IBM

8976 Wellington Road
Manassas, VA 20109

March 6, 2006

Mr. Jonathan Greco
Project Manager
New York State Department of Environmental Conservation
625 Broadway
Albany, NY 12233-7013

Re: Transmittal of Final RI Work Plan
Brownfields Cleanup Program
Former Burn Pit Area
IBM Endicott Gun Club
Site # C704044, Town of Union,
Broome County, New York

Dear Mr. Greco:

Enclosed please find two copies of our Final Remedial Investigation Work Plan for the IBM Endicott Gun Club, Former Burn Pit Area in the Town of Union, New York. The document has been prepared in accordance with our understanding of the requirements of the Brownfields Cleanup Program administered by the New York State Department of Environmental Conservation (NYSDEC). Copies of this plan are being provided to the established Document Repositories including the NYSDEC Region 7 Field Office and the Village of Johnson City Library.

We look forward to working with you on this project. Should you have any questions concerning this submittal, please contact me at (703) 257-4156.

Sincerely,

K Whalen

Kevin Whalen
Project Manager

cc: Justin Deming, New York State Department of Health
Diane Carlton, NYSDEC Region 7 Field Office
Sharon Dunscombe, Village of Johnson City Library

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SHA
Sanborn, Head & Associates
Consulting Engineers & Scientists

March 6, 2006
File No. 2400

Mr. Kevin Whalen
IBM Corporate Environmental Affairs
8976 Wellington Road
Manassas, VA 20109

Re: Remedial Investigation Work Plan
IBM Gun Club, Former Burn Pit Area
BCP #C704044
Union, New York

Dear Mr. Whalen:

We have enclosed a Remedial Investigation Work Plan for the subject site. The Work Plan was prepared to comply with the requirements of the Brownfield Cleanup Agreement between IBM Corporation (IBM) and the New York State Department of Environmental Conservation (NYSDEC). We understand that the Work Plan will be placed in a repository for public comment in accordance with the Brownfield Cleanup Program guidelines.

Thank you for the opportunity to serve IBM on this important project.

Very truly yours,
SANBORN, HEAD & ASSOCIATES, INC.

Jonathan Ordway, P.E.
Senior Associate Principal

Daniel B. Carr, P.E.
Principal

JO/DBC:jo

Encl. Remedial Investigation Work Plan

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Charles L. Head ■ Daniel B. Carr ■ R. Scott Shillaber ■ Charles A. Crocetti
Mathew A. DiPilato ■ Duncan W. Wood ■ Joseph G. Engels ■ Vernon R. Kokosa ■ James A. Chabot

Sanborn, Head & Associates, Inc.
95 High Street ■ Portland, Maine 04101
portland@sanbornhead.com ■ **www.sanbornhead.com**
Phone (207) 761-9300 ■ Fax (207) 761-9339

REMEDIAL INVESTIGATION WORK PLAN
FORMER BURN PIT AREA
IBM Gun Club
Union, New York

Prepared for
IBM Corporate Environmental Affairs

Prepared by
Sanborn, Head & Associates, Inc.

File 2400.00
March 2006

TABLES

FIGURES

APPENDICES

1.0 INTRODUCTION

On behalf of the IBM Corporation (IBM), Sanborn, Head & Associates, Inc. (SHA) has prepared this Remedial Investigation (RI) Work Plan for Brownfield Cleanup Program (BCP) activities associated with the former Burn Pit Area (BPA or Site) of the IBM Gun Club. The BCP is administered by the New York State Department of Environmental Conservation (NYSDEC). The work will be performed under IBM's executed BCP Agreement (#C704044) with NYSDEC, dated August 22, 2005. The IBM Gun Club is a 53.4-acre property located at 1395 Robinson Hill Road in Union, New York. The 4-acre area of investigation as outlined in this plan includes the former Burn Pit and adjacent down-slope portions of the Gun Club property.

The purpose of this RI is to sufficiently characterize the subsurface conditions to determine whether remedial activities are required to address potential contaminant exposure and migration concerns and, if so, which remedial activities are appropriate. Through the assessment of soil, bedrock, and groundwater conditions we will develop an understanding of the extent and magnitude of possible residual volatile organic compound (VOC) source areas and potential migration pathways. The results of the RI will also serve to confirm the effectiveness of previous soil removal activities conducted in the BPA.

This Work Plan is intended to communicate the elements associated with the planning and execution of a program of site-specific field exploration and testing, laboratory analysis, quality assurance/quality control and data management. The Work Plan was prepared in consideration of our present understanding of site conditions. Preparation of this Plan was completed under a contract for services authorized by IBM Purchase Order No. 5001745129, Line Item No. 2 on February 19, 2004. Our work and this document are subject to the Limitations provided in Appendix A.

A site Community Participation Plan was submitted to NYSDEC on August 12, 2005. A site-specific Health and Safety Plan (HASP) is included as Appendix B.

2.0 BACKGROUND

2.1 Site Description and Surrounding Land Use

The IBM Gun Club (Gun Club), Former Burn Pit Area (Site) consists of approximately 4 acres of an approximately 53.4-acre parcel located on the west side of Robinson Hill Road, about 1/2-mile south of the intersection with Struble Road in the Town of Union, Broome County, New York. Town of Union Tax Assessor's Office records list the Gun Club property as lot 20 of Section 126.18, Map 1, with a corresponding street address of 1395 Robinson Hill Road. As shown on the Locus Plan provided as Figure 1, the Site that is to be investigated currently consists of an open grassed area located in the southern area of the property. The property use surrounding the Gun Club consists primarily of residential, recreational, or undeveloped woodlands. Residences proximate to the Gun Club include:

- Five residences to the southeast in the Glen Crest Estates Subdivision;

- Residences to the southwest on Skylane Terrace;
- Residences to the northeast and north along Robinson Hill Road and Struble Road; and
- Residences to the northwest on Debonair Drive.

The site and immediate surrounding area is not served by a public water supply but rather by private wells. Properties west and south west of the site, and about ½ mile away, are served by the local public water supply.

2.2 Site History

IBM purchased the Gun Club property in 1935. Since the 1940s, activities at the Gun Club property have included a trap and skeet shooting range, a rifle and shotgun target range, a dog hunting club, and a ham radio station club. Between approximately 1951 and the mid-1950s, IBM disposed of certain chemicals from its Endicott manufacturing operations on an isolated approximately 4-acre area located in the southern portion of the Gun Club property. Consistent with chemical handling practices at the time, the chemicals were taken to this portion of the property and were burned in a pit. In the 1960s through 1976, small quantities of laboratory chemicals may also have been taken to this portion of the property and disposed of via burning. If this latter practice occurred, it is likely that it was performed at a frequency of approximately once per year.

2.3 Environmental History

Beginning in late 1979 and into 1980, IBM voluntarily undertook a two-phased hydrogeologic investigation at the Gun Club property to identify and remove contamination to the extent practicable. Results indicated the presence of certain volatile organic compounds (VOCs) in soil and to a lesser degree in groundwater samples from two monitoring wells. The results of the soils analyses also indicated the presence of certain metals, including in particular chromium, at concentrations that may be at levels higher than routinely found in nature.

In 1980, following the above-referenced hydrogeologic investigation, IBM took voluntary action, which involved removing soil from the Site and having it transported to an off-site secure landfill. The area and depth of excavation were selected based on soil sampling results that indicated the presence of VOCs. IBM notified NYSDEC of this soil removal activity and NYSDEC conducted a follow-up site visit in 1986. NYSDEC has required no further remedial action be taken at the site subsequent to that visit.

An early groundwater investigation of the site included the installation of two approximately 100-foot deep bedrock monitoring wells (GC-1 and GC-2). Groundwater was routinely monitored in these two wells and in two water supply wells (GC-A and GC-B) from 1979 to 2003. Locations of the two monitoring wells and two water supply wells are shown on Figure 2.

The monitoring well logs are included in Appendix C.1. No documentation of the water supply well depths or completion details is available.

The monitoring well samples were analyzed for VOCs and reported to NYSDEC. Time series plots of available historical monitoring data for wells GC-1 and GC-2 are included in Appendix C.2[1]. In summary, the monitoring data indicate the presence of trichloroethene (TCE) and its degradation by-product cis-1,2-dichloroethene (cDCE) in well GC-1 at concentrations at or below 100 micrograms per liter (µg/L) and 12 µg/L, respectively. Historical monitoring of well GC-2 has generally indicated lower concentrations of TCE at or below 35 µg/L, since 1998 TCE concentrations in this well have been close to or below 5 µg/L. No VOCs have been detected in groundwater samples collected from the water supply wells since the groundwater monitoring program began in 1979.

The water quality data also indicated the presence of "phenols" (probably total phenolics) at about 100 µg/L. Aromatic VOCs (typical components of petroleum), gasoline and fuel oils were not detected in the early characterization. Moreover, the lab methods and detection limits for the early characterization were not documented. As noted below, aromatic compounds including benzene, toluene, and xylenes were reported as detected sporadically at concentrations near the detection limits in later water quality monitoring.

Carbon tetrachloride (cTetCl) has been detected in samples from well GC-2 at concentrations as high as 73 µg/L but typically between 5 and 40 µg/L, and in samples from well GC-1 at concentrations as high as 11 µg/L, but typically near or below the method detection limit of 1 µg/L. cTetCl has not been detected in either well since 1999. A limited number of additional VOCs have been detected sporadically near method detection limits in samples from GC-1 and/or GC-2 including: 1,1,1-trichloroethane, 1,1-dichloroethane, 1,2-dichloroethane, chloroform, 1,1,2,2-tetrachloroethane, Freon 113, benzene, toluene, and xylenes.

In August 2003, IBM sampled the five drinking water supply wells serving the residences in Glen Crest Estates. These wells are the nearest drinking water supplies to the Gun Club and the two existing monitoring wells on the Site. VOCs were not detected in samples collected from four of the water supply wells. Results of analysis of the sample from the fifth water supply well only indicated the presence of styrene at a concentration of 2.1 micrograms per liter (µg/l), which is below the applicable drinking water standard. Styrene is a material commonly found in plastic piping and was not a substance reportedly disposed at the former Burn Pit.

In February 2004, IBM sampled a then newly installed well at a recently constructed residence abutting the Gun Club property to the north on the west side of Robinson Hill Road. The sample was analyzed for VOCs and none were detected.

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[1] The groundwater quality data plots are from a database entitled "Gun Club Chemistry Data Summary" provided electronically to SHA on April 12, 2004 by Groundwater Sciences Corporation (GSC) of Harrisburg, PA. GSC compiled the data based on file reviews performed during 2002 and the first half of 2003.

2.4 Topography and Drainage

As shown on Figure 1, the crest of local topographic relief is located in the southeastern portion of the Gun Club property with ground surface topography over the majority of the property sloping northwest towards undeveloped woodlands. The property and areas to the north and west appear to be drained by several intermittent unnamed streams that converge in the area of Debonair Drive and flow westward before discharging into Patterson Creek. One such unnamed tributary to Patterson Creek appears to originate near the northwestern corner of the property. Patterson Creek flows in a southerly direction for about three miles to its confluence with the Susquehanna River.

As indicated on Figure 1, the overall topographic relief between the BPA, at an elevation of about 1,380 feet above Mean Sea Level (AMSL), and the mapped upper reaches of the unnamed tributary located near the northwestern corner of the site is on the order of 200 feet or greater, while the relief between the BPA and Patterson Creek is on the order of 400 feet. Ground surface topography near the eastern property boundary slopes easterly towards a steeply cut streambed referred to as the Glen. Ground surface topography near the southern property boundary slopes southerly towards the Binghamton Country Club.

2.5 Site Hydrogeology

Our understanding of hydrogeologic conditions in the site vicinity is based on review of regional geologic mapping, bedrock-monitoring well logs from the BPA (wells GC-1 and GC-2), observations made during site walks, bedrock test borings/well logs for installations located on the former IBM Country Club property east of the site (now the Traditions Country Club), and on a fracture trace study conducted by SHA.

2.5.1 Site Geology

SHA conducted a limited fracture trace assessment to support development of this Work Plan. The assessment included mapping of fracture orientations and frequency at 13 bedrock outcrop locations on or near the Gun Club property and reviewing aerial photograph pairs with a stereoscope to identify linear features that may be associated with regional fracture patterns. The results of the fracture trace assessment are included with the description of site geology below.

According to regional geologic mapping[2,3], the site and surrounding region consists of glacial till overlying sedimentary bedrock of the Upper Devonian Period West Falls Group. Bedrock formations mapped in the vicinity of the site include a relatively shallow dipping interbedded sequence of shale and siltstone at the base of the West Falls Group described as the Beers Hill Shale, Grimes Siltstone, and Dunn Hill, Millport, and Moreland Shales.

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[2] Cadwell, D.H., and others, 1986, *Surficial Geologic Map of New York, Finger Lakes Sheet,* New York State Museum – Geological Survey, Map and Chart Series #40.

[3] Rickard, L.V., and Fisher, D.W., 1970, *Geologic Map of New York, Finger Lakes Sheet*, New York State Museum and Science Service, Map and Chart Series #15.

Based on observations made during the 1980 soil removal action conducted in the BPA, we understand the bedrock surface within the BPA is within approximately three to five feet of the ground surface. Subsurface stratigraphy includes silty glacial till overlying an interbedded sequence of shale, siltstone, and fine sandstone. The till consists of a heterogeneous mixture of silt, sand, gravel and clay. The thickness of the glacial till encountered during the 1980 soil excavation was reported to be less than five feet. For comparison, the thickness of glacial till encountered east of the site at borings MW-103 and MW-105 is 45 and 16 feet, respectively. A similar increase in the thickness of glacial till may be found down-slope of the BPA to the northwest.

A thin (generally less than five feet) zone of weathered bedrock was reportedly encountered within portions of the 1980 soil removal area. We believe that weathered rock was also excavated during the 1980 soil removal. Depending on the degree of weathering, the weathered rock could exhibit a greater percentage of clay and silt than the overlying glacial till soils (See the log for MW-103 in Appendix C.2).

A summary of the fracture trace assessment is provided below and is supported by Figure 3.

- Consistent with regional descriptions of bedrock that are considered to be included in the "West Falls Group," we observed bedrock at outcrops to consist primarily of shale and siltstone interbedded with lesser amounts of more competent layers of sandstone.

- We observed a predominance of bedding-parallel joints with less frequent steeply dipping to near vertical primary joint sets with orientations in the azimuth range of 340 degrees to 20 degrees and secondary (conjugate) joint sets in the azimuth range of 60 degrees to 100 degrees. Observations at outcrops within the Gun Club Property limits and nearly 1,700 feet away from the site are generally consistent, with little evidence of spatial variations in the azimuth of joint sets.

- We observed a predominant orientation of regional photolineaments that overlap with, but do not directly correlate to, the orientation of the steeply dipping joints observed at outcrops. The observed photolineaments typically coincide with drainage features such as intermittent and perennial streams.

Assuming that the most prominent fracture orientations in bedrock are parallel to bedding, this bedrock hydrogeologic setting is inferred to consist of near horizontal fracture systems that may be interconnected by more widely-spaced steeply-dipping fractures. As indicated in the bedrock well logs, observed fracture spacing ranged from one foot or less to tens of feet.

2.5.2 Potentiometric Observations

Results of historical water level monitoring from wells GC-1 and GC-2 indicate water levels were about 25 to 35 feet below ground surface (bgs). Based on our current conceptual model, described below, we anticipate groundwater to have a strong vertical gradient that would induce downward flow in the vicinity of wells GC-1 and GC-2. Therefore, since these monitoring wells were completed as open bedrock holes from about 8 or 10 feet bgs to approximately 100 feet bgs, the depth to the water table is expected to be less than the recorded water level depths, perhaps as shallow as 10 feet bgs. East of the Site, depths to water recorded for monitoring wells MW-103S, MW-103D and MW-105 generally range from about 6 to 12 feet bgs.

2.6 Current Conceptual Model

We believe that migration of VOCs dissolved in bedrock groundwater represents the potential migration pathway of primary interest. Given the apparent on-going presence of VOCs in groundwater samples from the limited site monitoring wells, it is probable that VOC residual in soil and or rock may represent an on-going, perhaps limited source for VOCs found in groundwater. Such residual may be present in the rock beneath the area where soil and weathered rock was removed or be outside of the 1980 soil removal area. Given the amount of time since disposal activities ceased, it is possible that the majority of the residual VOC mass is present in dissolved phase, diffused into the rock matrix. Diffusion out of the unfractured rock matrix into water transmissive fractures likely represents the mechanism for VOC mass contribution to migrating groundwater.

Although the data from the existing monitoring and water supply wells are insufficient to more precisely define lateral and vertical groundwater flow patterns, based on the topographic setting and apparent low permeability of the bedrock, we anticipate that relatively strong downward vertical hydraulic gradients exist near the top of the hill where the former Burn Pit was located. Moving down-slope, we anticipate that the magnitude of the downward vertical gradients decreases. At the bottom of the slope, near the natural drainage features, we anticipate upward vertical gradients.

Although the overall permeability of bedrock is expected to be modest, ranging from about 1×10^{-7} centimeters per second (cm/sec) to 1×10^{-4} cm/sec, variations in rock texture and fracturing likely influence groundwater migration potential and the distribution of contaminants. We expect that the vertical transfer of water between zones of differing rock-type may be limited due to the relatively flat-lying bedding. The nearly horizontal beds of shale and siltstone that exhibit little vertical fracturing may act more as primary aquitards, limiting vertical flow and exchange of water between zones of higher fracturing and water transmission potential. Multilevel monitoring of water levels and water quality is necessary to aid in distinguishing the hydraulic conditions among aquitard beds and bedding with greater water bearing potential.

The overall volumetric flux of groundwater through the former Burn Pit footprint is likely very small, driven by limited meteoric recharge. This relatively small volumetric flux may limit the flux of dissolved-phase contaminant mass from the BPA, and limit the potential degradation of downgradient groundwater quality. In areas down-slope of the Burn Pit, contaminant concentrations may be further reduced by dispersion and matrix diffusion.

Based on the frequency of observations within bedrock outcrops, we anticipate that the nearly horizontal bedding parallel joints are likely to be more frequently encountered during drilling compared to vertical jointing. The horizontal joints are likely to be more spatially contiguous and hence may represent preferential pathways for groundwater migration away from the former Burn Pit. Groundwater flowing through horizontal joints may daylight as “springlines” located along the side or at the base of the hill. Discharge of VOC-containing groundwater to overburden and surface water would further limit the extent of contaminant migration in rock.

Steeply dipping vertical fractures have been noted in the site bedrock monitoring well logs and during inspection of bedrock outcrops in the vicinity of the site. Although the regional photolineaments did not correlate well with joint patterns in the outcrops, the predominant joint orientations (azimuth ranges of 340 degrees to 20 degrees and 60 degrees to 100 degrees) may provide a directional influence on migration in groundwater.

The sedimentary rocks found at the site exhibit porosity associated with uncemented intergranular void space in the rock matrix (matrix porosity) as well as porosity associated with fracturing (fracture porosity). Based on a review of published values for similar rocks, we would expect that on the field scale, the matrix porosity of shales and siltstones may range from about 5 to 10 percent or less while the fracture porosity may be considerably smaller at 5 percent or substantially less, perhaps as low as 0.001 percent. Sandstone layers may exhibit marginally higher matrix porosity than the shales and siltstones.

When liquid enters a fractured bedrock environment, it initially migrates downward and laterally through air-filled fractures and, if the liquid is more dense than water, through water-filled fractures. The potential penetration of liquid solvent into the fracture voids would be through physical displacement of the water and gas originally residing in the fracture. When free-phase solvent or groundwater with high VOC concentrations enters the fractures, a concentration gradient develops between the fracture pore water and the pore water contained in the rock matrix adjacent to the fracture. The concentration gradient causes the VOC mass to diffuse into the water- and gas-filled inter-granular pore space (i.e., “forward diffusion”). Given that the saturated pore volume in the sedimentary rock matrix can be orders of magnitude greater than the fracture void volume, the rock matrix may offer a relatively high capacity to absorb the mass associated with free phase solvents into dissolved phase[4].

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[4] Parker, B.L, J.A. Cherry and R.W. Gillham. 1997. Diffusive loss of non-aqueous phase organic solvents from idealized fracture networks in geologic media. Ground Water 35, no. 6: 1077-1088

Both the matrix and fracture porosity represent potential to store contaminant mass. The fracture pore space offers greater potential for transfer of water under field hydraulic gradients and direct entry and transmission of NAPL. The matrix porosity offers limited potential for transport of groundwater under field hydraulic gradients but represents a significant reservoir for back diffusion and retention of contaminant mass. Matrix diffusion is also believed to retard dissolved phase transport. The presence of VOC mass in the low permeability unfractured rock matrix could greatly limit the effectiveness of available source reduction technologies.

Potential matrix diffusion could have significant implications on our work at the Gun Club. In particular, matrix diffusion could impact the work in the following ways:

- Site characterization activities should take into account the possible disappearance of mobile separate phase liquid through forward diffusion;

- The potential attenuation of dissolved plume migration to rates that are significantly less than the rate of groundwater flow; and

- Significant limitations to addressing materially VOC mass diffused in the rock matrix through source control remedies that are mandated under the BCP. [5]

The available information suggests that residual VOC mass present in the soil and rock may constitute an on-going source of VOCs in groundwater within the BPA. However, the migration of VOCs away from the former BPA may be limited by the relatively modest volumetric flux of groundwater through the area where residual VOC source mass is likely to reside. Further, the degradation of groundwater quality may be limited by:

- Biochemical degradation that may be enhanced through the presence of petroleum compounds; and

- The effects of matrix diffusion limiting VOC mass exchange within the residual source area, if any, and attenuating groundwater migration downgradient.

The conceptual model of solvent behavior in sedimentary rock as outlined above, will be supplemented by work intended to support quantification of solvent mass present in the bedrock matrix and quantitative physical characterization of the rock matrix properties (e.g., porosity, permeability, fraction of organic carbon). These efforts will support the development of a more robust and quantitative conceptual model of possible VOC mass sourcing and groundwater transport. We believe that chemical and physical characterization of the rock mass will also aid in better defining the vertical and horizontal extent of residual VOCs. This will support a more realistic assessment of remedial alternatives to consider for potential source reduction.

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[5] Lipson, D.L., B.H. Kueper, and M.J. Gefell. 2005. Matrix diffusion-derived plume attenuation in fractured bedrock. Ground Water 43, no. 1: 30-39

3.0 RI OBJECTIVES AND SCOPE

In accordance with the New York State BCP and the executed BCP Agreement, the goals of this RI are to define sufficiently the subsurface conditions to identify the nature and extent of potential contamination and possible pathways of human exposure as required to assess the need for remediation and, if necessary, establish goals for such remediation. The RI will be initiated with a sequence of tasks developed from the current conceptual model of site conditions and the evolving concepts associated with VOCs in fractured sedimentary bedrock as outlined in the section to follow. The scope of each task will likely vary as new information is reviewed and as the conceptual model is refined accordingly. In summary, the RI tasks will include:

- Geophysical logging and hydraulic testing of the existing bedrock monitoring and water supply wells to better understand stratigraphy, fracture density, vertical hydraulic gradients and the relative hydraulic conductivity of various fractured and non-fractured zones before drilling and installing additional groundwater monitoring points;

- Multi-level instrumentation of an existing bedrock monitoring well (GC-1) to aid in assessing the vertical distribution of potentiometric head and to preliminarily assess the vertical distribution of VOCs in groundwater. The installation of multi-level instrumentation will be followed by a round of water level measurements and groundwater sampling from all viable wells;

- A soil vapor survey followed by soil and shallow bedrock sampling, to preliminarily identify residual VOC source areas in the vicinity of the BPA;

- Collection of rock core samples and the installation and sampling of shallow bedrock monitoring wells proximate to and within the former Burn Pit to assess the presence of VOCs in the rock matrix and groundwater near the possible residual source(s) and to establish the water table depth in this area;

- Drilling deeper bedrock boreholes and installing multi-level monitoring equipment in locations considered generally downgradient of the BPA. Final drilling locations and specification of the multi-level monitoring equipment installations would be based on the data and inference obtained from the prior tasks.

This RI will include “matrix” VOC analyses of rock core samples and discrete fracture zone sampling through the use of multi-level groundwater monitoring systems. The rock core sampling and VOC extraction methods were developed at the University of Waterloo in Ontario, Canada (UW) to enhance the delineation of VOCs present in the rock matrix. The UW will be retained to assist with rock core sampling and analysis following protocols they have developed and applied on many prior projects. The multi-level systems are intended to enhance the delineation of potentiometric and water quality conditions beyond what could be accomplished using more conventional means. The discrete groundwater and rock matrix VOC data are used to assess the effects of matrix diffusion on VOC migration and remediation potential.

3.1 Land Surveying and Base Plan Preparation

The existing vertical and horizontal control for the site is relatively limited. Given the extent of proposed investigations, it is necessary to develop an accurate base plan of the site to document the exploration locations. A licensed land surveyor will be retained to perform an initial survey of the site for the development of a base plan and to establish temporary bench marks from which temporary explorations, such as soil vapor sampling, shallow soil sampling and test pit excavations, can be field referenced at the time of completion. The surveyor will also be directed to mark the approximate limits of the burn pit as interpreted from historic aerial photographs. The surveyor will return to the site after permanent monitoring installations (shallow and deep bedrock monitoring wells) are in place to accurately locate the horizontal position and reference point elevations. More details regarding the required land surveying are provided in Section 4.0.

3.2 Geophysical Logging and Hydraulic Testing of Existing Bedrock Wells

Geophysical and hydraulic testing of the existing bedrock monitoring wells (GC-1 and GC-2) and supply wells (GC-A and GC-B) will be used to confirm stratigraphy and fracture spacing that may be used to guide installation of multilevel sampling devices and future drilling and monitoring.

3.2.1 Borehole Geophysics

The proposed geophysical logging techniques will include:

- Temperature and conductivity to assess the possible presence of water bearing fracture zones;

- Caliper testing to measure variations in the borehole diameter and identify areas of potentially weaker and fractured rock zones. Fracture zones may appear on a caliper log as an abrupt widening of the borehole;

- Color videotaping for direct observation of possible fracture zones and changes in lithology;

- Gamma logging will measure naturally occurring radiation within the formation materials to distinguish changes in lithology. Gamma logging is proposed to aid in distinguishing between shale and sandstone layers and potentially to identify clay-filled fractures. Given that the success of this method is largely formation-dependent, the relevance of this technique across the site will be determined from the results of its initial application;

- Single point resistivity (SPR) and spontaneous potential (SP) are logged by measuring electrical characteristics between an electrode in the borehole and one at the surface. Lower zones of resistivity measured using the SPR method may be indicative of water filled voids in the borehole wall. SP is used to measure changes in formation water salinity, which can be an indirect indication of a potentially transmissive fracture;

- Acoustic televiewing (ATV) uses ultra-sonic sound waves to image the side of the borehole by creating a sonogram illustrating structures within the borehole wall as well as providing quantitative information such as the strike and dip of bedding and fracture planes. The amplitude of the returning sound wave can also provide an idea of the relative hardness of the borehole wall – an indicator of rock type and porosity; and

- Borehole flow velocity logging to assess the direction and magnitude of vertical flow of groundwater in the borehole under ambient and induced gradients.

3.2.2 Hydraulic Testing

Hydraulic testing of discrete zones within the existing boreholes will be conducted using straddle packer methods (first by extraction then by injection). The hydraulic testing is intended to complement the geophysical testing data. At this time, we do not anticipate continuous straddle packer testing over the entire length of the borehole; rather, we will target probable water-bearing fracture zones and several zones where the hydraulic characteristics are more likely to represent the rock matrix in between fracture zones. The hydraulic tests will help to confirm water-bearing fracture zones identified by geophysical testing, and to characterize the fracture zones by allowing for the calculation of “hydraulic conductivity” and “hydraulic aperture.”

Groundwater samples will be collected from selected zones during the extraction tests and submitted for VOC analyses. In general, we anticipate multi-depth samples (assume three per borehole) will be collected during straddle packer testing from wells GC-A, GC-B, and GC-2. Samples will not be collected from well GC-1 during packer testing since a multi-level monitoring system is proposed for that well (see Section 3.3 below).

3.3 Instrumentation and Monitoring of Existing Well(s)

A multi-level monitoring system is proposed for installation in the existing 4-inch diameter bedrock monitoring well GC-1. The monitoring system will allow for water level measurements and groundwater sampling at pre-selected depth intervals. Data from the multi-level monitoring system will be used to assess vertical hydraulic gradients within and between various bedrock strata. An understanding of vertical hydraulic gradients is essential to develop and resolve our conceptual model of contaminant migration in site bedrock, both within the BPA and in areas downgradient of the BPA. The equipment will be configured to monitor multiple separate zones through the use of monitoring “portals.” The portal depths and length intervals will be targeted based on the results of the geophysical and hydraulic testing, with the intent of monitoring both fractured and unfractured portions of the stratigraphic profile.

The multi-level monitoring system will also allow for collection of groundwater samples from discrete fracture zones to assess the vertical distribution of VOCs in bedrock groundwater at well GC-1. The individual assessment of VOC concentrations in fracture zones may provide insight into the general distribution of VOC mass in the rock matrix and fractures.

Recently published research has shown that dissolved-phase VOC migration through open boreholes can result in the long-term presence of VOCs within zones that are less likely to have been impacted in the absence of the well. Therefore, the vertical distribution of VOCs identified using the multi-level monitoring installation may be indicative of vertical contaminant migration caused by the large open interval. Given the potential ambiguity caused by the long open borehole intervals, the primary function of the multi-level installation will be to characterize the vertical distribution of potentiometric head within the various geologic strata and fracture networks.

3.4 Soil Vapor Survey and Shallow Soil Sampling

A program of investigation including sampling and analysis of soil vapor and soil/weathered bedrock is proposed within and outside the approximate limits of the former Burn Pit and the 1980 soil removal area. The findings of these activities will be used to assess direct and indirect evidence of the presence of residual VOCs in soil and/or surficial bedrock. Results of these field explorations will support:

- The selection of locations for subsequent rock core drilling and shallow monitoring well installation; and

- Assessment of whether additional remedial measures, focused on VOC residuals in soil and/or weathered bedrock, are appropriate.

Initially, soil vapor samples will be collected in the approximate area of the former Burn Pit. Soil vapor samples will be analyzed on-site in a mobile laboratory to allow for quick turnaround VOC analysis. Contingent on the initial vapor analysis results; the area of investigation will be expanded to areas further outside of the former Burn Pit as needed to delineate areas of detected VOC presence.

The screening-level soil vapor data will be used to target locations for soil sampling using direct-push drilling techniques and test pit excavation. Soil samples will be analyzed for VOCs by the on-site mobile laboratory and the initial data will be used to select subsequent soil sample locations. A subset of the soil sampling locations (25 percent) will be selected for replicate sample collection and submitted to a fixed laboratory for a more extensive set of analytes as required by the NYSDEC. The replicate soil sampling locations will be selected to confirm the on-site laboratory results that indicate both the presence and absence of residual VOC presence in soil.

3.5 Rock Core Sampling and Shallow Bedrock Monitoring Wells

Up to five relatively shallow rock-core borings will be drilled and completed as monitoring wells within and near to the BPA. The borings and wells are proposed to characterize groundwater quality and rock quality conditions proximate to and within the area of original release. The depth of drilling will be targeted to intercept the upper approximately 10 feet of the groundwater table and is anticipated to extend approximately 20 feet to 40 feet bgs or less. Soil samples of the overburden will be collected for classification, field screening, and possible laboratory analysis.

The shallow bedrock monitoring wells will be used to assess shallow groundwater levels and quality conditions in the immediate vicinity of the former Burn Pit. Preliminary locations for these rock core borings and wells are shown on Figure 4. The final well locations will be selected based on the findings of soil vapor survey and soil sampling work that will precede this task.

Bedrock core samples will be collected during drilling to classify rock types, to visually log the presence and degree of fracturing, and to allow for testing of selected samples of rock for VOC content and physical/chemical properties such as porosity, diffusivity, bulk density, and organic carbon content. After each core sample is retrieved, we propose to collect subsamples of the core at approximately one-foot intervals for subsequent matrix VOC analysis.

We have assumed five rock core samples per boring will be collected and analyzed for VOCs to provide an initial indication as to the concentration of VOCs in the rock matrix relative to the concentrations of VOCs in groundwater flowing through the fractures. For this comparison, groundwater quality will be assessed using samples from the shallow bedrock monitoring wells. This initial subset of samples is likely to include representation of each major rock type, rock adjacent to observed jointing, and more massive unfractured rock. However, all the rock samples will be preserved in the laboratory so that additional analysis for VOCs can be completed as appropriate based on the initial analytical data.

The concentrations of VOCs in groundwater flowing through the fractures and of VOCs in porewater that is within the rock matrix, together with the diffusivity of the rock matrix can be used to assess whether residual VOC mass exists within the unfractured rock that would constitute a persistent and significant continuing source of VOCs to the more water productive fractures. The laboratory data derived in units of mass per unit dry weight of rock will be used to estimate equivalent pore water concentrations given estimates of rock porosity, bulk density, and organic carbon content. The estimated pore water concentrations will be compared against:

- Aqueous solubility of the detected compounds individually and as mixtures to assess for the presence or absence of non-aqueous phase liquids; and

- Water quality data recorded in sampling of groundwater from nearby monitoring points to assess whether the apparent VOC presence in groundwater could be explained by diffusion from the bulk rock matrix. For example, porewater VOC concentrations that are significantly greater than the VOC concentrations obtained from groundwater sampling may indicate the presence of VOCs in the groundwater samples are the result of back-diffusion from the rock matrix.

If analysis of the initial rock core samples indicates that the shallow rock is a significant source of VOC mass; and, if the depth of residual VOC mass trapped in the rock matrix is considered important, then additional rock core sampling near to, and downgradient of, the former release area may be appropriate.

3.6 Bedrock Monitoring Installations Outside the Burn Pit

Up to four new approximately 200-foot deep, 4-inch diameter bedrock borings will be drilled in locations inferred to be outside the limits of the former Burn Pit. Multi-level monitoring systems, similar to that which is proposed for the existing monitoring well GC-1, will be installed in each of the borings. The deeper bedrock monitoring installations will be sited and designed to aid in characterizing the dissolved phase presence of VOCs and other contaminants downgradient of the former Burn Pit. The new installations will also be used to assess groundwater flow paths, vertical and horizontal hydraulic gradients, and the presence or absence of aquitard beds. The location and depth of these borings will be refined following the initial field investigations in consideration of: hydrologic features such as surface water bodies, which are probable groundwater discharge points; and the locations of off-site residential properties.

We currently anticipate that two of the borings will be advanced through bedrock by inclined coring techniques and two borings will be advanced vertically using air-rotary drilling techniques. The inclined core holes will allow for assessment of potentially steeply dipping or near vertical fractures. One inclined boring will be oriented perpendicular to the primary (most frequently occurring) fracture strike; the other will be oriented parallel to the primary fracture strike (to intercept conjugate vertical fractures that appear to be perpendicular to the primary fracture orientation). Overburden soil samples will be collected for classification, field screening, and possible laboratory analysis.

Depending on the results of the proposed shallow rock core sample analyses, and the observations recorded during drilling, samples of rock core may be retained for physical property testing and matrix VOC analysis. During air-rotary advancement, samples of solid drilling cuttings (rock chips) will be collected, logged, and field screened for VOCs. The apparent presence of water-bearing fractures or fracture zones will be assessed during drilling based on drilling advancement, review of the condition of the rock core and rock chips, and drill-stem yield testing.

Upon completion of drilling, a program of borehole geophysical testing will be completed in each of the four new borings to further assess the presence of water bearing fracture zones, changes in lithology, and vertical hydraulic gradients. The program of geophysical testing will likely include a subset of the methods proposed for assessment of the existing monitoring and supply wells. The borehole geophysics will be complemented by straddle packer testing, which will be conducted using the same approach as is proposed for the existing monitoring and supply wells.

It is currently our intent to design and install multi-level monitoring equipment in each of the new deep boreholes, similar to that which is proposed for the existing monitoring well GC-1. Design of the monitoring equipment will focus on assessment of potentiometric head and water quality in higher yielding bedrock fracture zones. These zones are considered the primary pathways for groundwater migration within bedrock. At this time, we anticipate between three and five zones may be monitored in each boring.

Out of concern that vertical migration of dissolved-phase VOCs within open boreholes may result in long lasting alteration of water quality within zones that may otherwise have been isolated from VOCs. Therefore, efforts will be made to limit this potential cross-contamination of the bedrock formations. After each day of drilling and during the period between completion of the borehole, geophysical testing, and installation of the multi-level monitoring systems, inflatable packers that extend the depth of the well will be installed.

3.7 Groundwater Monitoring

Several rounds of groundwater monitoring will be conducted over the course of this RI as described below.

- The first round of groundwater monitoring will include water level measurements and groundwater sampling from the newly-instrumented bedrock monitoring well (GC-1) and the remaining existing site monitoring and supply wells. The purpose of this round of monitoring is to provide an indication of groundwater potentiometric and quality conditions prior to selecting final locations for subsequent bedrock monitoring installations. At least two rounds of confirmatory sampling from the instrumented monitoring well will be completed over the course of the RI to assess the variability of groundwater quality.

- The second round of groundwater monitoring will be conducted to define near-source groundwater concentrations and potentiometric heads after the shallow bedrock monitoring wells have been installed. The results of the second round of monitoring will also be used to aid in selecting the deeper bedrock drilling locations. At least two rounds of confirmatory monitoring will be completed over the course of the RI on the shallow bedrock monitoring wells.

- The third round of monitoring will be conducted after the multi-level installations are complete. This round will include collection and analysis of samples from all site groundwater monitoring wells. At least two rounds of follow-up sampling will be conducted to characterize water quality conditions.

All samples will be analyzed for VOCs. A subset of groundwater samples will be analyzed for organic and inorganic parameters as appropriate, both to meet the requirements of the Brownfields Program and to support an assessment for indications of biochemical degradation. Field screening parameters measured during sampling will include dissolved oxygen, oxidation-reduction potential, temperature, specific conductance, pH, and turbidity.

3.8 Data Analysis and Reporting

Analysis of data from the above-referenced field program will include, but not be limited to:

- Design and population of a site database with links to a geographical information system (GIS) map of the site;

- Preparation of plan and profile figures depicting potentiometric head distributions and showing inferred groundwater flow pathways in relation to the former Burn pit;

- Calculation of horizontal and vertical hydraulic gradients; and

- Estimation of bedrock matrix pore-water VOC concentrations and comparison against VOC concentrations identified in groundwater samples from corresponding monitoring wells.

If after collection and analysis of the data as defined in the tasks outlined above we conclude that the site has been adequately characterized, then a detailed report will be prepared that documents the work completed, our findings, and recommendations for the next phase of study, which could include a remedial feasibility study. However, in the event that a second phase of RI work is recommended, SHA will prepare and submit a detailed work plan addendum. The work plan would include a summary of findings for the first phase of the RI and a detailed description of the proposed follow-up investigations.

4.0 FIELD ACTIVITIES PLAN

This section includes a more detailed description of the proposed field activities. Some of the field activities will be conducted more than once over the course of the RI. Refer to Section 3.0 for the objectives, rationale, and sequencing of the various field activities described below.

4.1 Survey

Prior to initiating the proposed field activities, a New York State licensed land surveyor will be retained and directed to conduct an initial location and elevation survey of key site features. Specifically, the surveyor will be directed to:

- Locate existing wells, buildings, and roadways on the site;

- Mark the approximate location of property boundaries in the vicinity of planned field explorations;

- Establish temporary vertical and horizontal benchmarks that can be used for subsequent survey activities, such as determining reference point elevations for wells that have yet to be installed, and for laying out a grid for the soil vapor and soil sampling program;

- Stake out the approximate limits of the BPA based on historical information gathered from geo-referenced aerial photographs and establish a baseline through the apparent center of the BPA; and

- Determine spot ground surface elevations in the vicinity of the proposed explorations for reference purposes.

The survey data will be conveyed on an AutoCAD map that will serve as a base for future report figures.

After the completion of the field exploration program, location and reference elevations for the newly-installed wells will be surveyed relative to the project datum. Survey control will be established within plus or minus 0.1-foot horizontal and plus or minus 0.01-foot vertical. Reference elevations will be recorded for the ground surface, top of PVC riser, and top rim of the locking protective standpipe.

4.2 Geophysical and Video Borehole Logging

Geophysical testing will be completed first on the existing bedrock wells (GC-1 and GC-2) and supply wells (GC-A and GC-B). Geophysical testing of the proposed deep borings will be conducted during a separate mobilization.

Our subconsultant, Northeast Geophysical Services of Bangor, Maine, will conduct the borehole geophysical testing. The results will be used to confirm our conceptual model of site stratigraphy and fracture spacing, and will be used to guide the design of multilevel monitoring installations. The order of the proposed geophysical logging techniques provided below was selected in an effort to limit the disturbance within the borehole and complete techniques sensitive to borehole disturbance first. The proposed order of testing was also selected so that information collected using the initial logging techniques could be used to plan the execution of subsequent techniques.

Each of the logging instruments will be calibrated by the manufacturer prior to use at the site. The geophysicist will undertake Field calibrations to the extent that such calibration is appropriate. Field calibration and field operational checks specific to individual logging tools are discussed below.

All down-hole logging tools will be decontaminated prior to mobilizing to the site as well as between boreholes. Tools will be decontaminated using the following procedure:

- Potable water rinse;
- Liqui-nox® (or equivalent) wash;
- Potable water rinse; and,
- Deionized water rinse.

A New York State licensed water well contractor will be retained to disconnect and pull the pump from the active existing water supply well (GC-A) prior to testing and to replace the pump after the testing is complete. The contractor will also be directed to disinfect the water system, as required by regulation, once the pump has been replaced and reconnected. A brief description of the proposed geophysical logging methods is provided below.

Temperature and Fluid Conductivity: The temperature/fluid conductivity testing will be the first method to be run on each borehole in order to collect those data before the fluid column is disturbed by other logging procedures. Temperature/conductivity will be logged using a top-down approach and a tool speed ranging from 5 to 10 feet per minute (fpm). Temperature and conductivity calibrations will be checked in the field by placing the tool in a water of known temperature and conductivity.

Caliper: The diameter of the borehole will be logged using a caliper tool. The caliper tool will be run from the bottom of the borehole up to the surface at a rate of approximately 10 to 15 fpm. Field calibration of the caliper tool will be completed using 4.5-inch and 7-inch cylinders. In addition to contributing to our general understanding of borehole stratigraphy, the caliper data will be used to select zones for borehole velocity logging and to identify potentially unstable portions of the borehole wall that could interfere with the movement of other logging tools.

Downhole Video: The downhole color video camera will include an on-screen depth readout and will have pan and tilt capabilities to provide a visual record of the lithology, fractures, and well casing construction. The downhole video will be recorded with a down-looking and side-looking view of the borehole. The video will be run from the top of the borehole to the bottom at a rate of approximately 10 fpm.

Natural Gamma Logging: Gamma logging will measure naturally occurring radiation within the formation materials to distinguish changes in lithology. Given that the success of this method is largely formation dependent, the relevance of this technique across the site will be determined from the results of its initial application. Calibration of this instrument shall be checked in the field by reading atmospheric conditions at ground surface, typically about 10 counts per second (cps), and then placing a mildly radioactive source next to the instrument (typically a lantern mantel – 80 to 90 cps) and recording the results. Gamma logging will be run from the top of the hole downward at a rate of about 5 to 10 fpm. If during the initial logging the gamma method does not provide meaningful results, the method may not be used in subsequent boreholes.

Single Point Resistivity (SPR) and spontaneous potential (SP): These parameters are quantified with the same instrument by measuring electrical characteristics between an electrode placed within the hole and one at the surface. SPR measurements will be made by inducing a small current and recording the resultant resistivity of the formation. SP measurements record ambient electrical potential, which identifies changes in formation water salinity that is due to groundwater flow into the borehole. This log will be run “bottom-up” at a rate of approximately 20 fpm.

