
Poughkeepsie, NY 12601

Project No. 20080291.L3N

FUSS & O'NEILL

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Site Health & Safety Plan
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1 General

1.1 Introduction

This Site Health and Safety Plan (HASP) was developed as part of the Fuss & O'Neill of New York, PC (Fuss & O'Neill) Remedial Action Work Plan (RAWP) at the Hudson River Psychiatric Center, Landfill Area 6 (LA 6) Site in Poughkeepsie, New York.

Fuss & O'Neill does not guarantee the health or safety of any person entering the site. Due to the potential hazards of this site and the activity occurring thereon, it is not possible to discover, evaluate and provide protection for all possible hazards which may be encountered. Strict adherence to the health and safety guidelines set forth herein will reduce, not eliminate, the potential for injury at this site. The site-specific information in the plan was prepared specifically for this site and should not be used on any other site without prior research and evaluation by trained health and safety specialists.

This note applies to all personnel legally required to be covered under this HASP pursuant to OSHA regulation 29 CFR 1910.120 and 29 CFR 1926.65, as determined by their employer. Those personnel working within the Exclusion Zone as defined by the HASP must be trained and engaged in a medical surveillance program in accordance with the requirements of 29 CFR 1910.120 and 29 CFR 1926.65.

This HASP has been developed for Fuss & O'Neill personnel. All on-site contractors not associated with Fuss & O'Neill must develop their own HASP, applicable to their work activities.

The procedures and protocols in this plan have also been established to provide a mechanism to protect project personnel from potential exposure to known site contaminants encountered during site activities. This plan addresses activities conducted by Fuss & O'Neill and its subcontractors. Compliance with this HASP is required of all authorized Fuss & O'Neill project personnel who enter the working areas of this project. Fuss & O'Neill will provide resources and personnel for the implementation of this HASP. As such, Fuss & O'Neill will make recommendations to those personnel not working under contract with Fuss & O'Neill pertaining to the safe execution of the proposed scope of work, as warranted. No one may enter an established exclusion zone without meeting the requirements of an appropriate HASP.

This HASP meets applicable requirements of Occupational Safety and Health Administration (OSHA) safety and health standards: OSHA 29 CFR 1926 Construction Industry and OSHA 29 CFR 1910 General Industry. This HASP is designed to cover those special and/or unique health and safety procedures arising from actual or potential contact with contaminated materials and those requirements pursuant to OSHA 29 CFR 1910.120 and 1926.65, Final Rule "Hazardous Waste Operations and Emergency Response".

The content of this HASP may change or undergo revision based upon additional information made available to health and safety (H&S) personnel, monitoring results, or changes in the technical scope of work. Any changes proposed must be reviewed by designated Fuss & O'Neill and other Project Personnel as specified in the pertinent contract.

1.2 Project Personnel

Project Personnel - refers to all Fuss & O'Neill of New York, PC. operations and project management personnel, including Fuss & O'Neill subcontractors whose responsibilities are to conduct construction activities within the work site.

Project Personnel are divided into two categories: Contact Project Personnel and Non Contact Project Personnel.

Contact Project Personnel - Refers to Project Personnel who may come into contact with hazardous materials (contaminated soil & water which may pose an unacceptable health risk potential). The specific job task will be evaluated to determine personnel classifications. The Health and Safety Manager (HSM) and/or the Health and Safety Supervisor (HSS) will assist with this determination.

Non Contact Project Personnel - Refers to Project Personnel who are not expected to come into contact with hazardous materials. The specific job task will be evaluated to determine personnel classifications. The HSM and/or the HSS will assist with this determination.

Project Support Personnel and Visitors - refers to all other persons who may enter the work site such as truck drivers, public officials, public utility workers, and emergency crews (police, fire, ambulance) as well as any other personnel designated as a project visitor.

Project Personnel Assignments

Fuss &O'Neill of New York, PC

Fuss & O'Neill Corporate Health and Safety Officer:

- Kevin W. Miller, Ph.D.: (845) 452-6801 (Ext. 3004)

Fuss & O'Neill Project Manager:

- Craig M. Lapinski, PE, LEED-AP: (845) 452-6801 (Ext. 5258)

Fuss & O'Neill Health and Safety Manager (HSM) and Site Health and Safety Supervisor (HSS):

- Gregory A. Toothill, PE: (845) 452-6801 (Ext. 4203)

Fuss & O'Neill Alternate Site Health and Safety Supervisor (HSS):

- Robert VanVlack: (845) 452-6801 (Ext. 4218)

Site Owner Contact:

- Gary Friedland: (914) 205-3075

Medical Consultant:

CorpCare Occupational Health Center, an affiliate of Manchester Memorial Hospital, located in Manchester, Connecticut.

1.3 Emergency Phone

Fuss & O'Neill Site Phone:		(845) 750-2705
Emergency		911
Local Police		911
Fire Department:		911
EMS:		911
Hospital:	Saint Francis Hospital 241 North Road Poughkeepsie, NY 12601	(845) 483-5000 (non-emergency)
Poison Control Center:		1-800-343-2722
USCG/DOT National Response Center:		1-800-424-8802

A route map for the listed emergency facility is provided in Appendix A.

2 Health and Safety Personnel

2.1 Site Health and Safety Personnel Designations

The following briefly describes the health and safety designations and general responsibilities which may be employed for this project.

2.2 Site Health and Safety Manager (HSM)

The Health and Safety Manager will be the Fuss & O'Neill point of contact for safety concerns at the project. The HSM has overall responsibility for the development and implementation of the site-specific HASP in conjunction with the other Fuss & O'Neill project personnel. Although the writing of the HASP may be delegated to another member of the team, the HSM shall approve any changes in the plan. This individual has the overall responsibility for the Contractor's performance.

The HSM is also responsible for the following:

1. Discussing any unusual safety and health concerns with the Company Health and Safety Officer prior to completion of the HASP.

2. Assuring that all personnel on-site have been made aware of the potential hazards and are provided appropriate personal protective equipment.

3. Monitoring the performance of personnel and the compliance with this HASP on a periodic basis, and correcting deficiencies.

4. Submit all project reports, including: progress, accident, incident and contractual. A copy of the Supervisor's Report of Accident Investigation form is located in Appendix B.

2.3 Site Health and Safety Supervisor (HSS)

The Site Health and Safety Supervisor (HSS) will be the field scientist, field chemist, engineer or hydrogeologist or other staff member, who will be involved in the on-site activities. The HSS shall be on-site for all work covered by this HASP. He will supervise activities at every phase of work taking place on the project. He will establish and maintain lines of communication at the job site. Before personnel may work in designated exclusion zones, he will obtain the appropriate documentation meeting the medical and health and safety training requirements specified in OSHA 29 CFR 1910.120 and 1926.65 (Hazardous Waste Operations and Emergency Response).

The HSS has the stop-work authorization which he will execute upon his determination of an imminent safety hazard, emergency situation, or other potentially dangerous situations, such as extreme weather conditions. Authorization to proceed with work will be issued by the HSM after such action. The HSS will initiate and execute all contact with support facilities and personnel when this action is appropriate.

The HSS responsibilities will include:

1. Overall responsibility for oversight and day to day enforcement of this HASP.

2. Conduct the initial site specific training of project personnel.

3. Evaluating air monitoring data and recommending changes to engineering controls, work practices and PPE.

4. Daily review of safety operations on-site and completion of a daily record of site activities. A copy of the Daily Record of Site Activities form is located in Appendix C.

5. Reporting and investigation of all accidents or incidents occurring on the site. Reporting of any unsafe acts or conditions. All incidents must be reported to the HSM.

6. Follow up of any corrective action required to reduce identified hazards.

2.4 Corporate Health and Safety Officer

The Corporate Health and Safety Officer helped develop the health and safety plan. The corporate health and safety officer will provide support and guidance to other project personnel on health and safety issues during the completion of site work.

2.5 Medical Consultant

The MC meets the requirements of OSHA 29 CFR 1910.120 and 1926.65. The MC will be available to consult with local emergency medical services and will be available, as necessary, to provide medical examinations of project personnel.

3 Site History and Physical Description

3.1 Site History and Physical Description

The site is the former Hudson River Psychiatric Center in the Town of Poughkeepsie, Dutchess County, New York. The full site consists of approximately 155.9 acres of land. The portion of the site defined in the Voluntary Cleanup Agreement (Site. No. V00657-3) as Landfill Area 6 consists of approximately 2.5 acres located to the east of the former pavilion south of Ryan Hall and west of the railroad bed. The Landfill Area 6 is bound by the parcel property lines to the south and east, by a catch basin south of Winslow Gate Road to the north, by the south margin of Ryan Drive to the northwest, and by the waste margins east of the concrete slab that was part of a former pavilion near MWHR6-20. Waste is believed to extend beyond these site boundaries onto adjacent properties to the east and southeast onto the banks of the railroad bed and to the south onto the lands of the adjacent property owner and under a gas line right-of-way.

3.2 Site Air Monitoring

Field activities associated with the site remediation at the site may pose hazardous conditions, such as the release of hazardous substances into the workers' breathing zone. These substances may be in the form of vapors, dusts, or mists that can enter the body through ingestion, inhalation, or direct contact with the skin or eyes. If the Health and Safety Supervisor, relying on observations and odor, determines that a condition exists in which workers may be exposed to airborne hazardous materials, monitoring will be performed to determine appropriate personal protective measures.
The following describes the monitoring parameters to be evaluated during the initial walk-through. All instruments to be used during site activities will meet the established requirements set forth by OSHA, NIOSH, and state agencies where applicable.

3.2.1 Initial Determinations

Observations will be made during the site walk-through with direct reading organic vapor meters, combustible gas indicators, and/or oxygen detectors as necessary to assess the background or initial conditions.

All site monitoring will be conducted by or under the direction of the Site Health and Safety Supervisor or designated representative. All readings obtained will be recorded in a dedicated site notebook maintained by the Field Operations Leader/HSS. The Field Operations

Leader/HSS will maintain all monitoring instruments throughout the site investigation to maintain their reliability and proper operation.

3.3 Scope of Work

The portion of work covered by this HASP includes environmental remediation activities. The tasks covered by this HASP include the following:

- Excavation in the former landfill area.
- Placement of a clean cover soil over the landfill.
- Abandonment of old and installation of new drainage facilities.

3.4 Results of Past Investigations

A closure investigation report prepared by EA Engineering, Science and Technology (EA) in 2001 states that wastes were disposed of at various locations across the HRPC parcel for more than 100 years, ending in approximately 1974. The wastes were reported to consist primarily of household and commercial refuse as well as substantial quantities of coal ash. Two petroleum spills were reported at the site, however both spills are listed as closed and neither spill is in the vicinity of Landfill Area 6.

The Chazen Companies reported that municipal waste, coal ash from the heating plant, and mixed construction debris from the facility are present in Landfill Area 6. In addition they report that the site may potentially contain some solid waste from the Town of Poughkeepsie.

An excerpt from the Hudson River Psychiatric Center Landfill Area 6 IRM Work Plan, dated March 2008, and prepared by The Chazen Companies that summarizes the previous Environmental Investigations follows:

"Multiple investigations have been completed to characterize potential landfill sites throughout the HRPC property, as well as studies that focused specifically on LA 6.
According to EA (EA, 2001), three PCB remedial actions were completed by Lawler Matusky & Skelly (LMS) near and downstream from LA 6 (LMS, 1996), pursuant to an Order on Consent with NYSDEC. A summary of those activities follow.

- May 1996: PCBs in a storm sewer system downstream from LA 6 were removed.
- December 1997: PCBs in stream sediments between LA 6 and US Route 9 were removed and disposed of off-site. The streambed and associated wetlands were restored. A Large Quantity Generator listing was apparently secured for the PCB soil removal task (Information System ID: NYD980779490).
- July 1999: PCB-containing concrete under a transformer vault in a building on the parcel (the Cheney building) was removed.
- October 2002: NYSDEC provided a written record to HRPC that requirements have been met to delete the site (DEC site # 314063) from the New York State Registry of Inactive Hazardous Waste Disposal Sites. The site is presently not a Class 2 inactive hazardous waste site.

At the time, the PCB remediation area was also referred to as LA 6, although it is not included in the present LA 6 site area as described in this document or as referenced in the VCP agreement.

During May 2000 as part of their closure investigation of the area currently identified as LA 6, EA sampled leachate from a seep found along the creek that flows along the south boundary of the waste area. Iron and thallium were detected in concentrations exceeding NYS surface water standards for Class D streams. In 2000, EA also located and sampled two of three monitoring wells installed by LMS in 1991 near Landfill Area 6. Well MWHR6-16 lies along the up gradient edge of the waste, to the west of the 12-inch diameter clay pipe to be abandoned on Drawing SPI. Sampling identified only manganese in concentrations exceeding NYS GA groundwater standards. Well MWHR6-19 lies in an area unrelated to LA 6 and downstream of the landfill to the west. Sampling identified iron, manganese, magnesium, sodium and chloride in concentrations above NYS GA groundwater standards. No VOCs were identified in either of these wells originally installed in 1991 by LMS (EA, 2001).

EA also advanced test pits at LA 6 to characterize wastes and define the approximate waste boundaries (EA,2001). Observed materials in the test pits included municipal waste, lumber, bricks, coal ash, light gray ash, glass and bottles, pottery, shells, plastic objects, tires, paper and newspaper and metal objects including rakes and a lawn chair. Test pitting identified the general limits and depth of the wastes. EA estimated the landfill volume to be 33,460 cubic yards. Maximum observed waste thickness was 16 feet, extending to below the water table. Test pitting indicated that the cap material placed on the site when fill activities ended in the late 1970s consisted of between 1 to 5 feet of sandy silt (EA, 2001). Grassy brush currently grows across most of the landfill, and forest growth has grown on the southern site margin along the stream which stabilizes slopes and provides shading to the stream corridor.

Three additional monitoring wells were installed at LA 6 in April 2002 by EA (EA, 2002). Well MWHR6-22 was installed up gradient of the landfill, as shown on Drawing SP1 and sampling identified iron, manganese, sodium, chloride, color and TDS above NYS GA standards. Wells MWHR6-20 and MWHR6-21 were installed down gradient of the landfill, adjacent to the creek. Sampling of Well MWHR6-20 identified iron, manganese, sodium, color, ammonia, and TDS in concentrations exceeding NYS GA standards. Sampling of Well MWHR6-21 identified the exceedences similar to those in MWHR6-20 and also 7.1 ppb dichlorodifluoromethane (NYS GA standard is 5 ppb) and 1.6 ppb benzene (NYS GA standard is 0.7 ppb). As first identified by the test pitting program, the monitoring wells installed in downgradient locations also identified wastes below the water table.

More recently, The Chazen Companies (TCC) conducted additional site investigations in 2003 and 2004 to identify sources of water contributing to leachate generation at LA 6 (TCC, March 2004). The work included installation of bedrock wells near downgradient wells MWHR6-20 and MWHR6-21 to create well couplets in these areas, installation of an upgradient overburden/bedrock couplet (MWHR6-23S/D), and replacement of monitoring well MWHR6-22 with MWHR6-22R per Department requirements conveyed previously to EA. Completion of the three overburden/bedrock couplet pairs allowed assessments of upward or downward gradients near the stream and up gradient of the landfill, documented in the March 2004 TCC report. Work also included installation of temporary 1-inch piezometers in downgradient areas near the stream to further evaluate water table elevations and waste profiles and installation of shallow piezometers in the stream. Additional fieldwork included further test pitting to inspect the condition of various culverts traversing the waste mass including a concrete stream culvert, an adjacent corrugated metal pipe which had been replaced by the concrete culvert, and a concrete stormwater culvert. All monitoring wells and seeps were sampled by TCC consistent with protocols for routine landfill monitoring.

Inspection of the culverts indicated that only the concrete stream culvert is a reliable water conveyance. The other two leak water into the landfill. Monitoring data and water level measurements in stream piezometers, 1-inch piezometers and monitoring wells identify downward gradients in the aquifer and slight upward gradients in the stream bed (TCC, March 2004). All hydrogeologic data suggest that current leachate discharges are caused by water leakage into the waste mass through the current capping material or from leaky water conveyance pipes. There is not hydraulic evidence that leachate is generated by aquifer discharges from regional overburden or the bedrock aquifer system.

Since the March 2004 TCC investigation, TCC in consultation with NYSDEC has updated prior evaluations of the stream by sampling stream water near and upstream of LA 6 and leachate precipitate/stream bottom sediments in the stream adjacent to LA 6. The sediment and precipitation samples were collected under observation of NYSDEC and focused on leachate precipitate where identifiable."

"Results indicate that pure leachate flocculant both from upstream locations (samples HRPC-A5-SS1 and HRPC-A5-SS1A) and at the site (sample HRPC-A6-SS2) contained no analytes above remedial guidance values." "Two samples that included stream substrate material (HRPC-A6-SS1 and HRPC-A6-SS2) exceed Fish and Wildlife moderate impact guidance values for iron, mercury, arsenic and lead. Open water stream samples collected near the headwall along the south, site margin and downstream of LA 6 identified sodium exceedences of Class D groundwater standards. These upstream and downstream samples also contained iron concentrations which exceeded surface water standards for iron, although iron was higher in the downstream sample, and a dissolved aluminum exceedence was identified only in the upstream sample. Existing leachate discharges are estimated to be the source of the increase in dissolved iron in the downstream stream sample. The source of elevated aluminum in the upstream sample is unknown."

4 Hazard Assessment

4.1 Introduction

As discussed previously in Section 3.4, there may be areas where contaminated soil may be encountered. The probability of worker exposure to a chemical hazard varies with the job task. The job tasks that involve contact with potentially contaminated soil are expected to have a greater potential for exposure than job tasks that do not come into contact with the soil. Site workers may be exposed to chemicals by inhalation, ingestion, and/or dermal contact. To protect potentially exposed personnel, dust control measures may be implemented, respirators and personal protective equipment may be worn, and decontamination procedures will be followed.

The following is a general discussion of the hazards that may be encountered on-site. A list of specific compounds detected on-site is found in Appendix D.

4.2 Task Specific Hazard Assessment

Because the potential for coming into contact with contaminated site media will vary with each job task, the probability of exposure will be assessed on an individual task basis. To simplify the hazard assessment two categories will be established; it is anticipated each job task will fit in one of the two categories. The site HSS will assist with determinations as necessary.

Category 1 Construction Activities; Limited Soil Contact:

It is anticipated that the following activities require minimal contact with contaminated media, and presents a low risk of exposure to potentially contaminated site media. These activities should not require additional health and safety considerations beyond good practices already in place for this type of construction project. These tasks may include:

- Construction of an access road.
- Grade work area.
- Air sampling.
- Delivery of Supplies.
- Site Walkovers.

Potential exposure to contaminated site media is not anticipated; however these operations will be evaluated and monitored by the HSS. Access to the work zone is limited to Project Personnel, Project Support Personnel, and Authorized Visitors.

Personnel must meet the training requirements as defined in this HASP. Personal protective clothing will not be required unless exclusion zones are established or as determined by the HSS.

Category 2 Construction Activities; Contact with Soil and/or Groundwater:

It is anticipated that personnel working in the following activities have some reasonable potential to come into contact with potentially contaminated site media. These activities may include:

- Environmental Sampling – Soil, Water, Containers.
- Decontamination of Equipment and Personnel.
- Excavation and Site Grading.

These activities may result in potential exposures to contaminated site media. These activities will be evaluated and monitored by the HSS and exclusion zones established as required. All Contact Project Personnel required to work in designated exclusion zones must meet the training requirements for working in an exclusion zone as outlined in this HASP. Personal protective clothing will be worn as determined by the HSS.

5 Zones and Site Control

5.1 Site Control

Three zones will be used to restrict access to construction areas where potential contamination may be present and to prevent the accidental spread of contaminated materials. The three zones are identified as 1) the construction work zone, 2) the construction exclusion zone, and 3) the contamination reduction zone (CRZ). Initially, exclusion and contamination reduction zones will not be established for the site construction activities. Exclusion and contamination reduction zones will be established if certain conditions are met, including the exceeding of project air monitoring action levels or the encountering of odorous or visibly contaminated materials. The designation of project zones will be by the HSS. If used, these zones will be monitored by the HSS.

5.2 Construction Work Zone (Restricted Area)

The construction work zone is the entire project work area or construction area. All project work activities will be conducted within the construction work zone. The construction work zone is restricted to project (contact and non contact) personnel, and project support personnel and visitors as defined in this document. Unauthorized people will be prohibited from entering the site.

All personnel (project personnel, project support personnel, visitors) entering the construction work zone will be briefed by the HSS prior to their initial entry. All Contact Project Personnel entering the construction work zone must meet the Training and Medical requirements as outlined in Sections 10.0 and Section 15.0. The protective work clothing and equipment to be worn is defined in Section 6.0 or as required by the HSS. All Contact Project Personnel and equipment exiting the construction work zone must clean-up before leaving the site or as determined by the HSS. These are general good health and safety work practices.

Activities defined as Category 1 will be performed within the construction work zone. The HSS will monitor those activities which may have an unacceptable hazard potential. Construction exclusion zones will be established for these operations by the HSS or designee if the action levels listed in Section 7.0 are exceeded, if there are visible signs of contamination and/or if there are changes in operations or the knowledge of the site, which would increase the probability of worker exposure.

5.3 Construction Exclusions Zones

A Construction Exclusion Zone will be established within the construction work zone for 1) tasks and operations occurring on or around areas of known contamination, 2) operations that significantly disturb the subsurface soil, and 3) operations where personnel will come into contact with the subsurface soil and or groundwater. Construction Exclusion Zones will be established during all Category 2 activities and/or as designated by the HSM or HSS. The HSS will monitor all construction exclusion zone activities.

Exclusion Zones will be established around work areas where there is a realistic probability of exposure to hazardous contaminants.

The area will be marked and isolated using barriers, tape, or other appropriate markers. Entry to this area will be only through the contamination reduction zone (CRZ). Air monitoring will take place in all exclusion zones as described in Section 7.0. All personnel working in an exclusion zone must meet the training and medical requirements as outlined in Section 10.0 and Section 15.0. All personnel and equipment exiting the exclusion zone will go through field decontamination (Section 12.0) before exiting the exclusion zone and the contaminant reduction zone. Once the excavation or designated operation has been completed, the exclusion zone may be removed by the HSS pursuant to the air monitoring protocols in Section 7.0.

Access to a construction exclusion zone will be limited to Contact Project Personnel that meet the Training and Medical requirements as outlined in Section 10.0 and Section 15.0. All Contact Project Personnel entering the construction exclusion zones will be briefed by the HSS prior to their initial entry into the exclusion area.

The protective work clothing and equipment to be worn is defined in Section 6.0 or as required by the HSS. All personnel and equipment exiting the construction exclusion zone will be decontaminated (Section 12.0) in the CRZ as exiting the construction exclusion zone or as the HSS determines is necessary.

Once the excavation or designated operation has been completed, the construction exclusion zone will be removed by the HSS or designee.

5.4 Contamination Reduction Zone (CRZ)

The CRZ is the transition area between the contaminated area and the clean area. The CRZ is marked off as a corridor between the exclusion zone and the support zone where personnel go through decontamination. There is one Access Control Point where personnel enter and exit the exclusion zone through the CRZ. When personnel exit the exclusion zone, they must go through field decontamination which is set up in the CRZ. Access to this zone will be limited to Contact Project Personnel exiting the Construction Exclusion Zone and Decontamination Technicians assisting with decontamination.

6 Personnel Levels of Protection

6.1 General

In accordance with 29 CFR 1910.120 and 1926.65(g)(5), Fuss & O'Neill, Inc. has developed a written Personal Protective Equipment (PPE) program which addresses the elements listed in the regulation. This document is attached as Appendix E. A Respiratory Protection Program which meets the requirements of 29 CFR 1910.134 and 1926.103 can be found in Appendix E. The level of protection to be utilized is determined by the task-specific hazard and will be determined by the HSS. It is expected that initially all site work where the employee may come into contact with potentially contaminated soil or ground water will be performed utilizing Modified Level D protection in an exclusion zone.

Safety equipment and protective clothing shall be used as directed by the Health and Safety Supervisor. All such equipment and clothing will be cleaned and maintained in proper condition by the personnel. The Health and Safety Supervisor will monitor the maintenance of personnel protective equipment.

Modified Level D is the minimum accepted level of protection for this site. Modified Level D provides minimal dermal protection. Respiratory protection is optional unless air-monitoring data indicated otherwise. Modified Level D includes:

- Tyvek disposable coveralls or equivalent (optional)
- Coveralls/dedicated work clothing
- Boots/shoes, leather or chemical resistant (steel toe and shank optional)
- Boots/shoes inner and boots outer, chemically resistant (may be disposable) (optional)
- Gloves inner, surgical and Gloves outer, chemically resistant (optional)
- Nitrile, PVC, or vitron gloves (when water or soil contact)
- Hardhat(during drilling and when overhead fall or bump hazard exist)
- Safety glasses or chemical splash goggles
- Hearing protection (during drilling or jackhammering operations)

If circumstances warrant upgrading to Level C, the following is required:

- Full-face, air purifying respirator with a combination type acid/gas/organic vapor and particulate filter
- Chemical resistant coveralls
- Gloves (outer), chemical resistant
- Gloves (inner), chemical resistant
- Boots (inner), leather work shoe with steel toe and shank.
- Boots (outer), chemical resistant
- Hard Hat (during drilling and when overhead fall or bump hazard exist)
- Taping between suit and gloves, and suit and boots

Action levels found in Table 1 in Section 7.0 determine levels of respiratory protection only. The level of protection of PPE for each job task is determined visually by the HSS.

Procedures for the proper donning and doffing of PPE are provided in Appendix E.

Tasks or locations which require level A or B protection will not be entered by Fuss & O'Neill employees.

The Health and Safety Supervisor may make changes to the levels of protection required based on the identification of known substances and any required changes to the scope of work. The Health and Safety Supervisor will revise those levels of protection, up or down, based on air monitoring results and on-site assessment of actual exposures.

6.2 Definition of Levels of Protection

Respirators:

Level D:	No respirator is required.
Level D Modified:	No respirator is required
Level C:	Full face, Air Purifying Respirator (APR) with combination HEPA (dusts, fumes, aerosols) and organic vapor/acid gas cartridges.

PPE:

Level D:
- Coveralls/dedicated work clothing
- Gloves
- Boots/shoes*
- Hardhat
- Safety Glasses or chemical splash goggles

**May be substituted with work boots with chemically resistant outer boots or chemically resistant rubber boots.*

Level D Modified:
- Tyvek disposable coveralls or equivalent (optional)
- Coveralls/dedicated work clothing
- Boots/shoes, leather or chemical resistant (steel toe and shank optional)
- Boots/shoes inner and boots outer, chemically resistant (may be disposable) (optional)
- Gloves inner, surgical and Gloves outer, chemically resistant (optional)
- Nitrile, PVC, or vitron gloves (when water or soil contact)
- Hardhat(during drilling and when overhead fall or bump hazard exist)
- Safety glasses or chemical splash goggles
- Hearing protection (during drilling or jackhammering operations)

Level C:
- Polytyvek disposable coveralls or equivalent
- Coveralls/dedicated work clothing
- Boots/shoes inner
- Boots outer, chemically resistant (may be disposable)
- Gloves inner, surgical
- Gloves outer, chemically resistant
- Hardhat
- Safety glasses or chemical splash goggles

7 Monitoring Procedures and Engineering Controls

7.1 Monitoring Procedures

Atmospheric air monitoring results are used by the HSS to provide data in determining when exclusion zones are established and when certain levels of personal protective equipment are required. For all instruments there are site specific action level criteria which are used by the HSS as guidelines in making field health and safety determinations. Other data, such as the visible presence of contamination and/or the steady state nature of air contaminant concentration, is also used by the HSS in making field health and safety decisions. Therefore it is possible that the HSM and HSS may establish exclusion zones and/or require a person to wear a respirator even though atmospheric air contaminant concentrations are below established action levels. HASP action levels are located in Table 1

Monitoring will be performed by the HSS. Air monitoring instrumentation will be utilized in all site work areas to monitor the worker breathing zone. Personal air sampling for specific airborne contaminants may be performed at the direction of and under the supervision of the HSS. The types of instruments used and the contaminants they can detect are illustrated in Table 2. All air monitoring will be recorded on the Field Air Monitoring Logs located in Appendix F. This information will also be recorded daily by the HSS in the Daily Record of Site Activities in Appendix C.

Table 1: Instrumentation Action Levels

INSTRUMENT	ACTION LEVEL	LEVEL OF PROTECTION OR ACTION REQUIRED
PID	>Bkgd - <5 ppm (5 min)**	Level D Respiratory Protection
PID	5 ppm - <30 ppm (5 min)**	Level C Respiratory Protection, establish an exclusion zone[a].
PID	$\geq$30 ppm**	Leave the area, monitor continuously.
O_2	<19.5% or >23.0%**	Leave the area; provide ventilation.
HAM	>2.5 mg/m^3 (5 min)	Implement dust control measures or Level C Respiratory Protection.
CGI	>10% LEL	Leave the area
CGI	>5% LEL	Leave the area at 5,000 ppm or greater

Sampling Locations
** samples taken at the breathing zone relative to organic interference.
[a]- If a zone has not yet been established.

Table 2: Air Monitoring Instrumentation

Air Monitoring Instrument Name	Acronym	Contaminant(s) Monitored
Detector Tubes		Gases, Organic vapors, others
Photo-ionization Detector	PID(OVM)	Organic Vapors
Handheld Aerosol Monitor	HAM	Dust, Particulate Material
Flame Ionization Detector	FID(OVA)	Organic Vapors
Combustible Gas Indicator	CGI	Combustible Gases, explosive limit

Exclusion Zone Monitoring

The frequency of real-time monitoring in exclusion zone work areas will be determined by the HSS and/or according to the task being conducted and whether potentially hazardous soil or contaminated groundwater will be contacted/disturbed. Real-time monitoring in the exclusion zone work areas will be conducted daily and minimally under the following conditions: during an activity which would have the highest probability of worker exposure as determined by the HSS; visible presence of contamination; or at the discretion of the HSS.

Air monitoring for organic vapors using a photo-ionization detector will be performed during intrusive site activities when buried solid waste may be disturbed including:

- Stripping and stockpiling existing cover soils for later reuse from areas overlying waste.
- Preparation of anchor trenches for the GCL.
- Excavation and relocation of waste from the southeast corner of the site to the main body of the landfill.
- Excavation and re-grading of waste on County property and along the eastern edge of the landfill in preparation of cap installation.
- Excavation of access points for grouting and abandonment of metal storm drain within the limits of the landfill.
- Excavation associated with installation of gas vent.
- Excavation associated with the abandonment of existing waterlines within the limits of the landfill.

Engineering controls as discussed in Section 7.2 may be implemented to reduce worker exposure potential in the exclusion zones.

Construction Work Zone (Restricted Area)

The frequency of real-time monitoring in restricted zone work areas will be determined by the HSS. Real-time monitoring in restricted zone work areas will be conducted under the following conditions: prior to the beginning of any new job task; prior to the beginning of a job task in any new area; periodically for a long-term job task; during an activity which would have the highest probability of worker exposure as determined by the HSS; visible presence of contamination; or at the discretion of the HSS.

During intrusive activities, such as soil sampling, project team members will conduct air monitoring in the working zone utilizing a photo-ionization detector (PID). If PID readings in the work zone indicate concentrations of volatile organic vapors of 5 parts per million for a sustained period of 5 minutes, that activity will be shut down until field conditions stabilize and mitigation arrangements can be made to upgrade to an appropriate safety level. If warranted, field personnel will don splash protective clothing, including Tyvek suits, chemical resistant gloves and boot covers, and safety glasses equipped with side shields.

Background Monitoring
Real-time monitoring will occur at locations such as in the main staging area as part of determining atmospheric background levels. Background levels will be established before conducting real-time monitoring in any restricted or exclusion zone work area.

Instrument Calibration and Maintenance
All monitoring equipment will be calibrated minimally once per day before each day's use or per the manufacturer's recommendation. The calibration results will be recorded using the Calibration Log in Appendix F. Monitoring equipment will be maintained on a schedule corresponding to the manufacturer's suggested maintenance schedule.

7.2 Engineering Controls

When airborne contaminants are detected in the breathing zone of workers or when LEL readings on the CGI are greater than 10%, engineering controls may be utilized to reduce the exposure potential to the worker and to prevent shutting down an operation. Various types of engineering controls may be utilized on a project such as this. Some available methods are listed below; however, this list does not provide the only types of engineering controls that may be available. Other methods may be implemented that are more effective and/or efficient than the ones listed below.

- Utilization of water to soak down area to minimize dust.
- Utilization of intrinsically safe blowers to provide ventilation.
- Utilization of polysheeting to cover stockpiles.
- Utilization of calcium chloride.

It is more desirable to reduce employee exposure potential than to increase levels of employee personal and respiratory protection. The implementation of engineering controls will reduce employee exposure potential and not require a greater level of protection of workers.

7.3 Dust Suppression Techniques

Dust suppression may include utilization of water. The exclusion zone areas and access roads can be wetted when required by visible reference or as an action level is approached or exceeded.

Dust control measures including applying water to work areas will be implemented to control dust levels.

The approach for air monitoring and the establishment of appropriate action levels will be determined prior to commencement of work at the site.

8 Safety Equipment and Communication

8.1 Safety Equipment

Basic emergency and first aid equipment will be available at each exclusion zone. This shall include at a minimum: first aid kit; emergency eyewash; and fire extinguisher.

8.2 Communications

Communications will be maintained between work being performed in the exclusion zones and the restricted zone utilizing hand-held radios, cellular phone, or other appropriate form of communications.

9 Community Air Monitoring Program

This section describes activities, equipment, and procedures employed to combat hazards to the health and safety associated with the site as they pertain to local residents, tenants of the site, and nearby businesses.

9.1 Ground Intrusive Activities

For on-site ground intrusive activities, including drilling, jack-hammering, and any activity disturbing normal surface and subsurface, the following air monitoring activities will be conducted to assess potential emissions to the ambient air, which may impact local residents, tenants of the site, and nearby businesses in addition to site workers:

- <u>Particulates</u>: Particulates should be monitored continuously upwind, downwind, and within the work area at temporary particulate monitoring stations. If the particulate levels in the downwind location or the work area are more than 2.5 mg/m^3 higher than the upwind particulates level, then dust suppression techniques must be employed. Monitoring locations will be adjusted to take into account changes in wind direction and areas of intrusive activities. All readings must be recorded and be available for State (NYSDEC and NYSDOH) personnel to review.

- <u>Volatile Organic Compounds</u>: Volatile organic compounds must be monitored at the perimeter of the work area on a continuous basis. If total organic vapor levels exceed 5 parts per million (ppm) above background levels, work activities must be halted and monitoring continued under the provisions of a Vapor Emission Response Plan (Section 9.3). All readings must be recorded and be available for State (NYSDEC and NYSDOH) personnel to review.

9.2 Non-Intrusive Activities

For non-intrusive activities on-site the following air monitoring activities will be conducted to assess emissions to the ambient air, which may impact local residents, tenants of the site, and nearby businesses in addition to site workers:

Community air monitoring for particulates/dust will be performed during earth moving operations associated with covering waste deposits including:

- Placement of cover soil over waste located along the stream bank.
- Placement of the sand layer over waste in preparation for installation of the GCL.

All procedures, identified under the ground intrusive activities to this section, apply.

9.3 Vapor Emission Response

If the ambient air concentration of total organic vapors at the downwind perimeter of the work area or exclusion zone exceeds 5 parts per million (ppm) above background for the 15-minute average, work activities must be temporarily halted and monitoring continued. If the total organic vapor level readily decreases (per instantaneous readings) below 5 ppm over background, work activities can resume with continued monitoring.

If total organic vapor levels at the downwind perimeter of the work area or exclusion zone persist at levels in excess of 5 ppm over background but less than 25 ppm, work activities must be halted, the source of the vapors identified, corrective actions taken to abate emissions, and monitoring continued. After these steps, work activities can resume provided that the total organic vapor level 200 feet downwind of the exclusion zone or half the distance to the nearest potential receptor or residential/commercial structure, whichever is less – but in no case less than 20 feet, is below 5 ppm over background for 15-minute average.

If the organic vapor level is above 25 ppm at the downwind perimeter of the work area or exclusion zone, activities must be shutdown. When work shutdown occurs, downwind air monitoring, as directed by the HSO, will be implemented to assess vapor emission, which may impact the nearest residential or commercial structure at levels exceeding those specified in the Major Vapor Emission section.

<u>Major Vapor Emission</u>: If any organic levels greater than 5 ppm above background levels are identified 200 feet downwind from the work area or half the distance to the nearest residential or commercial property, whichever is less, all work activities must be halted.

If following the cessation of the work activities, or as the result of an emergency, organic levels persist above background levels 200 feet downwind or half the distance to the nearest residential or commercial property from the work area, then the air quality must be monitored within 20 feet of the perimeter of the nearest residential or commercial structure (20 Foot Zone).

If efforts to abate the emission source are unsuccessful and if the following levels persist for more than 30 minutes in the 20 Foot Zone, then the Major Vapor Emission Response Plan shall automatically be placed into effect; if organic vapor levels are approaching 5 ppm above background levels.

However, the Major Vapor Emission Response Plan shall immediately be placed into effect if organic vapor levels are greater than 10 ppm above background levels.

Major Vapor Emission Response Plan: Upon activation, the following activities will be undertaken:

- Emergency services will be notified. Emergency phone numbers are identified in the Emergency Services section on page 2 of this Plan.
- The local police authorities will immediately be contacted by the HSO and advised of the situation.
- Frequent air monitoring will be conducted at 30-minute intervals within the 20 Foot Zone. If two successive readings below action levels are measured, air monitoring may be halted or modified by the HSO.

10 Training

10.1 Basic Training Required

All contact project personnel that are required to work within exclusion zones are required to have received a minimum of 40 hours of instruction off the site, and a minimum of three days actual field experience under the direct supervision of a trained, experienced supervisor pursuant to OSHA 29 CFR 1910.120(e) and 1926.65. Non contact personnel are not required to meet these initial training requirements unless directed otherwise by the HSS.

All personnel above are required to have successfully completed refresher training requirements pursuant to OSHA 29 CFR 1910.120(e) and 1926.65. All "supervisory" personnel as identified by Fuss & O'Neill will be required to have successfully met the supervisory training requirement pursuant to OSHA 29 CFR 1910.120(e) and 1926.65.

Fuss & O'Neill personnel shall have completed 40 hours of OSHA training and be current with their 8 hour refreshers in accordance with 29 CFR 1910.120. On–site personnel must also be familiar with the procedures and requirement of this HASP. In the event of conflicting safety procedures/requirements, personnel must implement those safety practices that afford the highest level of protection.

The objectives of the training program are to: communicate the potential hazards workers may encounter; provide the knowledge and skills necessary to perform the work with minimal risk to worker's health and safety; communicate the purpose and limitations of safety equipment; and communicate an emergency plan.

All employees and contractors engaged in site field work must sign an acknowledgement form to indicate that they have read this HASP, understand the content of this HASP, and agree to abide by the precautionary measures stated in this HASP. The Project Manager, Field Operations Leader, and Health and Safety Supervisor shall also sign-off on this HASP to verify that the content is factual.

Documentation of theses employees training certificates are to be maintained by Fuss & O'Neill.

10.2 Site Specific Training

10.2.1 Initial

All project personnel are required to have initial site-specific training while the potential for exclusion zone activities exist. This training will be provided on-site for all project personnel by the HSS prior to commencement of on-site field activities. The training will address the activities, procedures, monitoring, and equipment for the site operations. It will include site layout, chemical hazards (identification of, detection of, and physiological responses to), physical hazards and emergency services at the site, and will detail all provisions contained within this HASP.

All personnel must sign the Field Team Member form in Appendix G following the site specific training and review of the HASP. Personnel who do not receive initial site training will not be permitted to enter the restricted, CRZ, or exclusion zones.

10.2.2 Periodic Safety Briefings

The HSS will conduct daily safety briefings for site workers conducting operations in the restricted zone or in any exclusion zone. These informal briefings will generally be held in the support areas of the designated work areas. The content of these briefings will change as directed by the HSS and will generally include relevant health and safety topics affecting that day's operations.

11 Physical Hazards and Safety Considerations for Site Operations

11.1 Weather

The site activities may proceed through all seasons; therefore, precautions are to be taken to address both heat and cold stress. Monitoring of site personnel for the symptoms associated with each will be continuous.

If severe weather occurs that may affect the safety of site workers, the HSS shall stop such field operations. The HSS will resume operations when weather conditions improve to acceptable levels.

11.2 Heat Stress/Cold Stress

Heat and/or cold stress may be a potential problem for this project. The HSS may implement heat and cold stress programs and recommend that adequate rest breaks and liquid (i.e., water, Gatorade®) consumption occur. The heat and cold stress program is in Appendix H.

The proposed work/rest schedule will be dependent upon the weather conditions encountered and the level of personal protective equipment being utilized by on-site personnel. There will be a designated break area. The work/rest schedule will be established and adjusted by the HSS.

11.3 Slip, Trip and Fall Hazards

In any work area it is expected that the ground may be uneven, with platforms and other obstacles existing in the midst of the work environment. Therefore, the potential for slipping, tripping and falling is high, especially considering that respirators may be used, which can impede vision.

11.4 Confined Space

If entering a confined space is required at any time during this project, the HSS will ensure that appropriate confined space entry procedures are followed by appropriately trained confined space individuals in accordance with OSHA 29 CFR 1910.146 (Appendix I).

11.5 Electrical Hazards

To control the potential for electrical hazards, procedures will be followed in accordance with OSHA 29 CFR 1926 Subpart K.

Ground-Fault Circuit Interrupters (GFCI) shall be used on all sites that have temporary wiring or a power supply per 29 CFR 1926.400 (h)(2). All 120-volt, single-phase 15- and 20-ampere receptacle outlets on-sites, which are not part of the permanent wiring of the building or structure and are in use by Fuss & O'Neill employees or subcontractors to Fuss & O'Neill shall have UL7 approved GFCI for personal protection.

11.6 Trenching, Shoring and Excavations

Excavations will be in accordance with OSHA 29 CFR 1926 Subpart P. Prior to excavating, utility companies and other responsible authorities will be contacted to locate and mark the locations of underground installations.

11.7 Traffic

Different types of traffic (trains, delivery vehicles and heavy equipment) may be present at the job site. All work will be performed in accordance with State and Federal laws.

Vehicular traffic may be a hazard during the work covered by this HASP. Traffic cones will be used to block off areas around roadways to protect personnel and equipment. All signs shall meet the State and Local regulations regarding traffic safety. During work along highways or congested roadways, personnel shall wear orange safety vests and hard hats.

11.8 Pathogens

Although not expected, if pathogenic wastes (i.e. suspect medical wastes, sharps) are encountered during this project, workers will stop work in that area and inform the HSS.

11.9 Explosives

If explosives are encountered during this project workers will immediately stop work and qualified explosive handling personnel will be contacted.

11.10 Smoking Policy

Under no circumstances will smoking be permitted inside any established Exclusion Zone.

11.11 Hearing Protection

Hearing protection will be available to all site workers/visitors.

11.12 Drum/Container Handling

The procedures utilized for the movement and disposal of drums will comply with 29 CFR 1910.120(j) and 1926.65. This section specifies that drums and other containers of hazardous materials be handled in a manner to reduce possible rupture and minimize the potential for a spill.

11.13 Guarding of Machinery and Equipment

Machinery and equipment guarding will be installed and maintained in accordance with 29 CFR 1910 and 1926. Various OSHA standards specify machine and equipment guarding that must be in place to reduce potential injuries. All manufacturer's machine guards will remain intact and not be removed by any employee. Any damaged or missing guard will be replaced and the equipment will not be operated until the proper protection is provided.

11.14 Illumination

If work activities occur before sunrise or after sunset, sufficient lighting will be provided to meet the requirements of 29 CFR 1910.120(m) and 1926.65. Table H-120.1 - Minimum Illumination Intensities in Foot-Candles should be used as a guide for providing proper lighting in site operations. These minimums range from 3 to 30 foot-candles, depending on the area or operation performed.

11.15 Spill Cleanup

If a spill occurs the HSS will immediately notify the HSM. Immediate containment actions will be implemented to minimize the effects of a leak or spill. All cleanup procedures will be in accordance with applicable local, state and federal regulations. Spill clean up kits will be available on-site.

11.16 Drilling and other Underground Operations

The HSM shall contact New York Dig Safely (NYDS) prior to any drilling or digging activities. Three business days notification is required prior to starting work. The following Required Location Request Information is needed: Town, Street Address, and Nearest Street intersection, Type of Work, Name of Caller & Company, Phone Number, and Start Date & Time.

Documentation of the NYDS list, confirmation #, date, time and the person who called should be recorded on the form in Appendix J.

12 Decontamination/Wash-up Procedures

This section can be classified into four areas:

1. procedures for decontaminating heavy equipment that has entered exclusion zones;
2. decontamination procedures for personnel exiting exclusion zones;
3. wash-up procedures for all personnel; and
4. instrument decontamination.

12.1 Heavy Equipment Decontamination

Heavy equipment that has entered exclusion zones shall be clean on arrival and will be decontaminated prior to leaving the site. As necessary, equipment that has been in contaminated areas of the project site will be decontaminated before leaving the project site. The decontamination area will be located in a known contaminated area of the site.

All decontamination waters shall be disposed of properly off-site or containerized, characterized and treated, if necessary, prior to discharge on-site. Discharge of wastewater on-site must be conducted such that it does not infiltrate into the waste mass or cause erosion. If disposed of off-site, documentation must be submitted to the NYSDEC along with the Final Engineering Report showing appropriate disposal. For on-site discharge, analytical sampling results must show the wastewater meets applicable SCGs prior to discharge.

12.2 Personnel Field Decontamination

Personnel field decontamination facilities will exist at the exits to all established exclusion zones in contamination reduction zones (CRZs). If possible, these field decontamination facilities will be located upwind of the exclusion zone. The field decontamination facilities will be under the control of the HSS. The detailed extent of the decontamination will be a site-specific decision by the HSS based on the extent of personnel contamination.

Once removed, disposable PPE will be collected at the field decontamination-site in a drum or large plastic bag. The drum or plastic bag will be secured in order to prevent the accidental spread of contamination. Disposable PPE that has been worn in an exclusion zone must be removed and placed in the disposal container before leaving the CRZ. Disposable PPE may not be re-used.

12.3 Wash-up Facility

A portable wash-up apparatus and/or facility will exist in the main support area of the construction work zone. The facility will be under the control of the HSS.

After exiting a field decontamination facility, personnel may now use the "wash up" setup. All personnel working at the site must wash their hands and faces prior to eating, drinking or smoking and practice good personal hygiene. Potable water will be available at the site.

12.4 Instrument Decontamination

Instruments will be decontaminated whenever they have contacted soil or dust. Instrument decontamination will occur in the same area for personnel decontamination and will consist of the removal of any dust or soil from the surfaces of the instruments.

13 Disposal Procedures

13.1 General

A waste staging area will be located on-site in an area approved by Fuss & O'Neill. This area will be segregated from the support areas to control the potential for waste migration beyond the perimeter of this area. The area will be considered an exclusion zone requiring periodic air monitoring as deemed necessary and the appropriate level of protection pursuant to the protocols in this plan.

All waste materials shall be handled in such a way to avoid potentially spreading contamination, creating a hazard or littering the site. All disposable PPE will be placed in plastic bags during decontamination and site activities for disposal.

All disposal will be in accordance with local, state, and federal hazardous waste regulations, as well as the Resource Conservation and Recovery Act (RCRA).

13.2 Soil/Sludge

Generation of soil/sludge requiring management is not anticipated. All soil that has visible signs of contamination will be classified by the HSS as potentially contaminated material and will be stockpiled. The stockpiled soil will remain in place until the analytical results of samples collected by Fuss & O'Neill are made available to the Contractor. Within 30 days of waste classification finding the soil unsuitable for re-use the soil will be removed and disposed.

13.3 Water

Generation of decontamination liquids requiring management is not anticipated. All dewatering liquids will be containerized, stored in the staging area and/or disposed onsite if appropriate. Waste classifications will be made by Fuss & O'Neill. The liquids will be disposed of or treated with methods approved by Fuss & O'Neill.

14 Emergency Plan

14.1 General

All operations required have the potential to create an emergency situation. Emergency situations can be characterized as a Fire or Explosion; Environmental Release (spill or cloud); or Accident and/or Injury to one of the field personnel.

14.2 Site Emergency Coordinator

The emergency coordinator or alternate will be on-site during all working hours. The emergency coordinator shall implement the emergency plan whenever conditions at the site warrant such action. The coordinator will be responsible for assuring the evacuation, emergency treatment, emergency transport of site personnel as necessary, and notification of emergency response units and the appropriate project and management staff designated in Section 1.0.

14.3 Evacuation

In the event of an emergency situation, a specific emergency signal (such as air horn blasts) will sound and all personnel in all work zones will evacuate and assemble near the entrance of the construction work zone or other support area location determined prior to the beginning of the daily operating tasks.

For efficient and safe site evacuation and assessment of the emergency situation, the emergency coordinator will have authority to initiate proper action when outside services are required. Under no circumstances will incoming personnel or visitors be allowed to proceed into the construction work zone once the emergency signal has been given. The emergency coordinator will ensure that access for emergency equipment is provided and that all combustion apparatus (e.g.; operating machinery) has been shut down once the alarm has been sounded. The emergency coordinator will notify the Fire Department and other emergency response organizations by telephone of the emergency.

The emergency coordinator or designee will make a headcount of all site personnel at the assembly point. If a worker or site visitor is unaccounted for, the emergency coordinator will report this information to the emergency responders. The site evacuation plan shall be rehearsed as part of the overall training program for site operations.

14.4 Incipient Firefighting

Fire extinguishers will be located at every exclusion zone. Appropriate contractor project personnel will be trained in the use of fire extinguishers. All fire extinguishers will be inspected daily to make sure it is fully charged and in working order.

Fuss & O'Neill employees may fight incipient fires (small, just starting that can be extinguished easily with a portable fire extinguisher, like a garbage can fire) and clean up incidental spills (usually less than 1 gallon) that occur while working on-site. If a fire or spill of this type becomes larger and there is a potential for a hazardous substance release, Fuss & O'Neill employees will sound the emergency alarm and evacuate the area immediately. Emergency Coordinator will contact the responsible party in the event the emergency response is beyond their competency level.

14.5 Emergency Response Coordination

The emergency coordinator or designee will report any emergency immediately to the local emergency response organizations and will be available to brief them immediately upon their arrival as to the location of the emergency, nature and extent of the emergency, personnel involved, hazardous substances involved, and any other pertinent information.

14.6 Personnel Injury/Personnel Exposure/First Aid

Any minor cuts or abrasions are to be washed and treated immediately. First aid shall be given on-site as deemed necessary. If needed the individual will be decontaminated and transported to the nearest medical facility. The ambulance/rescue squad shall be contacted for transport as necessary in an emergency. In any life-threatening situation, the life-saving treatment of personnel is the immediate priority. The emergency coordinator or designee will be available to brief the rescue squad immediately upon their arrival as to the location of the injured person(s), nature and extent of the injury(ies), personnel involved, hazardous substances involved, and any other pertinent information. The HSS will supply medical data sheets and chemical hazard information to appropriate medical personnel and complete an incident report on the accident or injury.

In case of personnel exposure, the following procedures are to be provided:

SKIN CONTACT: Use copious amounts of water. Wash/rinse affected area thoroughly and then provide appropriate medical attention. Eyes should be thoroughly rinsed with water.

INHALATION: Move to fresh air and/or, if necessary decontaminate/transport to hospital.

INGESTION: Decontaminate and transport to emergency medical facility.

PUNCTURE WOUND OR LACERATION: Decontaminate, if possible and transport to emergency medical facility.

15 Medical Surveillance

All contact project personnel that are designated to work in the exclusion zones outlined in section V are required to meet the medical surveillance requirements of OSHA 29 CFR 1910.120 and 1926.65 and OSHA 29 CFR 1926.103 (respiratory protection), and to furnish documentation to that effect. In addition, a medical data sheet in Appendix K must be completed prior to beginning work on the site. The medical data sheet shall be kept on-site with the HSS and will accompany the employee whenever medical treatment is required.

All examining physicians must meet the requirements of 1910.120 and 1926.65. The physician performing medical examinations will determine the specific requirements of the physical. The employees must be given the results of their examination. Attached as Appendix K is the Fuss & O'Neill Written Medical Surveillance Program.

16 Recordkeeping

The HSS will maintain Health and Safety Records for the site. The following information will be recorded on the Daily Record form in Appendix C):

- Weather conditions (temp., wind speed and direction, precipitation)
- Air monitoring equipment calibration records
- Air monitoring results (date, time, location, data, instrument, person conducting sampling)
- Description of operation(s)
- Level of PPE
- Non-compliance with the HASP
- Personnel exposure incidents
- Description of accident(s) (OSHA 200 log)

All accidents and personnel exposures, regardless of the extent, will be reported to the HSS, who will complete a Supervisor's Report (Appendix B) on the incident.

17 Authorizations

Personnel authorized to enter the construction work zones and construction exclusion zones at this site must be approved by the HSS. Authorization will involve completion of appropriate training courses and medical examination requirements as stipulated by this HASP, and review and approval of this HASP.

18 Signatures

This plan was reviewed and approved by:

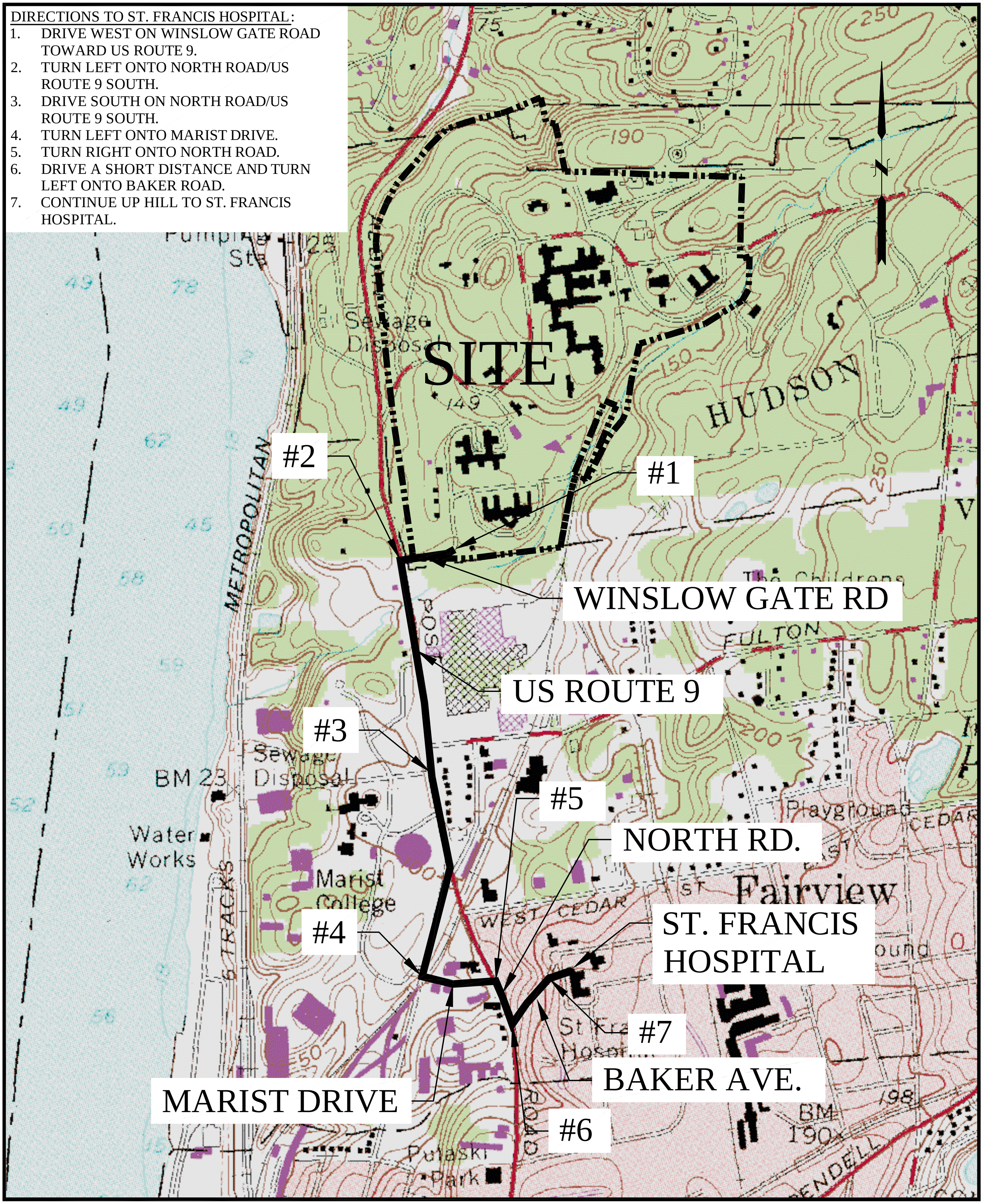
Project Manager – Craig M. Lapinski, PE, LEED-AP	Date:
Health & Safety Supervisor – Gregory A. Toothill, PE	Date:
Corporate Health & Safety Officer – Kevin W. Miller, Ph.D.	Date:

Appendix A

Site Maps

DIRECTIONS TO ST. FRANCIS HOSPITAL:

1. DRIVE WEST ON WINSLOW GATE ROAD TOWARD US ROUTE 9.
2. TURN LEFT ONTO NORTH ROAD/US ROUTE 9 SOUTH.
3. DRIVE SOUTH ON NORTH ROAD/US ROUTE 9 SOUTH.
4. TURN LEFT ONTO MARIST DRIVE.
5. TURN RIGHT ONTO NORTH ROAD.
6. DRIVE A SHORT DISTANCE AND TURN LEFT ONTO BAKER ROAD.
7. CONTINUE UP HILL TO ST. FRANCIS HOSPITAL.



File Path: J:\DWG\P2008\0291\L3N\Civil\Plan\20080291L3N_LOC01.dwg, Layout: Fig 1 Fri, Aug 07, 2009 - 3:32 PM User: czolezi

SCALE: HORZ.: 1" = 1000' VERT.: DATUM: HORZ.: VERT.: 0 500 1000 GRAPHIC SCALE	FUSS & O'NEILL *Disciplines to Deliver* WWW.FandO.COM 80 WASHINGTON ST SUITE 301 POUGHKEEPSIE, NY 12601 845.452.6801	HUDSON HERITAGE DEVELOPMENT, LLC MODIFIED RAWP HASP HOSPITAL DIRECTIONS FORMER HUDSON RIVER PSYCHIATRIC CENTER TOWN OF POUGHKEEPSIE NEW YORK	PROJ. No.: 20080291.L3N DATE: JULY 30, 2009 FIG. 1

UCS:WORLD MS VIEW:1:1000 LMAN:FIG 1 CTB:FO 2008 MONO (HALF)

Appendix B

Supervisor's Report of Accident Information

FUSS & O'NEILL

SUPERVISOR'S (HSS) REPORT OF ACCIDENT INVESTIGATION

Injured Employee ______________________________ Date of Report __________________
Occupation ____________________________________ Age ____________ Sex ____________
Length of Employment Years _______________ Months _______________________
Date of Accident ___________________________________ Time of Accident ______________
Exact Location? ____

Description of Accident (Detail what employee was doing and what tools, equipment, structures or fixtures where involved.)

____
____
____
____

Description of Injuries ____
____
____

Date Reported to Supervisor and First Aid ____

Date First Aid Received ____

Delayed? ________Yes ________No
If Yes, Why? ____
____

Type of First Aid Received? ____

Circle Accident Cause Listed Below that Apply:

Struck by/Against

Chemical Contact/Burn

Slip, Trip and/or Fall

Lifting/Lowering

Caught in/by

Motor Vehicle Accident

What would you recommend to prevent the recurrence of this type of accident in the future?
____
____
____
____
____
____

FUSS & O'NEILL

SUPERVISOR'S (HSS) REPORT OF ACCIDENT INVESTIGATION (CONT'D)

Are recommendations above being implemented? ______________________________________
____

Supervisor's Comments: ________________
____
____
____
____

Supervisor's Signature ____

Date: ________________________

Appendix C

Daily Record of Site Activities

FUSS & O'NEILL

DAILY RECORD OF SITE ACTIVITIES

SITE: ______________________________ DATE: ______________

PROJECT NO.: ______________________
TASK PERFORMED: ______________________________

____

PERSONNEL ON-SITE: ______________________________

A. WEATHER CONDITIONS: ______________________________

____

____

B. EQUIPMENT LIST (TYPE OF INSTRUMENT(S), PERSON(S) CONDUCTING SAMPLING AND DATA COLLECTION): ______________________

____

____

____

____

____

C: LEVEL OF PPE:

____

____

D. TASK:

____

____

E. NONCOMPLIANCE TO THE HASP GUIDELINES:

____

____

____

____

F. PERSONNEL EXPOSURE INCIDENTS:

____

____

G: ACCIDENT DESCRIPTION (if any):

____

____

Appendix D

Contamination Characterization

FUSS & O'NEILL

Known Contaminants of Concern

The previous investigations at the site have identified the following Contaminants of Concern (COCs) at the Landfill Area 6 site: Arsenic, Iron, Lead, Manganese, Mercury, and Sodium. These contaminants were identified in the leachate and streambed samples. It is possible that additional contaminants may be present at the site that have not yet been identified.

Appendix E

Personal Protective Equipment Program

PERSONAL PROTECTION PROGRAM

Overview

Personal Protective Equipment (PPE), such as, clothing and respiratory protection help control on-site workers from coming in contact with contaminants and other hazards. It is imperative that PPE be appropriate to protect against the known potential hazards for each investigation and each work site. The selection of PPE will be based upon the types, concentrations, and routes of personal exposure that may be encountered. The appropriate level of protection for initial site entry will be based upon a conservative assessment of the best available site contamination information. The NIOSH Pocket Guide to Chemical Hazards is supplied to the HSS and field scientists that have completed the 40-hour and 8-hour health and safety training courses for use as a source of general industrial hygiene and medical surveillance information. The responsibility of selecting the proper PPE, including respiratory protection, is that of the HSM and HSS. During field activities, the HSS has the authority to upgrade or downgrade the current PPE and respiratory protection.

In responding to an incident where the type(s) and concentration(s) in the ambient atmosphere of substances injurious to human health are unknown, a determination must first be made by the HSM and HSS if it is necessary to have personnel enter the site (close proximity to the potential source of exposure). A requirement for on-site operations necessitates that personnel initially enter the site to characterize and define the hazardous environment that potentially exists.

Until qualitative and quantitative information is available for assessing the ambient atmosphere at a site, levels of protection may have to be based on the site hazard Assessment and gross measurements from portable instruments for organic vapor analysis (i.e. photoionizer detector (PID), organic vapor analyzer or monitor (OVA or OVM), gas chromatograph (GC)). A Field Air Monitoring Log and Air Monitoring Instrument Calibration Log to be completed at the site.

The following criteria will be used as a Guide to determine the level of PPE. It is emphasized that the following values should not be the sole criteria for selecting levels of protection. The level should be selected case-by-case, with special emphasis on potential exposure and chemical and toxicological characteristics of the known or suggested material. These criteria are established from prior experience at the site under investigation and current assessments of site hazards.

Level C: If ambient breathing zone background concentrations are background to five (5) ppm (one (1) ppm for benzene or vinyl chloride) and meet the level C criteria listed in this document.

Level D: If ambient background concentrations are at background. Total atmospheric vapor/gas concentrations are used for determining the appropriate level of protection. The background concentration will be measured prior to the commencement of field operations each day, and checked periodically through the day in the support zone to account for any variation resulting from the weather or other external factors. There are four levels of personal protection recommended by the United States Environmental Protection Agency (USEPA). They range from Level D, used when little or no potential for exposure to contaminants exist;

upgrading to Level C, when contamination levels require protection levels from bodily contact and the filtering of breathing air; to Level B when contamination requires protection from bodily contact and the use of a supplied breathable air source; to Level A, which is used when the contamination levels require the highest available protection from bodily contact, respiratory and eye irritation. F&O personnel are supplied with equipment for Levels C and D. If conditions on site require upgrading to Levels A or B, personnel will be required to leave the area. The criteria for Levels C and D are provided below.

Level D protection is primarily a work uniform, though Tyvek™ could be used if desired i.e. muddy, dusty conditions. Dust respirators are available if dusty conditions (modified level D) exist on site.

<u>Level D Equipment</u>

a) Coveralls;
b) Leather or chemical-resistant boots or shoes, steel toe and shank;
c) Hard hat (face shield optional);
d) Options as required:
    1) Gloves (nitrile, neoprene);
    2) Disposable overboots (latex);
    3) Safety glasses or chemical splash goggles.

<u>Criteria for Use</u>

a) No indication of airborne health hazards present.
b) Frequent air monitoring with field instrument(s) to confirm ambient background concentrations.
c) Frequent visual observations of field personnel to prevent against i.e. heat stroke.
d) Normal work operations are not expected to create splashes, immersion or the potential for unexpected inhalation of or contact with hazardous levels of any chemicals.

<u>Level C</u>

Level C protection will be selected when the types and concentrations of respirable material are known, or reasonably known not to exceed the equipments rated/NIOSH approval capabilities, and exposure to the unprotected areas of the body (i.e. neck and back of head) is unlikely to cause harm.

A range of background to greater than 5 ppm (1 ppm if benzene or vinyl chloride is present) above ambient background breathing zone concentrations of vapors/gas (non-methane) in the atmosphere has been established as guidance by USEPA for selecting Level C protection. Concentrations of unidentified total vapors/gases approaching or exceeding 5 ppm in the breathing zone would warrant upgrading respiratory protection to a self-contained breathing apparatus (Level B) or shut down and evacuation. Wind direction and atmospheric conditions (i.e. humidity) should be established prior to taking background readings with the field instrument(s).

Level C Equipment

a) Full-face piece or half-face, though USEPA recommends full-face, air-purifying canister equipped respirator with appropriate chemical cartridge (i.e. organic vapor/acid gas/HEPA/dust/mist) that is MSHA/NIOSH approved. Splash shield and/or goggles if half-face respirator is used.

b) Tyvek™ clothing or polylaminated Tyvek™, if liquid splash is an issue, with long sleeves and elastic at the wrists and ankles.

c) Inner disposable gloves (i.e. vinyl or nitrile) and outer chemical-resistant gloves (i.e. nitrile or neoprene).

d) Leather or chemical-resistant boots or shoes, steel toe and shank.

e) Hard hat

f) Options as required:

   1. Coveralls
   2. Disposable overboots (i.e. latex)

Criteria for Use

a) Site is known to contain potential hazards not to exceed:

   1) Atmospheric contaminants, liquid splashes, or other direct contact that will not adversely affect or be absorbed through any exposed skin.

   2) Types and classes of air contaminants have been identified, concentrations measured, and an approved canister respirator is available that can remove the contaminants.

   3) Well-documented, reliable history of site or prior entry.

   4) No evidence of acute or chronic effects to exposed personnel.

   5) All criteria for the use of air-purifying respirators are met (i.e. no IDLH, no oxygen deficiency).

Total vapor readings are between 0 ppm and 5 ppm (0 ppm to 1 ppm for benzene or vinyl chloride) above ambient background concentrations on field instruments (i.e. PID, FID, gas chromatograph) as measured in the breathing zone.

Frequent air or personnel monitoring should occur while wearing Level C protection.

Respirator Maintenance Program

Respirators shall be inspected after each use by checking the condition of the face piece and all its parts. Parts should be inspected for pliability and signs of deterioration. Once a respirator has been used the wearer must clean it. All detachable parts such as straps, valves and gaskets are removed and cleaned separately. Cartridges cannot be cleaned. They can be used again if their service life has not been exhausted; however, it is recommended that on hazardous waste sites, worn cartridges be discarded at the end of each day.