Acoustic Televiewer (ATV): This method will employ a magnetometer to orientate acoustic response to magnetic north as well as both northing and easting values, which provide a control on the horizontal displacement of the borehole at depth relative to the point of entry at ground surface. Comparison of the ATV log to the caliper log in the field provides control on the calibration and functionality of the ATV. The ATV will be logged from the bottom of the borehole to the top at a rate of approximately 3 to 4 fpm. Comparison of the ATV log to the caliper log in the field will be used to provide control on the calibration and functionality of the ATV.

Borehole Flow Velocity Logging: Paired velocity measurements will be collected at discrete locations within the borehole based on potential fractures identified by the caliper, SPR, and SP logs. The paired measurements will consist of one measurement made above, and one below, each of the potential fracture zones. The instrument is capable of detecting flow rates ranging from 1 gpm to 0.03 gpm. In the event that no flow is detected under ambient conditions, the borehole will be pumped at a low rate of flow (less than 1 gpm) and the identified fracture zones will be re-evaluated. Proper field operation of the velocity logging tool will be checked by placing the tool in the casing and performing a measurement while moving the tool upward and downward within the casing at a constant and known rate.

4.3 Straddle Packer Testing

Straddle packer tests will be conducted on the existing wells (GC-A, GC-B, GC-1, and GC-2) and the proposed deep bedrock wells following completion of the geophysical logging. The packer tests will be performed by isolating 4-foot to 20-foot zones within the borehole with inflatable packers and either pumping water out of the packed interval (extraction method) or pumping water into the packed interval (injection/constant head method).

Extraction tests will be completed prior to constant head tests to allow for the collection of groundwater samples from within the packer intervals. If collected, the groundwater samples would be placed in appropriate pre-preserved laboratory containers, packed in a cooler with ice, and submitted for VOC analysis. The packer test intervals will be selected based on the results of geophysical testing and will be targeted toward potential higher yield water bearing fracture zones. However, packer testing of zones between fractures that are anticipated to have a low yield will also be performed to provide a range of transmissivity within the boreholes. The anticipated low-yield zones will only be tested using constant head methods.

A data-recording pressure transducer will be placed within the test interval to provide measurements of hydraulic head. Line-pressure measurements will also be monitored in the above ground piping as a check against the pressure transducer measurements. If space is available in the borehole, water levels above the packers will also be monitored to assess potential “short-circuiting” of groundwater around the packers. The pumping rate during the tests will be measured either by an in-line volumetric totalizer and stopwatch, or with a direct read flow meter. The flow measurement device will be sensitive enough to assess the relatively low anticipated flow rates (less than one gpm to approximately ten gpm).

The packer testing procedures will be carried out in general accordance with the protocols described in the Massachusetts Department of Environmental Protection document entitled “Standard References for Monitoring Wells Part 1.”[6] A copy of this guidance document is included in Appendix D.1.

4.4 Multi-Level Monitoring Installations

Multi-level groundwater monitoring systems are proposed for installation in the existing monitoring well (GC-1), and for a selection of the proposed deep bedrock boreholes. There are several available technologies being considered or multi-level monitoring systems including the Water FLUTe,™ and the Westbay MP system. Each system allows for multiple monitoring zones (up to seven or more within a 3.75-inch diameter borehole) within the well. The number and depths of sampling ports for each well will be selected based on review of the borehole geophysics and drilling data. Fabrication of the multi-level monitoring systems will be

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[6] Massachusetts Department of Environmental Protection, April 1991, Standard References for Monitoring Wells, Part 1, MADEP Publication No. WSC-310-91.

completed by the manufacturers who will also either install or assist with the installation of the systems when they are deployed.

4.5 Soil Vapor Survey

Up to five days of soil vapor survey sampling and on-site analysis are anticipated, which should allow for collection and analysis of soil vapor from up to approximately 100 locations, depending on site conditions. SHA will retain a subcontractor, Microseeps of Pittsburgh, Pennsylvania, to assist with the collection of soil vapor samples and mobile laboratory VOC analyses. The soil vapor sampling locations will be distributed in a grid (shown on Figure 4) that will be superimposed over the BPA. The grid will be established with 20-foot centers; however, the distance between sampling points may be reduced, and/or the limits of the grid may be extended if soil vapor data suggest that greater detail or aerial coverage is warranted to delineate the presence of VOCs in soil vapor.

Each probe will be driven using a pneumatic hammer to a depth of approximately 3.5 feet bgs, or to shallow refusal. Samples will be collected by advancing a stainless steel probe equipped with an expendable drive point to the desired depth and then retracting the probe approximately six inches to expose the sampling interval. The soil vapor samples will be collected through the stainless steel probe using a reusable 250-cubic centimeter (cc) glass syringe equipped with disposable needles.

Samples will be collected by extracting about 50 ccs of soil vapor from the probe and then injecting the sample from the glass syringe through a Teflon septa into a glass sample vial. Disposable needles will be replaced between samples. After sampling, the soil vapor probe holes will be filled with bentonite granules and marked with pin flagging for subsequent surveying, as appropriate. Between samples, the soil probe will be scrubbed with a wire brush to remove visible soil particles, and the sampling syringe will be purged five times with ambient air. A more detailed description of the proposed probe and sample collection methods is provided in Appendix D.2.

4.6 Shallow Soil Sampling

The shallow soil sampling program will consist of approximately three days of direct-push boring completions followed by two days of test pit explorations. The actual duration and number of soil borings and test pits, as well as the exploration locations, will be based in part on results of the soil vapor survey and the initial soil sample analysis results. The locations will also be selected to provide adequate geographic coverage for assessment of subsurface conditions across the 1980 soil removal area. The direct-push borings are proposed as the primary means of soil/weathered bedrock sampling. Test pit explorations are proposed due to the potential for shallow refusal of the direct-push borings on cobbles, boulders, and/or weathered bedrock, and to allow for larger sample volumes as appropriate when samples are to be submitted for an expanded list of analytical parameters.

4.6.1 Direct-Push Borings

The direct-push borings will be advanced using a Geoprobe® rig equipped with a Macro-Core® Soil Sampler. The 2.2-inch outer diameter (O.D.) Macro-Core® Soil Sampler will be equipped with single-use, thin-walled acetate liners and a bottom core catcher. The sampler will be advanced using direct-push methods in 3-foot intervals until refusal is encountered. The Macro-Core® Soil Sampler will be washed between samples using a non-phosphoric detergent (i.e. Liqui-nox™) and potable water solution followed by a potable water rinse. After sampling, direct-push soil borings will be backfilled with bentonite granules. The soil boring locations will be staked in the field for subsequent surveying, as appropriate.

4.6.2 Test Pit Explorations

The test pit explorations will be advanced up to 12 feet bgs or until refusal, using a rubber-tired backhoe with a maximum reach of about 14 feet. The test pit locations will be selected to provide geographic coverage across the area of the former soil removal with a particular focus on areas of direct-push boring refusals. In addition, if contaminated soil horizons are identified in the direct-push borings and adequate sample volume is not available for the desired analyses, then test pits may be positioned over the direct-push boring locations to better assess the extent of contamination and to retrieve adequate sample volume for a more comprehensive series of fixed laboratory chemical analysis.

During test pit advancement topsoil will be segregated from soil fill, glacial till, and/or weathered bedrock. Samples from the upper 3 feet of the test pit will be collected from the test pit walls while samples below 3 feet will be collected from the backhoe bucket. The backhoe bucket will be steam-cleaned prior to arrival on-site and between each test pit location. After sampling the test pits will be backfilled using formation material, covered with the previously segregated topsoil, and reseeded. The test pit locations will be staked in the field for subsequent surveying, as appropriate.

4.6.3 Collection, Screening, and Documentation of Soil Samples

Representative grab samples from the direct-push core sampler and test pits will be collected, classified, and headspace screened for the possible presence of VOCs. SHA will use the results of headspace screening to select additional grab samples from the direct-push cores and test pits for analysis of VOCs by the on-site mobile laboratory. Replicate soil samples will be collected at approximately 25 percent of the locations from which mobile laboratory samples were collected for confirmatory VOC analysis and analysis of additional constituents as described below. The replicate samples will be collected from the same approximate depth and vicinity as the mobile laboratory samples.

The soil used for headspace VOC screening will be classified using the modified Burmister Classification System and then placed in glass jars with lids or polyethylene Ziploc® -type bags for further reference/examination. If glass jars are used, aluminum foil will be placed over the top of the jar before securing the lid. Each sample jar or bag will be labeled with the project number, boring number, sample number, depth interval, sample recovery (for direct-push and split spoon samples), sample date, and initials of the sample logger. The headspace of soil samples will be screened in the field for total VOCs using a PID and FID. Typical direct-push boring and test pit log forms are included in Appendix D.3.

The PID will be equipped with a 10.6 eV lamp and calibrated to a 100 part per million by volume (ppmv) isobutylene-in-air standard with an instrument response factor setting of 1. The FID will be calibrated to a 100 ppmv methane-in-air standard with an instrument response factor setting of 1. The individually bagged samples will be broken up by hand and screened by inserting the PID or FID inlet probe through the bag. If glass jars are used, the samples will be shaken, the cap will be removed, and the PID/FID inlet probes will be inserted through the aluminum foil. If the soil samples are collected during cold weather conditions, the samples will be warmed to room temperature prior to field screening. The maximum VOC concentration detected for each sample will be recorded.

Jar shake tests to visually screen for the presence of separate-phase product will be performed for a subset of soil samples, in general, those with PID and/or FID headspace VOC readings greater than 100 ppmv. The jar shake tests will be performed by placing a portion of the sample in a sample jar, adding potable water, replacing the lid and shaking the sample to potentially mobilize droplets of separate-phase product.

Samples selected for on-site VOC analysis will consist of approximately 3 ccs or approximately 5 g of soil/weathered rock collected with a disposable syringe from the direct push soil core or from the backhoe bucket. The sample will be dispensed into a pre-weighed glass vial filled with 7 milliliters (mL) of distilled water. The vials will be crimped with Teflon septa, and then agitated to disperse the contents. The replicate fixed-laboratory samples will also be collected using a disposable syringe and then transferred into a pre-weighed laboratory-provided, 40-mL glass VOA vial. None of the headspace screening samples will be reused for mobile or fixed laboratory analysis.

As indicated in Table 1, samples that are intended for low-level laboratory quantitation limit VOC analysis will be placed in unpreserved 40-mL glass VOA vials with deionized (VOC-free) water. The low-level VOC analysis samples will either be analyzed or frozen for later analysis within 48 hours of collection. Samples for medium-level laboratory quantitation limit VOC analyses will be placed in 40-mL glass VOA vials pre-preserved with 5 mL of methanol. The samples will be submitted for low-level VOC analysis, unless the mobile laboratory results indicate concentrations in the mobile laboratory sample from that location are greater than 1 milligram per kilogram (mg/kg). Given the holding time constraints for low-level soil VOC analysis, samples will be shipped from the site to the analytical laboratory on a daily basis.

Soil/weathered rock samples to be analyzed for semi-volatile organic compounds (SVOCs), pesticides/aroclors, metals, cyanide, and/or total organic carbon (TOC) will be placed in unpreserved 4- or 8-ounce glass jars. Approximately ten samples will also be submitted to an analytical laboratory for moisture content and soils gradation analysis according to ASTM International (ASTM) Method D422 to aid in empirically assessing physical properties of the soil.

The analytical and soils laboratory sample containers will be labeled with the job number, boring identification number, sample number, sampling date and time, and the initials of the sampler. Samples selected for chemical analysis will be placed in a cooler with ice and transported to the analytical laboratory with accompanying duplicates/blanks using standard chain-of-custody protocols. Samples for moisture content and gradation analyses will also be transported using standard chain-of-custody protocols.

4.7 Mobile Laboratory Analyses

In addition to assistance with the collection of soil vapor and direct-push soil sampling, Microseeps will provide on-site mobile laboratory VOC analysis of soil vapor and soil samples. The mobile laboratory will be equipped with a laboratory-grade gas chromatograph (GC) using flame ionization and electron capture detectors (GC/FID/ECD).

4.7.1 Soil Vapor Samples

The soil vapor samples will be analyzed in the field, typically within 24 hours of collection. A summary of target VOCs and approximate method reporting limits in ppmv is provided in the following table.

COMPOUND	REPORTING LIMIT (ppmv)
Trichloroethene (TCE)	0.005
cis-1,2-Dichloroethene (cDCE)	0.1
Carbon Tetrachloride	0.005
1,1,1-Trichloroethane	0.005
1,1-Dichloroethane	0.01
1,2-Dichloroethane	0.01
Chloroform	0.005
Freon 113	0.005
Benzene	0.07
Toluene	0.07
Xylenes	0.07
1,1,2,2-Tetrachloroethane	0.005

A more detailed description of the proposed analytical method is provided in the “Methods and Procedures for use of Microseeps Soil Gas Sampling System” document prepared by Microseeps and included in Appendix D.2. Quality control (QC) samples will include 10% duplicates, daily method blanks, and daily method calibration samples compared to known standards.

4.7.2 Soil Samples

The presence of VOCs in the soil samples will be assessed in the mobile laboratory using a headspace screening analysis method. The results of this analysis will be expressed as VOC mass per wet soil weight. The samples will be analyzed for the same target VOCs as identified for the soil vapor analyses. The mobile laboratory reporting limit for each of the target VOCs will be approximately 50 micrograms per kilogram (µg/kg). We anticipate that approximately 15 soil/weathered bedrock samples may be screened per day with the mobile laboratory. Assuming a total of five days of direct-push drilling and test pit explorations, we anticipate that the mobile laboratory can analyze about 75 samples of soil/weathered bedrock. Since the soil samples will be unpreserved, they will be analyzed within 24 hours. QC samples will include 10% duplicates, daily method blanks, and daily method calibration samples compared to known standards.

4.8 Drilling and Sampling of Soil and Rock

As indicated in Section 3.0, shallow bedrock boreholes will be drilled to characterize bedrock composition and structure, to assess the presence of VOCs within the bedrock matrix, and to install shallow bedrock monitoring wells in the vicinity of the former Burn Pit. Bedrock boreholes will be drilled to greater depths outside the former Burn pit to further assess bedrock composition and structure and to allow for the construction of multi-level monitoring installations. Two of the deeper borings will be drilled at an approximate angle of 30 degrees from vertical in directions parallel and perpendicular to the primary strike orientation.

The overburden and weathered bedrock drilling methods (hollow stem auger [HSA], cased drive and wash, or other method proposed by the driller) will be the same for both the shallow and deep bedrock borings. The overburden drilling methods will allow for the completion of standard penetration tests (SPTs) and for the collection of additional soil/weathered bedrock samples for classification and screening.

The bedrock drilling will be conducted either by rock coring, or by “air rotary” methods. Both methods require the injection and recirculation of potable water to flush the rock cuttings to the surface. Efforts will be made to limit, to the extent practical, the volume of water that will be recirculated during rock coring and air-rotary (air-mist) drilling. The volume of water lost during drilling will be measured/estimated so that the volume can be assessed against the volume removed during well development prior to groundwater sampling.

We anticipate that all the bedrock borings can be drilled with a truck-mounted rig. All down-hole drilling equipment (including temporary steel casing) will be steam-cleaned prior to arrival of the drill rig on-site and between each location. During advancement of the borings, excess solid drill cuttings will be contained on plastic or in 55-gallon DOT-approved open-top drums. Fluids generated during drilling and well development (if performed) will be contained using a steel or plastic mud tub set around the drill casing and beneath the drill table and handled in accordance with the investigation derived waste (IDW) procedures outlined later in this section.

After each day of drilling the deep bedrock wells, and during the period between completing the geophysical/straddle packer testing and installing the multilevel systems, inflatable packers will be installed within the open boreholes. The packers are intended to limit the potential vertical migration of contaminants within the open borehole. The packers will be equal to the Solinst Model 808 Temporary Borehole Seal.

4.8.1 Standard Penetration Tests (SPTs)

SPTs will be performed continuously within the overburden and underlying weathered bedrock. The SPTs will be conducted in accordance with ASTM Method 1586, which consists of driving a 2-inch O.D. split-spoon sampler a minimum of 18 inches using a 140-pound hammer dropping 30 inches. The number of blows required to drive the sampler from 6 to 18 inches is the SPT index value, or N-value. The split-spoon samplers will be washed between samples using a non-phosphoric detergent (e.g. Liqui-nox^{TM}) and potable water solution followed by a potable water rinse.

The SPT samples will be documented, classified, and field screened for potential VOCs in accordance with the methods outlined above for the shallow soil sampling. Based on the field screening results, a subset of the soil samples (possibly one or two samples per borehole) may be submitted to an analytical laboratory for low-level VOC analysis.

4.8.2 Rock Core Drilling

As noted in Section 3.0, we anticipate that all the shallow bedrock wells and two of the deeper bedrock wells will be drilled using rock coring methods. However, the driller will be equipped to switch from rock coring to air rotary without additional mobilization efforts, allowing the number of wells drilled by rock coring to be modified based on the conditions encountered in the field. Rock core drilling will commence either through the HSA or through a casing seated into bedrock. Rock coring will be accomplished using HQ triple-barrel coring techniques. The HQ core will provide a 2.5-inch diameter rock core sample while creating a 3.78-inch diameter core hole.

As noted above, it is our intent that the shallow bedrock borings will extend to a depth of approximately 10 feet below the water table. The groundwater surface may be difficult to assess since the drilling methods require the injection of water; however, the field geologists will base their decisions on the identification of apparent water-bearing fractures or fracture zones; field observation of joints in core samples; water level measurements taken between core runs; and/or loss of drill water return during coring at a specific depth. We anticipate that no more than 30 to 40 feet of rock may need to be cored at each location to achieve the target well completion.

The rock core characteristics noted on the logs will include hardness, degree of weathering, color, grain size, lithology, and presence/characteristics of joints (fractures). The rock core samples will be photographed with labels indicating which well the core was taken from, the depth interval that it represents, and the date it was obtained. After photo-documenting the rock cores, sub-samples of each core will be collected for laboratory analysis of physical and chemical properties. The remaining rock core samples will be placed in wooden core boxes with lids. The core boxes will be labeled with the project name and number, coring date(s), boring number(s), core run numbers, depth intervals of core runs, sample recoveries, and Rock Quality Designations (RQDs).[7] Spacer blocks will be placed between each core run. Locations where small sections of core have been removed for field screening will be marked in the core box with spacer blocks. An example bedrock boring log is provided in Appendix D.3.

4.8.3 Rock Core Sample Collection for Laboratory Analysis

Initially, we anticipate that bedrock core samples from several, perhaps all, of the shallow bedrock boreholes will be used to assess the rock matrix VOC concentrations. This assessment will require the collection and preservation of bedrock samples for subsequent laboratory analysis (VOCs and physical properties). One-inch to two-inch sub-samples of the bedrock cores will be collected, processed, preserved, and packaged for shipping.

Rock samples collected for matrix VOC analysis will be immediately crushed using a specialized hydraulic rock crusher and the fragments (approximately 100 g) will then be preserved in methanol (approx. 60 mL) for laboratory analysis. As noted above, rock core sub-samples for VOC analysis will be collected at an average frequency of approximately one per foot and will be selected to include:

- Samples will be taken at distances of 6 and 18 inches both above and below identified fractures or partings; and,

- Pairs of samples will be collected from either side of distinct changes in lithology.

Subsamples of the rock core will also be collected for analysis of physical parameters (bulk density/porosity, permeability) and organic carbon content. As a general goal, three to five samples of each primary rock-type (i.e., where VOCs are considered most likely to be present in fractures and the rock matrix) will be collected and submitted for analysis. Approximately two

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[7] Rock Quality Designation (RQD) provides a method of assessing the degree of fracturing of the rock mass, based on the length of individual core sticks. RQD is measured per drill run and is defined as the total length of individual core sticks (neglecting drill breaks) that are greater than 4 inches in length divided by the length of the core run and expressed as a percentage. The method is typically utilized for NX-size core (2-inch diameter core).

samples from each of the less predominant rock-types will also be submitted. A typical rock core sampling log form is provided in Appendix D.3.

4.8.4 Shallow Monitoring Well Installation

The shallow monitoring wells will be constructed with sections of 1.5-inch I.D. Schedule 40 PVC well screen and riser attached by flush-threaded joints without using cement, glues, or solvents. The PVC well screen will be manufactured with 0.01-inch width machine cut slots. If results of field screening suggested the potential presence of separate-phase VOC residuals, the well screen and riser may be constructed with 1-inch I.D. stainless steel riser and No. 10-slot stainless steel well screen.

The annulus between the bedrock borehole and the well screen will be backfilled with a sand pack equal to Morie No. 2 sand that will extend approximately two feet above the top of the well screen. A bentonite seal will be installed above the sand pack and will extend across the overburden/bedrock interface. If sampling near the bottom of the borehole indicates the potential presence of residual separate-phase VOCs, a bentonite seal will also be placed at the bottom of the borehole separated from the bottom of the well screen by a thin “choke” layer of sand equal to Morie No. 00. A sump (two-foot long solid section of riser) will be installed below each well screen in case DNAPL liquids are present and able to migrate into the wells. The wells will be completed with locking protective standpipes set in a concrete surface seal.

Prior to collecting groundwater samples, the newly-installed monitoring wells will be developed using surging and bailing or pumping techniques to remove fine-grained formation material disturbed during drilling and well installation and to promote the exchange of groundwater from the formation into the well. If bentonite or cement grout is required as backfill in the annulus between the well riser pipe and the borehole wall, then the wells will not be developed before 72 hours after the time they are completed.

Typically, monitoring wells should be developed based on the following criteria:

- Removal of at least a comparable volume of water to that which was introduced to the well during drilling;
- Until field screening (e.g., pH, specific conductance) parameters measured in the extracted groundwater become stable;
- Removal of sediment inside the well screen and sump; and/or
- Production of visually clear (low turbidity) purge water at low flow rates.

Development of monitoring wells screened in highly weathered bedrock fractured zones (that is, in formations dominated by fine sand, silt, or clay) may not result in reduced turbidity or increased hydraulic efficiency of the well. Vigorous development may result in an increase in turbidity and a reduction in the hydraulic efficiency of the well. As such, no further development should be attempted in monitoring wells that do not show a significant reduction in turbidity within one hour of initiating development. If the well is pumped or bailed “dry”, the approximate length of time for the well to recover should be recorded. The details of well development will be recorded on the Summary of Monitoring Well Development Form included in Appendix D.4.

4.8.5 Air Rotary Drilling Methods

Two of the deeper bedrock borings, and possibly some of the shallow bedrock borings will be drilled using a 4-inch diameter open-hole air rotary (air mist) method. Each boring will be initially advanced about 5 feet into rock using a nominal 6-inch air-rotary drill bit. The 6-inch drill string will be removed and a section of 4-inch I.D. steel casing will be lowered into the borehole and grouted in place by pumping the grout down the inside of the casing until it flows to the ground surface through the annular space outside the casing. The grout will consist of a combination of Portland cement and bentonite. The grout will be allowed to set up at for least 24 hours before the grout is cleared from the inside of the casing and the borehole is advanced to depth.

During air-rotary advancement, samples of solid drilling cuttings (rock chips) will be collected at approximately five-foot intervals using a metal sieve. The solid drill cuttings will be logged for rock type and for evidence of the apparent encounter of a fracture or fractures (such as color changes and/or textural changes in drill cuttings). A portion of the drill cuttings from each sample interval will be placed in polyethylene Ziploc® -type bags and the sample headspace will be screened in the field for total VOCs using a PID and FID. The drill cutting samples will be retained for further geologic reference/examination. Each sample bag will be labeled with the project number, boring number, sample number, depth interval, sample recovery, sample date, and initials of the sample logger. Example blank drilling logs are provided in Appendix D.3.

At depths where a measurable groundwater yield is observed (typically greater than 1/4 gpm) a sample of the “blown yield” may be collected in a glass jar for PID/FID headspace screening.

4.9 Groundwater Level and Water Quality Monitoring

Groundwater level and water quality monitoring will be performed several times over the course of the RI. Manual groundwater level measurements will be made from established reference points at each well, or at each multi-level installation. If data-recording pressure transducers are used, water levels will be obtained by downloading from the transducer onto a personal digital assistant (PDA) or a notebook computer. Manual water level measurements will be recorded during the initial transducer installation and periodically thereafter to check and if necessary normalize the transducer readings.

Limited purging is necessary when collecting samples from multilevel installations, as there is typically no standing or "stagnant" water in the well. The multilevel sampling methods will be dictated by the type of equipment that is selected and will follow the manufacturer's specified methodology.

The shallow bedrock monitoring wells will be sampled using traditional bailing or pumping techniques. The lower yielding shallow wells exhibiting slow recovery during well development will likely be purged "dry" prior to sampling using single-use disposable polyethylene bailers or pumps. For monitoring wells with a measurable yield, groundwater sample collection methods are anticipated to be similar to low-flow, minimal drawdown techniques as defined by the United States Environmental Protection Agency (USEPA). Low-flow purging and sampling will be performed using dedicated 2-inch Grunfos Redi-Flow pumps or 1 to 2-inch bladder pumps with dedicated polyethylene tubing.

Field screening parameters measured during purging and sampling will include dissolved oxygen, oxidation-reduction potential, temperature, specific conductance, pH, and turbidity. Samples will be collected after stabilization of field water quality parameters during purge pumping or following purging of over three well volumes, whichever comes first. A Groundwater Quality Field Sampling Summary form and Low Flow sampling and equipment calibration data sheets are provided in Appendix D.5. Purge waters and decontamination fluids generated during sampling will be contained and transferred to an on-site storage tank.

The groundwater samples will be submitted to Lancaster Laboratories, Inc in Lancaster, PA (Lancaster) and analyzed for VOCs by USEPA Method 8260B. Selected samples collected during the first comprehensive round will also be analyzed for the Superfund Target list of organic and inorganic parameters listed in Table 1. Samples collected during the first comprehensive round will also be analyzed for a limited number of additional geochemical parameters to support assessment of potential remedial measures. As listed in Table 1, the additional geochemical parameters include TOC, total iron and manganese, hardness, and chemical oxygen demand (COD). Samples collected during the second comprehensive round will be analyzed for VOCs only, unless results of the first round suggest some of the other parameters listed in Table 1 should be added.

The groundwater samples will be transferred directly into containers provided by the analytical laboratory. A summary of sample container, preservation, and holding time requirements is provided as Table 1. The samples collected will be placed in a sample cooler with ice and transported to the laboratory by a commercial carrier via standard chain-of-custody protocols.

4.10 Laboratory Analysis of Soil, Bedrock, and Groundwater Samples

This section includes a description of off-site laboratory procedures that will be used for chemical analysis of soil, rock core, and groundwater samples. This section also includes the procedures to be followed for physical testing of the rock core samples that is required both for hydrogeologic characterization and to assess possible VOC concentrations in the matrix pore water.

4.10.1 Laboratory Analyses of Soil Samples

Approximately 25 percent (%) of the soil and/or weathered bedrock samples will be "split" and submitted to Lancaster and analyzed for the Target Compound List (TCL) parameters including VOCs, SVOCs, pesticides/aroclors, metals, and cyanide[8]. Samples will also be analyzed for total petroleum hydrocarbons (TPH). The samples will be collected from depths exhibiting the highest mobile laboratory and PID/FID field headspace screening result for a given boring or test pit or exhibiting visual evidence of contamination such as staining. In the absence of detectable compounds during field screening, samples from the lower two feet of a given boring or test pit will be submitted. Proposed analytical methods, sample holding times, sample volumes, container types, preservation, and quantitation limits are provided in Table 1. A listing of TCL analytes and their respective quantitation limits is provided as Appendix D.6. As indicated in the table, a subset of samples may also be analyzed for TOC analysis by USEPA Method 9060 (modified).

4.10.2 VOC Analysis of Rock Samples

Samples will be subjected to a proprietary extraction process developed by UW that facilitates the extraction of porewater and sorbed VOC mass into methanol. Aliquots of methanol are then analyzed by direct injection into a micro-electron capture detector tailored for the analysis of TCE and its breakdown products. For quality assurance purposes, five percent of the extracted samples will be split and analyzed by USEPA Method 8260.

4.10.3 Physical Properties of Rock Core Samples

Rock core samples selected from intervals in both the shallow and deep bedrock borings will be submitted for the following analyses:

- Porosity, according American Petroleum Institute (API) Method RP-40
- Diffusivity
- Permeability according to ASTM Method D-5084
- Bulk density (wet & dry) according to ASTM Method D-2937

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[8] The proposed frequency of analytical laboratory analyses is consistent with *NYSDEC December 2002 Draft DER-10 Technical Guidance for Site Investigation and Remediation* concerning remedial investigation of historic fill material (Section 3.11.2).

- Organic carbon content according to a method developed by Churcher and Dickhout[9]

4.11 Containment of Investigation-Derived Wastes

Investigation-derived wastes generated during each phase of exploration will be evaluated, contained and disposed in a manner consistent with nature of the material. A decontamination area will be established near the BPA where steam cleaning of the Geoprobe downhole equipment, the backhoe bucket, the drill rig, and downhole drilling equipment will be conducted. Wash water will be allowed to flow onto the ground and will not be separately contained.

Solid materials generated from HSA and air rotary drilling, as well as from equipment decontamination procedures that exhibit PID or FID readings above background will be contained on plastic or in 55-gallon DOT-approved open-top drums. Solids will be transferred to a covered 30 cubic yard "water-tight" roll-off by the end of the working day.

Fluids generated during drilling, borehole yield testing, and development will be contained using a steel or plastic mud tub set around the drill casing and beneath the drill table. Since each of the peripheral borings will be located outside the BPA, drill cuttings generated during the placement of the casing in overburden will not be containerized unless we observe evidence of contamination during field screening.

Fluids generated during drilling advancement and well development, decontamination fluids, and purge water generated during the initial round of groundwater sampling will be contained and transferred to a fractionalization (frac) tank.

Purge waters generated during subsequent sampling events will only be contained at monitoring well locations with previous detections of one or more VOCs. The drill solids and the contents of the frac tank will be characterized and properly disposed off-site in accordance with applicable laws and regulations.

4.12 Community Air Monitoring Plan

As indicated in the HASP (Appendix B), the breathing zone at the work site will be regularly screened for VOCs using a photoionization detector (PID) and Draeger tubes (where appropriate) during intrusive field activities. Protective work shutdown limits of 1 ppm sustained for vinyl chloride, 0.5 ppm sustained for benzene, and 5 ppm sustained above background for overall PID readings at the work site are identified in the HASP.

If the work shutdown limits are attained the site safety officer will use the monitoring instruments to screen the perimeter of the work area (exclusion zone). In the unlikely event that

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[9] Peter L. Churcher and R. D. Dickhout. 1987. Analysis of ancient sediments for total organic carbon - some new ideas. Journal of Geochemical Exploration, 29 (1-3): 235-246

VOCs are detected in the breathing zone at the perimeter of the exclusion zone that exceed the health and safety plan action limits, the work will not be resumed until work practices can be modified to limit the potential for further emissions.

5.0 QUALITY ASSURANCE/QUALITY CONTROL PLAN

This section provides an overview of data quality objectives, measurement performance criteria, and a proposed schedule of Quality Control elements such as field duplicates and blanks.

5.1 Data Quality Objectives

Project Data Quality Objectives (DQOs) were developed in a manner consistent with the DQO process described in USEPA (1994), and are based on historical information regarding the site, regulatory requirements of the NYSDEC, and the intended use of the data generated for the site. The Project DQOs are to:

1. Identify the presence and concentration or absence of target VOCs in soil vapor, soil, and weathered bedrock in the area of the former Burn Pit and previous soil removal;

2. Identify the presence and concentration or absence of target VOCs in groundwater at locations proximate to and outside the BPA;

3. Provide VOC and other organic and inorganic data for soil, weathered bedrock, and/or groundwater samples of sufficient accuracy, precision, representativeness and sensitivity to adequately assess the extent of organic and inorganic parameters in soil and bedrock groundwater and support screening of potential remedial options, if necessary.

Three general types of data will be collected including:

1. Field screening of soil, weathered bedrock, rock core, and drilling cutting sample headspace for total VOCs using hand-held instruments (PID and FID) to assist in selection of samples for laboratory analyses and siting of bedrock test borings and well screen elevations. The screening level data will not be used directly in making risk management decisions;

2. Mobile laboratory VOC analysis of samples of soil vapor and the headspace of soil and weathered rock samples. The objective of this work is to obtain information on the possible presence, speciation, and relative concentration of VOCs in the shallow subsurface soil and rock that were subject to the prior removal action. The mobile analytical laboratory analysis results will not be used directly in risk management decision-making and will be supplemented by collection and fixed laboratory analysis of soil and weathered rock samples; and

3. Fixed laboratory analysis of samples of soil, weathered bedrock, and/or groundwater for VOCs, and other organic and inorganic parameters as listed in Table 1.

The measurement performance criteria as outlined below are intended to guide the RI program. The analytical data will be validated, and a data usability assessment will be completed prior to use of the data. An Environmental Laboratory Accreditation Program (ELAP)-certified laboratory will complete the fixed laboratory analyses of samples.

5.2 Measurement Performance Criteria

This section documents the performance criteria defined for the analytical measurement systems so that the project DQOs, as defined above, are met. Measurement performance criteria (MPC) for precision, accuracy/bias, representativeness, completeness, sensitivity, and comparability have been determined for the proposed laboratory analysis of soil and groundwater samples. The proposed frequency of quality assurance elements associated with the measurement performance criteria are outlined in Table 2.

5.2.1 Precision

Precision is the degree of agreement among repeated measurements of the same characteristic (analyte, parameter, etc.) under the same or similar conditions. Precision data indicate how consistent and reproducible the field sampling or analytical procedures have been. “Overall project precision” will be measured by collecting data from duplicate field samples. Analytical laboratory precision will be measured by analyzing matrix spike/matrix spike duplicate samples (MS/MSD) for organics and matrix duplicates (MD) for inorganics. Laboratory control sample/laboratory control sample duplicates (LCS/LCSD) may also be analyzed by the laboratory as a measure of analytical precision in the absence of the site matrix. Comparing overall project precision and laboratory precision will help to identify sources of imprecision, such as sample matrix heterogeneity, if such imprecision exists.

Precision will be evaluated by calculating the relative percent difference (RPD) of the duplicate results using the following equation:

$$RPD = \frac{\left| x_1 - x_2 \right|}{\frac{x_1 + x_2}{2}} \bullet 100\%$$

Where,

RPD	represents the relative percent difference;
x_1	indicates the original sample concentration; and
x_2	indicates a replicate sample concentration.

For soil and groundwater sampling, targets for RPD for MS/MSDs and sample/MDs are given in Exhibit E of the New York State Analytical Services Protocol (NYSASP).[10] Targets for field

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[10] New York State Department of Environmental Conservation, June 2000, Analytical Services Protocol, Exhibit E -Quality Assurance Quality Control Requirements.

duplicate precision are 30% and 50% for groundwater and soil, respectively. For mobile analytical laboratory analysis the target for RPD is less than or equal to 30%.

5.2.2 Accuracy/Bias

Accuracy is the extent of agreement between an observed value (sample result) and the accepted, or true, value of the parameter being measured. Accuracy is frequently used synonymously with bias. Specifically, the term "bias" describes the systematic or persistent error associated with a measurement process. Sources of error in the field and the laboratory that may contribute to poor accuracy include laboratory measurement error, sampling inconsistency, field contamination, laboratory contamination, preservation and handling issues, and matrix interferences. Accuracy/bias will be evaluated using several different types of QC samples including standard reference material, MS samples, MSD samples, surrogate spikes, laboratory control samples (also called method blank spikes [MBS]) by NYSASP, and field and laboratory blank samples. In addition, method-required initial calibration and continuing calibration criteria provide for acceptable accuracy of the analytical measurements for this program.

For the QC samples that measure a "true" value of a standard, the following equation will be used to calculate the potential bias in the result as a "percent recovery:"

$$\textit{Accuracy/Bias} = \frac{\textit{Measured Value}}{\textit{True Value}} \bullet 100\%$$

Because environmental samples contain interferences (i.e., other compounds that may interfere with the analysis of a specific analyte), the accuracy for a specific analyte will be evaluated in relation to the sample matrix. This will be done by analyzing MS/MSD samples and surrogate spikes. A known concentration of an analyte is added to an aliquot of the sample for the MS. The difference between the concentration of the analyte in the unspiked sample and the concentration of the analyte in the spiked sample will be compared to the known amount of the spike added as a measure of accuracy in the sample matrix. Surrogate spikes contain a known amount of compounds that are similar to the environmental compounds of interest but are not normally found in environmental samples. As required by NYSASP, an LCS (or MSB) will be analyzed for each batch of samples so that the recovery for the analytes of interest can be evaluated in the absence of the site matrix. A comparison of MS and LCS (or MSB) recoveries may help determine whether observed bias in the data was matrix-related or due to analytical performance.

For the QC samples that measure the potential matrix effect on the accuracy of the result, including MS/MSD and surrogate recoveries, the following equation will be used to calculate the potential bias in the result as a percent recovery of the spike added:

$$\%\ \mathit{Recovery\ Accuracy/Bias} = \frac{\mathit{Spike\ Sample\ Conc.} - \mathit{Unspiked\ Sample\ Conc.}}{\mathit{Spiked\ Conc.\ Added}} \bullet 100\%$$

Target percent recoveries for fixed analytical laboratory analysis of samples of soil, weathered rock, and groundwater are given in Exhibit E of the NYSASP Protocol. For VOCs that may have been spiked that are not identified by NYSASP, recovery should be between 70 and 130%.

5.2.3 Representativeness

Representativeness is a qualitative term that describes the extent to which a sampling design adequately reflects the environmental conditions of a site. It takes into consideration the magnitude of the site area represented by one sample and assesses the feasibility/reasonableness of that design rationale. Representativeness also reflects the ability of the sampling team to collect samples and laboratory personnel to analyze those samples in such a manner that the data generated accurately and precisely reflect the conditions at the site. As a quantitative measure of representativeness, field duplicate samples will be collected and analyzed. See above section on precision for detailed approach to duplicate collection, analysis, and criteria.

5.2.4 Comparability

Comparability is a qualitative parameter that expresses the confidence with which data sets can be compared. Comparable data allows for the ability to combine analytical results acquired from various sources taken during the period of the assessment. Comparability relies upon precision and accuracy within the individual data sets to be acceptable, to promote confidence in the data sets. The consistent use of the sampling and analytical methods defined in this Action Plan will yield comparable results. In addition, comparability can be affected by QA/QC criteria such as sample preservation, holding times, blank contamination, quantitation limits, and matrix issues. The QC criteria for these parameters have been defined in this RI Work Plan to provide comparability of the data generated during the program.

5.2.5 Sensitivity

Sensitivity is the ability of the method or instrument to detect the target analytes at the concentration of interest. Several QC samples and procedures will be used to provide sensitivity consistent with site DQOs. These include collection and analysis of field blank samples, laboratory method and instrument blank samples, and instrument initial and continuing calibration criteria. Adherence to method procedures, and field and laboratory instrument/equipment maintenance, testing, and inspection will also assist in providing the appropriate level of sensitivity.

The analytical laboratory reporting limits are consistent with USEPA methodologies and sufficient to assess the extent of contamination, whether or not additional remedial activities should be considered, and if so, support screening of potential remedial measures. Proposed quantitation limits for soil and water sample analyses are listed by compound/analyte in Appendix D.6.

The reporting limits for mobile analytical laboratory analysis are sufficient for screening-level sampling of soil vapor, and headspace of soil and weathered rock samples in that the objective of mobile laboratory analysis is to support targeting of locations for soil, weathered bedrock, and groundwater sampling to be submitted to an analytical laboratory.

5.2.6 Completeness

Completeness is a measure of the amount of valid/usable data resulting from data collection and analysis activities. Completeness can be calculated as a percentage of the number of valid/usable results obtained compared to the total number of results planned (usable and rejected) for the investigation. Theoretically, a completeness target is reached through adherence to the methods and QC requirements. However, completeness may be affected as a result of unavoidable human error, equipment failure, or matrix effects.

5.3 Quality Assurance/Quality Control Elements

The proposed schedule of Quality Control measures such as field duplicates and blanks, and analytical laboratory blanks and matrix spikes are outlined in Table 2. QA/QC measures implemented during field sampling activities will include but not be limited to:

- Sample collection pursuant to the methods outlined in the Field Activities Plan (Section 4);
- Trip blanks (VOC analysis only) to accompanying sample containers (empty) to the field, and collected samples back to the lab;
- Collection of field duplicate samples;
- Collection of atmospheric blank samples (VOC analysis only); and
- Collection of field equipment (rinseate) blank samples during use of non-dedicated sampling equipment.

The trip blanks will be prepared by the analytical laboratory using laboratory-grade deionized and VOC-free water. In general, one trip blank will be submitted to the laboratory for each sampling cooler. Duplicate samples will consist of approximate splits of soil, weathered bedrock, and groundwater samples that will be collected at a frequency of approximately 10%. The sample depths and or monitoring wells selected for duplicate samples should represent locations with “upscale” but not “off scale” VOC concentrations so that there will be measurable concentrations for comparison between the field duplicate pair and small differences in absolute concentrations will not tend to yield large percentage differences. As a general rule, if the RPD for field duplicates exceeds 30% for aqueous samples or 50% for soil or bedrock samples, the specific RPD exceedance will be reviewed against compound and matrix specific RPD goals and subsequent duplicate sampling may be performed at a higher frequency.

As indicated in Table 2, atmospheric or field blank samples will be prepared by the analytical laboratory using laboratory-grade deionized and VOC-free water. Field equipment blanks obtained during soil/weathered bedrock sampling will be collected by pouring VOC-free water through the field-cleaned sampling equipment such as a split-spoon sampler. Equipment blanks are not planned during groundwater sampling given the proposed use of dedicated sampling equipment.

Laboratory handling of the samples, adherence to holding times, instrument calibration, and instrument accuracy and precision will be performed in a manner consistent with NYSASP and USEPA protocols. Data validation procedures will be employed by an SHA subconsultant to assess the quality and usability of the laboratory results as described in the following section.

5.4 Data Validation and Usability Assessment

Soil, weathered bedrock, and groundwater quality data will be validated, and the usability of the data for assessing the extent of VOCs, the extent of other organic and inorganic parameters, and the possible need for remedial measures will be assessed. Data validation and usability assessment will be completed following NYSASP and USEPA Guidelines[11] and project-specific requirements. The purpose of this data assessment is to provide information on the uncertainty and bias in the data as considerations for decision-making. A brief summary of data validation and usability assessment procedures and methods is provided below and is described in more detail in Appendix E.

The data assessment is performed using a two-step process. The first step involves an in-depth review of sample quality control data, as well as a review of the raw data on instrument calibrations, sampling procedures, and qualitative and quantitative determinations to evaluate whether the laboratory is providing data in a manner that is compliant with the analytical methods required, laboratory procedures, the work plan goals as outlined in Table 2, and NYSASP and USEPA Guidelines for data validation. If the in-depth review indicates sample analysis meets the DQOs, then the subsequent data are subject to a checklist review whereby all the project DQOs are assessed; however, evaluation of the raw data is not performed. The laboratory will still provide a full deliverable (i.e., including sample results and summary QC, method blank results, LCS recoveries, MS/MSD recoveries, instrument QC sample results, and raw data for all analyses, including instrument tunes and calibrations) for the checklist review, so in the event that an in-depth assessment is needed in the future, a full deliverable package is

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[11] NYSDEC Analytical Services Protocol June 2000; USEPA Region II SOP HW-24, *Standard Operating Procedure for the Validation of Organic Data Acquired Using SW-846 Method 8260B (rev. 2, Dec. 1996)*, Revision 1, June 1999; USEPA Region II SOP HW-2, *Evaluation of Metals Data for the CLP Program*, Revision 11, January 1992; *USEPA Contract Laboratory Program National Functional Guidelines for Organic Data Review*, Publication EPA540/R-99/008, October 1999; and *USEPA Contract Laboratory Program National Functional Guidelines for Inorganic Data Review*, Publication EPA540/R-01/008, July 2002.

readily available. The approach to data assessment, either through the in-depth, or checklist review, involves the twelve-step procedure described in Appendix E.