The parts should go through two water rinses and left to air dry. When dry, parts are reassembled and the respirator is put in a clean plastic bag and stored where it will be protected from conditions that could alter the shape of the mask, such as extreme temperatures or very dusty environments. DO NOT store respirators in direct sunlight or the trunk of a vehicle. At times when the above maintenance cannot be performed, the face piece and other parts can be washed with respirator cleansing wipes provided in individual packs.

Only a trained person with proper tools and replacement parts should work on respirators. No one should ever attempt to replace components or make adjustments or repairs beyond the manufacturer's recommendations. Any parts that require replacement will be returned by F&O to the manufacturer for repair. The manufacturer's instructions furnished with each respirator shall be read prior to field use.

Appendix F

Field Air Monitoring Log and Calibration Log

FUSS & O'NEILL

FIELD AIR MONITORING LOG

DATE: ______________ SITE: __________________________ PAGE ___OF ___

SITE SAFETY SUPERVISOR:____

SAFETY MONITORS: ____

WEATHER CONDITIONS:____

INSTRUMENTATION CONDITION: ____

ACTIVITY/REASON FOR MONITORING	LOCATION	TIME	READING	INITIALS

FUSS & O'NEILL

AIR MONITORING INSTRUMENT CALIBRATION LOG

Page __of ___

PROJECT NAME: ______________________________ JOB NUMBER: _________
PROJECT LOCATION: ____
INSTRUMENT TYPE: ____________________ INSTRUMENT NUMBER: _________

Date Name	Cal Gas Conc.	Instrument Reading	Adjusted (Y/N/)	New Setting	New Reading	Maintenance Notes

Appendix G

Field Team Member Form

FIELD TEAM MEMBER FORM

Each field team member shall sign this section following review of the HASP and site training before being permitted to work on site.

I have read and understand the HASP and had the required health and safety training pursuant to OSHA 1910.120 and will comply with the provisions contained herein.

NAME PRINTED	SIGNATURE	DATE

Appendix H

Heat and Cold Stress Program

THERMAL EXPOSURE

Overview

Adverse weather conditions are important considerations in planning and conducting site operations. Extremes in hot and cold weather can cause physical discomfort, loss of efficiency, and personal injury.

Heat Stress

Heat stress can result from working in a hot environment both indoors and outdoors whether protective clothing is or is not worn. Working under various levels of personal protection may require the wearing of low permeability disposable suits, gloves and boots. This type of clothing will prevent most natural body ventilation thereby causing discomfort due to increased sweating and eventually heat stress. Recommendations to reduce heat stress are to:

a) Drink plenty of fluids (water or Gatorade®) to replace loss through sweating, and eat light foods.

b) Wear cotton undergarments to act as a wick to absorb moisture and maximize natural cooling.

c) Make adequate shelter available for taking rest breaks in order to cool off.

d) The HSS shall develop an adequate and appropriate work and rest schedule for the field crew as needed.

For extremely hot weather, these additional recommendations should be followed:

a) Install portable showers or hose down field crew to cool clothing and body.

b) Shift working hours to early morning and early evening thereby avoiding the hottest part of the day.

c) Rotate field crews wearing the protective clothing into a work versus rest schedule.

d) Wear cooling devices to aid in ventilation (the additional weight may affect efficiency).

Some guidelines:

Ambient Temperature (°F)	Action Work Time (min/hr) Level C Clothing
75 or less	50
80	40
85	30
90	20
100	0

The following discusses the three types of heat stress: 1) Heat Exhaustion; 2) Heat Cramps; and 3) Heat Stroke.

Heat Exhaustion

Heat Exhaustion is brought about by the concentration of blood in the vessels of the skin. This condition may lead to an inadequate return of blood to the heart, and eventually, to physical collapse. The symptoms are:

- General weakness
- Excessive perspiration
- Dizziness
- Pale and clammy skin
- Weak pulse
- Rapid and shallow breathing
- Appearance of having fainted

To treat for heat exhaustion, place the individual in a cool place and remove as much clothing as possible. The individual should drink cool water, Gatorade® drink, or similar liquids. The individual should be fanned; however, do not over cool or allow chilling. Treat the individual for shock and remove to a medical facility if condition persists.

Heat Cramps

Heat Cramps are usually caused by loss of salt when an individual has perspired a great deal. Cramps usually in the leg and abdominal muscles can also be caused by drinking iced liquids quickly or in large amounts. The symptoms of cramps are as follows:

- Pain and cramps in legs or abdomen
- Faintness
- Profuse perspiration

Heat Stroke

Heat Stroke is a breakdown of the body's heat-regulating mechanism causing high fever and collapse. This condition, which is an IDLH (Immediately Dangerous to Life and Health) condition, can result in unconsciousness, convulsions, and even death. Persons in poor physical condition or of advanced age are particularly susceptible. The symptoms of heat stroke are:

- Muscle twitching or convulsions
- Dry hot skin
- Flushed skin
- High body temperature
- Loss of consciousness
- Deep breathing, then shallow or absent
- Dilated pupils

Heat stroke is a medical emergency situation. Medical emergency personnel should be contacted immediately in order that the person can be transported to a medical facility. In the interim, steps can be taken by the HSS. The individual should be removed to a cool environment and the body temperature reduced immediately by dousing the body with water or by wrapping in a wet sheet. If ice is available, it should be placed under arms and around the neck and ankles. If the victim is conscious, Gatorade® drink or other similar liquids containing electrolytes should be provided. Intake of these liquids will be monitored by the HSS so as not to be excessive. Steps should be taken to protect the victim from injury in the event of convulsions, such as removing any objects in the area of the victim.

To avoid problems from heat stress during conditions of high temperature and humidity, the HSS should assure that the field crew drink plenty of electrolyte fluids before and during field activities, breaks should be provided pursuant to the schedule outlined by the HSS, and should revise work schedules as necessary to take advantage of the cooler parts of the day.

Cold Exposure

Cold exposure can occur in temperatures at or below freezing. If prolonged exposure to cold occurs without proper protection, the effects of cold exposure can occur in temperatures above freezing. Exposure to cold can cause severe injury (frostbite) or overall drop in body temperatures (hypothermia). The extremities (fingers, toes and ears) are most susceptible to frostbite.

Both the outdoor temperature and the wind velocity play a part in cold injuries. Wind chill is used to describe the chilling effect of moving air in combination with low temperatures. Cold exposure can be a serious threat to a field crew that removes protective clothing and exposes perspiration soaked underclothing to the cool air. Water conducts heat 240 times faster than air, thus rapidly cooling the body. Systemic hypothermia is caused by exposure to freezing or rapidly dropping temperatures. Cold exposure symptoms (hypothermia) are usually seen in the following five stages:

1) Shivering
2) Apathy, listlessness, sleepiness and rapid body cooling
3) Unconsciousness, glassy stare, slow pulse and respiratory rates
4) Freezing of the extremities
5) Death

Recommended actions to avoid suffering the effects of cold exposure are:

a) Wear cotton, or even better, wool or synthetics (polypropylene) undergarments to absorb perspiration from the body.

b) Wear additional layers of light clothing as needed for warmth. The layering effect holds in air, trapping body heat, and some layers could be removed as the temperature rises during the day.

c) Pay close attention to body signals and feelings (hypothermia symptoms), especially to the extremities. Correct any problem indications by breaking from the work activity and moving to a rest area to warm up and add additional clothing.

d) Install a wind break at the drill site to minimize cold winds from blowing directly at the drilling crew.

e) Maintain good eating and drinking habits enabling the body to operate at top capacity.

f) Provide a sheltered area for resting and warming up.

Appendix I

Confined Space Entry Procedure

CONFINED SPACE ENTRY PROCEDURE

1) OSHA defines a "Permit-Required" confined space as:
   - An area large enough for an employee to enter and perform work;
   - An area with limited or restricted means for entry or exit; and,
   - An area that is not designed for continuous human occupancy.

2) The characteristics of a Permit-Required confined space are:
   - The space or area contains, or has a known potential to contain, a hazardous atmosphere;
   - The space or area contains a material with the potential to engulf an entrant;
   - The area has an internal configuration such that an entrant could be trapped by inwardly converging walls or a floor that slopes downward and tapers to a smaller cross-section;
   - The area contains any other recognized serious hazard.

Upon establishing that the area is a confined space or Permit-Required confined space and may contain one or more of the above characteristics, initial and subsequent atmospheric monitoring of the confined space shall be implemented prior to entry.

Monitoring shall be conducted using instruments that measure gases. Examples would be an oxygen meter and explosimeter. The need for respiratory protection and other protective equipment such as head protection, retrieval systems or self-contained or airline supply breathing apparatus shall be established through air monitoring.

1) Evaluation - This includes the initial monitoring of a confined space for harmful gases or vapors with instruments that measure gases in the area. Evaluation also includes determining how monitoring will be performed by employees and if any respiratory protection is required. Additional protective equipment may include head protection, retrieval systems or self-contained or airline supply breathing apparatus.

2) Control - This step involves the design of a confined space area. Industries with a permit-required confined space may want to consider controlling the space by changing its design, if possible. For example, a company could add ventilation to improve air quality in spaces that contain hazardous gases.

3) Monitoring - Ongoing monitoring is needed to assess the atmospheric quality for workers in confined spaces. Through monitoring, industries can verify the results of their initial evaluations to ensure worker protection.

Monitoring shall be conducted in the order listed:

1) <u>Measure oxygen deficiencies</u>. OSHA's standards call for a minimum oxygen (O_2) level of 19.5% by volume and a maximum of oxygen (O_2) level 23.5%.

2) <u>Measure combustible gases</u>. OSHA standards state that employees must not enter a confined space containing more than 10% of the lower explosive limit (LEL).

Note that for combustible gases to cause an explosion, the vapors must be within the limits of the LEL and the upper explosive limit (UEL).

NOTE: Even if a combustible level is below the 10% LEL, the combustible gas can still present a toxic hazard. To help ensure a combustible gas measurement is correct, it is important to take oxygen measurements first, since low levels of oxygen, below approximately 10% by volume, can cause erroneous combustible gas readings. This level is far below what are safe atmospheric conditions for human life.

Safety equipment needed for confined space entry may include the following:

a) Confined Space Entry Permit
b) Oxygen Deficiency Meter (Gastec)
c) Hardhat with Flashlight
d) Ladder (folding)
e) Tripod with recovery system, Body Harness and Safety Line
f) Propane powered blower and ventilation duct work

Safety procedures before entering a confined space:

1) Check oxygen (O_2), carbon monoxide (CO), lower explosive limit levels (LEL) and hydrogen sulfide (H_2S) in the confined space by lowering the meter or sampling tube as low as possible to the bottom of the space.

2) Record in a field book and on the Confined Space Entry Permit form.

Record: Time, Readings: % Oxygen _____; % LEL ____; carbon monoxide ______ PPM; and hydrogen sulfide ______ PPM;
If % LEL and carbon monoxide values are 0.0, record 0.

3) Remove sampling tube from the confined space; take a reading in ambient air and record values.

4) One person is to remain out of the confined space (attendant) at all times to observe and watch the person(s) (entrant) working in the confined space.

5) Instrument (oxygen meter) is to be left operating while entrant(s) is (are) in the confined space.

6) If a problem arises, the person(s) working in the confined space must leave immediately.

7) If work has ceased within the confined space for more than 15 minutes, repeat Steps 1 through 3 above to insure that no harmful gases/vapors have collected in the confined space before entering again.

8) At the end of the work shift, submit a copy of the air monitoring test information and Confined Space Entry Permit to the HSS and/or HSS.

NOTE: For confined space entry work conducted at a facility that has a confined space entry program, the HSS shall insure compliance with that program.

Appendix J

NY Dig Safely List

NY Dig Safely

Confirmation No.______________________

Date________________________________

Time________________________________

Person Called________________________

These companies shall be called in case of an **EMERGENCY.**
DO NOT CALL NY Dig Safely. NY Dig Safely may dictate additional and/or different utility companies than listed. The list below is intended as guidance only.

UTILITY COMPANY	
ELECTRIC COMPANY	
TELEPHONE	
GAS	
CABLE TV	
LOCAL WATER AND SEWER	
Local Water Co.	
Municipal Dept. of Public Works	
On-Site Utility Clearance	

Appendix K

Medical Surveillance Program – Medical Data Sheet

MEDICAL SURVEILLANCE PROGRAM

Federal regulations and F&O policy require all employees who participate in field activities in situations where there is a potential exposure to hazardous materials, with or without a respirator; 30 days or more per year must undergo physical examinations, including a base and termination exam. At a minimum, the physical exam complies with the requirements of OSHA 29 CFR 1910.120 Hazardous Waste Operations and Emergency Response.

The following tests are performed under the supervision of a licensed physician:

a) Physical exam
b) Hearing (base and as needed)
c) Chest x-ray (base and as deemed necessary by the attending physician)
d) Electrocardiogram (base and as needed)
e) Pulmonary function (base and as needed)
f) Urine analysis
g) Complete blood count

In the event F&O personnel are exposed to hazardous constituents, the person(s) would immediately go through the necessary exams for those particular constituents. An arranged physical exam pursuant to OSHA 29 CFR 1910.120 program has been developed between F&O and CorpCare Occupational Health Center, an affiliate of Manchester Memorial Hospital, located in Manchester, Connecticut. A medical data sheet, attached, must be completed by all company field personnel prior to working on-site. One copy of the form should be kept by the HSS, and a second copy by the HSM. Field personnel must be informed of the location of the medical data sheet while working on-site. Copies of employee physical exam reports are maintained at F&O by the HSM and by CorpCare Occupational Health Center.

FUSS & O'NEILL

MEDICAL DATA SHEET

This brief Medical Data Sheet will be completed by all on-site personnel and kept at the site during field operations. This data sheet must accompany personnel when medical assistance is needed or if transport to hospital facilities is required.

PROJECT NAME: ______________________________

PROJECT LOCATION: ______________________________

NAME: ______________________________
HOME TELEPHONE: ______________________________
ADDRESS: ______________________________
AGE: ______________________________
HEIGHT: ______________________________ WEIGHT: ______________________________

IN CASE OF EMERGENCY, NOTIFY:

SPOUSE OR FAMILY CONTACT: ______________________________
PHONE: ______________________________
SPOUSE OR FAMILY CONTACT: ______________________________
PHONE: ______________________________

ALLERGIES INCLUDING PRESCRIPTION MEDICATION: ______________________________
____

PARTICULAR SENSITIVITIES: ______________________________
____

DO YOU WEAR CONTACTS: ______________________________

ANY PREVIOUS ILLNESSES OR EXPOSURE TO HAZARDS CHEMICALS (EXPLAIN):
____
____

PERSONAL PHYSICIAN:
NAME: ______________________________
PHONE: ______________________________
ADDRESS: ______________________________
____

I am the individual described above:

______________________________ ______________________________
Signature

Appendix G

Inspection Forms

FUSS & O'NEILL

INSTITUTIONAL CONTROLS & SITE MANAGEMENT INSPECTION FORM

HUDSON RIVER PSYCHIATRIC CENTER LANDFILL AREA 6

Inspector Name:________________________

Inspection Date:________________________

1) Is the Site use currently restricted to commercial and/or industrial?_____Yes___No

If no, describe: ____

____

____

2) Is groundwater being used for any purpose at the Site? ______Yes ____No

If yes, is it being properly treated?____Yes____No
If no, describe: ____

____

____

3) Have all scheduled groundwater monitoring, sediment monitoring, landfill gas monitoring, and Site inspections been performed as scheduled in the last year?__ Yes ____No

If no, describe the reason for any deviation: ______________________________________

____

____

4) Is a current copy of the Site Management Plan, including all DEC approved revisions, maintained on-site? _____Yes ____No

If no, describe: ____

____

____

5) Are there any signs of leachate discharging along the stream bank?______Yes ______No

If yes, describe (Attach photos and/or site sketch if appropriate): _________________________

____

____

____

____

____

____

____

____

____

6) Has the scheduled mowing been performed (June and September)?_____Yes ______No

If no, explain: ____

____

____

____

GENERAL SITE CONDITION

Describe general Site condition: ____

____

____

____

____

____

INSPECTION LIMITATIONS

Describe any conditions that limited the completeness of this inspection: __________________

____

____

____

____

____

CORRECTIVE MEASURES

If any of the answers to items 1 through 4 or 6 was "No", please provide a description below and append additional pages or documentation, as necessary.

Description of corrective measures: ____

____

____

____

____

____

____

____

____

____

____

____

____

____

____

FUSS & O'NEILL

ENGINEERED CONTROL INSPECTION FORM
HUDSON RIVER PSYCHIATRIC CENTER LANDFILL AREA 6

Inspector Name:________________________

Inspection Date:________________________

ENGINEERED CONTROL OBSERVATIONS

1) Are there any signs of erosion or subsidence within the geosythetic clay liner (GCL) cover system? _________Yes _________No

If yes, describe (Attach photos and/or site sketch if appropriate): ______________________
____
____
____
____

2) Are there any signs of erosion or subsidence within the low permeability soil cover system? _________Yes _________No

If yes, describe (Attach photos and/or site sketch if appropriate): ________________________
____
____
____
____

3) Are there any tears, punctures, rips, or other damage to the lined swale of the storm water diversion system? _______Yes _________No

If yes, describe (Attach photos and/or site sketch if appropriate): ________________________
____
____
____
____

4) Is there any significant quantity of debris accumulating within the lined swale or the catch basins in the storm water diversion system that may be impeding flow? _________Yes _________No

If yes, describe (Attach photos and/or sketch if appropriate): ___________________________
____
____
____
____

5) Are any trees, shrubs, scrub brush, etc. becoming established in the geosynthetic clay liner or low permeability soil cover areas?_____Yes _________No

If yes, describe (Attach photos and/or sketch if appropriate): ____________________________

____

____

____

____

6) Is there any sign of damage to the Gas Vent Riser? _____Yes _________No

If yes, describe (Attach photos and/or sketch if appropriate): ____________________________

____

____

____

____

INSPECTION LIMITATIONS

Describe any conditions that limited the completeness of the inspection (e.g., snow cover limited observation of the low permeability soil cover system): __________________________

____

____

____

____

____

____

CORRECTIVE MEASURES

If any of the answers to items 1 through 6 were "Yes", please complete the Corrective Measures section below and append additional pages or documentation, as necessary.

Date repairs were completed:_____________ (Should be less than 30 days from inspection date)

Description of corrective measures: ____

____

____

____

____

____

____

____

Post-Repair Inspection:

Inspector: ___________________________ Date: _______________________________

Appendix H

Monitoring Well Construction Logs

EA Engineering, Science, and Technology, Inc.

LOG OF SOIL BORING

Job. No. 61317.23 | Client: DASNY | Location: HRPC

Drilling Method: Drive & Wash; 4" ID Steel Casing - CME-75 Mobile

Boring No. MWHR6-20

Coordinates: N: E:

Surface Elevation: FT MSL

Well-Riser Elevation: FT MSL

Sampling Method: 2' x 2" Split Spoon 140 lbs. Hammer

Sheet 1 of 1

Drilling Water Level | Date | Time

Start: 0830 3/21/02 | Drilling Date/Times | Finish: 1010 3/21/02

Surface Conditions: Peat/Humus

Sample Type	Inches Driven/In. Recvrd	Dpth Csg.	Samp # / depth (ft)	PID (ppm) Above bk.	Blows per 6"	Ft bgs	USCS Log	SOIL DESCRIPTION
						0	PT/OL	Peat/Humus at surface. Boring advanced at edge of wetlands.
						1	? FILL/ TRASH ?	Roller-bit wash includes quartz & concrete frags, metal shards - (0-4' bgs); indicative of possible fill/edge of waste.
						2		
						3		
SS	24/3	4	4-6	Ø	6, 4, 8, 15	4	ML	0-3" Brown very fine sand & silt w/trace medium to coarse angular gravel; little wood, organics; organic clay; moist
						5		
						6	▽	AT OR NEAR SUSPECTED H2O TABLE.
						7		
						8		
SS	24/9	9	9-11	Ø	2, 1, 10, 50/0	9	ML	0-9" Brown silt w/trace clay grading into tan silt w/few gray mottles; possible gleying; very dense; Dk gray to black weathered mudstone at base. Fluctuating H2O table within saturated zone.
						10		
						11	EoB, REF.	END OF BORING AT 10.5'. REFUSAL AT 10.5' bgs.
						12		
						13		
						14		
						15		
						16		
						17		
						18		
						19		

Logged by: ROB WASSERMAN | Date: 21 MARCH 2002

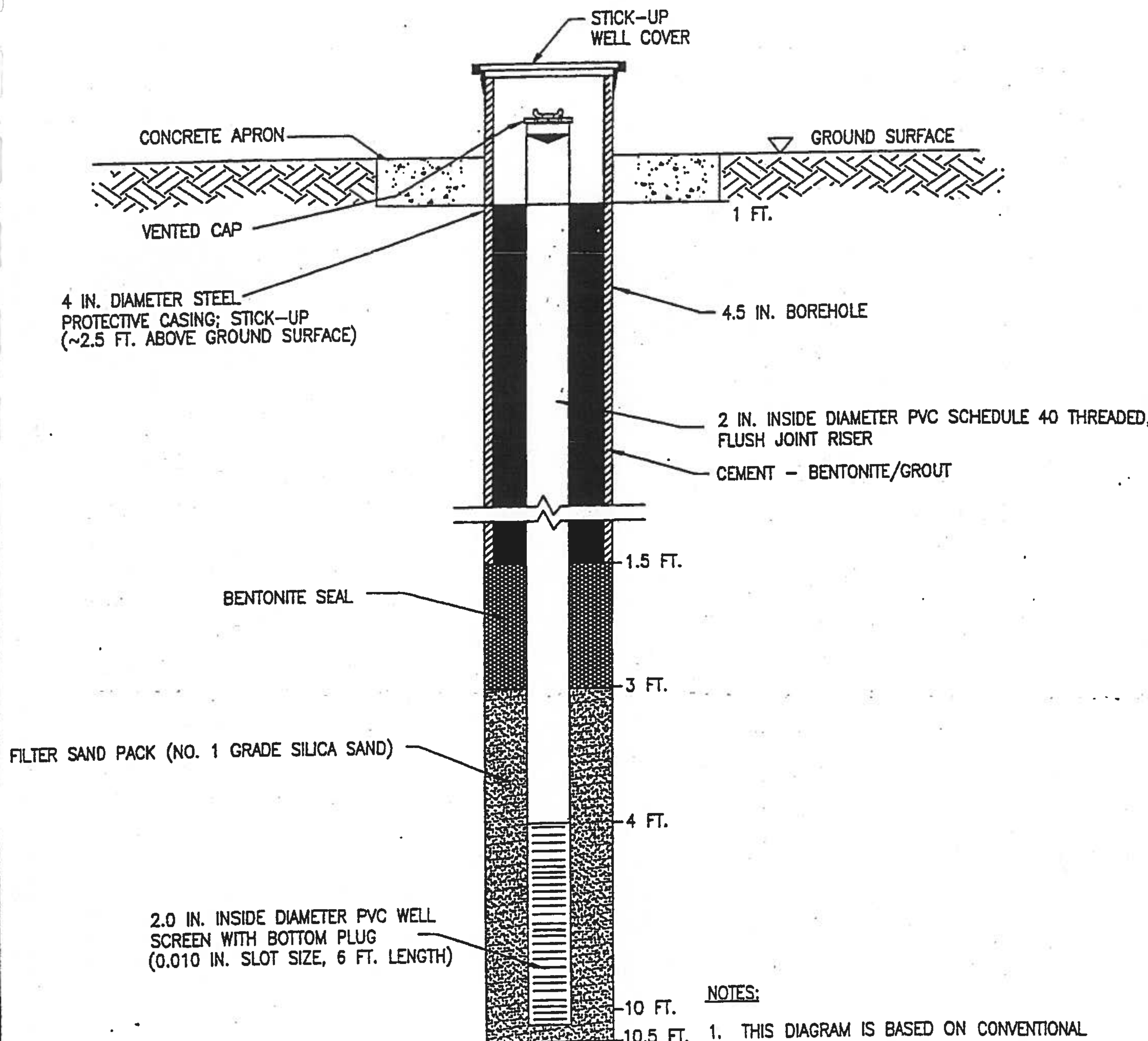
Drilling Contractor: ADT -- | Driller: LES DARROW

WELL SPECIFICATIONS: SEE WELL CONSTRUCTION SCHEMATIC

Diam. of Riser: 2" | Screen Interval: 4-10' bgs | Sandpack: 3-10.5' bgs | Grout: 1-1.5' bgs

Bottom of Hole: 10.5' bgs | Riser Interval: 4' bgs - 2.5' ags | Bentonite: 1.5-3' bgs | Cover: STICK-UP

MWHR6-20 MONITORING WELL SCHEMATIC CONSTRUCTION DIAGRAM



NOTES:

1. THIS DIAGRAM IS BASED ON CONVENTIONAL WELL CONSTRUCTION STANDARD OPERATING PROCEDURES.
2. THIS MONITORING WELL WAS INSTALLED USING DRIVE AND WASH DRILLING TECHNIQUES.

MONITORING WELL SECTION
NOT TO SCALE

DATE INSTALLED: 21 MARCH 2002

FILE: F:\STATEANDLOCAL\STATE\DASNY\6131723\WELLCONSTRUCTIONDIAGRAMS\MWHR6-20.DWG

EA ENGINEERING, PC AND ITS AFFILIATE EA ENGINEERING, SCIENCE, AND TECHNOLOGY	HUDSON RIVER PSYCHIATRIC CENTER POUGHKEEPSIE, NEW YORK	MWHR6-20 LANDFILL AREA 6 MONITORING WELL SCHEMATIC CONSTRUCTION DIAGRAM

DESIGNED BY	DRAWN BY	CHECKED BY	SCALE	DATE	PROJECT NO	FIGURE

EA Engineering, Science, and Technology, Inc.

LOG OF SOIL BORING

Job. No.	61317.23
Client:	DASNY
Location:	HRPC
Drilling Method:	Drive & Wash - 4" ID Steel Casing; CME-75 Mobile
Boring No.	MWHR6-21
Sampling Method:	2'x2" Split Spoon 140 lbs. hammer
Sheet	1 of 1
Drilling Water Level	
Date	
Time	
Surface Conditions:	Peat/Humus
Drilling Date/Times: Start	1440 3/20/02
Drilling Date/Times: Finish	1540 3/20/02

Coordinates: N: E:

Surface Elevation: FT MSL

Well Riser Elevation: FT MSL

Sample Type	Inches Driven/In. Recvrd	Dpth Csg.	Samp # / depth (ft)	PID (ppm) Above bk.	Blows per 6"	Ft bgs	USCS Log	SOIL DESCRIPTION
						0	PT/OL	Peat/Humus at surface
						1		
						2		
						3		
SS	24/13	4	4-6	ϕ	4, 8, 7, 7	4	ML	0-13" Tan/Grey Silt w/trace clay; trace medium angular gravel; fill; little tan mottling; trace fine sand
						5		
						6		
						7		
						8		
SS	24/3	9	9-11	ϕ	2, 1, 2, 2	9	ML	0-3" Same As Above (4-6'; 0-13") w/trace Red/Brown Silt; wood & organics at base; At or near suspected H_2O table
						10	▼	
						11		
						12		
						13		
SS	24/21"	14	14-16	ϕ	2, 1, 2, 2	14		0-21" Recovered coarse angular gravel; evidence of fill on fill; possible collapse
						15	ML	
SS	24/1	14	16-18	ϕ	3, 4, 3, 4	16		0-1" Brown silt w/trace clay; trace medium sub-angular gravel; possibly fill.
						17		END OF BORING AT 18' bgs.
						18	EOB	
						19		

Logged by: Rob Wasserman

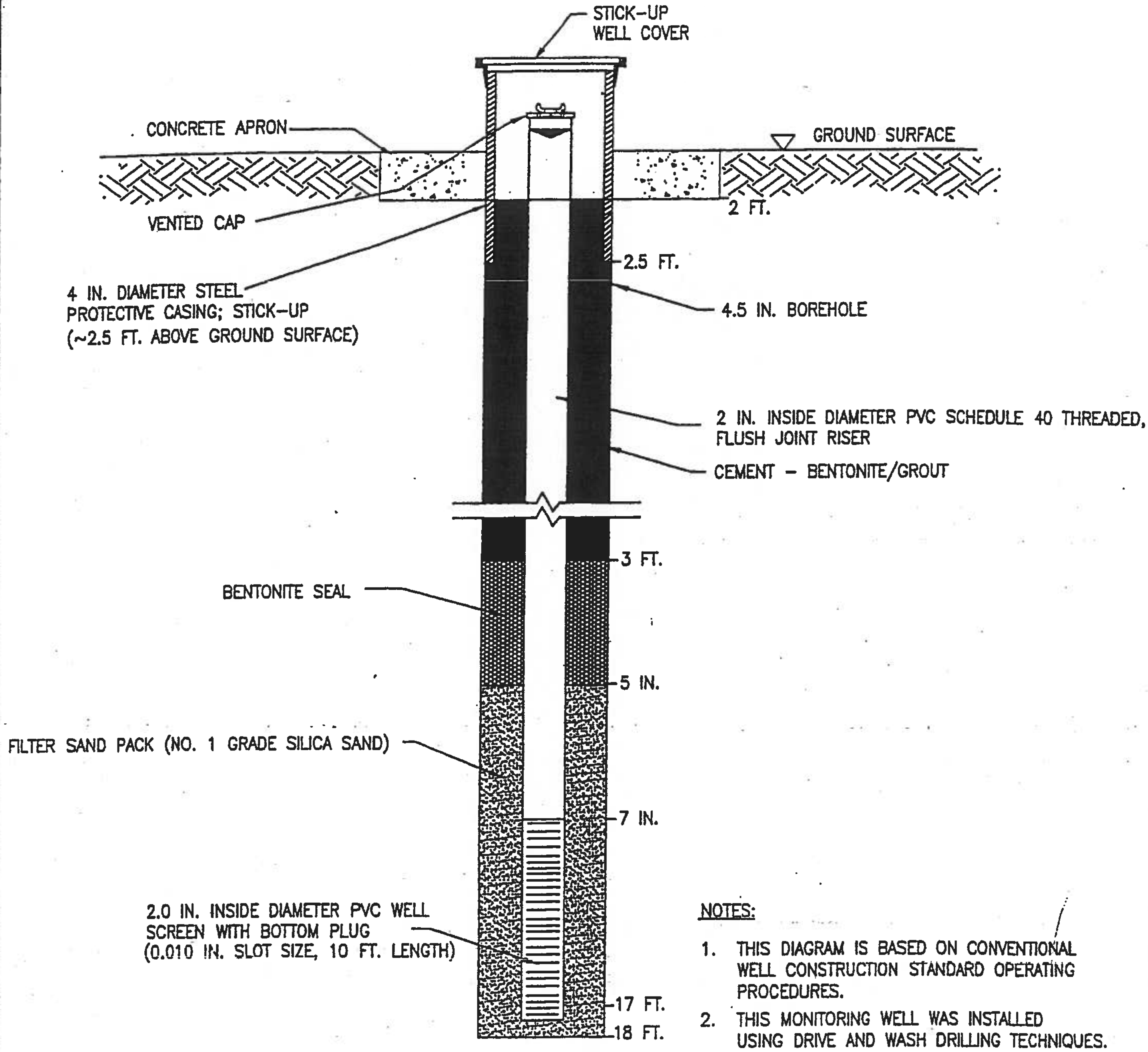
Date: 20 March 2002

Drilling Contractor: ADT

Driller: Les Darrow

WELL SPECIFICATIONS: See Well Construction Schematic

MWHR6-21 MONITORING WELL SCHEMATIC CONSTRUCTION DIAGRAM



NOTES:

1. THIS DIAGRAM IS BASED ON CONVENTIONAL WELL CONSTRUCTION STANDARD OPERATING PROCEDURES.
2. THIS MONITORING WELL WAS INSTALLED USING DRIVE AND WASH DRILLING TECHNIQUES.

MONITORING WELL SECTION
NOT TO SCALE

DATE INSTALLED: 20 MARCH 2002

FILE: F:\STATEANDLOCAL\STATE\DASNY\6131723\WELLCONSTRUCTIONDIAGRAMS\MWHR6-21.DWG

EA ENGINEERING, PC AND ITS AFFILIATE EA ENGINEERING, SCIENCE, AND TECHNOLOGY	HUDSON RIVER PSYCHIATRIC CENTER POUGHKEEPSIE, NEW YORK	MWHR6-21 LANDFILL AREA 6 MONITORING WELL SCHEMATIC CONSTRUCTION DIAGRAM

PROJECT MGR	DESIGNED BY	DRAWN BY	CHECKED BY	SCALE	DATE	PROJECT NO	FIGURE
DM	RW	KS	RW	NONE	17 JUNE 2002	61317.23	

Hudson River Psychiatric Center
Supplemental Hydrogeological Investigation - Landfill Area 6
BORING LOG

MWHR6-22R

PROJECT NAME: Hudson River Psychiatric Center **PROJECT No.:** #40307.00 **CLIENT:** Hudson Heritage, LLC **WELL TYPE:** 2" PVC Overburden Monitoring **WELL LOCATION:** Landfill Area 6 **CITY/TOWN:** Poughkeepsie **COUNTY:** Dutchess **STATE:** New York	**Elevations:** Ground Surface Elevation: 123.9' Water Level Reference Point: T.O.PVC Water Level Reference Point Elevation: 126.24' **Water Levels:** Date: 9/15/03 Depth to Water: 12.09'	**Starting Date:** 7/15/03 **Stop Date:** 7/15/03 **Method:** Hollow Stem Auger **Contractor:** ADT, Inc. **Driller:** Les, Walker **Rig:** CME-#184 **Geologist:** Will Olsen

Well Details	steel casing / 2" PVC / stick up	Depth (Depths in Feet)	Sample #	Blow Counts	Recovery (Depths in Inches)	Unified	Stratum and Field Descriptions:	Field Notes, Comments, PID Readings
Cement Grout 0- 5 ft		1			12		4" ASPHALT, crushed Stone 8" dark brown SILT, trace crs Gravel	
		2						
		3			0			
		4						large rock in spoon tip
		5			0			
6" Finer Sand Pack Bentonite Chips (Hydrated) 5.5-8.5 ft		6						crushed stone and plastic in tip
		7			12		dark brown SILT, organic matter, decaying wood, broken rock fragments	
		8						
6" Finer Sand Pack Coarse Sand Pack 9-16 ft		9			6		dark grey SILT, 2" rock, organic matter	slight organic decay odor
		10						tip moist
Screened Interval 11-16 ft		11			4		dark grey SILT, trace Clay, organic matter	slight odor of organic decay sample moist
		12						
		13			18		9 " grey-brown mottled SILT, fn Gravel 9" dark grey mottled SILT, dense, fn Gravel	saturated, water at 12-13 ft slightly moist
		14						
		15			16		10" brown-grey SILT, fn Sand, trace fn Gravel 6" broken blue-black Shale fragments	
Bottom of Well		16						
		17					Refusal at 16.1 ft - BEDROCK (Shale)	
		18						
		19						
		20						

NOTES:

Well installed in accordance to 6 NYCRR Part 360 - 2.11 (a)(8)(i)(ii) specifications
Well developed by bailing 10 well volumes.
Well replaces cross-formational well MWHR6-22 installed by EA Engineering.

Drilling Information:

	Casing	Sample	Tube	Core
Type:				
Diam.:				
Weight:				
Fall:				

Appendix I

Field Data Sheets

Monitoring Well Sample Log

Low Flow Sampling

Client/Project Name:		FUSS & O'NEILL *Disciplines to Deliver*
Project Location:	**PROJECT #:**	
Sample#:	**WELL ID:**	

Purge Data

Date:

Start time:_________________ **Stop time:**________________ **Sample time:**___________________

Pump Rate:________________ (ml/m) **Depth Sampled:**___________________

Total time purged:_________________ **Sampler:**___________________

Volume Purged:___________________(ltr)

Purge Device: Dedicated / Nondedicated **Weather:**___________________

Device Type: Bladder / Peristaltic / Submersible

Filtered? N / Y **Filter Size:** 10u / 0.45u **Filtered in:** Field / Lab

Appearance: **PVC:**___________________________

Well Yield: High / Moderate / Low / Dry **TPS:** ___________________________

Well Diameter: **DTB:**___________________________

Comments:

Sample Data

Container	Quantity	Preservative

Field Parameter Data

Instrument ID#

Solinst#		2020#	YSI 600 #				
Water Level (ft)	Time	Turbidity (ntu)	Dissolved Oxygen (mg/L)	pH	Temp. (deg C)	Specific Conductivity (uS)	ORP(mV)

Well Condition Checklist (circle appropriate item(s), cross out if not applicable]

General Condition: Good / Needs Repair
Protective Steel: OK / Cracked / Leaking / Bent / Loose/ None
Well # Visible?: Y / N
Well Cap: Good / Broken / None
Evidence of rain water between steel and PVC?: Y / N
Evidence of ponding around well?: Y / N
Gopher type holes around collar?: Y / N
Comments:

Is well plumb?: Y / N
Lock: Good / Broken / None
Rust around cap: Y / N
PVC Riser: Good / Damaged / None
Concrete collar: OK / Cracked / Leaking / None
Other evidence of: Rodents / Insects / None
Curb Box: N / Y (key is: Hex / Pent / Other)

Methane Field Data Sheet

Client/Project Name:	PROJECT #:	FUSS & O'NEILL *Disciplines to Deliver*
Project Location:	Date:	

Sampler:______________________ Weather:_____________________________

Start Time:____________________ Finish Time:__________________________

Meter Used:___________________ Calibrated date/time:___________________ Calibration Gas Used:___________________

Location	% Methane	%LEL	Comments

Sediment Sampling Field Data

Client/Project Name:__________ Project Location:__________ Date: _____ Weather: _____ Sampler(s): _____	**PROJECT #:** __________	FUSS & O'NEILL *Disciplines to Deliver*

SAMPLE #:

SITE ID: **Time:**

GPS Coord. _____N _____W \| Photo #: _____

Water Quality Parameters	Surface	Bottom
Temperature (C)		
Conductivity (uS/cm)		
pH / ORP (mV)	/	/
DO (mg/L / %)	/	/

Sampling Device: Core Sampler – Type: _____

Dredge – Type: Ponar / Ekman / Other: _____

Field Decon: Yes / No / Dedicated

Type of Sample: Grab / Composite / Other _____

Sample Depth: _____ Feet

Sample Time:

Sample Description:

Container	Quantity	Preservative

NOTES & COMMENTS

SAMPLE #:

SITE ID: **Time:**

GPS Coord. _____N _____W \| Photo #: _____

Water Quality Parameters	Surface	Bottom
Temperature (C)		
Conductivity (uS/cm)		
pH / ORP (mV)	/	/
DO (mg/L / %)	/	/

Sampling Device: Core Sampler – Type: _____

Dredge – Type: Ponar / Ekman / Other: _____

Field Decon: Yes / No / Dedicated

Type of Sample: Grab / Composite / Other _____

Sample Depth: _____ Feet

Sample Time:

Sample Description:

Container	Quantity	Preservative

NOTES & COMMENTS

Appendix J

QAPP

Quality Assurance Project Plan

Hudson River Psychiatric Center Site
Landfill Area 6

Town of Poughkeepsie
Dutchess County, New York

June 2011

FUSS & O'NEILL
Disciplines to Deliver

Fuss & O'Neill of New York, PC
80 Washington Street, Suite 301
Poughkeepsie, NY 12601

Document Title	**QUALITY ASSURANCE PROJECT PLAN**
	Hudson River Psychiatric Center Site **Landfill Area 6** **Town of Poughkeepsie** **Dutchess County, New York**
Prepared by:	**Fuss & O'Neill of New York, PC** **80 Washington Street, Suite 301** **Poughkeepsie, NY 12601**
Telephone Number:	**203-374-3748**
Project Director:	Craig Lapinski, PE
Project Engineer:	Craig Lapinski, PE
Project Manager:	Joseph Lenahan, PE
QA Officer:	Kevin W. Miller, Ph.D

Table of Contents

Quality Assurance Project Plan
Hudson River Psychiatric Center – Landfill Area 6

TABLES END OF TEXT

APPENDICES END OF TEXT

1.0 PROJECT ORGANIZATION AND RESPONSIBILITY

Fuss & O'Neill assigns a specialized team of experts to each project. These individuals act together to meet the needs of the project. Each project is assigned a Project Principal and Project Manager who oversee the components of the project.

Environmental projects are addressed primarily by Fuss & O'Neill's Environmental Assessment and Remediation working group. The Project Director of Fuss & O'Neill works with senior environmental staff to assign responsibility for day-to-day implementation of all task components. The Director or a senior environmental staff member is usually assigned the role of Project Manager for a particular project.

The Project Manager is responsible for ensuring that all project objectives are met, including schedule and budget tracking, QA adherence, and ultimate product delivery. The Project Manager reports project status to the supervising Director and discusses critical evaluations with the Director, senior staff, and the project team.

The following is a list of key personnel for the sampling program to be implemented in this study. Any questions regarding project status should be directed to the principle contact. The Quality Assurance Office (QAO) will not hold any other position on the project that involves production or profitability.

Principal Contacts:	William Burke Hudson Heritage Development, LLC (212) 283-0694 WBurke@communityp.com
Project Director/Project Engineer:	Craig Lapinski, PE Fuss & O'Neill of New York, PC (203) 374-3748 ext. 5258 clapinski@fando.com
Project Manager:	Joseph Lenahan III, PE Fuss & O'Neill of New York, PC (203) 374-3748 ext. 3509 jlenahan@fando.com
Quality Assurance Officer:	Kevin W. Miller, Ph.D. Fuss & O'Neill of New York, PC (860) 646-2469 ext. 3004 kmiller@fando.com
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2.0 INTRODUCTION

The following Quality Assurance Project Plan (QAPP) provides a framework for assessing the quality of data from the environmental sampling programs for the Hudson River Psychiatric Facility Landfill Area 6 site. This document will support all work performed by Fuss & O'Neill, for site investigations and other data collection efforts conducted for the Remedial Investigation Work Plan (RIWP), Remedial Work Plan (RWP), Alternatives Analysis Report (AAR), Remedial Action Work Plan (RAWP), environmental and facility site audits, and long-term environmental monitoring as necessary.

The format for this document was developed from the United States Environmental Protection Agency (US EPA) Brownfields Quality Assurance Project Plan Guidance Document and New York State Department of Environmental Conservation (NYSDEC) DER-10 Technical Guidance for Site Investigation and Remediation. This document defines the field and laboratory procedures to be used and contains several attachments including field sampling Standard Operating Procedures (SOPs), laboratory SOPs, and field sampling forms.

2.1 Site History and Description

The subject site, Hudson River Psychiatric Center Landfill Area 6, is located in the town of Poughkeepsie, New York. The site is located in the County of Dutchess, New York and is identified as a portion of Section 6163 Block 03 and Lot 011149 on the Dutchess County Tax Map. The site is the portion of the parcel known as Landfill Area 6. The site is situated on an approximately 2.5-acre area bounded by a gravel driveway and asphalt parking lot to the north and west, a stream to the south, and a former railroad bed to the east.

2.2 Project History and Description

A Remedial Investigation (RI) was performed to characterize the nature and extent of contamination at the site. The results of the RI are described in detail in the following reports:

> Remedial Investigation of Area 6 PCB Site at Hudson River Psychiatric Center Poughkeepsie, NY NYDEC ID No. 344063, prepared by Lawler, Matusky & Skelly Engineers, 1996.
>
> Landfill Characterization Investigation Report Areas 1, 2, 3, 5, 6, 7, and 8 Hudson River Psychiatric Center, Poughkeepsie, NY, prepared by EA Engineering, P.C. et al, January 2001.
>
> Landfill Closure Investigation Report Landfill Areas 1, 2, 3, 6 and 8 Hudson River Psychiatric Center, Poughkeepsie, NY, prepared by EA Engineering, P.C. et al, July 2002.
>
> Supplemental Closure Investigation Report, Hudson River Psychiatric Center Landfill Area 6, prepared by The Chazen Companies, March 2004.
>
> Supplemental Closure Investigation Report – Addendum, Hudson River Psychiatric Center Landfill Area 6, prepared by The Chazen Companies, July 2004.

Generally, the RI determined that Wastes located in Landfill Area 6 reportedly consist of municipal waste from the HRPC facility, coal ash from the heating plant, mixed construction debris from the HRPC facility, and potentially some municipal waste from the Town of Poughkeepsie (EA Engineering, 2001.) Two areas along the creek bank exhibit soils that have accumulated visible concentrations of leachate precipitate. The two areas total approximately 40 square feet. (Chazen, 2004) The site was remediated in accordance with the NYSDEC-approved Remedial Action Work Plan dated September 2004, the Addendum to Remedial Action Work Plan dated August 2009, the Interim Remedial Measures (IRM) Work Plan dated March 2008, and the Interim Remedial Measures (IRM) Work Plan Addendum dated July 2008. The Remedial Action is documented in the Final Engineering Report.

2.3 Plan Objective and Data Quality Objectives

This QAPP is designed to guide site-wide quality management of soil, groundwater, sediment, and waste sampling. Therefore, project descriptions of sampling locations, constituents of concern, analytical requirements, regulatory criteria, and data quality objectives will be developed in project-specific sampling plans.

The objective of this QAPP is to outline a structure for data quality such that the data collected will support decisions as well as to provide procedures for planning, implementing, and evaluating field sampling and analytical procedures.

The generation and use of quality data is important in the assessment of constituent impact on the site and, if necessary, in the selection of adequate responses to concentrations in soil, groundwater, sediment, or surface water. These data quality objectives will be documented following each sampling event on a Data Validation Completeness Checklist, included in *Appendix A*. The checklist will be an internal document which will be used to record key aspects of data quality thus ensuring that the data quality objectives are met.

Data quality objectives (DQOs) are stated qualitatively and quantitatively where applicable in the Work Plan for a site investigation or feasibility study. DQOs specify the required quality of data necessary to support decisions related to the program including site screening, characterization, assessment of health risk and, ultimately, to the remedial actions that may take place on site.

The basis of DQOs is that the quality of data is dependent upon the intended use of the collected data. DQOs are established based upon site-specific conditions and project objectives, and are applicable to all data collection activities.

Data quality objectives are developed through an evolving process, by which all the DQO elements are continually reviewed and re-evaluated to meet the overall project objectives. This process can be summarized in three stages as follows:

- Stage 1 defines the types of decisions which will be made during site remediation by identifying data users, evaluating available data, developing a conceptual model, and specifying goals for the project. Stage 1 results in identification of data gaps.

- Stage 2 identifies the data necessary to meet the objectives established in Stage 1. It also stipulates criteria for determining data adequacy. During Stage 2, sampling approaches and analytical options are evaluated to determine timely or cost-effective approaches.

- Stage 3 is the final design of the data collection program. The design of the data collection program results in the specification of the methods by which acceptable data will be obtained to make decisions.

3.0 SAMPLING DESIGN

3.1 Sampling Design Rationale

The goal of this project includes completion of the following primary tasks:

- Complete ongoing environmental monitoring according to the Site Management Plan

3.2 Number of Samples

This QAPP is designed to address site-wide quality management of sampling. The project-specific Site Management Plan provides the sampling rationale for the investigation, including the following tasks: sampling of environmental media, determination of constituents to be measured in each environmental media, sampling locations, sample depths and types, number and frequency of samples to be collected. The specific details of a monitoring plan, such as, sampling locations, target depths, analytical methods, and a reference map are detailed in the associated project-specific Site Management Plan.

3.3 Sampling Location

Proposed sampling locations will be identified in the Site Management Plan. The procedure outlined in the HASP will be followed before any soil borings or excavations with mechanized equipment commence.

4.0 SAMPLING AND ANALYTICAL PROCEDURES AND REQUIREMENTS

4.1 Sampling Procedures

The Standard Operating Procedures (SOPs) pertaining to sample collection (soil and water) and monitoring well installation are referenced in *Table 1* and included in *Appendix B*. These techniques and procedures conform to guidelines outlined in the EPA document "A Compendium of Superfund Field Operations Methods" and with NYSDEC "Division of Environmental Remediation Technical Guidance for Site Investigation and Remediation" (DER-10.)

4.1.1 Preventive Maintenance – Field Equipment

The SOPs pertaining to preventive maintenance of field equipment are referenced in *Tables 1 and 2* and included in *Appendix B*.

Field measurement equipment will be maintained in accordance with Fuss & O'Neill SOPs and manufacturer instructions. The field personnel will be responsible for confirming that equipment is operating properly during use by inspecting the instrument for physical damage and performing instrument performance checks. Problems encountered with field measurement equipment will be documented in the field logbook. An attempt will be made to correct problems with the instrument while in the field. If the instrument's problem is not remedied in the field, it will be taken out of service and replaced.

The field measurement equipment is inspected and cleaned on a daily basis prior to leaving Fuss & O'Neill. The field measurement equipment is calibrated daily or as otherwise recommended by the manufacturer. The calibration information is recorded on calibration forms which are kept at Fuss & O'Neill. The daily preventive maintenance checklist includes the following:

- Visual battery check of battery low indicator
- Replacement of batteries as necessary (spare batteries are kept on hand at Fuss & O'Neill)
- pH electrode is cleaned and calibrated on a daily basis and cleaned and re-calibrated after a noticeably dirty sample (full decontamination)
- Temperature is checked using a certified calibrated mercury thermometer and, if necessary, the sensor is replaced
- If the specific conductance electrodes are determined to be losing their platinum coating, the electrodes are replatinized according to manufacturer's instructions with 3 percent chloroplatinic acid and the instrument is then re-calibrated
- The conductivity electrode of the SC meter will be cleaned on a daily basis and cleaned and re-calibrated after a noticeably dirty sample (full decontamination)

4.1.2 Calibration – Field Equipment

SOPs for the calibration of field instruments to be used during this project are referenced in *Table 1* and included in *Appendix B*. Calibration frequency, acceptance criteria, and corrective action are included in *Table 3*.

Field instrument calibration is performed consistent with EPA Region I Draft Calibration of Field Instruments (EPA, June 1998) and in accordance with manufacturer's instructions. Groundwater sampling will include the measurements of pH, specific conductance, dissolved oxygen, oxidation reduction potential and temperature by portable field instruments. Soil samples will be screened using an Organic Vapor Monitor. Surface water sampling will include the measurement of pH, conductivity, and temperature by portable field instruments. Additionally, surface water will be monitored in-situ to determine the concentration of dissolved oxygen. Such measurements are conducted in the field because immediate or in-situ measurement produce sufficiently accurate results.

Field instruments will be calibrated before initial use. The instruments will be re-calibrated at the end of a daily sampling event. Calibration will be recorded in field log books. Calibration acceptance criteria for field instrumentation have been established by the respective instrument manufacturer. If a calibration check determines that any field instrument is outside of the criteria, the instrument will be re-calibrated. If a calibration cannot occur within the acceptance criteria a back-up instrument will be used.

4.2 Analytical Laboratory

Laboratory analyses will be scheduled based on historical information regarding potentially hazardous material disposal, previous site information, review of data objectives, and NYSDEC criteria. Specific parameters will be outlined in the Work Plan.

All sample analyses will be performed by a laboratory certified by the New York State Department of Health (NYSDOH). Standard sample analyses and reporting methods will follow NYSDEC ASP (Analytical Services Protocol, July 2005). In order to provide legally defensible data, selected analytical procedures will be used will be in accordance with the most recent NYSDEC ASP. Where applicable, CLP procedures may be specified in the Work Plan. Laboratory analytical parameters will be based on previous site information, as well as data quality objectives, and the applicable NYSDEC criteria. The sampling program and related analytical methods are documented in the SMP. Sample containers and preservation methods specified in NYSDEC protocols are summarized in *Table 4*.

4.2.1 Preventive Maintenance and Calibration

Preventative maintenance of analytical instrumentation is outlined in the QA documents of the subcontract analytical laboratory. The field operations leader shall ensure that all scheduled maintenance occurs as obligated.

The Laboratory's Project Manager will be responsible for the operation and calibration of all laboratory analytical instruments in accordance with the schedules and procedures specified by the NYSDEC ASP (Analytical Services Protocol, July 2005). The laboratory calibration procedures are addressed in the QA documents for the laboratory subcontractor.

4.3 Laboratory Data Package Deliverables

ASP Category B laboratory data deliverables will be obtained for the following types of samples:

- samples representing the final delineation of the nature and extent of contamination for a SC or RI;
- correlation samples;
- confirmation and documentation samples; and/or
- samples to determine closure of a system.

ASP Category A deliverables will be supplied for all other laboratory analysis. Validated field and laboratory data will be presented in a final report in the form of tables and/or figures. Data package deliverables from the contract laboratory will consist of the following elements:

- Cover letter/letter of transmittal signed by project manager of designee
- SDG narrative signed by project manager or designee

- Field and internal laboratory chain-of-custody records
- Data results sheets

4.4 Laboratory matrix spike and matrix spike duplicate results

- Laboratory control samples and control duplicate results
- Method blank results
- Surrogate recoveries
- Serial dilutions

4.5 Control and Disposal of Decontamination Materials

In general, Fuss & O'Neill is responsible for collecting, controlling, and staging hazardous material disposal for materials generated during field investigations. Disposal arrangements will be made for the client for particular work assignments, if required. Manifest signatures will not be made by Fuss & O'Neill personnel. Specific procedures for handling contaminated environmental materials and contaminated, disposable person safety equipment will be presented in the Work Plan, and/or the HASP.

Contaminated soils and water will be handled according to DER-10. This document describes alternatives for disposal and requirements for handling of these materials.

4.5.1 Soil Disposal

Drill cuttings and other soil generated on-site during an investigation from the installation of soil borings, monitoring wells or geoprobes are presumed to be contaminated. Such cuttings and spoil:

i. must be stored on protective sheeting and covered with protective sheeting if cuttings remain on ground at the end of the day;
ii. may be disposed at the site within the borehole that generated them to within 12 inches of the surface or if the site is a residential site backfilling may be to within 24 inches of the surface, unless:
    (1) free product, NAPL or grossly contaminated soil, are present in the cuttings;
    (2) the borehole will be used for the installation of a monitoring well (cuttings may only be used to backfill boreholes installed for soil sampling);
    (3) the borehole has:
        (A) penetrated an aquitard, aquiclude or other confining layer; or
        (B) extended into bedrock;
    (4) backfilling the borehole with cuttings will create a significant path for vertical movement of contaminants. Soil additives (bentonite) may be added to the cuttings to reduce permeability;
    (5) the soil cannot fit into the borehole.
iii. the borehole area must be restored, after backfill:
    (1) in unpaved areas, by placing 12 inches of cohesive, compacted soil meeting the requirements for fill over the area of the borehole, unless the site is a residential site in such case 24 inches are required; or

(2) for paved areas, by placing clean cohesive, compacted soil in the borehole to sufficient depth to allow restoration of the paved surface; and

iv. if the site includes streets, sidewalks or other publicly accessible areas, the off-site provisions should be applied to samples collected in those areas.

Drill cutting and spoil disposal from off-site locations not know to be contaminated are to be managed as follows:

i. cuttings, may initially be placed on plastic as generated,, but should be containerized as drilling progresses. Overnight storage outside of a container is not allowed. The cuttings may be transported from the point of generation to a temporary on-site storage area without a 6 NYCRR Part 364 permit;
ii. cuttings from off-site boring locations are considered non contaminated until testing indicates otherwise, unless field screening results of the soil are positive for the presence of contamination; and
iii. the borehole will be filled with soil or a soil bentonite mixture and restored.

Drill cutting and soil disposal from known contaminated locations. Representative samples of drill cuttings or other investigation disposal waste from known contaminated locations at a site or from off-site locations, must be characterized for disposal. Such samples must be analyzed to ensure proper classification, treatment and disposal and where determined to be:

i. hazardous waste or a solid waste, must be properly managed and disposed at a properly permitted treatment, storage or disposal facility. Such waste will:
   (1) be transported by a hauler permitted in accordance with 6 NYCRR Part 364;
   (2) if such cuttings and soil are determined to be a hazardous waste, the waste shipment shall be accompanied by a manifest in accordance with 6 NYCRR Part 372; and

   (3) any investigation disposal waste soil identified as either a solid or hazardous waste, may be stored on the site in a secure area awaiting disposal, in accordance with applicable DEC waste management regulations or other provisions approved by DER; and
ii. soil not characterized as a solid or hazardous waste may be placed at the site, or returned to the off site location where it originated, in a manner set forth in the DER-approved work plan.

When excavating test pits to delineate the extent of contamination, the soil removed from the excavation is to be managed as follows:

i. any drums or other containers encountered, as well as NAPL or other free product, will be over packed or otherwise containerized for appropriate off-site disposal;
ii. where subparagraph i above does not apply, material removed may be placed back in the excavation in the same general strata from which it was removed; and
iii. the excavation shall be managed so as not to contaminate the surface of the site, all soil removed will be placed on plastic.

4.5.2 Groundwater Disposal

All water/fluid resulting from well development and/or well purging before sampling must be collected, handled and discharged/disposed of pursuant to applicable guidance and regulations. Water/fluid generated during an investigation:

i. is to be containerized upon production and is to subject to the following handling/disposal guidelines:
   (1) 6 NYCRR Part 364 will not apply to the transport of the containers from the point of generation to a temporary on-site storage area, or treatment facility;
   (2) the containers must be securely staged, pending appropriate disposal as set forth in subparagraph ii below;
   (3) NAPL shall never be released to the ground;
   (4) where containers include water mixed with NAPL, the water can be decanted from the NAPL (or vice versa) as long as a measurable layer of water remains with the NAPL, and the decanted water is NAPL- and/or sheen-free;
   (5) groundwater from several monitoring wells may be combined provided they are associated with the same disposal site and aquifer; and
   (6) NAPL may be collected from several containers and combined provided it all comes from monitoring wells associated with the same disposal site;

ii. it may be stored on-site in labeled containers in an area with secondary containment awaiting treatment and/or disposal, in accordance with applicable DEC waste management regulations (e.g., 6 NYCRR Parts 360, 364 and the 370 series) or other provisions approved by DER. The contents of the containers will be:
   (1) properly treated or disposed of, when any of the following are observed:
      (A) visual evidence of contamination, consisting of discoloration, sheens, free product or NAPL;
      (B) olfactory evidence of contamination; or
      (C) concentrations of contaminants above groundwater standards at levels of concern are known to be present in the monitoring wells, based on previous sampling of the groundwater; or
   (2) if none of the conditions described above apply, the containerized water may be:
      (A) recharged to unpaved ground into the same groundwater unit, within or directly adjacent to a source area in a manner which does not result in surface water runoff, with DER approval; or
      (B) if a remedial treatment system designed to treat water is operational at the site the water may be added to the influent of the treatment system; and
   (3) treatment or disposal of contaminated water/fluids will be at:
      (A) a permitted off-site facility;
      (B) an existing on-site permitted facility or a remedial treatment facility capable of treating the water/fluids, if one exists; or
      (C) an on-site treatment unit brought to the site, properly designed to handle the water/fluids, where a permit waiver pursuant to section 1.10 has been granted by DER; and

iii. Sediment that settles out of the IDW, provided there is no NAPL or free product present, must be handled and disposed in accordance with section 4.5.1, as appropriate for the location of the well.

5.0 SAMPLE HANDLING AND CUSTODY REQUIREMENTS

5.1 Documentation of Field Activities

All field personnel will carry a bound, water-resistant field notebook in which to record observations during field activities, regardless of whether or not those activities involve sample collection. The field notebook will document site-specific information such as:

- Project name and location
- Time and date of arrival at the site
- Sampling locations and corresponding sample numbers
- Conversations with individuals on site
- Any unusual events or observations
- All information not recorded on field data sheets
- Time of departure from the site

For field investigations that involve the collection of samples, additional forms of documentation are required. These additional forms are discussed in the following sections.

5.2 Sample Identification

Each sampling location will be assigned a unique number by which samples can be identified. An example of a sample identification number is as follows:

402040401-01

This 11-digit code contains three types of information about the collection of the sample. The first three numbers in the code represent the identification number of the individual who collected the sample or supervised the sampling event. This is followed by the year, month and day of sample collection. The last two numbers refer to the site sampling order. If necessary, the number can be expanded to three digits; this should be determined before sampling begins in order to assure that all samples have the same format.

Samples collected at one time from the same sample location will have the same sample identification number. Some common situations are listed below:

- Multiple containers required for various analytical parameters

- Sampling events which require the sample to be submitted to two or more laboratories, as in the case of a split sample discussed below.

- Sampling events that require sampling at the same location over two or more days due to insufficient sample volume available per day.

5.3 Sample Location Identification

Each sampling location will be assigned a unique identifier (site ID). The Site ID will be recorded on the field data form in addition to the sample number and will primarily be used for graphical display of sample results as well as internal data handling.
In general, the Site ID will consist of a one- or two-letter prefix referring to the type of media sampled and a serial number indexing the sampling location. The following prefixes will be used for the indicated sampling media:

SB	Soil Boring
MW	Sampling Well or Monitoring
PZ	Piezometer
RP	River Piezometer
SD	Sediment
SS	Surficial Soil
SW	Surface Water
SV	Soil Vapor
IA	Indoor Air
OA	Outdoor Air

Sample locations within each class of sampling media will be assigned a two- or three-digit serial number in the order in which they are sampled. Examples of sample location IDs are as follows:

SB-01, SB-02, SB-03	Soil boring locations 01, 02, and 03
SD-12	Sediment sampling location 12
MW-01, MW-02	Groundwater sampling wells 01 and 02

Samples collected at multiple depths at the same location will have the same sample location ID. The depth or range of depths at which samples are collected will be recorded on the appropriate field data forms and chain-of-custody forms. Sample depth information will also be included on data tables.

5.4 Sample Labels

A sample label will be affixed to each sample container at the time of collection. The following information will be recorded on each label with waterproof ink:

- Sample identification number
- Client/project name
- Project location
- Project number
- Date of sample collection
- Time of sample collection
- Name of sample collector
- Sample location
- Type of preservation
- Analysis to be performed

An example of a sample label is included in *Appendix B*.

Field Data Forms

Samples will have a field data form documenting their collection. This record will be completed by field personnel at the time of sample collection. Examples of sampling field data forms are provided in *Appendix B*.

5.5 Chain-of-Custody Records

Control of samples shall be maintained at all times. The chain-of-custody will be used to document all transfers of the sample between the sample collector and the laboratory. The form, consisting of four copies, will include the following information:

- Chain-of-custody identification number
- Project/client name
- Project location
- Project number
- Laboratory conducting analysis
- Name/location of party to receive laboratory report
- Name/location of party to receive laboratory invoice
- Sample identification number
- Sample type
- Number and type of sample containers
- Type of preservatives
- Signature and affiliation of sampler
- Date and time of collection
- Signatures of people involved in chain of possession
- Dates and times of sample transfers

The samples will remain in the custody of the sample collector until that person relinquishes them to the laboratory or sample delivery person. To reduce the potential for sample tampering, coolers will be shipped to the laboratory with chain-of-custody seals on the edges of the cooler between the lid and the sides. One copy of the chain-of-custody record will be retained by Fuss & O'Neill personnel, while the original and two copies will be relinquished with the samples. A completed record will be returned to Fuss & O'Neill with the sample analysis report. An example chain-of-custody form is presented in *Appendix B*. Copies of all shipping papers will be retained by the sampler.

5.6 Sample Containers and Preservation

Samples will be collected in lab-supplied containers. The type of container utilized will depend upon the analysis to be conducted as indicated in *Table 4*. Note that the preservatives listed in each table apply only to aqueous samples, and not to solids or sediment samples. Containers will be pre-cleaned and certified clean (I-Chem 300 or equivalent).

For aqueous samples, containers will be pre-preserved by the laboratory in accordance with SW-846 standard methods. The pH of the samples will be verified in the field by pouring a small amount of the sample onto a piece of pH paper. If the pH is not at the appropriate level, additional preservative, as supplied by the laboratory, will be added to the container.

Liquid samples collected for volatile organic analyses will be preserved with HCl to a pH < 2. Any acid utilized for preservation will be added to the VOA vial before the sample is collected to ensure that adequate mixing occurs. VOA vials will not be reopened in the field once properly sealed.

Once the samples have been collected and labeled, they will be placed in a cooler to reduce the sample temperature to less than 4°C. Sample temperature upon reaching the laboratory is dependent on how much time has passed since the sample was collected and placed in the cooler. It is possible that the time between sample collection and delivery to the laboratory may not be long enough for the sample to reach 4°C. Generally, samples will be transferred and stored by Fuss & O'Neill in a refrigerated environment (maintained nominally at 4°C) until they are relinquished to the contract laboratory.

5.7 Sample Custody at the Laboratory

Samples for analytical chemistry will be delivered to the contract laboratory for this project. An internal chain-of-custody form will be generated as the samples are assigned locations within the specific laboratory. Procedures for sample log-in, internal sample tracking and sample disposal at the contract laboratory are outlined in the QA documents of the contract laboratory.

6.0 QUALITY CONTROL REQUIREMENTS

Quality control (QC) checks will be performed to ensure the collection of representative and valid data in accordance with the NYSDEC RCRA Quality Assurance Project Plan Guidance dated March 29, 1991. QC checks provide the mechanisms by which the quality assurance objectives are monitored.

6.1 Field Quality Control

QA/QC samples submitted to the laboratory will include equipment blanks, trip blanks and field duplicates. The purpose of these samples is to confirm that laboratory results reflect the condition of the various media in the environment and are not the result of poor sampling or laboratory technique. Additionally, duplicate samples will be collected in order to check the accuracy of the laboratory, also detailed below.

Each QA/QC sample will be given its own sample code. The identity of these samples will be withheld from the laboratory conducting the analysis. When more than one QA/QC sample is submitted with a set of samples, they will be interspersed within those samples so that they are not easily identifiable by the laboratory.

6.1.1 Equipment Blanks

Equipment blanks will be collected for sampling events in which non-dedicated sampling equipment is used. Equipment blanks may be obtained from equipment that has a potential to come into direct contact with samples. Equipment blanks are generally obtained from sampling equipment which is decontaminated between sample locations.

Blanks are prepared in the field during the sampling event. Laboratory-supplied deionized water is run through the decontaminated equipment which has been utilized during sampling. This water will then be transferred from that piece of equipment to the sample container.

Equipment blanks will be analyzed for the same parameters as samples collected with the piece of equipment used. For most parameters, the sampling device is the only piece of equipment that comes into contact with the sample. The frequency of equipment blank collection will be approximately one per 20 samples by piece of equipment.

For sampling events in which bailers are used, the following procedure will be followed for the collection of equipment blanks. Dedicated stainless steel bailers will be used to collect VOCs. The bailers are decontaminated at the Fuss & O'Neill office between each use. Organic-free deionized water, provided by the laboratory, will be run through a bailer and the rinsate collected in a clean laboratory-supplied container. The rinsate is submitted as a sample, blind to the laboratory, along with the groundwater samples and analyzed for the same analyses. One equipment blank will be prepared and submitted for each bailer sampling event.

6.1.2 Trip Blanks

Trip blanks for VOCs will be obtained for each day of sampling to determine whether samples have been exposed to contamination as a result of sample container handling or transport. Trip blanks will be submitted and analyzed only if VOCs make up a portion of the analyte list on the day of sampling. The blank will be prepared by the laboratory and will accompany the sample containers from the time they leave the lab until the time they will be returned to the lab as a sample. The trip blank sample is labeled as a sample and submitted blind to the laboratory for analysis.

6.1.3 Duplicate Samples

Duplicate samples for analysis will be collected for groundwater, surface water, soil gas, soil, and sediment samples to check the precision of the laboratory analysis. Duplicate samples will be collected at the same time as the original sample and will be analyzed for the same parameters. The duplicate sample will be assigned a different sample number than the original set so that the sample identity is blind to the laboratory. One duplicate sample by matrix will be collected nominally per 20 samples submitted to the laboratory. For groundwater and surface water samples, sampling will be in the order of decreasing parameter volatility by alternating between containers in the original set and those in the duplicate set.

6.1.4 Field Sample Control Limits

The standard Fuss & O'Neill field sample control limits for quality control are specified below. If the control limits are not met, the Quality Assurance Officer (QAO) will investigate the cause of the exceedance and determine the validity of the associated data.

Quality Control Sample	Control Limit
Trip Blank	Less than detection limit*
Equipment Blank	Less than detection limit*
Field Duplicates	± 30% Percent Difference for Water; Acceptable Percent Difference will be equal to Matrix Spike Recovery Values for Matrices other than Water **

* With the exception of common laboratory contaminants of acetone, 2-butanone, methylene chloride, phthalates and toluene which will have a control limit of 5X detection limit.

** Discrepancies will be addressed on a case-by-case basis.

6.2 Laboratory Internal Quality Control

Data from QC samples (e.g., blanks, spiked samples) will be used as a measure of performance and as an indicator of potential sources of cross-contamination. All quality control data and records will be submitted to the data validator. Laboratory analytical quality control will be in accordance with the requirements outlined in the NYSDEC RCRA Quality Assurance Project Plan.

7.0 DATA MANAGEMENT AND DOCUMENTATION

7.1 Introduction

This section defines the specific policies, organization, and procedures related to data management. The Data Management System that is being used for the electronic data management is the GIS/Key™ system. GIS/Key™ is a comprehensive environmental data management and visualization system that satisfies State and Federal reporting requirements by integrating database information, graphics, and analysis tools.

7.2 Data Classes

Many different classes of data may be generated during site investigations. Data generated include documentation of field activities, paperwork associated with environmental samples and investigations, and analytical data. The data classes in this section include:

- Field Logbooks
- Sample Identification Numbers
- Field Data Forms
- Fuss & O'Neill Sample Logbook
- Refrigerator Logbook
- Chain-of-Custody
- Analytical Data
- ArcView™ Drawings
- AutoCAD Drawings

7.2.1 Field Logbooks

Field logbooks will be utilized by field personnel to document field activities. Fuss & O'Neill logbook practices are standardized and Fuss & O'Neill field personnel are familiar with these standards.

7.2.2 Sample Numbers

Every sample collected will be assigned a unique sample number by which it can be identified. Details of the sample number format are discussed in Section 6.2.

7.2.3 Sample Location Identification

Each sampling location will be assigned a unique identifier (Site ID). The Site ID will be recorded on the field data form and in the field logbook, in addition to the sample number. Sample location IDs will primarily be used for graphical or tabular presentation of sample results as well as for internal data handling.

7.2.4 Field Data Forms

Field data forms will be utilized to record information pertinent to the type of field activity being conducted. Each sample will have a field data form documenting its collection. The field data form will be completed by field personnel at the time of sample collection. Example field data forms are provided in *Appendix B*.

7.2.6 Fuss & O'Neill Sample Logbook

The Fuss & O'Neill sample logbook serves as a central repository of general information on all environmental samples collected by Fuss & O'Neill personnel. The sample logbook is located in Environmental Field Services office area. Samples collected in the field which are relinquished to a fixed laboratory will be recorded in the sample logbook. Information recorded in the logbook includes sample number, job number, job name, sample location ID, laboratory, date relinquished, and date received.

7.2.7 Chain-of-Custody

The Chain-of-Custody (COC) serves as a record of control of samples. The COC will be used to document all transfers of a sample between personnel, coolers, refrigerators, etc., from the point of collection to the point of receipt by a laboratory. A sample Chain-of-Custody is provided in *Appendix B*.

7.2.8 Field Data

Field data collected will be entered into a data management system. Further discussions of field data management are provided in Section 8.3.1 - Field Documentation.

7.2.9 Analytical Data

Analytical data generated by the contract laboratory will be entered into a data management system. Data generated for field screening may be entered into the data management system at the discretion of the Project Manager. Further discussions of analytical data management are provided in *Section 8.3.2* - Internal Data Management.

7.2.10 AutoCAD Drawings

AutoCAD drawings produced for the project are electronically filed on two separate network servers. An example directory structure is for an AutoCAD drawing is J:\DWG\P2004\0453\A12 and all associated subdirectories.

7.2.11 Graphical Outputs

An original copy of all graphical outputs, i.e. line graphs, bar graphs, three-dimensional graphs will be stored in the appropriate correspondence file.

7.3 Data Administration

Data administration as outlined below describes the flow of data, the plan for handling and presenting data and the internal data quality measures that will be implemented prior to final data output to tables, graphics and electronic output to other programs.

7.3.1 Field Documentation

The three sources of field data are the Chain-of-Custody, Field Data Forms, and the Field Log.

7.3.1.1 Chain-of-Custody

The COC will be generated in the field and travels with any environmental sample from the point of collection. When the samples leave the custody of field personnel, the field personnel will relinquish them (to refrigerator, cooler, other personnel or the laboratory). The orange copy of the COC will be retained by the personnel relinquishing the sample(s). The yellow copy will then be returned to the project hydrogeologist or engineer after sample are relinquished to the labs and attached to the field data forms and forwarded to the project staff.

7.3.1.2 Field Data Forms

Field data forms are typically generated in the field and completed by field personnel. Field data forms will be relinquished on a daily basis to the project staff, who will perform a completeness review of the forms.

7.3.1.3 Field Logs

The field log is utilized throughout the day by field personnel. The field log will then be photocopied and the copy will be attached to the field data forms and forwarded to the project staff. Field logs, when full, will be archived in the Environmental Field Services area.

7.3.2 Internal Data Management

The following section describes data management, once field sampling has occurred.

7.3.2.1 Field Sampling Data

Once field sampling has occurred, all field data forms (including field staff logbook copies) will be forwarded to the Project Hydrogeologist or Engineer, who will review the field data for accuracy and completeness. If any field data forms are incorrect or incomplete, they will be returned to field personnel for completion.

7.3.2.2 Original Laboratory Data

When original laboratory data is received by the Project Hydrogeologist or Engineer, it will be reviewed for accuracy and completeness. Accuracy and completeness, as defined herein, means that the requested parameters were appropriately analyzed and that the Fuss & O'Neill sample numbers, date collected, date received, etc. are correctly identified on the laboratory report. Fuss & O'Neill may request that the laboratory deliver its report electronically by email or CD ROM, along with a hardcopy of the report.

7.3.2.3 Data Management System (DMS) Data Entry

Once the field and laboratory data have been reviewed by project staff, the data will be submitted to the DMS operator to be entered into the DMS. Field data and laboratory data can be submitted and entered into the DMS independently of each other or together. For instance, it may be desirable to view groundwater contours immediately after a round of water levels prior to the receipt of laboratory data. In this case, field measurements will be entered into the DMS and a groundwater contour map produced. Once analytical data are received, data entry will be independently scheduled for entry into the DMS.

7.3.2.4 Query Requests

Query requests (questions asked of the database with resultant output) can be made at the time the data is submitted to the DMS operator for data entry into the DMS. Queries can be performed by most Fuss & O'Neill personnel once data entry is complete. Typical queries are described in *Section 8.4*.

7.3.2.5 Database Verification

Once data entry is complete, a verification of the data will take place. This verification process will involve an individual visually comparing a hard copy of field data forms and the laboratory analytical report with a hard copy printout of data from the data management system. This process will ensure that data has been accurately keyed/imported into the data management system prior to utilizing the data for analysis/interpretation. This verification is not indented to meet data validation requirements established by the NYSDEC.

7.3.2.6 DMS Output for QA Interpretation

Once data entry and verification have been completed, a series of reports is available to evaluate data quality and to aid in data interpretation. The type of reports to be developed would be a function of the nature of the field investigation. These reports could include, but are not limited to:

- Analytical data summaries
- Exceedances of applicable Maximum Contaminant Levels (MCLs) and Action Levels
- Values that are outside of historical ranges

Project staff, in conjunction with data management staff, will evaluate these reports to identify any anomalous data, outliers and QA/QC sample integrity. Once this data review has occurred, any necessary corrective action steps will be taken.

Once the data review process has been completed, the original field data forms and analytical laboratory reports will be stamped with a "DMS" stamp and initialed by the person who conducted the verification of the data. The original data will then be filed in the job correspondence file.

7.4 <u>Data Presentation</u>

Data presentation must occur in a clear and logical format to accurately interpret and evaluate field and analytical data collected. Types of data that will be provided from the data management system include tabular data presentations, graphical data presentations, contour maps, geological cross sections, section view isopleths and three dimensional graphics.

EDD will be submitted to the NYSDEC for any future groundwater, sediment, and/or imported fill sampling performed at this site. Data submitted to the NYSDEC shall be in the NYSDEC-approved EDD format. EDD should be submitted on a continuous basis immediately after data validation occurs but in no event more than 90 days after the data has been submitted to the Volunteer or its consultant.

8.0 PERFORMANCE AND SYSTEM AUDITS

Performance and system audits are a qualitative evaluation of all of the components of the sampling program to ensure proper implementation and usage of the intended data gathering and associated QA/QC procedures. Internal assessments and response actions may be presented in letter reports or attached as an appendix in the final report.

All activities must be properly documented including: sampling procedures, decontamination activities, chain-of-custody procedures, equipment calibration, and justification for all actions taken contrary to the approved QAPP and Work Plan.

The person designated as the Quality Assurance Officer will check that the QAPP is being implemented. The Project Manager may designate the Project Hydrogeologist/Engineer as the QAO or the role may be filled by another individual who has experience in that capacity. Performance evaluations and audits are conducted routinely as part of the Data Management Plan explained in Section 8. The QAO or appropriate designee examines sample log books, field instrument calibration logs, and field data forms for accuracy and completeness.

8.1 System Audit

System audits will be performed to ensure that the QA/QC procedures are being followed. These audits include a careful evaluation of both field and laboratory control procedures.

Organization and Personnel – The project organization is reviewed for compliance with the proposed organization and for clarity of assigned responsibility. Personnel assigned to the project will be placed so that responsibility, skill, and training of the personnel are properly matched.

Facilities and Equipment – The audit will address whether field equipment and analytical instruments are meeting requirements specified by the project objectives stated in the Work Plan. Equipment and facilities provided for personnel health and safety may also be evaluated. Calibration and documentation procedures for instruments will also be verified.

Analytical Methodology – A review of analytical methodology with regard to the data requirements for the project will be performed. An on-site observation of analyst technique, data reduction, and record keeping may be performed if determined necessary. Periodic review of precision and accuracy of data will be performed.

Sampling and Sample Handling Procedure – An audit of scheduled samples versus samples collected versus samples received for analysis may be performed. Field documentation may be reviewed. If deemed necessary, a site visit will be made to document that designated control procedures are practiced during sampling activities.

Data Handling – During a system audit, the QAO will review data handling procedures with the TLs. Accuracy, consistency, documentation, and appropriate selection of methodologies will be discussed.

8.2 Field Systems Audits

Field systems audits will be performed by QA personnel to compare field practices with standard procedures. These audits will focus on such things as:

- Compliance with site-specific Work Plan and SAP
- Field equipment is in proper working order
- Documentation procedures
- Field team efficiency
- Level of QA conducted by field members
- Proper sample packaging and shipping

8.3 Laboratory Systems Audits

A laboratory systems audit will be conducted, as appropriate, to ensure that measurement systems are properly maintained and used. Laboratory records and procedures may be reviewed for completeness, accuracy, precision, and adherence to prescribed methods.

8.4 Field Performance Audits

Field performance audits will be conducted by QA personnel on an ongoing basis during the project as field data are generated, reduced, and analyzed. Field performance audits may include: review of numerical manipulations and review of blank and replicate samples.

8.5 Laboratory Performance Audits

Laboratory performance audits will be conducted, as appropriate, and may include:

- Verification of written procedures and analyst's understanding
- Verification and documentation of procedures and documents
- Periodic unannounced inspections, if warranted

- Review of a portion of all analytical data and calculations

9.0 DATA REDUCTION AND VALIDATION

Data will be validated using the NYSDEC ASP Revision 6/2005 and the USEPA Region II Functional Guidelines. The details supporting an independent validator's selection, describing how the individual is independent from the project, will be set forth in the Work Plan or other supplementary documentation.

9.1 Data Reduction

Data reduction is the conversion of raw data into a useful form from which conclusions can be made and presented. Raw data may consist of field data, which are real-time measurements, and technical data, which includes field and laboratory analytical data. The site-specific Work Plan will identify the data reduction scheme planned on all collected field and technical data and include all equations used to calculate the concentration or value of the measured parameter, the units that will be reported with the measurement value, and any MS spectrum matching procedures that will be followed for program qualification measurements by GC/MS.

9.2 Data Validation

Data validation is the process of reviewing data and accepting it or rejecting it on the basis of sound criteria. The objectives of data validation are to:

- Assess and summarize the analytical quality and defensibility of data for the end user

- Document factors contributing to analytical error that may affect data usability, such as: data discrepancies, poor laboratory practices that impact data quality, site locations for which samples were difficult to analyze

- Document any "sampling error" that may be identified by the data validation process, such as contaminated trip or equipment blanks, incorrect storage or preservation techniques, improper sampling containers, and improper sampling techniques

Records of all data will be maintained, even those judged to be "outlying" or spurious values. The principal criteria that will be used to validate the integrity of the data during collection and reporting should be modeled from the following EPA guidance documents:

- "National Functional Guidelines for Organics Review", (USEPA, June 1991)

- "Laboratory Data Validation, Functional Guidelines for Evaluating Inorganic Analyses" (USEPA, October 1989)

- "Analytical Service Protocol" (NYSDEC, June 2005)

9.2.1 Field Data Validation

Field data will be validated at the time of collection by following standard procedures and QC checks and after the data is reduced to review data sets for anomalous values. The objectives of field data validation are listed as follows:

- Adherence to approved site-specific plans

- Standard operating procedures are followed

- Sufficient sample volume is obtained, sample integrity is maintained, all required analyses are conducted, and all applicable field QC samples are provided with each sample set

- Complete chain-of-custody documentation is maintained throughout the duration of the field effort

- Minimize data consistency between field personnel by random checks or sampling and field conditions by supervisory personnel

9.2.2 Laboratory Data Validation

Data validation at the laboratory will be performed by qualified individuals appointed by the analytical laboratory. Data validation will involve routine audits of the data collection and flow procedures and monitoring GC sample results. Results from the analysis of project and blind audit QC samples will be calculated and evaluated as reported. Immediate corrective action will be taken if these results indicate data quality problems.

9.2.3 Independent Validation

The QA officer or his designee independent from the laboratory will be responsible for validating the laboratory data. Quality control issues will be discussed in the usability assessment and the QAO will recommend the use or rejection of the data. Ultimately, the project manager will determine the usability of the data based on an understanding of the project data quality objectives and the results of the data verification process. The results of the usability assessment will be summarized in a Data Usability Summary Report (DUSR). Details supporting the validator's selection, describing how the individual is technically qualified to do the validation and independent from the project, will be presented in the Work Plan. Validation will be performed according to criteria such as:

- holding times
- instrument tuning and performance
- calibration
- blanks
- surrogate recoveries
- matrix spike and matrix spike duplicate recoveries

Quality control checks and analytical procedures will be evaluated through an assessment of the precision, accuracy, completeness, representativeness, and comparability of the data set as defined in *Section 10.3*. Data validation will be performed on fixed-based laboratory results only; however, as a due diligence check, samples analyzed by Fuss & O'Neill using screening procedures will also be subjected to the completeness checklist presented in *Appendix A*.

9.3 Evaluation Criteria

9.3.1 Precision

Precision, which is defined as a measure of mutual agreement among individual measurements of the same property, can be described as reproducibility. In the case of laboratory analytical data, precision will be used to describe the reproducibility of the analytical data.

Field Measurement Systems

To assess precision in the field, a duplicate sample will be collected nominally for every 10 samples per matrix for all parameters. The collection of field duplicates measures a combination of field and laboratory precision, thereby exhibiting more variability than a laboratory duplicate. Calculation to determine Relative Percent Difference (RPD) between the two sample results is performed. RPD is used as a measure of precision. The laboratory will analyze duplicates on a one per 10 frequency, per matrix. Recovery limits are matrix and compound dependent.

RPD is defined as follows:

$$\frac{\left|Conc(p) - Conc(d)\right|}{(\frac{1}{2})(Conc(p) + Conc(d))} \times 100 = RPD$$

where,

- Conc(p) = Primary Sample Concentration, the first sample collected at that location
- Conc(d) = Duplicate Sample Concentration, the second sample collected at that location

For water sample analysis, the percent difference goal for the field will be 30 percent. For matrices other than water, however, there are no established percent difference goals; therefore, as a guide for sample analysis of other matrices, the percent difference goal for the field will be equal to the matrix spike percent recovery values. If a percent difference result falls outside the guidance range, the discrepancy will be addressed on a case-by-case basis since the results are laboratory, parameter, and matrix dependent.

Laboratory Measurement Systems

The objective concerning precision is to equal or exceeds the precision demonstrated in the analytical methods on samples of similar matrix. RPD is used as a measure of precision. The laboratory will analyze matrix spikes/matrix spike duplicates on a one per 20 frequency, per matrix. Recovery limits are matrix and compound dependent.

RPD is defined as follows:

$$\frac{\left| MSR - MSDR \right|}{(\frac{1}{2})(MSR + MSDR)} \times 100 = RPD$$

where,

- MSR = matrix spike recovery
- MSDR = matrix spike duplicate recovery

The absolute value of the recovery difference is used in the above equation.

For organic analysis, the laboratory will be spiking with the matrix spike compound list and utilizing the recovery limits defined in the analytical SOPs. Inorganics utilize the recovery limits defined in the analytical SOPs.

9.3.2 Accuracy

Accuracy can be defined as the degree of agreement of a measurement with an accepted reference or true value. Accuracy is generally expressed as the ratio of the measured value to the true value, which gives a measure of bias inherent in the system. Accuracy can be assessed both in the field and in the laboratory. The data validation completeness checklist in *Appendix A* will be used to document the field calibration and laboratory calibration for each sampling event.

Field Measurement Systems

Accuracy will be measured for field activities to assess the correct performance of the project measurement systems. Before initial use, the instruments will be calibrated to a known standard. Additionally, at the end of a daily sampling event, the instruments will be calibrated with a known control to assess the accuracy of field measurement systems. The calibration acceptance criteria are defined in *Table 3*.

Laboratory Measurement Systems

The laboratory accuracy will be determined from spiked sample recoveries, published historical data, method validation studies, experience with similar samples, and project specific requirements. The goal for spiked sample recoveries will be the concentrations published in SW-846 Guidance Document. These concentrations vary from one compound to another.

Field Screening for Lead in Soil

Accuracy of the lead field screening analysis using an XRF will be addressed by performing daily control analyses as a method calibration.

9.3.3 Completeness

Completeness is a measure of the amount of valid data obtained from each sampling event, compared with the amount which was expected to be obtained under correct conditions. A goal of 95 percent completeness of valid analytical results will typically be set for all samples collected. The completeness of the sampling data set can be evaluated as a percentage of the number of valid analytes to the total number of expected analytes.

The equation for determining the completeness of analytical results will be:

$$\frac{(Total\ Number\ of\ Valid\ Results)}{(Total\ Number\ of\ \ Results)} \times 100 = Completeness$$

Completeness of analytical results will be evaluated by analytical method.

If analytical data completeness is below 95 percent due to laboratory or field error, corrective action will consist of evaluation of the results in question as they pertain to the sampling program and possible re-sampling.

Data completeness for field measurement systems will be set at 100 percent. If an instrument fails, a back-up instrument will be used.

9.3.4 Representativeness

Representativeness is defined as the degree to which data accurately and precisely represent a characteristic of a population. This can be stated as how well the chosen sampling points represent the actual conditions and variations within the study area. For example, if a batch of samples was broken in transit to the laboratory or the samples were compromised in some fashion at the laboratory, a representative sampling event may not have occurred. If this were the case, the need for a resampling event would be considered.

Data representativeness of both field and laboratory systems will be addressed through field and analytical procedures. Trip blanks will be evaluated for detectable contaminant concentrations. If contamination is present in the blank samples, the representativeness of the concentration in the sample media may be affected. Representativeness in laboratory measurement systems will be addressed by the Project Hydrogeologist or other qualified personnel who will record that the laboratory is using the proper analytical procedures and meeting holding times.

9.3.5 Comparability

Comparability is an expression of the confidence with which one data set can be compared to another. The comparability objective is to collect and analyze samples in a method which will address that the data are comparable to data collected in previous and future investigations for this study area. The comparability of data is addressed by using standard protocols for the collection of field samples and by using standard methodologies for analytical procedures which were used in past investigations. If, for instance, it is determined that the laboratory used a different method than one specified, an evaluation will occur and document whether this compromised the comparability of data.

10.0 DATA MEASUREMENT ASSESSMENT PROCEDURES

The purpose of data quality assessment is to document that data generated under the program are accurate and consistent with project objectives. The quality of data will be assessed based on the precision, accuracy, representativeness, comparability, and completeness of the data that are generated. Data quality assessment will be conducted in three phases:

Phase I: Prior to data collection, sampling, and analysis procedures are evaluated in regard to their ability to generate the appropriate, technically acceptable information required to achieve project objectives.

Phase II: During data collection, results will be assessed to ensure that selected procedures are efficient and effective and that the data generated provide sufficient information to achieve project objectives. In general, evaluation of data will be based on performance audits, results of duplicate and spiked sample analyses, and review of completeness objectives.

Documentation may include:

- number and identity of duplicate samples collected
- number and identity of duplicate, spike, and field blank samples analyzed
- identification of statistical techniques, if used
- use of historical data
- identification of analytical method
- data validation results

Precision is generally expressed as the relative percent difference (RPD) among duplicate analyses. Accuracy is generally expressed as percent recovery. Precision and accuracy of instrumental analysis is further addressed in the NYSDEC ASP and the Laboratory QAPP. It is the laboratory's responsibility to attempt to identify the source of substandard recoveries and either take corrective action or document the cause as required by the NYSDEC ASP.

Phase III: Following the completeness of data collection activities, an assessment of the adequacy of the database generated in regard to completing project objectives will be undertaken by the Project Manager and/or the Technical Reviewer. Recommendations for improved QC will be developed, if appropriate. If data gaps are identified, additional raw data collection may be recommended to fully support the project findings and recommendations.

11.0 CORRECTIVE ACTIONS

Corrective actions are QA/QC problem-solving measures taken to rectify a laboratory or field measurement system that is out of control. Corrective action is required when potential or existing conditions are identified which may adversely affect the data quality. The need for corrective action may be identified by system or performance audits or by standard QC procedures. The corrective action system will include the following procedures:

The Project Manager will be immediately notified of any potential problem with the data quality, and will then evaluate the need for changes in affected procedures and conduct appropriate corrective actions. Potential data quality problems may include:

- Loss of a sample or damaged sample containers
- Analytical results that are substantially different from those expected
- Laboratory QC samples that do not attain target performance objectives
- Events that may require changes in specifications and sampling procedures

Corrective action related to questionable analytical results or damaged sample containers may include resampling and re-analysis, if appropriate. Modification of procedures may be necessary to remedy problems related to unexpected conditions encountered in the field.

12.0 QUALITY ASSURANCE REPORTS TO MANAGEMENT

The Project Manager will submit periodic QA reports for appraisal by management, appropriate to their level of responsibility. Reports to management will include:

- Periodic assessment of measurement data accuracy, precision, and completeness
- Results of performance and system audits
- Significant QA/QC problems and recommended solutions
- Resolutions of previously stated problems

12.1 Field Quality Assurance Reports

Status reports describing the progress of the project will be submitted periodically to management. These reports will include: copies of field notes or daily field progress reports, complied field data sets, and corrective action documentation. The Project Manager will be notified immediately of situations requiring corrective action measures.

12.2 Laboratory Quality Assurance Reports

A project QA report that summarizes QA activities and QC data will be issued to the QA Manager and Project Manager. This may addressed in project narratives with each sample delivery groups. Any laboratory QA situations requiring immediate corrective action will be reported to the Project Manager.

13.0 REFERENCES

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TABLES

Table 1
Fuss & O'Neill Standard Operating Procedures

SOP # and Appendix Reference	Project Sampling SOPs
010000	Site Etiquette
020000	Field Activity Documentation
030000	Sample Handling
040000	Decontamination Procedures
050000	Groundwater Monitoring
060000	Surface Water Sampling
070000	Sediment Sampling
080000	Soil Sampling
090000	Soil Vapor and Indoor Air Sampling
100000	Drilling Operations
110000	Direct Push Soil and Groundwater
120000	Aquifer Testing
130000	Geophysical Survey
140000	Miscellaneous Matrix Sampling
150000	Calibration of Instruments
160000	Monitoring Well Development

Table 2
Fuss & O'Neill Field Equipment Preventive Maintenance Schedule

Instrument	Activity	Frequency	SOP Ref.
YSI Model 63 SCT Meter	Battery replacement	As needed	150100
	pH probe cleaning	As needed	150100
	Specific conductivity and temperature sensor cleaning	Daily	150100
YSI Model 85 DO + SCT Meter	Battery replacement	As Needed	150200
	Sensor cleaning	Daily	150200
YSI-600 Series Water Analyzer	Probe or probe port replacement	As needed	150300
	Battery replacement	As needed	150300
	pH probe and ORP sensor cleaning	As needed	150300
	Specific conductivity and temperature sensor cleaning	Daily	150300
	DO sensor cleaning and membrane replacement	As needed	150300
Quanta Water Quality Monitoring System	Probe or probe port replacement	As needed	150350
	Battery replacement	As needed	150350
	pH probe and ORP sensor cleaning	As needed	150350
	Specific conductivity and temperature sensor cleaning	Daily	150350
	DO sensor cleaning and membrane replacement	As needed	150350
LaMotte 2020 Turbidimeter	Turbidity tube cleaning	Every use	150400
	Battery replacement	As needed	150400
	Lamp replacement	As needed	150400
Perkin Elmer Photo Vac Model 2020	Lamp cleaning	Each calibration	150500
	Lamp replacement	As needed	150500
	Battery recharging	As needed	150500
	Water trap filter replacement	As needed	150500
	Charcoal scrubber replacement	As needed	150500
Thermo Environmental OVM 580B	Lamp cleaning	Each calibration	150600
	Lamp replacement	As needed	150600
	Battery recharging	As needed	150600
	Filter replacement	As needed	150600
Thermo Environmental OVM 580EZ	Lamp cleaning	Each calibration	150700
	Lamp replacement	As needed	150700
	Battery recharging	As needed	150700
	Water trap filter replacement	As needed	150700
	Charcoal scrubber replacement	As needed	150700

Table 3
Fuss & O'Neill Field Equipment Calibration and Corrective Action

Instrument	Activity	Frequency	Acceptance Criteria	Corrective Action	SOP Ref.
YSI Model 63 SCT Meter	pH calibration	Every use	±0.15 pH units	Recalibrate	150100
	SC calibration	Every use	±25 micromhos/cm	Recalibrate	150100
YSI Model 85 DO + SCT Meter	DO calibration	Every use	8 - 10 mg/L	Recalibrate	150200
	SC calibration	Every use	±25 micromhos/cm	Recalibrate	150200
YSI-600 Series Water Analyzer	pH calibration	Every use	±0.15 pH units	Recalibrate	150300
	SC calibration	Every use	±25 micromhos/cm	Recalibrate	150300
	DO calibration	Every use	8 - 10 mg/L	Recalibrate	150300
	ORP calibration	Every use	±10 mV	Recalibrate	150300
Quanta Water Quality Monitoring System	pH calibration	Every use	±0.15 pH units	Recalibrate	150350
	SC calibration	Every use	±25 micromhos/cm	Recalibrate	150350
	DO calibration	Every use	8 - 10 mg/L	Recalibrate	150350
	ORP calibration	Every use	±10 mV	Recalibrate	150350
LaMotte 2020 Turbidimeter	Calibration	Every use	±5% of calibration solution	Recalibrate	150400
Perkin Elmer Photo Vac Model 2020	Calibration	Every use	±5% of calibration gas	Recalibrate	150500
Thermo Environmental OVM 580B	Calibration	Every use	±5% of calibration gas	Recalibrate	150600
Thermo Environmental OVM 580EZ	Calibration	Every use	±5% of calibration gas	Recalibrate	150700

Table 4
Summary of Required Container, Preservation Requirements for Holding Times

Parameter	Matrix	Required Container	Minimum Volume Required For Analysis	Preservation Technique	Holding Time *(2)*
Volatile Organics - TCL	Water	Glass vials with Teflon faced septa and screw cap. *(Three 40 ml vials per sample)*	50 ml	Cool (4°C) Preserved with Acid *(HCl to pH <2)*	14 days
	Soil	2 oz glass jar with Teflon lined screw cap	10 grams	Cool (4°C)	14 days
	Air/Soil Vapor	6 L Summa Canister	6L	Ambient temerature	14 days
TCL Semi-Volatiles & TCL Pesticides/PDBs & Total Petroleum Hydrocarbons	Water	Amber glass jar with Teflon lined screw cap. *(Either one 4 liter or two 80 ounce jars per sample)*	1,000 ml (1 liter)	Cool (4°C)	Extraction within 5 days of sampling. Analysis within 40 days of extraction.
	Soil	Amber glass jar with Teflon lined screw cap. *(Either one 4 liter or two 80 ounce jars per sample)*	50 grams	Cool (4°C)	Extraction within 14 days of sampling (except TPH, extract within 7 days). Analysis within 40 days of extraction.
Metals (Total and Dissolved) TAL *(1)*	Water	Polyethylene Bottle (One 1 liter bottle)	100 ml	Field filtered using a 0.45 micron filter (for Dissolved Metals only) Cool (4°C) Preserved with Acid *(HNO_3 to pH <2)*	180 days
	Soil	Wide mouth glass jar with Teflon lined screw cap. *(Either one 8 ounce or two 4 ounce jars)*	10 grams	Cool (4°C)	180 days
Total Petroleum Hydrocarbons Fingerprint Analysis	Water	Glass jar with Teflon lined screw cap. *(One 1 liter bottle)*	1,000 ml (1 liter)	Cool (4°C)	28 days

Table 4
Summary of Required Container, Preservation Requirements for Holding Times

Parameter	Matrix	Required Container	Minimum Volume Required For Analysis	Preservation Technique	Holding Time *(2)*
	Soil	Wide mouth glass jar with Teflon lined screw cap. *(Either one 8 ounce or two 4 ounce jars)*	50 grams	Cool (4°C)	28 days
Total Cyanide	Water	Polyethylene Bottle *(One 1 liter bottle)*	100 ml	Cool (4°C) Preserved with Base *(NAOH to pH>4)*	14 days
	Soil	Wide mouth glass jar with Teflon lined screw cap. *(Either one 8 ounce or two 4 ounce jars)*	10 grams	Cool (4°C)	14 days
Mercury (total and dissolved)	Water	Polyethylene Bottle. *(One 1 liter bottle)*	100 ml	Field filtered using a 0.45 micron filter *(for Dissolved Metals only)* Cool (4°C) Preserved with Acid *(HNO_3 to pH < 2)*	28 days
	Soil	Wide mouth glass jar with Teflon lined screw cap. *(Either one 8 ounce or two 4 ounce jars)*	10 grams	Cool (4°C)	28 days
Biochemical Oxygen Demand	Water	Polyethylene Bottle. *(One 1 liter bottle)*	100 ml	Cool (4°C)	48 hours
Chemical Oxygen Demand	Water	Polyethylene Bottle. (One 1 liter bottle)	100 ml	Cool (4°C) Preserved with Acid (HcSO4 to pH < 2)	28 days
Chloride	Water	Polyethylene Bottle.*(One 1 liter bottle)*	100 ml	None required	28 days
Sulfate	Water	Polyethylene	100 ml	Cool (4°C)	28 days

Table 4
Summary of Required Container, Preservation Requirements for Holding Times

Parameter	Matrix	Required Container	Minimum Volume Required For Analysis	Preservation Technique	Holding Time *(2)*
		Bottle. *(One 1 liter bottle)*			
Total Dissolved Solids (TDS)	Water	Polyethylene Bottle. *(One 1 liter bottle)*	100 ml	Cool (4°C)	7 days
Total Suspended Solids (TSS)	Water	Polyethylene Bottle. *(One 1 liter bottle)*	100 ml	Cool (4°C)	7 days

Reference: EPA Document No. 540 P-87 001, 1987, "A Compendium of Superfund Field Operations Methods"

KEY:

NaOH = Sodium Hydroxide
H2SO4 = Sulfuric Acid
HCL = Hydrochloric Acid
HNO3 = Nitric Acid

ml = milliliter
°C = Degrees Celsius
TAL = Target Analyte List
TCL = Target Compound List

(1) – Metals analysis will be conducted on unfiltered samples. If filtered samples are analyzed, unfiltered samples must also be collected and analyzed.

If turbidity presents a problem, the samples will be handles according to NYSDEC "Guidelines for Handling Excessively Turbid Samples", following approval by the Division of Hazardous Waste Remediation (DHWR).

(2) – Holding times are calculated from VTSR (Verified Time at Sample Receipt). Samples must be received by the lab within 48 hours of collection

APPENDIX A

DATA VALIDATION COMPLETENESS CHECKLIST

NYSDEC ASP Category B Data Deliverables Data Validation
Project Name: Hudson River Psychiatric Center Landfill Area 6
Project Number: 20080291.L4N **SDG:**

SDG Narrative	☐	☐
Contract Lab Sample Information Sheets	☐	☐
NYSDEC Data Package Summary Forms	☐	☐
Chain of Custody Forms (external and internal)	☐	☐
GC/MS Volatiles Data		
QC Summary	☐	☐
System Monitoring Compound Summary	☐	☐
MS/MSD Duplicate Summary	☐	☐
QC Check Sample/Standard	☐	☐
Method Blank Summary	☐	☐
GC/MS Instrument Performance Check	☐	☐
Instrument Detection Limits	☐	☐
Sample Data		
TCL Results (1 sig fig if <10; 2 sig figs if>10)	☐	☐
TICs (for up to 10 compounds)	☐	☐
RICs (Reconstructed Total Ion Chromatograms	☐	☐
Standards Data		
Initial Calibration Data	☐	☐
Continuing Calibration	☐	☐
Raw QC Data		
BFB	☐	☐
Blanks	☐	☐
Matrix Spike Blanks	☐	☐
Matrix Spike Data	☐	☐
Matrix Spike Duplicate Data	☐	☐
QC Check Sample/Standard	☐	☐
Copy of Calculations	☐	☐
Copy of Extraction Logs	☐	☐
GC/MS Semi-Volatiles Data		
QC Summary	☐	☐
Surrogate % Recovery Summary	☐	☐
MS/MSD Summary	☐	☐
QC Check Sample/Standard	☐	☐
Method Blank Summary	☐	☐
GC/MS Instrument Performance and Mass Calibration	☐	☐
Internal Standard Area and RT Summary	☐	☐
Instrument Detection Limits	☐	☐
Sample Data		
TCL Results	☐	☐
TICs	☐	☐

NYSDEC ASP Category B Data Deliverables Data Validation
Project Name: Hudson River Psychiatric Center Landfill Area 6
Project Number: 20080291.L4N **SDG:**

- RICs ☐ ☐

GC/MS Semi-Volatiles Data (continued)
- Standards Data
  - Initial Calibration Data ☐ ☐
  - Continuing Calibration ☐ ☐
  - Internal Standard Area Summary ☐ ☐
  - SVOC GPC Calibration Data ☐ ☐
  - Raw QC Data ☐ ☐
    - DFTPP ☐ ☐
    - Blanks ☐ ☐
    - Matrix Spike Blank Data ☐ ☐
    - MSD Data ☐ ☐
    - QC Check Sample/Standard ☐ ☐
- Copy of Calculations ☐ ☐
- Copy of Extraction Logs ☐ ☐

GC/ECD Pesticides/Aroclor Data
- QC Summary
  - MS/MSD/MS Blank Summary ☐ ☐
  - QC Check Sample/Standard Recovery ☐ ☐
  - Method Blank Summary ☐ ☐
  - Instrument Detection Limits ☐ ☐
- Sample Data
  - TCL Results ☐ ☐
  - Copies of Pesticide Chromatograms ☐ ☐
- Standards Data
  - ICal – Single ☐ ☐
  - ICal – Multi ☐ ☐
  - Analyte Resolution Summary ☐ ☐
  - Calibration Verification Summary (Pest 1) ☐ ☐
  - Calibration Verification Summary (Pest 2) ☐ ☐
  - Analytical Sequence ☐ ☐
  - Florisil Cartridge Check ☐ ☐
  - Pesticide GPC Calibration ☐ ☐
  - Pesticide Identification Summary – Single ☐ ☐
  - Pesticide Identification Summary – Multi ☐ ☐
  - Chromatograms/Data System Printouts ☐ ☐
  - Retention Times and Peak Areas/Heights ☐ ☐
- Raw QC Data
  - Blanks ☐ ☐
  - Matrix Spike Data ☐ ☐

NYSDEC ASP Category B Data Deliverables Data Validation
Project Name: Hudson River Psychiatric Center Landfill Area 6
Project Number: 20080291.L4N **SDG:**

Matrix Spike Duplicate Data	☐	☐
Matrix Spike Blank Data	☐	☐
QC Check Sample/Standard	☐	☐
Copy of Calculations	☐	☐
Copy of Extraction Log	☐	☐
GC Organic Data		
QC Summary	☐	☐
Surrogate Percent Recovery Summary	☐	☐
MS/MSD/MS Blank Summary	☐	☐
QC Check Sample/Standard	☐	☐
Method Blank Summary	☐	☐
Instrument Detection Limits	☐	☐
Sample Data		
TCL Results	☐	☐
Copies of Chromatograms	☐	☐
Copies of Chromatograms from 2nd Column	☐	☐
GC Integration Report/Data System Printout	☐	☐
Manual Work Sheets	☐	☐
GPC Chromatograms	☐	☐
Standards Data		
Initial Calibration Data	☐	☐
Continuing Calibration Data	☐	☐
QC Check Sample/Standard	☐	☐
Standard Chromatograms/Data System Printouts (ALL Standards)	☐	☐
Raw QC Data		
Blank Data	☐	☐
MS Data	☐	☐
MSD Data	☐	☐
QC Check Sample/Standard	☐	☐
Copy of Calculations	☐	☐
Copy of Extraction Log	☐	☐
Inorganic Data		
Results – Inorganic Analysis Data Sheet	☐	☐
Quality Control Data	☐	☐
Initial and Continuing Calibration Verification	☐	☐
CRDL Standard for AA and Linear Range Analysis for ICP	☐	☐
Blanks	☐	☐
ICP Interference Check Sample	☐	☐

NYSDEC ASP Category B Data Deliverables Data Validation
Project Name: Hudson River Psychiatric Center Landfill Area 6
Project Number: 20080291.L4N **SDG:**

Spike Sample Recovery	☐	☐
Post Digest Spike Sample Recovery	☐	☐
Duplicates	☐	☐
Quality Control Sample	☐	☐
Standard Addition Results	☐	☐
ICP Serial Dilutions	☐	☐
Holding Times	☐	☐
Verification of Instrument Parameters	☐	☐
Instrument Detection Limits (Semi-annually)	☐	☐
ICP Interelement Correction Factors (Annually) (Part 1)	☐	☐
ICP Interelement Correction Factors (Annually) (Part 2)	☐	☐
ICP Linear Ranges (Quarterly)	☐	☐
Raw Data		
Calibration Standards	☐	☐
Initial/Continuing Calibration Blanks/Prep Blanks	☐	☐
Initial/Continuing Calibration Verification Standards (Interference check samples, ICP serial dilution samples, CRDL Standard for ICP/AA, LCS, Post-Digest Spike)	☐	☐
Diluted/Undiluted Samples	☐	☐
Duplicates	☐	☐
Spikes	☐	☐
Digestion Logs	☐	☐
Wet-Chemical Data		
Results	☐	☐
QC Data	☐	☐
Raw Data	☐	☐
Digestion/Distillation Logs	☐	☐
TCLP Data	☐	☐
Results	☐	☐
Inorganic QC Data	☐	☐
Verification of Instrument Parameters	☐	☐
Raw Data	☐	☐
Digestion Logs	☐	☐

APPENDIX B

FUSS & O'NEILL STANDARD OPERATING PROCEDURES FOR SAMPLE COLLECTION AND FIELD EQUIPMENT OPERATION

Upon arrival on-site, all Fuss & O'Neill field personnel will follow the following guidelines:

1. The client/owner will be notified of site visits.

2. Field personnel will always carry their business cards for identification purposes.

3. Field personnel will strictly adhere to policies in effect at the client's facilities. An example of such a policy is signing in and out of buildings or offices and wearing facility specified safety gear (hard hats, eyeglasses).

4. The client/owner's property will be respected at all times.

5. Field personnel will not discuss specifics of sampling or contaminants with any site employees or passers-by without authorization from project management and the client.

6. Field personnel will not be permitted to smoke in the client's presence or while in indoor facilities. **In addition, no smoking will be permitted in the vicinity of sample collection.**

7. All field activities will be conducted following the established sampling plan and the site health and safety plan for the site.

8. Wells will be locked and maintained in good condition between sampling events.

9. The homeowner will be notified prior to any domestic well sampling. If no one is home and a sample cannot be obtained, field personnel will leave a note to inform the resident of the sampling attempt and the name of a contact person with whom to reschedule. A business card should always accompany this note.

10. When domestic wells are purged from an outside tap, a hose will be attached whenever possible to direct the water away from the building.

11. Contaminated and/or dirty protective gear will be properly decontaminated and removed prior to entering on-site buildings and offices.

12. No discarded materials will be left at sample locations. All trash, which has accumulated at a site as a result of field activities, will be collected and discarded back at Fuss & O'Neill offices.

13. Field Staff will keep company vehicles clean and in presentable condition while conducting field activities.

14. Fuss & O'Neill staff is not to sign a manifest for hazardous waste transport under any circumstances.

FIELD NOTEBOOKS

All field personnel will carry a bound field notebook. All field activities will be documented in the field notebook, regardless of whether or not those activities involve sample collection. Each employee's book will be numbered sequentially with the format of the employee number followed by the book number (i.e. **156-01**) and will be labeled on the cover as such with the range of dates covered by the book (i.e. 10/23/03 to 8/17/04). Each page of the field notebook book will be numbered with the employee number, the book number, and the page number (i.e. **156-01-01, 156-01-02, 156-01-03**, etc.). The field notebook will document site-specific information such as:

- Project name and location
- Names of other Fuss & O'Neill personnel involved in field activities
- Time and date of arrival at the site
- Weather conditions
- Sampling locations and corresponding sample numbers
- Documentation of field calibration of instruments
- Conversations with individuals on site
- Any unusual events or observations
- All information not recorded on field data sheets
- Time of departure from the site

For field investigations that involve the collection of samples, additional forms of documentation are required. See SOPs 020100, 020200, 020300, 020400, 020500, and 020600.

INTRODUCTION

All samples collected must have unique identifiers (Sample IDs). Since sampling locations may be sampled many times (e.g., quarterly monitoring programs), there must be a means of distinguishing samples from each other, whether from one sampling event or multiple events.

Fuss & O'Neill has adopted a protocol for assigning sample identification numbers. It is necessary to follow this protocol to ensure that:

- Sample locations are blind to the laboratory
- Analytical requests can be easily communicated with the laboratory
- Analytical data provided by the laboratory can be assigned to the correct sample location for reporting purposes

The only time sample IDs are to deviate from this protocol is when the client has specified an alternative sample numbering scheme.

SAMPLE IDENTIFICATION NUMBER

Each sampling location will be assigned a number by which samples can be identified. An example of a sample identification number is as follows:

XXXYYMMDD-## (e.g., 156050608-01)

This 11-digit code contains three types of information about the collection of the sample.

XXX	The employee number of the individual who collected the sample or supervised the sampling event
YY	Sample year
MM	Sample month
DD	Sample day
##	Assigned chronologically. Generally, the first sample collected during a sampling event is -01 and the numbers increase until the sampling event is completed. If the event continues over several days, the numbering sequence continues without returning to -01.

For sampling events that will involve the collection of over 100 samples, it is important to use a three-digit identifier (e.g., 156050608-001).

When multiple sample containers are filled from one sample location, all such samples are assigned the same sample identification number. Common situations where this will happen include, but are not limited to:

- Multiple containers required for various analytical parameters

- Split samples that are being submitted to different laboratories
- Sampling events that require sampling at the same location over two or more days dues to insufficient sample volume available (e.g., low yield monitoring wells)

An exception to this rule is duplicate samples which should be assigned unique sample identification numbers to keep the duplicates blind to the laboratory.

INTRODUCTION

All samples must be labeled in order to provide pertinent information to everyone who will be handling the sample. It is imperative that labels be applied to each sample container to ensure that all samples get transferred together.

SAMPLE LABELS

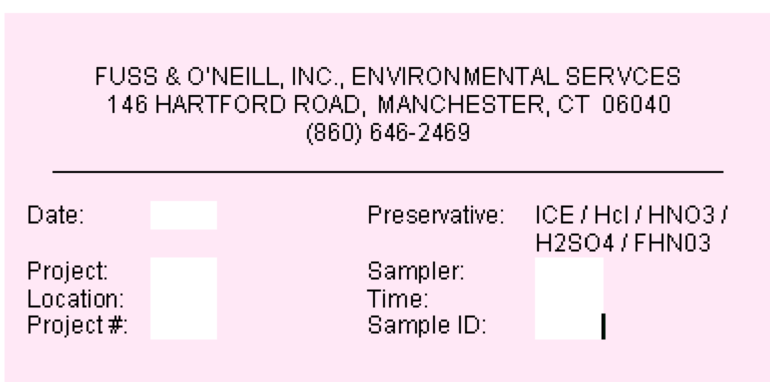
A sample label will be affixed to each sample container at the time of collection. Labels must be completed legibly with waterproof ink to prevent obliteration of the label. An example of a sample label is provided on Figure 020200.

The following information will be recorded on each label with waterproof ink:

- Sample identification number
- Project name
- Project location
- Project number
- Date of sample collection
- Time of sample collection
- Name/Initials of sampler
- Type of preservation

Labels are created using *Microsoft Word*, File, New…, Field Services Tab, Labels_Bottles.dot.

Figure 020200



FUSS & O'NEILL, INC., ENVIRONMENTAL SERVCES
146 HARTFORD ROAD, MANCHESTER, CT 06040
(860) 646-2469

Date:
Preservative: ICE / Hcl / HNO3 / H2SO4 / FHN03
Project:
Location:
Project #:
Sampler:
Time:
Sample ID:

INTRODUCTION

Many different types of environmental samples may be collected. These include, but are not limited to: groundwater, surface water, soil, sediment, concrete chips, wipes, indoor air, soil gas, and test pits. While some of the necessary documentation will be standard regardless of the type of sample (e.g., sample ID, date, time, sampler identification), each type also has information that is unique.

FIELD DATA SHEETS

Field data sheets have been developed for most types of samples encountered during field activities so that pertinent information is recorded at the time of sampling. Field personnel will thoroughly complete a field data sheet for each sample collected at the time of sampling.

At the conclusion of each sampling event, the field data sheets will be given to the project manager for review. This review should be conducted as soon as possible to ensure that, if edits are required, they can be done efficiently.

Examples of each of the existing field data sheets are provided as attachments to this Standard Operating Procedure.

Air Sampling Field Data

Client/Project Name:		FUSS & O'NEILL *Disciplines to Deliver*
Project Location:	**PROJECT #:**	
Sample#:	Sampling Location	

Sample Location Info

Sample Data

	Container	Quantity	Preservative
Date:____________________ Start Time:__________________ Sampler:____________________ Finish Time:_________________ Sample Time:________________			

Comments:

Concrete Sampling Field Data

Client/Project Name:		FUSS & O'NEILL *Disciplines to Deliver*
Project Location:	**PROJECT #:**	
Sample#:	Sampling Location	

Sample Location Info

Sample Data

	Container	Quantity	Preservative
Date:__________ Start Time:__________ Sampler:__________ Finish Time:__________ Sampling Method: Chisel / Core / Drill Bit / Other __________			

Description Data

Organic Vapor Reading:__________ Instrument:__________

Appearance:

Comments:

Concrete Sampling Field Data

Client/Project Name:	Project #	FUSS & O'NEILL *Disciplines to Deliver*
Project Location:		
Date:	Weather:	

Sample #: Sample Location:	Container	Quantity	Preservative
Sampler:________ Time:________ Sampling Device: Auger / Core Sampler / Shovel / Hammer Drill / Trowel / Other________ Field Decon: Yes / No / Dedicated Type of Sample: Grab / Composite / Other________ Generic Description:________ Sample Depth:________ PetroFLAG/OVM________			

Sample #:	Container	Quantity	Preservative
Sample Location:			
Sampler:________ Time:________ Sampling Device: Auger / Core Sampler / Shovel / Hammer Drill / Trowel / Other________ Field Decon: Yes / No / Dedicated Type of Sample: Grab / Composite / Other________ Generic Description:________ Sample Depth:________ PetroFLAG/OVM________			

Direct Push Groundwater Sample Field Data Sheet

Client/Project Name: Project Location:	**PROJECT #:**	FUSS & O'NEILL *Disciplines to Deliver*
Sample#:	**<u>Sample Location</u>**	

Sample Data

	Container	Quantity	Preservative
Date:________________ Time:________________ Sampler:________________ Weather:________________			
Approx. sample depth: ____________________ (ft) Sampling Method: Bailer / Peristaltic / Watera / Other________ Filtered in Field: No / @ Sample Location Method of Filtration: Pressure / Vacuum / Syringe Pump ID #: Filter: Disposable / Other ________________ Appearance: Comments:			

* - Organic-free DI water used in these containers.

Comments:

Sediment Sampling Field Data

Client/Project Name:__________ Project Location:__________ Date: ______ Weather: ______ Sampler(s): ______	**PROJECT #:** __________	FUSS & O'NEILL *Disciplines to Deliver*

Sample #: Site ID:	Container	Quantity	Preservative
GPS Coord. ______N ______W | Photo #: ______ Water Quality Parameters Surface Bottom Temperature (C) ______ ______ Conductivity (uS/cm) ______ ______ pH / ORP (mV) ___/___ ___/___ DO (mg/L / %) ___/___ ___/___ Sampling Device: Core Sampler – Type: ______ Dredge – Type: Ponar / Ekman / Other: ______ Field decon: Yes / No / Dedicated Type of Sample: Grab / Composite / Other ______ Sample Depth: ______ Feet			

Sediment Sampling Field Data

Client/Project Name:______________ Project Location:______________ Date: ________ Weather: ________ Sampler(s): ________	**PROJECT #:** ________	FUSS & O'NEILL *Disciplines to Deliver*

SAMPLE #: **SITE ID:**	Container	Quantity	Preservative
GPS Coord. ________N ________W | Photo #: ________ <u>Water Quality Parameters Surface Bottom</u> Temperature (C) ________ ________ Conductivity (uS/cm) ________ ________ pH / ORP (mV) ____/____ ____/____ DO (mg/L / %) ____/____ ____/____ Sampling Device: Core Sampler – Type: ________ Dredge – Type: Ponar / Ekman / Other: ________ Field Decon: Yes / No / Dedicated Type of Sample: Grab / Composite / Other ________ Sample Depth: ________ Feet			

NOTES & COMMENTS

SAMPLE #: **SITE ID:**	Container	Quantity	Preservative
GPS Coord. ________N ________W | Photo #: ________ <u>Water Quality Parameters Surface Bottom</u> Temperature (C) ________ ________ Conductivity (uS/cm) ________ ________ pH / ORP (mV) ____/____ ____/____ DO (mg/L / %) ____/____ ____/____ Sampling Device: Core Sampler – Type: ________ Dredge – Type: Ponar / Ekman / Other: ________ Field Decon: Yes / No / Dedicated Type of Sample: Grab / Composite / Other ________ Sample Depth: ________ Feet			

NOTES & COMMENTS

Equipment Blank Field Data

Client/Project Name: Project Location:	**PROJECT #:**	FUSS & O'NEILL *Disciplines to Deliver*
Sample#:	Well ID **Equip Blank**	

Sample Data

Date:____________________ Time:______________________

Sampler:____________________ Weather:______________________

Blank Water Supplied By: Lab / F&O / Other __________________

Equipment Used: Bailer / Filter / Pump / Other __________

Filtered in Field? No / @ Vehicle

Method of Filtration: Pressure / Vacuum / Syringe

Pump ID #:

Filter: Disposable / Other ____________________

Appearance:

Comments:

Container	Quantity	Preservative

* - Organic-free DI water used in these containers.

Comments:

Field Blank Field Data

Client/Project Name: Project Location:	**PROJECT #:**	FUSS & O'NEILL *Disciplines to Deliver*
Sample#:	Well ID **Field Blank**	

Sample Data

	Container	Quantity	Preservative
Date:____________________ Time:________________________ Sampler:____________________ Weather:_____________________			
Blank Water Supplied By: Lab / F&O / Other ____________________ Comments:			

* - Organic-free DI water used in these containers.

Comments:

Flow Meter Field Data

Client/Project Name: Project Location:	Project #: ***Sample Location***	FUSS & O'NEILL *Disciplines to Deliver*

Sample Location Info

Sample Data

Date:_______________________ Time:________________

Sampler: _______________________ Flow: _________________

Weather:_______________________

Water Temperature: ______________________

Pipe Outside Diameter: _______________________

Pipe Material: ______________________

Pipe Circumference: ______________________

Comments:

Monitoring Well Sample Log

Low Flow Sampling

Client/Project Name:		FUSS & O'NEILL *Disciplines to Deliver*
Project Location:	**PROJECT #:**	
Sample#:	**WELL ID:**	

Purge Data *Sample Data*

Date:	**Container**	**Quantity**	**Preservative**
Start time:________________**Stop time**:_______________**Sample time:**_________________ **Pump Rate:**________________ (ml/m) **Depth Sampled:**___________________ **Total time purged:**________________ **Sampler:**___________________ **Volume Purged**:__________________(ltr) **Purge Device:** Dedicated / Nondedicated **Weather:**___________________ **Device Type:** Bladder / Peristaltic / Submersible Appearance: **Well Yield:** High / Moderate / Low / Dry **Comments:**			

Field Parameter Data

Instrument ID#

Water Level (ft)	Time	Turbidity (ntu)	Dissolved Oxygen (mg/L)	pH	Temp. (deg C)	Specific Conductivity (uS)	ORP(mV)

Well Condition Checklist (circle appropriate item(s), cross out if not applicable]

General Condition: Good / Needs Repair **Protective Steel:** OK / Cracked / Leaking / Bent / Loose/ None **Well # Visible?:** Y / N **Well Cap:** Good / Broken / None **Evidence of rain water between steel and PVC?:** Y / N **Evidence of ponding around well?:** Y / N **Gopher type holes around collar?:** Y / N **Comments:**	**Is well plumb?:** Y / N **Lock:** Good / Broken / None **Rust around cap**: Y / N **PVC Riser**: Good / Damaged / None Concrete colar: OK / Cracked / Leaking / None **Other evidence of:** Rodents / Insects / None **Curb Box:** N / Y (key is: Hex / Pent / Other)

Methane Field Data Sheet

Client/Project Name:	PROJECT #:	FUSS & O'NEILL *Disciplines to Deliver*
Project Location:	**Date:**	

Sampler:______________________ Weather:______________________________

Start Time:____________________ Finish Time:__________________________

Meter Used:___________________ Calibrated date/time:___________________ Calibration Gas Used:__________________

Location	% Methane	%LEL	Comments

Monitoring Well Field Data Sheet

Client/Project Name: Project Location:	**PROJECT #:**	FUSS & O'NEILL *Disciplines to Deliver*
Sample#:	Well ID	

Elevation Data

Date:	Time:		
	Depth (feet)	+ Correction	= True Depth
Water Level PVC		+	=
Water Level TPS		+	=
Bottom of Well		+	=

Well Diameter (inches): ________________

Water Column Height: ____________ (feet)
Gal/foot x 3 factor: x ____________

Volume to be Purged: ____________ (gal)

Measuring Device ID#: ______________________________
Sampler: ______________________________________
Comments:
Weather: ______________________________________

Well Condition Checklist

[circle appropriate item(s); cross out if not applicable]

General Condition: *Good / Needs Repair*
Protective Steel: *OK / Cracked / Leaking / Bent / Loose / None*
Well # Visible?: *Y / N*
Well Cap: *Good / Broken / None*
Evidence of rain water between steel and PVC?: *Y / N*
Evidence of ponding around well?: *Y / N*
Gopher-type holes around collar?: *Y / N*

Is well plumb?: *Y / N*
Lock: *Good / Broken / None*
Rust around cap?: *Y / N*
PVC Riser: *Good / Damaged / None*
Concrete collar: *OK / Cracked / Leaking / None*
Other Evidence: *Rodents / Insects/ None*
Curb Box: *Y / N (key is: Hex/Pent/Other)*
Curb Box Gasket: *OK / Replace / Other* __________

Comments:

Purge Data

Start Time: ___________________________
Stop Time: ___________________________
Total Time Purged: ___________________________
Pump Rate: ___________________________ (gpm)
Volume Purged: ___________________________ (gallons)

Purge Device: Dedicated / Nondedicated
Device type: Bailer / Peristaltic / Submersible / Bladder
Comments:
Well Yield: High / Moderate / Low / Dry

Sample Data

	Container	Quantity	Preservative
Date:_______________ Time:____________ Sampler:______________ Approx. sample depth: __________ (ft) Weather:__________________________ Sampling method: Bailer / Peristaltic / Bladder Bailer type: SS 2" / SS 1.25" / SS Short / PVC 2" / Other________			
Bailer Cord: Dedicated / Nondedicated Filtered in Field?: No / @ Well Method of Filtration: Pressure / Vacuum / Syringe Pump ID # ____ Filter: Disposable / Other ________ Field Decon: Bailer / Tubing / Other __ Appearance:			

Field Parameters

Note: SC calculation based on (temp) at time of SC measurement.

Instrument ID#			Instrument ID#	
	pH	Temp		Spec. Cond.

Monitoring Well Abandonment Log

Client/Project Name: Project Location:	Project #: ***Well ID***	FUSS & O'NEILL *Disciplines to Deliver*

Water Column Data

Date:		Time:	
	Depth (feet)	+ Correction	= True Depth
Water Level PVC		+	=
Water Level TPS		+	=
Bottom of Well		+	=

Well Diameter (inches):____________________

Water Column Height:____________________ (feet)

gal/foot:____________________

Volume:____________________ (gal)

Gallons x 13 = ________________ (ml bleach)

Time Bleach Added to Well:____________________

Measuring Device ID: ____________________ Sampler:____________________

Comments: Weather:____________________

Description of Abandonment Procedures:

Backfill Info

Interval:________-________ (ft) (Approximate volumes if available)

Description: Bentonite Grout / Bentonite Chips Volume:____________cu. ft.

Other:__________

Surface Completion

Interval:________-________ (ft) (Approximate volumes if available)

Description: Concrete / Other:__________ Volume:____________cu. ft.

Licensed Non-Water Well Driller Name Signature Date

Monitoring Well Development Log

Client/Project Name:	FUSS & O'NEILL *Disciplines to Deliver*
Project Location:	
PROJECT #:	
WELL ID#:	

Elevation Data

Date:		Time:		Well Diameter (inches): ________
	Depth (feet)	+ Correction	= True Depth	Sampler: ________
Water Level PVC		+	=	Measuring Device ID#: ________
Water Level TPS		+	=	Weather: ________
Bottom of Well		+	=	
Comments:				

Well Condition Checklist

[circle appropriate item(s); cross out if not applicable]

General Condition: Good / Needs Repair
Protective Steel: OK / Cracked / Leaking / Bent / Loose / None
Well # Visible?: Y / N
Well Cap: Good / Broken / None
Evidence of rain water between steel and PVC?: Y / N
Evidence of ponding around well?: Y / N
Gopher-type holes around collar?: Y / N

Is well plumb?: Y / N
Lock: Good / Broken / None
Rust around cap?: Y / N
PVC Riser: Good / Damaged / None
Concrete collar: OK / Cracked / Leaking / None
Other Evidence: Rodents / Insects/ None
Curb Box: Y / N (key is: Hex/Pent/Other)
Curb Box Gasket: OK / Replace / Other ________

Comments:

Purge Data

Start Time	Stop Time	Volume Purged (gallons / Liters)	Purge Device Used	Comments

Monitoring Inspection Datasheet

Client/Project Name:	FUSS & O'NEILL *Disciplines to Deliver*
Project Location:	
PROJECT #:	
WELL ID#:	

Elevation Data

Date: 5/19/05		Time:		Well Diameter (inches): ________
	Depth (feet)	+ Correction	= True Depth	Sampler: ________
Water Level PVC		+	=	Measuring Device ID#: ________
Water Level TPS		+	=	Weather: ________
Bottom of Well		+	=	

Comments:

Well Condition Checklist

[circle appropriate item(s); cross out if not applicable]

Curb Box:Y / N (key is: Hex/Pent/Other)
Stand Pipe: Y / N
General Condition: Good / Needs Repair
Is well plumb?: Y / N
Protective Steel: OK / Cracked / Leaking / Bent / Loose / None
Locking Mechanism: Y / N/ Broken
Lock: Good / Broken / None
Well # Visible?: Y / N
Rust around cap?: Y / N
Well Cap: Good / Broken / None
PVC Riser:Good / Damaged / None
PVC Cap: Y / N
Evidence of rain water between steel and PVC?: Y / N
Concrete collar:OK / Cracked / Leaking / Pitted / None
Evidence of ponding around well?: Y / N
Other Evidence:Rodents / Insects/ None
Gopher-type holes around collar?: Y / N
Curb Box Gasket: OK / Replace / Other

Comments:

Potable Water Field Data

Client/Project Name: Project Location:	**PROJECT #:**	FUSS & O'NEILL *Disciplines to Deliver*
Sample#:	Well ID	

Sample Location Data

Document all sample attempts

	Date	Time	Reason for not sampling
Name: ____________			
Street Address: ____________			
City, State, Zip: ____________			
Special instructions:			
Sample taken on →			XXXXXXXXXXXXXXXXXXXXXXX

5 minute purge

Sample taken from: Outside tap / Inside sink / Pre-filter / Basement Tap/ Other ____________
Filter bypassed by: Sample point / Not Bypassed / No Filter / Other ____________
Start time: ____________
Stop time: ____________
Total Time Purged: ____________
Comments:

Sample Data

	Container	Quantity	Preservative
Date:____________ Time:____________ Sampler:____________ Weather:____________			
Appearance: Comments:			

Field Parameters

Note: SC calculation based on (temp) at time of SC measurement.

Instrument ID#			Instrument ID#	
	pH	Temp	(Temp)Corr Factor x Calib Factor x Conductivity =	Spec. Cond.
			( ) x x =	

Comments:

Pumping Well Field Data

Client/Project Name: Project Location:	Project #:	FUSS & O'NEILL *Disciplines to Deliver*
Sample #:	***Sample Location***	

Sample Location Info (sketch map including location of sample)

Special Instructions;

Sample Data

Date:______________________ Time:_______________________
Sampler:______________________ Weather:_____________________

Sampling Method: Bailer / Peristaltic / Grab / Other______
Sampling Device: SS 2" / SS 1.25" / SS Short / PVC 2" / Other____________________

Filtered in Field: No / @ Well
Method of Filtration: Pressure / Vacuum / Syringe
Pump ID#: Filter: Disposable / Other_____
Field Decon: Filter / Tubing / Other________________
Appearance:

Container	Quantity	Preservative

Field Parameters

Parameter	Instrument ID	Value
pH		
Temp		
Spec. Cond.		

Pumping Data

Time	Water Level	Q (rate in gpm)	Totalizer Reading

Type of Well

-Public Supply
-Interceptor
-Hydrocarbon Recovery
-Other________________

Comments:

Soil Gas Sampling Field Data

Client/Project Name:		FUSS & O'NEILL *Disciplines to Deliver*
Project Location:	**PROJECT #:**	
Sample#:	Sampling Location	

Sample Location Info

Sample Data

	Container	Quantity	Preservative
Date:______ Start Time:______ Sampler:______ Finish Time:______ Time Interval:______			

Comments:

Soil Sampling Field Data

Client/Project Name:		FUSS & O'NEILL *Disciplines to Deliver*
Project Location:	**PROJECT #:**	
Sample#:	Sampling Location	

Sample Location Info (sketch map including location of stockpile)

Sample Data

Date:______________________ Time:________________________
Sampler:______________________ Weather:_____________________

Sampling Device: Auger / Geoprobe / Shovel / Split Spoon / Trowel / Other __
Field decon: Yes / No / Dedicated
Type of Sample: Grab / Composite / Other ____

Sample Depth: ________________
PetroFLAG / OVM________________

Container	Quantity	Preservative

Comments:

Soil Sampling Field Data

Client/Project Name: Project Location: Date: Weather:	**PROJECT #:**	FUSS & O'NEILL *Disciplines to Deliver*

Sample #: Sample Location:	Container	Quantity	Preservative
Sampler: __Time:____________________ Sampling Device: Auger / Geoprobe / Core Sampler / Shovel / Split Spoon / Scoop/ Other __ Field decon: Yes / No / Dedicated Type of Sample: Grab / Composite / Other ____________________ Generic Soil Description:____________________ Sample Depth: ________________ PetroFLAG / OVM________________			

Sample #: Sample Location:	Container	Quantity	Preservative
Sampler: __Time: ____________________ Sampling Device: Auger / Geoprobe / Core Sampler / Shovel / Split Spoon / Scoop/ Other __ Field decon: Yes / No / Dedicated Type of Sample: Grab / Composite / Other ____________________ Generic Soil Description:____________________ Sample Depth: ________________ PetroFLAG / OVM________________			

Sample #: Sample Location:	Container	Quantity	Preservative
Sampler: __Time:____________________ Sampling Device: Auger / Geoprobe / Core Sampler / Shovel / Split Spoon / Scoop/ Other __ Field decon: Yes / No / Dedicated Type of Sample: Grab / Composite / Other ____________________ Generic Soil Description:____________________ Sample Depth: ________________ PetroFLAG / OVM________________			

Sample #: Sample Location:	Container	Quantity	Preservative

Sampler: ______Time:________________________________ Sampling Device: Auger / Geoprobe / Core Sampler / Shovel / Split Spoon / Scoop/ Other __ Field decon: Yes / No / Dedicated Type of Sample: Grab / Composite / Other ________________________________ Generic Soil Description:________________________________ Sample Depth: ________________ PetroFLAG / OVM________________			

Soil Stockpile Sampling Field Data

Client/Project Name:		FUSS & O'NEILL *Disciplines to Deliver*
Project Location:	**PROJECT #:**	
Sample#:	Sampling Location	

Sample Location Info (sketch map including location of stockpile)

Sample Data

	Container	Quantity	Preservative
Date:______________________ Time:______________________ Sampler:______________________ Weather:______________________ Sampling Device: Auger / Core Sampler / Shovel / Trowel / Other ___________ Field decon: Yes / No / Dedicated Type of Sample: Grab / Composite / Other ________________________________			

Description Data

Generic Sample Description: Sand, Gravel, etc.

Previous stockpile sampling Y / N

Source of Contamination:

Analytical parameters:

Comments:

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Stormwater Field Data Sheet

Client/Project Name:	Project #:
Project Location:	*Location ID*
Sample #:	

Sample Location Info

Special Instructions:

Sample Data

	Container	Quantity	Preservative
Date:________ Time:________ Sampler:____________Weather:______	32 oz. Amber 250 mL Plastic 500 mL Plastic 250 mL Plastic 1 L Plastic	1 1 1 1 1	H2SO4 HNO3 H2SO4 As Is As Is
Estimated Flow Rate(GPM)______________ Stagnant / Dry / Other______________			
Appearance: Comments:			

Field Parameters

Parameter	Instrument	Value
pH		
Temperature		
rain pH		

Comments:

Surface Water Field Data

Client/Project Name: Project Location:	Project #:	FUSS & O'NEILL *Disciplines to Deliver*
Sample #:	***Monitoring Location***	

Sample Location Info

Sample Data

Date:________________ Time:________________
Sampler:________________ Weather:________________

Estimated Flow Rate (GPM) ________________
Stagnant / Dry / Other________________

Filtered in Field: No / @ Well
Method of Filtration: Pressure / Vacuum / Syringe
Pump ID#: [ ] Filter: Disposable / Other____
Field Decon: Tubing / Other__________
Appearance:

Comments:

Container	Quantity	Preservative

Field Parameters

Parameter	Instrument ID	Value
pH		
Temp		
Spec. Cond.		