6.0 DATA ANALYSIS AND REPORT

SHA will compile, reduce, and analyze data generated as a part of the RI and prepare a Remedial Investigation report. The report will include: a summary of the work completed; an overview of the findings including a discussion of the reliability/usability of the analytical laboratory data; a discussion of the nature and extent of contamination relative to State Standards, Criteria and Guidance (SCG); an interpretation of hydrogeologic conditions pertinent to environmental fate and transport; a qualitative exposure assessment evaluating actual or potential exposure pathways; and conclusions and recommendations summarizing the area(s) of concern, unacceptable exposure pathways (if present), and recommendations for future work (if necessary) such as additional field investigations or an evaluation of remedial alternatives.

Specifically, the report will provide an assessment of the presence or absence of residual contamination in the area of the former Burn Pit, further definition of the lateral and vertical nature and extent of contamination in groundwater, and an evaluation of whether contamination is migrating off-site towards private water supplies or surface water. Elements of the RI report will include:

- A field exploration location plan;
- Stratigraphic logs with soil/rock descriptions, field screening results, and well installation details;
- Well development, packer testing, and water quality sampling records;
- Plan view and cross-section maps depicting subsurface hydrogeologic conditions;
- Plans depicting groundwater elevations, apparent flow directions, and water quality conditions; and
- Tabular summaries of soil vapor, soil/weathered rock, and water quality data, including tables of sampling results that exceed SCGs.

In addition to the RI report, other project reporting elements will include:

- Quarterly progress reports to IBM for forwarding to NYSDEC, as necessary depending on project milestones; and

- Project status briefings with NYSDEC after completion and preliminary review of soil characterization and groundwater characterization field explorations and testing.

If additional remedial measures are proposed, project reporting elements would include a Remedy Selection Scoping Meeting with NYSDEC, submittal of a Remedial Work Plan to NYSDEC, and submittal of an Engineering Report upon completion of construction of the selected remedial alternative.

7.0 SCHEDULE

Figure 5 presents a schedule of field investigation, data analysis, and reporting from initiation of RI field activities through a determination of No Further Action (Option 1) or through Remedy Selection, Construction, and Release and Operations and Monitoring (Option 2). The major elements and milestones listed in the schedule are compliant with BCP Guidance. The schedule is provided solely to portray estimated timeframes for BCP steps based on our current understanding of site conditions, estimated durations of field explorations activities, and anticipated timeframes for regulatory review and Citizen Participation (CP) steps.

As indicated on the figure, the RI is projected to be complete about 9 months after RI Work Plan approval. The remedy selection (if necessary) is projected to be complete about 4 months after NYSDEC approval of the Final RI Report. Timing for construction of a remedy (if necessary) will be specific to the remedy selected and other factors and cannot be more precisely delineated at this time. However, if construction of a remedy is necessary, a more accurate construction schedule projection will be provided upon completion of the remedy selection process.

Based on the current projected schedule, important milestones include:

- Start of RI initial studies and field soil characterization activities within about two weeks following RI Work Plan approval (February 2006);

- Completion of RI initial studies and field soil characterization activities (April 2006)

- Start of groundwater characterization activities (September 2006); and

- Submittal of an RI Report to NYSDEC, about seventeen months after the projected receipt of NYSDEC approval of the RI Work Plan (July 2007).

Please note the timeframes discussed in this section and shown on Figure 5 are subject to possible delays beyond IBM's control, including, but not limited to, regulatory approvals, field conditions, schedules of subconsultants and subcontractors, Citizen Participation steps, and other factors. The proposed schedule represents an estimate of project-specific time frames developed based on the anticipated scope of work set forth in this Work Plan. The schedule would need to be updated if the proposed scope of work specified in this Plan is modified based on comments by NYSDEC or findings of field explorations.

8.0 CITIZEN PARTICIPATION ACTIVITIES

Prior to start of the RI, a Citizen Participation (CP) Plan outlining the proposed project CP program will be submitted to the NYSDEC under separate cover. In accordance with the NYSDEC Brownfields Procedures Handbook[12], elements of the CP Plan include:

- Property information and background summary;
- A project description including a summary of project objectives;
- A schedule of the investigation program, including major reporting/decision making milestones;
- Identification of a local document repository;
- A contact listing of interested parties including owners/occupants of adjacent properties, government representatives or civic organizations, media representatives, or other groups with a potential interest in activities on the property;
- Identification of issues of interest to the public about the property and investigation program, and the information needs of interested parties; and
- A description of specific CP activities at major milestones of the investigation program.

CP activities performed to date include:

- Developing a public contact list;
- Designating the Village of Johnson City Library as a document repository;
- Publishing a notice of the request to participate in the BCP in the Binghamton Press & Sun Bulletin, the Environmental Notice Bulletin, and to those on the public contact list; and
- Completing the 30-day public comment period on the project BCP application.

Future CP activities proposed at specific project milestones may include but not necessarily be limited to:

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[12] New York State Department of Environmental Conservation, *Technical and Administrative Guidance Memorandum #4058 – Brownfields Procedures Handbook (Environmental Restoration (Brownfields) – Investigation and Remediation Projects*, Revised 12/22/97).

- Developing and distributing a notice and fact sheet to the contact list describing the RI Work Plan and the opportunity for participation in a 30-day public comment period;

- Developing and distributing a notice and fact sheet to the contact list describing the Proposed Remedial Action Plan (PRAP), participation in a 45-day public comment period, and participation in a public meeting (if requested);

- Addressing public comments on the PRAP;

- Developing and distributing a notice to the contact list announcing the start of construction of remedial measures (if necessary);

- Developing and distributing a notice and fact sheet to the contact list describing the engineering report; and

- Developing and distributing a notice and fact sheet to the contact list describing institutional/engineering controls (when used) within 10 days of receipt of a Certificate of Completion.

TABLES

Table 1
Summary of Proposed Sampling and Laboratory Analyses

RI Work Plan – Former Burn Pit Area
IBM Gun Club, Union, New York

Analysis	Method Number	Hold Time[5]	Typical Sample Volume, Container Type, Preservation	Quantitation Limit
SUPERFUND TARGET LIST				
SOIL/WEATHERED BEDROCK				
Volatile Organic Compounds	5035A, 8260B	10 days	Two 40 mL VOA vials, cooled to 4° C for ≤ 48 hours then frozen to < -7° C upon laboratory receipt OR Two 40 mL VOA vials, preserved w/ Methanol, 4° C	10 µg/kg (low) 1,200 µg/kg (med)
Semivolatile Organic Compounds	8270C	5 days until extraction, 40 days thereafter	One 8 ounce or two 4 ounce wide-mouth glass jars, 4° C	Compound and matrix specific
Pesticide/Aroclor	8081A, 8082	5 days until extraction, 40 days thereafter	One 8 ounce or two 4 ounce wide-mouth glass jars, 4° C	
Metals Except Mercury (See Note 2)	6010B, 7740	6 months	One 8 ounce wide-mouth glass jar, 4° C	
Mercury	7471	28 days	One 8 ounce wide-mouth glass jar, 4° C	
Cyanide	9010B	12 days	One 8 ounce wide-mouth glass jar, 4° C	
GROUNDWATER				
Volatile Organic Compounds	8260B	10 days	Three 40 mL VOA vials, preserved with HCl to pH< 2, 4° C	10 µg/L
Semivolatile Organic Compounds	8270C	5 days until extraction, 40 days thereafter	Two 1 L amber glass jars with PTFE-lined screw caps, 4° C	10-25 µg/L (See App. C.2)
Pesticide/Aroclor	8081A, 8082	5 days until extraction, 40 days thereafter	Two 1 L amber glass jars with PTFE-lined screw caps, 4° C	0.05-5.0 µg/L (See App. C.2)
Metals (dissolved) – See Note 2	6010, 245.1, 270.2	180 days (Mercury 28 days)	field filter (0.45 micron filter) into 1 L HDPE or glass, preserved with HNO_3 to pH <2, 4° C	0.2-5,000 µg/L (See App. C.2)
Cyanide	4500CN E	12 days	One 1 L HDPE or glass bottle, 0.6 g ascorbic acid per liter to neutralize residual chloride, preserved with NaOH to pH >12, 4° C	10 µg/L

ADDITIONAL GEOCHEMICAL PARAMETERS				
SOIL/WEATHERED BEDROCK				
Total Organic Carbon	9060	26 days	One 4 oz glass jar, 4° C	N/A
GROUNDWATER				
Total Organic Carbon	5310C	26 days	Two 40 mL VOAs, preserved with H_2S0_4 to pH <2, 4° C	1,000 µg/L
Total Iron and Manganese	6010	6 months	250 mL HDPE, preserved with HNO_3 to pH <2, 4° C	100 and 15 µg/L, respectively
Hardness	6010	6 months	250 mL HDPE, preserved with HNO_3 to pH <2, 4° C	N/A
Chemical Oxygen Demand	Hach 8000	26 days	250 mL HDPE, preserved with H_2SO_4 to pH <2, 4° C	N/A

NOTES:

1. This table is intended to summarize analytical parameters, methods, hold times, typical sample volumes and containers, preservation requirements, and quantitation limits for soil, weathered bedrock, and groundwater samples to be collected as part of the remedial investigation of the former Burn Pit area of the IBM Gun Club site in Union, New York.

2. Metals include the following: aluminum, antimony, arsenic, barium, beryllium, cadmium, calcium, chromium, cobalt, copper, iron, lead, magnesium, manganese, mercury, nickel, potassium, selenium, silver, sodium, thallium, vanadium, and zinc. Dissolved metals samples will be field filtered using single-use 0.45 0micron filters, prior to preservation.

3. If the site has unusual conditions (e.g., high or low pH), preservation for certain analyses may need to be altered (e.g., if high pH conditions exist at the site, preservation for metals and VOCs in groundwater may be an issue).

4. See Appendix C.2 for a listing of compound/analyte and matrix-specific analytical laboratory quantitation limits.

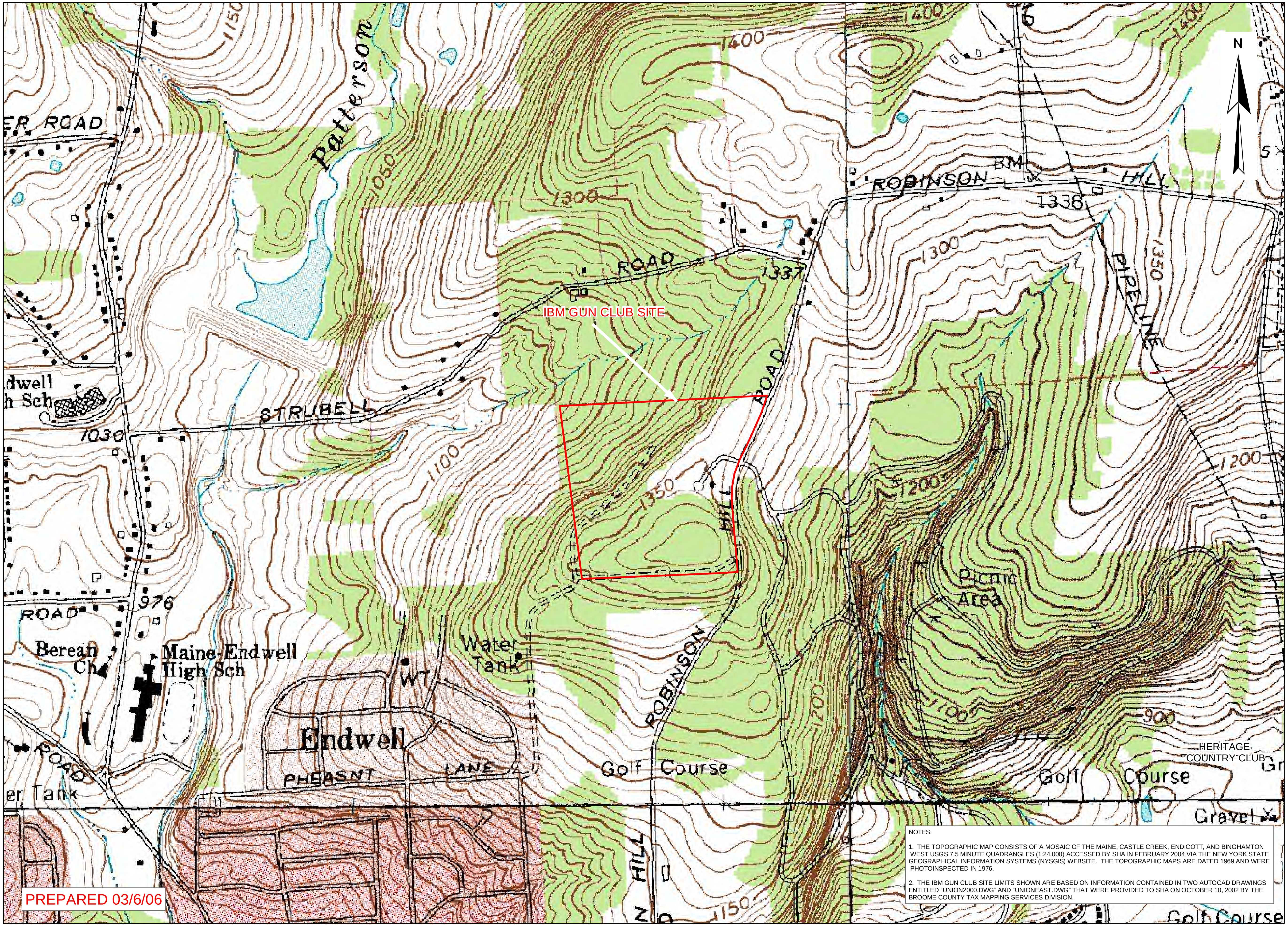
5. Hold times are from verified time of sample receipt (VTSR).

Table 2
Proposed Schedule of Quality Control Elements
RI Work Plan – Former Burn Pit Area
IBM Gun Club, Union, New York

Quality Control Element	Description	Frequency	Purpose	Synonyms
Sampling:				
Duplicate Samples	Two or more co-located samples collected simultaneously.	At least one set of duplicate samples per day of sampling or a minimum of one duplicate per ten samples (10 % frequency).	To improve confidence in measured concentrations and to evaluate representativeness.	Collocated samples Parallel samples
Trip Blank	Unused laboratory certified clean VOA vial containing VOA-free water or methanol (depending on how samples are collected) that accompanies VOA containers to field and samples back to laboratory.	One trip blank per sample cooler for VOA analysis – only.	To assess for the presence of target compounds that could be due to ambient field conditions, or sample container transportation to and from the field.	Field Blank Blank
Atmospheric Blank	Unused laboratory certified clean sampling container (i.e. VOA vial) that is opened in the field and then closed.	One atmospheric blank per day.	To assess for the presence of target compounds that could be due to ambient field conditions.	Field Blank
Equipment Blank	Metals: Distilled deionized water applied to non-dedicated equipment in the field following field decontamination procedures. VOA: VOA-free water applied to decontaminated field equipment.	At least one equipment blank per day, or one per 20 samples. Separate VOA and metals equipment blanks needed.	To assess for the presence of target compounds that could be due to carry over from non-dedicated sampling equipment.	Field Equipment Blank Rinseate Blank
Analysis:				
Method Blank	Analyte-free matrix analyzed like samples.	One per analytical batch, up to 20 field samples of same matrix.	To assess contamination from sample recovery.	Blank
Surrogates	Compounds similar to compounds of interest, but not normally found in nature.	Every sample including QC for organic analyses.	To assess accuracy of preparation and analysis.	Recovery Standards
Lab Control Sample (LCS)	Aliquot of analyte-free matrix spiked with compounds of interest and analyzed like samples.	One LCS per analytical batch.	To assess accuracy and precision of analyses in the absence of the site matrix.	Laboratory Fortified Blank (LFB) or Blank Spike (BS/BSD)
Matrix Spike (MS) and Matrix Spike Duplicate (MSD)	Aliquots of field samples spiked with compounds of interest and analyzed like samples.	One MS/MSD pair per analytical batch for organic analyses.	To assess accuracy and precision of analyses relative to matrix.	Laboratory Fortified Matrix (LFM)
Matrix Spike (MS) and Matrix Duplicate (MD)	Aliquots of field samples. One sample is spiked with compounds of interest and analyzed while the other aliquot is only analyzed like samples.	One MS/MD pair per analytical batch for inorganic analyses.	To assess accuracy and precision of analyses relative to matrix.	Laboratory Fortified Matrix (LFM), Duplicate (Dup)

Note: This table is intended to specify the type and minimum frequency of quality control elements proposed for soil, weathered bedrock, and groundwater sampling to be performed as part of Remedial Investigation activities in the former Burn Pit area of the IBM Gun Club site in Union, New York. As outlined in Section 5.3, the frequency of quality control samples such as duplicates and field blanks may be increased if warranted based on the observed results of initial testing.

FIGURES



NOTES:

1. THE TOPOGRAPHIC MAP CONSISTS OF A MOSAIC OF THE MAINE, CASTLE CREEK, ENDICOTT, AND BINGHAMTON WEST USGS 7.5 MINUTE QUADRANGLES (1:24,000) ACCESSED BY SHA IN FEBRUARY 2004 VIA THE NEW YORK STATE GEOGRAPHICAL INFORMATION SYSTEMS (NYSGIS) WEBSITE. THE TOPOGRAPHIC MAPS ARE DATED 1969 AND WERE PHOTOINSPECTED IN 1976.

2. THE IBM GUN CLUB SITE LIMITS SHOWN ARE BASED ON INFORMATION CONTAINED IN TWO AUTOCAD DRAWINGS ENTITLED “UNION2000.DWG” AND “UNIONEAST.DWG” THAT WERE PROVIDED TO SHA ON OCTOBER 10, 2002 BY THE BROOME COUNTY TAX MAPPING SERVICES DIVISION.

NO.	DATE	DESCRIPTION	BY

GRAPHICAL SCALE
400 0 400 800 1200 Feet

Sanborn, Head & Associates, Inc.
CONSULTING ENGINEERS & SCIENTISTS

DRAWN BY: EMB
DESIGNED BY: EMB
CHECKED BY: JO
REVIEWED BY: DBC
PROJECT MGR: JO
PIC: DBC
DATE: JAN 06

RI WORK PLAN - FORMER BURN PIT AREA
IBM GUN CLUB
UNION, NEW YORK

LOCUS PLAN

PROJECT NUMBER : 2400.00

FIGURE NUMBER : 1

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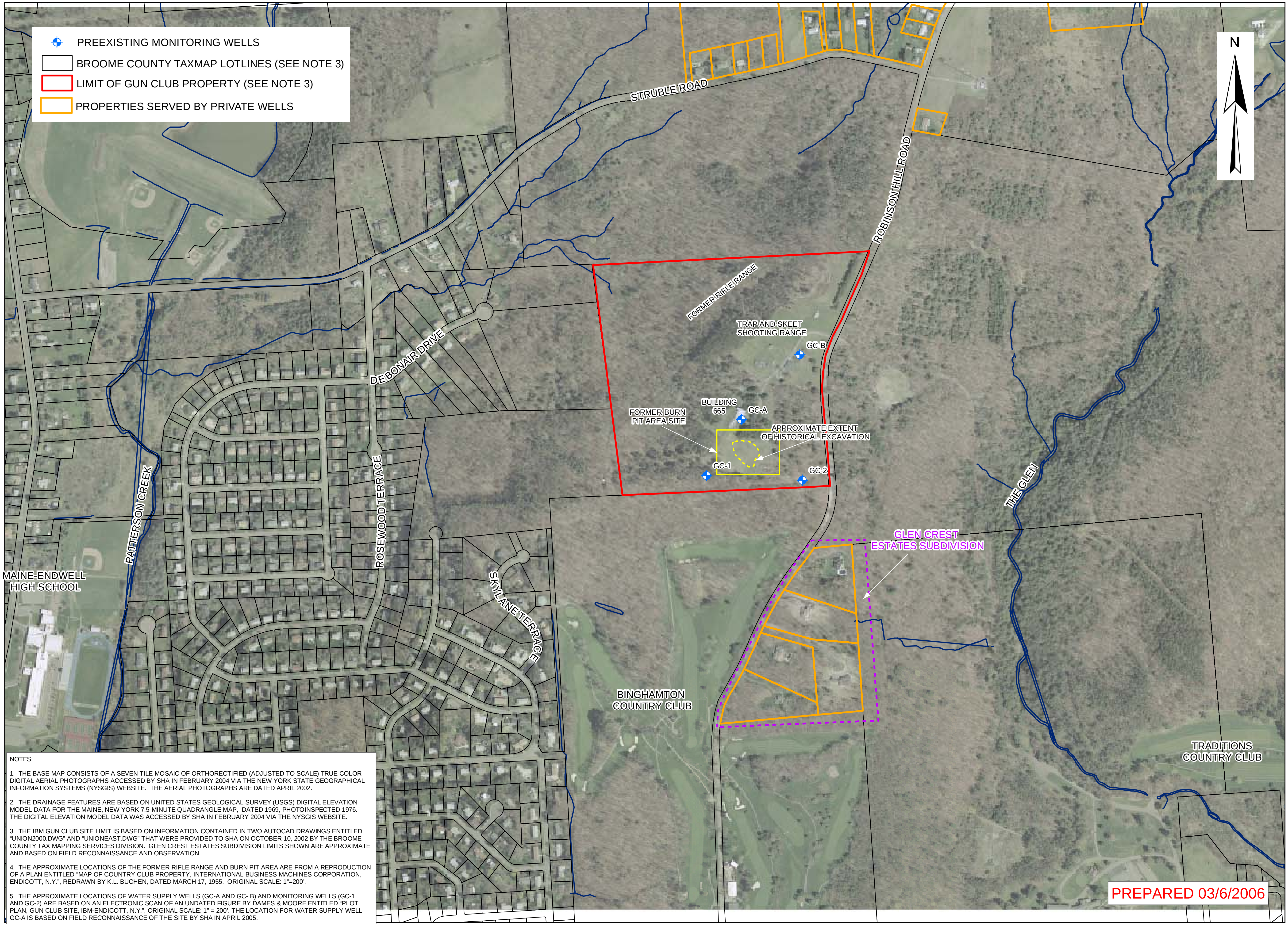
IMAGE FILE:
PLOT DATE:06/13/2005



⌖	PREEXISTING MONITORING WELLS
☐	BROOME COUNTY TAXMAP LOTLINES (SEE NOTE 3)
🟥	LIMIT OF GUN CLUB PROPERTY (SEE NOTE 3)
🟧	PROPERTIES SERVED BY PRIVATE WELLS

NOTES:

1. THE BASE MAP CONSISTS OF A SEVEN TILE MOSAIC OF ORTHORECTIFIED (ADJUSTED TO SCALE) TRUE COLOR DIGITAL AERIAL PHOTOGRAPHS ACCESSED BY SHA IN FEBRUARY 2004 VIA THE NEW YORK STATE GEOGRAPHICAL INFORMATION SYSTEMS (NYSGIS) WEBSITE. THE AERIAL PHOTOGRAPHS ARE DATED APRIL 2002.

2. THE DRAINAGE FEATURES ARE BASED ON UNITED STATES GEOLOGICAL SURVEY (USGS) DIGITAL ELEVATION MODEL DATA FOR THE MAINE, NEW YORK 7.5-MINUTE QUADRANGLE MAP, DATED 1969, PHOTOINSPECTED 1976. THE DIGITAL ELEVATION MODEL DATA WAS ACCESSED BY SHA IN FEBRUARY 2004 VIA THE NYSGIS WEBSITE.

3. THE IBM GUN CLUB SITE LIMIT IS BASED ON INFORMATION CONTAINED IN TWO AUTOCAD DRAWINGS ENTITLED "UNION2000.DWG" AND "UNIONEAST.DWG" THAT WERE PROVIDED TO SHA ON OCTOBER 10, 2002 BY THE BROOME COUNTY TAX MAPPING SERVICES DIVISION. GLEN CREST ESTATES SUBDIVISION LIMITS SHOWN ARE APPROXIMATE AND BASED ON FIELD RECONNAISSANCE AND OBSERVATION.

4. THE APPROXIMATE LOCATIONS OF THE FORMER RIFLE RANGE AND BURN PIT AREA ARE FROM A REPRODUCTION OF A PLAN ENTITLED "MAP OF COUNTRY CLUB PROPERTY, INTERNATIONAL BUSINESS MACHINES CORPORATION, ENDICOTT, N.Y.", REDRAWN BY K.L. BUCHEN, DATED MARCH 17, 1955. ORIGINAL SCALE: 1"=200'.

5. THE APPROXIMATE LOCATIONS OF WATER SUPPLY WELLS (GC-A AND GC- B) AND MONITORING WELLS (GC-1 AND GC-2) ARE BASED ON AN ELECTRONIC SCAN OF AN UNDATED FIGURE BY DAMES & MOORE ENTITLED "PLOT PLAN, GUN CLUB SITE, IBM-ENDICOTT, N.Y.", ORIGINAL SCALE: 1" = 200'. THE LOCATION FOR WATER SUPPLY WELL GC-A IS BASED ON FIELD RECONNAISSANCE OF THE SITE BY SHA IN APRIL 2005.

PREPARED 03/6/2006

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CAD FILE:
IMAGE FILE:
PLOT DATE:06/13/2005

NO.	DATE	DESCRIPTION	BY

GRAPHICAL SCALE
300 0 300 600 900 Feet

Sanborn, Head & Associates, Inc.
CONSULTING ENGINEERS & SCIENTISTS

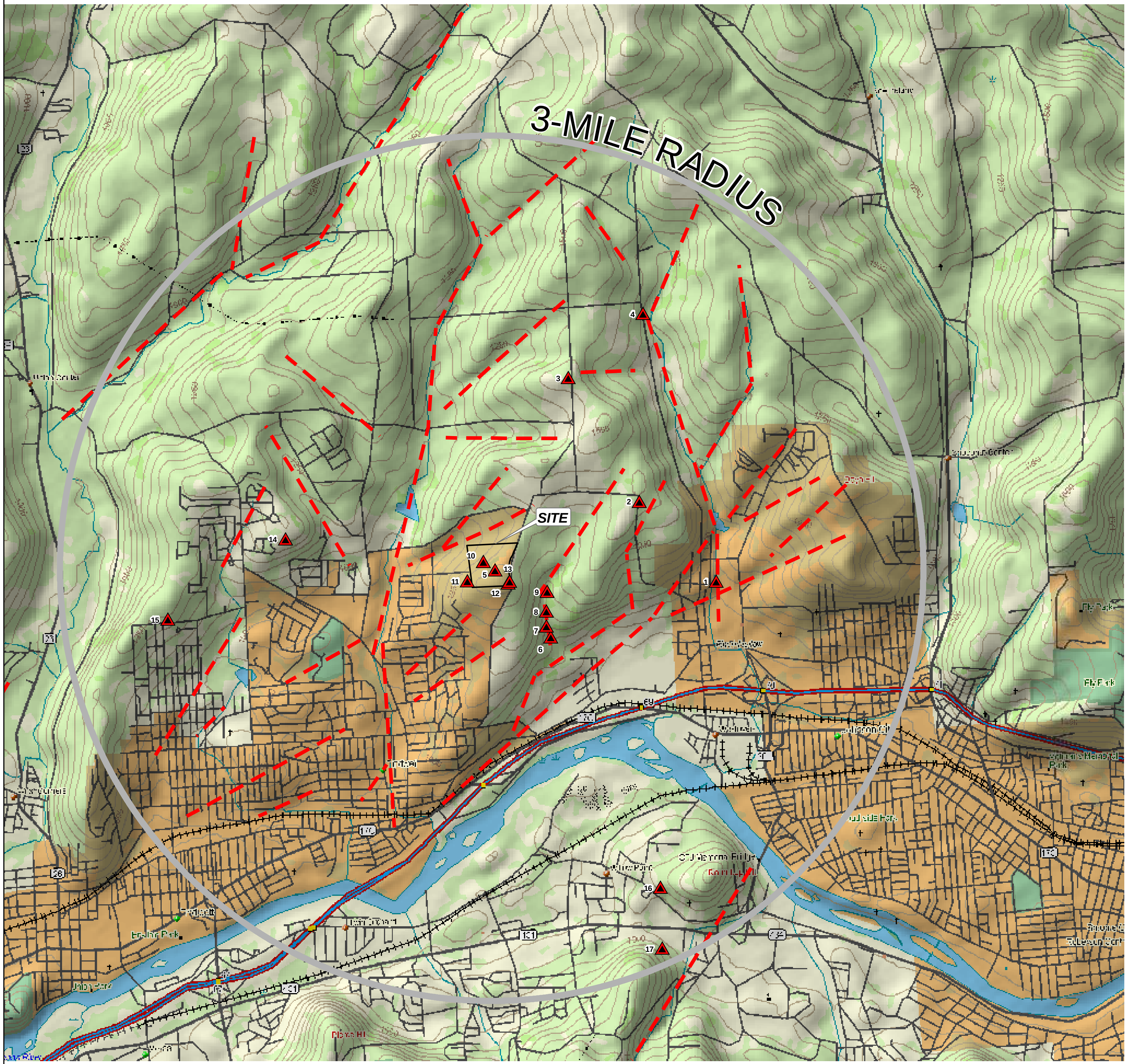
DRAWN BY: EMB
DESIGNED BY: EMB
CHECKED BY: JO
REVIEWED BY: DBC
PROJECT MGR: JO
PIC: DBC
DATE: MAR 06

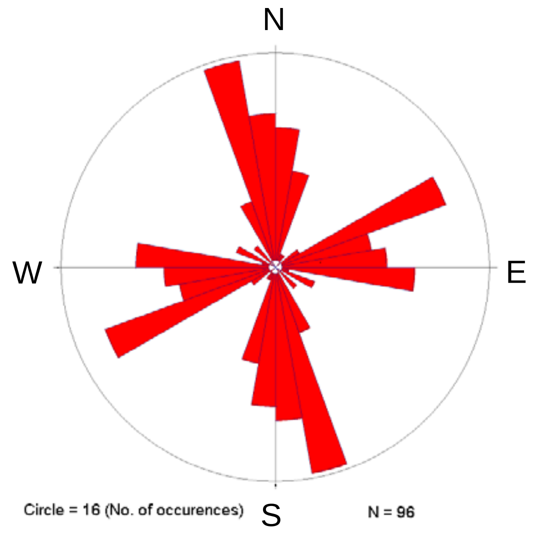
RI WORK PLAN - FORMER BURN PIT AREA
IBM GUN CLUB
UNION, NEW YORK

AREA PLAN

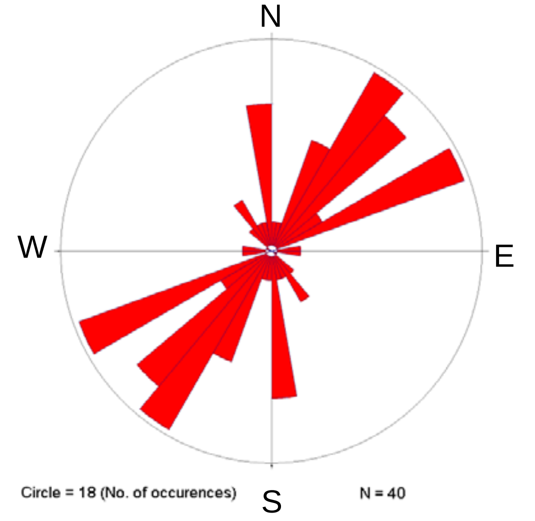
PROJECT NUMBER :
2400.00

FIGURE NUMBER :
2





STRIKE AZIMUTHS OF FRACTURES



TREND AZIMUTHS OF PHOTOLINEAMENTS SHOWN ON PLAN

NOTES:

1. THIS FIGURE IS INTENDED TO SHOW LINEAR TOPOGRAPHIC FEATURES AND BEDROCK OUTCROPS RELATIVE TO THE SITE. THE PHOTOLINEAMENTS SHOWN ARE BASED ON A SHA REVIEW OF STEREOSCOPIC PAIRS OF HIGH AND LOW ALTITUDE AERIAL PHOTOGRAPHS. FIELD RECONNAISSANCE MAPPING OF GEOLOGIC FEATURES WAS PERFORMED BY SHA PERSONNEL ON JULY 1, 2004. LOCATION OF BEDROCK OUTCROPS ARE BASED ON GPS POINTS COLLECTED BY SHA PERSONNEL ON JULY 1, 2004.

2. THE BASE MAP WAS CREATED USING MAPPING SOFTWARE BY DELORME ENTITLED TOPO USA, VERSION 3.0, COPYRIGHT 2001.

3. TREND AZIMUTHS OF PHOTOLINEAMENTS AND STRIKE AZIMUTHS OF BEDROCK JOINTS/FRACTURES ARE PLOTTED ON ROSE DIAGRAMS IN A 360 DEGREE PROJECTION.

PREPARED 03/6/2006

N

NO.	DATE	DESCRIPTION	BY

GRAPHICAL SCALE
2000 0 2000 4000 6000 Feet

Sanborn, Head & Associates, Inc.
CONSULTING ENGINEERS & SCIENTISTS

DRAWN BY: EMB
DESIGNED BY: EMB
CHECKED BY: JO
REVIEWED BY: DBC
PROJECT MGR: JO
PIC: DBC
DATE: MAR 06

RI WORK PLAN- FORMER BURN PIT AREA
IBM GUN CLUB
UNION, NEW YORK

PHOTOLINEAMENT AND BEDROCK OUTCROP PLAN

PROJECT NUMBER :
2400.00

FIGURE NUMBER :
3

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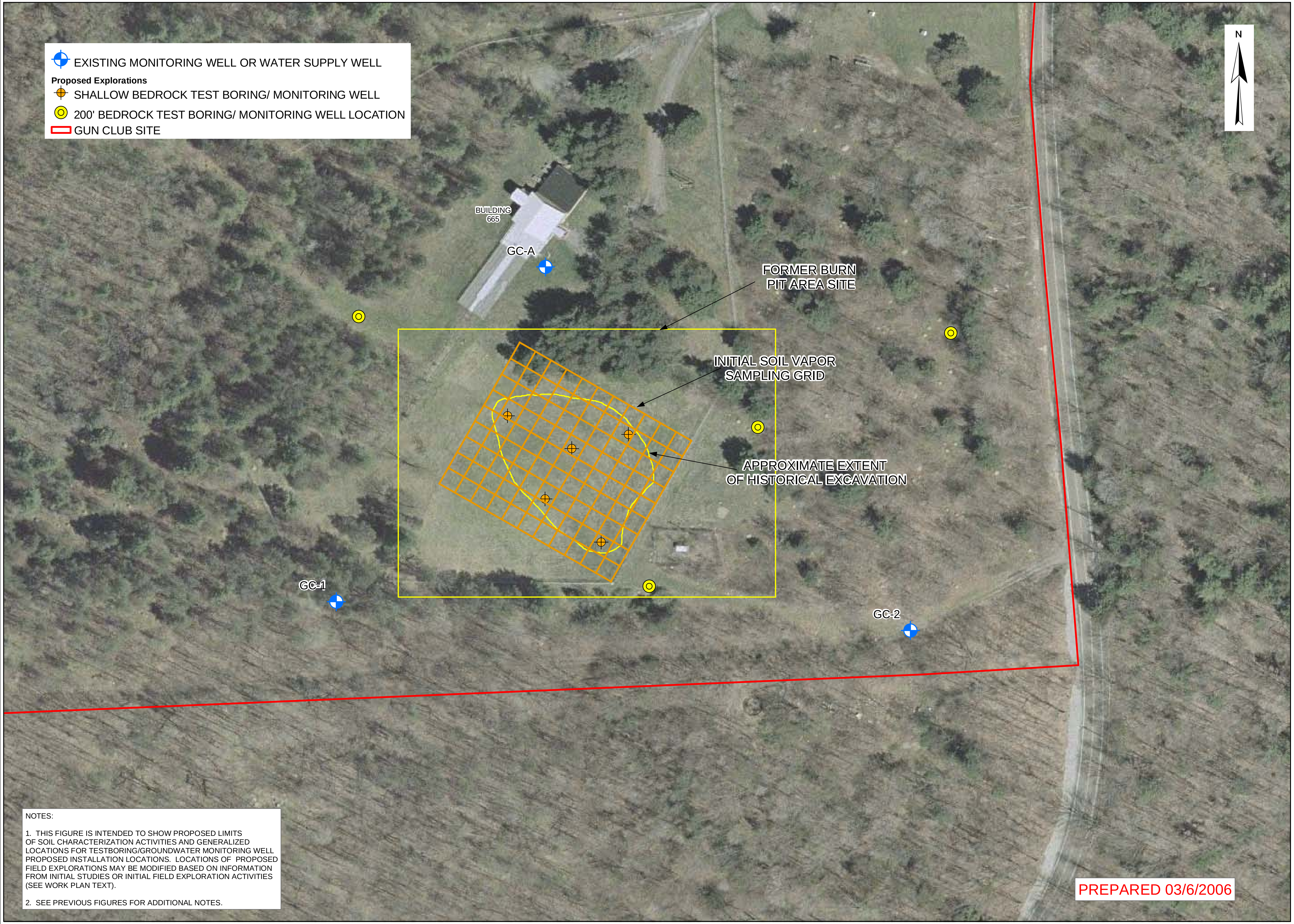
PLOT DATE:06/13/2005



⊕	EXISTING MONITORING WELL OR WATER SUPPLY WELL
Proposed Explorations	
⊕	SHALLOW BEDROCK TEST BORING/ MONITORING WELL
◎	200' BEDROCK TEST BORING/ MONITORING WELL LOCATION
▭	GUN CLUB SITE

NOTES:

1. THIS FIGURE IS INTENDED TO SHOW PROPOSED LIMITS OF SOIL CHARACTERIZATION ACTIVITIES AND GENERALIZED LOCATIONS FOR TESTBORING/GROUNDWATER MONITORING WELL PROPOSED INSTALLATION LOCATIONS. LOCATIONS OF PROPOSED FIELD EXPLORATIONS MAY BE MODIFIED BASED ON INFORMATION FROM INITIAL STUDIES OR INITIAL FIELD EXPLORATION ACTIVITIES (SEE WORK PLAN TEXT).

2. SEE PREVIOUS FIGURES FOR ADDITIONAL NOTES.

PREPARED 03/6/2006

NO.	DATE	DESCRIPTION	BY

GRAPHICAL SCALE
50 0 50 100 150 Feet

Sanborn, Head & Associates, Inc.
CONSULTING ENGINEERS & SCIENTISTS

DRAWN BY: EMB
DESIGNED BY: EMB
CHECKED BY: JO
REVIEWED BY: DBC
PROJECT MGR: JO
PIC: DBC
DATE: MAR 06

RI WORK PLAN - FORMER BURN PIT AREA
IBM GUN CLUB
UNION, NEW YORK

PROPOSED EXPLORATION LOCATION PLAN

PROJECT NUMBER : 2400.00

FIGURE NUMBER : 4

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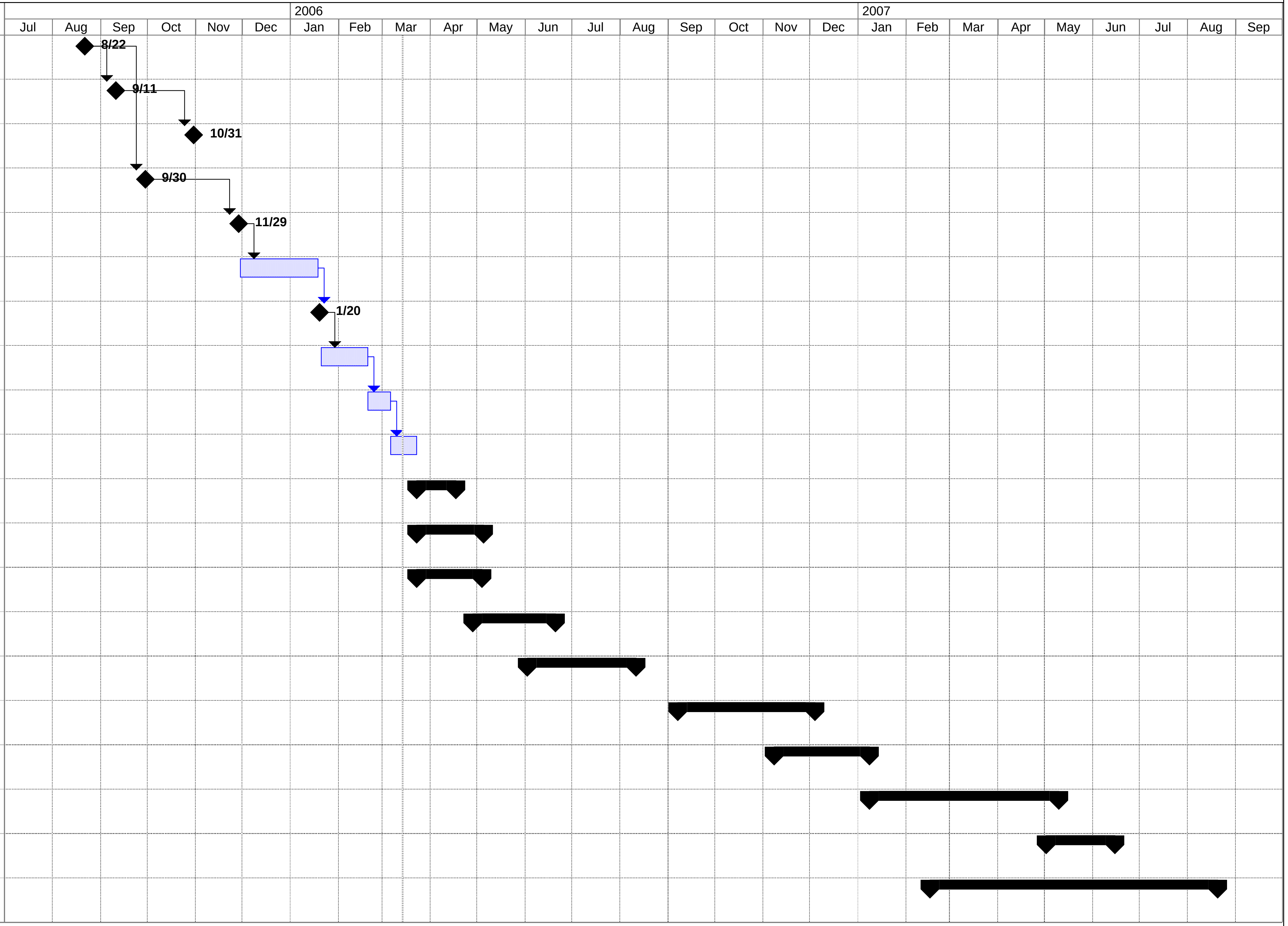
CAD FILE:
IMAGE FILE:
PLOT DATE:06/15/05

FIGURE 5
Projected Schedule
RI Work Plan - Former Burn Pit Area
IBM Gun Club
Union, New York

ID	Task Name
1	Execution of Brownfield Cleanup Agreement (BCA)
2	Agency Submittal of Draft Citizen Participation Plan (CPP)
3	Agency Approval of CPP
4	Submittal of Preliminary Draft Remedial Investigation (RI) Work Plan to Agencies
5	Agency Comments on Preliminary Draft RI Work Plan
6	Incorporation of Initial Agency Comments on RI Work Plan
7	Submittal of CPP, Fact Sheet, and Draft RI Work Plan for Public Comment
8	Public Comment Period
9	Final Regulatory Review of Work Plan
10	Finalize RI Work Plan
11	**Initial Studies**
14	**Soil Vapor Survey and Soil Explorations**
21	**Geophysical Logging of Existing Bedrock Wells**
26	**Instrumentation and Monitoring of Existing Bedrock Well**
32	**Data Analysis**
37	**Rock Core Sampling and Shallow Bedrock Monitoring Wells**
46	**Data Analysis**
51	**New Bedrock Monitoring Installations**
70	**Confirmatory Groundwater Sampling**
75	**Data Analysis and Reporting**



APPENDIX A

LIMITATIONS

LIMITATIONS

1. The conclusions and recommendations described in this report are based in part on the data obtained from a limited number of soil samples from widely spaced subsurface explorations. The nature and extent of variations between these explorations may not become evident until further investigation is initiated. If variations or other latent conditions then appear evident, it will be necessary to re-evaluate the recommendations of this report.