Comments:

Surface Water Field Data

Client/Project Name: Project Location: Date:______________________ Weather:_______________	**PROJECT #:**	FUSS & O'NEILL *Disciplines to Deliver*

Sample #:	Container	Quantity	Preservative
Sample Location			
Date:______________________ Time:________________________ Sampler:______________________ Weather:____________________ Estimated Flow Rate (GPM) ______________________ Stagnant / Dry / Other__________________________ Filtered in Field: No / @ Well Method of Filtration: Pressure / Vacuum / Syringe Pump ID#: Filter: Disposable / Other____ Field Decon: Tubing / Other____________ Appearance: Comments:			

Field Parameters

Parameter	Instrument ID	Value
pH		
Temp		
Spec. Cond.		

Sample #:	Container	Quantity	Preservative
Sample Location			
Date:______________________ Time:________________________ Sampler:______________________ Weather:____________________ Estimated Flow Rate (GPM) ______________________ Stagnant / Dry / Other__________________________ Filtered in Field: No / @ Well Method of Filtration: Pressure / Vacuum / Syringe Pump ID#: Filter: Disposable / Other____ Field Decon: Tubing / Other____________ Appearance: Comments:			

Field Parameters

Parameter	Instrument ID	Value
pH		
Temp		
Spec. Cond.		

Tank Grave Soil Sampling Field Data

Client/Project Name: Project Location: Date:__________ Weather:__________	Project #:__________ Site ID:__________ Tank ID:__________	FUSS & O'NEILL *Disciplines to Deliver*

Sample #: Sample Location:	Container	Quantity	Preservative
Date:__________ Time:__________ Sampler:__________ Weather:__________ Sampling Device: Auger / Core Sampler / Shovel / Split Spoon / Trowel Other ____ Field decon: Yes / No / Dedicated Type of Sample: Grab / Composite / Other __________ Generic Sol Description:__________ Sample Depth: __________ PetroFLAG / OVM__________			

Sample #: Sample Location:	Container	Quantity	Preservative
Date:__________ Time:__________ Sampler:__________ Weather:__________ Sampling Device: Auger / Core Sampler / Shovel / Split Spoon / Trowel Other ____ Field decon: Yes / No / Dedicated Type of Sample: Grab / Composite / Other __________ Generic Sol Description:__________ Sample Depth: __________ PetroFLAG / OVM__________			

Sample #: Sample Location:	Container	Quantity	Preservative
Date:__________ Time:__________ Sampler:__________ Weather:__________ Sampling Device: Auger / Core Sampler / Shovel / Split Spoon / Trowel Other ____ Field decon: Yes / No / Dedicated Type of Sample: Grab / Composite / Other __________ Generic Sol Description:__________ Sample Depth: __________ PetroFLAG / OVM__________			

Sample #: Sample Location:	Container	Quantity	Preservative
Date:__________ Time:__________ Sampler:__________ Weather:__________ Sampling Device: Auger / Core Sampler / Shovel / Split Spoon / Trowel Other ____ Field decon: Yes / No / Dedicated Type of Sample: Grab / Composite / Other __________ Generic Sol Description:__________ Sample Depth: __________ PetroFLAG / OVM__________			

Trip Blank Field Data

Client/Project Name: Project Location:	**PROJECT #:**	FUSS & O'NEILL *Disciplines to Deliver*
Sample#:	Well ID **Trip Blank**	

Sample Data

	Container	Quantity	Preservative
Date:________________ Time:________________ Sampler:________________ Weather:________________	Voa	2	HCl
Blank Water Supplied By: Lab / F&O / Other ________________ Comments:			

Comments:

Waste Sampling Field Data

Client/Project Name: Project Location:	Project #:	FUSS & O'NEILL *Disciplines to Deliver*
Sample #:	***Sample Location***	

Sample Location Info

Sample Data

Date:________________ Time:________________

Sampler:________________ Weather:________________

Sampling Device: Auger / Core Sampler / Shovel / Split Spoon/ Plastic Scoop / Trowel / Other__________

Field Decon: Yes / No / Dedicated

Type of Sample: Grab / Composite / Other__________

Container	Quantity	Preservative

Description Data

pH Reading: ________________________ Instrument:________________

Temp: ________________________

OVM (ppm): ________________________

Sample Description: (odor/color/consistency)

Type of Container Sampled: Drum / Tank / Tote / Other:__________

Comments:

Wastewater Field Data

Client/Project Name: Project Location: Willimantic CT	Project #:	FUSS & O'NEILL *Disciplines to Deliver*
Sample #:	***Monitoring Location***	

Sample Location Info

Permit:
Discharge Location:

Special Instructions:

Sample Data

	Container	Quantity	Preservative
Date:________ Time:________ Sampler:________ Weather:________ Estimated Flow Rate (GPM) ____see comments____ Stagnant / Dry / Other________ Filtered in Field: No / @ Well / @ Vehicle Method of Filtration: Pressure / Vacuum / Syringe Pump ID#: ☐ Filter: Disposable / Other____ Field Decon: Tubing / Other________ Appearance: Comments:			

Field Parameters

Parameter	Instrument ID	Value
pH		
Temp		
Spec. Cond.		

Comments:

Wipe Sampling Field Data

Client/Project Name: Project Location:	Project #:	FUSS & O'NEILL *Disciplines to Deliver*
Sample #:	***Sample Location***	

Sample Location Info

Sample Data

Date:________________ Time:________________

Sampler:________________ Weather:________________

Sampling Device: Wipe / Other

Wipe Area: ________ x ____________

Container	Quantity	Preservative

Description Data

Organic Vapor Reading: ______________________ Instrument:______________________

Appearance:

Comments:

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BORING LOG

	PROJECT:	SITE ID:__________
	LOCATION:	SHEET:_____ of _____
		PROJECT NO:__________
		WEATHER:__________

CONTRACTOR:__________
OPERATOR:__________
F&O REPRESENTATIVE:__________
DRILLING METHOD:__________
SAMPLING METHOD:__________
HAMMER WT:__________HAMMER FALL (IN)__________
BORING LOCATION:__________
GROUND ELEVATION:__________
DATE STARTED: __________
SAMPLE PREFIX:__________

WATER LEVEL MEASUREMENTS

DATE	MS. PT.	WATER AT	TIME

TIME AND DATE OF COMPLETION: __________

DEPTH (FT)	SAMPLE No. AND TIME	SAMPLE DEPTH (FT)	SAMPLE JARS/ PRE-SERVATIVE	REC/ PEN	BLOWS 6"	SAMPLE DESCRIPTION	STRATA CHANGE	LITHO-LOGIC CODE	FIELD TESTING

BORING DIAMETER	BORING METHOD	DEPTH

REMARKS
Field Instrument= If refusal is encountered, describe all efforts used to confirm.

Field Decon: Yes / No / Dedicated Device

PROPORTIONS USED:

trace	0 to 10%	some	20 to 35%
little	10 to 20%	and	35 to 50%

EXAMPLE DESCRIPTION:
SAND, f-c; some f-c gravel; little silt; trace clay. Moist. Loose. 10R5/4.

Reviewed by Staff:

BACKFILL

Native Material	__________	To __________	See Monitoring Well
Bentonite Grout/Chips	__________	To __________	Completion Report
Concrete/Asphalt	__________	To __________	

Other _______ _______ **To**
____

ROCK CORE LOG SITE ID:__________

FUSS & O'NEILL

	PROJECT: LOCATION:	SHEET ______ OF ______ PROJECT NO.: ______

DRILLING CO.:	DATE STARTED:	DATE FINISHED:
DRILLER:	GROUND ELEVATION:	
CORING METHOD:	CORE DIAMETER:	
FUSS & O'NEILL REPRESENTATIVE:		

DEPTH	COMMENTS	CORE RECOVERY/RQD			DISCONTINUITIES		LITHOLOGY
(ft)	TESTS INSTRUMENTATION CORING RATE AND SMOOTHNESS CORING FLUID/LOSS	CORE RUN LENGTH AND RECOVERY (%)	CORE LOSS ZONE	RQD	FRACTURE PER FOOT	DESCRIPTION TIGHTNESS ORIENTATION SPACING ALTERATION PLANARITY STAINING SMOOTHNESS WEATHERING FILLING STRUCTURE	MINERALOGY CEMETATION CLASSIFICATION HARDNESS COLOR WEATHERED STATE GRAIN SIZE TEXTURE ALTERATION ORIENTATION FORMATION NAME SPACING

FUSS & O'NEILL
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UST Excavation Field Data Sheet

Client/Project Name: ______________________________

Project Location: ______________________________

PROJECT #: ____________________	***SITE ID:*** ____________________
Sampler Name: ____________________	***Weather:*** ____________________
Tank ID: ____________________	***Date:*** ____________________

GENERAL CONTRACTOR:

LIQUID DISPOSAL:
Hauler Name: ____________________
Disposal Site Name: ____________________
Quantity: ______________ gallons

TANK DISPOSAL:
Hauler Name: ____________________
Disposal Site Name: ____________________

SOIL DISPOSAL: (Separate FDS required)
Disposal Site Name: ____________________
Estimated Quantity: __________ cubic yards
Location of Stockpile: ____________________

TANK DATA

Data Removed: ____________________ Dimensions: Diameter: ________ft. X Length: ________ ft.
Capacity: ______________gallons

Tank Material: Steel / Fiberglass / Other (describe) ____________________

TANK CONDITION
________ Good (not visibly deteriorated)
________ Fair (some corrosion, no obvious signs of tank failure)
________ Poor (visible holes, obvious failure)
________Tank Not Inspected

Tank Used For: ____Gasoline ____Diesel ____Waste Oil ____#2 Oil ____#4 Oil ____#6 Oil ____Other (describe)

Comments:

FIELD OBSERVATIONS

EXCAVATION DETAILS

Generic Soil Description: ______________________________ (Sand/Gravel/etc.)

Evidence of Bedrock? No__________ Yes__________ Depth__________
Groundwater Present? No__________ Yes__________ Depth__________

Comments:

- **Attach sketch showing limits and dimensions of excavation and stockpile(s) and indicate sample locations with sample IDs**
- **Confirm north arrow**
- **Describe pipe trench sampling**
- **Describe condition (staining, discoloration, etc.) of concrete pad**

WELL ID	PRIOR TO SLUG TEST				SLUG INSTALLATION		SLUG TESTING						
	DEPTH TO WATER	DEPTH TO BOTTOM	MEA. POIN T	TIME	SLUG TYPE	TIME INSTALL	TEST #	DEPTH TO WATER	REFERENCE PRESSURE	START TIME	STOP TIME	FINAL PRESSURE	DEPTH TO WATER FINAL

SLUG TESTING FIELD DATA SHEET

Comments:

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PROJECT NAME:	PROJECT #:	LOCATION:
DATE:	WEATHER:	INITIALS:

INTRODUCTION

Samples collected during field investigations and other activities are always subject to potential review by regulatory agencies and/or subpoena for litigation purposes. In order to document that control of the samples has been maintained at all times, it is necessary to utilize chain-of-custody forms to document where the sample is at all times from collection in the field to analysis in the laboratory.

CHAIN-OF-CUSTODY RECORDS

Chains-of-custody (COC) forms consist of four copies. One copy is kept by each person who has had custody. At a minimum, COCs will include the following information:

- Chain-of-custody identification number
- Project/client name
- Project location
- Project number
- Laboratory conducting analysis
- Name/location of party to receive laboratory report
- Name/location of party to receive laboratory invoice
- Sample number
- Sample type
- Number and type of sample containers
- Type of preservatives
- Signature and affiliation of sampler
- Date and time of collection
- Signatures of people involved in chain of possession
- Dates and times of sample transfer

A sample of a completed COC is attached.

With each transfer of the samples from one person to another or to a sample refrigerator, the transfer must be documented. All samples listed on the COC must be verified as being present by both the person relinquishing the samples and the one receiving them. This verification is documented by checking the appropriate transfer box for each sample on the right side of the COC.

1. When the sampler relinquishes the samples to someone else or to the sample refrigerator, the first transfer box is checked and the sampler signs the bottom of the COC as "relinquisher".

2. The person receiving the samples verifies that all samples are present and signs the bottom of the COC to accept the samples and documents the date and time. If the samples are relinquished to the Sample Refrigerator in one of the Fuss & O'Neill offices, the

"relinquisher" documents the receiver as "F&O Fridge".

3. The "relinquisher" keeps the last copy of the COC.

4. With each subsequent transfer of the samples, the last person to accept custody of the samples completes the transfer by checking the next transfer box for each sample and signing the COC.

5. The person receiving the samples verifies that the transfer boxes have been checked and signs the COC to acknowledge receipt.

6. The "relinquisher" keeps the last copy of the COC and forwards it to the project manager or his/her designee. When samples are relinquished from the F&O Fridge, they must be removed by F&O personnel. A copy of the COC is to be left in the filing basket in the field operations laboratory.

7. If subsequent transfers of the samples are made, steps 4 through 6 are repeated as necessary.

Each Fuss & O'Neill COC allows for samples to be transferred up to four times. If more than four transfers are necessary, additional COCs will be completed until the samples arrive at the laboratory. The original record will be returned to Fuss & O'Neill with the sample analysis report.

FUSS & O'NEILL
Disciplines to Deliver
(860) 646-2469 • www.FandO.com

- ❑ 146 Hartford Road, Manchester, CT 06040
- ❑ 56 Quarry Road, Trumbull, CT 06611
- ❑ 1419 Richland Street, Columbia, SC 29201
- ❑ 78 Interstate Drive, West Springfield, MA 01089
- ❑ 610 Lynndale Court, Suite E, Greenville, NC 27858
- ❑ 24 Madison Avenue Extension, Albany, NY 12203
- ❑ 275 Promenade Street, Suite 350, Providence, RI 02908
- ❑ 80 Washington Street, Suite 301, Poughkeepsie, NY 12601
- ❑ Other ________

CHAIN-OF-CUSTODY RECORD 18378

Turnaround

❑ 1 Day* ❑ 2 Days* ❑ 3 Days* ❑ Standard (____ days) ❑ Other ______ (days)
*Surcharge Applies

PROJECT NAME	PROJECT LOCATION	PROJECT NUMBER	LABORATORY

REPORT TO:

INVOICE TO:

P.O. NO.:

Sampler's Signature: Date:

Source Codes:
MW=Monitoring Well PW=Potable Water S=Soil W=Waste
SW=Surface Water T=Treatment Facility B=Sediment A=Air
X=Other ________

Analysis Request

Containers

Item No.	Transfer Check 1	2	3	4	Sample Number	Source Code	Date Sampled	Time Sampled									Soil VOA Vial, [ ] methanol	Soil VOA Vial, [ ] water	Glass Soil Container ( ) oz	Glass Soil Container ( ) oz	Other:	Water VOA Vial, [ ] As is [ ] HCl	Glass Amber ( ) ml, [ ] As is [ ] H_2SO_4	Plastic - As is, [ ] 250 ml [ ] 500 [ ] 1000 ml	Plastic - H_2SO_4, [ ] 250 ml [ ] 500 ml	Plastic - HNO_3, 250 ml [ ] Filtered [ ] Unfiltered	Plastic - NaOH, 250 ml	Comments

Transfer Number	Relinquished By	Accepted By	Date	Time
1				
2				
3				
4				

Reporting and Detection Limit Requirements:

Additional Comments:

INTRODUCTION

It is important to clearly communicate to the laboratory the analytical parameters that are being requested. When a large number of samples is being collected, it can be time consuming to write the parameter list repeatedly. Fuss & O'Neill has developed analytical parameter request forms (APRFs) which can be used to list all analyses for groups of samples thus simplifying the process of completing chains-of-custody. Instead of writing the parameters on the COC, samplers can simply write "See APRF" and attach the form to the COC.

ANALYTICAL PARAMETER REQUEST FORM

When used, the APRFs are to be submitted to the laboratory with the chain-of-custody forms. A sample APRF is attached to this SOP. Information to be provided on the APRF includes:

- Project/client name
- Project number
- Laboratory performing the sample analysis
- Date of sample collection
- Date the sample was relinquished to the laboratory
- Who to send reports and invoices to
- Sample numbers and chain-of-custody numbers
- Laboratory analyses to be performed

Field personnel will keep a copy of the analytical parameter request form and return it to Fuss & O'Neill attached to the copies of the chain-of-custody records.

Analytical Parameter Request

Project #:	Date Sampled:	FUSS & O'NEILL *Disciplines to Deliver*
Project Name:	Date Submitted:	
Laboratory	Submittor: Fuss & O'Neill, Inc.	

Report To:	Attention:

Invoice to: Mailing Address: City, State, Zip: Special Instructions:	Attention: Phone #:

COC #	Sample ID	COC #	Sample ID	COC #	Sample ID

Comments:		
		Blank(s) included in sample
		Duplicate(s) included in sample

<u>Requested Parameters</u>

INTRODUCTION

All samples collected by Fuss & O'Neill during investigations and other activities are subject to potential review by regulatory agencies and/or subpoena for litigation purposes. The field data sheets and chains-of-custody are used to document sample collection and transfers between collection and arrival at the laboratory. In order to maintain a comprehensive record of samples collected, log books are kept in the Field Operations area in each office.

SAMPLE LOGBOOKS

There are two sample logbooks in every F&O office: a refrigerator logbook and a "master" sample logbook. Every sample collected by F&O employees will be recorded in the "master" logbook in each F&O office. The logbook will contain:

- job name
- job number
- date collected
- sample id
- sample location
- initials of sampler
- where the samples were relinquished on what date

The refrigerator logbook will only be filled out if the samples are relinquished to the F&O refrigerator in each respective office. The refrigerator logbook will contain:

- job name
- job number
- date collected
- chain of custody id
- initials of sampler
- dates of relinquishing

See section 030100 for relinquishing procedures.

INTRODUCTION

Sample handling procedures are important for preserving the quality of data collected in the field.

SAMPLE HANDLING

Field samples are to be collected in lab-supplied containers. The type of container used will depend upon the analysis to be conducted. Samples will be preserved in the field with ice packs or ice and lab-supplied chemicals according to the instructions of the laboratory. The pH of the samples will be verified in the field after preservation by pouring a small amount of the sample onto a piece of pH paper.

Liquid samples collected for volatile organic analyses will be preserved with HCl to a pH of <2. Any acid used for preservation will be added to the VOA vial before the sample is collected to ensure that adequate mixing occurs. The vial will not be reopened once it has been properly sealed.

Once any necessary pH adjustments have been made, the sample container will be placed in a cooler to reduce the temperature to approximately 4 degrees Celsius. **The outside of the sample container will be rinsed with tap water before it is placed into the cooler**.

A chain-of-custody form, establishing the party responsible for the samples, will be filled out in the field after sample collection. This form will document the entire history of sample custody and all transfers of sample possession. A description of a chain-of-custody form is provided in the section entitled "Documentation of Field Activities." Once the sample information has been entered, field personnel will sign the form in the lower left-hand corner, noting also their affiliation with Fuss & O'Neill, the date and the time. The samples will then remain in the custody of the sample collector until that person relinquishes them to another party as discussed in Standard Operating Procedure No. 030100.

RELINQUISHING SAMPLES DIRECTLY TO THE LABORATORY

Under most circumstances, samples are transported from the site directly to the laboratory. Upon arriving at the laboratory, the sample collector will sign the chain-of- custody, thereby relinquishing the samples to the laboratory. The laboratory technician accepting the samples will make sure that all of the sample containers are present by checking transfer box next to each sample. The technician will then sign the chain-of-custody as well as record the date and time of sample transfer to acknowledge the transaction. The last sheet of the chain-of-custody will be retained by the sample collector, to be returned to Fuss & O'Neill.

RELINQUISHING SAMPLES TO THE REFRIGERATOR

Samples will be transferred to the refrigerator when they cannot be taken to the laboratory directly, or when the laboratory has agreed to pick them up at Fuss & O'Neill. Upon arriving at Fuss & O'Neill, the sample collector will unlock the refrigerator. As samples are transferred from the coolers to the refrigerator, the sample collector will check the box next to each sample to be sure that all samples are present. The sample collector will then sign the chain-of-custody, writing "F&O refrigerator" as the receiving party. The date and time at which the samples were placed into the refrigerator will also be recorded. The chain-of-custody will remain in the refrigerator with the samples. The serial number of each chain-of-custody form will be recorded in the refrigerator log book along with the sample collector's initials, the date and the time. The refrigerator will then be locked.

The samples must be relinquished from the refrigerator to the F&O employee who will transfer them to the laboratory. As samples are removed from the refrigerator, they will be checked against the chain-of-custodies to be certain that all are properly accounted for. The F&O employee will then write "F&O refrigerator" as the relinquishing party and sign to accept the samples. In addition, that person will write the date and the time of the transfer on the chain-of-custody as well as in the sample log book. Transfer of the samples from the F&O employee to the laboratory will then follow the procedure outlined in "Transferring the Samples Directly to the Laboratory," above.

INTRODUCTION

Decontamination of personal protective equipment (PPE) and field equipment is required when conducting activities which involve contact with hazardous materials.

The use of PPE and proper decontamination of PPE reduces the risk of exposure to hazardous materials. Field personnel should consult project personnel and relevant site-specific documents in order to determine the nature of the contamination at the site and the correct PPE to use while conducting site activities.

Field equipment and instruments which encounter hazardous materials or contamination must be decontaminated. If thorough decontamination is to be conducted in-house, all equipment must nevertheless be cleaned of all obvious contamination prior to leaving the site. A description of field cleaning and decontamination requirements for equipment and instruments and in-house decontamination techniques are described below.

FIELD DECONTAMINATION OF PERSONAL PROTECTIVE EQUIPMENT

Personal protective equipment which comes into contact with the sample will be replaced or decontaminated in the field between sampling locations.

In most cases, only gloves will need to be decontaminated or replaced between sampling locations to prevent the inadvertent cross-contamination of samples. With gloves on, field personnel will wash their hands in the following reagent sequence: non-phosphate soap solution scrub, tap water rinse, 20% methanol solution scrub and a final deionized water rinse. This procedure will be upgraded depending on the nature of the contamination.

All contaminated/soiled PPE will be discarded or decontaminated prior to leaving the site. The removal of this equipment will be undertaken outside of the exclusion zone, if one has been established, in the following order.

1. Tyvek suits will be removed and discarded.

2. Boots will at least be rinsed with water prior to being removed. The boot wash procedure will be upgraded depending on the nature of the contamination. Under some circumstances, disposable boots may be used and discarded prior to leaving the site.

3. When a respirator is utilized, it will be worn until all personal protective equipment except the gloves has been removed. The respirator will be washed with soap and water and wiped down with alcohol after use. Respirator cartridges will be discarded.

4. Gloves will be removed after all other personal protective equipment has been properly decontaminated and removed. They will either be decontaminated or discarded prior to leaving the site. Glove decontamination will follow the procedure outlined above.

FIELD DECONTAMINATION OF SAMPLING EQUIPMENT

Decontamination of field equipment must be conducted in the following two situations:

- When the same piece of sampling equipment is to be used at more than one sampling point
- Prior to removing equipment from a site

Equipment which comes into direct contact with the sample must be thoroughly decontaminated between sampling points in order to prevent cross-contamination. A description of field decontamination procedures for different types of equipment is included in sections pertaining to their use in the field. The decontamination procedure generally consists of the following sequence: non-phosphate detergent scrub, tap water rinse, 20% methanol solution scrub, deionized water rinse, 10% nitric acid solution rinse and a final deionized water rinse. In general, equipment must be disassembled in order to be adequately decontaminated.

In addition, all equipment, instruments and containers must be cleaned of obvious contamination prior to leaving the site. This practice reduces the possibility of transporting contamination off-site. This practice also protects subsequent handlers of these items from inadvertent exposure to chemicals or contamination.

All water-resistant equipment shall at least be cleaned with a non-phosphate detergent scrub and a water rinse. Grossly contaminated items, such as bailers utilized for the sampling of pure product, may require full field decontamination prior to removal from the site. Any field equipment which requires more extensive, in-house decontamination after treatment in the field will be stored in plastic bags or bins for transport to the Fuss & O'Neill facility. A description of in-house decontamination methods is provided below.

Water-sensitive equipment and all field instruments must be wiped down with a moist paper towel to remove debris and contamination prior to leaving a site.

The outside surface of containers is often covered with contamination and/or corrosive preservatives. **Consequently, sealed sample containers must be rinsed with tap water in the field before the samples are placed in the cooler**. This measure will reduce the possibility that subsequent handlers will be exposed to contamination and/or hazardous preservatives.

When the sampling vehicle comes into contact with excessive mud or dirt as a result of field activities, it should be washed as soon as possible. Field personnel often have access to water which may be used to clean the truck before leaving the site. When no such water is available on-site, the truck will be taken to a car wash. Both the outside of the truck and the cab will be cleaned when necessary. When the underside of the truck is washed, special emphasis will be placed on cleaning the mud off the brakes.

IN-HOUSE DECONTAMINATION OF SAMPLING EQUIPMENT

All sampling equipment will be fully disassembled and decontaminated between sampling events as described below. Decontamination procedures may vary slightly depending upon how the equipment will be used.

Equipment will be decontaminated in-house as follows: non-phosphate detergent scrub, tap water rinse, 20% methanol solution scrub, deionized water rinse, 10% hydrochloric acid solution rinse, and deionized water rinse. A double bottom stainless steel pan will be used during the acid rinse to collect all rinsate which must be neutralized to approximately pH 7 before disposal. Equipment will be allowed to air dry before it is wrapped in a protective aluminum foil covering.

This SOP applies to "purge and sample" groundwater techniques, not low-stress or low-flow sampling.

SAMPLING EQUIPMENT

The following list includes the equipment which may be necessary to perform the monitoring and sampling of groundwater:

1. DOCUMENTATION

- Field folders (maps, sampling and H&S plans, etc.)
- Logbook
- Pen and permanent marker
- Field data sheets
- Sample labels
- Parameter request forms
- Chain-of-custody forms

2. PERSONAL EQUIPMENT

- Disposable gloves
- Equipment required by Site Safety Plan
- Ruler or small tape measure
- Hand sprayers
- Paper towels
- Plastic garbage bags
- Bucket
- pH paper
- Scissors
- Extra locks
- Bolt cutters

3. SAMPLING EQUIPMENT

- Water level measurement devices
- Groundwater pumps with tubing and power source
- Bailers
- Rope
- Sample containers for field parameters
- pH meter with probe and calibration solutions
- Specific conductance meter/thermometer
- Filter cartridge
- Coolers with ice packs or ice
- Dissolved Oxygen meter (when applicable)
- Oxidation/Reduction Potential meter (when applicable)

- Turbidity meter (when applicable)

4. DECONTAMINATION EQUIPMENT

- Non-phosphate detergent
- Nitric acid solution
- Methanol solution
- Deionized water
- Tap water

5. SITE-SPECIFIC EQUIPMENT

- Keys to site facilities (when applicable)
- Keys to well locks
- Sample containers for lab parameters
- Sample preservatives

PROCEDURE CHECK-LIST FOR GROUNDWATER SAMPLING

1. Unlock the well.

2. Perform any air monitoring required by the Site Health and Safety Plan.

3. Measure and record the static water level.

4. Measure and record the level of any immiscible layers when required by the monitoring plan.

5. Measure and record the depth of the bottom of the well.

6. Complete monitoring well condition check-list on field data sheet.

7. Decontaminate water level measuring equipment and/or the interface probe.

8. Place a piece of plastic on the ground around the well and set up purging equipment.

9. Purge three well volumes from the well or purge until field parameters have stabilized, as indicated by the monitoring plan. Record purging information on the field data sheet.

10. Set up equipment required to collect samples on plastic covering.

11. Collect samples in order specified in "Parameter Sampling Order," below.

12. Conduct field parameter monitoring as required by the sampling plan.

13. Record sample collection information on the field data sheet.

14. Filter samples if necessary.

15. Preserve samples as necessary with laboratory-provided reagents and coolers filled with ice or ice packs.

16. Close and lock the well.

17. Decontaminate purging and sampling equipment if necessary.

WATER LEVEL MEASUREMENT

Measurement of the depth to water as well as the depth of the bottom of the well will be made at all sampling locations prior to purging. The determination of the depth to water will be made with a fiberglass plunker tape or an electronic device, such as an electric flat tape or an M-scope. The depth of the bottom of the well will be measured using only a mechanical measuring device due to the fact that electronic probes are often not designed to withstand pressures which exceed atmospheric pressure. Both distances will be measured at an accuracy of 0.01 feet.

All measurements should be made relative to an established reference point on the well. This point will be established in relation to a National Geodetic Vertical Datum (NGVD). On recently installed wells, this point will be marked by a notch in the PVC. If there is no such location marked and the PVC is uneven, the measurement will be taken from the highest point on the PVC. In addition, water level measurements will also be made relative to the top of the protective steel casing (TPS). When sampling, both PVC and TPS measurements will be recorded on a field data sheet. When no sampling is conducted, water level measurements will be recorded on a water level data sheet (Figure 050300) instead of a field data sheet. In the event that no PVC is present, or the PVC is too low to serve as a convenient reference point, water level measurements will be referenced only to the TPS.

Total depth measurements will be compared to original well depths to determine the degree of siltation which may have occurred. This information will be recorded on the field data sheet for monitoring well sampling. Should this data indicate that a significant amount of silt has accumulated in any monitor well, the well will be re-developed by an appropriate method, preferably prior to the next sampling event.

Regardless of the type of measuring device used, it will be thoroughly decontaminated between wells. Paper towels, saturated with a methanol solution, will be used to wipe off the device as it is retrieved from the well. The device will then be rinsed with D.I. water and stored in a clean area such as a plastic bag until it is used again. This decontamination procedure will be upgraded according to the nature of the contamination.

DETECTION OF IMMISCIBLE LAYERS

When it has been determined that there is a possibility of free phase insoluble organic liquid contamination, monitoring wells will be checked for the presence of these liquids prior to first-time purging. Upon opening the well cap, headspace in the well will be monitored with a portable photoionization or flame ionization detector for organic vapors which might exist in the presence of floating volatile organics (i.e. gasoline). Field personnel will then measure the depth to liquid to within 0.01 feet. Once the depth to liquid is established, immiscible layers throughout the rest of the water column will be measured with an interface probe relative to this point.

SAMPLING OF IMMISCIBLE LAYERS

When the sampling of immiscible layers is required, it will be conducted prior to monitoring well purging. Layers of light phase organic liquids with thicknesses greater than two feet will be sampled with a bottom valve bailer. If the immiscible layer is thinner than two feet, but is within suction limits, it may be sampled by peristaltic pump. Otherwise, a top-filling bailer will be utilized.

When a bottom-filling bailer is utilized for sampling, it will be carefully lowered until the bottom of the bailer is within the immiscible layer. The bailer will then be carefully withdrawn from the well and the sample collected in an appropriate sample container.

Light phase immiscible layers may be sampled by peristaltic pump by inserting the pump tubing directly into the liquid. Methods of sampling with a peristaltic pump are discussed in "Methods of Groundwater Sampling," detailed later in the text.

The top-filling bailer is the most appropriate method for sampling very thin light phase immiscible layers. The bailer will be lowered carefully into the well until its top is level with the upper-most portion of the floating layer. The sample will then be collected by lowering the bailer an additional distance equal to one-half the thickness of the immiscible layer. The bailer will then be carefully withdrawn and the sample collected.

Dense phase immiscibles are located at the bottom of the water column and are, therefore, most effectively sampled with a double check valve bailer. These samples will be collected by slowly lowering the bailer to the bottom of the well and then carefully retrieving it. Samples collected with a bladder or peristaltic pump are also acceptable when the dense phase immiscible layer is more than two feet thick, provided that the intake of the pump is within that layer. Methods of sampling with these pumps are discussed in "Methods of Groundwater Sampling," below.

Dedicated bailers used for the sampling of insoluble organic compounds will be constructed of stainless steel, Teflon or dedicated PVC. Equipment which is not stored in the well between sampling events will be decontaminated prior to use at each well location. In-house decontamination procedures are discussed in another part of the text. Under some circumstances it may be necessary to conduct this operation in the field.

Equipment will be decontaminated in the field by the following reagent sequence: non-phosphate detergent scrub, tap water rinse, 20% methanol solution scrub, deionized water rinse, 10% hydrochloric or nitric acid solution rinse, deionized water rinse. The dedicated nylon rope used to lower and retrieve the bailer from the well will be discarded between well locations.

When a peristaltic pump is used, the pump tubing will be the only part to come into contact with the sample. Tubing utilized in the sampling of immiscible layers will be constructed of inert materials and thoroughly decontaminated or replaced prior to any additional sample collection.

A bladder pump will be decontaminated between sample locations if it is not permanently dedicated in the well. In this process, the outside of the pump will first be rinsed with a 20% methanol solution and then rinsed with deionized water. The apparatus will then be placed in a bucket containing non-phosphate detergent. Once a volume of two gallons is pumped through the device, the detergent will be replaced with tap water followed by a 20% methanol solution and the pumping process will be repeated. The final rinse will be with deionized water. The bladder pump will be allowed to dry and stored in a clean location until it is used again.

PURGE AND SAMPLE PROCEDURE FOR GROUNDWATER MONITORING

CALCULATION OF PURGE VOLUMES

A minimum of three well volumes must be purged from high and moderate yield wells prior to sampling in order to arrive at a representative sample of the aquifer. This volume will be calculated by multiplying the height of the water column by the following conversion factors:

Nominal Well ID (inches)	Well Volume (gal/feet)	Conversion Factor (gal/feet x 3)
1	0.04	0.13
1.25	0.08	0.23
1.5	0.11	0.32
2	0.17	0.52
3	0.38	1.15
4	0.6	1.99
6	1.50	4.51
8	2.60	7.79
12	5.82	17.5

Low yield wells will be purged until they go dry unless this amount exceeds three well volumes.

MONITORING WELL PURGING TECHNIQUES

The rate of monitoring well purging will correspond as closely as possible to the yield of the well, particularly when that yield is low. Efforts will be made to prevent evacuation rates which may cause cascading of water into the well, as this results in aeration of the groundwater and a loss of volatile organics. The yield will also determine the depth from which water is purged. Wells will be purged from the top of the water column to draw fresh water into the screen. When the yield is moderate to low, purging may be conducted from within the screened interval.

The methods by which monitoring well water may be purged are described below.

EVACUATION BY MEANS OF A BAILER

Bailers will be constructed from inert materials such as stainless steel or Teflon. Dedicated nylon rope will be used to lower and retrieve the bailer from the well. The rope will be withdrawn with clean gloves and handled in such a way that it will not be contaminated by coming into contact with the ground at any time. To further prevent contamination of purging equipment, sampling personnel will position a clean four foot square plastic covering on the ground around the well over which to work.

The volume of water evacuated from the well will be measured with a five gallon bucket prior to disposal.

Equipment will be decontaminated in-house between sampling events. In-house decontamination techniques are discussed SOP 040000. In some circumstances decontamination may also have to be done in the field. This procedure will be carried out following SOP 040000. A protective aluminum foil covering will be wrapped around the outside of the bailer prior to use in order to protect it from contamination.

The following procedure will be followed when purging is conducted with a bailer:

1. Wearing clean gloves, remove foil wrapper from decontaminated bailer.

2. Measure a piece of dedicated nylon rope long enough to reach the bottom of the well and attach this rope to the bailer with a bowline knot.

3. Lower the bailer gently into the top of the water column.

4. Withdraw the bailer from the well, holding the rope in your hands to prevent it from touching the ground.

5. Pour the water from the bailer into a bucket graduated for purge volume measurement.

6. Repeat this operation until the correct purge volume has been attained.

EVACUATION BY MEANS OF A PERISTALTIC PUMP

One end of a length of decontaminated tubing will be inserted into the top of the water column after water level measurements have been obtained. The other end of this tubing will be connected to a peristaltic pump. Tubing will be constructed from tygon or silicone. The pump will be powered by an internal or portable 12-volt battery unless access to the well is such that it can be plugged into the battery of a sampling vehicle.

If the tubing is not dedicated, it will be decontaminated between sampling locations. In-house decontamination procedures are discussed in SOP 040000. This operation may be carried out in the field by following SOP 040000. Any part of the outside of the tubing which comes into contact with the well or the sample container will be decontaminated in the same way.

The rate of purging will be measured with a five gallon bucket and this value will be used to calculate the total required purge time. The pump may be left unattended during purging, unless the nature of the contamination requires that the purge water be strictly collected.

EVACUATION BY MEANS OF A SUBMERSIBLE PUMP

A decontaminated portable submersible pump will be lowered into the well. A braided tubing line will extend from the submersible pump to the top of the well. Manipulation of sample tubing will always be carried out while wearing clean gloves to minimize cross-contamination. Enough tubing will protrude from the well once the pump is in place to allow for the measurement and collection of purge water. At no time will this excess tubing come into contact with the ground while it is outside of the well.

The pump will be linked to an external power source by a coated power cord. To prevent gasoline contamination of the samples when a generator is used, the generator will be positioned at some distance downwind and, when necessary, it will be handled with disposable vinyl gloves which are dedicated for that purpose.

Both the cable and the power cord will be decontaminated in accordance with SOP 040000. The decontaminated pump will be stored in a clean location, such as a plastic bag, until it is reused.

EVACUATION BY MEANS OF AN INERTIAL PUMP

The inertial pump assembly will consist of a length of dedicated tubing terminated by a foot valve. Tubing will be constructed from inert materials such as high density polyethylene or

Teflon. Materials used in the construction of the foot valve will include either Delrin plastic or stainless steel. This assembly will be inserted into the well until the foot valve is within the screen. A stainless steel handle will be attached to the other end of the tubing by which to raise and lower the assembly in the well. Water entering the tubing as a result of this surging motion will be held by the foot valve. After each surge, the column of water within the tubing will increase until it can be collected at the well head.

If the tubing is not stored in the well between sampling events, it will be replaced or decontaminated in-house in accordance with SOP 040000.

METHODS OF GROUNDWATER SAMPLING

Of the three types of purging equipment described above, all but the submersible pumps are acceptable for sampling all parameters. The submersible pumps may be used to sample for inorganic parameters only due to the fact that it may slightly aerate the sample. Samples to be analyzed for volatile or semi-volatile organic compounds will be collected with a bailer, bladder pump or other approved device. Once a well has been purged with a submersible pump, it will be sampled for organics with an acceptable sampling device.

Samples from high yield wells will generally be collected immediately, but no longer than 24 hours after purging. Low-yield wells will be sampled for each parameter as soon as there is sufficient volume.

Samples will be collected from within the screened interval unless non-aqueous phase liquids (NAPLS) are present, or as otherwise indicated.

All sampling equipment, including sample containers, will be placed on a clean four foot square plastic ground covering to prevent contact with soils around the well. In addition, field personnel will handle this equipment while wearing clean gloves.

During the collection of samples for volatile and semi- volatile organics analysis, the stream of water will be directed toward the inside wall of the sample container so as to minimize the aeration that occurs due to turbulence in the sample container. Once a VOA vial has been sealed, it will be inverted and gently tapped against the wrist of the sample collector. If any bubbles are observed, the vial will be reopened and the sample discarded. The proper preservative will be added to the vial and a new sample will then be collected. This process will be repeated until a sample with no air bubbles is obtained.

Samples collected for bacterial analysis will be taken with clean, dedicated gloves. Field personnel will not touch anything but the sample container with these gloves prior to taking the sample. Gloves will be changed immediately before collecting the next sample. In addition, at no point will anything other than the sample touch the inside of the bacterial bottle.

Field parameters will be monitored after groundwater samples have been collected. Field parameter monitoring techniques are discussed later in the text.

BAILER TECHNIQUE

Groundwater sampling will be performed using pre-cleaned stainless steel bailers. The protocol for sampling of groundwater with a bailer is as follows:

a. Measure the depth to water and depth to the bottom of the height of the sampling well. Calculate three volumes of the water column, which is the amount to be purged. Record all measurements and calculations on a Monitoring Well Field Data Sheet.

b. Place a plastic sheet on the ground next to the sampling well. Cut a length of dedicated cord which is long enough to reach the center of the screened interval of the sampling well. Attach the cord to the bailer and place on the sheet of plastic. This will prevent contamination from ground surface materials.

c. Begin purging the monitoring well by lowering the bailer to just above the top of the water column, and then slowly lower the bailer through the water column to the screened interval. Retrieve the bailer slowly to the well head. Pour the water from the bailer into a five gallon bucket.

d. Continue this process until three well volumes of water have been purged, or the well has been bailed dry.

e. Record time of purge, well recovery and amount of water purged from the monitoring well prior to sampling.

f. Affix a sample label to each container for that particular location immediately prior to sampling.

g. Lower the bailer to just above the top of the water column, then slowly lower the bailer through the water column to the center of the screened interval.

h. If the well is purged with a device other than a bailer, lower the bailer used for sample collection into the well twice and remove that water prior to sample collection.

I. Collect samples in order of decreasing volatility.

j. Do not to agitate the sample, both during withdrawal from the well and collection in the sample container when sampling for volatile and semi-volatile organic compounds with a bailer. Tip the bailer so that a slow, laminar flow of water enters the VOA vial. Direct stream of water to the sides of the vial so as to prevent aeration of the sample due to turbulence. Fill no more than two VOA vials from a single bailer of water. Seal the vials with no headspace to prevent any further volatilization of the sample once it has been collected. After the lid is screwed on, turn the VOA vial over and tap on a hard surface and checked for bubbles.

k. Collect samples for all remaining parameters. Fill the remaining sample bottles to the base of the bottle neck.

l. Place all labeled sample containers in an iced cooler.

SAMPLING WITH AN INERTIAL PUMP

When sampling with an inertial pump, the tubing intake will remain within the screened interval at all times.

Prior to sampling for volatile and semi-volatile organic compounds, care will be taken not to agitate the sample, both during withdrawal from the well and collection in the sample containers. To minimize agitation, approximately eight feet of small diameter tubing will be inserted into the purge tubing. Two feet of this narrow diameter tubing will be allowed to protrude from the end of the purge tubing. Upon operating the pump, water will flow out of both lengths of tubing. When the pumping is stopped, water will flow out through the narrow diameter tubing only until the water in this tube reaches the same elevation as the discharge end of the purge tubing. The siphon action will be used to acquire small samples for volatile analysis, as the flow from the narrow tube is steady, laminar and easily directed into a small sampling vial. The stream of water will be directed along the inside wall of the VOA vial to further minimize aeration due to turbulence inside the sample container. VOA vials will be sealed with no headspace to prevent any further volatilization of the sample.

Samples for inorganic parameters may be collected by positioning the sample container directly under the discharge end of the tubing while operating the pump handle.

See SOPs 050010 and 050020 for field parameter measurements and field filtering.

INTRODUCTION

Specific conductance, pH and temperature will be measured at groundwater and surface water locations once all samples have been collected. Surface waters may also be measured for dissolved oxygen.

A sample for field parameter monitoring will be collected in a non-dedicated high-density polyethylene (HDPE) jar or similar container when it is not possible to measure these parameters in-situ. This is often the case for monitor wells and deep surface water sampling locations.

All field monitoring instruments have a designated instrument identification number and are calibrated daily at Fuss & O'Neill prior to use. The calibration process will be covered more fully in another section. The identification number of the meter will be recorded every time a reading is taken to provide a record of the accuracy of the instruments.

MEASUREMENT OF PH AND TEMPERATURE

pH and temperature readings will be taken with a YSI 63 meter or YSI 600XL multi-meter. These instruments are equipped with a combination pH and temperature probe as well as a microprocessor which automatically converts electron volts and temperature readings to pH units.

Prior to using the pH meter, the display will be checked to be sure that it has been calibrated to three standardized solutions. Instrument calibration will be discussed in a later section of the text. In addition, the accuracy of the meter will be checked against pH paper when pH readings are anomalous. The pH will be measured with an accuracy of +/- 0.01 pH units. The temperature will be measured to 0.1 degrees Celsius.

MEASUREMENT OF SPECIFIC CONDUCTANCE

Specific conductance readings will be taken with a digital instrument such as the YSI 63 or 85 meter. Specific conductivity will be measured with an accuracy of 1 μMhos/cm. Refer to <u>Section 120000</u> for operation of the instruments.

MEASUREMENT OF DISSOLVED OXYGEN

Dissolved oxygen readings will be taken with a YSI 85 Dissolved Oxygen Meter or YSI 600XL multi-meter. This parameter will be measured in-situ whenever possible, or in a flow through cell. Refer to <u>Section 140000</u> for operation of the instrument.

MEASUREMENT OF OXIDATION-REDUCTION POTENTIAL

Measurement of oxidation reduction potential (ORP) will be measured with a YSI 600XL multi-meter or equivalent. Refer to Section 140000 for operation of the instrument.

MEASUREMENT OF TURBIDITY

Turbidity will be measured with a Lamotte 2020 turbidimeter or equivalent. Refer to Section 140000 for operation of the instrument.

INTRODUCTION

Samples being analyzed for dissolved metals will be filtered in the field with a 0.45 micron pressure filter, unless otherwise noted by project staff (i.e. 10 micron filtering). This filter will be made of cellulose acetate or another approved material.

In some cases an unfiltered sample will be collected in an intermediate container and filtered into the final sample container. Otherwise, a disposable in-line filter cartridge will be used and filtered directly into the sample container.

Disposable Filter Cartridges: Self-contained disposable filter cartridges will be dedicated for each sampling location. The procedure is outlined below:

1. Obtain a peristaltic pump equipped with a length of new or decontaminated silicon tubing.

2. Attach the discharge end of the tubing to the intake end of the filter cartridge.

3. Place the intake end of the tubing into a small, clean container filled with deionized water. Position a spare empty container beneath the discharge end of the filter assembly.

4. Turn on the pump and purge the pump tubing and filter assembly with one (1) liter of deionized water.

5. Place the intake end of the tubing in the intermediate sample container just below the surface of the water.

6. Turn on the pump and allow a small quantity of sample to run through the pump tubing and filter assembly.

7. Remove the spare container and dispose of the liquid properly.

8. Position the final sample container beneath the discharge end of the filter assembly and turn on the pump.

Filters will be handled with clean gloves to minimize cross-contamination. The peristaltic pump tubing will be decontaminated between samples according to SOP 040000. The peristaltic pump is designed so that the sample is never in contact with any part other than the tubing.

INTRODUCTION

The purpose of low-flow sampling is to obtain a representative sample of the groundwater quality that includes both the dissolved and colloidal fractions that are migrating. Low-flow sample collection is a technique that allows samples to be collected without the bias of suspended solids and includes colloids.

The technique is based on the fact that laminar flow occurs through a well screen when the well is undisturbed. Samples are collected from the screen interval at flow rates that will not disturb the laminar flow or the fine grained material within the well or filter pack. Pumping stresses are minimized through controlled sampling operations. Objective criteria are used to determine when sampling should begin, thus variability between sampling events is minimized.

This procedure describes how samples of groundwater will be collected from monitoring wells using a bladder pump. The described decontamination, purging, and sampling procedures, intended to minimize pumping stress, are based on US Environmental Protection Agency, Region I, *Low Stress Purging and Sampling Procedure* (January 19, 2010). These procedures include descriptions of field measurements that are used to determine when sampling may begin.

APPLICABILITY

The finalized EPA procedure applies to Federal facilities, RCRA sites, and Superfund sites, and only to 1.5" or greater diameter monitoring wells that have fully submerged screens or open sections of 10 feet or less. If the site qualifies as above, the EPA procedure must be followed and any changes to the procedure must be approved by EPA and written into the site specific quality assurance project plan. The EPA procedure strongly discourages use of peristaltic pumps for collection of samples for VOC and dissolved gas analyses.

PERISTALTIC PUMPS

A peristaltic pump may be used for low-flow purging and sampling of wells at sampling well locations where the well diameter is too small for bladder pumps and can be used when the depth to groundwater is less than 20 feet.

The low-flow sampling system for peristaltic pumps is comprised of dedicated polyethylene tubing which is suspended in each of the sampling wells. The top of the tubing is connected to a stainless steel fitting secured to a milled PVC plastic cap which loosely fits the top of the PVC well casing and prevents the cap from sliding off the PVC. A small slot is cut into the side of the cap to allow for a water level measuring instrument to be lowered into the well without removal of the cap. This allows measurement of water levels without any disturbance of the sampling apparatus. A stainless steel fitting at the top of the cap allows connection of the sampling apparatus to peristaltic pump tubing.

The bottom of the tubing is centered at the midpoint of the screen and at a minimum of two feet above the well bottom to minimize disturbance of any fine-grained sediments that may have settled to the bottom of the well. The tubing is connected to a stainless steel fitting secured to a piece of PVC of a slightly smaller diameter than the well casing (a centralizer). The PVC centralizer and an additional piece of the PVC, which slides on the tubing, provide weight to keep the bottom of the tubing centered at the appropriate depth.

Groundwater is removed from the well through the tubing by suction provided by a peristaltic pump. The silicone tubing within the peristaltic pump is dedicated, of the same inside diameter as the well tubing, and is removed from the peristaltic pump after each use. The two types of tubing are joined with a tubing connector.

WATER LEVEL MEASUREMENTS

A water level measurement will be taken immediately after the well is opened. For shallow wells screened across the water table the water level will be used to determine the required depth to the pump intake (mid-point of the saturated screen length). A second water level measurement will be obtained after the pump has been installed and the water level has equilibrated.

WELL STABILIZATION

Prior to low flow purging, the tubing must first be purged of standing water. The determination of this purge volume is as follows:

Tubing radius	r	0.0104 feet
Tubing volume (ft^3)	V(ft^3)	πr^2 x length of tubing
Tubing volume (L)	V(L)	V(ft^3) x 28.316

Tubing Volume = Total Purge Volume

Begin purging the well at the minimum pumping rate. Slowly increase the pumping rate to a level that does not cause the well to drawdown more than 0.3 foot. Continue purging until the total purge volume has been met.

Continue to note and record any changes to the drawdown and pumping rate. Water levels in the well casing will be obtained with a water level indicator while pumping with the peristaltic pump is in progress. The variable speed of the peristaltic pump allows the pump to obtain flow rates as low as 0.1 liter per minute.

Begin monitoring designated indicator field parameters at 3 to 5 minute intervals with a flow-through cell. Stabilization parameters are pH, dissolved oxygen (DO), specific conductance, temperature, and turbidity. Oxidation/reduction potential (ORP) will be recorded during the stabilization process, but will not be used as a stabilization parameter. Research by Runnells and Lindberg (1990) and Whitfield (1974) has shown that there are limitations on monitoring ORP in the field.

The well is ready to sample when the designated field parameters have stabilized. Indicator field parameters have stabilized when three consecutive readings, taken at 3 to 5 minute intervals, satisfy the following criteria:

Temperature	± 3%
pH	± 0.1 unit
Specific Conductance	± 3%
DO	± 10% for values greater than 0.5 mg/L
Turbidity	± 10% for values greater than 5 NTU

Oxidation/reduction potential (ORP) will be recorded during the stabilization process, but will not be used as a stabilization parameter. Research by Runnells and Lindberg (1990) and Whitfield (1974) has shown that there are limitations on monitoring ORP in the field.

The target turbidity is three consecutive readings less than or equal to 5 NTUs. Every effort should be made to attain these levels, including decreasing the pumping rate and extending the purge time. In some instances, due to geologic conditions, the sample turbidity may not decrease to the desired level. In these cases, and with the approval of the Project Manager or Site Manager, completion of well purging will be based upon stabilization of the indicator parameters without attainment of the targeted turbidity.

Due to the configuration of the turbidity meter, it cannot be connected with the multi-parameter meter. Turbidity screening; therefore, must be conducted separately. To collect samples for measuring turbidity, the two-way valve located at the bottom of the flow-through cell is turned so that water will flow out through the sampling line. The water is collected and the turbidity is measured.

If, after 1 hour of purging, the indicator field parameters have not stabilized, then discontinue purging and proceed to sample the water. On a project specific basis, if target turbidities are not reached, a 10 micron glass wool in-line filter will be used to collect an additional dissolved metals sample. This is done to determine if metals are actually present in the dissolved state in groundwater, or has adhered to solid particles during sample collection. All efforts used to stabilize the parameters will be fully documented.

SAMPLING

The following procedure will be followed for the collection of groundwater samples.

After stabilization of indicator parameters or 1 hour of purging, record comments pertinent to the color and any obvious odors associated with the water.

Arrange and label necessary sample bottles and ensure that preservatives are added, as required. Labeling must include a unique sample number, time and date of sampling, the initials of the sampling personnel, and the identity of the sample fraction. Additionally, provide any information pertinent to the preservation materials or chemicals used in the sample. The pH of preserved samples should be checked to ensure that the proper sample pH has been attained. For VOC samples, collect a test sample to determine the adequacy of the amount of preservative in the pre-preserve sample bottles. Where needed, adjust the amount of preservative added to a sample bottle.

Make sure that the sampling tubing remains completely filled during sampling and that the water does not descend back into the well. Minimize turbulence when filling sample containers, especially VOCs, by allowing the liquid to run gently down the inside of the bottle. Fill the labeled sample bottles, and immediately seal each sample and place it on ice in a cooler to maintain sample integrity.

Once all sampling is completed, recover all sampling equipment and decontaminate or set aside for subsequent decontamination in accordance with the prescribed procedures. Close and secure the well site. Review all sampling records. Ensure that all necessary data is completed. Add additional information as needed.

DECONTAMINATION PROCEDURES

Equipment used for well purging and sampling shall be decontaminated in-house prior to its initial use and in the field after each subsequent use if necessary due to project-specific restraints. Pumps will not be removed from wells between purging and sampling operations. Detergent and organic solvents will be used sparingly in the decontamination process. If field decontamination is required, Standard Operating Procedure 040000 will be followed.

INTRODUCTION

The purpose of low-flow sampling is to obtain a representative sample of the groundwater quality that includes both the dissolved and colloidal fractions that are migrating. Low-flow sample collection is a technique that allows samples to be collected without the bias of suspended solids and includes colloids.

The technique is based on the fact that laminar flow occurs through a well screen when the well is undisturbed. Samples are collected from the screen interval at flow rates that will not disturb the laminar flow or the fine grained material within the well or filter pack. Pumping stresses are minimized through controlled sampling operations. Objective criteria are used to determine when sampling should begin, thus variability between sampling events is minimized.

This procedure describes how samples of groundwater will be collected from monitoring wells using a bladder pump. The described decontamination, purging, and sampling procedures, intended to minimize pumping stress, are based on US Environmental Protection Agency, Region I, *Low Stress Purging and Sampling Procedure* (January 19, 2010). These procedures include descriptions of field measurements that are used to determine when sampling may begin.

APPLICABILITY

The finalized EPA procedure applies to Federal facilities, RCRA sites, and Superfund sites, and only to 1.5” or greater diameter monitoring wells that have fully submerged screens or open sections of 10 feet or less. If the site qualifies as above, the EPA procedure must be followed and any changes to the procedure must be approved by EPA and written into the site specific quality assurance project plan.

WATER LEVEL MEASUREMENTS

A water level measurement will be taken immediately after the well is opened. For shallow wells screened across the water table the water level will be used to determine the required depth to the pump intake (mid-point of the saturated screen length). A second water level measurement will be obtained after the pump has been installed and the water level has equilibrated. The following procedure will be used to measure the water levels.

WELL STABILIZATION

Prior to low flow purging, the tubing and pump bladder must first be purged of standing water. The determination of this purge volume is as follows:

Tubing radius = r	= 0.0104 feet
Tubing volume (ft^3) = V(ft^3)	= πr^2 x length of tubing below water table
Tubing volume (L) = V(L)	= V(ft^3) x 28.316
Volume of Bladder Pump	= 0.300 L (Aquarius Model)
	= 0.200 L (Minnow Model)

Tubing Volume + Pump Bladder Volume = Total Purge Volume

Begin purging the well at the minimum pumping rate. Slowly increase the pumping rate to a level that does not cause the well to drawdown more than 0.3 foot (not more than 500 ml/min). Continue purging until the total purge volume has been met.

Begin monitoring designated indicator field parameters at 3 to 5 minute intervals with a flow-through cell. Stabilization parameters are pH, dissolved oxygen (DO), specific conductance, temperature, and turbidity. Oxidation/reduction potential (ORP) will be recorded during the stabilization process, but will not be used as a stabilization parameter. Research by Runnells and Lindberg (1990) and Whitfield (1974) has shown that there are limitations on monitoring ORP in the field.
Continue to note and record any changes to the drawdown and pumping rate.

Indicator field parameters have stabilized when three consecutive readings, taken at 3 to 5 minute intervals, satisfy the following criteria:

Temperature	± 3%
pH	± 0.1 unit
Specific Conductance	± 3%
DO	± 10% for values greater than 0.5 mg/L
Turbidity	± 10% for values greater than 5 NTU

The target turbidity is three consecutive readings less than or equal to 5 NTUs. Every effort should be made to attain these levels, including decreasing the pumping rate and extending the purge time. In some instances, due to geologic conditions, the sample turbidity may not decrease to the desired level. In these cases, and with the approval of the Project Manager or Site Manager, completion of well purging will be based upon stabilization of the indicator parameters without attainment of the targeted turbidity.

Due to the configuration of the turbidity meter, it cannot be connected with the multi-parameter meter. Turbidity screening; therefore, must be conducted separately. To collect samples for measuring turbidity, the two-way valve located at the bottom of the flow-through cell is turned so that water will flow out through the sampling line. The water is collected and the turbidity is measured.

If, after 1 hour of purging, the indicator field parameters have not stabilized, then discontinue purging and proceed to sample the water. On a project specific basis, if target turbidities are not reached, a 10 micron glass wool in-line filter will be used to collect an additional dissolved metals sample. This is done to determine if metals are actually present in the dissolved state in groundwater, or has adhered to solid particles during sample collection. All efforts used to stabilize the parameters will be fully documented.

SAMPLING

The following procedure will be followed for the collection of groundwater samples.

After stabilization of indicator parameters or 1 hour of purging, record comments pertinent to the color and any obvious odors associated with the water.

Arrange and label necessary sample bottles and ensure that preservatives are added, as required. Labeling must include a unique sample number, time and date of sampling, the initials of the sampling personnel, and the identity of the sample fraction. Additionally, provide any information pertinent to the preservation materials or chemicals used in the sample. The pH of preserved samples should be checked to ensure that the proper sample pH has been attained. for VOC samples, collect a test sample to determine the adequacy of the amount of preservative in the pre-preserve sample bottles. Where needed, adjust the amount of preservative added to a sample bottle.

Make sure that the sampling tubing remains completely filled during sampling and that the water does not descend back into the well. A clamp used to constrict the sampling end of the tubing will help to keep the tube completely filled with water. Minimize turbulence when filling sample containers, especially VOCs, by allowing the liquid to run gently down the inside of the bottle. Fill the labeled sample bottles, and immediately seal each sample and place it on ice in a cooler to maintain sample integrity.

Once all sampling is completed, recover all sampling equipment and decontaminate or set aside for subsequent decontamination in accordance with the prescribed procedures. Close and secure the well site. Review all sampling records. Ensure that all necessary data is completed. Add additional information as needed.

DECONTAMINATION PROCEDURES

Equipment used for well purging and sampling shall be decontaminated in-house prior to its initial use and in the field after each subsequent use if necessary due to project-specific restraints. Pumps will not be removed from wells between purging and sampling operations. Detergent and organic solvents will be used sparingly in the decontamination process. If field decontamination is required, Standard Operating Procedure 040000 will be followed.

PRINCIPLE OF OPERATION

The QED MP15 Low-flow backpack system consists of the MP15 MicoPurge controller, a CO_2 compressed air supply tank, regulator, pressure gauge and throttle control. This system is designed to work in conjunction with bladder pumps to collect groundwater samples under low-flow conditions by supplying the pumps with the compressed air they require to operate. The CO_2 tank and regulator supply the compressed air while the MP15 controller, pressure gauge and throttle allow the user to make fine adjustments to the airflow to obtain the optimum purge rate for each well and operating condition.

GENERAL OPERATIONS

Once the bladder pump has been properly set in a monitoring well and the well is ready to be stabilized and sampled the MP15 can be connected to the bladder pump by attaching the quick connect fitting on the MP15's air supply line to the airline coupling from the bladder pump. Once this is securely connected the valve on the CO_2 tank can be opened, this will pressurize the regulator. The MP15 controller can be turned on by pressing the, "I/O" On/ Start/ Off button once. The LCD display will turn on and it will display the battery power status and then be in the default standby mode. The default mode is programmed to pump air at four cycles per minute with a five second discharge and ten second recharge rate. This will be indicated on the LCD display as CPM4, ID 103. The default mode is generally acceptable for most sampling situations. Before allowing the controller to begin cycling the pressure must be set for the individual well that is to be sampled using the throttle control and pressure gauge. The gauge reads in feet over pressure and should be adjusted to match the pump depth. This is done by pulling up on the yellow throttle lock and turning the knob clockwise until the needle on the gauge indicates the depth at which the bladder pump was set. This depth will usually need to be increased in order to obtain enough pressure to push water to the surface. Starting at the pump depth and then increasing the pressure slowly as needed later helps limit turbidity and pressure on the system. With the air valve open, the controller on default standby, and the throttle and gauge set to the correct depth the user can begin pumping the well. Activate the controller by pressing the On/ Start/Off button a second time, this will initiate the sampling cycle. To shutdown the unit when sampling is complete first close the air valve on the tank. Allow the MP15 to cycle remaining air out of the system. When the regulator gauges read zero turn off the controller by pressing the On/Start/Off button once. Disconnect the air supply line from the bladder pump air coupling and close the backpack.

REGULATING FLOW RATES

Once the MP15 is set up and the sampling cycle is initiated it may take a few minutes for the pump to push water to the surface. Deeper wells with greater headspace will require more time. If after a few minutes water does not begin to flow from the sample port the throttle can be increased slowly until the gauge reads ~10- 15' deeper than the actual pump depth. Once water is flowing from the sample port the rate of flow can be regulated by changing the discharge / recharge ratio. This is changed on the controller by using the Up and Down arrow keys. The flow rate should be set so that the drawdown on the water column is minimized as much as possible. A water level meter should be used to monitor the water level in the well. The throttle control can also be used to increase and decrease the flow rate by making fine pressure adjustments. Once the proper flow rate for the well is achieved the well can be stabilized and sampled following proper low-flow procedures.

ADVANCED OPERATIONS/ SPECIAL CONDITIONS

The pump cycles can be changed from the MP15's default setting of CPM4 for greater pumping options under special conditions. The cycles per minute can be changed on the controller by using the Left/ Right arrow key. The MP15 can be set to cycle between 1 and 6 CPM. Each time the CPM is changed the discharge / recharge times change based on how the minute is divided, these can then be regulated with the Up /Down arrow keys. This helps the user customize the MP15 operations under various conditions. Well depth and ambient temperature affect the efficiency of the pump. Deeper wells may require fewer CPM allowing for greater discharge times to compensate for the greater depth while shallower wells may facilitate faster purges using a higher CPM. When using compressed CO_2 under colder conditions (<40 degrees F.) the regulator and tank have a tendency to frost over and even freeze limiting the systems efficiency or causing temporary breakdown. Freezing can be prevented by allowing for greater recharge time and decreasing the CPM's.

MAINTENANCE

Power

When the MP15 unit is turned on an opening display will indicate the battery strength as High, Good, Ok or Poor. The controller will operate under the first three conditions. If the battery strength is Poor the user will be unable to initiate the sampling cycle. If battery strength is too low the controller display may not turn on at all. The MP15 is run on three AA batteries, located behind a plate just above the control panel. To replace the batteries remove the plate by unscrewing the four black screws at each corner of the plate. This exposes the batteries and they can then be removed and replaced.

CO_2

The gauges on the regulator indicate the amount of compressed gas in the tank. When both gauges read zero the tank is empty and must be switched out. If the user is not in the process of sampling this is done by first closing the air valve on the tank. With the valve shut securely the regulator can be removed by unscrewing the brass fitting between the tank and regulator using the wrench located in the bottom of the backpack. The tank can then be removed from the backpack by releasing the tank clamp and sliding the tank out of its holding space. Replace a fresh tank into the space, check the regulator to insure that the Teflon ring is still in place inside the coupling and in good condition if it is not insert a new ring. The ring prevents over-tightening the regulator and air leaks and must be present.

Reattach the regulator to the new tank with the wrench then open the air valve and listen for leaks. Always handle compressed air tanks with care. If the air tank empties during sampling the cycle should be paused by pressing the Hold/ Sample/ Cycle key. The display will read "Held", the air valve can then be shut and the tank removed and replaced. Once a new tank is in place the sampling cycle can be restarted by pressing the Hold/ Sample/ Cycle key twice.

TROUBLESHOOTING

- No Power. Replace Batteries
- Pump will not cycle. The cycle is Held. Check battery power. Check air supply. Check throttle setting.
- No water. Check of air leaks at bladder coupling, listen down well for bubbling. Check/ Increase throttle pressure **do not increase pressure past 1.50x greater than total pump depth or greater than 125psi.** Decrease CPM's and increase discharge rates. Make sure bladder pump is fully submerged.
- Regulator frosting. Decrease CPM's. Decrease discharge rate. Warm regulator.
- Regulator frozen. Turn off unit, close air valve, disconnect regulator, warm unit.
- **Notes**: Battery life and air capacity limited in cold conditions. When using a "drop" screen bladder-pump configuration for deep well conditions use the depth at which the pump is set for the pumping depth not the total screen depth.
- **Consult QED Micro Purge basics MP15 Control & Power Pack Users Guide for more information.**

SYSTEM DESCRIPTION

The Geotech Peristaltic Pumps were designed for single and multi-stage pressure or vacuum pumping of liquids for field or laboratory use. Because they operate to a depth of 27 feet at sea level, they are ideally suited for sample removal from shallow wells and all surface water sources.

SYSTEM OPERATION

Remove the pump from the case, be sure pump is turned "OFF" (red, open circle).

For AC/DC combination units, plug in the appropriate power cord into the outlet in the back of the pump and other end of the power cord into the power source.

Insert a one foot piece of Geotech's silicon tubing (size 24) into the pump head simply by swinging the lever from right to left to open a space for the tubing and left to right to secure the tubing.

Connect one end of the silicon tubing to the sample tubing and use the other end to place into the sample container.

Determine the desired direction of flow and turn the direction toggle in that direction.

Turn the pump "ON" (the black filled circle).

When pumping has begun, the speed dial can be adjusted to the fluid pumping speed desired.

Note: Solutions to troubleshooting the Peristaltic Pump² can be found on page 6 of the installation and operation manual which is located inside each hard shelled carrying case.

SYSTEM MAINTENANCE

· To keep Geopump reliable follow these simple guideline.

1. Do not immerse Geopump
2. Do not subject Geopump to poor power supplies
3. Do not subject Geopump to *extreme* heat or cold when in use

· Periodically clean Geopump pump-head with a Phosphate free cleaning detergent and water solution.

· Use of the proper size and type of tubing for the pump head is essential. Use of incorrect tubing will cause damage to pump or pump head and void the warranty.

Important: After each use in the field, place the Geotech Modular Battery Pack with the appliance plug inside the lab to recharge.

INTRODUCTION

The method of sampling domestic water will depend upon whether or not a filtration or treatment system is in place. When the water is not being treated, one sample collected prior to the holding tank will be sufficient for water quality characterization. When a treatment system is in operation, however, there are two sets of samples which may be collected.

Samples collected prior to the treatment system indicate the water quality of the aquifer. In certain circumstances, samples will also be collected after the water has been treated so as to determine impact of that treatment on the potable water quality. If the sample must be collected from a faucet, any aerator present will be removed with the homeowner's permission. Further details for domestic water sampling are provided below.

During the collection of samples for volatile and semi-volatile organics analysis, the stream of water will be directed toward the inside wall of the sample container so as to minimize the aeration that occurs due to turbulence in the sample container. Once a VOA vial has been sealed, it will be inverted and gently tapped against the wrist of the sample collector. If any bubbles are observed, the vial will be re-opened and the sample discarded. A new sample will then be collected. This process will be repeated until a sample with no air bubbles is obtained.

Samples collected for bacterial analysis will be collected with clean, dedicated gloves. Field personnel will not touch anything but the sample container with these gloves prior to sample collection. In addition, at no point will anything other than the sample touch the inside of the bacterial bottle. Gloves will be changed prior to obtaining the next sample.

DOMESTIC WELLS WITHOUT FILTRATION OR TREATMENT SYSTEMS

1. A water tap will be located before the holding tank. No purging will be required if the water has been used frequently in the last 24 hours. If a tap cannot be found before the holding tank and the sample must be collected from a faucet, any aerator present will be removed with the homeowner's permission. The water tap will then be turned on and allowed to run for a minimum of five minutes.

2. Prior to sampling, the water flow will be reduced. If an outside tap is utilized, any hoses or attachments will be removed. Samples will then be collected by positioning the sample container beneath the spigot. Samples for each parameter will be placed in the appropriate containers and preserved in the field. Samples will be collected in order of decreasing volatility. Those to be analyzed for volatile or semi-volatile organics will be collected first with no headspace in order to prevent any further sample volatilization. Field testing for pH, specific conductance and temperature will be performed according to the methods described in "Field Parameter Monitoring," above.

3. After collection, the sample will be properly preserved and stored in a cooler or refrigerator and maintained at 4 degrees Celsius until analyzed by the laboratory.

All procedures and information will be documented on the field data sheet for potable water sampling.

PRE-TREATMENT DOMESTIC WELL SAMPLING

1. A water tap will be located before the treatment system. If a tap is also located before the holding tank and the water has been used frequently within the last 24 hours, no purging of the system will be required. If the tap is not located prior to the holding tank, the water tap will then be turned on and allowed to run for five minutes.

2. Prior to sampling, the water flow will be reduced. Samples will then be collected by positioning the sample container beneath the spigot. Samples for each parameter will be placed in the appropriate containers and preserved in the field. Samples will be collected in order of decreasing volatility. Some common parameters and their sampling orders are listed in "Methods of Groundwater Sampling," above. Those to be analyzed for volatile or semi-volatile organics will be collected first with no headspace in order to prevent sample volatilization. Field testing for pH, specific conductance and temperature will be performed according to the methods described in "Field Parameter Monitoring," above.

3. After collection, the sample will be properly preserved and stored in a cooler or refrigerator and maintained at 4 degrees Celsius until analyzed by the laboratory.

4. All procedures and information will be documented on the field data sheet for potable water sampling. An example of this field data sheet is attached.

POST-TREATMENT DOMESTIC WELL SAMPLING

1. A water tap will be located after the treatment system. If a tap is also located before the holding tank and the water has been used frequently in the past 24 hours, no purging of the system will be required. If the tap is not located prior to the holding tank, any aerator present will be removed with the homeowner's permission. The water tap will then be turned on and allowed to run for five minutes.

2. Prior to sampling, the water flow will be reduced. Samples will then be collected by positioning the sample container beneath the spigot. Samples for each parameter will be placed in the appropriate containers and preserved in the field. Samples will be collected in order of decreasing volatility. Some common parameters and their sampling orders are listed in "Methods of Groundwater Sampling," above. Those to be analyzed for volatile or semi-volatile organics will be collected first with no headspace in order to prevent sample volatilization. Field testing for pH, specific conductance, and temperature will be performed according to the methods described in "Field Parameter Monitoring," above.

3. After collection, the sample will be properly preserved and stored in a cooler or refrigerator and maintained at 4 degrees Celsius until analyzed by the laboratory.

4. All procedures and information will be documented on the field data sheet for potable water sampling. An example of this field data sheet is attached.

PRE- AND POST-TREATMENT DOMESTIC WELL SAMPLING

1. A water tap will be located after the system. Any aerator present will be removed with the homeowner's permission. The tap will then be turned on and allowed to discharge for a minimum of five minutes.

2. Samples of the treated water will be collected directly from the tap. Samples for each parameter will be placed in the appropriate containers and preserved in the field. Samples will be collected in order of decreasing volatility. Some common parameters and their sampling orders are listed in "Methods of Groundwater Sampling," above. Those to be analyzed for volatile or semi-volatile organics will be collected first with no headspace in order to prevent any further sample volatilization. Field testing for pH, specific conductance, and temperature will be performed according to the methods described in "Field Parameter Monitoring," above.

3. The water tap located after the system will be turned off and the tap located before the system will be turned on.

4. Samples of the untreated water will be collected for each parameter. Samples for each parameter will be placed in the appropriate containers and preserved in the field. Samples will be collected in order of decreasing volatility. Some common parameters and their sampling orders are listed in "Methods of Groundwater Sampling" above. Those to be analyzed for volatile or semi-volatile organics will be collected first with no headspace in order to prevent any further volatilization. Field testing for pH, specific conductance and temperature will be performed according to the methods described in "Field Parameters Monitoring," below.

5. Samples will be stored in a cooler or refrigerator and maintained at 4 degrees Celsius until analyzed by the laboratory.

INTRODUCTION

This Standard Operating Procedure is applicable to the collection of representative liquid samples, both aqueous and non-aqueous from streams, rivers, lakes, ponds, lagoons, and surface impoundments.

SURFACE WATER MONITORING

If water level monitoring is to be conducted at surface water locations, stakes will be inserted into the lake or stream bottom. The elevations of these stakes will be determined by a licensed surveyor. Field measurements will be made of the distance from the top of the stake to the surface of the water with a tape measure. The accuracy of these measurements will be to within 0.01 feet. Surface water monitoring will be documented on a field data sheet along with sampling information. An example of a surface water field data sheet is provided.

SURFACE WATER FLOW RATE CALCULATION

To calculate the flow rate of flowing surface water, a stop watch, float and tape measure will be used. Using the equation:

$$q = \frac{W \times d \times a \times l}{t}$$

Where:

- q flow (cubic meters/second)
- W the average width (meters) of the stream section
- d the average depth (meters) of the stream section
- a a constant of 0.8 for a gravely stream bed, or 0.9 for a smooth stream bed
- l length (meters) of the stream section
- t time (seconds) required for the float to travel a measured section of the stream

This test should be performed several times. The average value for q will be recorded on the Surface Water Field Data Sheet.

SURFACE WATER SAMPLING

When the sample location is easily accessible by foot, grab samples will be collected by submerging the sample container directly into the surface water. Dedicated beakers may also be used for sample collection in these circumstances. Samples should be of low turbidity obtained with no/minimal suspended solids.

In areas where access is limited or difficult, sampling may be conducted with a long-handled scoop. This is often the case at lakes or large stream locations where sampling away from the bank is necessary to achieve representative surface water samples. When such an intermediate container is utilized, it will be constructed of an inert material and decontaminated or replaced between samples.

The gloves worn by field personnel during surface water sample collection will be dedicated to that operation. Samples will be collected in order of decreasing volatility.

Sampling techniques for flowing and standing surface water are outlined in the following SOPs (060100 and 060200).

Surface Water Field Data

Client/Project Name: Project Location:	Project #:	FUSS & O'NEILL *Disciplines to Deliver*
Sample #:	Monitoring Location	

Sample Location Info

Sample Data

	Container	Quantity	Preservative
Date:__________ Time:__________ Sampler:__________ Weather:__________			
Estimated Flow Rate (GPM) __________ Stagnant / Dry / Other__________			
Filtered in Field: No / @ Well Method of Filtration: Pressure / Vacuum / Syringe Pump ID#: ☐ Filter: Disposable / Other_____ Field Decon: Tubing / Other__________ Appearance: Comments:			

Field Parameters

Parameter	Instrument ID	Value
pH		
Temp		
Spec. Cond.		

Comments:

INTRODUCTION

Surface water samples may be collected from streams, brooks, and other surface water bodies on-site. In general, when the sample location is easily accessible by foot, grab samples will be collected by submerging the sample container directly into the surface water. Dedicated beakers may also be used for sample collection in these circumstances. Samples should be of low turbidity, obtained with minimal suspended solids. Care should be taken not to disturb bottom sediments during sample collection to prevent particles from becoming suspended in the water column. In areas where access is limited or difficult, sampling may be conducted with a long-handled scoop. This is often the case at lakes or large streams where sampling away from the bank is necessary to obtain representative surface water samples. When such an intermediate container is utilized, it will be constructed of an inert material and decontaminated or replaced between samples.

SAMPLING FLOWING SURFACE WATER

For surface water samples collected from flowing water, the sample will be collected at mid-stream to ensure that the water is not stagnant. The sample will be collected upstream of the sampler, so as not to disturb the sample during collection. The downstream samples will be collected before upstream samples. The remainder of the samples will be collected as field personnel move upstream. Samples should be of low turbidity, and care should be taken to obtain samples with minimal suspended solids.

An estimate of flow will be made based on the channel cross-section, depth of water, and velocity of the stream (see SOP 060000).

BOTTLE IMMERSION TECHNIQUE

Surface water samples can be collected from flowing water by direct bottle submersion or by using a scoop or dipper. The protocol for collecting a surface water sample from flowing water using direct bottle submersion is as follows:

a. Uncap the sample bottle.

b. Lower the lip of the sample bottle just below the water surface.

c. Collect samples in order of decreasing volatility.

d. Care will be taken not to agitate the sample during collection in the sample container when sampling for volatile and semi-volatile organic compounds. Field personnel will tip the sample container so that a slow, laminar flow of water enters the sample container. The stream of water will be directed to the sides of the sample container so as to prevent aeration of the sample due to turbulence. Vials will be sealed with no headspace to prevent any further volatilization of the sample once it has been collected. After the lid is screwed on, the VOA vial will be turned over and tapped on a hard surface and checked for bubbles.

e. Allow the bottle to fill slowly with the water running down the sidewalls to prevent volatilization and/or splashing. Preserve the sample bottle if necessary.

f. Cap the sample bottle.
g. Label the sample bottles and place into an iced cooler.

SCOOP SAMPLING TECHNIQUE

The protocol for collecting a surface water sample from flowing water using a scoop or dipper is outlined below. If the samples are collected for volatile organic analysis, the sampling device must be made of Teflon® or stainless steel.

a. Uncap the sample bottle.

b. Reach the dipper out above the water. Lower the lip of the dipper to just below the water surface.

c. Allow the dipper to fill slowly with the water running down the sidewalls to prevent volatilization and/or splashing.

d. Samples will be collected in order of decreasing volatility.

e. Care will be taken not to agitate the sample, during collection, retraction and transfer to the sample container when sampling for volatile and semi-volatile organic compounds. Field personnel will tip the sample container so that a slow, laminar flow of water enters the sample container from the surface water scoop. The stream of water will be directed to the sides of the sample container so as to prevent aeration of the sample due to turbulence. Vials will be sealed with no headspace to prevent any further volatilization of the sample once it has been collected. After the lid is screwed on, the VOA vial will be turned over and tapped on a hard surface and checked for bubbles.

f. Preserve the sample bottle if necessary. Cap the sample bottle.

g. Label the sample bottles and place into an iced cooler.

INTRODUCTION

Surface water samples may be collected from streams, brooks, and other surface water bodies on-site. In general, when the sample location is easily accessible by foot, grab samples will be collected by submerging the sample container directly into the surface water. Dedicated beakers may also be used for sample collection in these circumstances. Samples should be of low turbidity, obtained with minimal suspended solids. Care should be taken not to disturb bottom sediments during sample collection to prevent particles from becoming suspended in the water column. In areas where access is limited or difficult, sampling may be conducted with a long-handled scoop. This is often the case at lakes or large streams where sampling away from the bank is necessary to obtain representative surface water samples. When such an intermediate container is utilized, it will be constructed of an inert material and decontaminated or replaced between samples.

SAMPLING STANDING SURFACE WATER

When sampling standing surface water, sampling personnel are prohibited from entering or otherwise disturbing the water with anything other than the sample container or intermediate sampling apparatus. Samples will be collected away from the bank or waters edge at a location central to the body of water. In larger water bodies, samples will be collected 6 feet from the waters edge with a long-handled scoop. Samples should be collected from below the water surface when water depth is adequate. Coarse debris will be avoided during sample collection. Sample depth will be recorded.

A submersible sampler will be used to collect surface water samples at discrete depths or when the sampling location cannot be accessed by foot. The sampling device will be lowered to the desired depth. The sampler will be closed before being retrieved, thereby capturing a water sample at the desired depth. Sample depth will be recorded.

Two types of submersible samplers are available for collection of surface water samples at varying depths: (1) an Alpha Horizontal Water Bottle and (2) a Bomb Sampler. If the sample is to be analyzed for volatile organic compounds, the device should be constructed of Teflon® or stainless steel.

ALPHA BOTTLE SAMPLE TECHNIQUE

The protocol for collecting a surface water sample using the Alpha Horizontal Water Bottle is as follows:

a. Attach Alpha Bottle to rope.

b. Set the end caps to the open position.

c. Lower the Alpha Bottle to the desired sampling depth.

d. Attach and send the “messenger” down the rope which will release the end caps and seal the Alpha Bottle.

e. Retrieve the Alpha Bottle.

f. Samples will be collected in order of decreasing volatility.

g. Care will be taken not to agitate the sample, transfer to the sample container when sampling for volatile and semi-volatile organic compounds. Field personnel will tip the sample container so that a slow, laminar flow of water enters the sample container from the Alpha Bottle. The stream of water will be directed to the sides of the sample container so as to prevent aeration of the sample due to turbulence. Vials will be sealed with no headspace to prevent any further volatilization of the sample once it has been collected. After the lid is screwed on, the VOA vial will be turned over and tapped on a hard surface and checked for bubbles.

h. Preserve the sample bottle if necessary. Cap the sample bottle.

i. Label the sample bottles and place into an iced cooler.

BOMB SAMPLER TECHNIQUE

The protocol for collecting a surface water sample using a Bomb Sampler is as follows:

a. Attach the Bomb Sampler to rope.

b. Lower the Bomb Sampler to the desired sampling depth.

c. Lift up on the sampling line and allow the Bomb Sampler to fill with water.

d. When the sampler is full, release the sampler line to close the reseal on the sampler.

e. Retrieve the Bomb Sampler.

f. Samples will be collected in order of decreasing volatility.

g. Care will be taken not to agitate the sample, transfer to the sample container when sampling for volatile and semi-volatile organic compounds. Field personnel will tip the sample container so that a slow, laminar flow of water enters the sample container from the Bomb Sampler. The stream of water will be directed to the sides of the sample container so as to prevent aeration of the sample due to turbulence. Vials will be sealed with no headspace to prevent any further volatilization of the sample once it has been collected. After the lid is screwed on, the VOA vial will be turned over and tapped on a hard surface and checked for bubbles.

h. Preserve the sample bottle if necessary. Cap the sample bottle.

i. Label the sample bottles and place into an iced cooler.

SEEP SAMPLING

Seep samples to be analyzed for non-volatile parameters will be collected using a peristaltic pump equipped with tubing made of inert materials, such as silicone. The intake end of the tubing will be placed directly into the seep flow, while the outflow end will be positioned at the mouth of the sample container. This procedure will reduce the possibility of contamination resulting from contact between the sample container and the ground, as well as facilitate sample collection.

Volatile organics will be sampled by submerging the VOA vial directly into the seep flow. The individual collecting the sample will take care that no suspended solids are introduced into the sample container or lid in this process.

Gloves will be decontaminated or replaced between samples. The peristaltic pump is designed in such a way that the sample does not come into contact with the inside of the pump itself during pumping. The tubing of the peristaltic pump will be thoroughly decontaminated or replaced between seep sampling locations. The decontamination procedure is to pump the following reagent sequence through the tubing: non-phosphate detergent, tap water, 20% methanol solution, deionized water, 10% hydrochloric or nitric acid solution, deionized water.

INTRODUCTION

Concerns have been voiced on the high probability of mercury lost in sample between time of collection and the time that the sample is analyzed. Sampling methods have been designed to reduce the likelihood that mercury be lost from samples.

SAMPLING APPROACH

Mercury samples collected from surface water may be filtered or unfiltered and can be collected from the upper level of the water body or the lower level of the water body. The procedure for each sample collection is very similar.

1. Unfiltered collection from upper surface water

The lab will supply Teflon bottles filled with dilute HCl. The following directions are based on sampling from a boat.

a. Set up sampling platform with Geo-pump.
b. Tie Kevlar rope to the loop of Teflon string on the sampling line weight. Slowly lower then end of the sample line from the plastic bag to avoid contamination.
c. Set up Geo-pump. Insert Teflon Tubing Adaptor Fitting into the long end of the pump tubing; insert into the plexi-glass clamp ring. Insert assembly into groove in sampling platform.
d. Flush for at least 5 minutes.
e. Place bottle under stream and fill 1/8 full, loosely cap and shake gently to rinse. Repeat process for a total of 4 times.
f. On the 5th time, fill bottle ½ way and place back in its plastic bag; bag does not have to be sealed.

2. Filtered collection from upper surface water

Following unfiltered sample collection of upper surface water,

a. Shut off pump and remove PCR/TTAF assembly from the platform.
b. Remove filter capsule, open vents and drain off storage MQ of Calex filter into river; insert support on filtering platform.
c. Flush capsule for 5 minutes or 3 liters before collecting the sample before sample collection.

3. Filtered collection from lower surface water

The only difference here is from the upper layer is that the filtered sample should be collected first.

4. Unfiltered collection from upper surface water

The only difference here is that the bottles are not rinsed.

SAMPLING DEVICES

BOAT
SAMPLE PLATFORM
GEO-PUMP
TEFLON TUBING
KEVLAR SUPPORT ROPE
TEFLON TUBING ADAPTOR FITTING
PLEXI-GLASS CLAMP RING
CALEX FILTER
TEFLON SAMPLING CONTAINERS
50% HCL

SAMPLE BOTTLES

500mL UNFILTERED MERCURY
125mL UNFILTERED METHYL MERCURY
125mL FILTERED METHYL MERCURY
500ML FILTERED MERCURY

INTRODUCTION

Sediments provide essential habitat for many freshwater, estuarine, and marine organisms. Many toxic chemicals and waste materials accumulate in sediments and can pose a hazard to aquatic life through direct toxicity as well as to aquatic life, wildlife and human health through bioaccumulation in the food chain.

Sediment quality assessment typically includes analysis of anthropogenic contaminants, benthic community structure, physico-chemical characteristics, and direct measures of whole sediment and pore water toxicity. Accurate assessment of environmental hazards posed by sediment contamination depends in large part on the accuracy and representativeness of these samples.

The use of consistent sediment collection, manipulation, and storage methods will help provide high quality samples which will, in turn, allow for accurate data to be obtained.

TECHNICAL TERMS

Sediment: Particulate material that usually lies below water or formulated particulate material that is intended to lie below water in a test

Contaminated Sediment: Sediment containing chemical substances at concentrations that pose a known or suspected threat to environmental or human health

Pore (Interstitial) Water: Water occupying space between sediment or soil particles

Core Sample: A sediment sample colleted to obtain a vertical profile

Grab: Any device designed to "bite" or "scoop" into the bottom sediment of a lake, stream, estuary, ocean, and similar habitats to sample sediment. Grabs are samplers with jaws that are forced shut by weights, lever arms, springs, or cables. Scoops are grab samplers that scoop sediment with a rotating container.

Ecotox Thresholds: Benchmark values in ecological risk assessments defined as media-specific contaminant concentrations above which there is sufficient concern regarding adverse ecological effects to warrant further site investigation

Data Quality Objectives: Qualitative and quantitative statements that clarify the purpose of the monitoring stuffy, define the most appropriate type of data to collect, and determine the most appropriate methods and conditions under which to collect them

Measurement Quality Objectives: Statements that describe the amount, type, and quality of data needed to address the overall project objectives

Bioaccumulation: The net accumulation of a substance by an organism as a result of uptake from all environmental sources

Bioavailability: The degree to which a chemical is taken up by aquatic organisms

PRE-SAMPLING CHECKLIST

Documentation

- General paperwork (maps, sampling and Health & Safety plans, etc.)
- Logbook
- Pen and permanent marker
- Sediment sampling field data sheets
- Sample labels
- Chain-of-custody forms

Personal Equipment

- Site-specific equipment required by Site Safety Plan
- Munsell Color Chart
- Grain size chart
- Disposable or rubber gloves
- 6' Ruler or small tape measure
- Water level measurement device
- Hand sprayers
- Paper towels
- Plastic garbage bags
- Bucket(s)
- Wooden stakes
- Survey flagging

Sampling Equipment

- Approved sampling device
- Sediment Core Samplers
  - AMS Core Sampler with Core Catcher (Slide hammer)
  - Wildco® Hand Corer
- Grab Samplers
  - Wildco® Ponar (petite or regular)
  - Wildco® Ekman (standard, tall or large)
- Stainless steel mixing bowl
- Wooden tongue depressors, stainless steel spoon, or disposable plastic scoop
- Zip-lock poly bags
- Turkey baster or Siphon

- Coolers with ice packs or ice
- Water quality multi-meter: temperature, conductivity/specific conductance, dissolved oxygen, oxidation-reduction potential (ORP), and pH

Decontamination Equipment

- Non-phosphate detergent
- 10% Nitric acid solution
- 20% Methanol solution
- Deionized water
- Tap water

Site-Specific Equipment

- Keys to site facilities (when applicable)
- Sample containers for lab parameters

GENERAL SAMPLING INFORMATION

Descriptive information of the site location and conditions will be documented before collecting sediment samples. Descriptive information includes:

- Date, time and weather conditions
- Explanation of the sample location
- GPS coordinates (NAD83, deg-min-sec)
- Site location photographs

Water quality data will be collected before collecting sediment samples. In waters less than two feet deep, water quality data will be collected just above (less than 6 inches) the sediment water interface. In waters greater than two feet deep, water quality data will be collected just below (6 to 12 inches) the water surface and just above the sediment/water interface. Water quality measurement will include temperature, conductivity/specific conductance, dissolved oxygen, oxidation-reduction potential (ORP), and pH.

Upon collection, sediment samples will be described in the field following ASTM D2488 methods. The color of the sediment will be determined by consulting a Munsell Color Chart. A description of grain size will be based on a particle size chart and in accordance with USDA particle size classification. Odors or sheens associated with the samples will be documented at the time of sampling.

SHALLOW (WADABLE) STREAMS AND LAKES

Sediments from shallow (wadable) fluvial (stream and river) and lacustrine (lake and pond) settings will be collected as grab samples or hand cores. Samples will be collected in areas of deposition where sediments are finer-grained and water turbulence is minimal. A labeled survey stake will be placed at the sampling location after samples have been collected.

Decontaminated stainless steel tools, disposable wooden tongue depressors, or disposable plastic scoops will be used to homogenize and/or transfer the samples to appropriate sample containers.

The type of sample containers and sampling devices used will depend upon the physical characteristics of the sediment, the depth of overlying water, the depth of sediment to be analyzed, and the proposed lab analyses.. The following table shows the appropriate sampling device based on proposed analysis.

	Sample Depth		
	0 – 0.5 ft	0 – 1.0 ft	>1.0 ft
Proposed Analysis	**Sampling Device**		
VOCs	C	C	C
SVOCs	C,G	C,G	C
Metals	C,G	C,G	C
Grain Size*	C,G	C,G	C
Total Organic Carbon*	C,G	C,G	C
pH*	C,G	C,G	C
SEM/AVS	C,G	C,G	C
Toxicity	C,G	C,G	C
Benthic Community	G	C,G	C

C = Core sampler; G = Grab or Dredge Sampler
*These analyses should be conducted for all sediment samples

When two (2) or more sample locations are identified within a water body, sampling will proceed with the downstream samples first. The remainder of the samples will be collected as field personnel move upstream. If the sample collector must enter a stream prior to sampling, sediment samples will be collected upstream of the disturbance. The sampler will not enter a stagnant body of water until such time as a sediment sampling is to be acquired. Samples will be collected from lakes only after all surface water samples and field measurements in the vicinity have been taken.

When relatively undisturbed samples are required, a stainless steel hand corer will be utilized. Once the sample is collected, it will either be capped (such as with Teflon® for VOC analyses) or removed from the tool with a stainless steel spatula or wooden tongue depressor, and placed into an appropriate sample container.

Grab samples will be visually inspected to ensure the following acceptability conditions are satisfied:

- The sample is not over filled such that sediment is touching the top of the sampler
- Overlying water is present (indicating minimal leakage).
- The overlying water is clear and not excessively turbid
- The sediment/water interface is intact and relatively flat, with no sign of channeling or sample washout
- The desired depth has been achieved
- There is no evidence of sediment loss due to incomplete closure of the sampler, penetration at an angle, or tilting upon retrieval

Core samples will be visually inspected to ensure the following acceptability conditions are satisfied:

- The core sampler was not inserted at an angle or tilted upon retrieval
- The desired depth has been achieved
- There is no evidence of sediment loss

Overlying water should be removed prior to processing and storage by siphoning, not decanting. Samples will be collected in such a manner that samples potentially containing volatiles are handled or agitated to the least possible extent. Once samples potentially containing volatiles have been collected, samples will be collected for the remaining constituents.

Sediment samples collected will be greater than 30 percent solids to be considered a valid sample. Therefore, the collected sample will be left undisturbed for a short time to separate into liquid and solid fractions. The water fraction can then be siphoned from the sediment to increase the percentage of solids in the sample. The laboratory performing analyses will be instructed to take corrective measures in the event it finds the solids content to be less than 30 percent. Corrective measures may include not analyzing the sample or analyzing the sample and including percent solids information in the report narrative.

DEEP STREAMS AND LAKES

When sampling sediments by hand (e.g. by core methods) is not convenient or possible, sediments will be collected with a dredge sampler.

The dredge will be lowered in a controlled manner to the sampling point by a length of nylon rope. At the point of contact, the rope will slacken and the sampler will be retrieved from the water. Dredge samples will be visually inspected to ensure the following acceptability conditions are satisfied:

- The sample is not over filled such that sediment is touching the top of the sampler
- Overlying water is present (indicating minimal leakage).
- The overlying water is clear and not excessively turbid
- The sediment/water interface is intact and relatively flat, with no sign of channeling or sample washout
- The desired depth has been achieved

- There is no evidence of sediment loss due to incomplete closure of the sampler, penetration at an angle, or tilting upon retrieval

A sample will be taken from the dredge with a decontaminated stainless steel tool or a wooden tongue depressor to be homogenized and/or placed into the appropriate sample container. Overlying water should be removed prior to processing and storage by siphoning, not decanting. Samples will be collected in such a manner that samples potentially containing volatiles are handled or agitated to the least possible extent. Once samples potentially containing volatiles have been collected, samples will be collected for the remaining constituents.

Sediment samples collected will be greater than 30 percent solids to be considered a valid sample. Therefore, the collected sample will be left undisturbed for a short time to separate into liquid and solid fractions. The water fraction can then be siphoned from the sediment to increase the percentage of solids in the sample. The laboratory performing analyses will be instructed to take corrective measures in the event it finds the solids content to be less than 30 percent. Corrective measures may include not analyzing the sample or analyzing the sample and including percent solids information in the report narrative.

This method of sediment sampling may cause significant bottom disturbance and, as a result, will be conducted only after water samples and field measurements in the vicinity have been conducted.

DECONTAMINATION

All equipment utilized for sediment sampling will be decontaminated or discarded between sampling locations as appropriate. Obvious sediment build-up or contamination will be thoroughly removed with site water paying careful attention to any joints, cavities, or pivot points. Equipment to be decontaminated in the field should be suspended over a tub or bucket. Decontamination procedures are outlined in SOP 040000.

SAMPLING PROCEDURE – CORE SAMPLES

Sediment core samples can be obtained using either a slide hammer, Wildco® sediment core sampler. The protocol for collecting sediment core samples using either core samplers is as follows:

a. Affix a sample label to each container for that particular location immediately prior to sampling.

b. If sampling in a stream or flowing body of water, approach the sampling location from downstream, being careful not to disturb any underlying sediment. When two or more sediment samples from the same stream are to be collected, the first sample collected should be at the furthest downstream location, with subsequent samples collected in a sequence progressing upstream.

c. Lower the sampler through the water, then advance the core barrel to the desired depth.

d. Remove the core barrel by gently rocking it from side to side, or reverse pounding it from the hole.

e. For VOC samples, remove the slide hammer from the core barrel and slide the sample sleeves out. Place caps lined with non-stretchable Teflon® (per EPA) over both ends of the sample sleeves. Label the sleeves, and place in an iced cooler. The laboratory performing the analyses will extract a sediment sample from the sleeve.

f. For grab samples, remove the slide hammer from the core barrel and slide the sample sleeves out. Transfer the sediment from the sample sleeves to the sample containers using a dedicated tongue depressor. For composite samples, transfer the sediment directly into a stainless steel bowl for homogenization. Materials such as surface vegetation (grass, leaves and plant stalks), roots, gravel, and artificial fill materials (e.g., asphalt, wood, brick, glass, ceramic, etc.) should not be included in the samples.

g. All labeled sample containers will be placed in an iced cooler.

Sediment core samples can also be obtained using a Wildco® hand corer capable of collecting samples to 20-inch depths. The cored sample can be separated into discrete sediment samples, typically corresponding to the top (0-6"), middle (6-13"), and bottom (13"-20") layers.

SAMPLING PROCEDURE – GRAB OR DREDGE SAMPLES

Surficial sediment samples can be obtained using either a simple scoop/dipper or a dredge sampler such as a Wildco® Ponar or Ekman dredge. The protocol for collecting surficial sediment samples using a scoop or dipper is as follows:

a. Affix a sample label to each container for that particular location immediately prior to sampling.

b. If sampling in a stream or flowing body of water, approach the sampling location from downstream, being careful not to disturb any underlying sediment. When two or more sediment samples from the same stream are to be collected, the first sample collected should be at the furthest downstream location, with subsequent samples collected in a sequence progressing upstream.

c. Push the scoop or dipper firmly downward into the sediment, then lift upward. Quickly lift the sampler out of the water.

d. Transfer the sediment from the scoop/dipper to the sample containers using a dedicated tongue depressor. For composite samples, transfer the sediment directly into a stainless steel bowl for homogenization. Materials such as surface vegetation (grass, leaves and plant stalks), roots, gravel, and artificial fill materials (e.g., asphalt, wood, brick, glass, ceramic, etc.) should not be included in the samples.

e. All labeled sample containers will be placed in an iced cooler.

A dredge sampler, such as a Wildco® Ponar or Ekman dredge, can be used to collect gross surficial, or bulk sediment samples. Typically, a dredge sampler is used to obtain a sample from the first four inches of surficial sediments, those nearest the sediment-water interface. Collection of surficial sediment samples is typically performed for analysis of bulk sediment parameters such as benthic invertebrates, acid volatile sulfides and simultaneously extracted metals (AVS/SEM), and sediment toxicity.

The general procedure for collecting surficial sediment samples using a dredge sampler is as follows:

a. Affix a sample label to each container for that particular location immediately prior to sampling.

b. If sampling in a stream or flowing body of water, approach the sampling location from downstream, being careful not to disturb any underlying sediment. When two or more sediment samples from the same stream are to be collected, the first sample collected should be at the furthest downstream location, with subsequent samples collected in a sequence progressing upstream.

c. For the Ekman dredge, Hold the sampling pole so the open sampler jaws are positioned several inches above the surface of the sediment, then firmly thrust the sampler downward. Depress the button at the top of the sampling pole to release the spring loaded jaws. For the Ponar dredge, lower the sampler into the water. Once the sampler is approximately one (1) foot from the bottom, allow it to free-fall.

d. Slowly retrieve the samples and inspect the jaws to ensure proper closer. Inspect the sample within the dredge to ensure no sediments were lost during retrieval.

e. Transfer the sediment from the dredge sampler to the sample containers using a dedicated tongue depressor. For composite samples, transfer the sediment directly into a stainless steel bowl for homogenization. Materials such as surface vegetation (grass, leaves and plant stalks), roots, gravel, and artificial fill materials (e.g., asphalt, wood, brick, glass, ceramic, etc.) should not be included in the samples.

f. All labeled sample containers will be placed in an iced cooler.

Sediment Sampling Field Data

Client/Project Name:__________ Project Location:__________ Date: _____ Weather: _____ Sampler(s): _____	**PROJECT #:** ________	**FUSS & O'NEILL** *Disciplines to Deliver*

Sample #: Site ID:	Container	Quantity	Preservative
GPS Coord. _____N _____W | Photo #: _____ Water Quality Parameters Surface Bottom Temperature (C) _____ _____ Conductivity (uS/cm) _____ _____ pH / ORP (mV) ___/___ ___/___ DO (mg/L / %) ___/___ ___/___ Sampling Device: Core Sampler – Type: _____ Dredge – Type: Ponar / Ekman / Other: _____ Field decon: Yes / No / Dedicated Type of Sample: Grab / Composite / Other _____ Sample Depth: _____ Feet			

INTRODUCTION

This standard operating procedure (SOP) for sampling benthic macroinvertebrates in streams and wadable rivers is based on procedures developed by two sources: United States Environmental Protection Agency (USEPA) document entitled "Rapid Bioassessment Protocols for Use in Wadable Streams and Rivers: Periphyton, Benthic Macroinvertebrates, and Fish" (Barbour, et al., 1999); the Connecticut Department of Environmental Protection (CTDEP) document entitled "Rapid Bioassessment in Wadable Streams and Rivers by Volunteer Monitors" (Beauchene, 2009). These procedures are also supplemented by other USEPA guidance including: Klemm et al. (1990) and Plafkin et al.(1989).

EQUIPMENT AND SUPPLIES

Documentation

- General paperwork (maps, sampling and Health & Safety plans, etc.)
- Logbook
- Pencil, pen, and permanent marker
- Physical Characterization and Water Quality Field Data Sheet
- Stream and Wadable River Habitat Assessment Field Data Sheet
- Sample labels (adhesive and inserts)
- Chain-of-custody forms
- Camera
- Global Positioning System (GPS) unit (10 m accuracy)

Personal Equipment

- Site-specific equipment required by Site Safety Plan
- Rubber gloves (arm length)
- Waders (hip or chest)
- Measuring tape
- Survey flagging
- Weight with survey flagging

Sampling Equipment

- Rectangular frame dip net (0.5 meter width and 0.3 meter height; 500-micron mesh)
- Sieve bucket (500 um mesh)
- Sample containers
- Specimen vials
- Ethanol (95% denatured)
- Forceps
- Coolers with ice packs or ice

- Sorting Tray & Ice cube trays
- Scrub brush
- Water quality meter for temperature, conductivity/specific conductance, dissolved oxygen, turbidity and pH

Site-Specific Equipment

- Keys to site facilities (when applicable)

GENERAL SAMPLING INFORMATION

All kick samples will be collected using a standard rectangular dip net (0.5 meter width and 0.3 meter height; 500-micron mesh) within a predetermined, representative 100 meter reach.

A 100 meter reach of stream or wadable river will be established prior to sampling. Whenever possible the downstream extent of the reach will be more than 100 meters upstream of bridge or road crossing. No major tributaries will discharge to the stream or river within the selected reach.

Prior to sampling, a site description, weather conditions and land use will be documented on a standard "Physical Characterization and Water Quality Field Data Sheet." A map of the sampling reach will be drawn including in-stream attributes (e.g. riffles, falls, fallen trees, pools, bends, etc.); important structures, plants, and attributes of the bank and near stream areas; and an arrow indicating the direction of flow. Approximate locations of samples will also be shown. A GPS point will be recorded at the furthest downstream location of the sample reach.

Water quality data will be collected before collecting benthic macroinvertebrate samples and will be collected at mid-depth at the upper and lower extent of the sampling reach. Water quality measurement will include temperature, conductivity/specific conductance, dissolved oxygen, turbidity, and pH. Sediment quality such as odors, oil sheens, and deposits will also be noted.

Each sample reach will yield one composite sample consisting of eight individual sample spots selected within the sampling reach. Sample locations will be collected from riffles or series of riffles such that different stream velocities are represented to create a composite sample of the reach. The objective is to sample from a minimum composite area of two (2) square meters.

SAMPLING PROCEDURE

- Sampling will begin at the downstream end of the reach and proceed upstream. Standing in the stream or river facing upstream the net will be placed firmly on the stream bottom with the opening of the net facing upstream.

- Within 0.5 meters upstream of the net, large rocks and cobbles will be removed and the surfaces scrubbed. Once removed and scrubbed, the rocks will be placed outside of the individual sample area.

- Once all the large rocks have been scrubbed, the exposed stream bed will be disturb or kicked by hand or foot to a depth of five (5) to ten (10) centimeters for 30 seconds. The net will be removed from the water and the sampler will move upstream to the next sample location.

- One (1) composite sample will consist of eight (8) individual sample spots selected within the sampling reach and collected over a cumulative period of four (4) minutes. This process will be replicated for 10% of the sample reaches.

- After every four (4) individual sample locations, or more frequently if the net begins to become clogged, the contents of the net will be transferred to a sieve bucket. Forceps may be needed to remove organisms from the net. If substantial clogging does occur, the material in the net will be discarded and that portion of the sample will be redone in the same habitat type but different location. Any vertebrates captured will be released immediately.

- Large debris will be removed after rinsing and inspected it for organisms and any organisms found will be placed into the sample container. The collected material will be washed in a sieve bucket by running clean (filtered) stream water through the sieve two (2) or three (3) times.

- Organisms will be transferred from the sieve bucket to sample containers and preserved in enough 95% denatured ethanol to cover the sample. Forceps may be needed to remove organisms from the sieve bucket.

- A label, written in pencil, will be placed in each sample container indicating the stream name, date and time of collection, site location, GPS coordinates, town, state, and collector. The outside of the container will include the same information and the words "Preservative: 95% Ethanol". If more than one sample container is needed, each container label will contain all the information for the sample and will be number sequentially (e.g. 1 of 3, 2 of 3, etc.).

- Sample container information as noted above will be recorded on a standard sample log-in sheet.

- Between sampling reaches and at the end of the day, the sampling net will be thoroughly rinsed using stream water and any remaining debris will be removed. All equipment will be examined again prior to use at the next site.

- After benthic macroinvertebrates collection is completed the standard "Physical Characterization and Water Quality Field Data Sheet" will be reviewed for accuracy and a "Habitat Assessment Form" will be completed for the reach.

- Samples will be submitted to a qualified laboratory for analysis. Samples will be documented and handled in accordance with Fuss & O'Neill SOP 020000.

REFERENCES

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Plafkin, J.L., M.T. Barbour, K.D. Porter, S.K. Gross, and R.M. Hughes. 1989. Rapid Bioassessment protocols for use in streams and rivers: Benthic macroinvertebrates and fish. EPA 440-4-89-001. U.S. Environmental Protection Agency, Office of Water Regulations and Standards, Washington, D.C.

INTRODUCTION

This standard operating procedure (SOP) for sampling benthic macroinvertebrates in non-wadable streams and rivers is based on procedures developed by United States Environmental Protection Agency (USEPA) document entitled "Benthic Macroinvertebrates in Concepts and Approaches for the Bioassessment of Non-wadeable Streams and Rivers." (Johnson, et al., 2006). These procedures are also supplemented by other USEPA guidance and peer-reviewed literature methods including: Barbour et al. (1999), Hester and Dendy (1962), Klemm et al. (1990) and Plafkin et al.(1989).

EQUIPMENT AND SUPPLIES

Documentation

- General paperwork (maps, sampling and Health & Safety plans, etc.)
- Logbook
- Pencil, pen, and permanent marker
- Physical Characterization and Water Quality Field Data Sheet (Barbour et al, 1999)
- Habitat Assessment Field Data Sheet (Barbour et al, 1999)
- Sample labels (adhesive and inserts)
- Chain-of-custody forms
- Camera
- Global Positioning System (GPS) unit (10 m accuracy)

Personal Equipment

- Site-specific equipment required by Site Safety Plan
- Rubber gloves (arm length)
- Waders (hip or chest)
- Measuring tape
- Survey flagging
- Weight with survey flagging

Sampling Equipment

- 14-plate Hester-Dendy Artificial Substrate Sampler (attached to a weight and bouy) (Hester and Dendy, 1962)
- Rectangular frame dip net (0.5 meter width and 0.3 meter height; 500-micron mesh)
- Sieve bucket (500 um mesh)
- 5-gallon plastic bucket
- Sample containers
- Specimen vials
- Ethanol (95% denatured)

- Forceps
- Coolers with ice packs or ice
- Sorting Tray & Ice cube trays
- Scrub brush
- Water quality meter for temperature, conductivity/specific conductance, dissolved oxygen, turbidity and pH

Site-Specific Equipment

- Keys to site facilities (when applicable)

GENERAL SAMPLING INFORMATION

Macroinvertebrates will be sampled using artificial substrate samplers. Three (3) Hester-Dendy (Hester & Dendy, 1962) style multi-plate artificial substrate (AS) samplers will be deployed at each sample station or reach. For 10% of the sample locations, a second sampler set of three samplers will be deployed as a replicates.

The AS samplers consist of fourteen 7.6-centimeter , 0.3-centimeter thick tempered hardboard square plates. Plates are separated by eight (8) single spaces (0.27 centimeter), two (2) double spaces and two (2) triple spaces.

Prior to sampling, a site description, weather conditions and land use will be documented on a standard "Physical Characterization and Water Quality Field Data Sheet" (Barbour et al., 1999). A map of the sampling reach will be drawn including in-stream attributes (e.g. riffles, falls, fallen trees, pools, bends, etc.); important structures, plants, and attributes of the bank and near stream areas; and an arrow indicating the direction of flow. Approximate locations of samples will also be shown. A GPS point will be recorded at the furthest downstream location of the sample reach.

At the time of deployment the standard a "Habitat Assessment Form" (Barbour et al, 1999) will also be completed for the reach. At the time of retrieval this form and the "Physical Characterization and Water Quality Field Data Sheet" (Barbour et al, 1999) form will be reviewed accuracy. Any changes between deployment and retrieval will be noted

Water quality data will be collected before deploying and retrieving the AS sampler and will be collected at mid-depth at the sample deployment location. Water quality measurement will include temperature, conductivity/specific conductance, dissolved oxygen, turbidity, and pH. Sediment quality such as odors, oil sheens, and deposits will also be noted upon deployment.

SAMPLING PROCEDURE

- AS samplers will be anchored and buoyed such that each sampler will stationary and will be oriented directly upward. Samplers will be exposed to similar depths across all sampling sites with a maximum water depth for each AS sampler of two (2) meters. AS samplers will be placed at equal intervals across the sample location. Samplers will be deployed for a colonization period six (6) weeks.

- Every attempt will be made to ensure AS samplers are located away from any structures. AS samplers will be located away from stream access points or areas where they may be directly visible to heavy foot, vehicle or boat traffic to minimize the potential for vandalism or theft.

- Following the colonization period and during retrieval, AS samplers will be handled to minimize loss of organisms. Transfers from surface waters to containers will occur in a 500-micron mesh net. Once a sampler has been touched, it will be pulled immediately and placed intact into a net.
-
- The sampler will be carefully and entirely transferred into a clean, labeled container (bucket) with screened stream water. A label, written in pencil, will be placed in each sample container indicating pertinent sample information.
-
- The AS sampler will be dismantled underwater and each individual piece of substrate will be rinsed, gently but thoroughly cleaned underwater with a soft brush, examined visually and placed in a labeled storage bag. The water in the bucket or sampling container will then be poured through a 500 micron sieve to remove fine particles. Organisms and debris will be retained on the surface of the screen and will subsequently be picked or washed from the screen and placed in a sample container for preservation with >70% ethanol.
-
- A label will be placed inside the container indicating the sample identification code, date, stream name, sampling location and collector's name. The outside of each container will be labeled similarly, but will also have the words "preservative: >70% ethanol" printed on the label.

- Samples will be submitted to Watershed Assessment Associates for taxonomic identification.

- After sampling has been completed at a given site, all sieves, pans, and other equipment that have come in contact with the sample will be thoroughly rinsed, examined and picked free of any remaining organisms or debris. Any additional organisms found will be placed into the appropriate sample containers. The equipment will be examined again prior to use at the next site.

- Collection of benthic macroinvertebrate samples and physical/habitat parameters at selected non-wadeable sites will include a total of

- Samples will be submitted to a qualified laboratory for analysis. Samples will be documented and handled in accordance with Fuss & O'Neill SOP 020000.

REFERENCES

Barbour, M.T., J. Gerritsen, B.D. Snyder, and J.B. Stribling. 1999. Rapid Bioassessment Protocols for Use in Streams and Wadeable Rivers: Periphyton, Benthic Macroinvertebrates and Fish, Second Edition. EPA 841-B-99-002. U.S. Environmental Protection Agency, Office of Water, Washington,D.C.

Hester, F.E., and J. S. Dendy. 1962. A multiple sampler for aquatic macroinvertebrates. Transactions of the American Fisheries Society 91:420-421.

Johnson, B.R., J.B. Stribling, J.E. Flotemersch and M.J. Paul. 2006. Chapter 6.0 Benthic Macroinvertebrates in Concepts and Approaches for the Bioassessment of Non-wadeable Streams and Rivers. EPA/600/R-06/127. U.S. Environmental Protection Agency, Office of Research and Development, Washington, D.C.

Klemm, D.J., P.A. Lewis, F. Fulk and J.M. Lazorchack. 1990. Macroinvertebrate field and laboratory methods for evaluating the biological integrity of surface waters. EPA 600/4-90-030. U.S. Environmental Protection Agency, Environmental Monitoring Systems Laboratory, Washington, D.C.

Plafkin, J.L., M.T. Barbour, K.D. Porter, S.K. Gross, and R.M. Hughes. 1989. Rapid Bioassessment protocols for use in streams and rivers: Benthic macroinvertebrates and fish. EPA 440-4-89-001. U.S. Environmental Protection Agency, Office of Water Regulations and Standards, Washington, D.C.

INTRODUCTION

Soil samples will be described in the field following ASTM D2488-69 methods. The soil color will be determined by consulting a Munsell Color Chart, while the description of grain size will be based on a particle size chart. This descriptive information, along with a thorough explanation of the sample location and sampling conditions, will be recorded on a field data sheet. Examples of soil sampling field data sheets and boring log are provided at the end of this document.

SAMPLING EQUIPMENT FOR SOIL SAMPLING

The following list includes the equipment which may be necessary to the sampling of soils:

1. **Documentation**

- General paperwork (maps, sampling and H&S plans, etc.)
- Logbook
- Pen and permanent marker
- Soil sampling field data sheets
- Sample labels
- Chain-of-custody forms

2. **Personal Equipment**

- Equipment required by Site Safety Plan
- Munsell Color Chart
- Grain size chart
- Disposable or rubber gloves
- 6' Ruler or small tape measure
- Water level measurement device
- Hand sprayers
- Paper towels
- Plastic garbage bags
- Bucket
- Wooden stakes

3. **Sampling Equipment**

- Excavation tools (shovels, post-hole diggers, pick, pry-bar and other tools)
- Approved sampling device (stainless steel hand auger, trier, aluminum coring tube, syringe sampler, etc.)
- Stainless steel mixing bowl
- Wooden tongue depressors or stainless steel spoon
- Zip-lock poly bags
- Organic vapor detector
- Coolers with ice packs or ice

4. Decontamination Equipment

- Non-phosphate detergent
- Nitric acid solution
- Methanol solution
- Deionized water
- Tap water

5. Site-Specific Equipment

- Keys to site facilities (when applicable)
- Sample containers for lab parameters

6. SS Soil Auger - Available Parts List

Qty	Description
3	Soil Auger Tool Kits
in each:	- 1-¼" or 2-½" auger w/bail
	- ⅞" open end combination wrench
	- $^{15}/_{16}$" open end combination wrench
	- strap wrench
	- 3-¼" or 2-½" auger brush
	- sampling tube extraction tool
	- container of vegetable lubricant
3	Extension handles
4	6' extensions
1	3' extension

SURFACE SOIL SAMPLING

Surface soil sampling will be conducted with a stainless steel hand auger, trier, aluminum coring tube, syringe sampler, scoop, or another approved sampling device. The hand auger and scoops can be used when undisturbed samples are not required. See SOP 080100 for scoop sampling techniques. See SOP 080200 for hand auger sampling techniques.

Both the trier and the coring tube are used to collect undisturbed soil samples.

Samples will be transferred from the sampling device to glass jars with Teflon-lined lids by means of dedicated wooden tongue depressors or decontaminated stainless steel spoons. Those samples to be analyzed for volatile and semi-volatile compounds will be collected in 40 ml VOA vials with Teflon septa. Ice or ice packs will be used to preserve lab samples at 4 degrees Celsius immediately after collection. Soils to be screened for organic compounds in the field will be separated from the rest of the sample prior to the screening procedure so that the portion submitted to the lab will remain intact. Methods of soil screening are discussed in a later section of the text.

Equipment which comes into contact with the sample will be thoroughly decontaminated or replaced between soil samples as outlined in SOP 040000.

SUB-SURFACE SOIL SAMPLING

A hand auger, soil core device, hand Geoprobe®, or direct push drill rig can be used to collect sub-surface soil samples (see SOP 080200). During monitoring well and test boring operations, sub-surface soil samples will be collected with a 24-inch split-tube sampler (hollow-stem auger rig) described in SOP 080300, or a 2-4 foot Geoprobe® sampler (direct-push rig) described in SOP 111000.

Sampling equipment will be cleaned between samples as outlined in SOP 040000. When necessary, drilling equipment will be steam-cleaned prior to the start of each boring.

METHODS OF SOIL SCREENING

The following are methods by which screening for volatile organic compounds in soil samples may be carried out: headspace screening, the bag method, and through on-site gas chromatography. A detailed description of the collection of soil vapor for on-site gas chromatography is discussed in "Soil Gas Testing" later in the text.

Headspace Screening

When headspace screening is conducted in conjunction with laboratory analysis, the sample for the laboratory will be collected first. The remaining soil will be placed in a jar, or more preferably, a resealable polyethylene bag. Any container utilized will be measured for organic vapors prior to use. The soil will be agitated within the sealed container to disaggregate the soil and liberate any volatile organic compounds into the headspace. The probe of the screening instrument will then be inserted into the headspace of the container and a reading will be obtained. Several readings of the vapors in the headspace will be measured in an attempt to duplicate the highest value. Between readings, the portable screening instrument will be allowed to pump ambient air until the reading reaches background levels.

The Bag Method

A third technique of soil screening utilizing a portable PID or FID is the bag method (Robbins, 1989). Due to the destructive nature of this method, a portion of each soil sample will be separated out for laboratory analysis prior to soil screening by this method.

Apparatus

A resealable polyethylene bag will be fitted with a three way valve to allow access to the headspace of the bag while it is sealed from the ambient air. One port of the valve will access the bag itself, while a second will permit the bag to be inflated by a hand pump once it has been sealed. The third valve port will be connected to the probe of the PID or FID by means of a length of inert tubing. Movement of air in and out of the sealed bag may consequently be controlled by the position of the valve. Figure 080430 depicts the polyethylene bag sampling system.

Method Blanks

Prior to a screening event, the relative accuracy of the bag method system will be determined by conducting a series of blanks.

First, ambient air within an empty polyethylene bag will be screened to determine the impact of background conditions upon sample integrity. Background conditions in this situation would include both the ambient air and the materials out of which the apparatus is constructed. The polyethylene bag will be sealed and inflated by means of a hand pump. After four minutes of agitation, the three-way valve will be opened to allow any vapor present to flow into the probe of the instrument. The reading obtained will represent the background concentration of organic vapors for this particular sampling event. If this concentration is unusually high, the sample collector will determine the source of the contamination and eliminate it, if possible, prior to continuing soil screening.

A second blank will be conducted to determine whether the deionized water utilized to liquidate the sample affects sample integrity. The polyethylene bag containing deionized water will be sealed and agitated for four minutes. The three-way valve will subsequently be opened to allow the vapor in the headspace to flow into the probe of the instrument. The concentration of any organic vapor emanating from the deionized water will then be measured.

A soil standard blank will be prepared prior to each sampling event in order to construct a calibration curve for the contaminant of concern. This curve is necessary to properly relate the results of headspace screening to the actual concentration of the contaminant in the soil.

A soil sample will be collected from an unaffected area of the site. After sealing the uncontaminated soil and water mix and inflating the bag as described above, a measured amount of tetrachloroethylene, m-xylene or the contaminant of concern will be injected by microliter syringe into the bag through a fitting with a Teflon septum.

The soil/water mix will be agitated for four minutes and an organic vapor concentration will subsequently be measured. This procedure will be repeated utilizing a series of concentrations within a calibration curve will then be constructed. Once this relationship is derived under experimental conditions, it can be used to calculate the concentrations of unknown volatile organics relative to the calibrated standards.

Gas Chromatography

Screening of soil samples may be conducted by an on-site gas chromatograph. Samples for this analysis will be collected in Teflon-lined glass jars, such as VOA vials.

Soil Sampling Field Data

Client/Project Name:		FUSS & O'NEILL *Disciplines to Deliver*
Project Location:	**PROJECT #:**	
Sample#:	Sampling Location	

Sample Location Info (sketch map including location of stockpile)

Sample Data

Date:________________________ Time:__________________________
Sampler:________________________ Weather:________________________

Sampling Device: Auger / Geoprobe / Shovel / Split Spoon / Trowel / Other ___
Field decon: Yes / No / Dedicated
Type of Sample: Grab / Composite / Other ____

Sample Depth: __________________
PetroFLAG / OVM__________________

Container	Quantity	Preservative

Comments:

Soil Sampling Field Data

Client/Project Name: Project Location: Date: Weather:	**PROJECT #:**	FUSS & O'NEILL *Disciplines to Deliver*

Sample #: Sample Location:	Container	Quantity	Preservative
Sampler: __Time:____________________ Sampling Device: Auger / Geoprobe / Core Sampler / Shovel / Split Spoon / Scoop/ Other ____ Field decon: Yes / No / Dedicated Type of Sample: Grab / Composite / Other ____________________ Generic Soil Description:____________________ Sample Depth: ________________ PetroFLAG / OVM________________			

Sample #: Sample Location:	Container	Quantity	Preservative
Sampler: __Time: ____________________ Sampling Device: Auger / Geoprobe / Core Sampler / Shovel / Split Spoon / Scoop/ Other ____ Field decon: Yes / No / Dedicated Type of Sample: Grab / Composite / Other ____________________ Generic Soil Description:____________________ Sample Depth: ________________ PetroFLAG / OVM________________			

Sample #: Sample Location:	Container	Quantity	Preservative
Sampler: __Time:____________________ Sampling Device: Auger / Geoprobe / Core Sampler / Shovel / Split Spoon / Scoop/ Other ____ Field decon: Yes / No / Dedicated Type of Sample: Grab / Composite / Other ____________________ Generic Soil Description:____________________ Sample Depth: ________________ PetroFLAG / OVM________________			

Sample #: Sample Location:	Container	Quantity	Preservative
Sampler: ______Time:____________________ Sampling Device: Auger / Geoprobe / Core Sampler / Shovel / Split Spoon / Scoop/ Other ____ Field decon: Yes / No / Dedicated Type of Sample: Grab / Composite / Other ____________________ Generic Soil Description:____________________ Sample Depth: ________________ PetroFLAG / OVM________________			

FUSS & O'NEILL
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BORING LOG

	PROJECT:	SITE ID:
	LOCATION:	SHEET: of
		PROJECT NO:
		WEATHER:

CONTRACTOR:
OPERATOR:
F&O REPRESENTATIVE:
DRILLING METHOD:
SAMPLING METHOD:
HAMMER WT: HAMMER FALL (IN)
BORING LOCATION:
GROUND ELEVATION:
DATE STARTED:
SAMPLE PREFIX:

WATER LEVEL MEASUREMENTS

DATE	MS. PT.	WATER AT	TIME

TIME AND DATE OF COMPLETION:

DEPTH (FT)	SAMPLE No. AND TIME	SAMPLE DEPTH (FT)	SAMPLE JARS/ PRE-SERVATIVE	REC/ PEN	BLOWS 6"	SAMPLE DESCRIPTION	STRATA CHANGE	LITHO-LOGIC CODE	FIELD TESTING

BORING DIAMETER	BORING METHOD	DEPTH

REMARKS
Field Instrument= If refusal is encountered, describe all efforts used to confirm.

Field Decon: Yes / No / Dedicated Device

PROPORTIONS USED:

trace	0 to 10%	some	20 to 35%
little	10 to 20%	and	35 to 50%

EXAMPLE DESCRIPTION:
SAND, f-c; some f-c gravel; little silt; trace clay. Moist. Loose. 10R5/4.

Reviewed by Staff:

BACKFILL

Native Material		To	See Monitoring Well
Bentonite Grout/Chips		To	Completion Report
Concrete/Asphalt		To	
Other		To	

Scoops are either large stainless steel spoons or plastic disposable spoons. In general, a scoop will only be used where surficial samples are required, and where there is a need to obtain samples at hard to reach places.

a. Insert the scoop into the soil at a 0 to 45° angle from horizontal. This orientation minimizes the spillage of the sample from the sampler. Extraction of the sample might require tilting of the sample containers.

b. Slowly withdraw the scoop from the soil.

c. Transfer the sample into a suitable sample container with the aid of a spatula and/or brush.

d. Ensure that a Teflon® liner is present in the cap of the sample container.

e. Place all labeled sample containers in an iced cooler.

f. Record observations and soil type onto a Field Data Sheet.

g. Measure the total volatile concentration inside a plastic zip closure bag using an Organic Vapor Monitor. Record readings on the Field Data Sheet.

A hand auger is a common sampling tool for shallow soils. The tool is composed of a bucket auger which comes in various shapes and sizes, a shaft, and a T-bar handle. Extensions of the shaft are available to allow sampling at deeper internals. Typically, this tool is only effective to 5 feet since the sample hole usually begins to collapse at this depth.

a. Begin collection of the sample by applying a downward pressure while rotating the auger clockwise. When the auger is full of solid material it should be removed from the hole, and the material transferred into a stainless steel bowl using a stainless steel spoon. Continue sampling in this manner until the bottom of the sampling interval is reached.

b. At desired collection depths, collect the sample for VOC analysis immediately after removal from the auger and transfer to the appropriate glass container to minimize volatile loss.

c. Composite the remaining material in the sampling bowl by using the stainless steel spoon to break apart any large chunks of material, then mix and stir the material enough to throughly homogenize the sample.

d. Transfer the material into a labeled sample jar using the stainless steel spoon.

e. Place all labeled sample containers in an iced cooler.

f. Record observations and soil type onto a Field Data Sheet.

g. Measure the total volatile concentration inside a plastic zip closure bag using an Organic Vapor Monitor. Record readings on the Field Data Sheet.

Split-spoon samples will be obtained using a drill rig operated by a contractor. In general, a drill rig will be used to collect split-spoon soil samples at locations where the refusal would be expected using the direct-push unit, where the terrain is rocky or hilly, where a large volume of sample is required to perform analyses, or where samples need to be obtained at depths beyond the capability of the direct-push unit. Sampling procedures using a drill rig unit are described below:

a. Advance the hollow stem auger to the top of the desired sampling depth.

b. Remove the center plug from inside the augers and attach a decontaminated steel split-spoon sampler to the drilling rods.

c. Insert the split-spoon sampler to the bottom of the boring and attach a 140-pound hammer to the drilling rods. The hammer will be lifted 30 inches and dropped repeatedly until the split spoon sampler has penetrated the soil 24 inches or until refusal, whichever comes first. Record hammer blows for each six inch interval the split spoon sampler travels.

d. Detach the hammer from the drilling rods. Pull rods and split-spoon sampler from inside the augers.

e. Remove the split-spoon sampler from the rods and place on a plastic sheet. Remove the ends of the split spoon and open the spoon.

f. Transfer the material into a labeled sample jar.

g. Place all labeled sample containers in an iced cooler.

h. Record observations and soil type onto a Field Data Sheet.

i. Measure the total volatile concentration inside a plastic zip closure bag using an Organic Vapor Monitor. Record readings on the Field Data Sheet.

INTRODUCTION

The size of the stockpile and the scope of the project will determine the frequency and number of samples collected.

SAMPLING PROCEDURE

a. Affix a sample label to each container for that particular location immediately prior to sampling.

b. Scrape off the top one foot of the soil pile at each sample location using the scoop to ensure a fresh, non-volatilized sample.

c. Begin collecting the sample by applying a downward pressure on the scoop handle until the desired sample depth is reached and then lift.

c. Transfer the sample directly to the sample container if a sample is being collected.

d. If a composite is being collected, calculate the volume of soil needed to fill the appropriate sample containers for the required laboratory analysis. Collect equal aliquots of the calculated volume at each of the discreet sample locations and add it to a stainless steel bowl. After all aliquots are added to the stainless steel bowl, homogenize the sample with a dedicated wooden tongue depressor. Once the composite sample is appropriately homogenized, transfer an aliquot of the composite to the sample container(s).

e. Attach a sample label to the sample container(s) and place into an iced cooler.

SAMPLING PROCEDURE

a. Affix a sample label to each container for that particular location immediately prior to sampling.

b. Scrape off the surface soil in the bucket using the scoop to ensure a fresh, non-volatilized sample.

c. Begin collecting the sample by applying a downward pressure on the scoop handle and then lift.

c. Transfer the soil directly to the sample container.

d. If a composite is being collected, a maximum of three discreet sample locations per bucket of soil will be used. Calculate the volume of soil needed to fill the appropriate sample containers for the required laboratory analysis. Collect equal aliquots of the calculated volume at each of the discreet sample locations and add it to a stainless steel bowl. After all of the aliquots are added to the stainless steel bowl, homogenize the soil with a dedicated wooden tongue depressor or dedicated spatula. Once the composite sample is appropriately homogenized, fill the appropriate sample container(s). No composite samples will be collected for VOCs.

e. Attach a sample label to the sample container(s) and place the sample into an iced cooler to maintain the temperature at 4□ C.

INTRODUCTION

The purpose of a soil gas survey is to identify areas of elevated levels of VOCs prior to soil and groundwater investigations. Typically, a grid system will be established over the site to be surveyed. Sampling stations will be located at 20 to 100 foot intervals within this grid—the specific distance will depend upon the purpose of the survey and the geologic/hydrogeologic characteristics of the site.

A depth sensitivity analysis may be conducted within this grid in order to establish a soil gas depth profile for the area. A profile is created by sampling a number of depth intervals at the selected sampling location. Once vertical concentration trends have been determined, the sampling depth for the remaining locations is selected. Geologic conditions may vary considerably across a site; therefore, confirmatory depth profiling should be conducted in each survey area.

Samples for the soil gas analysis will be collected in the field with a 5/8" diameter stainless steel well point driven into the soil to the desired sampling depth with an electric hammer drill. At the appropriate sampling depth, seal the area where the rod meets the ground with clay, and a 75 ml stainless steel vessel will be attached in-line between the probe and the vacuum pump. This sampling vessel will have two access ports, one entry and one exit, equipped with stopcocks. The vessel attaches to the top of the soil gas probe so that no intermediate tubing is required. A diagram of the soil gas survey set-up is provided on Figure 090000.

Prior to sample collection, three times the volume of gas contained within the probe and vessel will be evacuated before a sample is collected. The pressure gauge on the soil gas pump will be monitored on a regular basis to identify back-pressure indicative of soils with low permeability or clogging of the instrumentation. If back-pressures greater than five inches of water are observed, the source of the back-pressure should be investigated. When no correction is possible, the soil gas instrument will be operated for a longer period of time to ensure that representative soil gas samples are collected.

The sample will be transported directly to an on-site gas chromatograph (GC), and analyzed within fifteen minutes of collection.

SOIL GAS SURVEY EQUIPMENT LIST

The following equipment is required to conduct the collection and analysis of soil gas samples:

- Well point slotted intake assemblies
- Barbed fittings
- Shaft connecting sections
- Striker plate tube section
- Soil gas instruments
- 3 foot asphalt/concrete auger
- Rotary/hammer drills

- Chisels
- 18-inch asphalt/concrete auger
- Truck jack
- Screwdrivers
- Crescent wrenches
- Pairs of electrical gloves
- Drill adaptor driving ends
- Utility knives
- Extension cords
- Shield points
- Purge pump with tubing
- Rifle cleaning assemblies
- Spare clean brush attachments
- Flat cleaning brushes
- Rolls of Teflon tape
- Ground fault circuit interrupters (GFCI)
- Stainless vessels
- Vacuum chamber
- Tedlar bags with sampling tubing (2 sizes)
- Gasoline powered generator (if necessary)

SAFETY CONSIDERATIONS

In addition to site-specific health and safety concerns, the following safety considerations will always be followed when utilizing soil gas sampling equipment:

- Before conducting soil gas surveying, *always* walk the site with a qualified, authorized site representative and notify "Call-Before-You-Dig" to check for and identify all underground utilities.

- A metal detector should also be utilized to identify tanks and other subsurface metal objects when these are likely to be present.

- To protect against electric shock from the electric source of the hammer drill, a Ground Fault Circuit Interrupter (GFCI) will be utilized. This device will automatically shut down the electric hammer drill when it senses a short.

- As an added precaution when drilling, the hammer drill operator will wear insulated lineman's gloves to prevent the passage of an electric current up the drill and into the operator's body.

- Eye and ear protection are required while operating the hammer drill. It is advised that hand protection also be worn when manipulating the drill bit and/or soil gas probe apparatus on the electric hammer drill.

- Extra fuel for the generator will be stored away from drilling operations, particularly when these activities are taking place in the presence of a flammable vapor such as gasoline or methane gas.

SOIL VAPOR SAMPLING PROCEDURES

Soil vapor samples will be collected in the field from a stainless steel well point driven into the soil. The samples will be collected in a 75ml stainless steel vessel. Sampling will be conducted as follows:

- *Probe and Vessel Labeling:* All vessels and probe rods will be labeled with an identifying number. The identifying number of the vessel and probe rods used at each sampling location will be recorded on the soil gas sampling data sheet. No probe rod or vessel will be re-used until analysis of the soil gas sample collected from that equipment has shown that no further decontamination is necessary (see following QA/QC section).

- *Vapor Point Installation*: A 5/8" diameter stainless steel well point and riser will be driven to the desired depth using an electric hammer drill. Periodically check the rods to make sure the connections are tight; if they are loose, the threaded connector may break. Do not advance the rods beyond the last set of flattened notches or they will not be able to be easily removed once sampling is complete. Once the desired depth is reached, any space between the stainless steel riser and the ground surface will be filled with clay to prevent drawing air from the surface into the screened interval. Connect a decontaminated 75mL stainless steel vessel to the top of the probe.

- *Stainless Steel Vessel Description*:

    1. Sampling Port Septum – located on the side of the vessel. The septum attaches to a barbed fitting on the side of the vessel. The septum will be maintained by the mobile laboratory chemist. The septum allows the chemist to extract a syringe sample for gas chromatograph analysis.

    2. Stopcocks - located on the top and bottom of the vessel. The top stopcock will be closed immediately prior to the bottom stopcock during sample collection to the sampling pump from evacuating the sample from the chamber.

- *Vapor Probe and Vessel Purging*: The stopcocks will be opened and three times the volume of gas contained within the probe and vessel will be purged using a low-flow purge-pump. Purge times for sampling equipment are listed below:

Flow Rate (cc/min)	Purge Time for 3 volumes			
	75mL stainless steel vessel	2.5 ft of probe section	3 ft of probe section	1 foot of Masterflex tubing
80	56 sec	66 sec	1 min, 21 sec	21 sec
60	1 min, 15 sec	1 min, 40 sec	2 min, 3 sec	32 sec
40	1 min, 52 sec	2 min, 12 sec	2 min, 42 sec	42 sec

The pressure gauge on the purge-pump will be monitored on a regular basis to identify back-pressure indicative of soils with low permeability or clogging of the purge-pump or stainless steel screen. If back-pressures greater than five inches of water are observed, the source of the back-pressure will be investigated. When no correction is possible, (e.g., cleaning the screen or adjusting the sampling interval does not resolve the problem), the purge-pump will be operated for a longer period of time to attempt to collect a representative soil gas sample. This will be noted on the field sampling data sheet.