2. The generalized soil profile described in the text is intended to convey trends in subsurface conditions. The boundaries between strata are approximate and idealized and have been developed by interpretations of widely spaced explorations and samples; actual soil transitions are probably more gradual. For specific information, refer to the exploration logs.

3. Water level measurements have been made at times and under conditions stated within the text of the report and indicated on the exploration logs and in the report. Note that fluctuations in the level of the groundwater may occur due to variations in rainfall and other factors not evident at the time measurements were made.

4. Quantitative laboratory analyses were performed by others as part of the past investigations as noted within the report. It must be noted that additional compounds not searched for during the past investigations may be present in soil and groundwater at the site. SHA has relied upon the data provided by the analytical laboratory, and has not conducted an independent evaluation of the reliability of these data. Moreover, it should be noted that variations in the types and concentrations of contaminants and variations in their distributions within the groundwater and soil may occur due to the passage of time, seasonal water table fluctuations, recharge events, and other factors.

5. The interpretations and conclusions contained in this work plan are based in part upon various types of chemical data as well as historical and hydrogeologic information developed by previous investigators. While SHA has reviewed that data and information as stated in this report, any of SHA's interpretations, conclusions, and recommendations that have relied on that information will be contingent on its validity. Should additional chemical data, historical information, or hydrogeologic information become available in the future, such information should be reviewed by SHA and the interpretations, conclusions and recommendations presented herein should be modified accordingly.

6. This report has been prepared for the exclusive use of the IBM Corporation (IBM) for specific application for the IBM Endicott Gun Club Site in accordance with generally accepted hydrogeologic practices. No other warranty, express or implied, is made.

7. In the event that any changes in the nature, design, or location of the facilities are planned, the conclusions and recommendations contained in this report should not be considered valid unless the changes are reviewed and conclusions of this report modified or verified in writing by SHA. SHA is not responsible for any claims, damages, or liability associated with interpretation of subsurface data or re-use of the subsurface data or engineering analyses without the express written authorization of SHA.

APPENDIX B

SITE-SPECIFIC HEALTH AND SAFETY PLAN

SITE-SPECIFIC HEALTH AND SAFETY PLAN

IBM Gun Club Site
Union, New York

Prepared for
Sanborn, Head & Associates, Inc.

Prepared by
Sanborn, Head & Associates, Inc.

File 2400
September 2005

EMERGENCY INFORMATION

Please see attached area map in **Appendix A** showing route to nearest hospital from site.

Endwell Fire Department	911 or (607) 778-1911
Johnson City Police Department	911 or (607) 729-9321
Wilson Memorial Hospital	(607) 763-6000
Central NY Poison Control Center	1-800-222-1222
National Response Center	1-800-424-8802
Chemical Response Team:	1-800-526-9191
On-Site First Aider(s):	SHA cell phone
Site Safety Officer:	SHA cell phone
Safety Consultant: Safe-Tech	(207) 773-5753
Site Telephone	SHA cell phone

DIRECTIONS TO WILSON MEMORIAL REGIONAL HOSPITAL

From the Site, go northeast on Robinson Hill Road towards Case Road. Turn right onto CR-65/Oakdale Road. Turn sharp left onto CR-56/Harry L Drive after about 0.5 miles turn right onto NY-201 South. Take the RT-17C ramp and turn right onto 17C/Main Street. After approximately 0.5 miles turn right onto Harrison Road, Wilson Memorial Regional Hospital will be on your left.

ACKNOWLEDGMENT

I have read and understand the Site-Specific Health and Safety Plan for the IBM Gun Club Site in Union, New York. I agree to abide by these safety rules and understand that any violation may result in my removal from the Site.

NAME (Please print)	SIGNATURE	DATE

S:\DATA\2400s\2400\HASP\ACKNOWLEDGMENT.DOC

1.0 INTRODUCTION

This Site Safety and Health Plan (SSHP) has been developed for use by employees who will be working on the IBM Gun Club former Burn Pit Area (BPA or site) Remedial Investigation (RI). The site is located at 1395 Robinson Hill Road, Town of Union, Broome County, New York. The SSHP describes safety and health procedures and requirements for work that will be performed at this site. Field activities to be conducted at the site are defined in the RI Work Plan. All corporate health and safety programs (i.e., Construction Safety for Excavations, Hazard Communication, Personal Protective Equipment, Hearing Conservation, etc.) also apply to work performed on this Site.

For purposes of this plan, “employee(s)” means all Sanborn, Head & Associates, Inc. (SHA) employees who will be working on this Site. All employees will comply with the requirements of this SSHP and will sign the Acknowledgment on the last page of this SSHP. This SSHP will be provided to on-Site subcontractors at their request for informational purposes only. Pursuant to OSHA regulations and SHA’s subcontract agreement, the subcontractor is responsible for the health and safety of its employees. Similarly, the health and safety of employees of other entities (e.g., Site owners) will be the responsibility of their respective employers, and this SSHP will be provided to them at their request for informational purposes only.

Based on the results of available prior site characterization information and the history of the Site, Level D personal protective equipment (PPE) is anticipated to be appropriate for all planned field activities at the Site as described herein. If previously unidentified conditions that affect health or safety issues are discovered, work in the Work Zone will cease and this SSHP will be amended accordingly. Amendments are found in Appendix C of this SSHP.

2.0 KEY PERSONNEL/CONTACTS

2.1 Site Safety Officer

The Safety Officer, or his designee, is responsible for:

- Oversight of all aspects of the project;
- Coordination of all health and safety issues,
- Implementing the provisions of this SSHP;
- Performing Site hazard analysis;
- Provide recommendations for PPE modifications; and
- Emergency response procedures.

The Site Safety Officer will:

- Provide daily safety briefings to inform all Site workers of hazardous conditions;
- Be present during all field activities; and

- In consultation with the Project Manager and the Principal-in-Charge (PIC), modify this SSHP to ensure adequate protection from physical, health or environmental hazards.

2.2 Site Contacts

Title	Name	Company	On-Site Phone	Off-Site Phone
Project Manager	Jonathan Ordway	SHA	603-781-2249	207-761-9300
Site Safety Officer	Erica Bradstreet	SHA	207-841-8175	207-761-9300

3.0 SITE CONTROL

3.1 Medical Care

3.1.1 Emergency Medical Care

The closest medical facility to the Site providing emergency care is **Wilson Memorial Hospital** in Johnson City, New York. A map showing the route to this facility is included in **Appendix A**. Directions to the facility are listed on the Emergency Information page in the front of this plan.

3.1.2 On-Site First Aid

The on-site first aid provider is the Site Safety Officer. First Aid Kits are located in SHA ready bags.

3.2 Work Zones

Work zones will be established and marked prior to beginning work activities. The purpose of work zones is to:

- Reduce the migration of contaminants into “clean areas”;
- Limit access of unauthorized personnel;
- Control chemical exposure; and
- Limit physical hazards.

3.2.1 Work Zone

The Work Zone is the area where work is being performed and where physical and chemical hazards may be present. **Only authorized employees who meet training and medical surveillance requirements defined in Section 12.0 of this SSHP may enter this zone.** If a

Decontamination Zone is established, it will serve as the only means of entry or exit to the Work Zone.

3.2.2 Contamination Reduction Zone (CRZ)/Decontamination Zone

The Contamination Reduction Zone, if established, is the buffer zone between the Work Zone and the Support Zone. Employees entering and leaving the work area must use this corridor, if established. Only authorized employees who meet training and medical surveillance requirements may enter this zone. The access corridor through the CRZ to the Exclusion Zone will be clearly delineated and may serve as the Decontamination Zone, if one is required.

3.2.3 Support Zone

This zone is the “clean area” and contains site offices, sanitation facilities, and clean equipment. All employees are required to sign the Site Sign-in Log (found in Appendix B of this SSHP) upon entry and exit. The Log will be maintained by the Site Safety Officer.

3.3 Visitors

This SSHP is intended to cover SHA employees only. Refer to Section 1.0 for discussion regarding other personnel.

3.4 Work Rules

In addition to all applicable Corporate Health and Safety Programs, the following general safety rules will be followed by all project employees.

- Use specified safety equipment and PPE at all times in the work and contamination reduction zones (if established).
- Use intrinsically safe and non-sparking tools, where conditions warrant.
- Follow corporate health and safety requirements for use of hearing protection based on the specific task being performed.
- Extinguish all potential sources of ignition.
- Avoid unnecessary contact with contaminated or potentially contaminated surfaces.
- While in the work zones, do not eat, drink, chew gum or tobacco, smoke or engage in any practice that increases the probability of hand-to mouth transfer and ingestion of contaminants.
- Wash your hands and face upon leaving the work area and before eating, drinking, performing bathroom functions, or other activities.
- Because medication can increase the effects of toxic chemicals in exposure situations, employees who must be on medication will advise their supervisor prior to beginning work on site.

3.5 Buddy System

The buddy system ensures that no employee works alone in a high hazard area. When working in a "buddy-system required" area, employees are paired and must always be in close proximity to each other. If one employee leaves the zone for any reason, both employees must leave. The buddy system will be used for Task 2 (Former Burn Pit Area Soil Characterization) and Task 3 (Groundwater Characterization).

3.6 Communicating on the Site

Successful communication between workers in the exclusion zone and the support zone is essential. Normal verbal communication will be used, as all fieldwork as described in this SSHP is expected to be performed in Level D PPE.

4.0 HEALTH RISK ANALYSIS

See Table 1 for a complete listing of principal contaminants of concern. Material Data Safety Sheets (MSDS) for each analyte are located in **Appendix E**.

TABLE 1
Health Risk Analysis Data

Substance	OSHA PEL (ppm)	ACGIH TWA (ppm)	Air Monitoring Action Level (ppm)	NIOSH IDLH (ppm)	Principle Routes of Exposure	Target Organs and Systems	Carcinogen
Carbon Tetrachloride	10	5	5	200	Inh, Abs, Ing, Con	CNS, eyes, lungs, liver, kidneys, skin	Y
cis-1,2-Dichloroethene (1,2-DCE)	200	200	100	1000	Inh, Ing, Con	CNS, eyes, resp. sys	N
Trichloroethene (TCE)	100	50	25	1000	Inh, Abs, Ing, Con	Eyes, skin, resp sys, heart, liver, CNS	Y
Dichloroethane (1,1-DCA)	100	100	50	3000	Inh, Ing, Con	Skin, liver, kidney, lungs, CNS	N
Vinyl Chloride	1	1	5	N.D.	Inh, Con	Liver, resp. sys, CNS, blood, lymphatic sys.	Y
Trichloroethane (1,1,1-TCA)	350	350	175	-	Inh, Ing, Con	Eyes, skin, CNS, CVS, liver	Y
1,1,2,2-Tetrachloroethane	5	1	5	100	Inh, Abs, Ing, Con	skin, liver, kidneys, CNS, GI tract	Y
Benzene	1	0.5	5	500	Inh, Ing, Abs, Con	skin, eyes, resp. sys, CNS, blood, bone marrow	Y
Chloroform	50	10	5	500	Inh, Abs, Ing, Con	Liver, kidneys, heart, eyes, skin CNS	Y
Toluene	200	100	50	500	Inh, Abs, Ing, Con	Liver, resp. sys, CNS, kidneys, eyes, skin	N
Xylenes	100	100	50	900	Inh, Abs, Ing, Con	Eyes, skin, resp. sys., CNS, GI tract, blood, liver, kidneys	N

Notes:

OSHA = Occupational Safety and Health Administration
PEL = Permissible Exposure Limit
IDLH = Immediately Dangerous to Life or Health
N.D. = not yet determined
TWA = Time-Weighted Average. Measured over an 8-hour workday.
STEL = Short-Term Exposure Limit
ppm = parts per million
mm Hg = millimeters of mercury
Inh = inhalation
Abs = absorption
Ing = ingestion
Con = dermal contact
CNS = central nervous system
Resp. sys = respiratory system
GI = gastrointestinal
Carcinogen=an agent that is known or suspected to cause cancer

5.0 TASK RISK ANALYSIS

Each task to be performed as a part of the Scope of Work for this site has been identified in Section 3.0. Table 2 provides a summary of tasks associated with the Scope of Work for this project and the hazards and protective measures anticipated for each. Precautions will be taken to abate physical hazards as well as chemical hazards.

TABLE 2

Hazard Analysis for Work Activities

Task	Hazard (Chemical or Physical)	Description	Hazard Control or Abatement
Site Reconnaissance/ Location and Elevation Survey	Slip/Trip/Fall Hazards, Biological Hazards, Heat/Cold Hazards	The presence of slippery surfaces, surface debris, uneven or rough surfaces, and steep grades may precipitate a slip, trip, or fall. Personnel may also encounter a wide variety of insects and arachnids as well as irritating plants. Work conducted at temperatures at or below freezing or exceeding 70F may encounter heat/cold related stress.	Practice good housekeeping so as to avoid slip, trip, and fall hazards. Wear long sleeved shirts and pants and use insect repellent to avoid contact with insects and irritating plants. Appendix F presents the prevention and treatment of heat and cold related illness.
Soil Vapor Survey, Soil Sampling, Test Pit Excavation, Test Boring/ Monitoring Well Installations	Chemical Hazards, Hazards Working Near Heavy Equipment, Slip/Trip/Fall Hazards, Heat/Cold Hazards	Historical monitoring at the site indicates the presence of VOCs in groundwater. See Table 1 for health effects associated with chemical exposure to these compounds. SHA personnel will be in close proximity to the drilling rigs and trucks, which potentially present serious construction hazards. As above, slips, trips and falls, as well as heat/cold stress are also potential hazards.	Monitor airspace with PID w/ 10.6-eV. Practice general construction/heavy equipment safety practices. If air monitoring action levels are exceeded, stop work and evacuate. Avoid direct contact with samples to be collected. Wear nitrile gloves. Follow recommendations regarding cold stress provided in Appendix F. Wear layered clothing for warmth if necessary.
Groundwater Sampling and Analysis	Chemical Hazards, Slip/Trip/Fall Hazards, Heat/Cold Hazards	Historical monitoring at the site indicates the presence of VOCs in groundwater. See Table 1 for health effects associated with chemical exposure to these compounds. As above, slips, trips and falls, as well as heat/cold stress are also potential hazards.	Avoid direct contact with samples to be collected. Wear nitrile gloves. Follow recommendations regarding cold stress provided in Appendix F. Wear layered clothing for warmth if necessary.

6.0 AIR MONITORING

The purpose of air monitoring is to quantify airborne contaminants in order to determine and verify the level of PPE required. A direct-reading photoionization detector (PID) with a 10.6-ev bulb will be used. Table 3 summarizes the air monitoring program, which includes two action levels. The first action level is used to screen for the presence of benzene and vinyl chloride, the two compounds with the lowest ACGIH TWA values. If vinyl chloride or benzene exceed their TWA value (compared to background concentrations), then work should cease and the project should be reassessed. If this action level is reached but the concentrations of vinyl chloride and benzene remain below their respective TWA values, then work can continue with periodic monitoring of vinyl chloride and benzene concentrations. However, should the breathing zone concentrations reach 5.0 ppm above background, work should discontinue and the health and safety plan should be reassessed. An Air Monitoring Log, used to record the ambient air monitoring, is attached in Appendix D. Table 4 details the appropriate PPE for the proposed work.

TABLE 3
Air Monitoring Procedures

Type of Monitoring	Instrument	Monitoring Frequency/Protocols	Action Level	Action
Ambient Air (breathing zone)	ID w/ 10.6-ev bulb	Continuous/as needed based on observations	1.0 ppm	If sustained readings of 1.0 ppm above BACKGROUND are encountered, discontinue work and use Drager tubes to test for vinyl chloride and benzene. If vinyl chloride and benzene concentrations are below 1.0 ppm for both compounds, work can continue. Periodic monitoring of vinyl chloride and benzene concentrations using Drager tubes should be conducted until readings fall below the action level. If vinyl chloride or benzene concentrations exceed 1.0 or 0.5 ppm, respectively, discontinue work, contact the Project Manager to reassess operations.
			5.0 ppm	If sustained readings of 5.0 ppm above background (regardless of vinyl chloride and benzene concentrations) are encountered discontinue work, leave work area and contact Project Manager; if levels do not go below action levels, reassess operations and modify HASP before work can resume.

TABLE 4
Personal Protective Equipment and Corresponding Air Monitoring Results

Personal Protective Equipment Level		Application
Level D	Cotton long sleeve shirt and pants (or coveralls) Steel-toed and shank work boots Inner nitrile gloves Hard hat, as required Hearing protection, as required Work gloves, as required	PID level ≤ 1.0 ppm in breathing zone, or ≤5.0 ppm with confirmation of vinyl chloride and benzene below their respective TWA values

7.0 PROTECTION FROM POTENTIAL HAZARDS

7.1 Personal Protective Equipment (PPE)

Based on analytical data available, Level D is anticipated to be appropriate for all field activities at this Site as described in this SSHP. Use Table 1 (page 11) to obtain Action Levels for each contaminant and Table 4 to determine appropriate PPE levels. Hard hats, boots and safety glasses shall meet ANSI standards.

7.2 IDLH Conditions

It is unlikely that employees will encounter conditions that are immediately dangerous to life and health. Therefore, no special engineering controls or extraordinary work practices are required. **If IDLH conditions are detected based on results of monitoring, work in the Work Zone will cease and this SSHP will be revised.**

7.3 Engineering Controls

None anticipated for use at this Site as part of the field activities covered under this SSHP.

7.4 Reassessment of SSHP

When a significant change occurs, the hazards will be reassessed. Some indicators of the need for reassessment include:

- Beginning a new work phase not previously identified in this SSHP;
- Chemical compounds are discovered other than those previously identified; and/or
- A change in the Scope of Work that affects the degree of contact with contaminated material.

8.0 DECONTAMINATION PLAN

8.1 Decontaminating PPE

Based on current data, decontamination of PPE is not anticipated at this Site.

8.2 Decontaminating Equipment

Air monitoring equipment: If contamination is likely, wrap monitoring equipment in Ziploc bags to avoid the need for decontamination. If the equipment has to be decontaminated, follow the manufacturer's recommendations.

9.0 CONFINED SPACE ENTRY

No confined space entry will be performed by SHA personnel as part of our work at this Site.

9.0 TRAINING AND MEDICAL SURVEILLANCE

9.1 Training

All employees shall be trained prior to performing any work activities or entering the work zones. Training shall include:

- 40-hour Hazardous Waste Operations training;
- Three days supervised field experience;
- Annual 8-hour refresher training, as required; and
- Review of this SSHP including Hazard Communication, hazard evaluation, safe work practices, emergency response, evacuation routes, and PPE use and limitations.

Additional training is required for the following positions.

- Supervisors - 8 hours above the 40-hour and annual 8-hour refreshers.
- Air-monitoring - Training as recommended by manufacturer.

Documentation of employee training and medical surveillance clearance for hazardous waste site work is kept at the company office.

10.0 EMERGENCY RESPONSE

In the event of an exposure, accident, injury, or fire, the following general accident and emergency response procedures are to be followed by all employees working under this SSHP.

The Site Safety Officer shall:

- Establish evacuation routes on a daily basis;
- Brief site employees on emergency response procedures; and implement emergency response procedures, including
- Order evacuation,
- Contact local emergency services and environmental authorities,
- Investigate the incident or accident, and
- File all necessary reports and notifications to Federal, State and local authorities.

10.1 Evacuation

- In the event of an emergency, immediately notify the Site Safety Officer.
- The signal to evacuate is to yell "evacuate."
- Due to the size of the Site, when so ordered, all employees will evacuate to the Site location designated by the Site Safety Officer at the beginning of each day.

Following an evacuation, the Site Safety Officer or designee will perform a head count, using the logbook, to account for all employees who entered the site.

10.2 Fire or Explosion

In the event of a fire or explosion, the Site Superintendent will notify the local fire department. Fire extinguishers may be used for small incipient fires by **trained employees only**. Otherwise, evacuate!

10.3 Chemical Leaks or Spills

Mitigate if feasible to do safely, and call Emergency Service Personnel.

10.4 Medical Emergencies

For minor injuries in the Work Zone, call for assistance, if necessary, decontaminate fully, and apply first aid.

For serious injuries in the Work Zone, call for assistance, decontaminate as fully as possible, move victim to non-contaminated area, and apply first aid if possible. If necessary, provide a copy of the MSDS to medical personnel.

10.5 Emergency Equipment

The following equipment will be available and will be located in the support zone upon immediate exit from the work area.

- First aid kit
- SHA cell phone

11.0 REPORTING INJURIES AND ILLNESSES

All employees on the site must immediately report injuries, illnesses, and near misses to their supervisor. If the injury is a result of, or could result in, a chemical exposure, the supervisor will report it to the Site Safety Officer. He or she will then take appropriate action to prevent further exposure.

Following an incident, a report will be completed by the supervisor and a copy given to the Site Safety Officer. All incident and illness reporting will follow corporate policies and procedures.

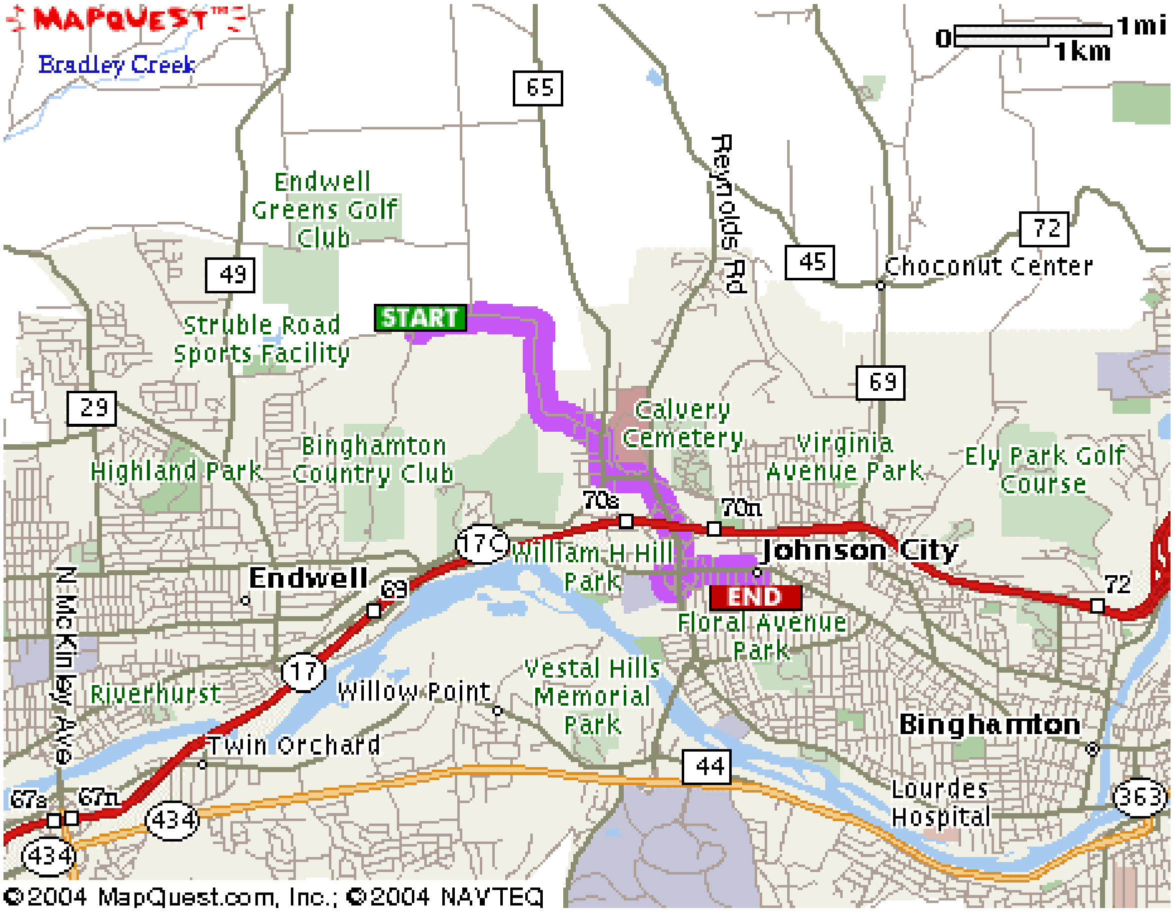
In the event of a hazardous material spill or chemical release above the reportable quantity, the Site Superintendent or designee will notify the appropriate federal and state agencies.

APPENDIX A

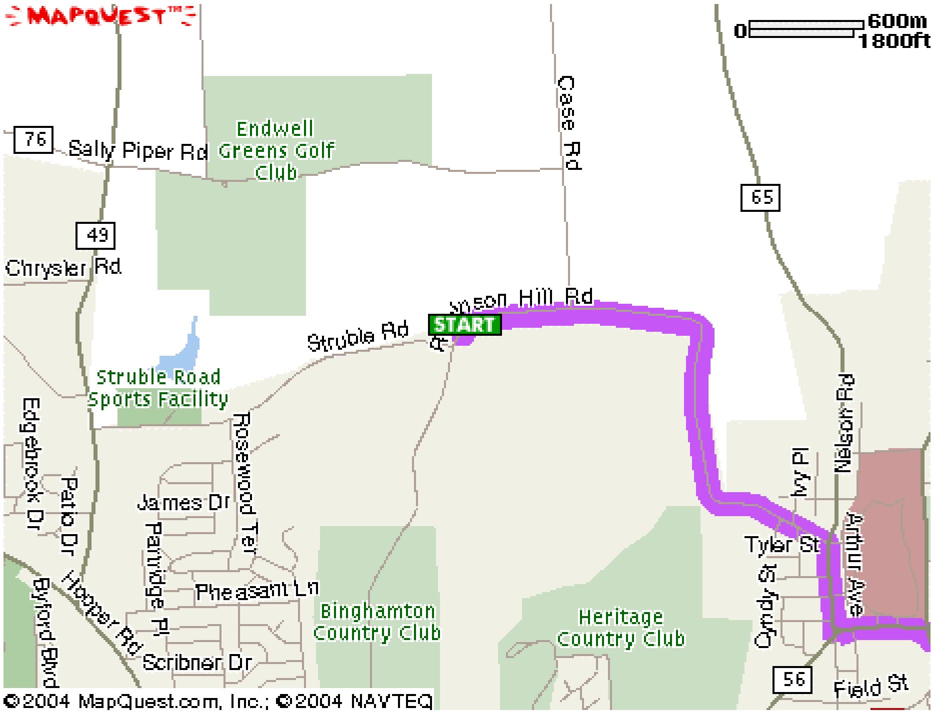
MAP OF ROUTE TO HOSPITAL

Appendix A

Route to Hospital



©2004 MapQuest.com, Inc.; ©2004 NAVTEQ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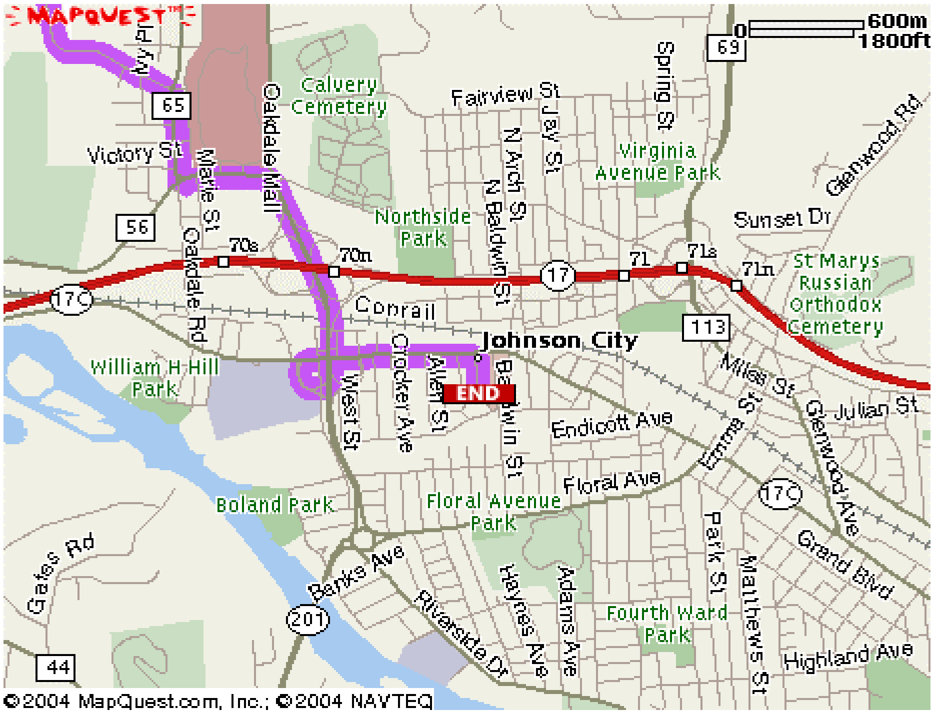
Endwell Greens Golf Club
Case Rd
65
49
Chrysler Rd
Struble Rd
START
Struble Road Sports Facility
Edgebrook Dr
Patio Dr
James Dr
Rosewood Ter
Partridge Pl
Pheasant Ln
Hooper Rd
Byford Blvd
Scribner Dr
Binghamton Country Club
Heritage Country Club
Ivy Pl
Nelson Rd
Tyler St
Arthur Ave
Cindy St
56
Field St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1800ft
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Calvery Cemetery
Fairview St
Jay St
N Arch St
Spring St
Virginia Avenue Park
Glenwood Rd
Victory St
Marie St
56
N Baldwin St
Northside Park
Sunset Dr
Oakdale Rd
70s
70n
71
71s
71n
St Marys Russian Orthodox Cemetery
17C
17
Conrail
113
Johnson City
William H Hill Park
West St
Crocker Ave
Allen St
Baldwin St
END
Endicott Ave
Miles St
Emma St
Julian St
Glenwood Ave
17C
Boland Park
Floral Avenue Park
Floral Ave
Grand Blvd
Park St
Matthews St
Gates Rd
Banks Ave
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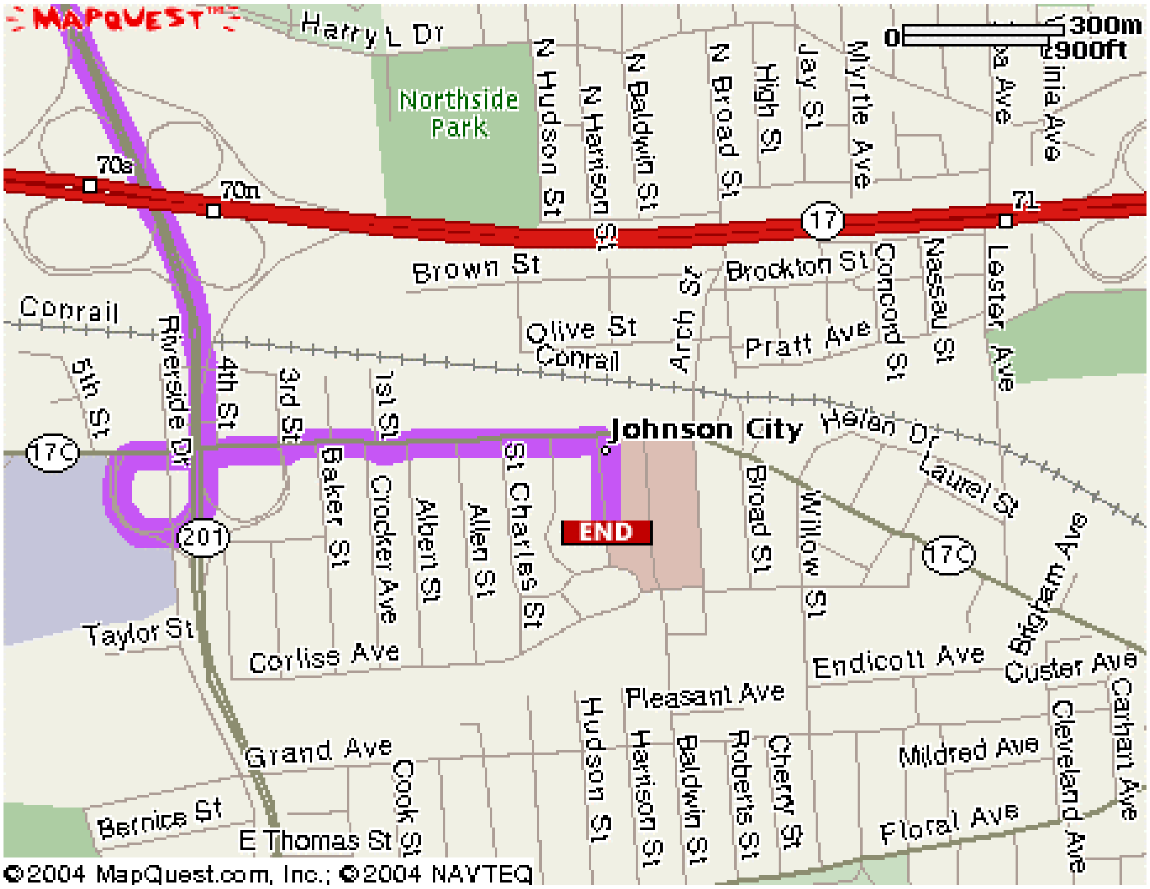
Riverside Dr
Haynes Ave
Adams Ave
Fourth Ward Park
Highland Ave
44


MAPQUEST
Harry L Dr
Northside Park
0
300m
900ft
N Hudson St
N Harrison St
N Baldwin St
N Broad St
High St
Jay St
Myrtle Ave
Ave
inia Ave
70s
70n
17
71
Brown St
Brockton St
Concord St
Nassau St
Lester Ave
Conrail
Olive St
Conrail
Arch St
Pratt Ave
Riverside Dr
4th St
5th St
3rd St
1st St
17C
Johnson City
Helen Dr
Laurel St
Baker St
Crocker Ave
Albert St
Allen St
St Charles St
END
Broad St
Willow St
201
17C
Brigham Ave
Taylor St
Corliss Ave
Endicott Ave
Custer Ave
Pleasant Ave
Hudson St
Harrison St
Baldwin St
Roberts St
Cherry St
Grand Ave
Mildred Ave
Cleveland Ave
Carhart Ave
Cook St
Bernice St
E Thomas St
Floral Ave

APPENDIX B

SITE SIGN-IN LOG

APPENDIX B

Site Sign-in Log
IBM Gun Club, Union, New York

Name	Affiliation	Date & Time

APPENDIX C

AMENDMENTS TO SITE-SPECIFIC HEALTH AND SAFETY PLAN

APPENDIX C

Amendments to Site Health and Safety Plan
IBM Gun Club Site, Union, New York

DATE	SECTION	PAGE	BY WHOM	RECEIVED BY

APPENDIX D

AIR MONITORING LOG

APPENDIX D

AIR MONITORING LOG

Date: ______________________________

Project: **IBM Gun Club Site, Union, New York**

Instrument: ______________________________

Contaminants of Concern And Explosion Control	PEL	Time	Monitoring Results

APPENDIX E

AIR MONITORING EQUIPMENT CALIBRATION AND MAINTENANCE RECORDS

(REFER TO FORMS KEPT WITH EACH PIECE OF EQUIPMENT)

APPENDIX F

HEAT AND COLD STRESS INFORMATION AND PREVENTION

APPENDIX F

HEAT / COLD STRESS INFORMATION

COLD STRESS INFORMATION

Exposure to cold among workers results in cold stress conditions (frost bite or hypothermia) if employees fail to escape from low environmental air temperatures or from immersion in low temperature water. Workers should be protected from exposure to the cold so that the deep core body temperature does not fall below 96.5 degrees Fahrenheit. Lower body temperatures will very likely result in reduced mental alertness, reduction in rational decision making or loss of consciousness with the threat of fatal consequences.

Pain in the extremities may be the first early warning of the danger to cold stress. During exposure to cold, maximum severe shivering develops when the body temperature has fallen to 95 degrees Fahrenheit. This must be taken as a sign of danger to the workers and exposure to cold should be immediately terminated for any workers when severe shivering becomes evident. Useful physical or mental work is limited when severe shivering occurs.

Protective Measures

Wear adequate insulating dry clothing to maintain normal core body temperatures. Remember wind chill factors must be taken into account as this lowers the air temperatures even more. All employees need to ensure their clothing remains dry working in cold temperatures as the wet clothing will freeze and cold stress symptoms such as frost bite (the whitening and freezing of the moisture cells in the tissue) may occur. If frost bite occurs, warm naturally as not to damage the cells of the tissue any further.

HEAT STRESS INFORMATION

Heat stress is a leading cause of illness at a hazardous waste site. Its causes include a number of interacting factors, such as: environmental conditions (e.g. temperature, humidity), clothing and level of PPE being worn, workload, and individual characteristics of the worker. Heat stress must still be considered as a potential physical hazard. Below are individual factors that may increase the chances of heat stress:

- Lack of physical fitness
- Lack of acclimation
- Age
- Dehydration
- Obesity
- Alcohol or drug use
- Infection
- Sunburn
- Chronic disease

Signs and Symptoms of Heat Stress

Condition	Symptoms	Causes
Heat rash	Skin rash	Continuous exposure to heat or humid air
Heat cramps	Muscle spasms; pain in the hands, feet and abdomen	Heavy sweating without nourishment (loss of electrolytes)
Heat exhaustion	Pale, cool, moist skin; heavy sweating; dizziness; nausea; fainting	Increased stress on body organs, including inadequate blood circulation due to cardiovascular inefficiency or dehydration
Heat stroke	Red, hot, usually dry skin; reduced perspiration; nausea; dizziness; strong, rapid pulse; coma	Body temperature regulation failure; body temperature rises to critical levels **NOTE:** body must be immediately cooled and medical assistance must be sought.

Prevention of Heat Stress

- Recognize symptoms
- Maintain body fluids
- Provide cooling devices
  (e.g., vests, suits, showers)
- Provide cool or shaded shelter
- Maintain physical fitness
- Adjust work schedules
  (e.g., breaks, slowdowns, rotation of personnel, work during cooler hours)

APPENDIX G

TRAINING AND MEDICAL SURVEILLANCE RECORDS

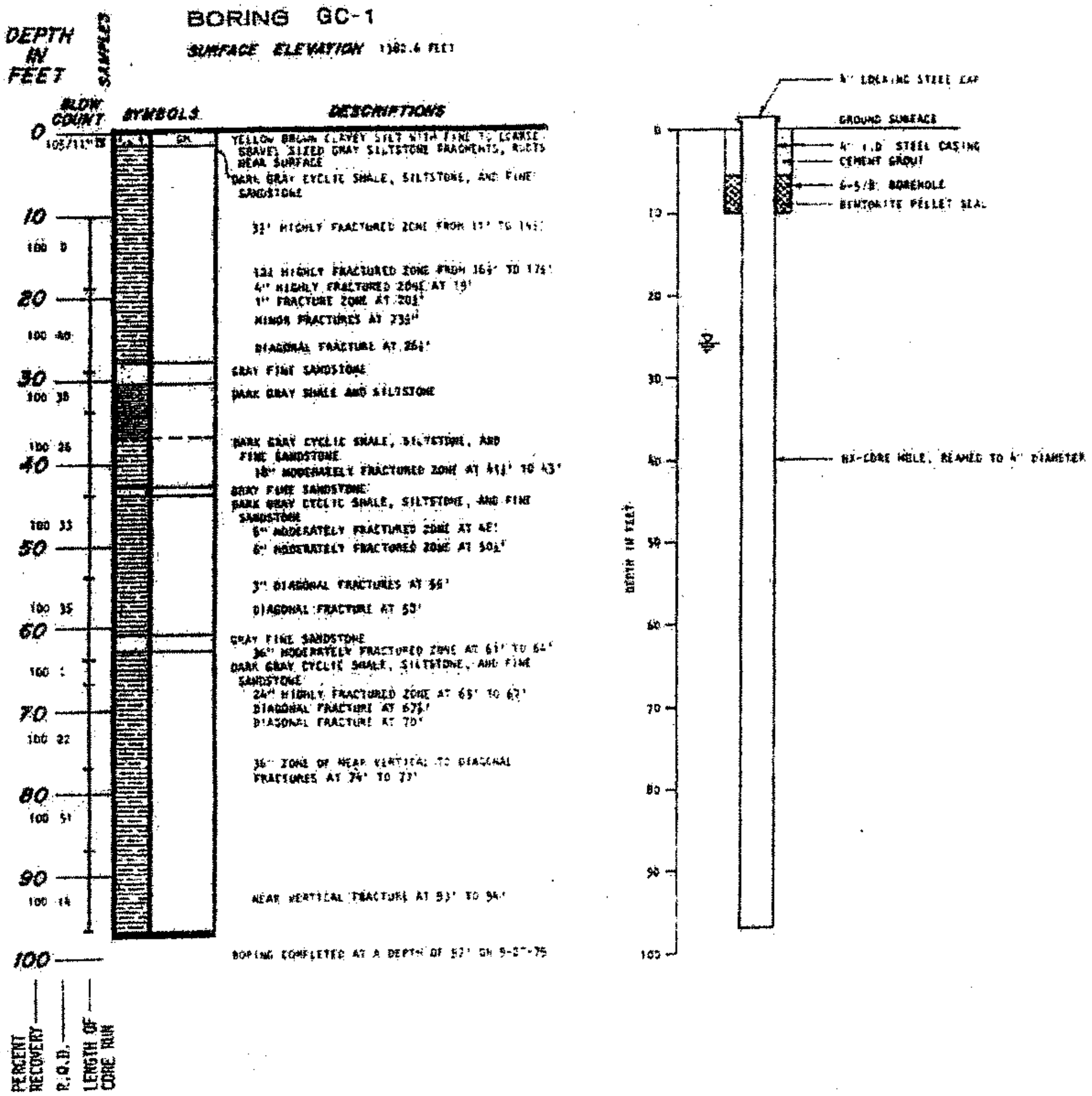
(KEPT AT COMPANY OFFICE)

APPENDIX C

BACKGROUND INFORMATION

APPENDIX C.1

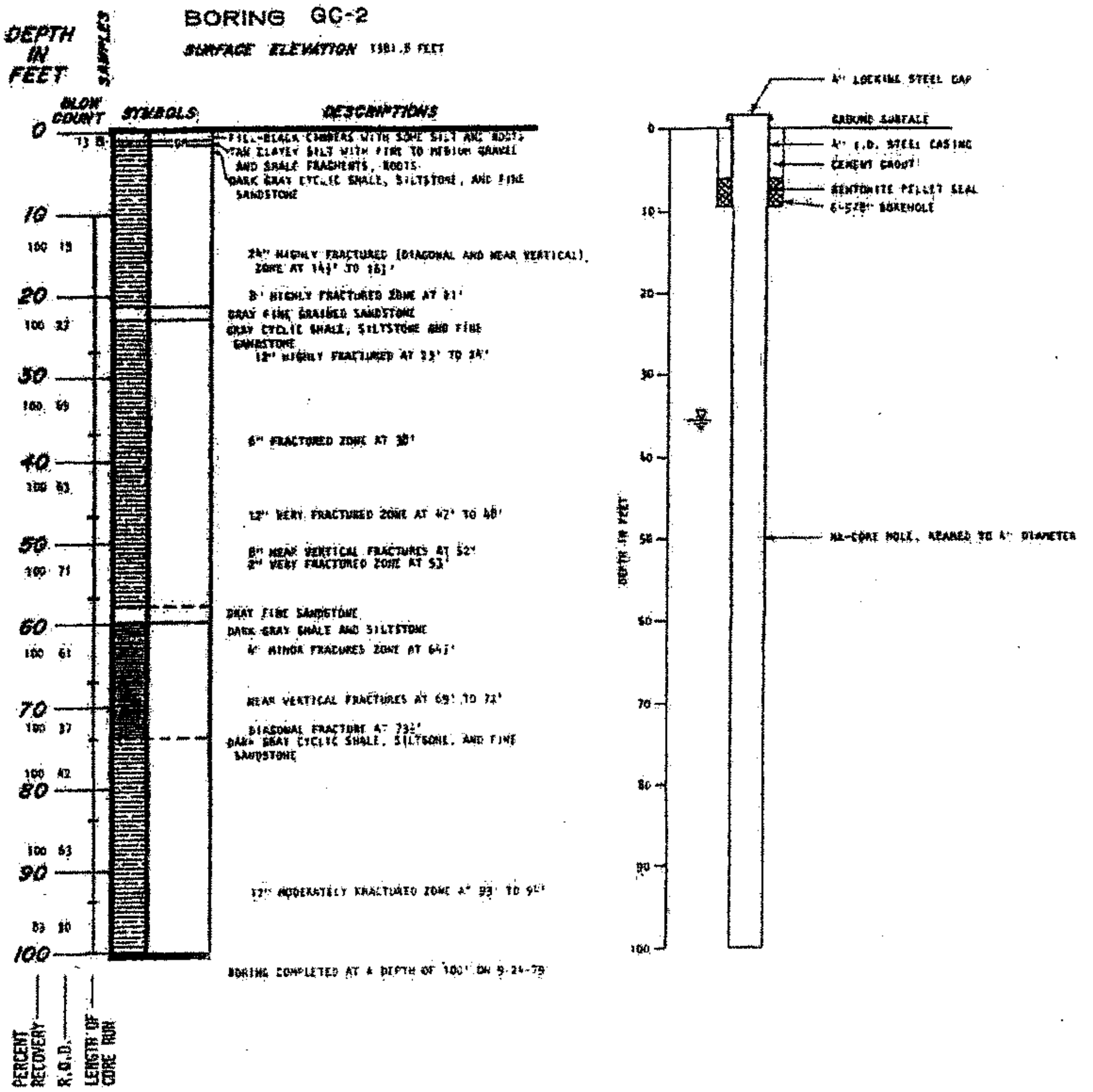
TEST BORING/ WELL INSTALLATION LOGS



BORING LOG AND MONITORING WELL DETAILS

IBM-ENDICOTT, N.Y.