- *Soil Vapor Sample Collection*: After purging three volumes, the vapor sample will be collected by closing the top stopcock on the vessel immediately before closing the bottom stopcock to avoid evacuating the sample from the vessel.

Record the location and depth of sample collection on the vessel label and transport it to the on-site mobile laboratory immediately or place it in a cooler and stored at 4 degrees centigrade (°C). Samples must be analyzed within 24 hours.

Once samples from all desired depths have been collected from the sample location, remove the probe from the ground with a jack assembly or probe extractor. Do not remove probe assemblies with the hammer drill as reverse force on the drill will cause premature failure of the drill. Decontaminate equipment if necessary.

QUALITY ASSURANCE/QUALITY CONTROL (QA/QC)

To preserve sample integrity, corn oil is the only lubricant which will be used on the soil gas sampling apparatus. In addition, all sampling equipment will be stored away from volatile organic vapors when not in use. To reduce the risk of cross-contamination, all equipment which comes into contact with the sample will be thoroughly purged using the vacuum pump.

Each vessel and section of probe rod will be labeled with an identifying number. The identifying number of the vessel and probe rods used at each sampling location will be recorded on the soil gas sampling data sheet. No probe rod or vessel will be re-used until analysis of the soil gas sample collected from that equipment has shown that no further decontamination is necessary. If significant concentrations of VOCs were detected, a blank will be collected from the probe assembly after further decontamination.

If necessary, heat can be applied to the probe assembly during purging to increase volatilization of contaminants. Contaminated equipment may also be washed/decontaminated when necessary in the following reagent sequence: non-phosphate detergent scrub, tap water rinse, and a final deionized water rinse. Decontaminated equipment will be dried and air purged prior to reuse. Once the equipment has been thoroughly dried, an equipment blank will be run to verify the effectiveness of the decontamination procedure.

Additional QA/QC checks should include ambient air blanks, duplicates, frequent analysis of appropriate standards, and system purges.

ALTERNATE COLLECTION METHOD – TEDLAR BAG

This method of collection will be used in the following situations:

- Constituents of concern are not able to be analyzed by the Mobile Laboratory
- Split samples are needed for fixed lab analysis
- Sampling an SVE/DVE system
- Sampling permanently installed vapor points

The vapor probe installation section only applies to the first two situations above.

- *Vapor Probe Installation*: A 5/8" diameter stainless steel well point and riser will be driven to the desired depth using an electric hammer drill. Periodically check the rods to make sure the connections are tight; if they are loose, the threaded connector may break. Do not advance the rods beyond the last set of flattened notches or they will not be able to be easily removed once sampling is complete. Once the desired depth is reached, any space between the stainless steel riser and the ground surface will be filled with clay to prevent drawing air from the surface into the screened interval. Connect a clean, threaded, barbed fitting to the top of the probe.

- *Vacuum Chamber Description*: The vacuum chamber has three ports:

    1. Outside Sampling Port (OSP) – located on the outside of the vacuum chamber. The OSP connects to the stainless steel riser. A stopcock on the OSP controls the flow of soil vapor through the wall of the chamber.

    2. Inside Sampling Port (ISP) - located on the inside of the vacuum chamber. The ISP connects to a tedlar sampling bag inside the chamber.

    3. Vacuum Port (VP) – port piercing the wall of the vacuum chamber to which the vacuum pump is attached to evacuate air from the chamber. When air is evacuated from the chamber, negative pressure is created in the chamber, and soil vapor is drawn out of the ground and into the tedlar bag through an airtight fitting connecting the ISP and OSP.

- *Vacuum Chamber Purging and Connection to Vapor Probe*: The vacuum chamber OSP and ISP will be purged using a high-flow vacuum pump for 3-5 minutes prior to connecting it to the vapor point. Following purging, the vacuum chamber OSP will be connected to the vapor point using dedicated Masterflex tubing.

- *Vapor Probe Purging*: The OSP stopcock will be opened and approximately three times the volume of gas contained within the probe and tubing will be purged using a low-flow purge-pump attached to the ISP. Purge times for sampling equipment are listed below:

Flow Rate (cc/min)	Purge Time for 3 volumes			
	1 foot of probe section	2.5 ft of probe section	3 ft of probe section	1 foot of Masterflex tubing
80	27 sec	66 sec	1 min, 21 sec	21 sec
60	41 sec	1 min, 40 sec	2 min, 3 sec	32 sec
40	54 sec	2 min, 12 sec	2 min, 42 sec	42 sec

  The pressure gauge on the purge-pump will be monitored on a regular basis to identify back-pressure indicative of soils with low permeability or clogging of the purge-pump or stainless steel screen. If back-pressures greater than five inches of water are observed, the source of the back-pressure will be investigated. When no correction is possible, (e.g. cleaning the screen or adjusting the sampling interval does not resolve the problem), the purge-pump will be operated for a longer period of time to attempt to collect a representative soil gas sample. This will be noted on the field sampling data sheet.

- *Connection of Tedlar Sample Bag*: When purging is complete, the OSP stopcock will be closed to prevent backflushing of ambient air into the soil gas rods, and the low-flow purge-pump will be disconnected. The tedlar sample bag will be attached to the ISP, and the sample valve on the tedlar bag will be opened. The vacuum chamber will then be closed.

- *Soil Vapor Sample Collection*: The high-flow vacuum pump will be connected to the vacuum port and the air evacuated from the vacuum chamber. The vapor sample will be collected by opening the stopcock on the OSP to allow soil vapor to be drawn into the tedlar bag. When the bag is full, the stopcock on the OSP will be closed and the vacuum chamber vented through the vacuum port. The vacuum chamber will then be opened, and the valve on the tedlar bag will be closed.

Record the location and depth of sample collection on the tedlar bag and transport it to the on-site mobile laboratory immediately or place it in a cooler and stored at 4°C. Samples must be analyzed within 24 hours.

FIELD SCREENING – TEDLAR BAG

This method is for field screening purposes only. No analytical data will be collected.

When collecting a soil gas sample in a tedlar bag for field screening purposes with a photoionization detector (PID), multi-gas meter, or other air monitoring field instrument, the following procedure should be followed:

- Follow procedures above for installing the soil gas rod.
- Attach a T-valve to the top of the soil gas rod, with both valves closed.
- Connect the purge pump to one valve, open it, and purge three volumes as described above, closing the valve after purging.
- Connect flexible tubing to the other valve and connect a peristaltic or hand pump.
- Connect a Tedlar bag to the peristaltic or hand pump.
- Open the valve and collect a soil gas sample in the tedlar bag using the peristaltic or hand pump, closing the valve on the tedlar bag and the T-valve after filling.
- Power on the field instrument. Refer to the user manual for the field instrument for operating instructions.
- Connect the tedlar bag with the sample port on the field instrument with flexible tubing.
- Open the valve on the tedlar bag.
- Record the reading on the field instrument when the concentration has stabilized.

FUSS & O'NEILL *Disciplines to Deliver*	Soil Gas Survey Field Data	Date: Sheet: _____ of _____ Job No.:

Project/Location:	**Instrument Utilized:**
Type of Survey:	**Weather Conditions:**
Fuss & O'Neill Representatives:	

Sample Number	Station Designation	Vessel Number	Probe Number	Sampling Depth	Back Pressure	Purge Time	Flow Volume	Sample Time

Soil Gas Sampling Field Data

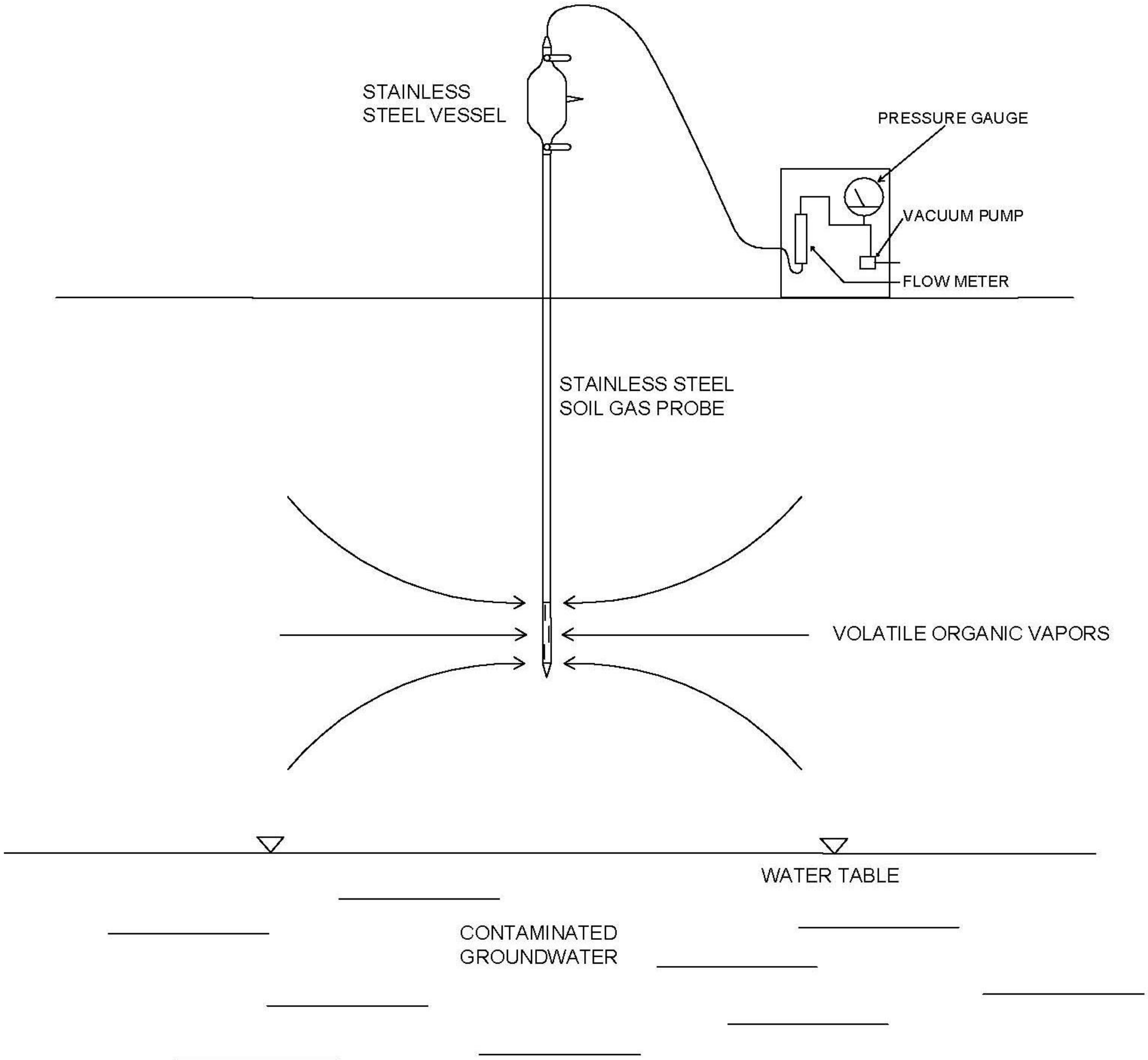
Client/Project Name:		
Project Location:	**PROJECT #:**	FUSS & O'NEILL *Disciplines to Deliver*
Sample#:	Sampling Location	

Sample Location Info

Sample Data

	Container	Quantity	Preservative
Date:_______________ Sample Time:_______________ Sampler:_______________ Back Pressure:_______________ Vessel #_______________ Rod Section #'s_______________			

Comments:



UCS: MS VIEW: LMAN: CTB:

SCALE:
HORZ.: NOT TO SCALE
VERT.:
DATUM:
HORZ.:
VERT.:

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SOIL GAS SAMPLING
EQUIPMENT DIAGRAM
SOIL GAS SAMPLING SOP

PROJ. No.:
DATE: SEPTEMBER 2005

FIGURE 090000

GRAB SAMPLING WITH A SUMMA CANISTER

1. Remove the Summa Canister from any shipping containers. Cross reference the summa number with those that appear on the Media Agreement form. If there are any discrepancies, contact the laboratory.

2. Remove the swagelock fitting (nut) from the top of the canister with a 9/16" wrench.

3. Place the canister in the desired sampling area.

4. Open the valve ONE FULL TURN. At this point, you will hear the air being drawn into the canister. When the sound has ceased, the sampling is complete. The sampling time should be about 10 seconds.

5. When the sampling has been completed, close the canister and reattach the swagelock fitting to the top of the canister.

6. Return the summa canister to the laboratory for analysis. Be sure that the chain of custody has been completely filled out.

Note: *It is important that the summa canister be in the exact area of the desired sampling location to collect the suspected contaminants. If you are using pressurized sampling, please note the initial and final pressure on the labels provided with the canisters.*

CONTROLLED SAMPLING WITH A SUMMA CANISTER AND FLOW CONTROLLER

1. Remove the Summa Canister from any shipping containers. Cross reference the summa number with those that appear on the Media Agreement form. If there are any discrepancies, contact the laboratory.

2. Remove the swagelock fitting (nut) from the top of the canister with a 9/16" wrench.

3. Attach the flow controller to the top of the canister. Tighten the connection with the wrench. The connection should be snug but not overly tight.

4. Place the canister in the desired sampling area.

5. Open the valve ONE FULL TURN. This will start the sampling process. Each flow controller is preset for a specific period of time in the lab.

6. Check the pressure reading on the gauge and note it in the space provided for initial pressure on the label attached to the canister and on the field data sheet.

7. When the sampling has been completed, close the canister and note the pressure reading in the space provided for finial pressure on the label attached to the canister. Remove the flow controller, and reattach the swagelock fitting to the top of the canister.

8. Return the summa canister to the laboratory for analysis. Be sure that the chain of custody has been completely filled out.

Note: *It is important that the summa canister be in the exact area of the desired sampling location to collect the suspected contaminant*

INTRODUCTION

The purpose of this air/gas sampling method is to obtain reliable and cost effective gas samples with longer shelf lives.

Using a syringe and needle, air/gas is obtained by piercing a rubber septum, withdrawing the sample, and ejecting the sample into evacuated glass vials. This rubber septum / syringe method allows for taking samples under pressure or against a vacuum.

SVE SOIL GAS SAMPLING EQUIPMENT LIST

- Syringe stopcock adapter
- Ballpoint Pen

The following equipment is required *for each sample location* in order to conduct the collection and analysis of soil gas samples:

- Two evacuated 22cc glass vials, with approved labels
- 55 cc disposable syringe
- Syringe needle

SAFETY CONSIDERATIONS

In addition to site-specific health and safety concerns, the following safety considerations will always be followed when utilizing soil gas sampling equipment:

- In the event that an outlet is needed for some unforeseen piece of equipment, a Ground Fault Circuit Interrupter (GFCI) extension cord will be utilized. This device will automatically shut down when it senses a short.

- Ear protection is required during the operation of any blower or other loud equipment.

- Extra care will be taken when handling syringe needles. Syringe needles will have protective caps on them when not being used.

- When extracting soil gas that is *under pressure*, the syringe plunger may experience forces strong enough to cause it to shoot out. Precaution will be taken to prevent this from happening.

SOIL VAPOR SAMPLING PROCEDURES

Soil vapor samples will be collected in the field from Swageloc fittings using 50 cc disposable syringes as described below:

1. Attach completed labels to each 22 cc sample vial, and create an organizational layout, as it may be difficult to tell which bottles have / have not been used later on. Use only pre-approved labels, as others may jam autosamplers.
2. Attach stopcock adapter to tip of disposable 50 cc syringe.
3. Insert needle into Swageloc at desired sample location.
4. Take 50 cc sample, remove needle, and discard.
5. Take 40 cc sample, close stopcock, remove needle.
6. Insert needle into septum of 22 cc sample vial. Try to keep syringe and bottle "in line" so that the size of the puncture hole is minimized.
7. Open stopcock and compress all of the 40 cc into the vial while holding the syringe plunger "down" in one hand, and the bottle "up" in the other hand. Compress the plunger by pressing down against a convenient solid object.
8. While holding the plunger compressed, quickly remove the syringe from the bottle, keeping the needle "in line" so as not to increase the size of puncture.
9. Repeat steps 2-8 for a duplicate sample.
10. Repeat steps 2-9 with a new syringe and needle for each sample location, or flush syringe five times before reusing.
11. Ship samples at ambient temperature (do not cool them) to address listed above.

QUALITY ASSURANCE/QUALITY CONTROL (QA/QC)

The samples are stored in evacuated 22 cc glass vials, and must be analyzed within two weeks of sampling.

Evacuated vials should not be used more than 4 weeks beyond the date found on the bottom.

For every twenty (20) samples collected, one duplicate should also be collected. The frequency of taking duplicates will be dictated by the number of samples taken per event. (4 per event = 1 duplicate every 5 event)

GRAB SAMPLING WITH A SUMMA CANISTER

1. Remove the Summa Canister from any shipping containers. Cross reference the summa number with those that appear on the Media Agreement form. If there are any discrepancies, contact the laboratory.

2. Remove the swagelock fitting (nut) from the top of the canister with a 9/16" wrench.

3. Place the canister in the desired sampling area.

4. Open the valve ONE FULL TURN. At this point, you will hear the air being drawn into the canister. When the sound has ceased, the sampling is complete. The sampling time should be about 10 seconds.

5. When the sampling has been completed, close the canister and reattach the swagelock fitting to the top of the canister.

6. Return the summa canister to the laboratory for analysis. Be sure that the chain of custody has been completely filled out.

Note: It is important that the summa canister be in the exact area of the desired sampling location to collect the suspected contaminants. If you are using pressurized sampling, please note the initial and final pressure on the labels provided with the canisters.

CONTROLLED SAMPLING WITH A SUMMA CANISTER AND FLOW CONTROLLER

1. Remove the Summa Canister from any shipping containers. Cross reference the summa number with those that appear on the Media Agreement form. If there are any discrepancies, contact the laboratory.

2. Remove the swagelock fitting (nut) from the top of the canister with a 9/16" wrench.

3. Attach the flow controller to the top of the canister. Tighten the connection with the wrench. The connection should be snug but not overly tight.

4. Place the canister in the desired sampling area.

5. Open the valve ONE FULL TURN. This will start the sampling process. Each flow controller is preset for a specific period of time in the lab.

6. Check the pressure reading on the gauge and note it in the space provided for initial pressure on the label attached to the canister and on the field data sheet.

7. When the sampling has been completed, close the canister and note the pressure reading in the space provided for finial pressure on the label attached to the canister. Remove the flow controller, and reattach the swagelock fitting to the top of the canister.

8. Return the summa canister to the laboratory for analysis. Be sure that the chain of custody has been completely filled out.

Note: It is important that the summa canister be in the exact area of the desired sampling location to collect the suspected contaminant

INTRODUCTION

Drilling operations include all operations involving a drilling rig other than a direct-push or Geoprobe® rig. The following list includes the equipment which may be necessary to the sampling of soils associated with the drilling of monitoring wells or test borings:

1. Documentation

- General paperwork (maps, drilling, sampling and H&S plans, etc.)
- Logbook
- Pen and permanent marker
- Boring logs
- Sample labels
- Chain-of-custody forms

2. Personal Equipment

- Hard Hat
- Equipment required by Site Safety Plan
- Munsell Color Chart
- Grain size chart
- Disposable or rubber gloves
- 6' Ruler or small tape measure
- Water level measurement device
- Hand sprayers
- Paper towels
- Plastic garbage bags
- Bucket
- New locks

3. Sampling Equipment

- Organic vapor detector
- Sample containers for field parameters
- Coolers with ice packs or ice
- Wooden tongue depressors or stainless steel spoon
- Zip-lock poly bags

4. Decontamination Equipment

- Non-phosphate detergent
- Methanol solution
- Nitric Acid Solution
- Deionized water
- Tap water

5. Site-Specific Equipment

- Keys to site facilities (when applicable)
- Sample containers for lab parameters

SOIL BORINGS

Subsurface soil sampling during the drilling of test borings involves collecting soil samples retrieved by the drill rig from selected depth intervals for analysis. Test borings will be conducted with 4-inch minimum inside diameter hollow stem augers. Samples will be collected at appropriate intervals with a 24-inch steel split-tube sampler. The sampling interval and the total boring depth will depend upon the nature of the project.

Fuss and O'Neill field personnel will keep a record of the number of blows required for each six inches of split spoon penetration. In addition, the total penetration of the spoon and the amount of recovery will be recorded. Soil samples will be logged following ASTM D2488-90 methods. The soil color will be determined by consulting a Munsell Soil Color Chart, while the description of grain size will be based on a grain size chart.

Those samples to be analyzed for laboratory parameters will be placed in appropriate sample containers and cooled to 4 degrees Celsius. When screening is to be conducted in the field, soils for laboratory analysis will be separated from the rest of the sample prior to the screening operation. As a result, field screening will not affect the integrity of laboratory samples. See SOP 080300 for split-tube sampling techniques. Samples will be screened following one of the methods described in SOP 080000.

In some circumstances, drums or tanks will be used to temporarily contain the drilling water and/or cuttings resulting from test boring operations. Any containers used for this purpose will be clearly labeled with the location and date at the time of water collection. Personnel should consult the project manager prior to drilling in order to determine whether temporary storage of these materials is required.

The decontamination procedure will depend upon the nature of the contamination. When required by the sampling plan, split-tube samplers will be thoroughly decontaminated between samples as outlined in SOP 040000. In addition, drilling equipment may be steam-cleaned prior to drilling each test boring.

Test borings will be backfilled with an approved material taking care to completely fill the annular space. In some cases, the boring may be completed as a monitoring well or a gas port.

MONITORING WELL INSTALLATION

Monitoring wells provide an access point from which to study in-situ groundwater conditions. Specific monitoring well designs and construction methods are determined by staff hydrogeologists based on site hydrology and program objectives. These objectives may include the following:

- To provide samples of groundwater
- To measure groundwater elevations
- To study the effect of production wells
- To measure free product in groundwater
- To delineate other aquifer characteristics

Designs and methods which are required by such site-specific objectives are specified in appropriate project documents such as drilling bid documents, project work plans and the scope of work.

Regardless of the application, the usefulness of a monitoring well depends upon the degree to which it accurately reflects the conditions within the screened aquifer. Consequently, in addition to any site-specific requirements, all monitoring well installations should meet the following criteria:

1. There should be minimal disturbance of the formation during installation. Preservation of the physical and chemical nature of the formation should be a principal consideration in the selection of a drilling method.

2. The well screen should be set at an appropriate depth.

3. The well should be constructed of inert materials or materials which are compatible with the anticipated environment. Inappropriate well construction materials may chemically react with the aquifer, thereby affecting sample integrity and resulting in possible damage to the installation itself.

4. The well should be completed properly. Proper well construction should be a major consideration when selecting the drilling method and equipment.

5. The well should be protected from natural and human disturbance.

6. The well should be developed such that material introduced during drilling is removed and water flow through the well is not obstructed by suspended solids. Appropriate development techniques are discussed in "Monitoring Well Development."

7. Care should be taken to ensure that contamination in one aquifer is not introduced to another aquifer by vertical migration as a result of drilling activities. This may require special installation and completion techniques.

The geologist will log any soil and rock samples that are collected during drilling activities. Protocols regarding subsurface soil sampling during monitoring well drilling are discussed in the sections entitled "Test Borings" and "Soil Sampling." It is the responsibility of the geologist to record all construction details and methods used, including the depth and quantities of all materials used in the well construction. In addition, the collection of water level data following the immediate installation of the well often provides valuable information about the aquifer.

In some circumstances, drums or tanks will be used to temporarily contain the drilling water and/or cuttings resulting from monitoring well installation. Any containers utilized for this purpose will be clearly labeled with the location and date at the time of sample collection. Personnel should consult the project manager prior to drilling activities in order to determine whether temporary storage of those materials is required.

Methods most commonly used to advance a boring through the overburden in Southern New England are: hollow stem auger, spun or driven casing and air rotary. Other methods such as cable tool and mud rotary are less frequently used. The following discussion of overburden well installation specifically addresses hollow stem auguring and spinning or driving casing, although it may be applicable to other drilling methods as well. The typical method of advancing a borehole through bedrock is by core barrel, although a roller bit may be used when no sample collection is desired.

OVERBURDEN MONITORING WELLS

It is recommended that overburden monitoring wells be installed using standard 4-1/4"-inch minimum inside diameter (I.D.) hollow stem augers or casing.

At the depth to be screened, a 2-inch I.D. slotted screen and well casing will be inserted into the borehole. Both the casing and the screen will be threaded, flush joint, schedule 40 polyvinyl chloride (PVC). The annular space will be packed with appropriately-sized quartz sand to two feet above the top of the screen. It may be appropriate to place fine-grained sand above the screen in the upper two feet of the filter pack to reduce the possibility of bentonite seeping into the screened interval. Under optimum conditions, the filter pack should be installed by means of a tremie pipe. Voids in the filter pack should be prevented by tamping on the sand as it is installed. The type of sand to be used in the filter pack should be specified in the bid document. A minimum of two feet of sodium bentonite pellets will be set on top of the filter pack to provide an effective seal against the vertical migration of water into the screen.

The bentonite pellets should be tamped into place with an appropriate device such as a tremie tube. The annular space above the bentonite seal will be filled with a high suspended solids bentonite grout by means of a tremie tube. Side-dispersing tremie tubes are preferred for this application. The grout slurry will extend from the top of the bentonite pellet seal to approximately 24 to 18 inches below the ground surface.

A 4-inch minimum diameter protective steel casing will be inserted at least four feet into the borehole. The cover of the steel casing will be locking, with no hinges or threads. The protective steel casing will be equipped with small drain holes positioned just above grade to prevent the accumulation of water between the steel casing and the riser. Cement will be used to fill the remainder of the borehole in and around the protective steel casing. The sides of the cement collar will be vertical to minimize the effects of frost heaving. In addition, the surface of the collar will be sloped to prevent ponding around the well and thereby limit the infiltration of meteoric or surface water.

The casing in flush-mounted wells will be completed with a curb box. Curb boxes will be supplied by the driller and clearly labeled as monitoring wells. Small-diameter drain holes or permeable material such as sand will be placed at the bottom of the curb box to drain any water which infiltrates the curb box cap.

A notch will be cut into the highest point of the PVC casing and later surveyed. All water levels will be taken from this point.

BEDROCK MONITORING WELLS

Hollow Stem Auger Method

A) A minimum of 4.25" inside diameter hollow stem auger will be advanced through the unconsolidated material, the contractor shall make every effort to ensure the borehole is plumb. The borehole may be checked using a plumb line; the field geologist has the option of rejecting the borehole if it is substandard.

B) Split spoon samples may be obtained at intervals specified in the sampling work plan and screened with an organic vapor meter if appropriate. Samples are generally obtained continuously or every five feet. The field geologist may use split spoon samples or observe cuttings from the auger flights in order to determine elevation of water table.

C) The field geologist will log the borehole in order to identify likely contaminant bearing strata. Once the top of the bedrock surface is encountered, a four-inch (4") inside diameter threaded or welded steel casing will be inserted inside the hollow stem augers. The casing will be spun a minimum of one foot into competent rock.

Rotary Drilling Method

A) This system uses a circulating fluid pumped down a rotating apparatus through the cutting bit and up the annulus between the drill string and borehole wall. A four-inch inside diameter threaded or welded steel casing will be spun or driven behind the cutting bit, the contractor shall make every effort to ensure the borehole is plumb. The borehole may be checked using a plumb line, the field geologist has the option of rejecting the borehole if it is substandard.

B) There are two primary purposes of the drilling fluid. The first function is to lubricate the drilling apparatus; the second is to transport cuttings to the surface. The selection of the drilling fluid is unique to each drilling program and is the responsibility of the project hydrogeologist. Generally a drilling fluid composed of 30-50 lb of bentonite per 100 gallons of fresh water is selected. The bentonite is slowly mixed with the water in a fifty five gallon drum or mud tub. When drilling in known contaminated areas all mud and cuttings will be contained in a mud tub. When the drilling location is known to be clean, a pit can be dug at the surface to contain mud and cuttings.

C) Split spoon samples may be obtained at intervals specified in the sampling work plan and screened with an organic vapor meter if appropriate. Samples are generally obtained continuously or every ten feet. Once the top of the bedrock surface is encountered the casing will be spun a minimum of one foot into the competent rock.

D) A four-inch diameter roller bit will be used to clean out the inside of the casing and advance the hole into the upper surface of the competent bedrock. Drilling mud (if used) may be flushed out of the borehole by recirculating fresh water through the drilling string.

E) The roller bit will be replaced with an HQ size core barrel which has an outside diameter of 2.8 inches and is approximately five feet long. The core will be retained for visual inspection.

F) At the depth to be screened, a well screen and well casing will be inserted into the borehole. Generally at the depth to be screened, a two inch I.D. well screen and well casing fitted with an O-ring to eliminate leakage at the coupling will be inserted into the borehole. Both will be made of Type I polyvinyl chloride which conforms to the most recent ASTM-1785 requirement. Attached to the bottom of the well screen will be a sediment sump of equal size and material with threaded couplings compatible to the riser pipe. Slot size will be determined by the project hydrogeologist. The top of the PVC well casing will be notched, the function is to serve as a permanent reference point for survey and depth to water measurements.

F) Wells extending beyond thirty feet may require a centralizer to assure proper placement of the well within the borehole.

G) Once the screen and well casing have been inserted into the open borehole, a well plug will be inserted into the well casing in order to prevent backfill materials from entering the well screen. The annular space between the borehole and the well screen shall be backfilled with silica sand to assure continuous sediment free water. The grain size for the filter pack within the screened area will be determined by the project hydrogeologist. The silica sand pack shall be placed in the annular space around the well screen, extending three feet above the screen. If a large grain size is selected for the filter pack, silica sand of a smaller grain size will be placed at the top of the filter pack in order to prevent the penetration of the lower seal into the screened area. The filter pack will be tamped using an acceptable device such as a tremie pipe to avoid creation of void spaces.

H) A lower seal of at least three feet of sodium bentonite pellets or chips shall be placed above the filter pack. The pellets will be placed at a rate within the borehole such that they will sink through the water column to the top of the filter pack. The seal should extend up through the bedrock surface.

I) The remainder of the annular space above the filter pack must be sealed. High suspended solids bentonite grout will be mixed in accordance with the manufacturers directions. The grout mixture will then be tremied to the bottom of the zone to be sealed. Hand mixing is an acceptable method when small volumes of grout are needed (<30 gal.). When larger volumes are required, recirculation mixing is necessary. Grout will be allowed to settle prior to surface completion. Additional grout will be allowed to settle prior to surface completion. Additional grout may be added to bring the final level up to the required elevation.

J) Monitoring wells will be completed at the surface with either a flush mounted curb box or protective sleeve casing stickup as determined by the project hydrogeologist.

1. Asphalt or concrete that must be penetrated for monitoring well installation will be saw cut.

2. A 2'x2'x2' concrete pad shall be constructed to support the protective steel casing. A square hole with vertical sides centered about the borehole will be dug. The hole should extend six inches below the frost line, which in this region is assumed to be three feet below grade. At least one layer of chicken wire will be set into the concrete as reinforcement. Concrete shall slope up from the sides of the pad at the ground surface to the protective sleeve. Sloping the top of the concrete pad in this configuration will prevent surface water infiltration.

3. For a two inch diameter monitoring well, the protective steel sleeve will be a minimum of four inches in diameter with three weep holes approximately one half inch diameter at the bottom. The steel sleeve should be long enough such that the bottom is located below the frost line and the top is approximately four inches above the well casing. A snug fitted lockable steel cap should be installed on the top of the protective sleeve.

4. For a two inch diameter monitoring well, a flush mounted steel curb box a minimum of eight inches in diameter will be used. The curb box will be installed within a 2'x2'x1.5' concrete pad. The curb box will have a rubber gasket between the box and the lid to prevent surface water infiltration. A lockable well plug will be inserted in the top of the well casing.

5. All well installations shall be numbered by steel stamping, or welding on the exposed portion of the protective steel casing (not the cap) with a numbering system designated by the project hydrogeologist. The well designation will also be marked on the protective sleeve using a weather resistant paint.

INTRODUCTION

It is crucial that basic information (completing the comments section, recording core length and recovery, fracture depths, labeling core boxes, etc.) be completed in the field. Information that is important to field notes and information that can be recorded later is indicated in the attached explanation. Nevertheless, all information indicated herein should be included when reporting rock coring operations to regulatory agencies. It is important to note that the principle purpose of performing a rock coring operation when conducting environmental investigations is to determine the direction of ground water and contaminant flow within the bedrock aquifer and to map the location of contaminants. Therefore, efforts should be focused on noting the depth, orientation, etc. of fractures in the rock and determining which are the major water bearing conduits. Information concerning the mineralogy, grain size, color, etc. of the bedrock is secondary, unless specified by the project manager.

FIELD PROCEDURES FOR LABELING ROCK CORES AND CORE BOXES

When inspecting rock cores for monitoring well construction or geotechnical purposes, the following is the minimum information that should be recorded in field note books and on the inside of the core boxes.

Job Name
Job Number
Monitor Well or Core Number
Run Number
Starting Depth
Starting Time
Stop Depth
Stop Time
Run Length
Recovery Length

The run number, starting depths and times, stop depths and times, run length and recovery length should be recorded for each run. In addition, notes should be made in the field book indicating the length of the core pieces, angles of fractures and relative orientation of fractures. The core should be observed carefully as it is removed from the barrel to help differentiate natural fractures from those which may have been caused by moving and handling. A distinction between natural and man-made fractures should be indicated in the field book. Depths of all fractures should be recorded. Important Note: Only naturally occurring fractures should be considered when performing DRQD analyses.

When placing core pieces into boxes for storage it is important to note on the box which end is the top of core, and which direction is up. Wooden blocks should be placed between cores to separate runs.

Indications such as run number or depth can be made on the edges of the core boxes or on spacer blocks between core runs. Cores should always be placed in boxes so they may be read the way you read a book. The top of the first core run should be placed in the upper left hand corner and the core pieces should be laid out to the right in the order they came out of the barrel.

DEFINITION OF TERMS USED DURING ROCK CORE LOGGING

INFORMATION THAT MUST BE FILLED OUT IN FIELD

Tests: Note any tests performed.

Instrumentation: Note any instrumentation used during tests.

Coring Rate: Rate at which core barrel penetrates rock (ft/min). Note depths of any rate changes (i.e. slow downs or sudden drops).

Smoothness: Is coring smooth or does bit chatter?, etc.

Fluid Loss: Note depths of any changes in fluid pressure or visible loss of recirculating mud or water.

Core Run: A run is the period from when the core barrel is lowered into the bore hole until the rock core is retrieved. Indicate run number (No. 1, 2, 3, etc.), to be numbered consecutively. Start with Run No. 1 again when starting new bore hole.

Run Length: Depth core barrel penetrated rock since finishing the last run.

Recovery: Length of core retrieved (ft.).

Core Loss: Core run length minus recovery length.

Fractures: Indicate depth at which fractures occur and number of fractures per foot. Also indicate angle of fracture and/or orientation (if coring with an aligned core barrel). If discrete hydrologic tests are performed (i.e. packer tests, etc.), indicate estimated yield from fracture.

INFORMATION THAT CAN BE FILLED OUT IN THE OFFICE

DRQD: Deeres rock quality designation. (Sum of core pieces greater than 100 mm/run length) x 100. Indicated as a percent.

Percent Recovery: (Length of core/length of run) x 100 (can be obtained later from DRQD sheet).

DISCONTINUITIES

Tightness: How well do the pieces fit together? Indicate loose, very loose, tight, very tight, etc.

Very Tight Fracture invisible or faintly visible when pieces reunited.

Tight Fracture less than 1 mm.

Loose Fracture 1 mm to 2 mm.

Very Loose Fracture > 2 mm.

Planarity:

Planer Flat

Semi-Planer Slightly curved or angled

Non-Planer Sharply curved or angled

Orientation: Indicate dip of fracture planes (angle of fracture to horizontal, core is assumed to be 90 degrees to horizontal).

Spacing: Indicate the closeness or spacing of fractures:

<2 in. very close

2 in. to 1 ft. close

1 ft. to 3 ft. moderately close

3 ft. to 10 ft. wide

10 ft. or more very wide

Smoothness: Indicate smoothness of fracture surface; very rough, rough, smooth, very smooth.

Alteration: Indicate any alteration or mineralization on fracture surface (i.e. chlorite, talc, calcite, silica, hematite, etc.).

Weathering: Indicate the degree of weathering of the fracture surface (i.e. fresh, slightly, moderately, high, severe).

Filling, Staining: Indicate any materials filling fractures (calcite, silt, clay, etc.) or staining on fracture surface (iron staining, etc.).

LITHOLOGY

Mineralogy: List major mineral constituents in order of abundance, starting with the most abundant mineral.

Classification: Indicate rock type (sandstone, shale, schist, gneiss, etc.).

Color: Indicate color of core according to color scale. Use the Munsell rock color charts.

Grain Size: Size of the mineral crystals in the rock matrix. Best applied to equigranular rocks.

Very Fine Cannot be seen with the naked eye.

Fine <1 mm

Medium 1 to 5 mm

Coarse >5 mm

Alteration: Indicate any products of alterations of minerals due to weathering or retrograde metamorphism (chlorite, talc, silica, etc.).

Cementation: Indicate cementation material binding grains (i.e., calcite, hematite, etc.).

Hardness: Indicate hardness of the rock sample or constituent mineral grains as follows:

Very Hard Cannot be scratched with knife.

Hard Difficult to scratch with knife.

Medium Knife leaves well-defined groove.

Soft Easily scratched with knife; leaves broken edges on groove.

Very Soft Can be scratched with fingernail.

Weathered State: Indicate degree of weathering of rock core and/or fracture surface. Terms used to describe weathering are as follows:

Fresh Rock is unstained. Fractures may be present but surfaces are unstained.

Slightly Rock is unstained. Fractures show some staining; does not penetrate rock mass.

Moderate	Fracture surfaces are stained. Discoloration may extend into rock mass.
High	Individual rock fragments are very stained and can be crushed with hammer.
Severe	Rock appears to consist of gravel silica fragments in a soil-like matrix. Individual fragments are thoroughly discolored and can be broken with fingers.

<u>Spacing</u>: Indicate closeness of spacing or bedding, foliation, banding or other textural features as follows:

<2 in.	very thin
1 ft. to 1 ft.	thin
3 ft. to 10 ft.	thick
>10 ft.	very thick

<u>Texture</u>: Indicate any textural features of the rock fabric (i.e. banding, schistocyte, bedding, etc.). Also indicate orientation of any features noted.

<u>Rock Formation</u>: Indicate name of formation, if known.

DIRECT PUSH SOIL SAMPLING

In general, direct-push technology will be employed using a Geoprobe® Soil Sampler. Direct-push technology will be used when the soil conditions are favorable (e.g., sandy soils), when the volume of soil required for analysis is less than 8 ounces, and when the depth of sampling does not extend more than 16 feet below ground level (BGL). The following procedure will be used.

1. Assemble the Geoprobe® soil sampler lined with an acetate sleeve.

2. The assembled sampler will be placed in the driving position beneath the anvil and driven using a slow throttle speed to ensure straight penetration of the sampler for the first two or four feet. In order to install the sampler, the throttle control will be adjusted for the remainder of the stroke as necessary to compensate for geologic conditions.

3. Additional lengths of rod will be attached to the sampler and driven until the desired depth of sample collection is obtained.

4. The stop pin will be removed by inserting extension rods inside the probe rods enabling the piston to retract into the sample tube while the sample is taken.

5. The soil sampler will be advanced to the bottom of the sample interval. Care will be taken not to over-drive the sampler, to avoid compacting the soil sample in the sampler tube.

6. The pull cap will be attached to the top of the drill string and lifted to remove the soil sampler from the ground.

7. The acetate sleeve will be removed from the soil sampler and cut lengthwise with a razor knife to collect the soil sample. The sample will be transferred into the necessary containers using a dedicated wooden tongue depressor or similar method (i.e. dedicated gloves). Care will be taken to minimize disturbance of the soil during transfer.

8. Sample labels will be attached to the sample containers. The containers will then be placed into a cooler and maintained at 4° C until they are delivered to the laboratory or the Fuss & O'Neill sample refrigerator. All information pertaining to the samples will be documented on field data sheets.

9. The geology of the sample will be recorded on a boring log.

10. The total VOC concentration of the excess soil will be measured inside a plastic zip closure bag using a photo-ionization detector (PID) or a flame-ionization detector (FID). This information will be recorded on the boring log.

DIRECT PUSH GROUNDWATER SAMPLING

Installation of Screen Point 15® Sampler

1. The assembled sampler will be placed in the driving position beneath the anvil and driven using a slow throttle speed to ensure straight penetration of the sampler for the first two feet. In order to install the sampler, the throttle control will be adjusted for the remainder of the stroke as necessary to compensate for geologic conditions.

2. Additional three-foot lengths of rod will be attached to the sampler as necessary and driven until the desired depth of sample collection is obtained.

3. A pull cap will be attached to the top of the drill string and lifted to expose the screen sampler at the desired sampling interval.

Groundwater Sampling Method - Peristaltic Pump

The purpose of groundwater sample collection with direct-push technology is to obtain screening-level groundwater data. The screening data is used to determine the necessity for groundwater sampling wells and to optimize the well placement. The protocol for groundwater sample collection with direct-push technology is described below:

1. A stainless steel sampler sheath 52 inches long by 1.25-inches diameter with a retractable screen will be driven to the desired depth using the direct-push technology procedures (SOP 9A). The disposable point is then disengaged, and the assembly is retracted 48 inches leaving the screen exposed.

2. Lower dedicated polyethylene tubing down the rods to one foot above well point bottom. Connect the polyethylene tubing to a three-foot length of dedicated silicon tubing and thread the silicon tubing through a battery operated, peristaltic pump. Purge the rods by withdrawing approximately one well volume as defined as the interior volume of the drill rods from the water table to the bottom of the well point. Allow the well point to refill with water and operate the pump to collect water samples. If it proves impractical to evacuate one well volume due to slow recharge and deep installation depth, withdraw the tubing and continue to evacuate water using a small diameter bailer. Collect the sample using the tubing and pump or bailer after purging is complete.

3. Contain and seal the water sample into sample containers in order of decreasing volatility. Tip the sampling container so that a slow, laminar flow of water enters the VOA vial. Direct the stream of water to the sides of the vial so as to prevent aeration of the sample due to turbulence. Fill no more than two VOA vials from a single bailer of water. Seal the vials with no headspace to prevent any further volatilization of the sample once it has been collected. After the lid is screwed on, turn the VOA vial over and tap it to check for bubbles.

4. Collect samples for all remaining parameters. Fill the remaining sample bottles to the base of the bottle neck.

5. Place all labeled sample containers in an iced cooler.

6. Remove drill rods from borehole. Abandon the borehole.

<u>Groundwater Sampling Method - Tubing and Foot Valve</u>

1. A foot valve attached to the bottom of a dedicated length of poly tubing will be installed to the depth of the screened interval.

2. The tubing assembly will be oscillated in an upward and downward motion to purge and/or sample the groundwater (See Section 7.1.4).

3. Samples will be collected in order of decreasing volatility and/or increasing stability.

4. Samples will be collected directly from the discharge end of the sample tubing.

5. Care will be taken not to agitate the sample during collection when sampling for volatile and semi-volatile organic compounds. Field personnel will hold the tubing end and VOC vial steady, ensuring that a slow, laminar flow of water enters the VOC vial. The stream of water will be directed to the side of the vial to prevent aeration of the sample due to turbulence. Vials will be sealed with no headspace to prevent any further volatilization of the sample once it has been collected. After the lid is screwed on, the VOC vial will be turned over and tapped to check for bubbles.

6. Sample containers will be filled at least to the base of the neck for all remaining parameters.

7. Sample labels will be attached to the sample containers. The containers will then be placed into a cooler and maintained at 4°C until they are delivered to the laboratory or the Fuss & O'Neill sample refrigerator. All information pertaining to the samples will be documented on field data sheets.

OBJECTIVE

The objective of this procedure is to install a permanent, small-diameter groundwater monitoring well that can be used to collect water quality samples, conduct hydrologic and pressure measurements, or perform any other sampling event that does not require large amounts of water over a short period of time (e.g. flow rate> 1 liter/minute). These methods meet or exceed the specifications discussed for direct push installation of permanent monitoring wells with pre-packed screens in the U.S. Environmental Protection Agency's guidance document, Expedited Site Assessment Tools For Underground Storage Tank Sites, (EPA, 1997) and ASTM Standards D 6724 (ASTM, 2002) and D 6725 (ASTM, 2002).

BACKGROUND

Definitions

Geoprobe® Direct Push Machine: A vehicle-mounted, hydraulically-powered machine that uses static force and percussion to advance small-diameter sampling tools into the subsurface for collecting soil core, soil gas, or groundwater samples. The Geoprobe® brand name refers to both machines and tools manufactured by Geoprobe Systems®, Salina, Kansas. Geoprobe® tools are used to perform soil core and soil gas sampling, groundwater sampling, soil conductivity and contaminant logging, grouting, materials injection, and to install small-diameter permanent monitoring wells or temporary piezometers.
**Geoprobe® is a registered trademark of Kejr, Inc., Salina, Kansas.*

0.5-inch X l.4-inch OD Pre-packed Well Screen (0.5-inch prepack): An assembly consisting of a slotted PVC pipe surrounded by environmental grade sand contained within a stainless steel wire mesh cylinder. The inner component of the pre-packed screen is a flush-threaded, 0.5-inch Schedule 80 PVC pipe with 0.01-inch (0.25 mm) slots. Stainless steel wire mesh with a pore size of 0.011 inches (0.28 mm) makes up the outer component of the prepack. The space between the inner slotted pipe and outer wire mesh is filled with 20/40 mesh silica sand. Geoprobe® 0.5-inch x l-inch prepacks are available in 3-foot and 5-foot sections and have an outside diameter of 104 inches (36 mm) and a nominal inside diameter of 0.5 inches (13 mm).

0.75-inch x l.4-inch OD Pre-packed Well Screen (0.75-inch prepack): An assembly consisting of a slotted PVC pipe surrounded by environmental grade sand contained within a stainless steel wire mesh cylinder. The inner component of the pre-packed screen is a :(flush-threaded, 0.75-inch Schedule 40 PVC pipe with 0.01-inch (0.25 mm) slots. Stainless steel wire mesh with a pore size of 0.011 inches (0.28 mm) makes up the outer component of the prepack. The space between the inner slotted pipe and outer wire mesh is filled with 20/40 mesh silica sand. Geoprobe® 0.75-inch x l-inch prepacks are available in 3-foot and 5-foot sections and have an outside diameter of 104 inches (36 mm) and a nominal inside diameter of 0.75 inches (19 mm).

Discussion

Conventional monitoring wells are typically constructed through hollow stem augers by lowering slotted PVC pipe (screen) to depth on the leading end of a string of threaded PVC riser pipe. A filter pack is then installed by pouring clean sand of known particle size through the tool string annulus until the slotted section of the PVC pipe is sufficiently covered.

Installing the entire filter pack through the tool string annulus becomes a delicate and time-consuming process when performed with small-diameter direct push tooling. Sand must be poured very slowly in order to avoid bridging between the riser pipe and probe rod. When bridging does occur, considerable time can be lost in attempting to dislodge the sand or possibly pulling the tool string and starting over.

Pre-packed screens greatly decrease the volume of loose sand required for well installation as each screen assembly includes the necessary sand filter pack. Sand must still be delivered through the casing annulus to provide a minimum 2-foot grout barrier, but this volume is significantly less than for the entire screened interval.

The procedures outlined in this document describe construction of a permanent groundwater monitoring well using Geoprobe® 2.l25-inch (54 mm) outside diameter (OD) probe rods and lA-inch OD pre-packed screens. Geoprobe® lA-inch prepacks are available with either nominal 0.5-inch schedule 80 or 0.75-inch schedule 40 PVC components. Further options include running lengths of 3 and 5 feet for both 0.5- and 0.75-inch prepacks.

Installation of a prepack monitoring well begins by advancing 2.125-inch (54 mm) outside diameter (OD) probe rods to depth with a Geoprobe® direct push machine. Pre-packed screen(s) are then assembled and installed through the 1.5-inch (38 mm) inside diameter (ill) of the probe rods using corresponding 0.5-inch schedule 80 or 0.75-inch schedule 40 PVC risers.

The prepack tool string is attached to an expendable anchor point with a locking connector that is threaded to the bottom of the leading screen. Once the connector is locked onto the anchor point, the rod string is slowly retracted until the lower end of the rods is approximately 3 feet above the top prepack.

Regulations generally require a minimum 2-foot grout barrier above the top prepack to avoid contaminating the well screens with bentonite or cement during installation. In some instances, natural formation collapse will provide the required barrier. If the formation is stable and does not collapse around the riser as the rod string is retracted, environmental grade 20/40 mesh sand may be installed through the probe rods to provide the minimum 2-foot grout barrier.

Granular bentonite or bentonite slurry is then installed in the annulus to form a well seal. A highpressure grout pump (Geoprobe® Model GS 1 000 or GS500) may be used to tremie high-solids bentonite slurry or neat cement grout to fill the well annulus as the probe rods are retracted. The grout mixture must be installed with a tremie tube from the bottom up to accomplish a tight seal without voids to meet regulatory requirements.

In certain formation conditions, the pre-packed screens may bind inside the probe rods as the rods are retracted. This is most common in sandy formations sometimes called flowing or heaving sands. This binding can generally be overcome by lowering extension rods down the inside of the well riser and gently, but firmly, tapping the extension rods against the base of the well as the rods are slowly retracted. If the binding persists, clean tap water or distilled water may be poured down the annulus of the rods to increase the hydraulic head inside the well. This, combined with the use of the extension rods, will free up the pre-packed screen and allow for proper emplacement.

Once the well is set, conventional flush-mount or aboveground well protection can be installed to prevent tampering or damage to the well head. These wells can be sampled by several available methods (bladder pump, peristaltic pump, mini-bailer, Geoprobe® tubing check valve, etc.) to obtain high integrity water quality samples. These wells also provide accurate water level measurements and can be used as observation wells during aquifer pump tests.

When installed properly, these small-diameter wells generally meet regulatory requirements for a permanent monitoring well. While a detailed installation procedure is given in this document, it is by no means totally inclusive. Always check local regulatory requirements and modify the well installation procedure accordingly. These methods meet or exceed the specifications discussed for direct push installation of permanent monitoring wells with pre-packed screens in the U.S. Environmental Protection Agency's guidance document, Expedited Site Assessment Tools For Underground Storage Tank Sites, (EPA, 1997) and ASTM Standards D 6724 (ASTM, 2002) and D 6725 (ASTM, 2002).

WELL INSTALLATION

Monitoring well installation can be broken down into five main steps:

- Anchoring the well assembly at depth
- Providing a sand pack and grout barrier
- Installing a bentonite seal above the screen
- Grouting the well annulus
- Installing well protection

Anchoring the Well Assembly

In this portion of the well installation procedure, an expendable anchor point is driven to depth on the end of a 2.125-inch (54 mm) OD probe rod string. A pre-packed screen assembly is inserted into the I.D. of the rod string with 5-foot (1.5 m) sections of PVC riser pipe. The screens and riser pipe are attached to the anchor point via a snap-lock connector.

1. If the monitoring well is to have a flush-mount finish, it is a good practice to prepare a hole large enough to accept a standard well protector before driving the probe rods.
2. Move the Geoprobe® direct push machine into position over the proposed monitoring well location. Unfold the probe and place in the proper probing position as shown in the unit Owner's Manual. Access to the top of the probe rods will be required. It is therefore important to allow room for some derrick retraction when placing the unit in the probing position.

3. Place an O-ring in the groove of a 2. 125-inch Expendable Anchor Point (GW2040). Insert the point into the unthreaded end of a 2.125-inch Expendable Point Holder. Note that expendable point holders are available in lengths of 36 inches/0.9 meters (AT2110), 48 inches/l.2 meters (AT2111), or 60 inches/1.5 meters (AT2112).

4. Attach a 2.125-inch Drive Cap (AT210l) to the threaded end of the point holder.

5. Place the expendable point holder under the probe hammer in the driving position (refer to unit Owner's Manual). Drive the point holder into the ground utilizing percussion if necessary. It is important that the rod string is driven as straight as possible to provide a plumb monitoring well. If the point holder is not straight, pull the assembly and start over with Step 2.

6. Remove the drive cap from the expendable point holder. Install an O-ring (AT2100R) on the point holder in the groove located at the base of the male threads.

   Note: The operator may choose to lubricate the O-ring with a small amount of clean water. Lubricating the O-ring makes it easier to thread the probe rods together and nearly eliminate tom O-rings. A small spray bottle works well for applying the water.

7. Thread a 2.125-inch Probe Rod (AT2136, AT2139, AT2148, or AT2160) onto the expendable point Holder. Place the drive cap on the probe rod and advance the rod string.

8. Remove the drive cap and install an O-ring (AT2100R) at the base of the male threads of the probe rod. Add another probe rod and replace the drive cap. Once again, advance the rod string.

9. Repeat Step 8 until the end of the rod string is 4 inches (102 mm) below the bottom of the desired screen interval. The additional depth allows for the connection between the expendable anchor point and screen assembly. The top probe rod must also extend at least I foot (25 mm) above the ground surface to allow room for the rod grip puller later in this procedure. Move the probe foot back to provide access to the top of the rod string.

10. With the probe rods and anchor point driven to the proper depth, the next step is to deploy the screen(s) and riser pipe. Thread together 1.4-inch OD pre-pack sections to achieve the desired screen interval. l.4-inch OD pre-packs are available with 0.5-inch Schedule 80 PVC or 0.75-inch Schedule 40 PVC components and in lengths of 3 or 5 feet (0.9 or 1.5 m). O-rings (GW430R) can be installed between the screen sections if desired.

11. Thread a Snap-lock Connector (0.5-inch, GW2030 or 0.75-inch, 17469) into the female end of the assembled pre-packs. An O-ring can be placed on the male threads of the connector if desired.

12. Insert the screen assembly into the top of the probe rod string with the connector facing toward the bottom of the rods.

13. With the assistance of a second person, attach 5-foot (1.5 m) sections of 0.5-inch Schedule 80 or 0.75-inch Schedule 40 PVC Riser (GW2050 or 11747) to the top of the screen assembly. O-rings are required at each riser joint to prevent groundwater from seeping into the well from above the desired monitoring interval. Continue adding riser sections until the assembly reaches the bottom of the rods. At least 1 foot (0.3 m) of riser should extend past the top probe rod.

14. Install a PVC top cap or locking well plug on the top riser. If using the vinyl cap, secure the cap with two wraps of duct tape or electrical tape.

15. Raise the screen and riser assembly a few inches and then quickly lower it onto the expendable anchor point. This should force the snap-lock connector over the mushroomed tip of the anchor. Gently pull up on the riser to ensure that the connector and anchor are firmly attached. Approximately 0.25 inches (6 mm) of play is normal.

16. It is now time to pull up the probe rods from around the well screen and riser. Reposition the probe unit so that the Rod Grip Puller can be attached to the rod string.

17. Retract the rod string the length of the screens plus an additional 3 feet (1 m). While pulling the rods, observe whether the PVC risers stay in place or move up with the rods.

    a. If the risers stay in place, stable formation conditions are present. Continue retracting the rods to the depth specified above.
    b. If the risers move up with the probe rods, have a second person hold it in place while pulling up the rods. An additional section of PVC riser may be helpful. Once the probe rods have cleared the anchor point and part of the screen, the screen and riser assembly should stop raising with the rods. Continue retracting to the depth specified above.
    c. If the risers continue to move up with the probe rods and can not be held in place by hand, the anchor point is most likely located in heaving sands. Extension rods are now required.
    d. Place a Screen Push Adapter (GWI535) on the end of an Extension Rod. Insert the adapter and extension rod into the PVC riser and hold by hand or with an Extension Rod Jig (AT690). Attach additional extension rods with Extension Rod Couplers (AT68) or Extension Rod Quick Links (AT694K) until the push adapter contacts the bottom of the screens. Place an Extension Rod Handle (AT69) on the top extension rod after leaving 3 to 4 feet (1 to 1.2 m) of extra height above the last probe rod.
    e. Slowly retract the probe rods while another person pushes and taps on the screen bottom with the extension rods. To ensure proper placement of the screen interval and prevent damage to the well, be careful not to get ahead while pulling the probe rods. The risers should stay in place once the probe rods are withdrawn past the screens. Retrieve the extension rods. Place the cap back on the top riser and secure the cap with duct tape if necessary.

Sand Pack and Grout Barrier

The natural formation will sometimes collapse around the well screens as the probe rod string is withdrawn. This provides an effective barrier between the screens and grout material used to seal the well annulus. If the formation does not collapse, a sand barrier must be placed from the surface. This portion of the well installation procedure is important because an inadequate barrier will allow grout to reach the well screens. Non-representative samples and retarded groundwater flow into the well may result from grout intrusion.

1. Using a Water Level Sounder (GWI200) or flat tape measure, determine the depth from the top of the PVC riser to the bottom of the annulus between the riser and probe rods. Two scenarios are possible:
    a. Measured depth is 2 to 3 feet (0.6 to 0.9 m) less than riser length. This indicates that unstable conditions have resulted in formation collapse. A natural grout barrier has formed as material collapsed around the PVC riser when the probe rods were retracted. This commonly occurs in heaving sands. No further action is required. Proceed to the bentonite seal section and perform Step 2 (for unstable formations).
    b. Measured depth is equal to or greater than riser length. This indicates that stable conditions are present and the cohesive formation did not collapse. The probe hole has remained open and void space exists between the riser (and possibly the screen) and formation material. Clean sand must be placed downhole to provide a suitable grout barrier. Continue with Step 2.

2. Begin slowly pouring 20/40 mesh sand down the annulus between the PVC riser and probe rod string. Reduce spillage by using a funnel or flexible container. Add approximately 2.0 liters of sand for each 3-foot (1 m) screen section or 3.25 liters of sand for each 5-foot (1.5 m) screen, plus 1.75-2.0 liters for a minimum 2-foot (0.6 m) layer of sand above the top screen section.

    Note: The sand volumes specified above assume maximum annular space where no formation collapse has occurred. Actual volumes may be less in field conditions.

3. Measure the annulus depth after each 1.0-1.5 liters of sand. The sand may not fall all the way past the screens due to the tight annulus and possible water intrusion. This is acceptable, however, since the pre-packed screens do not require the addition of sand. The important thing is that a sand barrier is provided above the screens.

4. Sand may also bridge within the annulus between the risers and probe rods and consequently fail to reach total depth. This most likely occurs when the sand contacts the water inside the probe rods during well installations below the water table. Wet probe rods also contribute to sand bridging. If the annulus is open, skip to the bentonite seal section, Step 1. If bridging is evident, continue with Step 5.

5. In case of a sand bridge above the screens (wet rods, high water table, etc.), insert clean extension rods into the well annulus to break up the sand. Simultaneously retracting the probe rods usually helps. Check annulus depth again. If sand is no longer bridged, proceed to the bentonite seal section. If bridging is still evident, continue with Step 6.

6. If the sand bridge can not be broken up with extension rods, inject a small amount of clean water into the annulus. This is accomplished with a Geoprobe® Model GS 1 000 or GS500 Grout Machine and 3/8-inch (9.5 mm) OD nylon tubing (11633). Simply insert the nylon tubing down the well annulus until the sand bridge is contacted. Attach the tubing to the grout machine and pump up to one gallon of clean water while moving the tubing up and down. The jetting action of the water will loosen and remove the sand bridge. Check annulus depth again. The distance should be 2 to 3 feet (0.6 to 0.9 m) less than the riser length when the sand barrier is completed.

<u>Bentonite Seal Above Screen</u>

Bentonite is a clay material which exhibits very low permeability when hydrated. When properly placed, bentonite can prevent contaminants from moving into the well screens from above the desired monitoring interval. The seal is formed either by pouring granular bentonite into the annulus from the ground surface, or by injecting a high-solids bentonite slurry directly above the grout barrier. The use of bentonite chips is limited to cases in which the top of the screen ends above the water table (no water is present in the probe rods). Whichever method is used, at least 2 feet (0.6 m) of bentonite must be placed above the sand pack.

1. **Stable Formation -**Granular bentonite is recommended if the following conditions are met:
   1) Top of screen interval is above the water table
   2) Formation remained open when probe rods were retracted
   3) Bridging was not encountered while installing the sand pack and grout barrier in Section
      a. Withdraw the probe rod string another 3 to 4 feet (0.9 to 1 m) and ensure that the PVC riser does not rise with rods. It is important that the bottom of the rod string is above the proposed seal interval. If positioned too low, dry bentonite will backup into the expendable point holder. Bridging then results if moisture is present inside the probe rods.
      b. Pour approximately 1.5 liters of granular bentonite between the probe rods and PVC riser
      c. Measure the riser depth to the bottom of the annulus. The distance should now equal the installed riser length minus the minimum 2 feet (0.6 m) of sand pack and 2 feet (0.6 m) of bentonite seal. As was stated with the sand pack, if the measured depth is significantly less than expected, the bentonite has more than likely bridged somewhere along the rod string. A procedure similar to that identified for bridged sand may be utilized to dislodge the granular bentonite.
      d. Once it has been determined that the bentonite seal is properly emplaced, add 1 liter of clean water to hydrate the dry bentonite according to regulations. This is not necessary if water was used to clear bridged bentonite.

2. **Unstable Formation** A grout machine is required to install the bentonite seal if the formation collapsed when the rods were retracted or the sand bridged when installing the grout barrier. The pump is able to supply a high-solid bentonite slurry under sufficient pressure to displace formation fluids. Void spaces often develop when poured (gravity installed) granular bentonite is used under these conditions, resulting in an inadequate annular seal. Wet rods will often lead to bridging problems as well.
    a. Mix I gallon (3.8 L) of high-solids bentonite (20 to 25 percent by dry weight) and place in the hopper of the grout machine.
    b. Insert 3/8-inch nylon tubing (see note below) to the bottom of the annulus between the probe rods and well riser. Leaving at least 15 feet (5 m) extending from the top of the rod string, connect the tubing to the grout machine. This extra length will allow rod extraction later in the procedure.

        NOTE: The side-port tremie method is recommended to prevent intrusion of grout into the sand barrier. To accomplish side-port discharge of grout, cut a notch approximately one inch up from the leading end of the tubing and then close the leading end with a threaded plug of suitable size.

    c. Activate the grout pump and fill the tremie tube with bentonite. Begin slowly pulling the rod string approximately 3 feet (1 m) while operating the pump. This will place bentonite in the void left by the retracted rods before it is filled by the collapsing formation. Continue to watch that the PVC riser does not come up with the rod string. When removing the retracted probe rod, slide the rod over the nylon tubing and place it on the ground next to the grout machine. This eliminates cutting and reattaching the tubing for each rod removed from the string. Take care not to "kink" the tubing during this process as it will create a weak spot in the tubing which may burst when pressure is applied.
    d. Measure the annulus depth to ensure that at least 2 feet (0.6 m) of bentonite was delivered. Pump additional bentonite slurry if needed.

<u>Grouting Well Annulus</u>

The placement of grout material within the remaining well annulus provides additional protection from vertical contaminant migration. Most grout mixes are composed of neat cement, high-solids bentonite slurry, or a combination of cement and bentonite. Such mixes must be delivered with a high-pressure grout pump. When stable formations exist, the well may be sealed by pouring dry granular bentonite directly into the annulus from the ground surface. Consult the appropriate regulatory agency to determine approved grouting methods.

This section presents the procedure for grouting the well annulus with the Geoprobe® Model GS 1000 or GS500 Grout Machines.

1. Mix an appropriate amount of grout material and place it in the hopper on the grout machine. (Refer to the Geoprobe® Yellow Field Book for tables on grout volume requirements.)
   NOTE: It is recommended that an additional 25 to 30 percent of the calculated annulus volume is included in the total grout volume. This allows for material that is left in the grout

hose and tubing or moves into the formation during pumping. An approximate range is 0.25 to 0.30 gallons (0.9 to 1.1 L) of grout for each foot of riser below ground surface.

2. A side-port tremie tube may be made from a roll of 3/8-inch OD Nylon Tubing (11633) by cutting a notch in the side of the tubing approximately 1 inch (25 mm) up from the discharge end. Thread a bolt or screw of suitable diameter into the end of the tubing so that pumped grout is forced out through the notch in a side-discharge manner.

   Insert the side-port tremie tube into the well annulus until the leading end of the tube reaches the top of the bentonite seal. At least 15 feet (5 m) of tubing should extend from the top of the rod string. This extra length allows rod extraction with the tubing attached to the pump.

3. Attach the tubing to the grout machine and begin pumping. If the bentonite seal was below the water table (deep well installation), water will be displaced and flow from the probe rods as the annulus is filled with grout. Continue operating the pump until undiluted grout flows from the top probe rod.

4. Reposition the direct push machine and prepare to pull rods.

5. Begin pulling the probe rods while continuing to pump grout. Match the pulling speed to grout flow so that the rods remain filled to the ground surface. This maintains hydraulic head within the probe rods and ensures that the space left by the withdrawn rods is completely filled with grout.

   NOTE: Slide the probe rods over the nylon tubing and place neatly on the ground next to the grout machine. **Be careful not to pinch or bind the tubing as this forms weak spots which may burst when pressure is applied.**

   NOTE: Try to avoid filling the upper 12 inches (305 mm) of well annulus with grout when pulling the expendable point holder. This will make for a cleaner well protector installation.

6. When all probe rods have been retrieved and the well is adequately grouted, unstring the tremie tube and begin cleanup. It is important to promptly clean the probe rods, grout machine, and accessories. This is especially true of cement mixes as they quickly set up and are difficult to remove once dried.

<u>Surface Cover / Well Protection</u>

A surface cover protects the PVC well riser from damage and tampering. Although aboveground and flush mount well covers may be used, most Geoprobe® pre-pack monitoring wells have been installed with flush mount covers. Consult the project planners and/or appropriate regulators to determine the approved well cover configuration for your specific application.

1. In order to fit under a flush-mount cover, the top of the well riser must be below the ground surface. Place the well cover over the riser to mark the cover diameter. Remove the cover and excavate the soil around the well head to install the protector.

2. The top of the riser should be located several inches above the bottom of the hole (but below the adjacent ground surface) before installation of the well cover. If a riser joint is near this level, the operator may choose to unthread the top riser and adjust the depth of the hole to fit the riser height. Most pre-pack installations will instead require trimming the top riser to the appropriate height with PVC cutters.

   NOTE: Do not cut off the riser with a hacksaw as cuttings may fall down into the screens.

3. In most areas, regulations specify that a locking plug be installed on the top riser of permanent monitoring wells. Insert a locking well plug into the riser and tighten the hex bolt with a l/2-inch T-handle wrench or nut driver until the cap fits snugly.

4. Position the well cover so that it is centered over the well riser. Provide at least 0.5 inches (13 mm) of space between the top of the locking plug and bottom of the well cover lid. If flush-mount protection is used, install the cover slightly above grade to prevent ponding of runoff water at the well head.

5. Support the well cover by installing a concrete pad according to project requirements. Pads are commonly square-shaped with a thickness of 4 inches (102 mm) and sides measuring 24 inches (610 mm) or greater. Finish the pad so that the edges slope away from the center to prevent ponding of surface water on the well cover.

6. Fill the inside of the well cover with sand up to approximately 2 to 3 inches (51 to 76 mm) from the top of the riser and locking plug.

INTRODUCTION

Slug tests are conducted to determine the hydraulic conductivity of the screened aquifer. This procedure consists of creating an instantaneous water level change and monitoring the recovery of the well with a miniTROLL™ pressure transducer. This water level change will be affected by the insertion of a slug of known volume into the water column and its subsequent withdrawal.

Once an initial water level reading and depth to bottom is recorded, a miniTROLL™ transducer will be lowered to a depth greater than the submerged depth of a six foot stainless steel slug. Avoid hitting the bottom of the well as the transducer can become clogged with sediment. A stainless steel slug of known volume will be lowered into the water by means of a length of dedicated nylon rope, and secured in place. Water level measurements will be taken once the slug has been inserted until the well has returned to static conditions.