FIGURE 8.D



BORING LOG AND MONITORING WELL DETAILS

IBM - ENDICOTT, N.Y.

DAMES & MOORE

FIGURE 3.E

PRIVILEGED AND CONFIDENTIAL
ATTORNEY/CLIENT WORK PRODUCT

Cato Pump & Well Drilling, Inc.

13104 South Street, Cato, New York 13033

Project: Groundwater Protection Phase II & III
IBM Corporation Endicott, N.Y.
Purchase Order No. Z882869 513
Client: IBM Corporation
Date Started: 7/24/80
Date Completed: 7/24/80
Driller: Thomas Begley
Inspector:

Project No.: CA1007
Boring No.: GC-1_2
Surface Elev.:
Groundwater Depth-Casing In:
Below Ground Surf.-Casing Out:

Sheet 1 of 1

DEPTH	SAMPLE DEPTH	SAMPLE NO.	BLOWS ON SAMPLER 0"/6"	6"/12"	12"/18"	18"/24"	N	MATERIAL DESCRIPTION
	No samples required							Drilled with 7 7/8" tricone roller rock bit from 0.0'-8.0' Placed nominal 6" ID steel drive pipe to 8.0' Bentonite pellet seal 8.0'-6.0' Grout 6.0'-1.0' Cuttings 1.0'-0.0' Advanced hole with 5 7/8" bit and pneumatic hammer from 8.0'-100.0' Locking casing cap installed upon completion of boring

N = No. of blows to drive____spoon____w/____lb. weight____ each blow.
Casing Type:

PRIVILEGED AND CONFIDENTIAL
ATTORNEY/CLIENT WORK PRODUCT

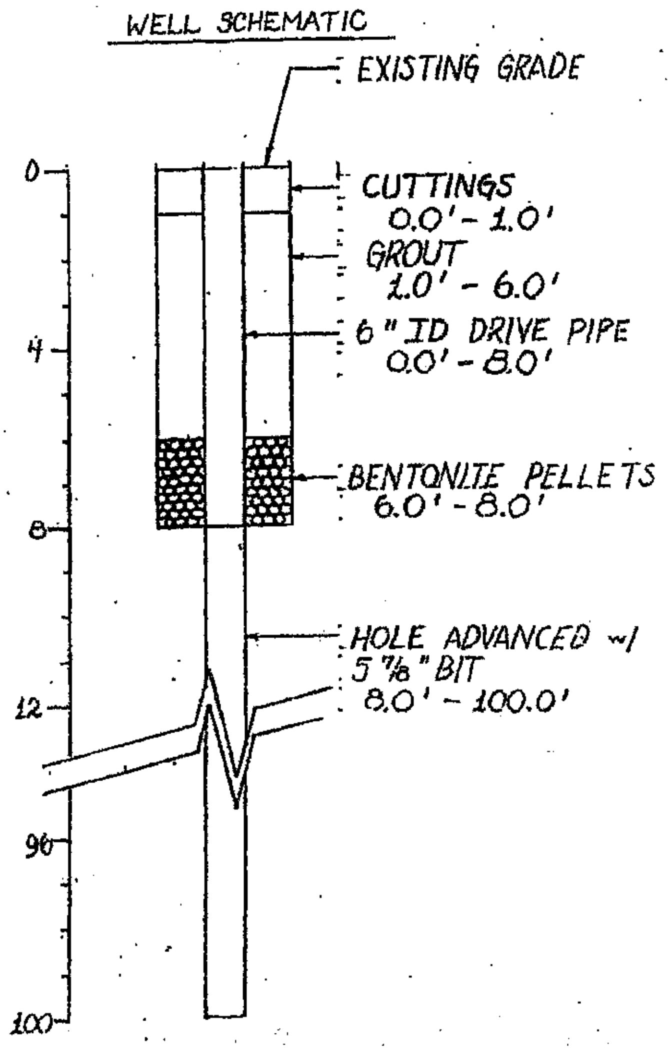
Cato Pump & Well Drilling, Inc.

13104 South Street, Cato, New York 13033

- WELL SCHEMATIC &/or SUBSURFACE PROFILE -

Project: Groundwater Protection I & II
Endicott, NY
Client: IBM Corporation
Date Started: 7/24/80
Date Completed: 7/24/80
Driller: Thomas Begley
Inspector:

Project No.: CA1007
Boring No.: GC-1$_2$
Surface Elev.: 1382.90
Groundwater Depth-Casing In:
Below Ground Surf.-Casing Out:
Casing Diam.: 2"
Sheet 1 of 1



Scale: 1" = 4'

PRIVILEGED AND CONFIDENTIAL
ATTORNEY/CLIENT WORK PRODUC

Cato Pump & Well Drilling, Inc.

13104 South Street, Cato, New York 13033

WELL LOCATION SKETCH

Project/Location: IBM - Endicott, NY

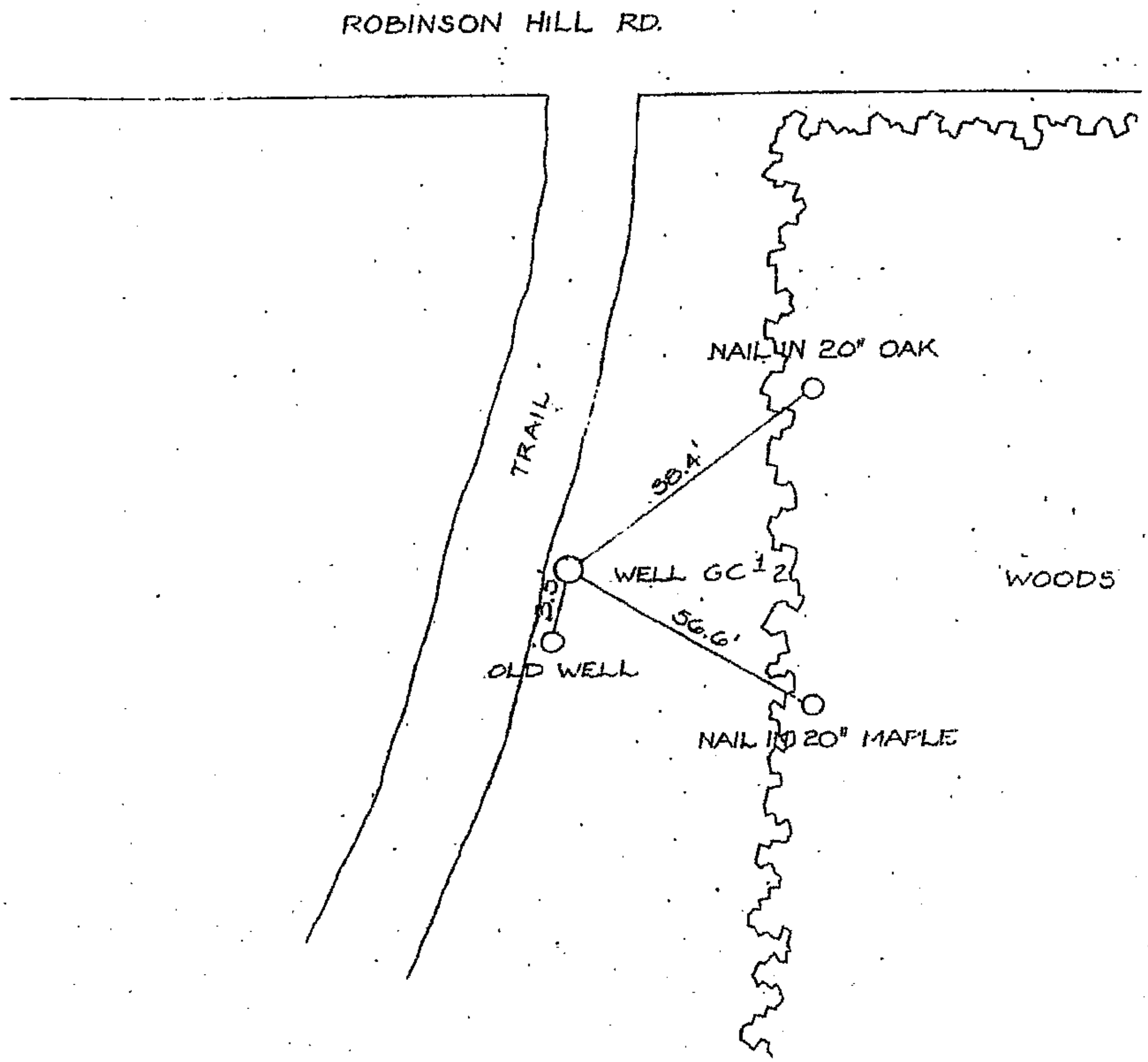
Date Surveyed: Certified 1/19/80

Survey By: Jas. P. McNamara, L.S.

Project No.: CA1007

Boring No.: GC-1_2

Casing Elev.: 1382.90



Not To Scale

PRIVILEGED AND CONFIDENTIAL
ATTORNEY/CLIENT WORK PRODUCT

GROUNDWATER SCIENCES CORPORATION

GEOLOGIC LOG: MW-103

Page 1 of 1

PROJECT INFORMATION		DRILLING INFORMATION	
JECT:	*IBM - Endicott Country Club*	DRILLING CO.:	*Parratt-Wolff*
LOCATION:	*Endicott, New York*	DRILLER:	*Glen Lansing*
NO.:	*02013*	RIG TYPE:	*Truck-mounted*
GED BY:	*David L. Reusswig/Jason M. Taylor*	DRILLING METHOD:	*HSA/Air Rotary/Air Hammer*
ES DRILLED:	*11/1/02 & 11/4/02*	DEVELOPMENT DATE:	*11/5/02*
		LOCATION:	*Approximately 150' southeast (downgradient) of Lab Fill Area*
TES:	All PID readings for overburden soil were 0.0 ppm	ELEVATION:	
		NORTHING: ---	EASTING: ---

FEET	CUM. BLOWN YIELD	SAMP. #	LITHOLOGY	GRAPHIC	DEPTH FEET	WELL CONSTRUCTION	WELL CONSTRUCTION DETAILS

VEGETATION/HUMUS: grass, vegetation, organic material, dark brown to black

SILT: medium brown with sand and some gravel, dry

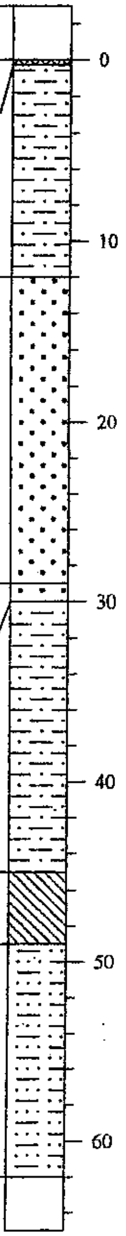
SAND: dark brown with gravel and some silt, dry

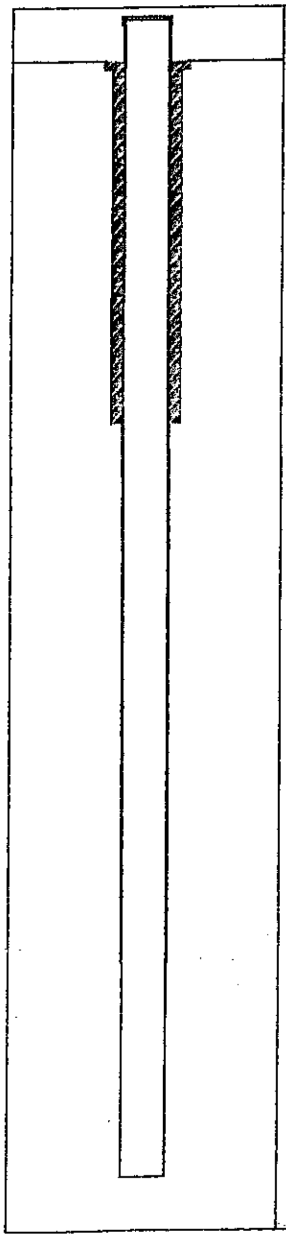
SAND: dark brown with gravel and some silt, thin wet layer at 29'-30'

SILT: blue, with fine grained sand and gravel and little clay, dry

WEATHERED SILTSTONE: dark brown/gray with high clay content, some silt and gravel/rock fragments, fissile, moist

SILTSTONE: gray to light gray, slightly fissile, competent, water-bearing zone 50' - 58'





4" diameter steel standpipe with steel cap and 16" diameter pad

6.25" diameter hollow stem auger, 0'-20'

4" diameter air rotary, 20-50'

4" diameter steel casing, 2.5' above grade - 50'

4" diameter air rotary open borehole, 20'-62'

PRIVILEGED AND CONFIDENTIAL
ATTORNEY/CLIENT WORK PRODUCT

GROUNDWATER SCIENCES CORPORATION

GEOLOGIC LOG: MW-103S

Page 1 of 1

PROJECT INFORMATION

JECT: *IBM - Endicott Country Club*
E LOCATION: *Endicott, New York*
NO.: *02013*
GED BY: *David L. Reusswig/Jason M. Taylor*
ES DRILLED: *11/1/02 & 11/4/02*

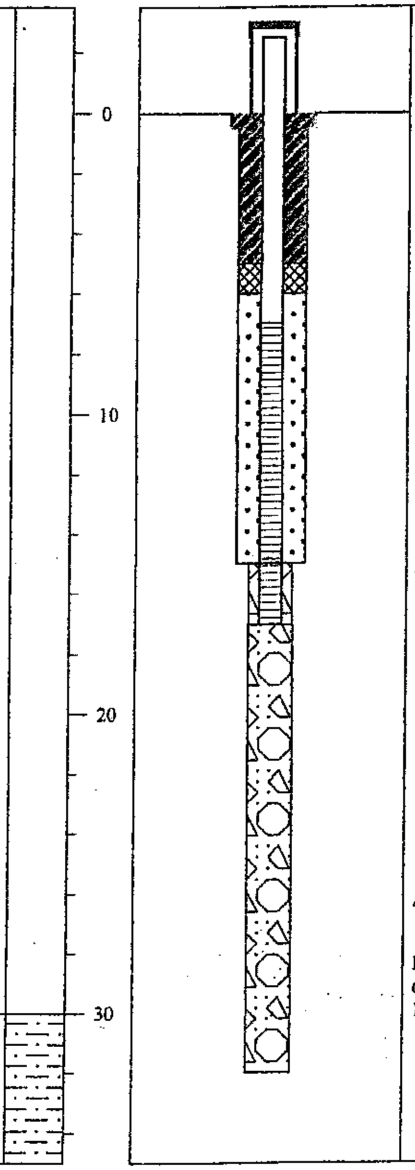
TES: All PID readings for overburden soil were 0.0 ppm

DRILLING INFORMATION

DRILLING CO.: *Parratt-Wolff*
DRILLER: *Glen Lansing*
RIG TYPE: *Truck-mounted*
DRILLING METHOD: *HSA/Air Rotary/Air Hammer*
DEVELOPMENT DATE: *11/5/02*
LOCATION: *Approximately 150' southeast (downgradient) of Lab Fill Area*

ELEVATION:
NORTHING: — EASTING: —

FEET	CUM. BLOWN YIELD	SAMP. #	LITHOLOGY	GRAPHIC	DEPTH FEET	WELL CONSTRUCTION	WELL CONSTRUCTION DETAILS
			SILT: blue, with fine grained sand and gravel and little clay,dry		30		



4" diameter steel standpipe with steel cap and 16" diameter pad

6.25" diameter hollow stem auger, 0'-15'

Portland cement, 0'-5'

Bentonite annular seal, 5'-6'

#0 Sand, 6'-17'

0.010-slot screen, 7'-17'

4" diameter air rotary, 15'-32'

Drilling ceased at 32'. Collapsed overburden, 15'-32'. Set well at 17'.

PRIVILEGED AND CONFIDENTIAL
ATTORNEY/CLIENT WORK PRODUCT

GROUNDWATER SCIENCES CORPORATION

GEOLOGIC LOG: MW-105

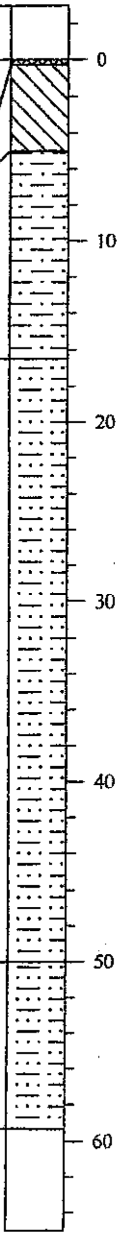
Page 1 of 1

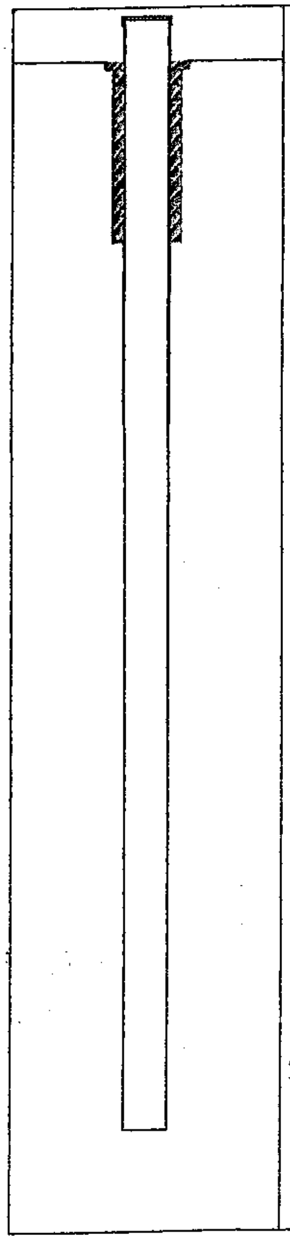
PROJECT INFORMATION		DRILLING INFORMATION	
ECT:	*IBM - Endicott Country Club*	DRILLING CO.:	*Parratt-Wolff*
LOCATION:	*Endicott, New York*	DRILLER:	*Glen Lansing*
NO.:	*02013*	RIG TYPE:	*Truck-mounted*
GED BY:	*David L. Reusswig/Jason M. Taylor*	DRILLING METHOD:	*HSA/Air Rotary/Air Hammer*
		DEVELOPMENT DATE:	*11/6/02*
ES DRILLED:	*11/5/02 - 11/6/02*	LOCATION:	*Approximately 150' southwest (upgradient) of Lab Fill Area*

ES: All PID readings for overburden soil were 0.0 ppm
WL on 11/6/02 at 16:00 = 38.21' from TOC

ELEVATION:
NORTHING: —
EASTING: —

FEET	CUM. BLOWN YIELD	SAMP. #	LITHOLOGY	GRAPHIC	DEPTH FEET	WELL CONSTRUCTION	WELL CONSTRUCTION DETAILS
			VEGETATION/HUMUS: grass, vegetation, organic material, dark brown to black		0		4" diameter steel standpipe with steel cap and 16" diameter pad
			CLAY: brown, moist, cohesive, with some silt and trace gravel				6.25" diameter hollow stem auger, 0'-10'
			SILT: brown, dry, with little clay and fine grained sand, and some gravel		10		4" diameter air rotary, 10'-20'
			SILTSTONE: gray, dry, slightly fissile, competent		20		4" diameter steel casing, 2.5' above grade - 20'
			SILTSTONE: gray, wet, slightly fissile, competent, (water-bearing)		50		4" diameter air rotary open borehole, 20'-59.3'

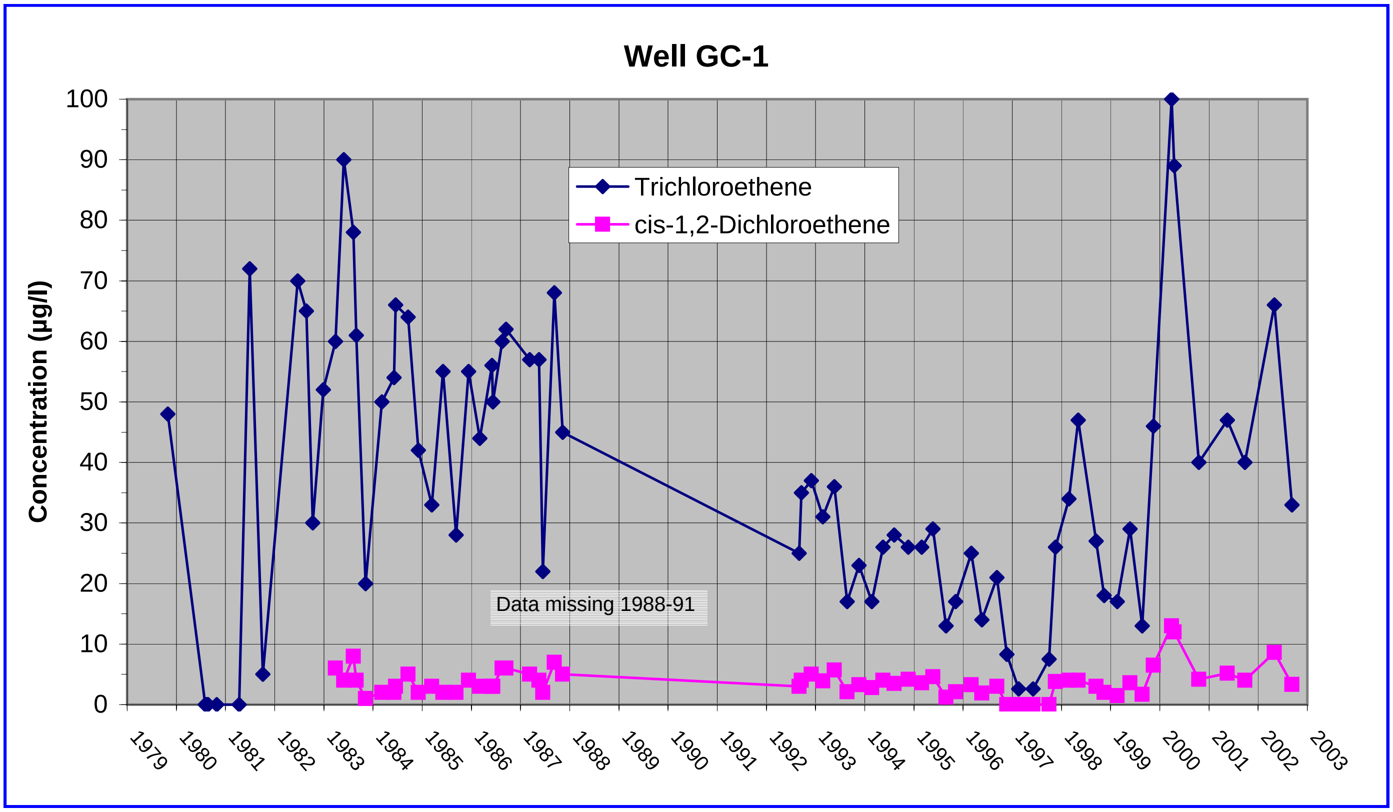


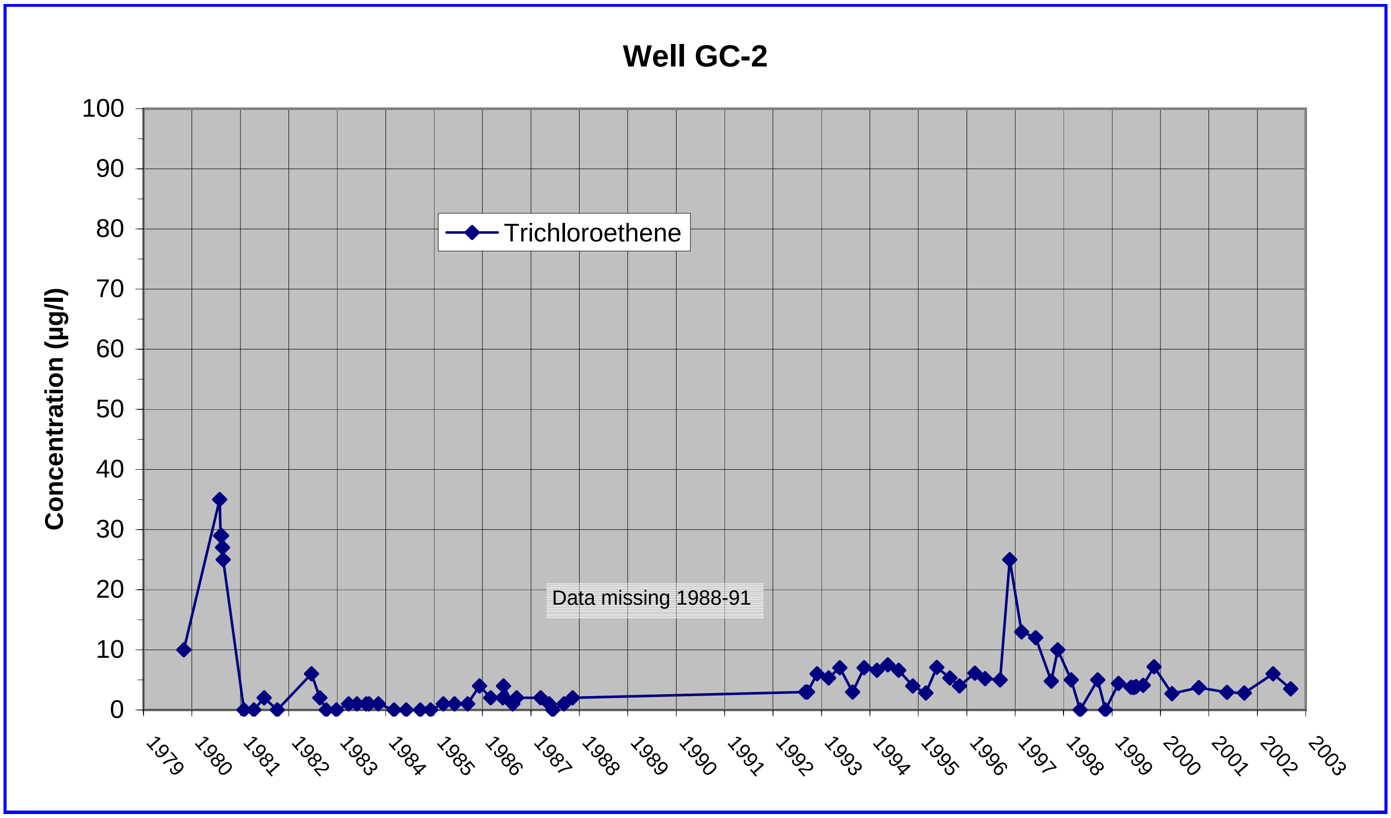


APPENDIX C.2

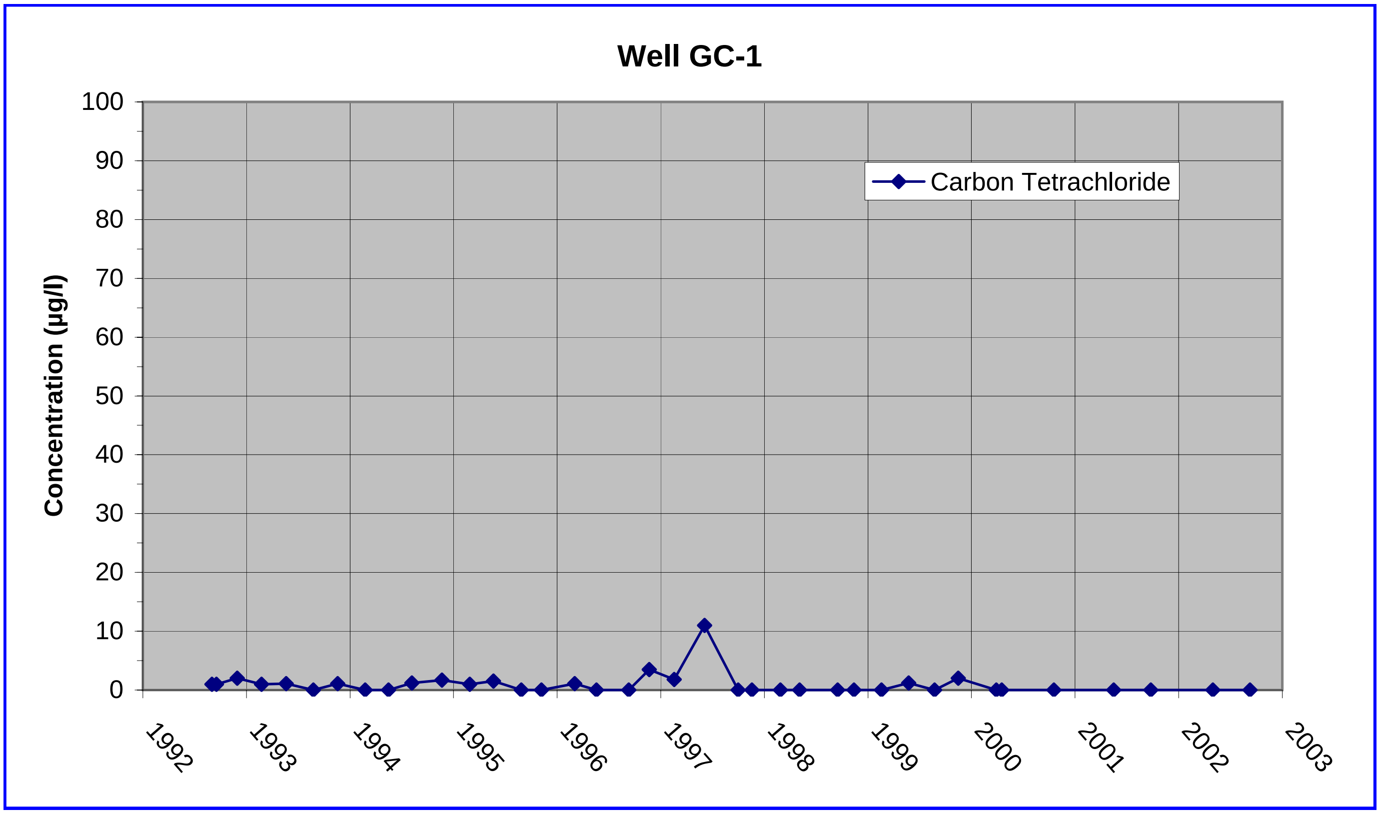
HISTORICAL WATER QUALITY DATA

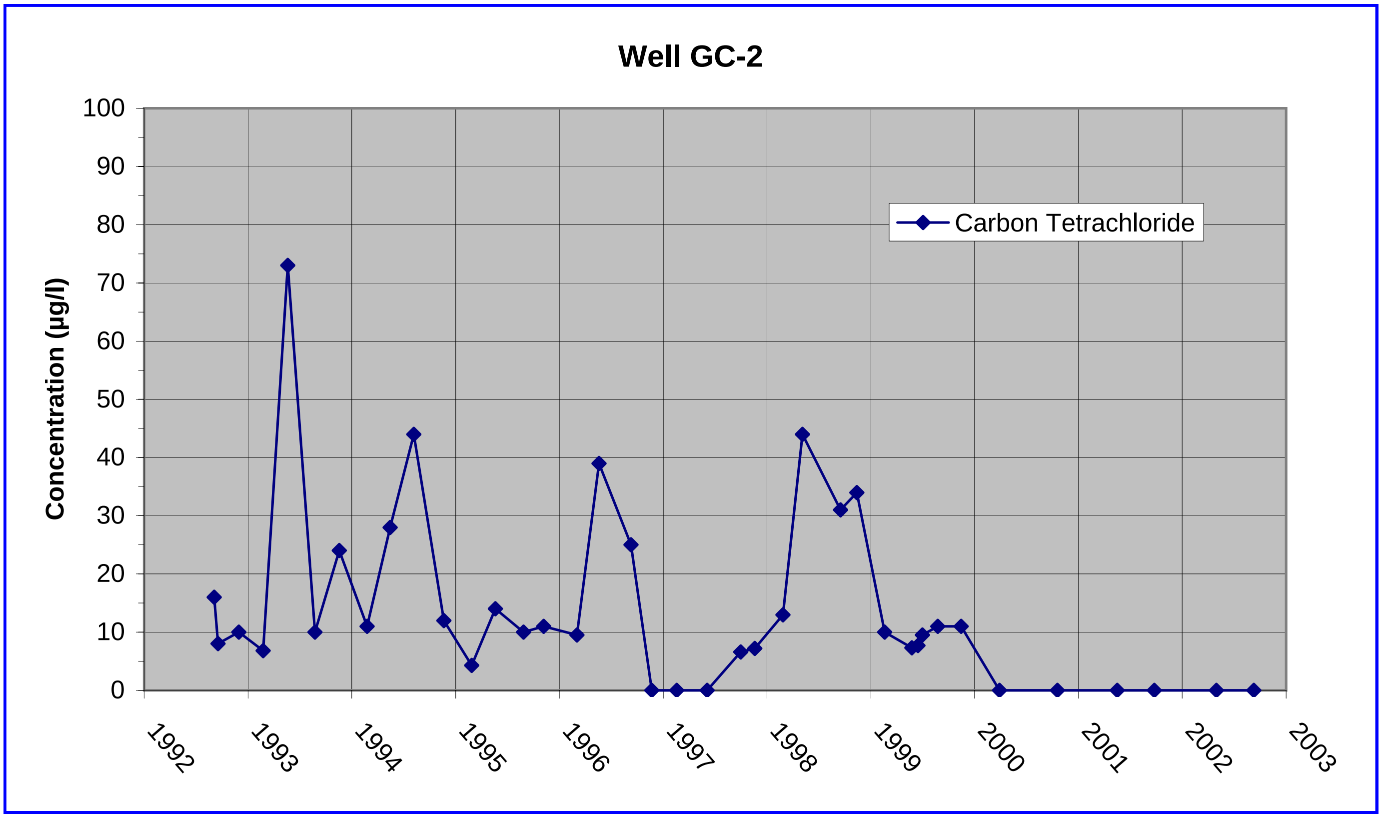
HISTORICAL WATER QUALITY DATA
Former Burn Pit Area, IBM Gun Club, Union, New York





HISTORICAL WATER QUALITY DATA
Former Burn Pit Area, IBM Gun Club, Union, New York





HISTORICAL WATER QUALITY DATA
Former Burn Pit Area, IBM Gun Club, Union, New York

NOTES:

1. The graphical plots are intended to summarize results of groundwater quality monitoring of wells GC-1 and GC-2 located near the Former Burn Pit Area in the southern portion of the IBM Gun Club site in Union, New York.

2. The historical water quality monitoring data were compiled and plotted by Groundwater Sciences Corporation (GSC) of Harrisburg, Pennsylvania. The concentration plots were provided to Sanborn, Head & Associates, Inc. by GSC electronically as a file entitled "Gun Club Chemistry Data Summary.xls", dated April 12, 2004.

APPENDIX D

FIELD EXPLORATION PROCEDURES AND FORMS

Standard References for Monitoring Wells

Part I

Daniel S. Greenbaum, Commissioner

The Massachusetts Department
of Environmental Protection
One Winter Street, Boston, MA 02108

DEP Publication #WSC-310-91

$56.00

Published by William Francis Galvin, Secretary of the Commonwealth

COMMONWEALTH OF MASSACHUSETTS

DEPARTMENT OF ENVIRONMENTAL PROTECTION

STANDARD REFERENCES FOR MONITORING WELLS

SECTION 5.4 PACKER TESTS

SECTION 5.4 PACKER TESTS

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5.4 PACKER TESTS

5.4-1 PURPOSE

Water pressure tests or "packer tests" are in-situ tests performed to measure the permeability of a specific zone in a bedrock borehole. Water pressure tests are used to estimate bedrock permeabilities for hydrogeologic studies and in estimating grouting and dewatering requirements for construction purposes.

Packer tests may be done during the advancement of the borehole or after drilling is completed. Packer tests are usually conducted in NQ/NX-size (3-inch) boreholes, but can be conducted in boreholes of a larger size. The test involves placing expandable packers, either mechanical or pneumatic, in a borehole. A pneumatic packer assembly is preferred because it is easier to use and provides a more positive seal. A section of the borehole, usually five feet in length, is sealed off with the packers. Water is then pumped through the zone between the packers at a known pressure. The rate of flow into the formation is measured with a flow meter. The permeability of the test zone is calculated using the data obtained in the test.

5.4-2 METHODOLOGY

The following methodology was designed to present the general requirements of a bedrock packer test. It is advisable to consult additional references before actually preforming this type of test.

1. Flush the borehole with clean water to remove cuttings. Measure the depth of the borehole, and check for caving. Be sure that an adequate reserve of water is available to avoid running out of water during a test.

2. Determine the test zone. The test section length should be a minimum of 5 times the diameter of the borehole. Avoid placing the packer in a zone of fractured rock or in the bottom of the casing because leakage will occur. Keep the rock core or drilling logs handy to refer to during the test.

3. Maintain the test pressures below what is commonly referred to as the Maximum Water Pressure (Pmax). This should avoid the chance of hydrofracturing (loosening) the rock mass. Pmax is determined by the following formula:

$$\text{Pmax} = (H_1)\ (1\ \text{psi/ft})$$

(Note: in highly fractured rock this should not exceed 0.75 psi/ft.)

where,

H_1 = depth in feet from ground surface to the bottom of the upper packer

During test operations the water pressures are observed at the gauge. The Maximum Gauge Pressure (GPmax) is calculated by the following formula:

$$\text{Gpmax} = (H_1+H_3)\ (1\ \text{psi/ft}) - (H_1-H_2)\ (.43\ \text{psi/ft})$$

where,

H_1 = depth in feet from ground surface to the bottom of the upper packer

H_2 = depth in feet from ground surface to the static water level

H_3 = height in feet of pressure gauge above ground surface

The depth and height variables (H_1, H_2 and H_3) are shown on Figure 5.4-2.

When significant flow rates are encountered during the test the gauge pressure may need to be increased to compensate for system pressure loss due to frictional head loss. This is an unusual situation.

4. To ensure that the packer system is not leaking, test it prior to the start of the actual permeability test. This can be done by installing the packer in a piece of steel casing and conducting the test as if it were being done in the borehole. The water pressure must not exceed the Packer Inflation Pressure (see Step #5, below). Calibration for a particular test assembly can be obtained on site by laying the system out on the ground and pumping water through the system while collecting the data as if the test were being performed in-situ. Check the hose for leaks. Check the water meter to assure that it is working properly.

5. Determine the Packer Inflation Pressure (PIP), by performing the following steps :

   Step 1 - Establish Minimum Inflation Pressure (MIP) (i.e., the pressure required to inflate the packers in the casing so that they can no longer be pushed or pulled through the casing)

Step 2 - Establish the Static Head Pressure (Ps) in psi at the test depth by the following calculation:

$$Ps = (H_1-H_2)\ (0.43\ psi/ft)$$

where,

H_1 and H_2 are as above

Step 3 - Make sure the Packer Inflation Pressure (PIP) equals the Minimum Inflation Pressure (MIP) plus the Static Head Pressure plus the Maximum Gauge Pressure (Gpmax) of the test zone between the packers. This is sometimes written as follows:

$$PIP = MIP + Ps + Gpmax$$

6. Determine the static water level in the borehole prior to the installation of the packer.

7. Assemble and install the packer equipment in the borehole. Measure each rod to top of coupling as it goes into the hole. Be sure rods are tightened to prevent leakage at the joints; teflon tape may be helpful. Number the rods for easy tracking of the packer location for sequential tests. Lower the equipment to the location of the deepest test. Figures 5.4-1 and 5.4-2 depict configurations for mechanical and pneumatic packer tests.

8. Before performing the first test, bleed air out of the lines by forcing water through the packer system assembly before the packers are inflated. Inflate both packers to the required packer pressure. Double packers are usually spaced five feet apart, but spacing can be varied to meet specific test requirements.

9. Before starting the test, review the Packer Test Data Sheets (Figure 5.4-3) and record the following:

   - Test number
   - Test section (i.e., length)
   - Hole size
   - Height of pressure gauge above ground surface
   - Ground surface elevation
   - Depths to rock surface, ground water, bottom of boring, bottom of upper packer, and to top of lower packer

10. Conduct the bedrock packer test in three stages:

    Step 1 - 1/2 Gpmax

    Pump water into the system and record observations of gauge pressure and water meter at 30-second intervals for at least three to five minutes after a constant rate of flow is reached.

    Step 2 - Full Gpmax

    Pump water into system and record observations of gauge pressure and water meter at 30-second intervals for at least three to five minutes after a constant rate of flow is reached.

    Step 3 - Full Gpmax plus 20 psi increase on the Packer Inflation Pressure

    Increase Packer Inflation Pressure by 20 psi. Pump water into the system and record observations of gauge pressure and water meter at 30-second intervals for at least three to five minutes after a constant rate of flow is reached. The results of Steps 2 and 3 should be similar. If they are not, Step 3 should be repeated, increasing the Packer Inflation Pressure by an additional 20 psi. This is done to check for leakage past the packers.

    For all test steps, record water levels in the casing during the test. If the water level rises or bubbles appear during the test, the packers may not be sealed and the test results may be suspect. Measurements of doubtful accuracy must be noted, along with a description of the questionable aspects. If possible, testing should be continued until accurate data is obtained. It may be necessary to move the packer assembly a short distance to obtain an adequate seal.

11. If leakage of water from the packed section into the surrounding rock is so great that the Gpmax cannot be reached, run the pump at its full capacity with the bypass valve closed. Record the volume of water pumped into the test section and the associated pressure readings at timed intervals. This data will give a minimum value of the rock permeability.

12. Upon completion of the test, deflate the packers and move to the next test depth. Complete log sheets (see Figure 5.4-3).

13. The same test methodology may be used with a single packer. Single packer tests are conducted either as the borehole is advanced or after the entire borehole has been completed. With this test configuration the bottom of the borehole takes the place of the second packer.

5.4-3 COMPUTED ROCK MASS PERMEABILITY

Compute the rock mass permeability. Additional data required for each test are as follows:

(1) depth of hole at time of each test;
(2) depth to bottom of top packer;
(3) depth to top of bottom packer;
(4) depth to water level in borehole at frequent intervals;
(5) elevation of potentiometric level;
(6) length of test section;
(7) radius of hole;
(8) length of packer;
(9) height of pressure gauge above ground surface;
(10) height of water swivel above ground surface; and
(11) description of material tested.

Item (4) is important since a rise in water level in the borehole may indicate leakage from the test section or an interconnected bedrock fracture pattern. A sketch of the test equipment arrangement showing the relative portions of the components should be made for each configuration used. (See Figure 5.4-3, page 3 of 3.)

The formulas used to compute the permeability from pressure test data are:

$$K = (Q/2\pi LH) \quad \ln(L/r)$$

When $L > 10r$ (the above formula is used when the length is greater then ten times the radius)

and,

$$K = (Q/2\pi LH) \quad \sinh^{-1}(L/2r)$$

When $10r > L > r$ (the above formula is used when the length is greater than the radius but less the ten times the radius)

where,

K = permeability
Q = constant rate of flow into the hole
L = length of the test section
H = differential head on the test section
r = radius of the borehole

It should be noted that when the test is conducted above the water table H is the distance from the water pressure gauge to the middle of the test section. When the test is below the water table H is the distance from the gauge to the static water level.

While the above formula is most often used with a double packer arrangement, it also applies for use with a single packer. With a single packer the length of the test section (L) is not fixed (as with the double packer arrangement) and is equal to the distance from the bottom of the packer to the bottom of the hole.

These formulas provide only approximate values of K since they are based on several simplifyin0g assumptions and do not take into account the flow of water from the test section back to the borehole (U.S. Bureau of Reclamation, 1977).

However, they give values of the correct order of magnitude and are suitable for practical purposes. Table 5.4-1 (Haley and Aldrich, 1977) provides a general grouping of rock mass permeability.

5.4-4 PROBLEMS AND POSSIBLE SOLUTIONS

There are a number of possible problems that may develop while preforming a bedrock packer test. Several of the most common problems and their possible solutions are outlined below.

1. Packers move up out of the hole at the start of the test.

Occasionally, particularly in low permeability rocks, the packer assembly may lift out of the hole due to the water pressure. Observers should stay clear of the top of the borehole to avoid injury. It may be helpful to deflate and re-inflate the packers to obtain a more positive seal in the borehole. Also, the rig drive head can be placed over the top of the swivel to help to hold the packers in place during the testing.

2. Excessive amounts of water are pumped into the formation.

In certain types of hydrogeologic or contaminant investigations, large quantities of water should not be pumped into the aquifer as this may impact local ground water quality and movement. If this is a concern, packer tests should be avoided. Alternatively, falling or rising head tests may be performed or geophysical borehole data may be obtained.

3. The packers jam in the borehole.

Packers may become caught in the borehole for two reasons: 1) caving of the formation around the packers, or 2) failure of the packers to deflate. In the latter case, it is generally advisable to re-inflate and deflate the packers a second time to try to remedy the problem.

Forcibly removing the packers from the hole should be avoided as they may become permanently lodged or damaged. In some instances it may be helpful to pump water through the system to help lubricate the equipment for removal. Packer tests in soft, broken or cavernous formations should always be attempted with great caution.

4. Water meter malfunctions.

Water meters are sensitive instruments and are subject to malfunctions due to clogging by debris or mechanical failure. It is important to check the water meter prior to use to be certain that it is working properly. Generally, it is best to place the water meter in a horizontal position, particularly for low flow measurements. It is also important to determine what the units of the meter dial are prior to use, as they are often poorly marked. Discharging water from the meter into a container of known volume (e.g., 5-gallon bucket or a 55-gallon drum) and comparing this to the metered volume provides a reasonably accurate check.

REFERENCES

Haley and Aldrich Inc., 1977, Manual of field procedures, procedure no. 27, water pressure test (rock): Cambridge, MA.

U.S.Bureau of Reclamation, 1977, Ground water manual: Denver, CO, U.S. Government Printing Office, 783 p.

ADDITIONAL REFERENCES

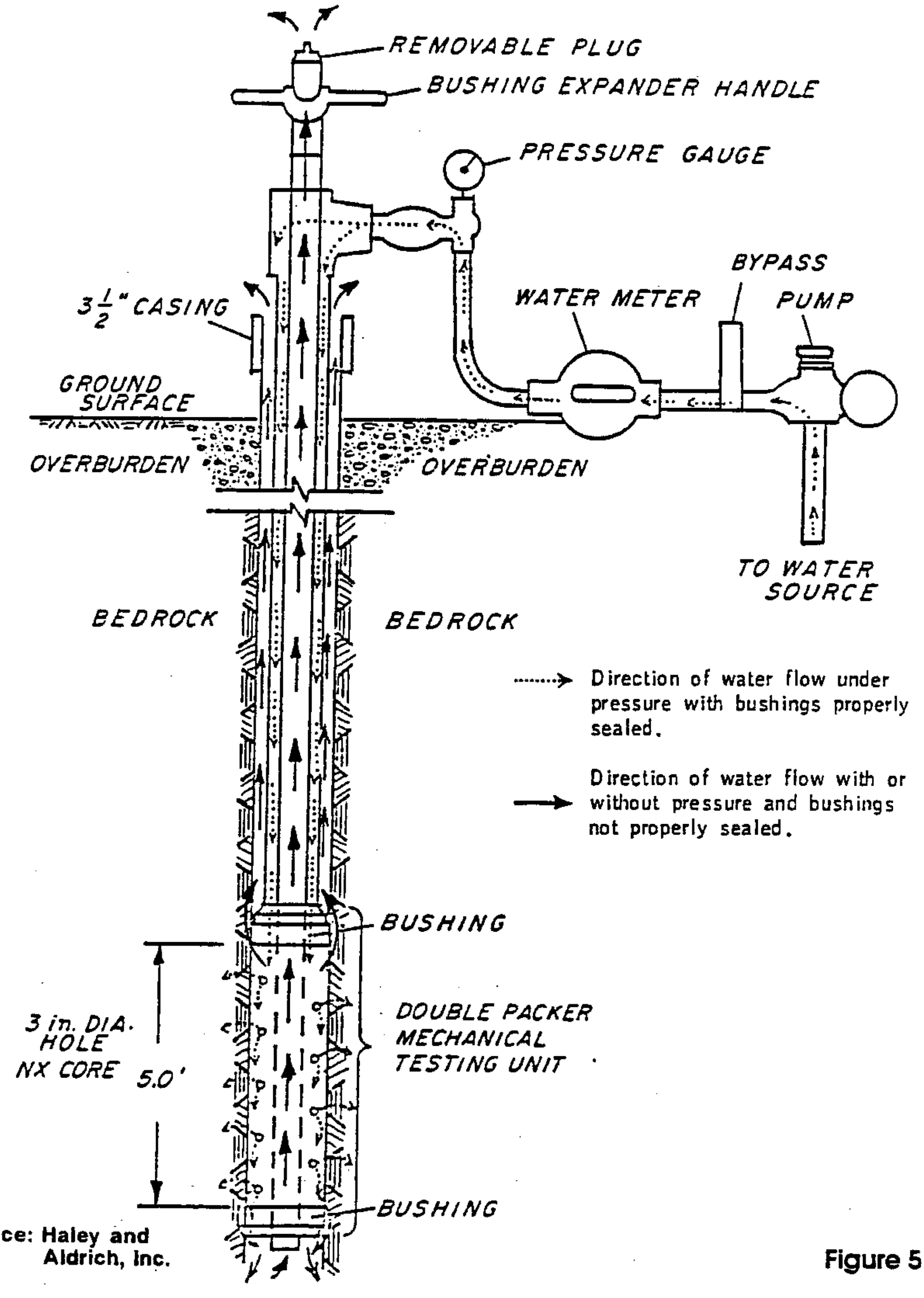
U.S.Bureau of Reclamation, 1974, Earth manual, Washington: DC, U.S. Government Printing Office, 810 p.

Winterkorn, H., F., and Fang, H., 1975, Foundation engineering handbook: New York, NY, Van Nostrand Reinhold Company, 751 p.

SECTION 5.4
PACKER TESTS

LIST OF FIGURES

LIST OF TABLES



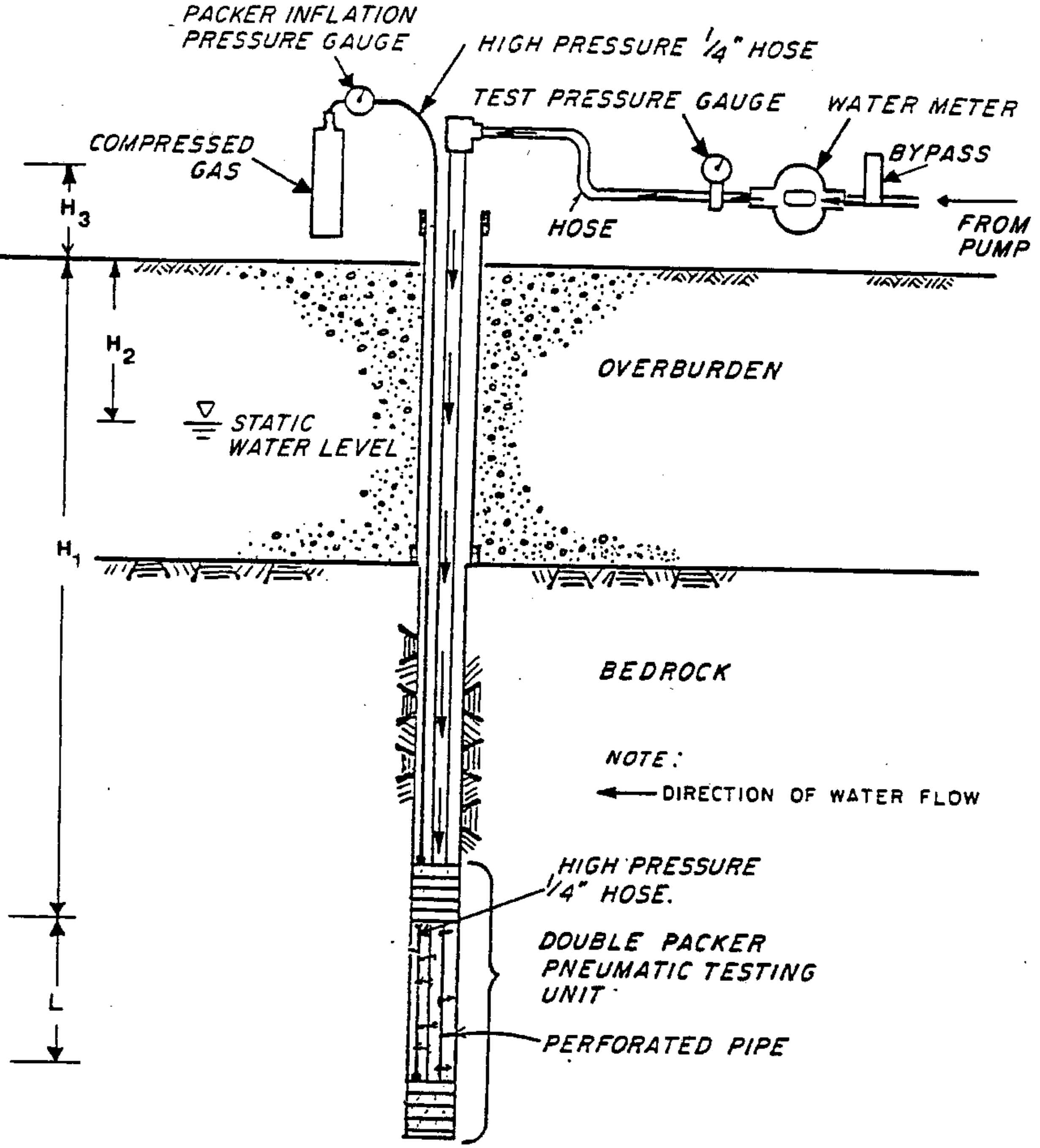
········➤ Direction of water flow under pressure with bushings properly sealed.

——➤ Direction of water flow with or without pressure and bushings not properly sealed.

Source: Haley and Aldrich, Inc.

Figure 5.4-1

Schematic of Mechanical Packer Pressure Test and Related Equipment.



Source: Haley and Aldrich, Inc.

Figure 5.4-2

Schematic of Pneumatic Packer Test and Related Equipment.

WATER PRESSURE TEST

HOLE NO.
TEST NO.

PROJECT: ______
CLIENT: ______
CONTRACTOR: ______

JOB NO. ______
SHEET NO. ______
LOCATION: ______
ELEVATION: ______
DATE START: ______
DATE FINISH: ______
DRILLER: ______
INSPECTOR: ______
GEOLOGIST: ______

	PACKER SYSTEM	WATER METER	WATER GAUGE	SURGE CHAMBER
TYPE				
MFG.				
MODEL NO.				

M.G.P. = (0.566 to 1.0) x Z
COMPUTED MAX GAUGE PRESS: (MGP) ______
COMPUTED INTERNAL FRICTION: ______

ROCK TYPE: ______ HOLE SIZE ______
RECOVERY (%) ______
R Q D (%) ______

DEPTHS: (All Distances Measured From Ground Surface In Feet)

TO TOP OF ROCK ______
TO BOTTOM OF BORING ______
TO WATER TABLE ______
TO TOP LOWER PACKER ______
TO BOTTOM UPPER PACKER (Z) ______
LENGTH OF TEST SECTION ______
HEIGHT OF WATER PRESSURE GAUGE ABOVE GROUND SURFACE ______

TIME	ELAPSED TIME (MIN)	PACKER PRESSURE (PSI)	GAUGE PRESSURE (PSI)	METER READING (GALS)	VOLUME OF FLOW (GALS/MIN)	REMARKS

Source: Weston Geophysical

Figure 5.4-3
Page 1 of 3
Example of Packer Test Data Sheet.

WATER PRESSURE TEST

Project ____________________ Boring No. __________ Test No. __________

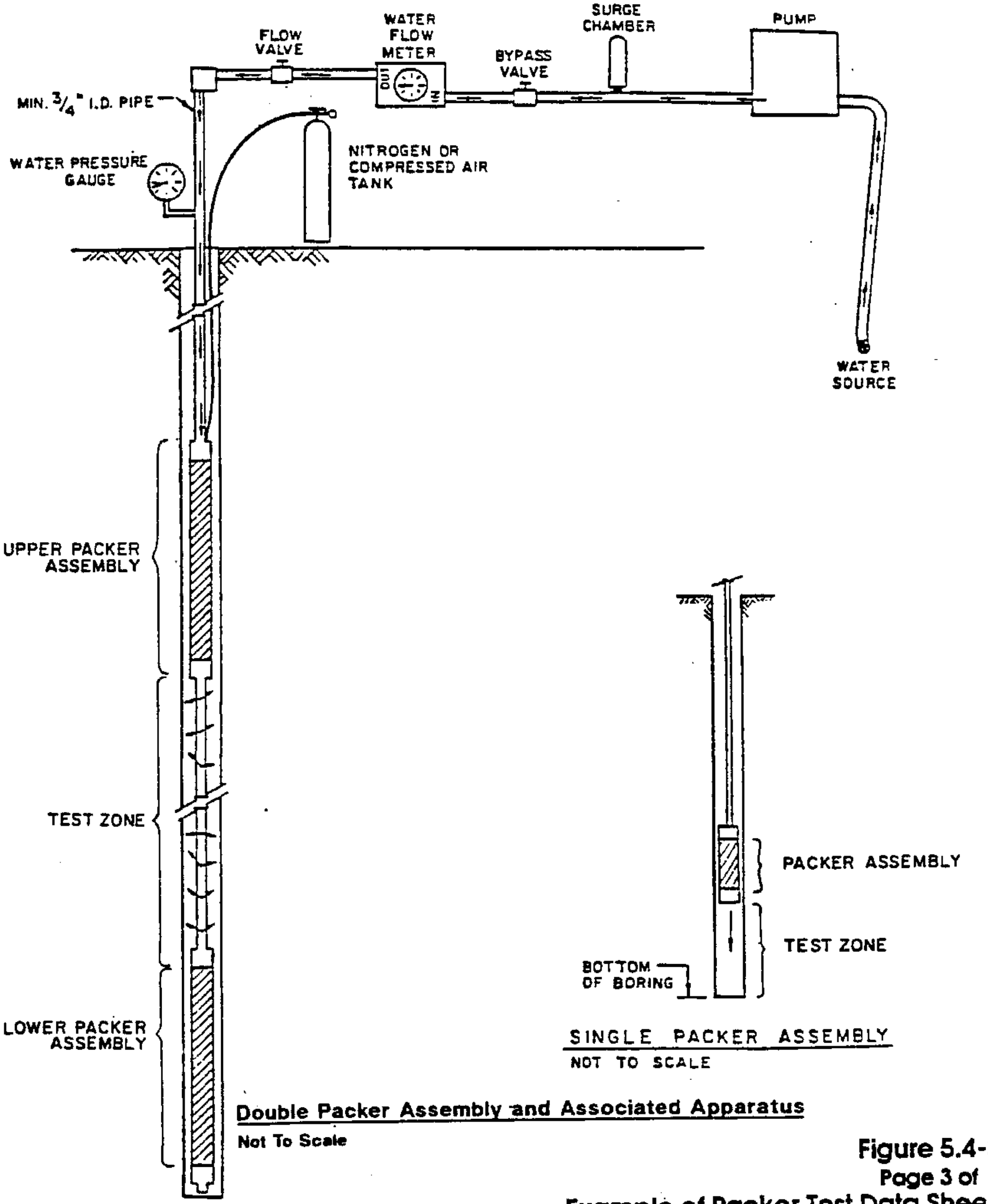
TIME	ELAPSED TIME (MIN)	PACKER PRESSURE (PSI)	GAUGE PRESSURE (PSI)	METER READING (GALS)	VOLUME OF FLOW (GALS/MIN)	REMARKS

Source: Weston Geophysical

Figure 5.4-3
Page 2 of 3
Example of Packer Test Data Sheet.

SITE /LOCATION ______________ PROJECT NO. ____________ DATE ___________ BORING NO. ____________

INSPECTOR ______________________________ APPROVED BY ______________________________



SINGLE PACKER ASSEMBLY

NOT TO SCALE

Double Packer Assembly and Associated Apparatus

Not To Scale

Figure 5.4-3
Page 3 of 3
Example of Packer Test Data Shee

Source: Weston Geophysical

Description	Range
Very low (equivalent to clay)	Less that 1 x 10^{-7} cm/sec
Low (equivalent to silt)	1 x 10^{-5} to 1 x 10^{-7} cm/sec
Medium (equivalent to fine sand)	1 x 10^{-4} to 1 x 10^{-5}cm/sec
High (equivalent to sand)	1 x 10^{-2} to 1 x 10^{-4} cm/sec
Very high (equivalent to clean sand or gravel)	More than 1 x 10^{-2} cm/sec

Table 5.4-1

General Grouping of Rock Mass Permeability.

APPENDIX D.2

MICROSEEPS SOPs FOR SOIL VAPOR SAMPLING AND MOBILE LAB ANALYSIS

METHODS AND PROCEDURES

for use of

MICROSEEPS SOIL GAS SAMPLING SYSTEM

MICROSEEPS

University of Pittsburgh Applied Research Center
220 William Pitt Way
Pittsburgh, PA 15238
(412) 826-5245

METHODS AND PROCEDURES FOR SOIL GAS SAMPLING

Step by Step Sampling Procedure

The following step by step procedures are designed to give the operator a better understanding of the sequence required to properly collect a soil gas sample. Details and other technical information should be obtained from subsequent sections of this manual.

1. With the needle removed, purge the soil gas sampling probe. Leave the syringe plunger tip completely compressed.
2. Turn the three-way valve to the stop position.
3. Make a sample hole in the soil with the slide hammer plunger bar. Remove the plunger bar and immediately insert the sample probe into the hole, being certain that the rubber collar forms a seal at the top of the hole.
4. Place the needle onto the needle fitting and insure a tight seal.
5. Turn the three-way valve to the probe/syringe position.
6. Draw a 15 cc volume of gas into the syringe.
7. Turn the three-way valve to the syringe/needle position.
8. Discard the 15 cc volume through the needle to the atmosphere.
9. Turn the three-way valve to the probe/syringe position and draw ~~the appropriate amount~~ 50 cc's of soil gas into the syringe.
10. Attach an evacuated sample vial by pushing the sample vial septum onto the needle.
11. Turn the three-way valve to the syringe/needle position and displace the soil gas sample into the sample vial by completely depressing the syringe plunger.
12. While holding the syringe plunger compressed, turn the three-way valve to the off position.
13. Quickly pull the filled sample vial from the needle.

14. Turn the three-way valve back to the syringe/needle position, and draw a volume of approximately 50 cc of ambient air back through the needle.

15. **Remove the needle.**

16. Remove the sample probe from the hole.

17. Repeat Step 1.

Purging the Soil Gas Probe

Before a soil gas sample is taken, the soil gas probe should be purged with 5 x 250 cc of air. This is accomplished, as shown in Figure 2, by drawing 250 cc of air through the needle port, turning the three-way valve, and exhausting the air through the sample probe. This procedure should be repeated at least five times before each sample.

Preparation to Take the Sample

At each soil gas sample station, the steel drive rod should be driven to the desired sampling depth and removed, thus creating a hole into which the sampling probe may be inserted. Immediately upon removal of the drive rod, the soil gas sampler should be placed into the hole, making sure that the flexible rubber collar is wedged between the probe and the ground surface. The syringe needle should then be installed on the needle port.

Upon completion of this procedure, air which occupies the probes' 1/4-inch sampling tube and the port volume of the three-way valve (about 10 ml in volume) should be drawn through the probe into the magnum syringe and expelled through the syringe needle in order to completely remove atmospheric air from the probe and to fill the probe volume with an undiluted soil gas sample.

Taking the Soil Gas Sample

Soil gas samples should be taken by turning the three-way valve toward the sample probe and slowly withdrawing* the plunger of the magnum syringe to the desired sample volume** as shown in Figure 3a.

*If the sample syringe plunger is withdrawn rapidly, the soil gas may be caused to flow so rapidly through the connected pore space so as to move particulate matter or moisture, possibly clogging the soil pores preventing the collection of the soil gas sample.

**The sample volume to be taken should be 1.5 to 2.0 times the volume of the sample vial into which soil gas sample will be compressed. This results in a positive pressure in the sample vial. Any resulting leakage through the septum will be out of the vial resulting in no dilution or contamination of the soil gas sample.

Before installing the sample vial onto the syringe needle, the underside of the vial septum should be viewed and <u>one</u> puncture mark should be observed in the septum. This puncture mark is evidence that the vial has been evacuated. If no puncture mark is observed, this may mean that the vial has not been evacuated and the vial should be checked for vacuum with the vacuum gauge provided.

The previously evacuated sample vial should be installed on the syringe needle and the three-way valve should be turned toward the needle port as shown on Figure 3b. The magnum syringe plunger should now be observed to move toward the bottom of the syringe as the soil gas sample fills the sample vial. This observation is also qualitative evidence of vacuum in the sample vial.

Pressure should then be applied to the magnum syringe plunger in order to compress the soil gas sample into the sample vial. The plunger should be held at the bottom of the syringe until the three way valve is turned to the "off" position or the sample vial has been removed from the syringe needle.

Before removing the syringe needle from the needle port, clean the needle by drawing a small amount (about 50cc) of clean air through the needle as described on Figure 4. After cleaning, the needle should be covered and removed from the syringe port, prior to the removal of the probe from the hole.

Additional Operating Tips

The fittings located in the bottom of the sampling probe and probe tip, are 17/32 inch in diameter. This is 1/32-inch smaller than a new slide hammer drive rod ball tip. The sample probe fittings, in conjunction with the rubber collar provide the barrier which prevents atmospheric air from diluting the soil gas sample. When the slide hammer ball tip becomes worn, it may be difficult to insert and remove the sample probe from the hole.

RECORD KEEPING

All sample containers should be affixed with a label indicating the sample identification, sample depth, date, time, daily sequence number and the samplers initials.

Sample Collection Logs such as the one shown in Figure 6, should be used in the field by the sample collectors for recording all sampling events and field observations. The information recorded on the soil gas sampling logs will include the client name and/or project number, location, sample identification, date, time, daily sequence number, sample depth, sample size or volume, and any comments regarding local conditions or observations.

MAINTENANCE OF THE SOIL GAS PROBE SYSTEM

Probe Decontamination Procedures

Following the collection of each soil gas sample, any soil adhering to the probe and drive rod should be removed with a wire brush and/or a paper towel. The soil gas sampling probe tip, shown in Figure 5, should be visually inspected to determine whether the inside of the probe tip may be clogged with soil. If necessary, the probe tip should be removed and the inside of the probe tip should be cleaned with heavy gauge wire. The loosened soil can then be tapped out of the probe tip. It is also recommended that the glass wool dust filter be inspected and changed often.

After the soil gas sampling probe has been visually cleaned, the sampler should be further decontaminated to remove any residual constituents. The specific decontamination procedure used will depend on the type and concentration of the compounds of interest. For volatile hydrocarbon compounds, purging of the system with atmospheric air, as described above, will usually be sufficient. For heavily contaminated samples, steam cleaning in combination with the purging procedure may be required. The adequacy of the cleaning procedure should be confirmed by routine collection and analysis of system blanks.

Cleaning Of The Magnum Syringe

Should dust or moisture become evident in the magnum syringe, the syringe should be cleaned. This may be accomplished by unscrewing the plastic plunger tip guide, located under the plunger tip handle, and removing the plunger. Dust should be removed from the teflon plunger using a clean damp cloth and/or compressed air. The glass barrel/nose piece assembly may also cleaned with a damp cloth or water. Soap/water solution may also be used or even pumped through the sampling system. All parts should be thoroughly dried before reassembly. It is not recommended that the glass barrel be removed from the syringe nose piece unless absolutely necessary, as it may easily be cross-threaded during replacement.

When it is necessary to clean the syringe, the dust filter usually needs replacing also.

Operational Tests of The Magnum Syringe

The sample syringe should be periodically tested to insure that there is no leakage under vacuum or pressure. Specifically, with the plunger completely compressed and the three-way valve in the "off" position, the plunger should be withdrawn 3 to 4 inches creating a vacuum in the barrel of the syringe. The plunger should be held in this position for a period of 15 to 30 seconds and then released. If there are no leaks, the plunger should snap back to the completely compressed position.

Conversely, with the plunger withdrawn to permit an observable gas volume in the syringe barrel and the three-way valve in the "off" position, the operator should attempt to compress the plunger. If gas can be forced out of the syringe barrel, a leak is indicated.

In the event that leakage is indicated either under pressure or vacuum it is likely that the plunger tip (teflon end) has become worn or distorted. In this case, the plunger tip will most likely need replaced. Often the life of the plunger tip may be temporarily extended by repositioning the o-ring located behind the teflon plunger tip seal. The tightness of the seal obtained by the plunger tip is also temperature dependent. In cold weather conditions, a worn plunger tip will most likely need to be replaced.

Installation of the Dust Filter in the Sample Probe Tip

A dust filter should always be installed in the sample probe tip in the position illustrated in Figure 5. The filter material should be glass wool, an amount of which has been provided with the system. The amount of material used should be sufficient to prevent dust from entering the sampling syringe, while allowing gas to flow freely. Often, when a fresh dry filter is properly installed, a slight whistling sound may be heard when air is caused to flow out through the filter. When moisture is drawn into the probe, the filter may become clogged. Sometimes this may be temporarily cleared by forcing air out of the syringe through the filter. The glass wool filter should be changed often, especially when dusty conditions exist.

SAFETY PRECAUTIONS

- Do not use a mechanical device to depress the sampling syringe plunger.
- Do not attempt to collect soil gas probe samples without prior knowledge of the location of underground utilities and other possible environmental hazards.
- Always cap or remove the soil gas probe syringe needle when transporting or handling the soil gas probe.

MICROSEEPS SOIL GAS SAMPLING SYSTEM

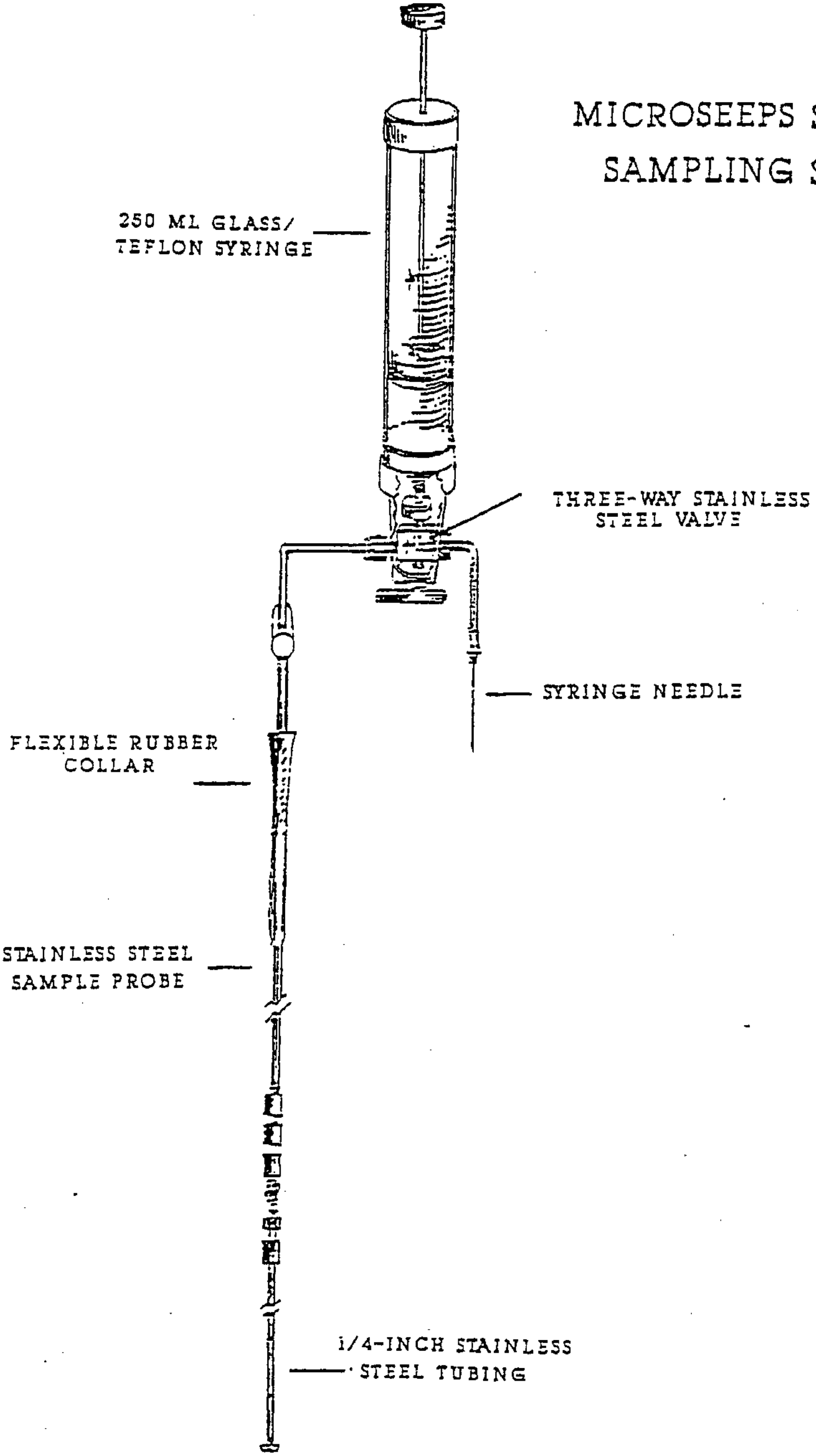
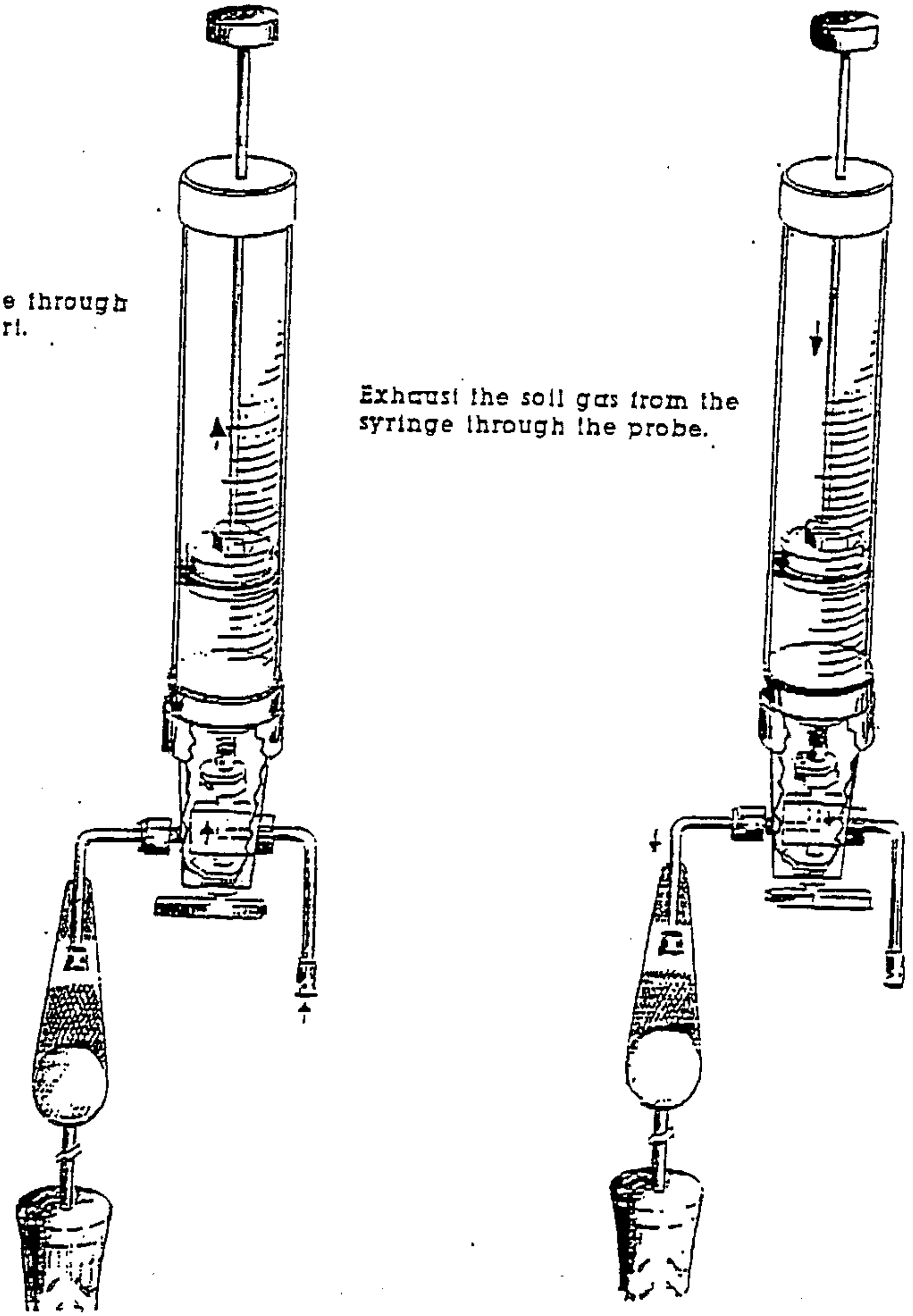


FIGURE 1



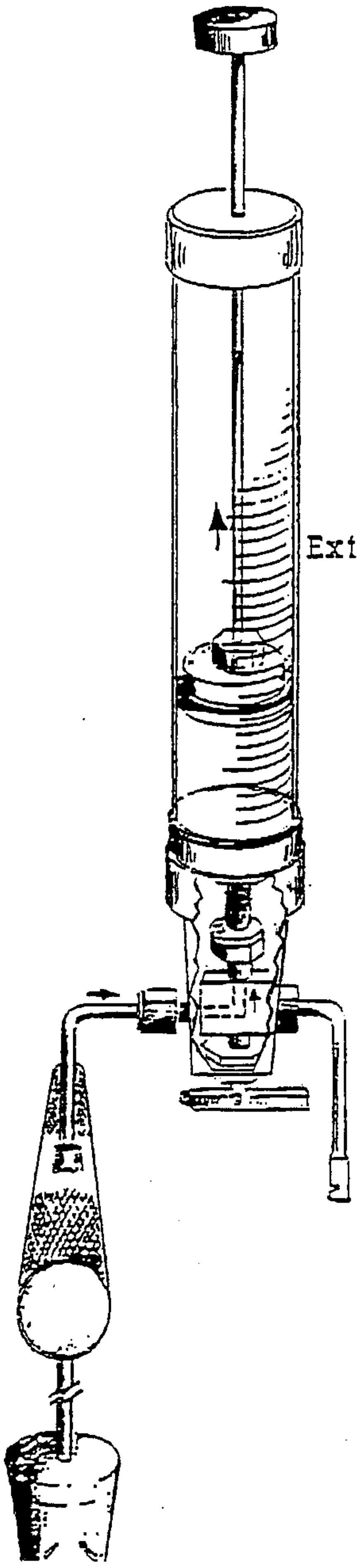
Fill the syringe through the needle port.

Exhaust the soil gas from the syringe through the probe.

Purge the Soil Gas Sampling System
with with 5 x 250cc air between each sample

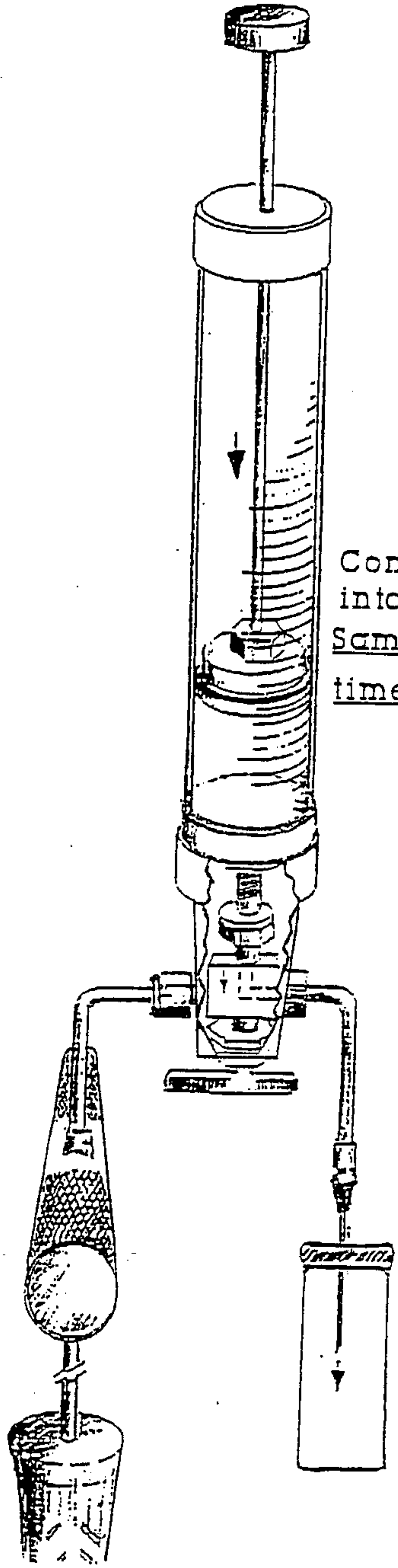
FIGURE 2

THE SAMPLE SYRINGE



Extraction of soil gas into the syrin

FIGURE3a



THE SAMPLE SYRINGE

Compress the soil gas sample into the sample vial.

Sample volume should be 1.5 - 2.0 times the volume of the sample vi

FIGURE3b

THE SAMPLE SYRINGE

After each sample, clean the need
by drawing air into the syringe.
Then cover the needle and remov

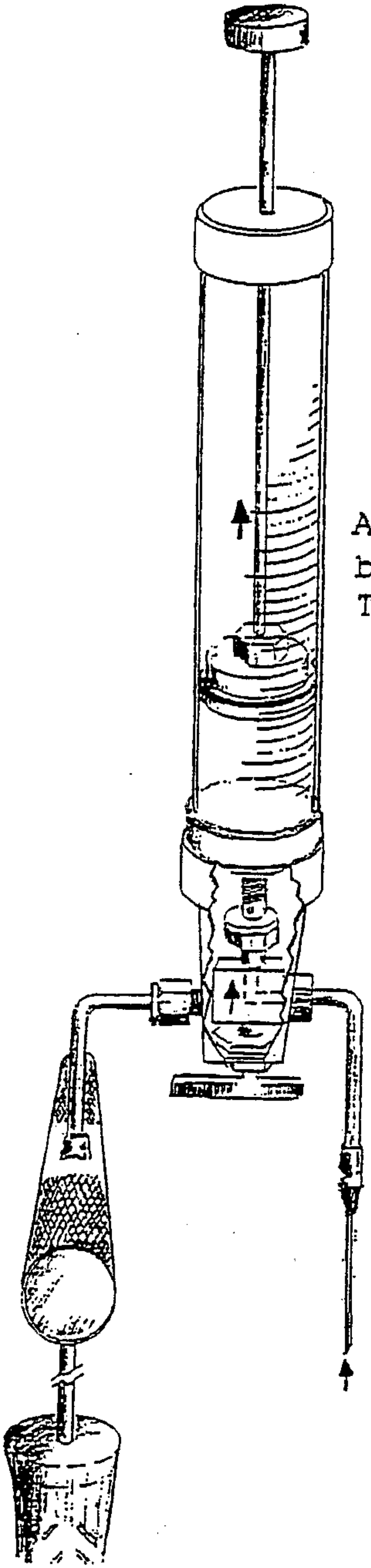


FIGURE 4

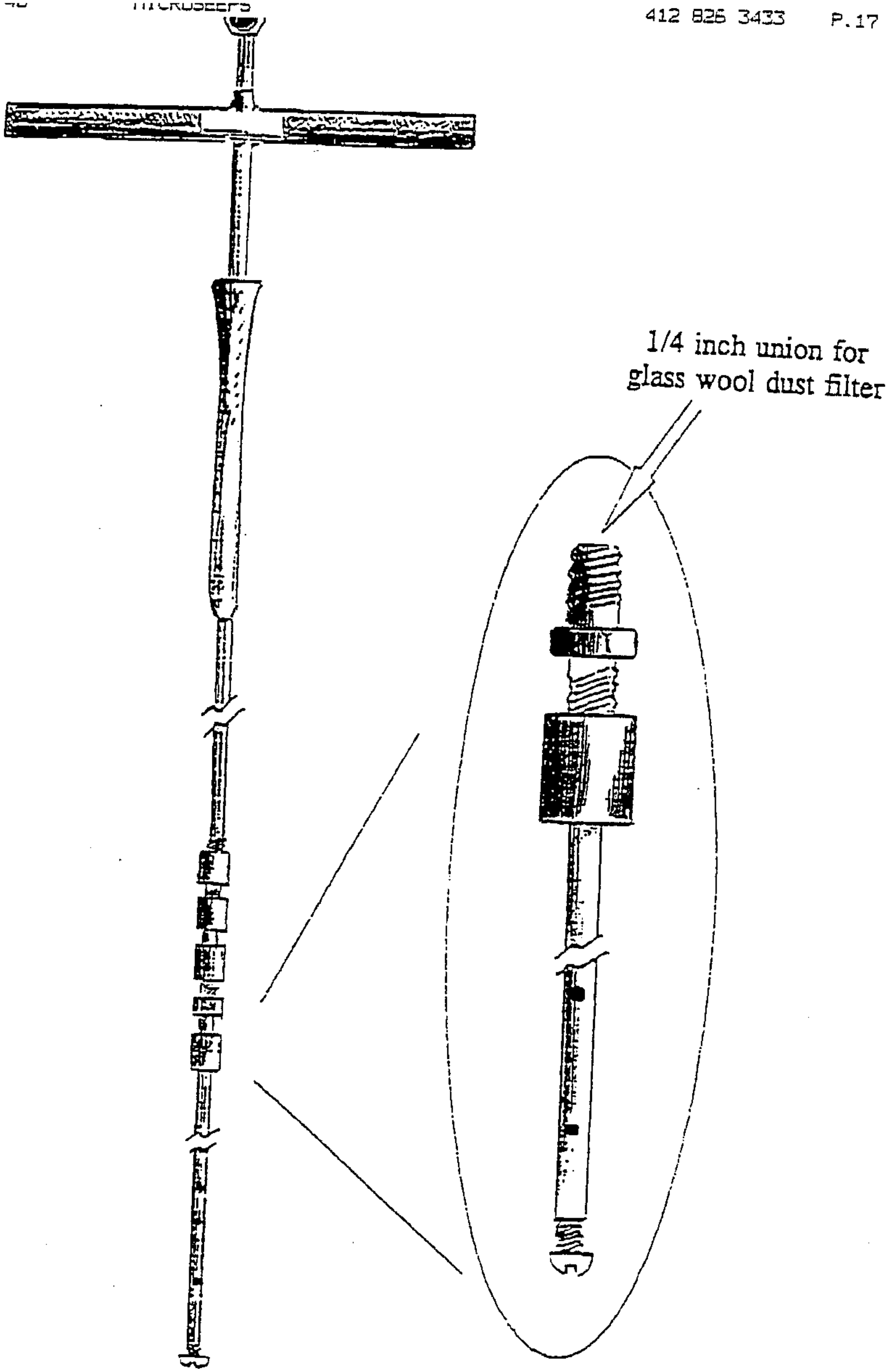


FIGURE 5

THE SOIL GAS PROBE

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CLIENT: ____________________
LOCATION: ____________________
PROJECT(#): ____________________
PAGE: ____ OF: ____

*********** SAMPLE COLLECTION LOG **********

SAMPLER NAME(S): ____________________

SAMPLE ID#	DATE	TIME	SEQ.#	SAMPLE DEPTH	SAMPLE TYPE			SAMPLE SIZE	COMMENTS
					G	S	W		

USE A NEW SHEET WHEN RESTARTING SEQUENCE #

FIGURE 6

MICROSEEPS, INC. STANDARD OPERATING PROCEDURES FOR SOIL GAS AND SOIL HEADSPACE ANALYSIS

ANALYTICAL METHOD

AM4A.03

FIELD ANALYSIS OF VOLATILE ORGANIC COMPOUNDS IN SOIL GAS

MICROSEEPS

University of Pittsburgh Applied Research Center
220 William Pitt Way
Pittsburgh, PA 15238
(412) 826-5245

ANALYTICAL METHOD AM4A.03

FIELD ANALYSIS OF VOLATILE ORGANIC COMPOUNDS IN SOIL GAS

1.0 Scope and Application

1.1 Method AM4A.03 is used to determine the concentration of volatile organic compounds in soil gas samples. Specifically, Method AM4A.03 may be used to detect the volatile organics including but not limited to the following compounds:

- pentane
- hexane
- heptane
- octane
- nonane
- decane
- 1,1-dichloroethylene
- methylene chloride
- 1,1-dichloroethane
- trans 1,2-dichloroethylene
- chloroform
- 1,1,1-trichloroethane
- carbon tetrachloride
- trichloroethylene
- tetrachloroethylene
- benzene
- toluene
- m & p-xylene
- o-xylene
- ethyl benzene

1.2 This method is recommended for use by, or under the supervision of, analysts experienced in the operation of a gas chromatograph and in the interpretation of a chromatogram.