Connect to the transducer using a handheld PDA or laptop computer loaded with Pocket-Situ™ or Win-Situ™ software. The miniTROLL™ can be referenced either to zero or the reference can be set to the actual water level measurement. At this point, the slug will be rapidly removed from the water taking care not to disturb the pressure transducer probe in the process. The time at which the slug was removed from the water column is recorded on the Slug Test Data Sheet. The rate of water level recovery will be measured logarithmically by the miniTROLL™. Measurement of water level variation will be carried out until the well has recovered to at least 85 percent of its original volume. The pressure of the probe at the end of the test will be recorded as will the time and a final depth to water measurement.

Whenever possible, data stored on a miniTROLL™ will be downloaded in the field. Slug tests will be repeated three times at each well as time allows and the data compared to insure that the test has been conducted correctly and adequate data has been collected. Care will be taken to allow sufficient recovery time between slug tests.

Data retrieved from this procedure will be interpreted through the use of techniques specifically developed for slug testing, yielding hydraulic conductivity values for each screened interval. These methods will be discussed elsewhere in the text.

INTRODUCTION

Pumping tests may be conducted to determine the performance characteristics of a well and the hydraulic conductivities of an aquifer. Well performance tests measure the capacity and production rates of the well. Pumping tests allow for transmissivity and storage coefficient calculations for aquifers. These tests predict the effect of new withdrawals on existing wells and the cone of influence for individual or multiple pumping wells.

PUMPING TESTS

A pumping test consists of pumping a well at a certain rate and recording the drawdown in the pumping well and nearby observation wells. This data can be collected by hand or with pressure transducer/data loggers such as miniTROLLs®.

Constant Rate Test – the well is pumped at one rate for the duration of the test.

Step-Drawdown Test – the well is pumped at increasing rates to achieve multiple levels of drawdown and discharge rates.

PROCEDURE

It is recommended that the well be pumped in a "pre-test" to indicate the maximum drawdown and discharge rate, to improve the effectiveness and accuracy of the pumping test. Allow time for static water levels to return, 1-3 days, before conducting the actual pumping test.

Pressure transducers will be installed in the pumping well and observation wells, and a period of static water level measurements and transducer readings will be obtained to understand any natural water level fluctuations (background conditions.)

After sufficient "background" readings, the pump will be started at the anticipated rate and the discharge should be directed far enough away as not to aid in recharging the pumping well. Measurements of discharge rate and water levels will be collected for the duration of the test. The drawdown during the first 10 to 20 minutes of the test should be taken at faster intervals, to accurately measure the initial rate of drawdown. The following are recommended measurement intervals for water levels in the pumping well:

Time Since Pumping Started (or Stopped) in Minutes	Time Intervals Between Measurements in Minutes
0 – 10	0.5
10 – 15	1
15 – 60	5
60 – 300	30
300 – 1440	60
1440 – test termination	480 (8 hr)

The following are recommended measurement intervals for water levels in the observation well:

Time Since Pumping Started (or Stopped) in Minutes	Time Intervals Between Measurements in Minutes
0 – 60	2
60 – 120	5
120 – 240	10
240 – 360	30
360 – 1440	60
1440 – test termination	480 (8 hr)

Ideally, pumping tests will be continued until equilibrium is reached – until the cone of depression stabilizes. In unconfined aquifers, 24 hours is often sufficient to record reliable data. In confined aquifers, 72 hours are usually required to collect sufficient data.

For a step-drawdown test, increasing pumping rates are used to affect drawdown. Between each increase in pumping rate, time will be allowed for the well to recover to static conditions.

For all pumping tests, it is important to collect data during the recovery period, after the pump is stopped. The above tables of measurement time intervals should be followed again, as they were at the beginning of the test, until static conditions return.

Pump test data will be analyzed using specialized software to calculate well efficiency and hydraulic conductivity.

BASIC THEORY

Ground-penetrating radar uses short electromagnetic pulses at central frequencies of 80 to 1000 megahertz (MHZ), generated at the transmitting antenna at a high repetition rate. The pulses travel through the earth until a change in electrical properties (absolute/relative permittivity or dielectric constant) is encountered. At this interface some of the electromagnetic energy will be reflected while the rest of the energy continues downward to be reflected off of deeper interfaces. A portion of the reflected electromagnetic energy is intercepted by the receiving antenna where it is amplified, converted to a digital signal and sent to, and stored in, a portable computer.

The saved record can be downloaded to a personal computer for data analysis and manipulation. The intensity of the record is indicative of the strength of the reflection. Depth determinations can be derived from the relative dielectric permittivity for the medium through which the electromagnetic energy is traveling. Dielectric permittivity is a measure of the capacity of a material to store a charge when an electric field is applied to it relative to the same capacity in a vacuum. Representative dielectric permittivities and one-way travel velocities have been published for a variety of earth materials.

GPR surveys are conducted by moving an antenna/receiver combination across the ground surface. A variety of antenna configurations can be used; the antenna is chosen based on the goals of the investigation. Depth of penetration and resolution are the two key factors considered when choosing a specific frequency of antenna for a survey. Higher frequency antennas produce better resolution but have less depth of penetration.

Total depth of penetration of the GPR signal is based both on the frequency of the antenna used and the electrical conductivity of the material through which the electromagnetic wave travels. A material with a low electric conductivity such as sand and gravel will allow deep penetration of low frequency electromagnetic waves. A highly conductive material such as clayey soil produces severe attenuation (and reflection) of the electromagnetic wave resulting in a minimal depth of penetration.

Based on our findings at a variety of sites, GPR has a maximum effective depth of penetration of 10 feet when used with the 500 MHZ antenna capable of identifying tanks and utilities under ideal conditions (dry sandy soils). Depth of penetration with lower frequency antennas (100 MHZ) has been as great as 65 feet under ideal conditions.

APPLICATIONS

Ground-penetrating radar has proven useful for a variety of applications:

- Locating underground utilities (water, electric, gas, phone, sewer).

- Locating existing or former locations of underground tanks.

- Geotechnical investigations (water table, stratigraphy, bedrock surface, excavation boundaries, ice profiling, lake bottom profiling).

- Hazardous and solid waste investigations (former pits, lagoons, trenches, septic tanks and leaching fields, limits of landfilling and aquitard profiling).

- Engineering studies (asphalt and concrete thickness/integrity, rebar location and depth, voids).

- Forensics/Archaeology (grave locations).

LIMITATIONS

The limitations of GPR should be considered prior to beginning any survey. Some of the more important limitations include the following:

- Salt (chloride ions) greatly affects depth of penetration.

- Bouldery till may scatter the signal masking underlying bedrock.

- Clay greatly attenuates the signal reducing the depth of penetration (may be useful - see applications).

- Accurate determination of depth from the GPR record relies on "calibrating" the GPR records to known subsurface interfaces through boring logs, test pits, etc.

SURVEY PROCEDURES

To perform most GPR survey, we will use our Geophysical survey Systems, Inc., SIR-2000⌣ utilizing primarily either a 400 MHZ or 500 MHZ antenna. The 400 and 500 MHZ antennas have an ideal depth capability of 0 to 15 feet and are the antennas we typically use for most surveys. We also have a 100 MHZ antenna which has an ideal depth capacity at 5 to 40 feet. This antenna is ideal for looking for deeper subsurface features. Prior to conducting each survey, field operator should go over with project team goals of survey and any other project specifics that will affect the field effort to conduct the survey. Once all site and project specifics are complete and the field operator is clear on the objectives of the survey, the following procedures should be employed for all surveys conducted:

1. Locate the area to be surveyed using GPR and select the appropriate antenna based on the depth of the subsurface feature you are looking for. The GPR system will then be calibrated on-site. Following this initial calibration, several transects will be run across the survey area to determine whether site conditions are amenable to conduct a GPR survey and if the appropriate antenna has been selected. If data from these transects indicate that GPR will be ineffective, the survey will be discontinued. If this technology is applicable to the site, a grid or transect lines will be established at a specified interval pre-determined before going to the site. The

specified interval will range from 1 to 10 feet and will be dependent on the features and/or objects to be identified for the specific survey.

2. During the survey, grids and/or transect lines shall be measured from fixed objects such as buildings or fences, when practicable, to enable GPR record interpretations to be transferred to the surveyed area. Once the grid has been established and all pertinent features have been identified. The GPR operator will perform the survey. Following the survey, all data and site grids and features will be transferred to a site field sketch. This sketch will be done on graph field paper and will show all features detailed above. In addition, when possible, pertinent GPR information shall be interpreted and marked in field at the time of the GPR survey using spray paint, stakes, flagging, or other appropriate means.

3. Following the survey, data collected using GPR shall be reviewed by Fuss & O'Neill, Inc. staff knowledgeable in GPR technology. This shall include at a minimum, review of all transects by the field operator and a senior review of the data interpretation. GPR transect data from the areas of interest will be interpreted using our GPR-Advanced RADAN Software Package. Following the data interpretation, at a minimum, a brief letter report with site sketch documenting our findings should be prepared. It is recommended that prior to commencing the field survey, discussions occur between the GPR operator and the project team to determine the level of reporting that will be required for each select survey. These discussions will ensure that all data is obtained during the field survey to produce the final report product.

INTRODUCTION

A geophysical survey may be conducted at the site to determine the presence or location of subsurface anomalies such as significant strata changes (e.g., fill/native material interface), buried materials or structures (e.g., metal, tanks or drums, or utilities), or even shallow groundwater. Such surveys may be conducted during this investigation using Ground-Penetrating Radar (GPR) equipment or one of two ground conductivity electromagnetic (EM) measurement devices. Geophysical surveys of these types are subject to interferences such as the proximity of electrical equipment, metal structures or fencing, or the presence of high-conductivity materials on the ground surface (e.g., salt); therefore, these surveys may not be effective at all locations and must be evaluated for effectiveness on a location-specific basis. The procedures for conducting these surveys are detailed in the following subsections.

ELECTROMAGNETIC SURVEY

This type of EM survey will be conducted using either a Geonics EM-31 or a Geonics EM-34 unit. The following procedure will be followed when conducting these surveys:

1. Locate the Area of Concerns (AOCs) to be surveyed. Prior to conducting a survey, background readings will be collected in areas on-site that are not considered AOCs to determine if site conditions are amenable to conduct an EM-31 or EM-34 survey. Survey areas must be free of surface and sub-surface anomalies/interferences. If data from these transects indicate that the EM-31 or EM-34 will be ineffective, the survey will be discontinued. If this technology is applicable to the site, a grid and/or transect lines will be established.

2. Grids and/or transect lines shall be measured or surveyed from fixed objects such as buildings or fences, when practicable, to aid data interpretation.

3. Data collected using the EM-31 or EM-34 shall be reviewed by Fuss & O'Neill, Inc. staff knowledgeable in EM-31 and EM-34 theory, practical application, and interpretation.

INTRODUCTION

This procedure outlines the recommended protocol and equipment for the collection of representative concrete chip and core samples to evaluate potential surficial contamination and to confirm surface decontamination and post-remedial efforts.

Since surface situations vary widely, no universal sampling method can be recommended. The sampling methods and equipment must be selected to suit the site-specific conditions.

Concrete chip samples will be described on concrete sampling field data sheets. Required information includes: color, observations, sample location, and sampling conditions.

CONCRETE SAMPLING EQUIPMENT

The following equipment is recommended for collecting concrete chip and core samples.

- Electric Rotary/Hammer Drills
- 36-inch Asphalt/Concrete Auger
- 18-inch Asphalt/Concrete Auger
- Hammer Drill Chisel
- Two Pound Sledge Hammer
- Cold Chisels
- Carbide-tipped Core Bits/Kit
- Tool Kit
- Anti-vibration Gloves
- Electrical Gloves
- Inner Rubber and Leather Outer Gloves
- Camera
- Polyethylene Resealable Bags
- Cooler with Ice/Ice Packs
- Non-Shrink Grout
- Concrete Trowel

Electrical Equipment:
- Generator for remote sites
- Ground Fault Circuit Interrupters (GFCI)
- Extension Cords
- Gasoline

Decontamination Equipment:
- Flat Cleaning Brushes
- Non-Phosphate Detergent
- Tap Water
- 20% Methanol Solution
- Deionized Water
- 10% Nitric Acid Solution

CONCRETE CHIP SAMPLING

Chips can be extracted from the surface using a hammer and chisel or an electric hammer drill with a carbide tipped core bit. Chips may be taken from a large area or smaller localized area at a deeper depth, depending upon the site-specific conditions. Chips should remove at least 1/4-inch of the surface being evaluated. All concrete chips and related debris (fines) generated during chipping should be captured and considered part of the sample.

Generally, a hand chisel and hammer will be used for samples that are to be analyzed for volatile organic compounds (VOCs) while a hammer drill and drill bits will be used for all other samples.

Sampling for Volatile Organic Compounds (VOCs)

Concrete sampling for VOCs will be performed using a hand chisel and hammer by chipping off concrete in the desired location until sufficient sample is obtained to fill sample containers. Ice or ice packs will be used to preserve lab samples at 4□ C immediately after collection.

Sampling for Non-VOC Analytes

Concrete sampling for non-VOC analytes will be conducted using a hammer drill and 1" drill bits. The drill bits will be advanced approximately 2 inch into the concrete and the resultant dust collected on aluminum foil. The dust is then transferred to the sample container. This process is repeated as necessary to obtain sufficient sample to fill all sample containers. Ice or ice packs will be used to preserve lab samples at 4°C immediately after collection.

CONCRETE CORE SAMPLING

For samples requiring depths greater than 2-inch into a concrete wall or floor, an electric hammer drill should be used. **NOTE: DO NOT USE the hammer drill in areas that have or may have flammable vapors present.** The hammer drill will enable the sampler to extract a concrete core sample as deep as 24-inches, in 3-inch segments.

Samples collected will be placed into sample containers appropriate to the analyses to be performed.

Following sample collection, each sample location will be grouted with non-shrink grout or hydraulic cement.

DECONTAMINATION

Equipment that comes into contact with samples will be thoroughly decontaminated or replaced between samples. Equipment involving more than one part, such as a hammer drill, will be dismantled prior to decontamination. Obvious concrete dust will be rinsed off with tap water prior to beginning the decontamination sequence listed below.

- Non-Phosphate Detergent Scrub
- Tap Water Rinse
- 20% Methanol Solution Rinse
- Deionized Water Rinse
- 10% Nitric Acid Solution Rinse
- Deionized Water Rinse

Tools which are used for excavation purposes, but which do not come into contact with the sample, will be rinsed with tap water to remove residues prior to leaving the site. This will be upgraded, as necessary, depending upon the nature of the contamination.

Concrete Sampling Safety Considerations

In addition to site-specific health and safety concerns, the following safety considerations will always be followed when conducting concrete chip or core sampling.

- Before conducting concrete chip/core sampling, always walk the site with a qualified, authorized site representative or notify "Call-Before-You-Dig" to check for utilities. It is important to remember that utility lines are often embedded in the concrete flooring and/or walls.

- A metal detector should also be utilized to identify subsurface metal objects (rebar) when they are likely to be present.

- To protect against electric shock from the electric source of the hammer drill, a Ground Fault Circuit Interrupter (GFCI) will be utilized at all times. This device will automatically shut power off the electric hammer drill when it detects an electrical short or overload.

- As an added precaution when drilling/coring, the hammer drill operator will wear insulated electrical lineman's gloves to prevent the passage of an electric current up the drill and into the operator's body.

- Appropriate PPE including eye, ear, hand, respiratory, and Tyvek™ protection is required while operating the hammer drill. It is advised that hand protection also be worn when manipulating the concrete core bits and chisels on the electric hammer drill.

- Extra fuel for the generator will be stored away from drilling operations. The generator shall not be operated when there is potential for flammable vapors or gases to be present.

QUALITY ASSURANCE/QUALITY CONTROL

To preserve sample integrity, the following precautions will be taken:

- The electric hammer drill will not be used to collect samples which will be analyzed for volatile organic compounds

- All sampling equipment will be stored away from volatile organic vapors when not in use

- All equipment which comes into contact with the sample will be decontaminated between sampling locations

- Contaminated equipment will be cleaned when necessary following the sequence listed in the decontamination section above, dried, and air purged prior to reuse

QA/QC samples should include a background concrete chip/core sample of the same matrices and blind duplicate samples. The selected background sampling location should provide typical background concentrations of contaminants at the site. Background samples should be collected as close to the main sampling area as possible to insure similar matrices.

Concrete chip/core sampling data shall be recorded on customized data sheets and carefully reviewed on a daily basis.

INTRODUCTION

This sampling procedure outlines the recommended protocol and equipment for the collection of representative asphalt samples to evaluate potential surficial and widespread contamination and to confirm surface decontamination and post remedial efforts.

Since surface situations vary widely, no universal sampling method can be recommended. Rather, the sampling methods and equipment must be selected to suit site-specific conditions.

Asphalt samples will be described on asphalt sampling field data sheets, including color, observations, sample location and sampling conditions. An asphalt sampling equipment checklist, identifying necessary sampling equipment, is included at the end of this section.

ASPHALT SAMPLING EQUIPMENT

The following equipment is required to conduct the collection asphalt chip and core samples:

<u>Sampling Equipment:</u>

- Electric Rotary/hammer drills
- 36 inch asphalt/concrete auger
- 18 inch asphalt/concrete auger
- Hammer drill chisel
- Two pound Sledge Hammer
- Cold Chisels
- Carbide-tipped core bits/Kit
- Tool Kit
- Anti-vibration gloves
- Electrical gloves
- Inner rubber and leather outer gloves
- Camera
- Polyethylene resealable bags
- Cooler With Ice or Ice Packs

<u>Decontamination Equipment:</u>

- Flat cleaning brushes
- Tap water
- Deionized water
- 10% Nitric
- 10% Methanol

<u>Electrical:</u>

- Generator, for remote sites
- Ground Fault Circuit Interrupters (GFCI)

- Extension cords
- Gasoline

SURFACE SAMPLING - ASPHALT

Surface samples (chips) can be extracted from the surface using a hammer and chisel an electric hammer drill with carbide tipped core bit. Chips may be taken from a large area or smaller localized area at a deeper depth, depending on the site-specific conditions. Chips should remove at least one-quarter (1/4) inch of the surface being evaluated. All asphalt chip samples and related debris (fines) generated during sampling should be captured and considered part of the sample.

Appropriate PPE including eye, hearing, respiratory, gloves and Tyvex™ shall be worn during sampling. Following chipping/coring, the sample should be placed into eight ounce (8 oz) sample jars with teflon-lined caps. Ice or ice-packs must be used to preserve all lab samples at 4 degrees celsius immediately after collection.

Equipment which comes into contact with the sample will be thoroughly decontaminated or replaced between sample locations. Equipment involving more than one part, such as the hammer drill, will be dismantled prior to decontamination. Obvious asphalt or contamination will be rinsed off with tap water. The equipment will then be scrubbed with non-phosphate detergent followed by a tap water rinse, a 20% methanol solution scrub and a final deionized water rinse. Tools which are used for excavation purposes, but which do not come into contact with the sample, will be rinsed with tap water to remove residues prior to leaving the site. This procedure will be upgraded depending on the nature of the contamination.

ASPHALT CORE SAMPLING

For samples requiring depths greater than one-half (2) inch into asphalt, an electric hammer drill should be used for collection of the sample. Currently, F&O is equipped with the following carbide tipped core bits: 12 inch O.D., 3", 4" and 5" bits. **NOTE: DO NOT USE the hammer drill in areas that have or may have flammable vapors present.**

The hammer drill will enable the sampler to extract an asphalt core sample as deep as twenty-four (24) inches, in three inch pieces, into the surface being sampled.

Appropriate PPE including eye, hearing, respiratory, gloves and Tyvex™ shall be worn during sampling. Following chipping / coring, the sample should be placed into sample jars with teflon-lined caps for chip samples collected from the larger asphalt core samples. Large diameter asphalt core samples that are not crushed shall be placed into plastic resealable bags and labeled. Ice or ice-packs must be used to preserve all lab samples at 4 degrees celsius immediately after collection. Following sample collection, each sample location will be repaired.

Equipment which comes into contact with the asphalt sample will be thoroughly decontaminated or replaced between sample locations. Equipment constructed of multiple pieces, such as the hammer drill, will be dismantled prior to decontamination. Obvious asphalt or contamination will be rinsed off with tap water. The equipment will then be scrubbed with non-phosphate detergent followed by a tap water rinse, a 20% methanol solution scrub and a final deionized water rinse. Tools which are used for excavation purposes, but which do not come into contact with the sample, will be rinsed with tap water to removed residues prior to leaving the site. This procedure will be upgraded depending on the nature of the contamination.

QUALITY ASSURANCE/QUALITY CONTROL

To preserve sample integrity, the following precautions will be taken:

- The electric hammer drill will not be used to collect samples which will be analyzed for volatile organic compounds
- All sampling equipment will be stored away from volatile organic vapors when not in use
- All equipment which comes into contact with the sample will be decontaminated between sampling locations
- Contaminated equipment will be cleaned when necessary following the sequence listed in the decontamination section above, dried, and air purged prior to reuse

QA/QC samples should include a background asphalt chip/core sample of the same matrices and blind duplicate samples. The selected background sampling location should provide typical background concentrations of contaminants at the site. Background samples should be collected as close to the main sampling area as possible to insure similar matrices.

Asphalt chip/core sampling data shall be recorded on customized data sheets and carefully reviewed on a daily basis.

SAFETY CONSIDERATIONS

In addition to site-specific health and safety concerns, the following safety considerations will always be followed when conducting asphalt chip / core sampling:

- Before conducting asphalt chip / core sampling, always walk the site with a qualified, authorized site representative or notify "Call-Before-You-Dig" to check for utilities. At many industrial facilities, utility lines are located under asphalt.
- To protect against electric shock from the electric source of the hammer drill, a Ground Fault Circuit Interrupter (GFCI) will be at utilized at all times. This device will automatically shut power off to electric hammer drill when it detects an electrical short or overload.
- As an added precaution when drilling/coring, the hammer drill operator will wear insulated electrical lineman's gloves to prevent the passage of an electric current up the drill and into the operator's body.

- Appropriate PPE including eye, ear, hand, respiratory and Tyvek protection is required while operating the hammer drill. It is advised that hand protection also be worn when manipulating the core bits and chisels on the electric hammer drill.

- Extra fuel for the generator will be stored away from drilling operations. The generator shall not be operated when there is the potential for flammable vapors or gases to be present.

- To preserve sample integrity the electric hammer drill cannot be used to collect surface samples or volatile analysis, due to heat buildup during coring. In addition, all sampling equipment will be stored away from volatile organic vapors when not in use.

The following procedure is used to sample non-porous material to verify that media closure criteria have been achieved after decontamination or removal has been completed. Examples of non-porous material are: steel or fiberglass tanks, structural steel (painted or unpainted), aluminum pipe or conduit, metal stair treads.

Select an area of 100 square centimeters on the equipment/structure to be tested. A flexible, non-porous square template 10 centimeters by 10 centimeters should be used to delineate the area to be sampled. Alternately, a rectangular or circular template may be used provided that the area is 100 square centimeters.

For analysis of constituents of concern, saturate a cotton gauze with:

- Methanol for volatiles
- 1:1 Hexane-acetone mix or methylene chloride for semi-volatiles
- Hexane for PCBs
- Dilute sodium hydroxide for cyanide

For metals analysis, the gauze should be used as provided by the laboratory.

1. Select an area of 100 square centimeters on the equipment/structure to be tested.

2. Moisten gauze with appropriate solution as detailed above.

3. Remove the saturated gauze from the sampling jar with tweezers or forceps.

4. Wipe saturated gauze over the sampling area repeatedly in the vertical direction, applying moderate pressure. Turn the gauze over and wipe repeatedly in the horizontal direction.

5. Place the gauze from each sampling location in a labeled jar with a Teflon seal and submit the samples for laboratory analysis.

6. QA/QC samples (field blank) should be submitted with the sample set. The field blank consist of a moistened gauze placed in a sample container (not wiped on media).

INTRODUCTION

This procedure outlines the recommended protocol and equipment for the collection of representative concrete chip and core samples to evaluate potential surficial contamination and to confirm surface decontamination and post-remedial efforts.

Since surface situations vary widely, no universal sampling method can be recommended. The sampling methods and equipment must be selected to suit the site-specific conditions.

Concrete chip samples will be described on concrete sampling field data sheets. Required information includes: color, observations, sample location, and sampling conditions.

WOOD SAMPLING EQUIPMENT

The following equipment is recommended for collecting concrete chip and core samples.

- Electric Rotary Drills
- Boring drill bits
- Cold Chisels
- Tool Kit
- Anti-vibration Gloves
- Camera
- Polyethylene Resealable Bags
- Cooler with Ice/Ice Packs

Electrical Equipment:
- Generator for remote sites
- Ground Fault Circuit Interrupters (GFCI)
- Extension Cords
- Gasoline

Decontamination Equipment:
- Flat Cleaning Brushes
- Non-Phosphate Detergent
- Tap Water
- 20% Methanol Solution
- Deionized Water
- 10% Nitric Acid Solution

WOOD SAMPLING

Wood chips can be extracted from the surface using a hammer and chisel or an electric drill with a wood boring bit. Wood chips may be taken from a large area or smaller localized area at a deeper depth, depending upon the site-specific conditions. Wood drilling should remove at least 1/4-inch of the surface being evaluated. All wood chips and related debris (fines) generated during chipping should be captured and considered part of the sample.

Wood chip sampling will be conducted using an electric drill and wood boring drill bits. The drill bits will be advanced approximately ½ inch into the wood and the resultant wood chips collected on aluminum foil. The chips are then transferred to the sample container. This process is repeated as necessary to obtain sufficient sample to fill all sample containers. Ice or ice packs will be used to preserve lab samples at 4°C immediately after collection.

NOTE: DO NOT USE the electric drill in areas that have or may have flammable vapors present.

DECONTAMINATION

Equipment that comes into contact with samples will be thoroughly decontaminated or replaced between samples. Equipment involving more than one part, such as an electric drill, will be dismantled prior to decontamination. Obvious dust will be rinsed off with tap water prior to beginning the decontamination sequence listed below.

- Non-Phosphate Detergent Scrub
- Tap Water Rinse
- 20% Methanol Solution Rinse
- Deionized Water Rinse
- 10% Nitric Acid Solution Rinse
- Deionized Water Rinse

Wood Sampling Safety Considerations

In addition to site-specific health and safety concerns, the following safety considerations will always be followed when conducting wood chip sampling.

- Before conducting concrete chip/core sampling, always walk the site with a qualified, authorized site representative or notify "Call-Before-You-Dig" to check for utilities. It is important to remember that utility lines are often embedded in the flooring and/or walls.

- A metal detector should also be utilized to identify subsurface metal objects (nails) when they are likely to be present.

- To protect against electric shock from the electric source of the electric drill, a Ground Fault Circuit Interrupter (GFCI) will be utilized at all times. This device will automatically shut power off the electric drill when it detects an electrical short or overload.

- As an added precaution when drilling/coring, the drill operator will wear insulated electrical lineman's gloves to prevent the passage of an electric current up the drill and into the operator's body.

- Appropriate PPE including eye, ear, hand, respiratory, and Tyvek™ protection is required while operating the drill. It is advised that hand protection also be worn when manipulating the wood bore bits and chisels on the electric drill as they can become very hot.

- Extra fuel for the generator will be stored away from drilling operations. The generator shall not be operated when there is potential for flammable vapors or gases to be present.

QUALITY ASSURANCE/QUALITY CONTROL

To preserve sample integrity, the following precautions will be taken:

- All sampling equipment will be stored away from volatile organic vapors when not in use

- All equipment which comes into contact with the sample will be decontaminated between sampling locations

- Contaminated equipment will be cleaned when necessary following the sequence listed in the decontamination section above, dried, and air purged prior to reuse

Wood chip sampling data shall be recorded on customized data sheets and carefully reviewed on a daily basis.

PRINCIPLE OF OPERATION

The YSI-63 Series is a field portable pH, conductivity, salinity and temperature water analyzer.

The pH portion has a combination electrode consisting of a proton selective glass reservoir filled with a buffer at a pH of approximately 7 and an Ag/AgCl reference electrode that utilizes gelled electrolyte. A silver wire coated with AgCl is immersed in the buffer solution. Protons (H+ ions) on both sides of the glass (media and buffer reservoir) selectively interact with the glass, setting up a potential gradient across the glass membrane. Since the hydrogen ion concentration in the internal buffer solution is invariant, this potential difference, determined relative to the Ag/AgCl reference electrode, is proportional to the pH of the media.

The conductivity cell utilizes four pure nickel electrodes for the measurement of solution conductance. Two of the electrodes are current driven and two are used to measure the voltage drop. Conductivity expressed in micromhos/cm is the measure of the electric conductance that would be exhibited by a sample if it were measured between opposite daces of a 1 centimeter cube.

INSTRUMENT MAINTENANCE

The following calibration and maintenance procedures are conducted at Fuss & O'Neill before instruments are released for use.

- Calibration of the instrument will be performed as described in the calibration procedure.

- The pH glass electrode requires maintenance only when obviously coated with sediment or biological growth. The glass can be cleaned by carefully removing the guard and wiping with a soft cloth soaked with soapy water and rinsed with clean water, followed by a routine decontamination process. The glass electrode is very delicate, be sure to wipe the electrode gently and do not put the probe down until the guard is replaced. Then a moistened cotton swab can remove any material that may be blocking the reference electrode junction of the sensor.

- The temperature and specific conductivity portion of the probe have openings that allow fluid access to the conductivity electrodes and must be cleaned regularly. This is accomplished by inserting a small cleaning brush into each hole several times using a mild detergent with the brush if necessary. After cleaning and decontamination, the probe will be checked with a calibration standard.

INSTRUMENT CALIBRATION

A complete calibration check will be performed before, after and once at a mid point of each sampling day at Fuss & O'Neill. Checks will be carried out in the field if there is a possibility that any memory has been cleared or readings seem anomalous.

1. pH Calibration using the 4, 7 and 10 pH buffer solutions

The pH calibration is accomplished by pressing MODE until pH is displayed. Using a thermometer take the temperature of the standard solution and verify that the temperature displayed on the meter is the as the temperature on the thermometer. Rinse the probe with de-ionized water and wipe dry or do a final rinse with pH 7 buffer solution. Place the probe in the pH 7 buffer solution. Simultaneously press the up down arrow keys to enter the calibration menu. Press ENTER. The pH of the buffer solution will be displayed. When the decimal point stops flashing press ENTER again. Remove and rinse the probe with de-ionized water and wipe dry. Place the probe in either a pH 4 or 10 solution. Press ENTER and the pH of the solution will be displayed and the decimal point will flash. When the decimal point stops flashing press and hold ENTER until the display reads SAVE. At the end of the calibration press MODE to begin pH measurements. Remove the probe and rinse with DI water and wipe dry. Return the probe to the last pH solution, press read and when the decimal point stops flashing record the pH. The pH should be within +/- 0.15 pH units. Re-calibrate if outside of this range.

2. Specific Conductance Calibration

Turn the instrument on and allow it to complete its self test. Press MODE until conductivity is displayed. The proper display shows degrees C flashing. This is the temperature compensated mode. Insert the probe into the KCl calibration solution deep enough to cover both of the conductivity ports. Allow at least 60 seconds for the temperature reading to become stable. Move the probe from side to side to dislodge any air bubbles from the electrodes. Press the up arrow and down arrow simultaneously until the CAL symbol is displayed. Use the up arrow and down arrow keys to adjust the reading on the display until it matches the concentration of the solution being used for calibration. Once the display reads the exact value of the calibration solution being used press the ENTER key. The word SAVE will momentarily appear in the display indicating the calibration has been accepted. Remove the probe, rinse with DI water and dry. Place the probe back into the last solution and determine the Specific conductance. A correctly calibrated meter will read within +/- 25 micromhos/cm of the true value. If the reading falls outside of this range it will need to be re-calibrated.

PRINCIPLE OF OPERATION

The YSI Model 85 is a portable, battery-powered, micro-processor based, digital meter, designed to measure salinity, conductivity, and temperature. The probe for the Model 85 is both a rugged plastic conductivity cell and a precision YSI thermistor temperature sensor with a dissolved oxygen probe, combined in a single unit.

YSI 85 PARAMETER SPECIFICATIONS

The YSI Model 85 SCT + DO has the following specifications:

Ranges	Conductance: User selected or Autoranging 0 to 499.9 μS/cm 0 to 4999 μS/cm 0 to 49.99 mS/cm 0 to 200.0 mS/cm
	Salinity: 0 to 80 PPT Temperature: -5°C to +65°C Dissolved Oxygen: Autoranging 0 to 200% Air Saturation 0 to 20 mg/L
Readability (Resolution):	Conductance: 0.1 μS/cm 1.0 μS/cm .01 mS/cm 0.1 mS/cm
	Salinity: 0.1 ppt Temperature: 0.1°C Dissolved Oxygen: 0.1% Air Saturation 0.01 mg/L
Accuracy:	Conductance: +/- 0.5% fs Salinity: +/- 2% or +/-0.1 ppt Temperature: +/- 0.1°C (+/- 1 lsd) Dissolved Oxygen: +/- 2% Air Saturation +/- 0.3 mg/L

Temperature Compensation:	Calculated automatically
Adjustable Conductivity Reference Temperature:	15°C to 25°C
Adjustable Temperature Compensation Factor for Conductivity:	0% to 4%

INSTRUMENT MAINTENANCE

The following daily calibration and maintenance procedures are conducted at Fuss & O'Neill before instruments are released for use.

- The instrument is inspected for physical damage or abnormalities and is then wiped down with a clean cloth dampened with deionized water. The probe is inspected and decontaminated with a solution of reagent grade methanol, HCl and deionized water.
- The instrument is calibrated with a known standard solution of KCl in water.

INSTRUMENT CALIBRATION

Daily Calibration Procedure for Conductivity and Dissolved Oxygen:

The following steps are used to calibrate the conductivity meter:

1. The instrument is cleaned with a cloth dampened with deionized water. The probe is rinsed with solutions of reagent grade hydrochloric acid, methanol, and deionized water. Then the probe is thoroughly rinsed with deionized water.
2. The temperature of the calibration solution is determined with a mercury-filled thermometer and this reading is noted in the calibration log book.
3. The probe is placed in the known calibration solution (see calibration solution preparation below) and the instrument is switched to the appropriate range.
4. Once the meter has reached a stable reading, the value observed is recorded in the calibration log book.

Daily Calibration Procedure for Dissolved Oxygen:

The following steps are used to calibrate the dissolved oxygen meter at 100% saturated air method:

1. Insert probe into the cleaned calibration chamber with a clean wet sponge provided at

the chambers bottom.

2. With instrument on, press the mode button until dissolved oxygen is displayed in mg/L or % and let reading stabilize. Fifteen minutes is usually required for stabilization of the temperature and dissolved oxygen readings.

3. With two fingers, press and release both the UP ARROW and DOWN ARROW buttons at the same time.

4. The display will prompt user to enter the local altitude in hundreds of feet (1 = 100ft). Press the arrow keys to increase or decrease the altitude. When the proper altitude appears on the display, press the ENTER button once.

5. CAL should now be at the lower left of the display, the calibration value should be displayed in the lower right of the display and the current % reading should be on the main display. When the % reading is stable press the ENTER button. The display should read SAVE and return to the normal operation mode.

YSI 85 METER DOCUMENTATION

Daily calibration will be documented. The unit number, date, and calibration information will be recorded in a calibration log (Appendix S). The following information will be recorded on a standard field data sheet as the specific conductance data is obtained:

- Project name and number.
- Operator's name.
- Date and time of specific parameter measurement.
- Meter ID number.
- Sample code
- Conductivity reading
- Dissolved oxygen reading
- Temperature reading

PRINCIPLE OF OPERATION

The YSI-600 Series Water Analyzer consists of a sonde, a monitoring device that is placed in water to gather water quality data that is measured by individual probes, the probes and a 610-D. The probes are fastened at the base of the sonde and take measurements of oxidation/reduction potential, dissolved oxygen, temperature, and temperature-compensated pH and specific conductance. Readings are displayed on the 610-D display unit in units of mV, mg/l, °C, S.U., and µMhos/cm (µS/cm) respectively.

INSTRUMENT MAINTENANCE

The following calibration and maintenance procedures are conducted at Fuss & O'Neill before instruments are released for use.

- Calibration of the instrument will be performed as described in the calibration procedure.
- The Sonde must be thoroughly dried before removing or replacing a probe or probe port plug. When a probe or port is replaced, the connector port inside the Sonde is to be examined for moisture. If any moisture is found, the connector is to be completely dried. If any corrosion is found the unit will be replaced with another comparable unit. The cable connector port at the top of the Sonde should be covered at all times. Any moisture found in this area will be completely dried before continuing.
- The pH glass electrode and ORP platinum button require maintenance only when obviously coated with sediment or biological growth. The glass and platinum can be cleaned by carefully removing the guard and wiping with a soft cloth soaked with soapy water and rinsed with clean water, followed by a routine decontamination process. The glass electrode is very delicate, be sure to wipe the electrode gently and do not put the probe down until the guard is replaced. Then a moistened cotton swab can remove any material that may be blocking the reference electrode junction of the sensor.
- The temperature and specific conductivity probe have openings that allow fluid access to the conductivity electrodes and must be cleaned regularly. This is accomplished by inserting a small cleaning brush into each hole several times using a mild detergent with the brush if necessary. After cleaning and decontamination, the probe will be checked with a calibration standard.
- Maintenance of the DO sensor is required when the instrument does not calibrate properly or when the membrane is dirty or damaged. Following cleaning and decontamination, recalibration is performed. The membrane and electrolyte is changed on a regular schedule to maximize the accuracy and life of the sensor.

CALIBRATION PROCEDURES

A complete calibration check will be performed before and after each sampling day at Fuss & O'Neill. Checks will be carried out in the field if there is a possibility that any memory has been cleared or readings seem anomalous.

When not in use, the YSI-600's sensors are protected with a screw on storage cup filled with tap water. This storage cap is utilized during all calibration procedures. A description of each calibration procedure is below.

1. pH Calibration

   The pH calibration is accomplished by pressing ESC and scrolling through the menu to CAL MODE, and pressing enter. The pH is then entered from the calibration menu. A three point calibration is chosen, the display then prompts the user to enter pH buffer that will be checked first, typically the 7.00 buffer. Buffer 7.00 is poured into the storage cup and placed under the probe, the user then presses enter, the unit will then prompt user to press enter again and to enter the next buffer for calibration. The sensor and storage cup are then rinsed with deionized water and the same procedure is followed using pH 4 or pH 10 buffers. Following these steps, calibration checks of all buffers will be conducted.

2. Specific Conductance Calibration

   The specific conductance calibration is accomplished by first rinsing the sensor and storage cup with deionized water several times, then filling the storage cup with KCl solution of a known standard molar concentration and specific conductance. When in CAL MODE the specific conductance, is chosen from the calibration menu and the known specific conductance value is entered in the display unit and the calibration is then saved. Following these steps, the storage cup is rinsed again with deionized water and then refilled with the standard KCl solution to recheck the calibration.

3. Dissolved Oxygen Calibration

   The dissolved oxygen calibration is accomplished by calibrating at 100% saturated air. This procedure is completed by filling the storage cup with tap water to a level just below the membrane and then capping the storage cap. When in the CAL MODE the Barometer reading for the day is entered. These values are used to determine the correct calibration value to be entered into the display unit. Once the correct pressure has been entered, press the ENTER key to save the value.

4. ORP Calibration

   The ORP calibration is accomplished by filling the storage cup with Zobel solution to a level to cover the ORP probe, about one half inch. While in CAL MODE scroll to ORP and press enter. The unit will then prompt for a value to be entered (Zobel has a value of 225), after entering the value, press enter to calibrate.

When the values for all the parameters have all been entered for calibration, press ESC until the MAIN MENU is displayed. Scroll back to run and press enter. Check the calibration for all parameters before continuing.

YSI 600 METER DOCUMENTATION

Daily calibration will be documented. The unit #, date, and calibration information will be recorded in a calibration log. The following information will be recorded on a standard field data sheet as the specific conductance data is obtained:

- Project name and number.
- Operator's name.
- Date and time of specific parameter measurement.
- Meter ID number.
- Sample code
- Conductivity reading
- Dissolved oxygen reading
- Oxidation/Reduction potential reading
- pH reading
- Temperature reading

YSI 600 COMPONENT SPECIFICATIONS

600XL Sonde

Operating Environment

Medium:	Fresh, sea, or polluted water
Temperature:	-5 to +45 °C
Depth:	0 to 200 feet (61 meters)

Storage Temperature:	-40 to +60 °C for sonde and all sensors except pH and ORP -20 to +60 °C for pH and ORP sensors

Material:	Polyurethane, PVC, Stainless Steel
Maximum Diameter:	1.6 inches (4.06 cm)
Maximum Length:	20.75 inches (52.7 cm)
Maximum Weight:	4.9 pounds (2.22 kg)
Internal logging memory size:	384 KB (150,000 individual parameter readings)
Computer Interface:	RS-232C, SDI-12
Power:	External 12 VDC (8 to 13.8 VDC)

Conductivity Probe

Sensor type	4 electrode cell with autoranging
Range	0 to 100 mS/cm
Accuracy	+/- 0.5 % of reading + 0.001 mS/cm
Resolution	0.001 mS/cm to 0.1 mS/cm (range dependent)
Depth	200 meters

Temperature

Sensor Type	Thermistor
Range	-5 to 45 °C
Accuracy	+/- 0.15 °C
Resolution	0.01 °C
Depth	200 meters

Dissolved Oxygen, % saturation

Sensor Type	Rapid Pulse-Clark type, polarografic
Range	0 to 500 % air saturation
Accuracy	0-200 % air saturation, +/- 2 % of the reading or 2% air saturation, whichever is greater 200-500 % air saturation, +/- 6 % of reading
Resolution	0.1 % air saturation
Depth	200 meters

Dissolved Oxygen, mg/L (calculated from % air saturation, temperature and salinity)

Sensor Type	Rapid Pulse-Clark type, polarographic

Range	0 to 50 mg/L
Accuracy	0 to 20 mg/L, +/-2 % of the reading or 0.2 mg/L,

whichever is greater 20 to 50 mg/L, +/- 6 % of the reading

Resolution	0.01 mg/L
Depth	200 meters

Salinity

Sensor Type	Calculated from conductivity and temperature
Range	0 to 70 ppt
Accuracy	+/- 1.0 % of reading or 0.1 ppt, whichever is greater
Resolution	0.01 ppt

pH

Sensor Type	Glass combination electrode
Range	0 to 14 units
Accuracy	+/- 0.2 units
Resolution	0.01 units
Depth	200 meters

ORP

Sensor Type	Platinum button
Range	-999 to +999 mV
Accuracy	+/- 20 mV
Resolution	0.1 mV
Depth	200 meters

PRINCIPLE OF OPERATION

The Quanta Water Quality Monitoring System consists of a transmitter and a display screen. The transmitter is a monitoring device that is placed in water to gather water quality data that is measured by individual probes. The probes are fastened at the base of the transmitter and take measurements of oxidation/reduction potential, dissolved oxygen, temperature, pH, salinity/total dissolved solids (TDS), specific conductance, and barometric pressure. Readings are shown on the Quanta display screen in units of mV, mg/l, ºC, PSS, µMhos/cm (µS/cm), and mmHg respectively.

INSTRUMENT MAINTENANCE

The following calibration and maintenance procedures are conducted at Fuss & O'Neill before instruments are released for use.

- Calibrations of the instrument will be performed as described in the calibration procedure.

- The Transmitter must be thoroughly dried before removing or replacing a probe or probe port plug. When a probe or port is replaced, the connector port inside the transmitter is to be examined for moisture. If any moisture is found, the connector is to be completely dried. If any corrosion is found, the unit will be replaced with another comparable unit. The cable connector port at the top of the transmitter should be covered at all times. Any moisture found in this area will be completely dried before continuing.

- The pH glass electrode and ORP platinum band require maintenance only when obviously coated with sediment, oil or biological growth. The glass and platinum are cleaned by carefully removing the guard and wiping with a soft cloth soaked with soapy water and rinsed with clean water, followed by routine decontamination process. The routine decontamination process we use consists of: methanol, de-ionized water, HCL, and de-ionized water again. The glass electrode is <u>very</u> delicate and is handled carefully. Then a moistened cotton swab can remove any material that may be blocking the reference electrode junction of the sensor.

- The specific conductivity, salinity, and TDS probe are cleaned with a mild detergent using a small non- abrasive brush and then rinsed with water. This is followed by the routine decontamination process. After cleaning and decontamination, the probe will be calibrated and checked with a calibration standard.

- Maintenance of the dissolved oxygen sensor is required when the instrument does not calibrate properly or when the membrane contains air bubbles. Following cleaning and decontamination and re-calibration is performed. The membrane and electrolyte is changed on a regular schedule to maximize the accuracy and life of the sensor.

- The temperature and probes are cleaned by using a mild detergent with a non-abrasive brush and then rinsed with water. This is followed by a routine decontamination process and calibration check.

CALIBRATION PROCEDURES

A complete calibration check will be performed before and after each sampling day at Fuss & O'Neill. Checks will be carried out in the field if there is a possibility that any memory has been cleared or readings seem anomalous.

When not in use, the Quanta sensors are protected with a screw on storage cup containing a sponge soaked with tap water. This storage cap is utilized during all calibration procedures and is always rinsed first. A description of each calibration procedure is below.

1. pH Calibration

This is a two point calibration therefore a pH standard between 6.8 and 7.2 is used and treated as zero; all other values are treated as slope. The pH buffer representing "zero" is poured into the cup and the probe is submersed in the solution. The pH calibration is accomplished by using the arrow key to scroll over to the CALIB button and pressing enter. Once on this screen, the cursor is used to scroll down to pH and selected by pressing enter. A new screen appears with the present pH value that the probe is reading. Utilizing the up/down arrow key the pH value is adjusted to read the value of the buffer solution that the probe is submersed in. Once the appropriate value is reached is reached the value is saved. The sensor and storage cup are then rinsed with de-ionized water and the same procedure is followed using pH 4 or pH 10 buffer. Once calibration is complete a check is done on the pH buffers just utilized.

2. Specific Conductance Calibration

The storage cup is filled with KCl solution of a known standard molar concentration and specific conductance (1000 is the standard usually used). The same steps are followed to reach the calibration screen as in the pH calibration. The up/down arrow key is used to scroll down to specific conductance and selected by pressing enter. A new screen appears showing the value that the probe is presently reading based on the calibration standard. This number is adjusted by using the up/down arrow key to reach the value that the standard equals. Once this value is reached the number is saved by pressing the enter key. Following these steps, the storage cup is rinsed again with de-ionized water and then refilled with the standard KCl solution to check the calibration.

3. Dissolved Oxygen Calibration

The barometric pressure is set at 760 mmHg as a default. The value of 8.4 mg/L is used as the calibration standard for dissolved oxygen. The dissolved oxygen calibration is accomplished by holding the probe in the ambient air. The same steps are followed for dissolved oxygen as for the other calibrations. Once the value reads 8.4 mg/L the enter button is pushed prompting 760mmHg to read on the screen, by pressing enter once more the 8.4mg/L value will be saved. This completes the calibration process. A check is now done to assure the operator that the value is saved.

4. ORP Calibration

The ORP calibration is accomplished by sufficient filling the storage cup with Zobel solution to cover the probe. While in CALIB mode scroll to ORP and press enter. Then, using the up/down arrow key the number is adjusted to 225 mV; the value of the solution. Press enter and the value will be saved. A check is now done to assure that the value is saved in the memory.

When the values for all the parameters have all been entered and saved, ESC is pressed. The screen will take 5 seconds to power up followed by the appearance of the original screen. Any values that did not save will be calibrated until the values are held in the database.

QUANTA METER DOCUMENTATION

Daily calibration will be documented. The unit #, date, and calibration information will be recorded in a calibration log. The following information will be recorded on a standard field data sheet as data is obtained:

- Project name and number
- Operator's name
- Date and time of specific parameter measurement
- Meter ID number
- Sample code
- Conductivity reading
- Dissolved oxygen reading
- Oxidation/Reduction potential reading
- pH reading
- Temperature reading

QUANTA COMPONENT SPECIFICATIONS

Operating Environment:

Medium:	Fresh, sea, or polluted water
Temperature:	-5 to 50 ºC
Depth:	0 to 328 feet (100 meters)

Materials Used:	Polyurethane, PVC, Stainless Steel
Transmitter Diameter:	7.6 cm (3 in)
Screen Width:	12.7 cm (5 in)
Handle Width:	6.4 cm (2.5 in)

Screen Size (diagonal): 8.9 cm (3.5 in)

Screen Length: 26.9 cm 10.6 in)

Transmitter Length: 22.9 cm (9 in)

Screen Weight (w/batteries): 0.95 kg (2.1 lbs)

Transmitter Weight: 1.3 kg (3 lbs)

Memory Size (1 frame stores all parameter values): 100 data frames (nonvolatile flash)

Batteries: 3C alkaline, >15 hour life

Waterproof Rating: NEMA 6 (IP67)

Operating Voltage Range: 7 to 14 VDC

Conductivity Probe

Range	0 to 100 mS/cm
Accuracy	+/- 1 % of reading +/- 1count
Resolution	4 digits

Temperature

Range	-5 to 50ºC
Accuracy	+/- 0.2ºC
Resolution	0.01 ºC

Dissolved Oxygen

Range	0 to 50 mg/L
Accuracy	+/- 0.2 mg/L less than or equal to 20 mg/L +/- 0.6 mg/L > 20 mg/L
Resolution	0.0l mg/L

Salinity

Range	0 to 70 PSS
Accuracy	+/- 1 % of reading +/- 1 count
Resolution	0.01 PSS

pH

Range	2 to 12 units
Accuracy	+/- 0.2 units
Resolution	0.01 units

ORP

Range	-999 to 999 mV
Accuracy	+/- 25 mV
Resolution	1 mV

INTRODUCTION

The LaMotte 2020 Turbidimeter is a battery-operated, portable, microprocessor controlled nephelometer. A multi-detector optical configuration assures long term stability and minimizes stray light and color interferences. All readings are determined by the process of signal averaging over a 5 second period, minimizing fluctuations in readings attributed to large particles and enabling rapid, repeatable measurements. The microprocessor enables auto-ranging over the full range of to Nephelometric Turbidity Units (NTU) and provides a direct digital readout with a resolution of NTU for the lowest range.

PRINCIPLE OF OPERATION

Turbidity, or cloudiness in water, can be interpreted as an absence of clarity or brilliance. It is caused by suspended or colloidal particles such as clay, silt, organic/inorganic material, and microscopic organisms. In surface and groundwaters, turbidity is an indicator of quality and productivity.

Light passing through clear water will travel in a straight line. Particles in turbid water will scatter the light and cause it to look cloudy. The turbidity of a sample is the measure of the amount of scatter that occurs when light is passed through the sample. High turbidity indicates greater scattering of the light.

Nephelometers are turbidimeters that measure the scattered light at a 90° angle from the light source. A reference beam passes through the sample and is measured at a 180° angle. The ratio of these two readings is converted to a turbidity measurement in NTU.

CALIBRATION

1. Select a LaMotte AMCOJ 2020 Standard in the range of the samples to be tested. (NOTE: Only LaMotte AMCOJ Standards specific to this instrument are to be used.)

2. Fill a turbidity tube with the standard, cap, and wipe the tube clean with a lint-free cloth.

3. Open the lid of the meter. Align the indexing arrow on the tube with the indexing arrow on the meter and insert the tube into the chamber.

4. Close the lid. Push the READ button. If the displayed value is not the same as the value of the reacted standard (±1%), continue with the calibration procedure.

5. Push the CAL button for 5 seconds until CAL is displayed. Release the button. The display will flash. Adjust the display with the ↑ and ↓ buttons until the value of the standard is displayed.

6. Push the CAL button again to set the calibration. The 2020 display will stop flashing. Calibration is complete.

7. Turn the unit off by holding the READ button down for at least 1 second, or proceed to measure the test samples.

8. Prepare a sample of turbidity free water as described below to verify the calibration of the instrument.

ANALYSIS PROCEDURE

The 2020 turbidity meter has two operating modes. The standard mode displays the measured turbidity to the full resolution of the meter. The EPA mode displays the measured turbidity rounded to the reporting requirements of the EPA and Standard Methods compliance monitoring programs. To switch from one mode to the other, turn the instrument off, press and hold the CAL button while pressing the READ button to turn the meter on.

1. Fill a clean container with at least 50 mL of sample water and cover. Set sample aside to allow it to equilibrate to air temperature and let the gases escape. Avoid contamination and analyze as soon as possible.

2. Rinse an empty turbidity tube with a portion of the sample. Shake out the excess water.

3. Fill the turbidity tube to the neck by carefully pouring the sample down the side of the tube to avoid creating bubbles.

4. Cap the tube and wipe it dry with a clean, lint-free tissue.

5. Open the lid of the meter. Align the indexing arrow on the tube with the indexing arrow on the meter and insert the tube into the chamber.

6. Close the lid. Push the READ button. The turbidity in NTU will be displayed within 5 seconds.

7. The instrument will turn off automatically 2 minutes after the last button push. To turn the meter off manually, hold the READ button down for at least 1 second, release when OFF is displayed.

NOTE: If the sample is higher than 1100 NTU, it must be diluted and retested.

PREPARATION OF TURBIDITY FREE WATER

Turbidity free water is essential when dilution of samples is necessary. The introduction of any foreign matter will affect the turbidity reading. A filtering device with a special membrane is used to remove particulate matter. The filter, filter holder, and syringe are conditioned by forcing at least two syringes full of deionized water through the apparatus. The first and second rinses should be discarded.

1. Unscrew the top of the filter holder. The black O-ring should remain in the top part of the filter holder. Place a white membrane filter on the screen inside. Position the filter disk so that it covers the entire surface of the screen. Replace the top of the filter holder and screw on securely. (NOTE: The membrane filters are white and are packaged between two blue protective disks. Handle membrane filters with extreme caution.)

2. Remove the plunger from the syringe. Attach the filter holder to the bottom of the syringe.

3. Pour approximately 50 mL of deionized water into the barrel of the syringe. Replace the plunger and exert pressure on it to force the water through the filter. Collect the water in a clean container.

4. Remove the filter holder from the syringe then remove the plunger from the barrel. (Removal of the filter holder before the plunger is necessary to prevent rupturing the membrane as the plunger is removed.

5. Replace the filter holder and repeat steps 3 and 4 until the desired amount of turbidity free water is collected.

6. Periodically examine the membrane filter to insure that no holes or cracks are present. The membrane filter may be stored in the holder indefinitely and used as required.

TESTING TIPS

X Samples should be collected in clean glass or polyethylene containers.
X Samples should be analyzed as soon as possible after collection.
X Discard tubes that are badly scratched.
X Gently invert sample to mix before taking a reading. Avoid introducing air bubbles.
X Turbidity readings will be affected by electric fields around motors.
X Carbon in the sample will absorb light and cause low readings.
X Observe shelf life of turbidity standards.
X The turbidimeter should be placed on a surface free from vibration which can cause high readings.

Excessive color in a sample will absorb light and cause high readings.

MAINTENANCE

1. Turbidity Tubes

   a. Turbidity tubes should always be washed prior to use. Use a mild detergent to remove any dirt or fingerprints. Dry the outside with a clean, lint-free tissue. Allow the tubes to sir dry in an inverted position to prevent dust from entering the tube.
   b. Scratches, fingerprints, and water droplets on the turbidity tube or inside the light chamber cause stray light and false readings. Tubes can be acid washed periodically and a special silicon oil is available to coat the tubes and mask imperfections in the glass. After a tube has been filled and capped, it should be held by the cap and the outside surface should be wiped with a clean, lint-free, absorbent cloth.

2. Battery Replacement
   a. Open the battery compartment lid (on the bottom of the case).
   b. Remove the standard 9-volt alkaline battery and disconnect from the polarized plug.
   c. Carefully connect the new 9-volt battery to the polarized plug and insert it into the compartment.
   4. Close the battery compartment lid.

3. Lamp Replacement

   The tungsten lamp included with the 2020 turbidimeter has a life of approximately 800 hours. If the display becomes unstable, call LaMotte Company for a return authorization number to have the lamp replaced and the unit examined.

TROUBLESHOOTING

PROBLEM	CHECK	ACTION
Meter won=t turn on	Battery	Replace
	AC Adapter	Plug in
	AC Wall Outlet	Verify power source
	Contact LaMotte for Return Authorization	Return to LaMotte for repair
Suspect Calibration	Check calibration with standards	Use new standards
	Verify standards with Formazin	Run alternate test with Formazin

PROBLEM	**CHECK**	**ACTION**
Suspect Calibration (continued)	Verify with another meter	Check other meter calibrations
	Check tube alignment	Re-align tube
	Check the sample tubes for dirt and scratches	Check, clean, and/or replace sample tubes
	Check to see if internal meter components are wet	Always dry tubes before inserting. Examine for visible moisture
	Contact LaMotte for Return Authorization	Return to LaMotte for repair
Er1	Very low battery	Replace
Er2	Over Range	Dilute sample
Er3	Burnt out bulb or misaligned tube	Check tube alignment Call LaMotte
BAT	Low battery	Replace

INTRODUCTION

The Photovac Model 2020 Portable Photoionization Detector (PID) is a portable micro-processor controlled, photoionization instrument which is used to detect and measure volatile organic compounds in various atmospheres.

The analyzer is a single, self-contained unit with the probe assembly, detector, amplifying and recording assembly all housed in a single self-contained unit.

Personnel who operate the PID will have read the factory manual and have received training on the proper usage of the instrument in the field. All calibrations of the PID will be conducted in-house at Fuss & O'Neill prior to use of the instrument in the field. Personnel will have a cylinder of isobutylene in the field to periodically verify instrument calibration.

PRINCIPLE OF OPERATION

The Photovac Model 2020 Portable Photoionization Detector measures the concentration of trace volatile organic gases by the principle of photoionization. The general operation of the PID is in a non-compound specific mode. That is, the detector, which has been calibrated to isobutylene (a benzene equivalent), can accurately measure isobutylene or benzene, but when exposed to other volatile organic compounds, will measure them qualitatively and not quantitatively. If the measurement of a specific volatile organic compound is desired, then a conversion factor can be calculated in the lab for the VOC of interest. This conversion factor can then be programmed into the memory in the lab or in the field. However, in this case a correction factor will not be applied to convert from the calibration compound to the compound of interest. The field screening data collected with the PID is a quantitative assessment of total PID concentrations to be used in comparison to other PID data from the same boring collected during similar weather conditions via similar methods. The potential variability associated with field screening is too high to simply correlate and compare laboratory data.

Photoionization occurs when an atom or molecule absorbs light of sufficient energy to remove an electron, leaving a positively charged atom or electron. This process will occur in the PID when the ionization potential of a compound (the energy in eV required to remove an electron) is less than the energy of the lamp in the unit. The lamps which Fuss & O'Neill use have ionization potentials of 10.6. Therefore, any volatile organic compound which has an ionization potential of less than 10.6 eV can be detected by the PID. Within the detection chamber is a positive-biased electrode. This electrode causes the ionized molecules to travel to a collector in the chamber. Here the ions create a current proportional to the concentration at the collector. This current is then amplified and the signal displayed on the meter.

DAILY CALIBRATION PROCEDURE

Daily calibration and maintenance involve the following procedures which are carried out in-house prior to releasing an instrument for field use.

1. The instrument is cleaned with a cloth dampened with deionized water and inspected for physical damage or abnormalities.

2. The probe is then visually inspected for any physical damage. The probe tip is opened and inspected for any clogging with dirt or sediment and cleaned if necessary. The filter located in the probe tip is also inspected for any clogging and cleaned if necessary.

3. The lamp is removed for cleaning.

4. The lamp is then cleaned with a wipe.

5. The lamp is reinstalled.

6. The instrument is zeroed.

7. The analyzer is calibrated with a cylinder and a regulator. The cylinder contains a calibration gas consisting of a mixture of isobutylene in zero air. The analyzer is turned on, and the span setting is set to match the ppm reading stamped on the side of the cylinder. This reading will set the instrument to an isobutylene standard.

8. Verify the calibration of the instrument with a check standard (e.g. a standard gas with a different lot number).

PHOTOVAC 2020 DOCUMENTATION

Daily calibration is documented with the date and calibration information recorded in an equipment log book. The following information is recorded on a standard field data sheet as the data are obtained.

- X Project name and number.
- X Operator's name.
- X Date and time of gas measurement.
- X Data values obtained.

INSTRUMENT OPERATION

1. Press "ON/OFF" key to turn instrument on. The Photovac will display the instrument software version and then proceed to the mode display. The Photovac has an instant-on lamp. For maximum accuracy and stability, allow the machine to warm up for 10 minutes prior to calibration.

2. The Photovac 2020 can run in six different modes. The mode is displayed in the upper right-hand corner of the display. The Logging Off Mode, displayed "LOG" with a diagonal line through it, will continuously display the concentration of total volatile compounds present that the Photovac can ionize. The reading is updated once per second.

   The TAG mode, displayed "TAG", will continuously display the instantaneous concentration of total volatile compounds. This mode also allows the user to manually tag and datalog readings (both background and sample) and assign Site Codes to readings.

   The Interval Mode, displayed "INT", displays the instantaneous readings as well as Short-term Exposure Limit, Time-Weighted Average and PEAK readings. Interval automatically updates and stores these readings in the memory at a pre-set interval selected by the user.

   The Short-Term Exposure Limit Mode, displayed "STEL", displays the concentration as a fifteen-minute moving average. It maintains fifteen samples, averaging a one-minute interval. Every minute, the oldest of the fifteen samples is replaced with a new one-minute average. STEL is set to zero each time it is turned on and there is no need to clear or re-set the STEL. Results of the calculations can be displayed by selecting the Interval mode.

   The Time-Weighted Average Mode, displayed "TWA", sums concentrations every second until eight hours of data have been combined. If this value exceeds the TWA alarm setting, the TWA alarm is generated. Once eight hours of data have been accumulated and summed, the accumulation stops. To reset the TWA, press "Clear" key, then select "TWA" using the "Down Arrow", then press "Clear". The meter displays the current sum divided by eight hours (no matter how long it has run). Results of the calculations can be displayed by selecting the Interval mode.

   The PEAK Mode, displayed "PEAK", displays the current detected concentration. The reading is updated once per second. The datalogger samples the concentration and measures minimum, maximum and average concentrations for a selected averaging interval. At the end of every interval, one entry is placed in the datalogger until the datalogger is full. In order to re-set the PEAK, press "Clear" then select "PEAK" using the "Down Arrow" key and then press "Clear.

3. There are two options for data manipulation under the "Erase/Download" selection. Deleted data cannot be recovered.

a. To empty the datalogger:

1. Press MENU key
2. Use DOWN ARROW to chose "Data Logger Options" and press SELECT key
3. Chose "Clear Data Log", then press SELECT (this will delete ALL readings in memory)
4. Press either YES or NO in response to the question "Are you sure you want to clear all data?"

b. To download data to a PC:

1. Install and run the 2020Pro software package on the PC
2. Connect the 2020Pro computer cable, MX750120, between the PID and the PC
3. Press the MENU key
4. Use the DOWN ARROW key to chose "Data Log Options", then press the SELECT key
5. Use the DOWN ARROW key to chose "Download to PC", then press the SELECT key
6. Press the NEXT key at the "Connect Instrument to PC" prompt
7. The display will show "Downloading Data" and the data will now download to the PC. Press the DONE key to stop the download at any time

4. The backlight function maybe turned on or off, depending on whether there is sufficient light to read the display.

To turn the backlighting on and off:

a. Press the MENU soft key and select "Unit Setup"
b. Select BACKLIGHT and then press the SELECT soft key. Press the DOWN ARROW soft key to either turn the backlight on or off
c. Press SELECT soft key to return to the main display

5. To set the time and date:

a. Press the MENU soft key
b. With "Unit Setup" highlighted, press the SELECT soft key
c. Using the DOWN ARROW soft key, highlight "Clock", press SELECT
The UP and DOWN arrows change the underlined character.
The RIGHT arrow advances the cursor to the right

d. Use the arrow keys to enter the correct time (hour:minute)
e. Use the RIGHT Arrow until the "Checkmark" on the display is highlighted. Press DONE to confirm the time and move to the date option
f. The date format is Month/Day/Year. Use ARROW keys to enter the correct date
g. Press the DONE key to confirm the date and the display will return to the main screen

6. Readings may be displayed in Parts Per Million (PPM), Parts Per Billion (PPB) or Milligrams per cubic meter (mg/M^3).

   a. Select "Units" from the main menu
   b. Highlight the desired units of measure and press SELECT to set unit choice

7. The unit must undergo periodic calibration (once every 8 hours of use or once per day). First expose unit to zero air. A zero signal will be generated. Next, expose the unit to span gas. Then calibrate with isobutylene. The reading will indicate the total ionizables present and their concentration in relation to the calibration gas.

   In order to calibrate with a gas bag:

   a. Connect the sample probe to the unit inlet
   b. Press the CAL key
   c. Follow the instructions on the display; connect the unit to the zero air bag to sample clean ambient air. Then press the "Next" key. Zero point calibration will take 60 to 90 seconds for calibration.
   d. Display will show "Zero air calibrated. Continue calibration?" Press the "Next" key
   e. Enter the span gas concentration if the concentration of the 2020 is different from the concentration of the span gas cylinder. Press the "New" key and follow prompts. If span gas concentration equals the span gas cylinder concentration, press the "Next" key.
   f. Connect the sample bag containing span gas to the unit. It will take 60 to 90 seconds to set the span set point. When finished with calibration, the unit will display "Calibration complete".

PHOTOVAC 2020 SPECIFICATIONS

Concentration Range:	0.5 to 2000 ppm isobutylene equivalent 100 to 20,000 ppm isobutylene equivalent with dilution probe
Response Time:	Less than 3 seconds to 90%
Low Detection Limit:	0.5 ppm isobutylene
Accuracy:	+/- 10% or +/- 2 ppm, whichever is greater
Temperature Range:	32°F to 105°F (0°C to 40°C)
Humidity Range:	0 to 95% relative humidity (non-condensing)
Power Requirements:	Removable/rechargeable battery pack
Battery Operating Time Charge/Discharge:	4 hours / 8 hours

INTRODUCTION

The Model 580B Organic Vapor Meter (OVM) is a portable micro-processor controlled, photoionization instrument which is used to detect and measure volatile organic compounds in various atmospheres.

The analyzer is a single, self-contained unit with the probe assembly, detector, amplifying and recording assembly all housed in a single self-contained unit.

Personnel who operate the OVM 580B will have read the factory manual and have received training on the proper usage of the instrument in the field. All calibrations of the OVM 580B will be conducted in-house at Fuss & O'Neill prior to use of the instrument in the field. Personnel will have a cylinder of isobutylene in the field to periodically verify instrument calibration.

PRINCIPLE OF OPERATION

The OVM 580B measures the concentration of trace volatile organic gases by the principle of photoionization. The general operation of the OVM 580B is in a non-compound specific mode. That is, the detector, which has been calibrated to isobutylene (a benzene equivalent), can accurately measure isobutylene or benzene, but when exposed to other volatile organic compounds, will measure them qualitatively and not quantitatively. If the measurement of a specific volatile organic compound is desired, then a conversion factor can be calculated in the lab for the VOC of interest. This conversion factor can then be programmed into the OVM 580B's memory in the lab or in the field. However, in this case a correction factor will not be applied to convert from the calibration compound to the compound of interest. The field screening data collected with the OVM is a quantitative assessment of total VOC concentrations to be used in comparison to other OVM data from the same boring collected during similar weather conditions via similar methods. The potential variability associated with field screening is too high to simply correlate and compare laboratory data.