2.0 Summary of Method

The volatile organic compounds are analyzed using a Hewlett Packard Model 5890 Series II Gas Chromatograph in conjunction with a Hewlett Packard Model 7694 Automated Headspace Sampler. A Supelco, 60M x 0.75mm i.d. Vocol, wide bore capillary column is used in conjunction with an output splitter connected to an electron capture detector and a flame ionization detector. The detector output signals are interfaced directly to an IBM compatible microcomputer through an analog to digital converter. Data storage, processing, analysis and presentation are facilitated using a chromatography data system (Chrom Perfect, Justice Innovations).

3.0 Interferences

3.1 Contamination by carryover can occur whenever high-level and low-level samples are sequentially analyzed. While in the standby mode, the HP 7694 provides continuous flushing of the sample loop and sample valve between sample analyses. This flush flow should be maintained and the sample valve and loop should be kept heated.

3.2 The analyst should demonstrate the absence of carryover contamination by analysis of the contents of the sample loop when purged with pure nitrogen. This demonstration should be performed prior to the analysis of a sample set and when carryover contamination is suspected (after high samples). In the event that 'ghost peaks' (peaks similar to previous sample) appear when a pure nitrogen sample is analyzed measures should be taken to eliminate the carryover contamination.

3.3 Extra peaks in a chromatogram can be actual peaks from a previous run. Contamination from compounds eluting late in the chromatogram can occur when injection to injection time is too short. The HP 5890 Series II is equipped with a temperature programmable oven which can be utilized to minimize this interference.

3.4 The analyst should be certain that all peaks have eluted from the previous analysis prior to analyzing any sample or standard. This can be accomplished by elevating the oven temperature after an analysis until such time that a clean stable baseline is obtained. If samples or standard chromatograms contain suspected 'extra peaks' the sample should be reanalyzed after a clean baseline is established.

4.0 Materials and Equipment

4.1 Sample vials: 22 ml glass vials (Hewlett Packard #9301-0716 or equivalent). Vials should be free of interferences prior to use. This can be accomplished by washing and rinsing with hydrocarbon free water then heating to 100 degrees C for 1 hour followed by purging with pure nitrogen.

4.2 Septums: Teflon lined septums (Wheaton #224168 or equivalent) may be used provided vials are capped within two weeks prior to use. Other septums may be used provided they are gas tight and do not produce interferences.

4.3 Gas Chromatograph: The Hewlett Packard 5890 Series II Gas Chromatograph is equipped with a Supelco, 60M x 0.75mm i.d. Vocol, wide bore capillary column connected to an electron capture detector and flame ionization detector.

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4.4 Headspace Sampler: A Hewlett Packard Model 7694 is used. The headspace sampler contains 44 slots for headspace vials. The Model 7694 contains a heated platen, a heated sample valve, a heated sample loop and a heated transfer line to facilitate transfer of the sample onto the column in the gas chromatograph.

4.5 Data Acquisition: Chrom Perfect Direct 4i, Justice Innovations, Mountain View, CA. The detector output signals are interfaced directly to an IBM compatible microcomputer through an analog to digital converter (Model DT2804, Data Translations). Data storage, processing, analysis and presentation are facilitated using the Chrom Perfect data system.

5.0 Sample Preparation and Analysis

5.1 Sample vial preparation: All sample vials should meet specifications as noted in sections 4.1 and 4.2 above. Vials should be tightly capped and evacuated to a pressure of less than 100 millitorr. The vial septum should be punctured only with needles of 22 gauge or smaller.

5.2 The evacuated sample vials should be filled with sample or standard gas to a positive gauge pressure. Sample vials should be used (filled with sample) within two weeks of preparation.

5.3 The 22 cc sample vials are heated in the headspace sampling unit for a minimum of 45 minutes prior to injection to minimize component loss via adsorption to the walls of the vial.

5.4 The headspace sampling unit is programmed to mechanically puncture the septum, transfer the sample to the heated sample loop, and mechanically inject the sample into the column flow stream via the heated transfer line.

6.0 Standards and Calibrations

6.1 Gas standards or liquid standards may by used to achieve calibrations. In some situations it may be necessary to use both types of standards. Certified commercial gas standards are most desirable, but may not always be available for all the compounds or for the concentration levels of the compounds of interest.

6.2 Commercial gas standards are introduced by filling a 22ml headspace vial with standard gas. The gas standards are placed in the vials and analyzed in the same manner as samples (as described in section 5.0). The concentrations are those certified by the manufacturer.

1/2/96

6.3 Liquid standard solutions are injected directly into a capped vial and allowed to vaporize. These standards are produced from high purity compounds as described in the Standard Preparation Methods. The liquid standard solutions are placed in vials that meet specifications described in sections 4.1 and 4.2. The vials used must be capped and be at atmospheric pressure when the liquid standard is injected. The vial is then analyzed in the same manner as a sample as described in section 5.3.

6.4 At the beginning of a project or sample set, standards of appropriate calibration ranges will be run at least three times or until the results agree with a percent standard deviation no greater than 10%.

6.5 Thereafter, at least one standard will be run for every 10 samples.

6.6 The instrument response (for any one subsequent standard in section 6.5 above) must not vary by more than 20%.

7.0 Quality Control

7.1 If the parameters set forth in section 6.6 are not met the analytical program will be terminated until the cause is determined and a solution is effected.

7.2 Before and during sample analysis, instrument blanks (sample loops filled with flush nitrogen) should be analyzed to assure the absence of interferences as described in section 3.0 above.

7.3 Prior to the analysis of a sample set, multiple standards, at different concentration levels, should be analyzed to establish an initial calibration table. During sample analysis, standards should be run at a rate of 1 for each 10 samples.

7.4 Standards analyzed during the course of analyzing samples are compared to the calibration table as well as being used for peak identification. All chromatograms should be examined by an experienced analyst.

7.5 The soil gas sample vial is pressurized at the time of sampling. This pressure preserves sample integrity since any leakage is out of the vial and does not result in contamination or sample dilution.

7.6 The headspace sampling unit contains a heated platen as well as a heated sampling loop and transfer line. The latter two zones are continually flushed with nitrogen between sample analyses to minimize the chance of instrumental carry over. This nitrogen in the sample loop is injected periodically to check for instrument contamination.

7.7 Once the headspace vials are punctured in the headspace unit, the sample loop is allowed to equilibrate to atmospheric pressure just prior to injection (see section 8.2, vent time). This insures that an accurate, equal volume will be injected each time. Each vial is analyzed one time only.

7.8 Calibration records are generated and stored in the computer. All such records will be maintained in the laboratory during the course of the project.

8.0 Instrument Conditions

8.1 Gas Chromatograph:

- Injection Temp. 220 deg. C.
- Flame Ionization Detector Temp. 220 deg. C.
- Electron Capture Detector Temp. 375 deg. C.
- Oven Temp. Program:
  - Initial temp. 30 deg. C.
  - Hold 10 min.
  - Rate 4 deg. min. to 110 deg. C.
  - Hold .01 min.
  - Rate 20 deg. min. to 200 deg. C.
  - Hold 15 min.
- Equilibration Time 1 min.
- Initial E.C.D. Signal Range 5
- Initial F.I.D. Signal Range 4
- Carrier Flow Rates: (output of column split)
  - Head Space Sampler in 12 cc/min.
  - Make up gas to E.C.D. 76 cc/min.
  - Make up gas to F.I.D. 34 cc/min.
  - Total column 12 cc/min.
- Hydrogen Pressure 22 psig.
- Flame Air Pressure 30 psig.

8.2 Headspace Sampler:

- Platen Temp. 75 deg. C.
- Valve/Loop Temp. 110 deg. C.
- Transfer Line 110 deg. C.
- Sample Equilibration time 45 min.
- Sampling interval 60 min (remote)
- Valve Timing:
  - Pressurize 0.0 min.
  - Vent/fill loop 0.25 min.
  - Loop equilibration 0.33 min.
  - Inject to G.C. 1.0 min.
- Carrier Flow 12 cc/min.

1/12/9

601/602 LIST OF COMPOUNDS Microseeps Method AM4.03	METHOD DETECTION LIMITS (PPMV)
CHLOROMETHANE	3
VINYL CHLORIDE	3
BROMOMETHANE/CHLOROETHANE*	1
FLUOROTRICHLOROMETHANE	0.005
1,1 DICHLOROETHYLENE	0.01
METHYLENE CHLORIDE	2
TRANS-1,2 DICHLOROETHYENE	0.1
1,1 DICHLOROETHANE	0.01
CHLOROFORM	0.005
1,1,1 TRICHLOROETHANE	0.005
CARBON TETRACHLORIDE	0.005
BENZENE	0.07
1,2 DICHLOROETHANE	0.01
TRICHLOROETHYLENE	0.005
1,2 DICHLOROPROPANE	0.01
BROMODICHLOROMETHANE	0.005
CIS-1,3 DICHLOROPROPYLENE	0.01
TOLUENE	0.07
TRANS-1,3 DICHLOROPROPYLENE	0.01
1,1,2 TRICHLOROETHANE	0.005
TETRACHLOROETHYLENE	0.005
CHLORODIBROMOMETHANE	0.005
CHLOROBENZENE	0.07
ETHYL BENZENE	0.07
BROMOFORM	0.005
1,1,2,2 TETRACHLOROETHANE	0.005
1,3 DICHLOROBENZENE	0.07
1,4 DICHLOROBENZENE	0.07
1,2 DICHLOROBENZENE	0.07

STANDARD OPERATING PROCEDURES

FOR

THE COLLECTION OF SOIL GAS, SOILS, AND WATER WITH ON-SITE ANALYSIS

MICROSEEPS

University of Pittsburgh Applied Research Center
220 William Pitt Way
Pittsburgh, PA 15238
(412) 826-5245

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STANDARD OPERATING PROCEDURES FOR THE COLLECTION OF SOIL GAS, SOILS, AND WATER WITH ON-SITE ANALYSIS

1. INTRODUCTION

1.1 This SOP describes the overall procedures used for the collection, handling, on-site analysis, and data reporting for soil gas, soil, and water samples. It is meant to be used in concert with documented sampling and analytical methods specific to particular classes of analytes.

1.2 Analysis of all samples are divided into three categories:

a. Volatile and limited semivolatile organics addressed in Analytical Method Series AM4 (soil gas), AM9 (soil), and AM10 (water).
b. Light hydrocarbons (C1-C4), hydrogen and helium addressed in AM1 (soil gas)
c. Permanent gases addressed in AM11 (soil gas).

2. SOIL GAS SAMPLING

2.1 Soil gas samples may be collected using any of several documented methods. Regardless of the method used, each sampling procedure requires penetration of the surface to a targeted depth, sealing the hole to prevent drawing atmosphere, withdrawing and discarding a volume of sample equal to the volume of the sampling probe, then withdrawing and displacing the sample into a pre-evacuated glass sample vial.

2.2 All vials are filled with a volume of sample twice that of the pre-evacuated vial. This creates a positive pressure in the vial of 1 atmosphere. Sample integrity is checked by observing the syringe during collection. As the sample vial septum is punctured, the syringe plunger will be pulled down due to the vacuum in the vial. Increasing force on the plunger will be required as the vial is pressurized to one atmosphere.

2.3 Detailed sampling procedures can be found in the following sample collection methods:

a. SM1: This method uses a commercially available slide hammer plunger bar in conjunction with a Microseeps sample probe outfitted with a reusable 250 cc glass syringe.
b. SM6: Similar to SM1 but uses a disposable sample syringe and disposable tubing which virtually eliminates the possibility of sample to sample contamination.
c. SM1-H: A hydraulically powered soil gas sampling method using a reusable 250 cc glass syringe.

3. SOIL AND WATER SAMPLING

3.1 Soil samples may be collected manually as described in sampling method SM5 or with a hydraulically powered probe system as described in Geoprobe's Standard Operating Procedure (SOP) for the Geoprobe AT-660 Series Large Bore Soil Sampler (technical bulletin 93-660).

3.2 Water samples may be collected from probe holes by using the Geoprobe mill-slotted well point assembly or PVC slotted well screen and a bottom check valve as described in sampling method SM2H.01. If approved, this sampling method may be modified to utilize a peristaltic pump in place of, or in conjunction with, the bottom check valve for obtaining larger volumes of water.

4. SAMPLE HANDLING

Glass vials provide a secure, stable environment for the sample. The following guidelines will prevent loss of samples after collection:

a. Vials should be separated from one another with a shock absorbing material to prevent glass to glass contact and breakage due to jostling.
b. Any special instructions for samples particularly sensitive to heat or light are to be followed.
c. Associated paperwork such as sample collection logs and chain of custody documents should accompany samples.

5. SAMPLE RECEIPT

The following steps are used to receive, log in and prepare samples for analysis.

5.1 Remove the contents of the package and inventory against the Chain of Custody and/or Collection Log form. Note and alert the sampling crew of any discrepancies.

5.2 Complete the Chain of Custody documents if present.

5.3 Complete a Laboratory Sample Log (Figure 1), and mark all sample containers.

5.4 File all documentation in an appropriately labeled folder.

***** MICROSEEPS, INC *****

***** LABORATORY SAMPLE LOG *****

LABORATORY LOCATION:________________________

MICROSEEPS PROJECT #:________________

CLIENT:________________________

RECEIVER NAME____________________

SAMPLE ORIGIN:________________________

DATE:____________ TIME:________

PROJECT #:________________________

CHAIN OF CUSTODY ?____

SAMPLE NAME	SAMPLE TYPE			SIZE	PSIG	COMMENTS
	G	S	W			

6. SOIL GAS SAMPLE PREPARATION

6.1 Test and record the pressure of each vial using the following procedures:

a. The pressure and vacuum gauge must be evacuated prior to each sample vial tested to prevent cross contamination of the samples.

b. Puncture sample vial septum and record pressure on the Laboratory Sample Log. If pressure is zero, evacuate the vacuum gauge and test for vacuum. Repeat for all vials. If any sample vial is under vacuum, it is unusable - notify sample collection crew. Determine acceptability of pressure in vial for requested analysis using the following;

(1) Volatiles and semivolatiles may be analyzed with vial pressures of 0 psig and above. The vial is ready for analysis if the pressure is 3 psig or above. If vial pressures are 0 to 3 psig, the sample may be repressurized and diluted by a factor of two by venting sample vial to atmospheric pressure, then using clean syringe and needle, add 22 cc helium.

(2) Hydrogen/helium and permanent gases may also be analyzed with vial pressures of 0 psig and above. The vial is ready for analysis if the pressure is 6 psig or above. If vial pressures are 0 to 6 psig, the sample may be repressurized and diluted by a factor of two by venting the sample vial to atmospheric pressure, then using clean syringe and needle, add 22 cc Nitrogen (for hydrogen/helium analysis) or Helium (for permanent gas analysis) to the sample vial.

7. SOIL AND WATER SAMPLE PREPARATION

7.1 Water samples are prepared at the sampling site by filling a 22ml headspace vial with 10ml of sample and capping the vial with a teflon lined crimp cap as described in method series AM10.

7.2 Soil samples are prepared at the sampling site or in the mobile lab by placing 5 grams of soil along with 7ml of distilled water into a 22ml headspace vial and capping the vial with a teflon lined crimp cap as described in method series AM9.

8. SCHEDULING

8.1 Generally, samples are scheduled for analysis in the order in which they arrive unless specific instructions are received to do otherwise.

8.2 Sample sets are sequenced with an instrument blank at beginning of the set, then cycles of the following:

Sample Blank/trip blank

Continuing calibration standard(s)
10 samples
Duplicate

8.3 Since most analyses are automated, sample sequencing within sets should be in order of increasing likelihood of analyte concentrations, e.g. effluents before influents to reduce the possibility of carryover within the instrument. Sample names are entered into the sequence file exactly as written on the sample container or chain of custody documents. Continuing calibration checks and blanks are entered as follows:

STD_(name)_(range or amount)
HE IN LOOP
N2 IN VIAL

8.4 If sample screening data are available, high concentration soil gas samples will be diluted prior to analysis to prevent instrument carryover and/or detector saturation. If possible, samples should be diluted to a concentration of less than 1000 ppmv prior to analysis. High concentration soil samples may be reanalyzed by decreasing the sample weight used when preparing the sample.

9. ANALYSIS MONITORING

9.1 Each morning:

a. Check Chrom Perfect display, integrators or chart recorder, and autosampler for concurrent cycle numbers.

b. Check chromatograms for the following:

  (1) Excessively noisy baseline which would require manual peak integration.
  (2) Completely flat baseline which could indicate a defective detector, GC oven temperature program, or integrator.
  (3) Absence of methane/air peaks which could indicate inadequate filling of loop or defective injection valve.
  (4) Extremely wide or flat top peaks which could indicate detector saturation.

c. Check instrument calibration by comparing continuing calibration checks against known amounts.

d. Check reports for noise spikes. If present, manually reintegrate peaks and save new area files.

e. Check that GC oven temperature is appropriate for current run time.

f. Check detector signal outputs for proper readings. See individual instrument manufacture manuals for acceptable baseline levels.

9.2 Periodically throughout the day repeat steps a - f above.

10. DATA REVIEW PROCEDURE

The following steps are used to review the raw data prior to reporting analytical results. See Figure 2 for flow chart.

10.1 Use Chrom Perfect Results data package to print out preliminary data from each detector.

10.2 Line out results for compounds not applicable to detector.

10.3 Circle values which are greater than Minimum Detection Levels (MDL) for each compound .

10.4 Line out values which are above detector saturation points. If secondary detector is available, circle values. If secondary detector is not available, sample must be diluted appropriately and reanalyzed.

10.5 Compare retention times (RTs) for identified compounds in sample with known RTs in continuing calibration checks. Reject values based on unacceptable RTs.

10.6 Verify peak integration; manually reintegrate if necessary, record new values, and save new area file.

10.7 If applicable, use MSEEPS data package to process results from multiple detectors and save as PRN file.

10.8 Import PRN file to QuatroPro spreadsheet and make any changes necessitated by manual review.

10.9 Print draft data report.

10.10 Compare values in draft report to corrected preliminary results. Make changes as necessary.

10.11 Print final data report.

11. DATA REPORTS

Analytical results are reported in tabular format using QuatroPro spreadsheet software (see example at Figure 3). Elements included in the reports are:

Client name
Client project number
Sample name
Date sample collected
Date sample received
Date sample analyzed
Date of report
Analytical results
MDLs
Microseeps project number
Data file name

APPENDIX D.3

EXAMPLE TEST BORING/ WELL INSTALLATION LOGS

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CONSULTING ENGINEERS & SCIENTISTS

Log of Monitoring Well

Sheet: 1 of 1

Project:
Location:
SHA Project No.:
Drilling Method:
Sampling Method:
Drilling Company:
Foreman:
Date Started: Date Finished:
Logged By: Checked By:

Ground Elevation:
TOC Elevation:
PVC Elevation:
Datum:

Groundwater Readings

Date	Time	Depth to Water	Ref. Pt.	Depth of Casing	Stab. Time

Depth (ft)	Casing Blows per ft	Sample Information					Stratum		Geologic Description	Well Diagram	Well Description
		Sample No.	Depth (ft)	Spoon Blows per 6"	Pen/ Rec (in.)	PID Values (ppm)	Log	Description			
2											
4											
6											
8											
10											
12											
14											
16											
18											
20											
22											
24											

Sanborn, Head & Associates, Inc.
CONSULTING ENGINEERS & SCIENTISTS

Sheet: 1 of 2

Log of Bedrock Monitoring Well

Project:
Location:
SHA Project No.:
Drilling Method:

Drilling Company:
Foreman:
Date Started: **Date Finished:**
Logged By: **Checked By:**

Ground Elevation:
TOC Elevation:
PVC Elevation:
Groundwater Readings

Date	Time	Depth	Ref. Pt.	Stab. Time

Depth (ft)	Drill Rate (min/ft)	Down Pressure (PSI)	Sample No./ Depth (ft)	Yield Test/ Depth (ft)	PID Values (ppm)	Graphic Log	Stratum	Geologic Description	Well Diagram	Well Description
0										
2										
4										
6										
8										
10										
12										
14										
16										
18										
20										
22										
24										

Sanborn, Head & Associates, Inc.
CONSULTING ENGINEERS & SCIENTISTS

Sheet: 2 of 2

Log of Bedrock Monitoring Well

Project:
Location:
SHA Project No.:
Drilling Method:

Drilling Company:
Foreman:
Date Started: **Date Finished:**
Logged By: **Checked By:**

Ground Elevation:
TOC Elevation:
PVC Elevation:
Groundwater Readings

Date	Time	Depth	Ref. Pt.	Stab. Time

Depth (ft)	Drill Rate (min/ft)	Down Pressure (PSI)	Sample No./ Depth (ft)	Yield Test/ Depth (ft)	PID Values (ppm)	Graphic Log	Stratum	Geologic Description	Well Diagram	Well Description
27										
29										
31										
33										
35										
37										
39										
41										
43										
45										
47										
49										

Test Pit Field Log

Sanborn, Head & Associates, Inc.
SHA
60 Forest Avenue, Suite 1
Portland, ME 04101

Project No.:
Description:
Location:

Test Pit No.:
Ground Elevation:

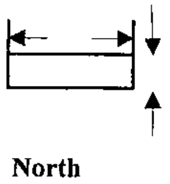
SHA Representative:
Date:
Weather:
Start Time: Finish Time:

Excavation Equipment
Contractor: Operator:
Make: Model:
Reach: Bucket Capacity:

Depth (feet)	PID Reading/ Groundwater	Soil Description	Excavation Effort	Boulder Qty/Class	Note Number
1					
2					
3					
4					
5					
6					
7					
8					
9					
10					
11					
12					
13					
14					
15					
16					

Notes:
1.
2.
3.

Test Pit Plan



Boulder Size Classification

Range	Letter Designation
6" - 18"	A
18" - 36"	B
36" and larger	C

Minor Component Proportions

Trace	0 - 10%
Little	10 - 20%
Some	20 - 35%
And	35 - 50%

Excavation Effort

E	Easy
M	Moderate
D	Difficult

S:\DATA\xx\TESTPTME.XLS

Sanborn, Head & Associates, Inc.
CONSULTING ENGINEERS & SCIENTISTS

Sheet: 1 of 2

Log of Boring

Project:
Location:
SHA Project No.:

Drilling Method:
Drilling Company:
Foreman:
Date Started: Date Finished:
Logged By: Checked By:

Ground Elevation:

Groundwater Readings

Date	Time	Depth	Ref. Pt.	Stab. Time

Depth (ft)	Sample No.	Depth (ft)	Blows per 6"	Pen/ Rec (in.)	PID Values (ppm)	Graphic Log	Stratum	Geologic Description	Remarks
0									
2									
4									
6									
8									
10									
12									
14									
16									
18									
20									
22									
24									
26									
28									
30									

Sanborn, Head & Associates, Inc.
CONSULTING ENGINEERS & SCIENTISTS

Sheet: 2 of 2

Log of Boring

Project:
Location:
SHA Project No.:

Ground Elevation:

Groundwater Readings

Date	Time	Depth	Ref. Pt.	Stab. Time

Drilling Method:
Drilling Company:
Foreman:
Date Started: Date Finished:
Logged By: Checked By:

Depth (ft)	Sample No.	Depth (ft)	Blows per 6"	Pen/ Rec (in.)	PID Values (ppm)	Graphic Log	Stratum	Geologic Description	Remarks
32									
34									
36									
38									
40									
42									
44									
46									
48									
50									
52									
54									
56									
58									
60									

APPENDIX D.4

WELL DEVELOPMENT FIELD FORM

Summary of Monitoring Well Development

Well	Water Volume Added During Drilling (gal)	Date Development Performed	Development Water Level (ft)	Pumping Data	Approximate Pumping Rate (gal/min)	Pumping Duration (min)	Approximate Volume Purged (gal)	Silt @ Bottom of Well	Visual Indicators			pH Pre- & Post-Development (s.u.)		Specific Conductance Pre- & Post-Development (µS/cm	
									Turbid	Cloudy	Clear	Pre-	Post-	Pre-	Post-

Approximate Total Volume of Water Purged (gallons):

Comments

1.
2.
3.

APPENDIX D.5

GROUNDWATER SAMPLILNG FIELD FORMS

Low Flow Purge and Sample Data Sheet

SHA
Sanborn, Head & Associates
Consulting Engineers & Scientists

Project No.:
Location:
SHA Rep.:

Well Diameter:
Reference Point:
Intake Depth:

Water Level:
Total Depth:
Screen Interval:

Well No.:
Date:
Weather:

Time (min.)	Water Level (ft)	Flow (ml/min)	Temperature (°C)	Specific Conductance (µS/cm)	DO (mg/l)	pH (s.u.)	ORP (mV)	Turbidity (NTU)	Pump Speed	Intake Depth (ft)	Comments

Equilibrium Goals (3 consecutive readings 3-5 min apart)
Flow: 100 - 400 ml/min
Water Level: <0.3 ft
DO: ±10%
Turbidity: ±10%
Spec. Cond.: ±3%
pH: ±0.1
ORP: ±10 mV
Temperature: 3% (may not equilibrate)

Adapted from State of Maine Department of Environmental Protection

Meters Used

Water Level:
Flow:
DO:
Conductivity:
Temperature:
pH:
ORP:
Turbidity:

Purge/Sample Device:

Laboratory Sample Numbers

Analysis/Depth	Number

pH of Sacrificial Sample(s):

Low Flow Equipment Calibration / Calibration Check Data Sheet
(circle one)

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CONSULTING ENGINEERS & SCIENTISTS

Location: ______________ Time: ______________

SHA Rep: ______________ Weather: ______________

YSI 600 Sonde with Flow Through Cell, serial number: ______________

YSI 650 MDS Display, serial number: ______________

Date and Time Dissolved Oxygen Filter membrane last changed: ______________

Local Barometric Pressure: ________ Ambient Air Temperature (measured with YSI 600 temperature probe): ______________

Calibration of Dissolved Oxygen (DO) Probe by water-saturated air: Yes ☐ No ☐ Value read back from instrument: ______________

Theoretical DO concentration in water-saturated air (from QAPP Table B-2): ______ Meet calibration check acceptance criteria Yes ☐ No ☐

Calibration check of DO Probe with zero mg/l DO Standard: Yes ☐ No ☐ Value read back from instrument: ______________

First pH Standard: ______ s.u. Calibration check: ______ s.u. Meet calibration check acceptance criteria Yes ☐ No ☐

Standard manufacturer, lot number and expiration date: ______________

Second pH Standard: ______ s.u. Calibration check: ______ s.u. Meet calibration check acceptance criteria Yes ☐ No ☐

Standard manufacturer, lot number and expiration date: ______________

Third pH Standard: ______ s.u. Calibration check: ______ s.u. Meet calibration check acceptance criteria Yes ☐ No ☐

Standard manufacturer, lot number and expiration date: ______________

Specific Conductance of Stnd: ______ µS/cm Calibration check: ______ µS/cm Meet calibration check acceptance criteria Yes ☐ No ☐

Standard manufacturer, lot number and expiration date: ______________

Oxidation Reduction Potential Stnd: ______ mV Calibration check: ______ mV Meet calibration check acceptance criteria Yes ☐ No ☐

Standard manufacturer, lot number and expiration date: ______________

Hach 2100P Portable Turbidimeter, serial number: ______________

Date & Time Turbidity Meter last calibrated with Primary Standards: ______________

Standard manufacturer, lot number and expiration date: ______________

Formazin Standard No 1: ______ NTU Calibration Check: ______ NTU Meet calibration check acceptance criteria Yes ☐ No ☐

Formazin Standard No 2: ______ NTU Calibration Check: ______ NTU Meet calibration check acceptance criteria Yes ☐ No ☐

Formazin Standard No 3: ______ NTU Calibration Check: ______ NTU Meet calibration check acceptance criteria Yes ☐ No ☐

Formazin Standard No 4: ______ NTU Calibration Check: ______ NTU Meet calibration check acceptance criteria Yes ☐ No ☐

Comments and Corrective Actions:

Signature: ______________

Groundwater Quality Field Sampling Summary

SHA
Sanborn, Head & Associates
Consulting Engineers & Scientists

pH Meter:	Project Number:	Date:
Conductivity Meter:	Project Name:	
Water Level Meter:	Project Location:	
Other:	Project Manager:	
	Collector:	
	Weather:	

Field Measurements

Sampling Location							
Reference Point							
Reference Point Elevation (feet)							
Depth to Floating Product (feet)							
Depth to Water (feet)							
Water Table Elevation (feet)							
Depth to Bottom (feet)							
pH (standard units)							
Specific Conductance (µS/cm)							
Temperature (°C)							
Dissolved Oxygen (mg/L)							
Oxidation Reduction Potential (mv)							
Date of Sample							
Sample Time							
Gallons Purged							
Purge/Sample Device							
Comment Reference Number							

Comments

1.
2.
3.
4.
5.
6.
7.
8.

APPENDIX D.6

SUPERFUND TARGET COMPOUND LIST AND QUANTITATION LIMITS

Superfund Target Compound List (TCL) and Contract Required Quantitation Limits (CRQL)

			Quantitation Limits*			
	Volatiles	CAS Number	Water µg/L	Low Soil µg/Kg	Med Soil µg/Kg	On Column (ng)
1.	Dichlorodifluoromethane	75-71-8	10	10	1200	(50)
2.	Chloromethane	74-87-3	10	10	1200	(50)
3.	Bromomethane	74-83-9	10	10	1200	(50)
4.	Vinyl chloride	75-01-4	10	10	1200	(50)
5.	Chloroethane	75-00-3	10	10	1200	(50)
6.	Trichlorofluoromethane	75-69-4	10	10	1200	(50)
7.	1,1-Dichloroethene	75-35-4	10	10	1200	(50)
8.	1,1,2-Trichloro-1,2,2-trifluoroethane	76-13-1	10	10	1200	(50)
9.	Acetone	67-64-1	10	10	1200	(50)
10.	Carbon Disulfide	75-15-0	10	10	1200	(50)
11.	Methyl Acetate	79-20-9	10	10	1200	(50)
12.	Methylene chloride	75-09-2	10	10	1200	(50)
13.	trans-1,2-Dichloroethene	156-60-5	10	10	1200	(50)
14.	Methyl tert-Butyl Ether	1634-04-4	10	10	1200	(50)
15.	1,1-Dichloroethane	75-35-3	10	10	1200	(50)
16.	cis-1,2-Dichloroethene	156-59-2	10	10	1200	(50)
17.	2-Butanone	78-93-3	10	10	1200	(50)
18.	Chloroform	67-66-3	10	10	1200	(50)
19.	1,1,1-Trichloroethane	71-55-6	10	10	1200	(50)
20.	Cyclohexane	110-82-7	10	10	1200	(50)
21.	Carbon tetrachloride	56-23-5	10	10	1200	(50)
22.	Benzene	71-43-2	10	10	1200	(50)
23.	1,2-Dichloroethane	107-06-2	10	10	1200	(50)
24.	Trichloroethene	79-01-6	10	10	1200	(50)
25.	Methylcyclohexane	108-87-2	10	10	1200	(50)
26.	1,2-Dichloropropane	78-87-5	10	10	1200	(50)
27.	Bromodichloromethane	75-27-4	10	10	1200	(50)
28.	cis-1,3-Dichloropropene	10061-01-5	10	10	1200	(50)
29.	4-Methyl-2-pentanone	108-10-1	10	10	1200	(50)
30.	Toluene	108-88-3	10	10	1200	(50)
31.	trans-1,3-Dichloropropene	10061-02-6	10	10	1200	(50)
32.	1,1,2-Trichloroethane	79-00-5	10	10	1200	(50)
33.	Tetrachloroethene	127-18-4	10	10	1200	(50)
34.	2-Hexanone	591-78-6	10	10	1200	(50)
35.	Dibromochloromethane	124-48-1	10	10	1200	(50)

Superfund Target Compound List (TCL) and Contract Required Quantitation Limits (CRQL)

	Volatiles (cont.)	CAS Number	Quantitation Limits* Water µg/L	Low Soil µg/Kg	Med Soil µg/Kg	On Column (ng)
36.	1,2-Dibromoethane	106-93-4	10	10	1200	(50)
37.	Chlorobenzene	108-90-7	10	10	1200	(50)
38.	Ethyl Benzene	100-41-4	10	10	1200	(50)
39.	Total Xylenes	1330-20-7	10	10	1200	(50)
40.	Styrene	100-42-5	10	10	1200	(50)
41.	Bromoform	75-25-2	10	10	1200	(50)
42.	Isopropylbenzene	98-82-8	10	10	1200	(50)
43.	1,1,2,2-Tetrachloroethane	79-34-5	10	10	1200	(50)
44.	1,3-Dichlorobenzene	541-73-1	10	10	1200	(50)
45.	1,4-Dichlorobenzene	106-46-7	10	10	1200	(50)
46.	1,2-Dichlorobenzene	95-50-1	10	10	1200	(50)
47.	1,2-Dibromo-3-chloropropane	96-12-8	10	10	1200	(50)
48.	1,2,4-Trichlorobenzene	120-82-1	10	10	1200	(50)

* Quantitation Limits listed for soil/sediment are based on wet weight. The quantitation limits calculated by the laboratory for soil/sediment, calculated on dry weight basis, as required by the protocol, will be higher.

Superfund Target Compound List (TCL) and Contract Required Quantitation Limits (CRQL)*

	Semivolatiles	CAS Number	Quantitation Limits*			
			Water µg/L	Low Soil µg/Kg	Med Soil µg/Kg	On Column (ng)
34.	Phenol	108-95-2	10	330	10,000	(20)
35.	bis(2-Chloroethyl) ether	111-44-4	10	330	10,000	(20)
36.	2-Chlorophenol	95-57-8	10	330	10,000	(20)
37.	1,3-Dichlorobenzene	541-73-1	10	330	10,000	(20)
38.	1,4-Dichlorobenzene	106-46-7	10	330	10,000	(20)
39.	1,2-Dichlorobenzene	95-50-1	10	330	10,000	(20)
40.	2-Methylphenol	95-48-7	10	330	10,000	(20)
41.	2,2'-oxybis(1-Chloropropane) #	108-60-1	10	330	10,000	(20)
42.	4-Methylphenol	106-44-5	10	330	10,000	(20)
43.	N-Nitroso-di-n-propylamine	621-64-7	10	330	10,000	(20)
44.	Hexachloroethane	67-72-1	10	330	10,000	(20)
45.	Nitrobenzene	98-95-3	10	330	10,000	(20)
46.	Isophorone	78-59-1	10	330	10,000	(20)
47.	2-Nitrophenol	88-75-5	10	330	10,000	(20)
48.	2,4-Dimethylphenol	105-67-9	10	330	10,000	(20)
49.	bis(2-Chloroethoxy) methane	111-91-1	10	330	10,000	(20)
50.	2,4-Dichlorophenol	120-83-2	10	330	10,000	(20)
51.	1,2,4-Trichlorobenzene	120-82-1	10	330	10,000	(20)
52.	Naphthalene	91-20-3	10	330	10,000	(20)
53.	4-Chloroaniline	106-47-8	10	330	10,000	(20)
54.	Hexachlorobutadiene	87-68-3	10	330	10,000	(20)
55.	4-Chloro-3-methylphenol	59-50-7	10	330	10,000	(20)
56.	2-Methylnaphthalene	91-57-6	10	330	10,000	(20)
57.	Hexachlorocyclopentadiene	77-47-4	10	330	10,000	(20)
58.	2,4,6-Trichlorophenol	88-06-2	10	330	10,000	(20)
59.	2,4,5-Trichlorophenol	95-95-4	25	800	25,000	(50)
60.	2-Chloronaphthalene	91-58-7	10	330	10,000	(20)
61.	2-Nitroaniline	88-74-4	25	800	25,000	(50)
62.	Dimethyl phthalate	131-11-3	10	330	10,000	(20)
63.	Acenaphthylene	208-96-8	10	330	10,000	(20)
64.	2,6-Dinitrotoluene	606-20-2	10	330	10,000	(20)
65.	3-Nitroaniline	99-09-2	25	800	25,000	(50)
66.	Acenaphthene	83-32-9	10	330	10,000	(20)

\# Previously known by the name bis(2-Chloroisopropyl) ether

Superfund Target Compound List (TCL) and Contract Required Quantitation Limits (CRQL)

			Quantitation Limits*			
	Semivolatiles	CAS Number	Water µg/L	Low Soil µg/Kg	Med Soil µg/Kg	On Column (ng)
67.	2,4-Dinitrophenol	51-28-5	25	800	25,000	(50)
68.	4-Nitrophenol	100-02-7	25	800	25,000	(50)
69.	Dibenzofuran	132-64-9	10	330	10,000	(20)
70.	2,4-Dinitrotoluene	121-14-2	10	330	10,000	(20)
71.	Diethylphthalate	84-66-2	10	330	10,000	(20)
72.	4-Chlorophenyl phenyl ether	7005-72-3	10	330	10,000	(20)
73.	Fluorene	86-73-7	10	330	10,000	(20)
74.	4-Nitroaniline	100-01-6	25	800	25,000	(50)
75.	4,6-Dinitro-2-methylphenol	534-52-1	25	800	25,000	(50)
76.	N-nitrosodiphenylamine	86-30-6	10	330	10,000	(20)
77.	4-Bromophenyl phenyl ether	101-55-3	10	330	10,000	(20)
78.	Hexachlorobenzene	118-74-1	10	330	10,000	(20)
79.	Pentachlorophenol	87-86-5	25	800	25,000	(50)
80.	Phenanthrene	85-01-8	10	330	10,000	(20)
81.	Anthracene	120-12-7	10	330	10,000	(20)
82	Carbazole	86-74-8	10	330	10,000	(20)
83.	Di-n-butyl phthalate	84-74-2	10	330	10,000	(20)
84.	Fluoranthene	206-44-0	10	330	10,000	(20)
85.	Pyrene	129-00-0	10	330	10,000	(20)
86.	Butyl benzyl phthalate	85-68-7	10	330	10,000	(20)
87.	3,3'-Dichlorobenzidine	91-94-1	10	330	10,000	(20)
88.	Benz[a]anthracene	56-55-3	10	330	10,000	(20)
89.	Chrysene	218-01-9	10	330	10,000	(20)
90.	bis(2-Ethylhexyl)phthalate	117-81-7	10	330	10,000	(20)
91.	Di-n-octyl phthalate	117-84-0	10	330	10,000	(20)
92.	Benzo[b]fluoranthene	205-99-2	10	330	10,000	(20)
93.	Benzo[k]fluoranthene	207-08-9	10	330	10,000	(20)
94.	Benzo[a]pyrene	50-32-8	10	330	10,000	(20)
95.	Indeno(1,2,3-cd]pyrene	193-39-5	10	330	10,000	(20)
96.	Dibenz[a,h]anthracene	53-70-3	10	330	10,000	(20)
97.	Benzo[g,h,i]perylene	191-24-2	10	330	10,000	(20)

* Quantitation limits listed for soil/sediment are based on wet weight. The quantitation limits calculated by the Laboratory for soil/sediment, calculated on dry weight basis as required by the Protocol, will be higher.

Superfund Target Compound List (TCL) and Contract Required Quantitation Limits (CRQL)*

			Quantitation Limits*		
	Pesticides/Aroclors	CAS Number	Water µg/L	Soil µg/Kg	On Column (pg)
98.	alpha-BHC	319-84-6	0.05	1.7	5
99.	beta-BHC	319-85-7	0.05	1.7	5
100.	delta-BHC	319-86-8	0.05	1.7	5
101.	gamma-BHC (Lindane)	58-89-9	0.05	1.7	5
102.	Heptachlor	76-44-8	0.05	1.7	5
103.	Aldrin	309-00-2	0.05	1.7	5
104.	Heptachlor epoxide	1024-57-3	0.05	1.7	5
105.	Endosulfan I	959-98-8	0.05	1.7	5
106.	Dieldrin	60-57-1	0.10	3.3	10
107.	4,4'-DDE	72-55-9	0.10	3.3	10
108.	Endrin	72-20-8	0.10	3.3	10
109.	Endosulfan II	33213-65-9	0.10	3.3	10
110.	4,4'-DDD	72-54-8	0.10	3.3	10
111.	Endosulfan sulfate	1031-07-8	0.10	3.3	10
112.	4,4'-DDT	50-29-3	0.10	3.3	10
113.	Methoxychlor	72-43-5	0.50	17.0	50
114.	Endrin ketone	53494-70-5	0.10	3.3	10
115.	Endrin aldehyde	7421-36-3	0.10	3.3	10
116.	alpha-Chlordane	5103-71-9	0.05	1.7	5
117.	gamma-Chlordane	5103-74-2	0.05	1.7	5
118.	Toxaphene	8001-35-2	5.0	170.0	500
119.	AROCLOR-1016	12674-11-2	1.0	33.0	100
120.	AROCLOR-1221	11104-28-2	2.0	67.0	200
121.	AROCLOR-1232	11141-16-5	1.0	33.0	100
122.	AROCLOR-1242	53469-21-9	1.0	33.0	100
123.	AROCLOR-1248	12672-29-6	1.0	33.0	100
124.	AROCLOR-1254	11097-69-1	1.0	33.0	100
125.	AROCLOR-1260	11096-82-5	1.0	33.0	100

* Quantitation Limits listed for soil/sediment are based on wet weight. The quantitation limits calculated by the Laboratory for soil/sediment, calculate on dry weight basis, as required by the Protocol, will be higher.