Photoionization occurs when an atom or molecule absorbs light of sufficient energy to remove an electron, leaving a positively charged atom or electron. This process will occur in the OVM 580B when the ionization potential of a compound (the energy in eV required to remove an electron) is less than the energy of the lamp in the unit. The lamps which Fuss & O'Neill use have ionization potentials of 10.6. Therefore, any volatile organic compound which has an ionization potential of less than 10.6 eV can be detected by the OVM 580B. Within the detection chamber of the OVM 580B is a positive-biased electrode. This electrode causes the ionized molecules to travel to a collector in the chamber. Here the ions create a current proportional to the concentration at the collector. This current is then amplified and the signal displayed on the meter.

DAILY CALIBRATION PROCEDURE

Daily calibration and maintenance involve the following procedures which are carried out in-house prior to releasing an instrument for field use.

1. The instrument is cleaned with a cloth dampened with deionized water and inspected for physical damage or abnormalities.

2. The probe is then visually inspected for any physical damage. The probe tip is opened and inspected for any clogging with dirt or sediment and cleaned if necessary. The filter located in the probe tip is also inspected for any clogging and cleaned if necessary.

3. The housing of the OVM 580B is opened and the high voltage power supply is removed.

4. The lamp is removed for cleaning.

5. The lamp is then cleaned with the cleaning compound supplied by Thermo Environmental Instruments as specified below under "Maintenance".

6. The lamp and the power supply are reinstalled.

7. The instrument is zeroed.

8. The analyzer is calibrated with a cylinder and a regulator. The cylinder contains a calibration gas consisting of a mixture of isobutylene in zero air. The analyzer is turned on, and the span setting is set to match the ppm reading stamped on the side of the cylinder. This reading will set the instrument to an isobutylene standard.

9. Verify the calibration of the instrument with a check standard (e.g. a standard gas with a different lot number).

OVM 580B METER DOCUMENTATION

Daily calibration is documented with the date and calibration information recorded in an equipment log book. The following information is recorded on a standard field data sheet as the OVM 580B data are obtained.

- X Project name and number.
- X Operator's name.
- X Date and time of gas measurement.
- X Data values obtained.

MAINTENANCE

Routine maintenance of this instrument involves the calibration of the instrument (see above), cleaning the lamp and lamp window, and maintaining the battery charge.

1. Lamp Cleaning and Replacement

Removal

- X Make sure the instrument is turned off.
- X Loosen the four screws holding the case top and bottom together. Place case bottom flat on the table and the top on its side next to the bottom.
- X Remove the high-voltage power supply by loosening the thumbscrews on each side and pulling the power supply towards the rear of the instrument.
- X Remove lamp by loosening the lamp nut.

Cleaning

- X Clean the lens surface of the lamp using the aluminum oxide scouring powder provided by Thermo Environmental Instruments.
- X Place a small amount of aluminum oxide on the lens of the lamp.
- X Gently scour in a rotary type motion with a soft cloth or tissue.
- X Gently blow the remaining powder from the lens.
- X Thoroughly wipe the lamp lens with a clean tissue to remove the last traces of cleaning powder.

Insertion

- X Place lamp flat against o-ring and fasten lamp nut to create a proper seal.
- X Insert the high-voltage power supply and tighten thumb screws. There are three pins protruding which should fit snugly into connectors located beneath the detector.
- X The lamp spring should make contact with the lamp ring.

2. Battery Recharging

When there is a flashing "B" in the lower left corner of the display while the instrument is in the run mode, the battery is low.

- X The battery is recharged by plugging the charger into the RUN/CHARGE plug at the rear of the instrument.
- X The instrument will run while charging.
- X The charger has an LED which indicates the amount of current being drawn. The LED gets brighter as more current is drawn and can therefore be used as a rough indication of the charge on the battery.

INSTRUMENT OPERATION

1. Press "ON" to turn instrument on. This will indicate to the microprocessor to turn on the lamp and pump. The microprocessor will send power to the lamp and pump and check to make sure the lamp is lit. If it does not light, the microprocessor will try again. If

after 14 seconds, the lamp does not light, a lamp out condition will be indicated. Once the lamp is lit, the display will show the PPM on the bottom line. The top line will be either a bar graph or the maximum reading.

2. There are two run modes available: Max Hold and Concentration. In concentration mode, the top line of the display is a bar graph. The bar graph is a logarithmic bar graph over the range of 0-2000 ppm which is intended as a rough visual indicator of the current ppm. The bottom line will indicate the exact ppm.

   In Max Hold mode, the top line of the display will indicate the maximum reading while the bottom line indicates the current ppm. Whenever a new maximum is seen, the top line will be updated. The Max Hold reading may be reset by pressing the RESET button while in the run mode.

3. The instrument has the capability to store up to 700 data points for review later. Each reading is assigned a date and time as well as a location code. This mode is entered by pressing the MODE/STORE switch while in the Run mode at which time the message "LOG THIS VALUE?" will appear on the top line and either ppm or max ppm will be on the bottom line.

Pressing "-/CRSR" will bring up the Main Menu.

4. Press "-/CRSR"again to enter the Parameters Mode. Press "-/CRSR" twice more to calibrate. Press RESET.

5. The instrument will ask whether you wish to restore backup. Press "-/CRSR".

6. Press RESET when ready to zero the gas. The display will read "Model 580 Zeroing" which will change to "Span ppm = 0098, "+" to continue". Make sure the span ppm = calgas ppm. Press "+/INC".

7. The message "Span Gas, Reset when ready" will appear. Attach the Tedlar bag of calgas to the probe. Press RESET. The display will show "Model 580 Calibrating". Press MODE/STORE.

8. You are now in "ready" mode. If the reading is not □1 ppm of calgas, clean the bulb and check the filter for dirt.

OVM 580B SPECIFICATIONS

Detection Range:	0.1 to 2000 ppm by volume.
Ranges:	Digital readout (LCD) - auto ranging.
Resolution:	0.1 ppm 0-200 ppm range

	1.0 ppm 200-2000 ppm range
Response Time:	2.0 seconds at 400 mL/min. sample flow.
Sampling Rate:	Nominal flow 400 mL/min.
Power Requirements:	Internal battery or AC.
Battery Operating Time:	8 hours on full charge

INTRODUCTION

The 580EZ is a portable organic vapor meter (OVM) which detects and quantifies most organic vapors with photoionization potential less than 10.6 eV. The instrument has an operating range of 0-2000 ppm with a minimum detection of 0.1 ppm. The 580EZ is effective for leak detection, head space measurements, and field survey. No support gases are needed and the internal battery pack operates for up to eight hours in the field.

Personnel who operate the OVM 580EZ will have read the factory manual and have received training on the proper use of the instrument in the field. All calibrations will be conducted in-house at Fuss & O'Neill prior to use of the instrument in the field.

PRINCIPLE OF OPERATION

The OVM 580EZ measures the concentration of trace volatile organic gases by the principle of photoionization. The general operation of the OVM 580EZ is in a non-compound specific mode. That is, the detector, which has been calibrated to isobutylene (a benzene equivalent), can accurately measure isobutylene or benzene, but when exposed to other volatile organic compounds, will measure them qualitatively and not quantitatively. If the measurement of a specific volatile organic compound is desired, then a conversion factor can be calculated in the lab for the VOC of interest. This conversion factor can then be programmed into the OVM 580EZ's memory in the lab or in the field. However, in this case a correction factor will not be applied to convert from the calibration compound to the compound of interest. The field screening data collected with the OVM is a quantitative assessment of total VOC concentrations to be used in comparison to other OVM data from the same boring collected during similar weather conditions via similar methods. The potential variability associated with field screening is too high to simply correlate and compare laboratory data.

Photoionization occurs when an atom or molecule absorbs light of sufficient energy to remove an electron, leaving a positively charged atom or electron. This process will occur in the OVM 580EZ when the ionization potential of a compound (the energy in eV required to remove an electron) is less than the energy of the lamp in the unit. The lamps which Fuss & O'Neill use have ionization potentials of 10.6. Therefore, any volatile organic compound which has an ionization potential of less than 10.6 eV can be detected by the OVM 580EZ. Within the detection chamber of the OVM 580EZ is a positive-biased electrode. This electrode causes the ionized molecules to travel to a collector in the chamber. Here the ions create a current proportional to the concentration at the collector. This current is then amplified and the signal displayed on the meter.

CALIBRATION

1. The instrument is cleaned with a cloth dampened with deionized water and inspected for physical damage or abnormalities.

2. The UV lamp is cleaned by gently scouring the lens of the lamp with a small amount of aluminum oxide powder (supplied by Thermo Environmental Instruments, Inc.) On a soft, lint-free cloth. After scouring, the remaining powder is blown from the lens and the lens is rinsed with alcohol or acetone and wiped dry with a soft tissue. Do not touch the lens with your finger.

3. Allow the instrument to run for about 20 minutes to stabilize.

4. From the Main menu, select Calibration.

5. From the Calibration menu, choose Select Setup. Up to 10 calibrations can be stored in the instrument=s memory. Select Setup allows you to choose the active one.

6. Choose a calibration setup (0-9) using the Next and Select keys.

7. Select Edit Setup to edit the calibration setup. This contains four screens allowing entry of a descriptive label, low span calibration, high span calibration, and lamp type. Use Prev and Next keys to bring the letter or number you wish to include in the description. Press Select to transfer that character to the current cursor position on line 1 of the display. Once all characters have been added, select A*@ to move to the next edit screen.

8. Enter a low span concentration value. Use the Crsr key to move the cursor to the digit you wish to change, then press Inc to increment the value. Once the low span value has been entered, press Sel to move to the third edit screen.

9. Enter a high span concentration value.

10. Select Calibration.

11. Connect AZero Air@ to the sample inlet. Total air flow must exceed the demand of the instrument to prevent ambient air from being pulled into the instrument. After connecting AZero Air@ wait for 30-60 seconds while the instrument stabilizes and press Ready. After the reading is taken, the instrument will prompt you to connect the low span gas.

12. Connect the low span gas to the sample inlet. Total air flow must exceed the demand of the instrument to prevent ambient air from being pulled into the instrument. After connecting low span gas wait for 30-60 seconds while the

instrument stabilizes and press Ready. After the reading is taken, the instrument will prompt you to connect the high span gas.

13. Connect the high span gas to the sample inlet. Total air flow must exceed the demand of the instrument to prevent ambient air from being pulled into the instrument. After connecting high span gas wait for 30-60 seconds while the instrument stabilizes and press Ready.

14. After the zero air and span gases have been sampled, the detector readings are recorded and the processor calculates the calibration function used to convert the detector signal to ppm.

15. Select Cal Report. This report shows the span values used in the most recent calibration on the first screen and the type of calibration used on the second screen. Additionally, diagnostic codes are shown here when problems have occurred.

16. Select Cal Check. This allows verification of the span readings. When this is selected, you will be prompted to connect the span gas to the sample inlet. A reading is taken and compared to the original span reading recorded in memory. Any error or difference is noted and recorded as a percent error. Cal Check does not alter the calibration; it serves only as a convenient method for checking for instrument drift or calibration errors.

17. Verify the calibration of the instrument with a check standard (e.g. a standard gas with a different lot number).

DETERMINATION OF RESPONSE FACTORS

Response factors enable the instrument to accurately measure compounds other than the one used to calibrate the instrument. For example, calibrating the instrument to isobutylene ensures that only isobutylene is accurately measured. Measurements of other compounds will either be high or low, depending on how sensitive those particular compounds are to the 580EZ. The use of response factors prevents having to calibrate the instrument to each compound in order to get an accurate measurement.

Response factors are determined by measuring known concentration of a compound and dividing it by the concentration that is displayed on the instrument. For example, to determine the response factor for benzene for an instrument calibrated to isobutylene, begin by measuring the benzene. If the benzene is known to be 55 ppm and it reads 91 ppm on the 580EZ, the response factor is 55/91, or 0.604.

Setting the response factor in the Parameters menu to 0.6 will correct the instrument to directly read benzene. The response factor is a multiplier which the 580EZ will automatically incorporate into the calibration function.

MAINTENANCE

1. Removing the UV Lamp
   - X Unscrew the lamp cap.
   - X Gently pull the UV lamp out of the lamp holder.
   - X Clean lamp or select replacement lamp.
   - X Push the lamp into the lamp holder and screw lamp cap back on.

2. Cleaning the UV Lamp
   As a general rule, the UV lamp should be cleaned after 8 hours of use.

   A. 10.6 eV Lamp
   Place a small amount of aluminum oxide scouring powder (provided with the instrument) on the lens of the lamp. Gently scour the lens surface in a circular motion with a soft, lint-free tissue of cloth. After scouring, gently blow the remaining powder off the lens and rinse the lens with alcohol or acetone and wipe dry with a soft tissue.

   B. 11.8 eV Lamp
   Gently polish the lamp lens with anhydrous alcohol on a cotton swab, followed by an anhydrous methanol or alcohol rinse. Wipe dry with a soft tissue. Do not allow the alcohol to remain on the surface too long because it will leave a film.

   Do not clean the 11.8 eV lamp with aluminum oxide. It will scratch the lamp lens.

3. Battery Charging
   The 580EZ has a 7.2V NiCad rechargeable battery pack. Fourteen hours is required to fully charge the battery pack with the instrument off. More time is needed with the instrument on. Avoid allowing the battery to discharge fully.

   The battery pack should be charged overnight after a day of use. The charger switches to trickle charge as the battery pack nears full charge so there is no danger of overcharging.

   Connect the battery charger via the port located on the access panel. Plug the AC receptacle into an appropriate outlet. When the LED is off, the battery is charging. Green LED indicates the battery is fully charged and ready for use. When the LED is red, the battery is self-discharging which is done automatically after every 10 charging cycles. This is done to update the battery=s capacity to hold a charge and also to prevent the battery from developing a Amemory effect@.

4. Replacing the Water Trap Filter
   The probe houses a filter to effectively stop water and particulates from entering the instrument. Water traps can be re-used after drying at room temperature. If the trap becomes contaminated, it should be discarded.

- X Remove the sample probe by pressing the quick change tab and pulling.
- X Unscrew the probe body.
- X Pull the water trap out of the probe body.
- X Install a new water trap.
- X Replace the probe body and sample probe.

5. Replacing the Charcoal in the Scrubber
The charcoal scrubber prevents hydrocarbons from entering the instrument detector. The amount of hydrocarbons in the environment will determine the operating time of the scrubber.

- X Remove the charcoal scrubber probe from the 580EZ inlet by pressing the quick connect tab and pulling.
- X Holding the probe with the quick connect attachment on top, unscrew the charcoal holder from the spring holder and slowly separate the pieces.
- X Remove the scrubber screen and the mesh cloth from the top of the charcoal holder.
The charcoal holder is filled with charcoal which covers two screens: a mesh cloth screen and a scrubber screen. Do not lose these screens when dumping the charcoal.
- X Replace the scrubber screen in the bottom of the charcoal holder.
- X Replace the mesh cloth screen on top of the scrubber screen.
- X Refill the charcoal holder with charcoal, do not overfill.
- X Place the mesh cloth screen on top of the charcoal and place the scrubber screen on top of the mesh cloth screen.
- X Make sure the o-ring is seated properly in the spring holder and place the spring in the holder.
- X Rejoin the charcoal holder and the spring holder.

TROUBLESHOOTING

MALFUNCTION	POSSIBLE CAUSE	ACTION
Display is blank	Low battery	Run instrument with charger
	Battery needs to be replaced	Replace battery
	Blown fuse	Return to TEI for service
No response to gas	Bad calibration	Recalibrate
	Incorrect response factor	Check response factor
	Bad span gas	Verify quality of span gas

MALFUNCTION	**POSSIBLE CAUSE**	**ACTION**
	Dirty lamp	Clean lamp
Slow response time	Clogged water trap	Replace water trap
	Leak in flow system	Perform leak test
580EZ does not properly read calibration gas	Incorrect response factor	Check response factor
	Incorrect span gas concentration	Check the entered span gas concentration value to ensure it matches the concentration of your span gas cylinder or bag standard
Pump not running	Clogged water trap	Replace water trap

INTRODUCTION

The MiniRAE 2000 Portable VOC Monitor PGM-7600 is a portable micro-processor controlled, photoionization instrument which is used to detect and measure volatile organic compounds(VOCs) in various atmospheres.

The analyzer consists of the detector, amplifying and recording assembly, and LCD monitor, which are all housed in a single self-contained unit, and a detection probe which connects to the self-contained unit.

Personnel who operate the MiniRAE will have read the factory manual and have received training on the proper usage of the instrument in the field. All calibrations of the MiniRAE will be conducted in-house at Fuss & O'Neill prior to use of the instrument in the field. Personnel will have a cylinder of isobutylene in the field to periodically verify instrument calibration.

PRINCIPLE OF OPERATION

The MiniRAE 2000 Portable VOC Monitor measures the concentration of trace volatile organic gases using the principle of photoionization. The MiniRAE generally operates in a non-compound specific mode. That is, the detector, which has been calibrated to isobutylene (a benzene equivalent), can accurately measure isobutylene or benzene, but when exposed to other volatile organic compounds, will measure them qualitatively and not quantitatively. If the measurement of a specific VOC is desired, then a conversion factor can be calculated in the lab for the VOC of interest. This conversion factor can then be programmed into the memory in the lab or in the field. However, in this case a correction factor will not be applied to convert from the calibration compound to the compound of interest. The field screening data collected with the MiniRAE is a quantitative assessment of total VOC concentrations to be used in comparison to other VOC measurements collected from both the same boring and other borings during similar weather conditions. The potential variability associated with field screening is too high to simply correlate and compare laboratory data.

Photoionization occurs when an atom or molecule absorbs light of sufficient energy to remove an electron, leaving a positively charged atom or electron. This process will occur in the MiniRAE when the ionization potential of a compound (the energy in eV required to remove an electron) is less than the energy of the lamp in the unit. The lamps which Fuss & O'Neill use have ionization potentials of 10.6 eV. Therefore, any volatile organic compound which has an ionization potential of less than 10.6 eV can be detected by the MiniRAE. Within the detection chamber is a positive-biased electrode. This electrode causes the ionized molecules to travel to a collector in the chamber. Here the ions create a current proportional to the concentration at the collector. This current is then amplified and the signal displayed on the meter.

DAILY CALIBRATION PROCEDURE

Daily calibration and maintenance involve the following procedures which are carried out in-house prior to releasing an instrument for field use.

1. The instrument is cleaned with a cloth dampened with deionized water and inspected for physical damage or abnormalities.

2. The probe is then visually inspected for physical damage and clogging with dirt or sediment, and cleaned if necessary.

3. The analyzer is zeroed in a clean-air environment.

. The analyzer is calibrated with a cylinder and a regulator. The cylinder contains a calibration gas consisting of a mixture of isobutylene in zero air. The analyzer is turned on, and the span setting is set to match the ppm reading stamped on the side of the cylinder. This reading will set the instrument to an isobutylene standard.

DOCUMENTATION

Daily calibration is documented with the date and calibration information recorded in an equipment log book. The following information is recorded on a standard field data sheet as the data are obtained.

X Project name and number.
X Operator's name.
X Date and time of gas measurement.
X Data values obtained.

INSTRUMENT OPERATION

1. The monitor of the MiniRAE has three function keys:
   - The "MODE" key turns the instrument on or off and allows the user to scroll through the menu items
   - The "Y/+" key is used for positive acknowledgement, starting measurements, and increasing numbers or values
   - The "N/-" key is used for negative acknowledgement, turning the monitor backlight on or off, and decreasing numbers or values

2. Press the "MODE" key to turn instrument on. The MiniRAE will display the instrument software version and then proceed to the mode display. The MiniRAE has two operation modes: Survey and Hygiene. In Survey mode, the user can manually start and stop monitoring of VOC gases (i.e. turn the lamp on and off). In Hygiene mode, the instrument monitors continuously (i.e. the lamp is continuously on). The MiniRAE has been set up to operate in Survey mode. For maximum

accuracy and stability, allow the machine to warm up (lamp is on) for 10 minutes prior to calibration.

3. While in Survey mode, the user may perform one of two options. Pressing the "Y/+" key will run a diagnostic test on the lamp and sensor to ensure that they are working properly. If the diagnostic test shows no failure, the lamp will then turn on and the instrument will begin measuring VOC vapor concentrations. Pressing the "MODE" key will allow the user to scroll through the Main Menu. The Main Menu displays features such as instrument battery level, exposure values, and datalogging values. Some of these features can be changed using the function keys on the monitor – refer to the MiniRAE 2000 Operation and Maintenance Manual for further instructions on using and adjusting features found on the Main Menu. In Hygiene mode, pressing the "MODE" key will allow the user to scroll through the Hygiene Operation Menu, which displays most of the same features as the Survey mode Main Menu.

4. To turn the lamp off while in Survey mode, press the "MODE" key while the lamp is on. The LCD monitor will display "Stop?". Pressing the "Y/+" key will turn the lamp off and stop measurement. (Pressing the "N/-" key will continue measurement and operation of the lamp)

5. The backlight function maybe turned on or off, depending on whether there is sufficient light to read the display. To turn the backlighting on, press and hold the "N/-" key for one second during normal operation. The backlight will automatically turn off after a pre-set amount of time elapses, or the user can turn it off by pressing the "N/-" key a second time.

6. Readings may be displayed in parts per million (ppm) or milligrams per cubic meter (mg/m^3). Refer to the MiniRAE 2000 Operation and Maintenance Manual for further instructions on how to change the units displayed by the instrument.

7. The unit must undergo periodic calibration (once every 8 hours of use or once per day).

   In order to calibrate with a gas bag:

   a. Once the unit has been turned on and warmed up (lamp has been on for 10 minutes), press and hold the "MODE" and "N/-" keys until the LCD monitor displays "Calibrate/Select Gas?"
   b. Press the "Y/+" key. The monitor will display "Fresh Air Cal?" Make sure the instrument is in a clean (fresh) air environment.
   c. Press the "Y/+" key. The monitor will display "Zero In Progress", then will initiate a 30-second countdown. After the countdown is complete, the monitor will display "Update Data", then "Zeroed!", then "Span Gas Cal?"
   d. Fill up a 1-Liter Tedlar bag with 100 ppm Isobutylene gas. This is the span gas used to calibrate the instrument.

e. Press the "Y/+" key. The monitor will display "Span Gas = Isobutylene", then "Span Value = 100 ppm", then "Apply Gas Now!". Connect the tedlar bag to the probe of the instrument.
f. The monitor will then initiate a 30-second countdown, followed by "Update Data", then "Cal'ed!". The monitor will then display the current reading in ppm (the reading should be 100 ppm). Disconnect the tedlar bag from the probe. The monitor should display "0.0 ppm". Connect the tedlar bag to the probe again to confirm proper calibration (the monitor should display "100 ppm").
g. After calibration, the monitor will display "Calibration complete – turn off gas!" Disconnect the tedlar bag from the probe. The monitor will then display "Span Cal?" once again. Press the "MODE" key until the monitor displays "Ready…." The instrument is now calibrated and ready for use.

8. To turn off the instrument, press and hold the "MODE" key. The monitor will display "Off in…" and initiate a 5-second countdown. The instrument will also beep with every second in the countdown. Continue to hold the "MODE" key until the monitor displays "OFF!" and emits a long beep.

MINIRAE 2000 SPECIFICATIONS

Concentration Range:	0 to 10,000 ppm isobutylene equivalent
Response Time:	2 seconds
Low Detection Limit:	0.1 ppm isobutylene
Accuracy:	0-2000 ppm: +/- 10% or +/- 2 ppm > 2000 ppm: +/- 20%
Temperature Range:	32°F to 113°F (0°C to 45°C)
Humidity Range:	0 to 95% relative humidity (non-condensing)
Power Requirements:	Removable/rechargeable battery pack
Battery Operating Time Charge/Discharge:	Up to 10 continuous hours (fully charged)

INTRODUCTION

The Landtech GEM 2000 portable gas analyzer is a portable instrument which is used to detect and measure oxygen, carbon dioxide, and methane gas.

The analyzer is a single, self-contained unit with the probe assembly, detector, amplifying and recording assembly all housed in a single self-contained unit.

Personnel who operate the Landtech GEM 2000 will have read the factory manual and have received training on the proper usage of the instrument in the field. All calibrations of the Landtech GEM 2000 will be conducted in-house at Fuss & O'Neill prior to use of the instrument in the field.

PRINCIPLE OF OPERATION

The Landtech GEM 2000 portable gas analyzer measures the concentration carbon dioxide and methane gases by dual wavelength infrared cell and oxygen by internal electrochemical cell. The sample is drawn through the instrument via an internal pump, and readings are displayed on a screen and can be stored in the instrument or downloaded to a personal computer for reporting, analyzing, and archiving.

DAILY CALIBRATION PROCEDURE

Daily calibration and maintenance involve the following procedures which are carried out in-house prior to releasing an instrument for field use.

1. The instrument is cleaned with a cloth dampened with deionized water and inspected for physical damage or abnormalities.

2. The instrument is zeroed.

3. The analyzer is calibrated with ambient air (for oxygen and carbon dioxide) and a methane gas cylinder and a regulator (for methane gas). The cylinder contains a calibration gas consisting of a mixture of methane and carbon dioxide. The analyzer is turned on, and the span setting is set to match the ppm reading stamped on the side of the cylinder. This reading will set the instrument to an methane standard.

DOCUMENTATION

Daily calibration is documented with the date and calibration information recorded in an equipment log book. The following information is recorded on a standard field data sheet as the data are obtained.

- X Project name and number.
- X Operator's name.
- X Date and time of gas measurement.
- X Data values obtained.

INSTRUMENT OPERATION

1. Press the power key to turn instrument on. The Landtech GEM 2000 will display the instrument software version and then proceed to the 20 second self-test. For maximum accuracy and stability, allow the instrument to warm up for 10 minutes prior to calibration.

2. The Landtech GEM 2000 will then display Read Gas Levels on the screen in sampling mode.

3. The Read Gas Levels screen is considered the normal operation screen and all operations are carried out from this starting point.

4. From the ID list press "Select No ID" for non-logging mode. Once the return key is pressed, purge will begin and the Read Gas Levels screen.

5. Place inlet in the desired sample location and record gas level readings a on field data sheet.

6. To record readings in the instrument for download, select option 3, "Next ID", and select sampling site ID.

7. The pump will run for a specified time and store a gas level reading.

8. A tone will sound when next reading is ready to be collected.

9. To power instrument down, press and hold the power button for approximately 15 seconds.

Landtech GEM 2000 SPECIFICATIONS

Flow Rate:	300 cc/min
Response Time:	$\leq$ 20 seconds
Low Detection Limit:	
Accuracy:	CH_4 = +/- 0.5 – 3% CO_2 = +/- 0.5 – 3% O_2 = +/- 1%
Temperature Range:	32°F to 104°F
Humidity Range:	0 to 95% relative humidity (non-condensing)
Power Requirements:	Rechargeable battery pack
Battery Operating Time Charge/Discharge:	4 hours / 8 hours

MONITORING WELL DEVELOPMENT

Once complete, each monitoring well will be developed in order to establish an unencumbered hydraulic connection between the screened interval and the aquifer. This will be accomplished by the surging and pumping of the water in the well. Forcing formation water in and out of the screened interval prevents the bridging of fine particles which often accumulate in the formation during monitoring well construction. Well development also connects the well to the aquifer by initiating a flow of water through the filter pack. This process sorts the sand around the screen, promoting optimum flow and a more effective filter pack.

Small diameter wells with less than fifty feet of static water will generally be developed manually with a surge block in conjunction with a submersible pump, or sometimes a watera or bailer (see Table 16-1). High volume wells may require the use of a bladder, submersible or vacuum pump for sufficient evacuation during development. The use of air will be prohibited in the development of wells suspected of volatile, semi-volatile or metal contamination.

The surge block is a cylinder constructed of PVC or another approved material with a diameter that is close to the inner diameter of the well casing. This cylinder will be moved in an up and down, plunger-like motion in the well by means of the pipe to which it is attached. Initially, surging will be conducted above the screened interval; however, the depth of surging will increase during development until the bottom of the screen is reached. After several strokes, the surge block will be withdrawn from the well and dislodged particles will be removed from the well with a watera pump, an externally powered pump, or bailer.

A pump used in conjunction with a surge block for well development will be placed so that water is taken from just above the screened interval.

Regardless of the evacuation method used, development will continue until the well water is sufficiently free of fine particles and has a turbidity factor of <5 NTU. When water is used in the drilling process, at least an equal volume will be removed from the aquifer during well development. This water will be allowed to soak into the ground unless groundwater contamination is such that it must be collected and treated prior to disposal.

All development equipment will be decontaminated or replaced prior to use at each well. In some circumstances, this operation will be carried out in the field. Surge blocks, bailers, surge pumps and tubing will be decontaminated in the following the procedure outlined in SOP 040000.

In some circumstances, drums or tanks will be used to temporarily contain the water evacuated during monitoring well development. Any containers utilized for this purpose will be clearly labeled with the location and date at the time of water collection. Personnel should consult the project manager prior to monitoring well development activities in order to determine whether temporary water storage is required.

Table 16-1

Well Diameter	**>2”**	**2”**	**1.5”**	**1” or Less**
Pump Type	Submersible Grunfos Type or ES-60 Type	Submersible (ES-60 Type) or Watera	Submersible (ES-60 Type) or Watera	Watera or Peristaltic
Surge Block	Custom	2”	1.5”	Watera can be used as surge block

Appendix K

GCL Manufacturer's Specifications

BENTOMAT® ST

GEOSYNTHETIC CLAY LINER SPECIFICATION GUIDELINES

This specification is intended for use as a GENERAL GUIDELINE for developing a specification for a specific project. It is NOT intended as a substitute for a detailed specification, which must be written to address site-specific conditions.

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1.0 GENERAL

1.1 Scope

This specification covers the technical requirements for the furnishing and installation of the geosynthetic clay liner described herein. All materials used shall meet the requirements of this specification, and all work shall be performed in accordance with the procedures provided herein and the contract drawings.

1.2 Definitions

For the purposes of this specification guideline, the following terms are defined below:

Geosynthetic Clay Liner (GCL). A manufactured hydraulic barrier consisting of clay bonded to a layer or layers of geosynthetics.

Geomembrane. An essentially impermeable geosynthetic composed of one or more geosynthetic sheets.

Geotextile. Any permeable geosynthetic comprised solely of textiles.

Minimum Average Roll Value. For geosynthetics, the value calculated as the typical value minus two (2) standard deviations from documented quality control test results for a defined population from one specific test method associated with one specific property.

Overlap. Where two adjacent GCL panels contact, the distance measuring perpendicular from the overlying edge of one panel to the underlying edge of the other.

1.3 Unit Prices

Measurement will be made of the total surface area in square feet covered by the GCL as shown on the contract drawings. Final quantities will be based on as-built conditions. Allowance will be made for GCL in anchor and drainage trenches but no allowance will be made for waste, overlap, or materials used for the convenience of the Contractor. GCL installed and accepted will be paid for at the respective contract unit price in the bidding schedule.

1.4 Submittals

A. With the bid, the Contractor shall furnish the following information:

1. Conceptual description of the proposed plan for placement of the GCL panels over the area of installation.
2. GCL manufacturer's MQC Plan for documenting compliance to Sections 2.1 and 2.2 of these specifications.
3. GCL manufacturer's historical data for a) 10,000-hour creep shear testing per Section 2.1 E and b) seam flow data at 2 psi confining pressure per Section 2.1 F.

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4. A copy of GCL manufacturer's ISO quality Certificate of Registration.

B. At the Engineer's or Owner's request the Contractor shall furnish:

1. A representative sample of the GCLs.
2. A project reference list for the GCL(s) consisting of the principal details of at least ten projects totaling at least 10 million square feet (100,000 square meters) in size.

C. Upon shipment, the Contractor shall furnish the GCL manufacturer's Quality Assurance/Quality Control (QA/QC) certifications to verify that the materials supplied for the project are in accordance with the requirements of this specification.

D. As installation proceeds, the Contractor shall submit certificates of subgrade acceptance, signed by the Contractor and CQA Inspector (see Sections 1.6 and 3.3) for each area that is covered by the GCL.

1.5 Qualifications

A. GCL Manufacturer must have produced at least 300 million square feet (30 million square meters) of GCL within the past three years, including at least 30 million square feet (3 million square meters) with 3.5 lb/in (610 N/m) peel strength.

B. The GCL Installer must either have installed at least 1 million square feet (100,000 square meters) of GCL, **or** must provide to the Engineer satisfactory evidence, through similar experience in the installation of other types of geosynthetics, that the GCL will be installed in a competent, professional manner.

1.6 Construction Quality Assurance (CQA)

A. The Owner and Engineer shall provide a third-party inspector for CQA of the GCL installation. The inspector shall be an individual or company who is independent from the manufacturer and installer, who shall be responsible for monitoring and documenting activities, related to the CQA of the GCL, throughout installation. The inspector shall have provided CQA services for the installation of the proposed or similar GCL for at least 5 completed projects totaling not less than 1 million square feet (100,000 square meters).

B. Testing of the GCL, as necessary to support the CQA effort, shall be performed by a third party laboratory retained by the Contractor and independent from the GCL manufacturer and installer. The laboratory shall have provided GCL CQA testing of the proposed or similar GCL for at least 5 completed projects totaling not less than 1 million square feet (100,000 square meters).

C. CQA shall be provided in accordance with the *GCL CQA Manual* provided by the engineer.

2.0 PRODUCTS

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A. The GCL shall consist of a layer of granular sodium bentonite clay needlepunched between two geotextiles and shall comply with all of the criteria listed in this Section.

B. Bentonite shall be a high-swelling sodium bentonite, with a minimum swell index of 24 mL/2g and a maximum fluid loss of 18 mL. Bentonite shall be CG-50 granular bentonite, mined and processed by American Colloid Company.

C. Bentonite shall have a granular consistency (1 percent max. passing a No. 200 sieve [75 μm]), to ensure uniform distribution throughout the GCL and minimal edge loss during handling and installation.

D. Prior to using an alternate GCL, the Contractor must furnish independent test results demonstrating that the proposed alternate material meets all requirements of this specification. Contractor must also provide evidence of successful use of the proposed alternate material on past similar projects. This evidence can include past direct shear results against similar materials under similar site conditions, and/or past permeability/compatibility test results with a similar leachate or waste stream. The Contractor also must obtain prior approval of the alternative GCL by the Project Engineer.

2.1 Materials

A. Acceptable GCL products are Bentomat® ST, as manufactured by CETCO, 2870 Forbs Avenue, Hoffman Estates, Illinois 60192 USA (800-527-9948), or an engineer-approved equal.

B. The GCL shall have the properties shown in the Bentomat ST Certified Properties table.

C. The moisture content of the bentonite in the finished GCL shall be between 20 and 40 percent, to ensure uniform bentonite distribution, consistent needlepunch density, and adequate electrical conductivity to maximize leak location survey sensitivity.

D. GCL shall be needlepunch-reinforced, with a minimum peel strength of 3.5 lb/inch (610 N/m). To maximize large-displacement shear strength, GCL reinforcement shall be achieved solely through needlepunching, without any supplemental heat treatment.

E. The GCL shall have 10,000-hour test data for large-scale constant-load (creep) shear testing under hydrated conditions. The displacement shall be 0.11 in. (2.7 mm) or less at a constant shear load of 250 psf (12 kPa) and a normal load of 500 psf (24 kPa).

F. The GCL shall have seam test data from an independent laboratory showing that the seam flow with a grooved cut in the nonwoven geotextile is less than 1×10^{-8} $m^3/m^2/s$ at 2 psi hydraulic pressure.

G. The minimum acceptable dimensions of full-size GCL panels shall be 150 feet (45.7 m) in length. Short rolls [(those manufactured to a length greater than 70 feet (21 m) but less than a full-length roll)] may be supplied at a rate no greater than 3 per truckload or 3 rolls every 36,000 square feet (3,500 square meters) of GCL, whichever is less.

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H. A 6-inch (150 mm) overlap guideline shall be imprinted on both edges of the upper geotextile component of the GCL as a means for providing quality assurance of the overlap dimension. Lines shall be printed in easily visible, non-toxic ink.

2.2 Product Quality Documentation

The GCL manufacturer shall provide the Contractor or other designated party with manufacturing QA/QC certifications for each shipment of GCL. The certifications shall be signed by a responsible party employed by the GCL manufacturer and shall include:

A. Certificates of analysis for the bentonite clay used in GCL production demonstrating compliance with the swell index and fluid loss values shown in the Bentomat ST Certified Properties table.

B. Manufacturer's test data for the finished GCL product demonstrating compliance with the values shown in the Bentomat ST Certified Properties table.

C. GCL lot and roll numbers supplied for the project (with corresponding shipping information).

Manufacturer's test data for finished GCL product(s), including GCL index flux, permeability and hydrated internal shear strength data, which demonstrate compliance with the performance parameters shown in the Bentomat ST Certified Properties table, are available upon request of the manufacturer.

2.3 Product Labeling

A. Prior to shipment, the GCL manufacturer shall label each roll, identifying:

1. Product identification information (Manufacturer's name and address, brand product code).

2. Lot number and roll number.

3. Roll length, width and weight.

BENTOMAT® ST CERTIFIED PROPERTIES

MATERIAL PROPERTY	TEST METHOD	TEST FREQUENCY $ft^2(m^2)$	REQUIRED VALUES
Bentonite Swell Index[1]	ASTM D 5890	1 per 50 tonnes	24 ml/2g min.
Bentonite Fluid Loss[1]	ASTM D 5891	1 per 50 tonnes	18 ml max.
Bentonite Mass/Area[2]	ASTM D 5993	40,000 ft^2 (4,000 m^2)	0.75 lb/ft^2 (3.6 kg/m^2) min
GCL Tensile Strength[3]	ASTM D 6768	200,000 ft^2 (20,000 m^2)	30 lbs/in (53 N/cm) MARV
GCL Peel Strength[3]	ASTM D 6496	40,000 ft^2 (4,000 m^2)	3.5 lbs/in (6.1 N/cm) min
GCL Index Flux[4]	ASTM D 5887	Weekly	1 x 10^{-8} m^3/m^2/sec max
GCL Hydraulic Conductivity[4]	ASTM D 5887	Weekly	5 x 10^{-9} cm/sec max
GCL Hydrated Internal Shear Strength[5]	ASTM D 5321 ASTM D 6243	Periodic	500 psf (24 kPa) typ @ 200 psf

Bentomat ST is a reinforced GCL consisting of a layer of granular sodium bentonite between woven and nonwoven geotextiles, which are needlepunched together.

Notes

[1] Bentonite property tests performed at a bentonite processing facility before shipment to CETCO's GCL production facilities.
[2] Bentonite mass/area reported at 0 percent moisture content.
[3] All tensile strength testing is performed in the machine direction using ASTM D 6768. All peel strength testing is performed using ASTM D 6496. Upon request, tensile and peel results can be reported per modified ASTM D 4632 using 4 inch grips.
[4] Index flux and permeability testing with deaired distilled/deionized water at 80 psi (551kPa) cell pressure, 77 psi (531 kPa) headwater pressure and 75 psi (517 kPa) tailwater pressure. Reported value is equivalent to 925 gal/acre/day. This flux value is equivalent to a permeability of 5x10^{-9} cm/sec for typical GCL thickness. Actual flux values vary with field condition pressures. The last 20 weekly values prior the end of the production date of the supplied GCL may be provided.
[5] Peak values measured at 200 psf (10 kPa) normal stress for a specimen hydrated for 48 hours. Site-specific materials, GCL products, and test conditions must be used to verify internal and interface strength of the proposed design.

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2.4 Packaging

A. The GCL shall be wound around a rigid core whose diameter is sufficient to facilitate handling. The core is not necessarily intended to support the roll for lifting but should be sufficiently strong to prevent collapse during transit.

B. All rolls shall be labeled and bagged in packaging that is resistant to photodegradation by ultraviolet (UV) light.

2.5 Accessory Bentonite

A. The granular bentonite sealing clay used for overlap seaming, penetration sealing and repairs shall be made from the same natural sodium bentonite as used in the GCL and shall be as recommended by the GCL manufacturer. Seaming of GCLs shall be conducted in accordance with the manufacturer's guidelines for each particular GCL.

3.0 EXECUTION

3.1 Shipping and Handling

A. The manufacturer assumes responsibility for initial loading the GCL. Shipping will be the responsibility of the party paying the freight. Unloading, on-site handling and storage of the GCL are the responsibility of the Contractor, Installer or other designated party.

B. A visual inspection of each roll should be made during unloading to identify if any packaging has been damaged. Rolls with damaged packaging should be marked and set aside for further inspection. The packaging should be repaired prior to being placed in storage.

C. The party responsible for unloading the GCL should contact the Manufacturer prior to shipment to ascertain the appropriateness of the proposed unloading methods and equipment.

3.2 Storage

A. Storage of the GCL rolls shall be the responsibility of the installer. A dedicated storage area shall be selected at the job site that is away from high traffic areas and is level, dry and well drained.

B. Rolls should be stored in a manner that prevents sliding or rolling from the stacks and may be accomplished by the use of chock blocks. Rolls should be stacked at a height no higher than that at which the lifting apparatus can be safely handled (typically no higher than four).

C. All stored GCL materials and the accessory bentonite must be covered with a plastic sheet or tarpaulin until their installation.

D. The integrity and legibility of the labels shall be preserved during storage.

3.3 Earthwork

A. Any earthen surface upon which the GCL is installed shall be prepared and compacted in accordance with the project specifications and drawings. The surface shall be smooth, firm, and unyielding, and free of:

1. Vegetation.
2. Construction Debris.
3. Sticks.
4. Sharp rocks.
5. Void spaces.
6. Ice.
7. Abrupt elevation changes.
8. Standing water.
9. Cracks larger than one-quarter inch (6 mm) in width.
10. Any other foreign matter that could contact the GCL.

B. Subgrade surfaces consisting of granular soils or gravels may not be acceptable due to their large void fraction and puncture potential. In applications where the GCL is the only barrier, subgrade soils should have a particle-size distribution at least 80 percent finer than the #60 sieve (0.25 mm). In other applications, subgrade soils should range between fines and 1 inch (25 mm). In high-head applications (greater than 1 foot or 30.48 cm), CETCO recommends a membrane-laminated GCL (Bentomat CL or Bentomat CLT).

C. Immediately prior to GCL deployment, the subgrade shall be final-graded to fill in all voids or cracks and then smooth-rolled to provide the best practicable surface for the GCL. At completion of this activity, no wheel ruts, footprints or other irregularities shall exist in the subgrade. Furthermore, all protrusions extending more than one-half inch (12 mm) from the surface shall either be removed, crushed or pushed into the surface with a smooth-drum compactor.

D. On a continuing basis, the project CQA inspector shall certify acceptance of the subgrade before GCL placement.

E. It shall be the installer's responsibility thereafter to indicate to the Engineer any change in the condition of the subgrade that could cause the subgrade to be out of compliance with any of the requirements listed in this Section.

F. At the top of sloped areas of the job site, an anchor trench for the GCL shall be excavated or an equivalent runout shall be utilized in accordance with the project plans and specifications and as approved by the CQA Inspector. When utilizing an anchor trench design, the trench shall be excavated and approved by the CQA Inspector prior to GCL placement. No loose soil shall be allowed at the bottom of the trench and no sharp corners or protrusions shall exist anywhere within the trench.

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3.4 GCL Placement

A. The areas to be lined with GCL shall be agreed upon by the Installer and the Engineer prior to installation.

B. GCL rolls should be delivered to the working area of the site in their original packaging. Immediately prior to deployment, the packaging should be carefully removed without damaging the GCL. The orientation of the GCL (i.e., which side faces up) should be in accordance with the Engineer's recommendations.

C. Equipment which could damage the GCL shall not be allowed to travel directly on it. If the installation equipment causes rutting of the subgrade, the subgrade must be restored to its originally accepted condition before placement continues.

D. Care must be taken to minimize the extent to which the GCL is dragged across the subgrade in order to avoid damage to the bottom surface of the GCL. A temporary geosynthetic subgrade covering commonly known as a slip sheet or rub sheet may be used to reduce friction damage during placement.

E. The GCL panels shall be placed parallel to the direction of the slope.

F. All GCL panels should lie flat on the underlying surface, with no wrinkles or fold, especially at the exposed edges of the panels.

G. Only as much GCL shall be deployed as can be covered at the end of the working day with soil, a geomembrane, or a temporary waterproof tarpaulin. The GCL shall not be left uncovered overnight. If the GCL is hydrated when no confining stress is present, it may be necessary to remove and replace the hydrated material. The project Engineer, CQA inspector, and GCL supplier should be consulted for specific guidance if premature hydration occurs.

3.5 Anchorage

A. As directed by the project drawings and specifications, the end of the GCL roll shall be placed in an anchor trench at the top of the slope or an equivalent runout design shall be utilized. When utilizing an anchor trench design, the front edge of the trench should be rounded so as to eliminate any sharp corners. Loose soil should be removed from the floor of the trench. The GCL should cover the entire trench floor but does not extend up the rear trench wall.

3.6 Seaming

A. The GCL seams are constructed by overlapping their adjacent edges. Care should be taken to ensure that the overlap zone is not contaminated with loose soil or other debris.

B. The minimum dimension of the longitudinal overlap should be 6 inches (150 mm) for Bentomat ST. If the GCL is manufactured with a grooved cut in the nonwoven geotextile that allows bentonite to freely extrude into the longitudinal overlap then no supplemental bentonite is required for this overlap. If the GCL does not have a grooved cut in the nonwoven geotextile longitudinal overlap, then bentonite-enhanced seams are required as described below.

C. End-of-roll overlapped seams should be constructed with a minimum overlap of 24 inches (600 mm) for Bentomat ST. Seams at the ends of the panels should be constructed such that they are shingled in the direction of the grade to prevent the potential for runoff flow to enter the overlap zone. End-of-roll overlapped seams require bentonite-enhanced seams as described below.

D. Bentonite-enhanced seams are constructed between the overlapping adjacent panels as follows. The underlying edge of the longitudinal overlap is exposed and then a continuous bead of granular sodium bentonite is applied along a zone defined by the edge of the underlying panel and the 6-inch (150-mm) line. The granular bentonite shall be applied at a minimum application rate of one quarter pound per lineal foot (0.4 kg/m). A similar bead of granular sodium bentonite is applied at the end-of-roll overlap.

E. Cyclical wetting and drying of GCL covered only with geomembrane can cause overlap separation. Soil cover should be placed promptly whenever possible. Geomembranes should be covered with a white geotextile and/or operations layer without delay to minimize the intensity of wet-dry cycling. If there is the potential for unconfined cyclic wetting and drying over an extended period of time, the longitudinal seam overlaps should be increased based on the project engineer's recommendations.

F. To avoid seam separation, the GCL should not be put in excessive tension by the weight or expansion of textured geomembrane on steep slopes. The project Engineer should be consulted about the potential for GCL tension to develop.

3.7 Detail Work

A. The GCL shall be sealed around penetrations and embedded structures embedded in accordance with the design drawings and the GCL Manufacturer.

B. Cutting the GCL should be performed using a sharp utility knife. Frequent blade changes are recommended to avoid damage to the geotextile components of the GCL during the cutting process.

3.8 Damage Repair

A. If the GCL is damaged (torn, punctured, perforated, etc.) during installation, it may be possible to repair it by cutting a patch to fit over the damaged area. The patch shall be obtained from a new GCL roll and shall be cut to size such that a minimum overlap of 12 inches (300 mm) is achieved around all of the damaged area. Granular bentonite or bentonite mastic should be applied around the damaged area prior to placement of the patch. It may be desirable to use an adhesive to affix the patch in place so that it is not displaced during cover placement.

3.9 Cover Placement

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A. Cover soils shall be free of angular stones or other foreign matter that could damage the GCL. Cover soils should be approved the project Engineer with respect to particle size, uniformity and chemical compatibility. Cover soils with high concentrations of calcium (e.g., limestone, dolomite) are not acceptable.

B. Soil cover shall be placed over the GCL using construction equipment that minimizes stresses on the GCL. A minimum thickness of 1 foot (300 mm) of cover should be maintained between the equipment tires/tracks and the GCL at all times during the covering process. This thickness recommendation does not apply to frequently trafficked areas or roadways, for which a minimum thickness of 2 feet (600 mm) is required.

C. Soil cover should be placed in a manner that prevents the soil from entering the GCL overlap zones. Cover soil shall be pushed up slopes, not down slopes, to minimize tensile forces on the GCL.

D. Although direct vehicular contact with the GCL is to be avoided, lightweight, low ground pressure vehicles (such as 4-wheel all-terrain vehicles) may be used to facilitate the installation of any geosynthetic material placed over the GCL. The GCL supplier or CQA engineer should be contacted with specific recommendations on the appropriate procedures in this situation.

E. When a textured geomembrane is installed over the GCL, a temporary geosynthetic covering known as a slip sheet or rub sheet should be used to minimize friction during placement and to allow the textured geomembrane to be more easily moved into its final position.

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BENTOMAT® DN

GEOSYNTHETIC CLAY LINERS SPECIFICATION GUIDELINES

This specification is intended for use as a GENERAL GUIDELINE for developing a specification for a specific project. It is NOT intended as a substitute for a detailed specification, which must be written to address site-specific conditions.

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1.0 GENERAL

1.1 Scope

This specification covers the technical requirements for the furnishing and installation of the geosynthetic clay liner described herein. All materials used shall meet the requirements of this specification, and all work shall be performed in accordance with the procedures provided herein and the contract drawings.

1.2 Definitions

For the purposes of this specification guideline, the following terms are defined below:

Geosynthetic Clay Liner (GCL). A manufactured hydraulic barrier consisting of clay bonded to a layer or layers of geosynthetics.

Geomembrane. An essentially impermeable geosynthetic composed of one or more geosynthetic sheets.

Geotextile. Any permeable geosynthetic comprised solely of textiles.

Minimum Average Roll Value. For geosynthetics, the value calculated as the typical value minus two (2) standard deviations from documented quality control test results for a defined population from one specific test method associated with one specific property.

Overlap. Where two adjacent GCL panels contact, the distance measuring perpendicular from the overlying edge of one panel to the underlying edge of the other.

1.3 Unit Prices

Measurement will be made of the total surface area in square feet covered by the GCL as shown on the contract drawings. Final quantities will be based on as-built conditions. Allowance will be made for GCL in anchor and drainage trenches but no allowance will be made for waste, overlap, or materials used for the convenience of the Contractor. GCL installed and accepted will be paid for at the respective contract unit price in the bidding schedule.

1.4 Submittals

A. With the bid, the Contractor shall furnish the following information:

1. Conceptual description of the proposed plan for placement of the GCL panels over the area of installation.
2. GCL manufacturer's MQC Plan for documenting compliance to Sections 2.1 and 2.2 of these specifications.
3. GCL manufacturer's historical data for a) 10,000-hour creep shear testing per Section 2.1 D and b) seam flow data at 2 psi confining pressure per Section 2.1 E.

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4. A copy of GCL manufacturer's ISO quality Certificate of Registration.

B. At the Engineer's or Owner's request the Contractor shall furnish:

1. A representative sample of the GCLs.
2. A project reference list for the GCL(s) consisting of the principal details of at least ten projects totaling at least 10 million square feet (100,000 square meters) in size.

C. Upon shipment, the Contractor shall furnish the GCL manufacturer's Quality Assurance/Quality Control (QA/QC) certifications to verify that the materials supplied for the project are in accordance with the requirements of this specification.

D. As installation proceeds, the Contractor shall submit certificates of subgrade acceptance, signed by the Contractor and CQA Inspector (see Sections 1.6 and 3.3) for each area that is covered by the GCL.

1.5 Qualifications

A. GCL Manufacturer must have produced at least 300 million square feet (30 million square meters) of GCL within the past three years, including at least 30 million square feet (3 million square meters) with 3.5 lb/in (610 N/m) peel strength.

B. The GCL Installer must either have installed at least 1 million square feet (100,000 square meters) of GCL, **or** must provide to the Engineer satisfactory evidence, through similar experience in the installation of other types of geosynthetics, that the GCL will be installed in a competent, professional manner.

1.6 Construction Quality Assurance (CQA)

A. The Owner and Engineer shall provide a third-party inspector for CQA of the GCL installation. The inspector shall be an individual or company who is independent from the manufacturer and installer, who shall be responsible for monitoring and documenting activities related to the CQA of the GCL, throughout installation. The inspector shall have provided CQA services for the installation of the proposed or similar GCL for at least 5 completed projects totaling not less than 1 million square feet (100,000 square meters).

B. Testing of the GCL, as necessary to support the CQA effort, shall be performed by a third party laboratory retained by the Contractor and independent from the GCL manufacturer and installer. The laboratory shall have provided GCL CQA testing of the proposed or similar GCL for at least 5 completed projects totaling not less than 1 million square feet (100,000 square meters).

C. CQA shall be provided in accordance with the *GCL CQA Manual* provided by the engineer.

2.0 PRODUCTS

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A. The GCLs shall consist of a layer of granular sodium bentonite clay needlepunched between two geotextiles and shall comply with all of the criteria listed in this Section.

B. Bentonite shall be a high-swelling sodium bentonite, with a minimum swell index of 24 mL/2g and a maximum fluid loss of 18 mL. Bentonite shall be CG-50 granular bentonite, mined and processed by American Colloid Company.

C. Bentonite shall have a granular consistency (1 percent max. passing a No. 200 sieve [75 µm]), to ensure uniform distribution throughout the GCL and minimal edge loss during handling and installation.

D. Prior to using an alternate GCL, the Contractor must furnish independent test results demonstrating that the proposed alternate material meets all requirements of this specification. Contractor must also provide evidence of successful use of the proposed alternate material on past similar projects. This evidence can include past direct shear results against similar materials under similar site conditions, and/or past permeability/compatibility test results with a similar leachate or waste stream. The Contractor also must obtain prior approval of the alternative GCL by the Project Engineer.

2.1 Materials

A. Acceptable GCL products are Bentomat® DN, as manufactured by CETCO, 2870 Forbs Avenue, Hoffman Estates, Illinois 60192 USA (800-527-9948), or an engineer-approved equal.

B. The GCL and its components shall have the properties shown in the Bentomat DN Certified Properties table.

C. The moisture content of the bentonite in the finished GCL shall be between 20 and 40 percent, to ensure uniform bentonite distribution, consistent needlepunch density, and adequate electrical conductivity to maximize leak location survey sensitivity.

D. GCL shall be needlepunch-reinforced, with a minimum peel strength of 3.5 lb/inch (610 N/m). To maximize large-displacement shear strength, GCL reinforcement shall be achieved solely through needlepunching, without any supplemental heat treatment.

E. The GCL shall have 10,000-hour test data for large-scale constant-load (creep) shear testing under hydrated conditions. The displacement shall be 0.07 in. (1.8 mm) or less at a constant shear load of 250 psf (12 kPa) and a normal load of 500 psf (24 kPa).

F. The GCL shall have seam test data from an independent laboratory showing that the seam flow with a grooved cut in one of the nonwoven geotextiles is less than 1×10^{-8} $m^3/m^2/s$ at 2 psi hydraulic pressure.

G. The minimum acceptable dimensions of full-size GCL panels shall be 150 feet (45.7 m) in length. Short rolls [(those manufactured to a length greater than 70 feet (21 m) but less than a full-length roll)] may be supplied at a rate no greater than 3 per truckload or 3 rolls every 36,000 square feet (3,500 square meters) of GCL, whichever is less.

H. A 6-inch (150 mm) overlap guideline shall be imprinted on both edges of the upper geotextile component of the GCL as a means for providing quality assurance of the overlap dimension. Lines shall be printed in easily visible, non-toxic ink.

2.2 Product Quality Documentation

The GCL manufacturer shall provide the Contractor or other designated party with manufacturing QA/QC certifications for each shipment of GCL. The certifications shall be signed by a responsible party employed by the GCL manufacturer and shall include:

A. Certificates of analysis for the bentonite clay used in GCL production demonstrating compliance with the swell index and fluid loss values shown in the Bentomat DN Certified Properties table.

B. Manufacturer's test data for finished GCL product(s) demonstrating compliance with the values shown in the Bentomat DN Certified Properties table.

C. GCL lot and roll numbers supplied for the project (with corresponding shipping information).

Manufacturer's test data for finished GCL product(s), including GCL index flux, permeability and hydrated internal shear strength data, which demonstrate compliance with the performance parameters shown in the Bentomat DN Certified Properties table, are available upon request of the manufacturer.

2.3 Product Labeling

A. Prior to shipment, the GCL manufacturer shall label each roll, identifying:

1. Product identification information (Manufacturer's name and address, brand product code).

2. Lot number and roll number.

3. Roll length, width and weight.

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BENTOMAT® DN CERTIFIED PROPERTIES

MATERIAL PROPERTY	TEST METHOD	TEST FREQUENCY $ft^2(m^2)$	REQUIRED VALUES
Bentonite Swell Index[1]	ASTM D 5890	1 per 50 tonnes	24 mL/2g min.
Bentonite Fluid Loss[1]	ASTM D 5891	1 per 50 tonnes	18 mL max.
Bentonite Mass/Area[2]	ASTM D 5993	40,000 ft^2 (4,000 m^2)	0.75 lb/ft^2 (3.6 kg/m^2) min
GCL Tensile Strength[3]	ASTM D 6768	200,000 ft^2 (20,000 m^2)	50 lbs/in (88 N/cm) MARV
GCL Peel Strength[3]	ASTM D 6496	40,000 ft^2 (4,000 m^2)	3.5 lbs/in (6.1 N/cm) min
GCL Index Flux[4]	ASTM D 5887	Weekly	1×10^{-8} $m^3/m^2/sec$ max
GCL Hydraulic Conductivity[4]	ASTM D 5887	Weekly	5×10^{-9} cm/sec max
GCL Hydrated Internal Shear Strength[5]	ASTM D 5321 ASTM D 6243	Periodic	500 psf (24 kPa) typ @ 200 psf

Bentomat DN is a reinforced GCL consisting of a layer of granular sodium bentonite between two nonwoven geotextiles, which are needlepunched together.

Notes

[1] Bentonite property tests performed at a bentonite processing facility before shipment to CETCO's GCL production facilities.
[2] Bentonite mass/area reported at 0 percent moisture content.
[3] All tensile strength testing is performed in the machine direction using ASTM D 6768. All peel strength testing is performed using ASTM D 6496. Upon request, tensile and peel results can be reported per modified ASTM D 4632 using 4 inch grips.
[4] Index flux and permeability testing with deaired distilled/deionized water at 80 psi (551kPa) cell pressure, 77 psi (531 kPa) headwater pressure and 75 psi (517 kPa) tailwater pressure. Reported value is equivalent to 925 gal/acre/day. This flux value is equivalent to a permeability of 5×10^{-9} cm/sec for typical GCL thickness. Actual flux values vary with field condition pressures. The last 20 weekly values prior the end of the production date of the supplied GCL may be provided.
[5] Peak values measured at 200 psf (10 kPa) normal stress for a specimen hydrated for 48 hours. Site-specific materials, GCL products, and test conditions must be used to verify internal and interface strength of the proposed design.

2.4 Packaging

A. The GCL shall be wound around a rigid core whose diameter is sufficient to facilitate handling. The core is not necessarily intended to support the roll for lifting but should be sufficiently strong to prevent collapse during transit.

B. All rolls shall be labeled and bagged in packaging that is resistant to photodegradation by ultraviolet (UV) light.

2.5 Accessory Bentonite

A. The granular bentonite sealing clay used for overlap seaming, penetration sealing and repairs shall be made from the same natural sodium bentonite as used in the GCL and shall be as recommended by the GCL manufacturer. Seaming of GCLs shall be conducted in accordance with the manufacturer's guidelines for each particular GCL. Please refer to the installation guidelines for Bentomat /Claymax GCLs.

3.0 EXECUTION

3.1 Shipping and Handling

A. The manufacturer assumes responsibility for initial loading the GCL. Shipping will be the responsibility of the party paying the freight. Unloading, on-site handling and storage of the GCL are the responsibility of the Contractor, Installer or other designated party.

B. A visual inspection of each roll should be made during unloading to identify if any packaging has been damaged. Rolls with damaged packaging should be marked and set aside for further inspection. The packaging should be repaired prior to being placed in storage.

C. The party responsible for unloading the GCL should contact the Manufacturer prior to shipment to ascertain the appropriateness of the proposed unloading methods and equipment.

3.2 Storage

A. Storage of the GCL rolls shall be the responsibility of the installer. A dedicated storage area shall be selected at the job site that is away from high traffic areas and is level, dry and well drained.

B. Rolls should be stored in a manner that prevents sliding or rolling from the stacks and may be accomplished by the use of chock blocks. Rolls should be stacked at a height no higher than that at which the lifting apparatus can be safely handled (typically no higher than four).

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C. All stored GCL materials and the accessory bentonite must be covered with a plastic sheet or tarpaulin until their installation.

D. The integrity and legibility of the labels shall be preserved during storage.

3.3 Earthwork

A. Any earthen surface upon which the GCL is installed shall be prepared and compacted in accordance with the project specifications and drawings. The surface shall be smooth, firm, and unyielding, and free of:

1. Vegetation.
2. Construction Debris.
3. Sticks.
4. Sharp rocks.
5. Void spaces.
6. Ice.
7. Abrupt elevation changes.
8. Standing water.
9. Cracks larger than one-quarter inch (6 mm) in width.
10. Any other foreign matter that could contact the GCL.

B. Subgrade surfaces consisting of granular soils or gravels may not be acceptable due to their large void fraction and puncture potential. In applications where the GCL is the only barrier, subgrade soils should have a particle-size distribution at least 80 percent finer than the #60 sieve (0.25 mm). In other applications, subgrade soils should range between fines and 1 inch (25 mm). In high-head applications (greater than 1 foot or 30.48 cm), CETCO recommends a membrane-laminated GCL (Bentomat CL or Bentomat CLT).

C. Immediately prior to GCL deployment, the subgrade shall be final-graded to fill in all voids or cracks and then smooth-rolled to provide the best practicable surface for the GCL. At completion of this activity, no wheel ruts, footprints or other irregularities shall exist in the subgrade. Furthermore, all protrusions extending more than one-half inch (12 mm) from the surface shall either be removed, crushed or pushed into the surface with a smooth-drum compactor.

D. On a continuing basis, the project CQA inspector shall certify acceptance of the subgrade before GCL placement.

E. It shall be the installer's responsibility thereafter to indicate to the Engineer any change in the condition of the subgrade that could cause the subgrade to be out of compliance with any of the requirements listed in this Section.

F. At the top of sloped areas of the job site, an anchor trench for the GCL shall be excavated or an equivalent runout shall be utilized in accordance with the project plans and specifications and as approved by the CQA Inspector. When utilizing an anchor trench design, the trench shall be excavated and approved by the CQA Inspector prior

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to GCL placement. No loose soil shall be allowed at the bottom of the trench and no sharp corners or protrusions shall exist anywhere within the trench.

3.4 GCL Placement

A. The areas to be lined with GCL shall be agreed upon by the Installer and the Engineer prior to installation.

B. GCL rolls should be delivered to the working area of the site in their original packaging. Immediately prior to deployment, the packaging should be carefully removed without damaging the GCL. The orientation of the GCL (i.e., which side faces up) should be in accordance with the Engineer's recommendations.

C. Equipment, which could damage the GCL, shall not be allowed to travel directly on it. If the installation equipment causes rutting of the subgrade, the subgrade must be restored to its originally accepted condition before placement continues.

D. Care must be taken to minimize the extent to which the GCL is dragged across the subgrade in order to avoid damage to the bottom surface of the GCL. A temporary geosynthetic subgrade covering commonly known as a slip sheet or rub sheet may be used to reduce friction damage during placement.

E. The GCL panels shall be placed parallel to the direction of the slope.

F. All GCL panels should lie flat on the underlying surface, with no wrinkles or fold, especially at the exposed edges of the panels.

G. Only as much GCL shall be deployed as can be covered at the end of the working day with soil, a geomembrane, or a temporary waterproof tarpaulin. The GCL shall not be left uncovered overnight. If the GCL is hydrated when no confining stress is present, it may be necessary to remove and replace the hydrated material. The project Engineer, CQA inspector, and GCL supplier should be consulted for specific guidance if premature hydration occurs.

3.5 Anchorage

A. As directed by the project drawings and specifications, the end of the GCL roll shall be placed in an anchor trench at the top of the slope or an equivalent runout design shall be utilized. When utilizing an anchor trench design, the front edge of the trench should be rounded so as to eliminate any sharp corners. Loose soil should be removed from the floor of the trench. The GCL should cover the entire trench floor but does not extend up the rear trench wall.

3.6 Seaming

A. The GCL seams are constructed by overlapping adjacent panel edges and ends. Care should be taken to ensure that the overlap zone is not contaminated with loose soil or other debris.

B. Longitudinal seams should be overlapped a minimum of 6 inches (150 mm) for Bentomat DN. If the GCL is manufactured with a grooved cut in the nonwoven geotextile that allows bentonite to freely extrude into the longitudinal overlap, then no bentonite-enhanced seam is required for this overlap. If the GCL does not have a grooved cut in one of the nonwoven geotextiles in the longitudinal overlap, then longitudinal bentonite-enhanced seams are required as described below.

C. End-of-roll overlapped seams should be constructed with a minimum overlap of 24 inches (600 mm) for Bentomat DN. Seams at the ends of the panels should be constructed such that they are shingled in the direction of the grade to prevent the potential for runoff flow to enter the overlap zone. End-of-roll overlapped seams for all reinforced GCL seams require bentonite-enhanced seams as described below.

D. Bentonite-enhanced seams are constructed between the overlapping adjacent panels described above. The underlying edge of the longitudinal overlap is exposed and then a continuous bead of granular sodium bentonite is applied along a zone defined by the edge of the underlying panel and the 6-inch (150 mm) line. A similar bead of granular sodium bentonite is applied at the end-of-roll overlap. The granular bentonite shall be applied at a minimum application rate of one quarter pound per lineal foot (0.4 kg/m).

E. Cyclical wetting and drying of GCL covered only with geomembrane can cause overlap separation. Soil cover should be placed promptly whenever possible. Geomembranes should be covered with a white geotextile and/or operations layer without delay to minimize the intensity of wet-dry cycling. If there is the potential for unconfined cyclic wetting and drying over an extended period of time, the longitudinal seam overlaps should be increased based on the project engineer's recommendations.

F. To avoid seam separation, the GCL should not be put in excessive tension by the weight or expansion of textured geomembrane on steep slopes. The project Engineer should be consulted about the potential for GCL tension to develop.

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A. The GCL shall be sealed around penetrations and embedded structures embedded in accordance with the design drawings and the GCL Manufacturer.

B. Cutting the GCL should be performed using a sharp utility knife. Frequent blade changes are recommended to avoid damage to the geotextile components of the GCL during the cutting process.

3.8 Damage Repair

A. If the GCL is damaged (torn, punctured, perforated, etc.) during installation, it may be possible to repair it by cutting a patch to fit over the damaged area. The patch shall be obtained from a new GCL roll and shall be cut to size such that a minimum overlap of 12 inches (300 mm) is achieved around all of the damaged area. Granular bentonite or bentonite mastic should be applied around the damaged area prior to placement of the patch. It may be desirable to use an adhesive to affix the patch in place so that it is not displaced during cover placement.

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A. Cover soils shall be free of angular stones or other foreign matter that could damage the GCL. Cover soils should be approved the project Engineer with respect to particle size, uniformity and chemical compatibility. Cover soils with high concentrations of calcium (e.g., limestone, dolomite) are not acceptable.

B. Soil cover shall be placed over the GCL using construction equipment that minimizes stresses on the GCL. A minimum thickness of 1 foot (300 mm) of cover should be maintained between the equipment tires/tracks and the GCL at all times during the covering process. This thickness recommendation does not apply to frequently trafficked areas or roadways, for which a minimum thickness of 2 feet (600 mm) is required.

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D. Although direct vehicular contact with the GCL is to be avoided, lightweight, low ground pressure vehicles (such as 4-wheel all-terrain vehicles) may be used to facilitate the installation of any geosynthetic material placed over the GCL. The GCL supplier or CQA engineer should be contacted with specific recommendations on the appropriate procedures in this situation.

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