Superfund Target Compound List (TCL) and Contract Required Quantitation Limit

Parameter		Contract Required Quantitation Level (µg/L)
1.	Aluminum	200
2.	Antimony	60
3.	Arsenic	10
4.	Barium	200
5.	Beryllium	5
6.	Cadmium	5
7.	Calcium	5000
8.	Chromium	10
9.	Cobalt	50
10.	Copper	25
11.	Iron	100
12.	Lead	3
13.	Magnesium	5000
14.	Manganese	15
15.	Mercury	0.2
16.	Nickel	40
17.	Potassium	5000
18.	Selenium	5
19.	Silver	10
20.	Sodium	5000
21.	Thallium	10
22.	Vanadium	50
23.	Zinc	20
24.	Cyanide	10

United States
Environmental Protection
Agency

Office of
Solid Waste and
Emergency Response

OSWER Document 9240.1-43FS
EPA Publication 540-F-04-001
February 2004

EPA

Multi-Media, Multi-Concentration, Inorganic Analytical Service for Superfund (ILM05.3)

Office of Superfund Remediation and Technology Innovation
Analytical Services Branch (5204G)

Quick Reference Fact Sheet

Under the legislative authority granted to the U.S. Environmental Protection Agency (EPA) under the Comprehensive Environmental Response, Compensation, and Liability Act of 1980 (CERCLA) and the Superfund Amendments and Reauthorization Act of 1986 (SARA), EPA develops standardized analytical methods for the measurement of various pollutants in environmental samples from known or suspected hazardous waste sites. Among the pollutants that are of concern to EPA at such sites is a series of inorganic analytes and cyanide that are analyzed using Inductively Coupled Plasma-Atomic Emission Spectroscopy (ICP-AES), Inductively Coupled Plasma-Mass Spectrometry (ICP-MS), Cold Vapor Atomic Absorption (CVAA), and colorimetric techniques. The Analytical Services Branch (ASB) of the Office of Superfund Remediation and Technology Innovation (OSRTI) offers an analytical service that provides data from the analysis of water/aqueous and soil/sediment samples for inorganic analytes for use in the Superfund and other decision making processes. Through a series of standardized procedures and a strict chain-of-custody, the inorganic analytical service produces data of known and documented quality. This service is available through the Superfund Contract Laboratory Program (CLP).

DESCRIPTION OF SERVICES

The inorganic analytical service provides a technical and contractual framework for laboratories to utilize EPA/CLP analytical methods. These methods are used in the isolation, detection and quantitative measurement of 23 target analyte metals (including mercury) and cyanide in both water and soil/sediment environmental samples. The CLP provides the methods to be used and the specific technical, reporting, and contractual requirements, including Quality Assurance (QA), Quality Control (QC), and Standard Operating Procedures (SOPs), by which EPA evaluates the data.

Three data delivery turnaround times are available to CLP customers: 7, 14, and 21-day turnaround after receipt of the last sample in the set. A 72-hour preliminary data submission option also is available for all turnaround times. The data associated with these Preliminary Results is due within 72 hours after receipt of each sample at the laboratory. In addition, data users may request modifications to the SOW that may include, but are not limited to, additional analytes and modified quantitation limits.

DATA USES

This analytical service provides data that EPA uses for a variety of purposes. Examples include determining the nature and extent of contamination at a hazardous waste site, assessing priorities for response based on risks to human health and the environment, determining appropriate cleanup actions, and determining when remedial actions are complete. The data may be used in all stages in the investigation of a hazardous waste site including: site inspections, Hazard Ranking System scoring, remedial investigations/feasibility studies, remedial design, treatability studies, and removal actions. In addition, this service provides data that are available for use in Superfund enforcement/litigation activities.

TARGET ANALYTES

The inorganic analytes and quantitation limits for which this service is applicable are listed in **Table 1**. Specific detection limits are method and matrix dependent.

The list of target analytes for this service was originally derived from the EPA Priority Pollutant List of 129 compounds. In the years since the inception of the CLP, analytes have been added to and deleted from the Target Analyte List (TAL), based on advances in analytical methods, evaluation of method performance data, and the needs of the Superfund program.

METHODS AND INSTRUMENTATION

The Contractor laboratories will demonstrate the ability to meet certain program data quality objectives prior to analyzing field samples. The laboratories must document methods used to generate analytical results and determine Method Detection Limits (MDLs).

Table 1. Inorganic Target Analyte List and Contract Required Quantitation Limits (CRQLs)

Analyte	ICP-AES CRQL for Water (µg/L)	ICP-AES CRQL for Soil (mg/kg)	ICP-MS CRQL for Water (µg/L)
1. Aluminum	200	20	--
2. Antimony	60	6	2
3. Arsenic	10	1	1
4. Barium	200	20	10
5. Beryllium	5	0.5	1
6. Cadmium	5	0.5	1
7. Calcium	5000	500	- -
8. Chromium	10	1	2
9. Cobalt	50	5	1
10. Copper	25	2.5	2
11. Iron	100	10	- -
12. Lead	10	1	1
13. Magnesium	5000	500	- -
14. Manganese	15	1.5	1
15. Mercury	0.2	0.1	- -
16. Nickel	40	4	1
17. Potassium	5000	500	- -
18. Selenium	35	3.5	5
19. Silver	10	1	1
20. Sodium	5000	500	- -
21. Thallium	25	2.5	1
22. Vanadium	50	5	1
23. Zinc	60	6	2
24. Cyanide	10	2.5	- -

ICP-Atomic Emission Spectroscopy (ICP-AES) is used to analyze water, sediment, sludge, and soil samples. Water and soil samples are treated with acids and heated. The digestates are then analyzed for trace metals by an atomic emission optical spectroscopic technique. The samples are nebulized and the aerosol is transported to a plasma torch. The atomic-line emission spectra are dispersed and a photosensitive device monitors line intensities.

ICP-Mass Spectrometry (ICP-MS) is used to determine the concentration of dissolved and total recoverable elements in water/aqueous samples. The sample material is introduced, by nebulization, into radio frequency plasma where desolvation, atomization, and ionization take place. The ions are extracted from the plasma through a differentially pumped vacuum interface and separated based on their mass-to-charge ratio.

Cold Vapor Atomic Absorption (CVAA) is used to analyze water, sediment, sludge, and soil samples for total mercury. Organo-mercury compounds may also be present and will need to be broken down and converted to mercuric ions to respond to the CVAA techniques. For water samples, organic compounds are oxidized and then reacted with a strong reducing agent. The volatile free mercury is then driven from the reaction flask by bubbling air through the solution. The air stream carries the mercury atoms to an absorption cell, which is then placed in the light path of the AA spectrophotometer. For soil/sediment, the samples undergo acid digestion/oxidation followed by reduction and measurement by conventional cold vapor technique.

Various water types, sediment, sludge, and soil samples are also analyzed for total cyanide. Hydrocyanic acid (HCN) is released through a reflux-distillation and absorbed in a scrubber containing sodium hydroxide solution. The cyanide ion is determined colorimetrically by converting it to cyanogen chloride (CNCl).

Table 2 summarizes the methods and instruments used in this analytical service.

DATA DELIVERABLES

Data deliverables for this service include both hardcopy/electronic data reporting forms and supporting raw data. The laboratory must submit data to EPA within 7-, 14- or 21-days, or preliminary data must be submitted within 72 hours after laboratory receipt of each sample in the set, if requested. EPA then processes the data through an automated Data Assessment Tool (DAT). DAT is a complete CLP data assessment package. DAT incorporates Contract Compliance Screening (CCS) and Computer-Aided Data Review and Evaluation (CADRE) review to provide EPA Regions and other data users with electronic reports (PC-compatible reports, spreadsheets, and electronic files) within 24 to 48 hours from the receipt of the data. This automated tool facilitates the

Table 2. Methods and Instruments

Analyte	Instrument	Method
Al, Sb, As, Ba, Be, Cd, Ca, Cr, Co, Cu, Fe, Pb, Mg, Mn, Ni, K, Se, Ag, Na, Tl, V, Zn	Inductively Coupled Plasma - Atomic Emission Spectroscopy (ICP-AES)	ICP analysis of atomic-line emission spectra.
Sb, As, Ba, Be, Cd, Cr, Co, Cu, Pb, Mn, Ni, Se, Ag, Tl, V, Zn	ICP - Mass Spectrometry (ICP-MS)	ICP analysis of ions separated on basis of mass-to-charge ratio.
Mercury (Hg)	Cold Vapor Atomic Absorption (CVAA)	Acid digestion/oxidation followed by reduction and CVAA analysis.
Cyanide (CN)	Colorimeter or Spectrophotometer	Distillation followed by colorimetric analysis.

Table 3. Quality Control

QC Operation	Frequency
Instrument Calibration	Daily or each time instrument is set up.
Initial Calibration Verification	Following each instrument calibration for each wavelength or mass used.
Initial Calibration Blank	Following each instrument calibration, immediately after the Initial Calibration Verification (ICV).
Continuing Calibration Verification	For each wavelength or mass used, at a frequency of 10% or every two hours of a run, whichever is more frequent, and at the beginning and end of each run.
Continuing Calibration Blank	10% or every two hours of a run, whichever is more frequent, and at the beginning and end of each run. Performed immediately after the last Continuing Calibration Verification (CCV).
CRQL Check Standard (CRI)	Every 20 analytical samples and at the beginning and end of each run, but not before the ICV. Performed before the Interference Check Sample.
Interference Check Sample	For ICP-AES, every 20 analytical samples and at the beginning and end of each run, immediately after the CRI. For ICP-MS, at the beginning of the run.
Serial Dilution for ICP	For each matrix type or for each SDG, whichever is more frequent.
Preparation Blank	For each SDG or each sample preparation and analysis procedure per batch of prepared samples.
Laboratory Control Sample	For each SDG or each sample preparation and analysis procedure per batch of prepared samples, except aqueous mercury and cyanide.
Spike Sample	For each matrix type or for each SDG, whichever is more frequent.
Post Digestion/Distillation Spike	Each time Spike Sample Recovery is outside QC limits.
Duplicate Sample Analysis	For each matrix type or for each SDG, whichever is more frequent.
ICP-MS Tune	Prior to calibration.
Method Detection Limit Determination	Prior to contract, annually thereafter, and after major instrument maintenance.
Interelement Corrections	Prior to contract, quarterly thereafter, and after major instrument adjustment.
Linear Range Analysis	Prior to contract, and quarterly thereafter.

transfer of analytical data into Regional databases. DAT can also be used to assist in the data validation process at the Region. In addition to the Regional electronic reports, the CLP laboratories are provided with a data assessment report that documents the instances of noncompliance. The laboratory has four business days to reconcile defective data and resubmit the data to EPA. EPA then reviews the data for noncompliance and sends a final data assessment report to the CLP laboratory and the Region.

QUALITY ASSURANCE

The Quality Assurance (QA) process consists of management review and oversight at the planning, implementation, and completion stages of the environmental data collection activity and ensures that the data provided are of the quality required. During the data collection effort, QA activities ensure that the Quality Control (QC) system is functioning effectively and that the deficiencies uncovered by the QC system are corrected. After environmental data are collected, QA activities focus on assessing the quality of data obtained to determine its suitability to support enforcement or remedial decisions. Each contract laboratory will establish a Quality Assurance Plan (QAP) with the objective of providing sound analytical chemical measurements. The QAP must specify the policies, organization, objectives, functional guidelines, and specific QA/QC activities designed to achieve the data quality requirements for this analytical service.

QUALITY CONTROL

The QC process includes those activities required during analytical data collection to produce data of known and documented quality.

The analytical data acquired from QC procedures are used to estimate and evaluate the analytical results and to determine the necessity for, or the effect of, corrective action procedures. The QC procedures required for this analytical service are shown in **Table 3**.

PERFORMANCE MONITORING ACTIVITIES

Laboratory performance monitoring activities are provided primarily by ASB and the Regions to ensure that contract laboratories are producing data of the appropriate quality. EPA performs on-site laboratory audits, data package audits, and evaluates laboratory performance with blind performance evaluation samples.

For more information, or for suggestions to improve this analytical service, please contact:

Anand R. Mudambi
Inorganic Program Manager
USEPA/ASB
Ariel Rios Building (5204G)
1200 Pennsylvania Avenue, NW
Washington, D.C. 20460
Tel: 703-603-8796
Fax: 703-603-9112

John D. Nebelsick
Deputy Inorganic Program Manager
USEPA/ASB
Ariel Rios Building (5204G)
1200 Pennsylvania Avenue, NW
Washington, D.C. 20460
Tel: 703-603-8845
Fax: 703-603-9112

United States
Environmental Protection
Agency

Office of
Solid Waste and
Emergency Response

OSWER Document 9240.1-39FS
EPA Publication 540-F-02-008
October 2002

EPA

Multi-Media, Multi-Concentration, Inorganic Analytical Service for Superfund (ILM05.2)

Office of Emergency and Remedial Response
Analytical Operations/Data Quality Center (5204G)

Quick Reference Fact Sheet

Under the legislative authority granted to the U.S. Environmental Protection Agency (EPA) under the Comprehensive Environmental Response, Compensation, and Liability Act of 1980 (CERCLA) and the Superfund Amendments and Reauthorization Act of 1986 (SARA), EPA develops standardized analytical methods for the measurement of various pollutants in environmental samples from known or suspected hazardous waste sites. Among the pollutants that are of concern to EPA at such sites is a series of inorganic analytes and cyanide that are analyzed using Inductively Coupled Plasma-Atomic Emission Spectroscopy (ICP-AES), Inductively Coupled Plasma-Mass Spectrometry (ICP-MS), Cold Vapor Atomic Absorption (CVAA), and colorimetric techniques. The Analytical Operations/Data Quality Center (AOC) of the Office of Emergency and Remedial Response (OERR) offers an analytical service that provides data from the analysis of water/aqueous and soil/sediment samples for inorganic analytes for use in the Superfund decision making process. Through a series of standardized procedures and a strict chain-of-custody, the inorganic analytical service produces data of known and documented quality. This service is available through the Superfund Contract Laboratory Program (CLP).

DESCRIPTION OF SERVICES

The inorganic analytical service provides a technical and contractual framework for laboratories to utilize EPA/CLP analytical methods. These methods are used in the isolation, detection and quantitative measurement of 23 target analyte metals (including mercury) and cyanide in both water and soil/sediment environmental samples. The CLP provides the methods to be used and the specific technical, reporting, and contractual requirements, including Quality Assurance (QA), Quality Control (QC), and Standard Operating Procedures (SOPs), by which EPA evaluates the data.

Three data delivery turnaround times are available to CLP customers: 7, 14, and 21-day turnaround after receipt of the last sample in the set. A 72-hour preliminary data submission option also is available for all turnaround times. The data associated with these Preliminary Results is due within 72 hours after receipt of each sample at the laboratory. In addition, data users may include, but are not limited to, additional analytes and/or lower quantitation limits.

DATA USES

This analytical service provides data that EPA uses for a variety of purposes. Examples include determining the nature and extent of contamination at a hazardous waste site, assessing priorities for response based on risks to human health and the environment, determining appropriate cleanup actions, and determining when remedial actions are complete. The data may be used in all stages in the investigation of a hazardous waste site including: site inspections, Hazard Ranking System scoring, remedial investigations/feasibility studies, remedial design, treatability studies, and removal actions. In addition, this service provides data that are available for use in Superfund enforcement/litigation activities.

TARGET ANALYTES

The inorganic analytes and quantitation limits for which this service is applicable are listed in **Table 1.** Specific detection limits are method and matrix dependent.

The list of target analytes for this service was originally derived from the EPA Priority Pollutant List of 129 compounds. In the years since the inception of the CLP, analytes have been added to and deleted from the Target Analyte List (TAL), based on advances in analytical methods, evaluation of method performance data, and the needs of the Superfund program.

METHODS AND INSTRUMENTATION

The Contractor will demonstrate the ability to meet certain program data quality objectives prior to analyzing field samples. The Contractor must document methods used to generate analytical results and determine Method Detection Limits (MDLs). ICP-Atomic Emission Spectroscopy (ICP-AES) is used to analyze water, sediment, sludge, and soil samples.

Table 1. Inorganic Target Analyte List and Contract Required Quantitation Limits (CRQLs)

	Analyte	ICP-AES CRQL for Water (µg/L)	ICP-AES CRQL for Soil (mg/kg)	ICP-MS CRQL for Water (µg/L)
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2.	Antimony	60	12	2
3.	Arsenic	15	3	1
4.	Barium	200	40	10
5.	Beryllium	5	1	1
6.	Cadmium	5	1	1
7.	Calcium	5000	1000	- -
8.	Chromium	10	2	2
9.	Cobalt	50	10	0.5
10.	Copper	25	5	2
11.	Iron	100	20	- -
12.	Lead	10	2	1
13.	Magnesium	5000	1000	- -
14.	Manganese	15	3	0.5
15.	Mercury	0.2	0.1	- -
16.	Nickel	40	8	1
17.	Potassium	5000	1000	- -
18.	Selenium	35	7	5
19.	Silver	10	2	1
20.	Sodium	5000	1000	- -
21.	Thallium	25	5	1
22.	Vanadium	50	10	1
23.	Zinc	60	12	1
24.	Cyanide	10	1	- -

Water and soil samples are treated with acids and heat or microwave energy. The digestates are then analyzed for trace metals by an atomic emission optical spectroscopic technique. The samples are nebulized and the aerosol is transported to a plasma torch. The atomic-line emission spectra are dispersed and a photosensitive device monitors line intensities.

ICP-Mass Spectrometry (ICP-MS) is used to determine the concentration of dissolved and total recoverable elements in water/aqueous samples. The sample material is introduced, by nebulization, into radio frequency plasma where desolvation, atomization, and ionization take place. The ions are extracted from the plasma through a differentially pumped vacuum interface and separated based on their mass-to-charge ratio.

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Table 2 summarizes the methods and instruments used in this analytical service.

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ICP-MS Tune	Prior to calibration.
Method Detection Limit Determination	Prior to contract, annually thereafter, and after major instrument maintenance.
Interelement Corrections	Prior to contract, quarterly thereafter, and after major instrument adjustment.
Linear Range Analysis	Quarterly.

into Regional databases. DAT can also be used to assist in the data validation process at the Region. In addition to the Regional electronic reports, the CLP laboratories are provided with a data assessment report that documents the instances of noncompliance. The laboratory has four business days to reconcile defective data and resubmit the data to EPA. EPA then reviews the data for noncompliance and sends a final data assessment report to the CLP laboratory and the Region.

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The QC process includes those activities required during analytical data collection to produce data of known and documented quality. The analytical data acquired from QC procedures are used to estimate and evaluate the analytical results and to determine the necessity for, or the effect of, corrective action procedures. The QC procedures required for this analytical service are shown in **Table 3**.

PERFORMANCE MONITORING ACTIVITIES

Laboratory performance monitoring activities are provided primarily by AOC and the Regions to ensure that contract laboratories are producing data of the appropriate quality. EPA performs on-site laboratory audits, data package audits, and evaluates laboratory performance with blind performance evaluation samples.

For more information, or for suggestions to improve this analytical service, please contact:

John Nebelsick
Inorganic Program Manager
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Washington, D.C. 20460
Tel: 703-603-8845
Fax: 703-603-9112

APPENDIX E

NEH DATA VALIDATION AND USABILITY SOP

DATA USABILITY
STANDARD OPERATING PROCEDURE
New Environmental Horizons, Inc.

This section describes the QA/QC procedures and the protocols for data usability assessment as it is performed at NEH.

Overview of Data Usability Assessment

At NEH, data usability is performed using an organized approach to reviewing the chemical data as presented in the laboratory’s data package as well as the on-site field measurements and quality control. The data assessment evaluates both compliance with specific methods and regulations and technical quality of the data. The goal of the assessment is to provide, to the data users, a complete and understandable report that describes the uncertainties in the results and the effect of these uncertainties on the usability of the data. NEH applies to the data the USEPA Region II and National Functional Guidelines standard data validation qualifiers J, U, UJ, N, NJ, and R to help the data user determine, at a glance, the quality and validity of each chemical result. These data validation qualifiers are defined as follows.

J - The associated numerical value is an estimated quantity due to quality control criteria exceedance(s). The value is usable for project decisions as an estimated result.

U - The compound was analyzed for, but was not detected. The associated numerical value is the sample-specific reporting limit. The value is usable for project decisions as a non-detect result at the reporting limit.

UJ - The compound was analyzed for, but was not detected. The associated numerical value is the sample-specific reporting limit and is an estimated quantity. The value is usable for project decisions as a non-detect result at the estimated reporting limit.

N - The analysis indicates the presence of an analyte for which there is presumptive evidence to make a "tentative identification". The value is usable for project decisions as an estimated result.

NJ - The analysis indicates the presence of an analyte that has been "tentatively identified" and the associated numerical value represents an estimated concentration. The value is usable for project decisions as an estimated result.

R - Reject data due to severe or cumulative exceedance of quality control criteria. The value is unusable (compound may or may not be present) for project decisions.

For matrix-matched blanks (method and field) potential blank contamination will be handled using the data qualifiers listed above, if necessary (*e.g.*, negation (U) of data). However, for non-matrix matched blanks, professional judgment may be used to indicate the source of possible contamination as follows:

EB - The compound was detected in a non-matrix matched Equipment Blank (organic analyses)

TB - The compound was detected in a non-matrix matched Trip Blank (VOC only)

B - The compound was detected in a non-matrix matched Method Blank (inorganic analyses)

NEH Procedure for Data Assessment

Data Assessment in support of the IBM Gun Club Burn Pit Area requires the review and evaluation of chemical data based upon NYSDEC and USEPA guidance for data assessment of inorganic and organic analyses and site-specific requirements as may be defined in the project Quality Assurance Project Plan (QAPP). The purpose of assessment is to provide information to the data users (*e.g.*, regulators, risk assessors) of the uncertainty and bias in the data for decision making.

A two-stage process for assessment will be performed: 1) an in-depth evaluation including review of raw data, and 2) a stream-lined evaluation of summary quality control (QC). The analytical laboratory must submit a full deliverable (NYSDEC ASP Category B) for all data generated during this project, even for data undergoing the second stage QC review process, so that all supporting information is available in the event that data users need to revisit the data review for further evaluation.

The first stage in-depth review will be performed on the first groundwater SDG and the first solids SDG (soils or bedrock) for each type of analysis (e.g., VOCs, SVOCs, metals, etc.). These SDGs will undergo an in-depth evaluation of all of the QC information provided, as well as a review of the raw data on instrument calibrations, extraction procedures, qualitative and quantitative determinations to ensure that the laboratory is producing data in a manner which is compliant with the methods and with the QAPP. An example of this in-depth evaluation is given in Attachment A, Data Usability Review Report, which consists of a letter report and an attached hand-completed checklist to document the review. Any deficiencies in performance of the work by the laboratory that are uncovered during this review will immediately be brought to the laboratory's attention for corrective action. If these deficiencies prove to be major (i.e., result in rejection of data), the reviewer may require that an additional SDG, submitted after the corrective actions were implemented, undergo this in-depth review to ensure the integrity of the project data. The data user will be supplied with the Data Usability Review Report (including the hand-completed checklists) and excel spreadsheets of the data containing validation qualifiers, as appropriate.

Once the first stage has been successfully completed, the second stage of the assessment process involves a stream-lined evaluation of summary QC documented in the NYSDEC Data Usability Summary Report (DUSR). NEH uses a Usability Checklist Review (Attachment B) to evaluate the key data quality indicators and document uncertainties in the results (without a review of the raw data, therefore, it is "stream-lined" compared to the in-depth review). The data user will be provided with the DUSR (example included in Appendix C), the hand-completed Usability Checklist Review, and excel spreadsheets of the data containing validation qualifiers, as appropriate.

The NEH approach to data assessment, either through stage one or stage two, involves the following 12 steps, in the order presented.

1. Receive data package and electronic data deliverables from client or laboratory. Initial and date the front of the data package.
2. Log-in data package using NEH tracking spreadsheet (Excel). This log-in serves to maintain the chain-of-custody. An example NEH tracking spreadsheet is presented in Attachment D.
3. Perform data package Completeness check. Check that all required reporting forms and associated raw data, if required, are included in the data package. Check that all samples listed on the COC were analyzed by the laboratory. Check that the correct analyses were performed.
4. Issue Resubmittal Requests for any missing or incorrect information. An example resubmittal request form is included in Attachment E.
5. Perform Initial Review of data package report and quality control (QC) forms using appropriate regulatory guidance. The following guidance is used to perform data assessment reviews for the IBM Gun Club Burn Pit Investigation: NYSDEC Analytical Services Protocol June 2000; USEPA Region II SOPs for Validation of Analytical Data, as appropriate (e.g., SOP HW-24 for evaluation of SW-846 Method 8260B; SOP HW-2 for Evaluation of Metals Data for the CLP Program**,** SOP HW-22 for evaluation of SW-846 Method 8270C, etc); *USEPA Contract Laboratory Program National Functional Guidelines for Organic Data Review*; Publication EPA540/R-99/008, October 1999; and *USEPA Contract Laboratory Program National Functional Guidelines for Inorganic Data Review*; Publication EPA540/R-01/008, July 2002. For the initial review for each analysis-type, a first-stage, in-depth Data Usability Review Report will be executed (Attachment A). For all remaining reviews, a second-stage, stream-lined Usability Checklist Review (Attachment B) will be used in the assessment process. Method- and QAPP-specific requirements will be used to modify the checklists for each type of analyses being performed. Completed checklists are included in the data assessment report.
6. Perform initial review of data to confirm reported results using examples in Attachment A or B. If any errors are found, contact laboratory immediately and request resubmittal (see Attachment E) and explanation.
7. Apply data qualifiers (J, U, UJ, N, NJ, and R, as appropriate) to data on the excel spreadsheets provided by the client. Data qualifiers are applied in strict accordance with NYSDEC and USEPA SOPs for data validation. In cases where a quality discrepancy is noted that is not covered in the SOPs or if there is technical evidence to suggest an SOP action should not be taken, professional judgment will be used. This must be detailed in the data assessment narrative report. Note, site-specific requirements (such as detection levels) will over-ride the USEPA SOP criteria.
8. Complete initial review by preparing a data usability narrative report delineating major and minor quality control exceedances and the affect on the results in the SDG. The results will be assessed based on the following QC parameters and the specific data validation SOPs according to NYSDEC ASP and USEPA. The data usability narrative (either the first-stage, in-depth narrative Data Usability Review Report or the second-stage NYSDEC DUSR)will be generated and will include the following items:

Accuracy:

- Holding Times
- Calibration Criteria (tuning, linearity of calibration curves, initial and continuing calibration standards and checks)
- Surrogate recoveries
- Matrix Spike/Matrix Spike Duplicate recoveries
- Laboratory Control Sample or Blank Spike Sample recoveries
- Interference Check Sample and serial dilution sample results for metals on ICP
- Internal Standard recoveries

Precision:

- Matrix Spike/Matrix Spike Duplicate relative percent differences (RPDs)
- Sample/Matrix Duplicate RPDs
- Field Duplicate RPDs

Representativeness:

- Field Duplicate RPDs
- Dissolved vs. Total metals results for Iron and Manganese
- Evaluation of sampling methods in obtaining samples representative of the site conditions (usually done by field team; choice of sampling method may affect representativeness; but validator may comment if an obvious discrepancy is noted that would affect representativeness of the sample results to the site location).

Sensitivity:

- Review of MDLs compared to laboratory reporting limits
- Low standard evaluation in standard curves (includes evaluation of CRDL standard recoveries for metals) – first data package
- Blank contamination including method blanks, instrument blanks, trip blanks, equipment rinsate blanks

Comparability:

- Review of method compliance; evaluation of method modifications and potential affects on results (define bias, if possible).
- Check sample result calculations from raw data – first data package only unless quality issues are uncovered
- Confirm validity of detection limits for non-detects

Completeness:

- Measure of amount of data planned to be collected compared to amount of valid data obtained for the program. Most programs will require a minimum of 90% completeness. Detail data gaps based on rejected results.

9. Perform senior review of data usability report including narrative, review report or checklist, and data tables with qualifiers. All data usability reports at NEH will have both initial and senior reviewers. Both the initial and senior data assessor’s names will appear on the front page of the data usability report with signatures and dates of review. This procedure of a two-level review ensures high quality and accuracy of NEH data assessment reports. Senior review will check narrative report and data summary tables against the data usability checklists to confirm that correct actions were taken for all samples.

10. Submit final report to client with hard-copy. The final report includes the <u>Data Usability Review Report</u> or <u>NYSDEC DUSR</u>, the data summary tables with qualifiers applied, and the hand-completed data usability checklists associated with these review types. Each SDG received from the client or laboratory will have a separate data usability report.
11. Return laboratory data packages to client; or, based on client request, hold data packages for specified time period.
12. File/Record Retention: Archive data usability report, data summary tables, all correspondence (including faxes, resubmittals, emails), and NEH tracking COC for project on diskette and store at NEH.

Attachment A
Example Data Usability Review Report

Data Usability Review Report
Organic Analysis by NYSDEC ASP 8260B

Client:

Site:

Laboratory:

SDG: ___________________________

# of samples/Analyses: x # of soil samples for project-specific list of volatile organic compounds (VOCs)

Initial Reviewer: Dr. Nancy C. Rothman, New Environmental Horizons, Inc.

Senior Reviewer: Susan D. Chapnick, New Environmental Horizons, Inc.

Date Completed: [date]

The Data Usability Review was performed on the data package. The intentions of this review are: 1) to determine if the data were generated and reported in accordance with SW-846 Method 8260B, the Work Plan and Quality Assurance Project Plan for XXXX, NYSDEC Analytical Services Protocol, June 2000; USEPA Region II SOP HW-24, *Standard Operating Procedure for the Validation of Organic Data Acquired Using SW-846 Method 8260B (rev. 2, Dec. 1996)*, Revision 1, June 1999, and *USEPA Contract Laboratory Program National Functional Guidelines for Organic Data Review*; Publication EPA540/R-99/008, October 1999; 2) to determine if the data met the program data quality objectives for acceptable accuracy, precision, and sensitivity; 3) to determine and define the technical usability of the data based on the accuracy, precision, and sensitivity QA/QC indicators; and 4) to update the project database with appropriate data quality qualifiers.

The Data Usability Review consists of four sections plus the attached data summary tables generated from the project database. Section I is the Overall Summary of Data Usability including subsections addressing technical usability, accuracy, precision, representativeness, and sensitivity of the data. Sections II through IV are hand-completed checklists: Section II - Data Package Completeness Review; Section III - Review of the Laboratory Data Summary Forms and Additional QA/QC Parameters; Section IV - Calculation Verification Review of One Sample.

Attachment A
Example Data Usability Review Report and Checklist - First Stage "In-Depth" Approach

I. Overall Summary of Data Usability

A. Summary of Technical Usability of Data

All soil results for volatile organic compounds (VOCs) for samples collected and analyzed on [date] are usable for project objectives. The laboratory reported an estimated result for Trichloroethylene in one sample which was unchanged by this assessment. Non-detected results for all of the analytes of interest should be considered as estimated (J) for four samples due to quality control criteria exceedances based upon this assessment. Data users should note the following uncertainties in the estimated results. The estimated results are usable for project objectives.

B. Technical Issues Affecting Accuracy

The accuracy for Vinyl Chloride, Carbon Tetrachloride, and Trichloroethylene in three low-level samples (X, Y, and Z) was compromised since the samples were analyzed outside of analytical holding time (analyzed beyond 24 hours from sample collection but less than 48 hours). All three samples reported non-detect for the analytes of interest. Based upon this slight holding time exceedance, these non-detected results in these three samples should be considered estimated (UJ) due to a possible low bias in the data.

The accuracy for Vinyl Chloride, Carbon Tetrachloride and Trichloroethylene in one sample (X) was compromised due to poor response of the Internal Standard Fluorobenzene in this sample compared to the Continuing Calibration verification criteria (i.e., the IS response was less than half of the response seen the continuing calibration). This sample reported non-detect for all analytes of interest. Based on the Internal Standard not meeting specification, these non-detected results in this sample should be considered estimated (UJ).

The accuracy for all other samples analyzed met project requirements.

C. Technical Issues Affecting Precision and Representativeness

The laboratory performed one set of MS/MSD samples for this set of samples: XMS and XMSD. This was a low-level analysis and the precision was acceptable for the target VOCs based upon the matrix spike (MS) and matrix spike duplicate (MSD) results. This is an indication of acceptable precision in the analysis of the low-level samples within this SDG.

Precision of the high-level analysis could not be assessed since the laboratory did not analyze any high-level MS/MSD samples.

The field duplicate samples within this set were X and XFD. Since the results for both samples were non-detect for all analytes of interest, field duplicate precision could not be assessed based on these results.

D. Technical Issues Affecting Sensitivity

Five samples were analyzed as high-level samples due to holding time constraints. The laboratory, realizing that they could not analyze the samples within 24 hours, preserved approximately 5g of sample with 5 mL of methanol and then analyzed an aliquot of the methanol in water to obtain results. The reporting limit for these high-level samples, uncorrected for sample solid content of the sample, was 250 µg/kg or 25 times higher than the reporting limits obtained by the low-level method.

E. Additional Technical and QA/QC Issues

Blanks, such as trip blanks, rinsate blanks, and field blanks, were not generated in the field for this project. For the samples validated in this set, the lack of field quality control did not affect the results reported since all values for all samples, except for Y, were non-detect for the compounds of interest.

Calibration verification on the instrument, for this set of data, was done once following the tune at the beginning of the analysis sequence. This verification was used for the remaining analyses over the next 24 hours of instrument run time.

The surrogate, 1,2-Dichloroethane, did not meet Initial Calibration criteria (%RSD was 29.9% across the six-levels of standards analyzed as compared to the required %RSD ≤ 20%). No action was taken based on this finding other than to note this non-conformance.

The surrogate Dibromofluoromethane, did not meet Continuing Calibration verification criteria in the standard analyzed on the day this set of samples was processed. The %Difference was 20.7% compared to method criteria of %Difference ≤ 20%. No action was taken based on this finding other than to note this non-conformance.

One of the Method Blanks (GC file A) analyzed during the sequence did not have acceptable Internal Standard response and did not recover three of the four surrogates. The raw data does not indicate that the laboratory investigated whether the results reported were correct and there is no indication of corrective action as a consequence of this poor blank result. No action was taken based on this finding other than to note this non-conformance.

No high-level Method Blank or LCS was performed for this set of samples. Since the only sample that reported a positive result did so as an estimated value below the sample reporting limit, the lack of this high-level method blank did not impact the results.

Internal Standard variations outside of acceptance criteria were noted for nine samples (i.e., the response for the Internal Standards was below 50% of the continuing calibration Internal Standard's response). For all samples except one, the IS variation did not affect the quantitation of the analytes of interest; therefore, no action for eight samples was taken based on these findings accept to note this non-conformance. The Internal Standard variation in one sample may have affected the accuracy for quantitation of the analytes of interest resulting in estimation of the results, as discussed in Section B.

F. Summary of Completeness, Documentation, and Chain-of-Custody Issues

The original data sent by the laboratory did not properly adjust the reporting limit for samples based on sample preparation and percent solids content of the sample. The laboratory re-issued the data sheets with the low-level samples properly reported; however, a second re-issue of the data was required for the high-level samples since the laboratory did not properly account for sample weight variations between samples in calculating the reporting limits. The revised data sheets for the high-level samples were received on [date].

The Chain-of-custody for samples collected on [date] did not record the time of collection for the samples. Since the laboratory analyzed these samples on the date of receipt, this improper chain-of-custody documentation from the field did not impact the results for this sample set.

Sample ID's on five samples were incorrectly reported on the raw data, as verified with the laboratory on [date]. The data sheets, and database, correctly identified these sample ID's. During this assessment, the raw data, including chromatograms and run logs, were changed by the reviewer to reflect the correct ID's.

II. Data Package Completeness

The data package is reviewed for completeness using Quality Assurance Project Plan XXX.

1. Were all required reporting forms and associated raw data included in the data package? **Yes / No**. Was the data received in NYSDEC ASP Category B format? **Yes / No**. If needed, contact laboratory for resubmittals and attach copy of resubmittal request to this checklist.

2. Was the data accompanied by a Project Narrative explaining any non-compliance issues with the analyses? **Yes / No**. Was the narrative complete? **Yes / No**.

3. Were all samples listed in the laboratory data review checklists included in the data package? **Yes / No**. Were all sample analyses requested on the Traffic report and Chain-of-Custody performed by the laboratory? **Yes / No**. Were there any Chain-of-custody deviations noted? (e.g., labeling discrepancy between sample jar and COC, etc.) **Yes / No**.

Comments:

Attachment A
Example Data Usability Review Report and Checklist - First Stage “In-Depth” Approach

Case Narrative Review

Review the Case Narrative provided with each data package. Were there any issues addressed in the case narrative that were not addressed in the Data Usability Checklist (complete this section after full review). Was the narrative complete? **Yes / No**.

Comments:

III. Review of Volatile Organic Data

1. Holding Times

Holding times and QC association with the samples are reviewed to ensure the accuracy of the reported results. The table on the following page (Table 1a) was completed to document the holding times and QC association.

Was headspace or air bubbles present in the aqueous samples? **Yes / No.** Was the pH of any aqueous sample measured in the field to have a pH > 9? **Yes / No**. If acid preserved, was the pH of the samples < 2 upon receipt at the lab? **Yes / No.**

For soil/bedrock samples, were the samples weighed and frozen by the laboratory upon receipt or weighed and analyzed within 7 days? **Yes / No.** If no, list below.

Were the holding time requirements (non-acid preserved waters analyzed within 7 days, acid preserved waters analyzed within 10 days; and soils/bedrock analyzed within 7 days, if unfrozen, or 14 days, if frozen or methanol extracted, of sample receipt) met for each sample? **Yes / No**. If no, list below the affected samples and the number of days outside of holding time.

Action: If there is severe temperature exceedance for samples, estimate (J) detects and reject (R) non-detects. Professional judgment required in data qualification.
Waters: If headspace (air bubbles > 2mm in diameter) was present, estimate detects (J) and reject (R) non-detects. **If pH < 2**: if 10days < HT ≤ 20days; estimate detects and non-detects (J and UJ), if HT > 20days, estimate detects (J) and reject (R) non-detects. **If pH > 2**: if 7days < HT≤ 14days accept non-aromatic detects and non-detects, estimate aromatic detects (J) and reject aromatic non-detects (R); if 14days < HT≤ 28days estimate aromatic and non-aromatic detects (J), estimate non-aromatic non-detects (UJ) and reject (R) aromatic non-detects, if HT > 28days estimate detects (J) and reject non-detects (R).
Soils/Bedrock: If unfrozen, 7days < HT ≤ 14days, estimate detects and non-detects (J and UJ); if HT > 14days, estimate (J) detects and reject (R) non-detects. If frozen or methanol extracted, 14days < HT ≤ 28days, estimate detects and non-detects (J and UJ); if HT > 28days, estimate (J) detects and reject (R) non-detects

Comments:

Attachment A
Example Data Usability Review Report and Checklist - First Stage “In-Depth” Approach

Table 1a. Holding Time and Associated QC Table

Sample Matrix: ________________________

Sample ID	Date Sampled	Field Blank	Trip Blank	Method Blank	LCS		Date Analyzed

2. GC/MS Instrument Performance Check

   The BFB instrument performance checks (tunes) are reviewed to assess the accuracy and sensitivity of the results relative to instrument performance.

   Review the tune summaries for BFB

   Were all Method 8260B (same as NYSDEC ASP) defined mass calibration and ion abundance criteria met for the BFB analyses? **Yes / No**. If no, list below the tune and affected samples.

   Review the raw data for one tune. Did the laboratory obtain the BFB mass spectrum in a straight-forward manner (e.g., average of three scans centered across the BFB peak with background subtraction from a scan within 20 scans prior to the BFB scan)? **Yes / No**. If no, list below the method used to obtain the mass spectrum and the affected samples.

   Were all samples analyzed within 12 hours of an acceptable tune? **Yes / No**. If no, list below the affected samples.

   Action: If the mass assignment criteria were not met (e.g., base peak assigned to m/z 96 instead of m/z 95), reject (R) all associated data. If the ion abundance criteria were not met, sound technical judgment should be used in evaluating whether or not the data require estimation (U and UJ) or rejection (R) (e.g., the criteria requirements for the m/z 95/96, 174/175, 174/176 and 176/177 ratios are most important for proper tune while the relative abundances for m/z 50 and 75 are of lesser importance.)

Comments:

3. Initial Calibration

The initial calibration data are reviewed to determine if the standards were compliant with the method protocols.

Review the Initial Calibration Data Summary. Check and recalculate the RRFs, avg. RRF and %RSD for at least one volatile analyte across the ICAL. Does the avg. RRF and %RSD check back to the raw data? **Yes / No**. Were the RRFs for all analytes in the standard all greater than or equal to minimum RRF in Table 5 of NYSDEC ASP Exhibit E? **Yes / No.** If no, was an IS used which was different from the CLP/NYSDEC ASP IS' (bromochloromethane, 1,4-difluorobenzene and chlorobenzene-d5)? **Yes / No.** If yes, list IS and verification that sensitivity for those analytes with RRF< critera was adequate.

Were at least five concentration levels of each compound analyzed during the initial calibration? **Yes / No.** Were all calibration standards analyzed within 12 hours of BFB tune? **Yes / No.**

Was the lowest initial calibration standard at a concentration equivalent to the sample-specific reporting limit? **Yes / No.** Were retention times for each target analyte stable across the calibration (i.e., minimum drift)? **Yes / No.**

Did the initial calibration meet %RSD criteria for all analytes (surrogates and targets) as required in Table 5 of Exhibit E NYSDEC ASP 2000 across the calibration range? **Yes / No**. If no, was a calibration curve used for quantitation of results and was the correlation coefficient for the curve ≥ 0.99? **Yes / No**. Was the curve forced through the origin? **Yes / No.**

Action: If RRF < criteria and the CLP IS' were used for quantitation, estimate (J) positive detects and reject (R) non-detects. If the RRF < criteria; however, alternate IS' have been used and the analyte has adequate sensitivity to detection, accept all results based on RRF evaluation.
If the %RSD >criteria, evaluate analyte to determine source of high %RSD. If elimination of lowest point causes %RSD to be in criteria, estimate (J) any positive detects for analyte between new acceptable lowest calibration point and original calibration point and raise all non-detects for analyte to new sample-equivalent RL associated with new lowest calibration point. If elimination of high-point results in %RSD ≤ criteria, estimate (J) all data reported above the new highest level of calibration, on a sample-equivalent basis, and accept all non-detects. If elimination of the highest or the lowest point in the calibration does not result in %RSD ≤ criteria, qualify positive and non-detected results as estimated (J and UJ). Sound technical judgment should be used in qualification of the data. The results for each sample associated with ICAL should be evaluated to determine if a result reported would be impacted by the mis-calibration.

Comments:

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3. Initial Calibration continued:

ICAL Check: Compound Checked

	Level 1	Level 2	Level 3	Level 4	Level 5	Level 6	Avg. RRF	%RSD
Concentration								
Response Cpd								
Conc, IS								
Response IS								
RRF								

4. Continuing Calibration Check

The continuing calibration data are reviewed to determine if the standards were contractually compliant.

Review the Continuing Calibrations and Summaries. Check and recalculate the RRF and %Difference (%D) for at least one of the target volatile compounds in one of the CCALs. Does the RRF and %D check back to the raw data? **Yes / No**. Were the RRFs for all analytes in the standard all ≥ criteria (Table 5, Exhibit E of NYSDEC ASP 2000)? **Yes / No.** If no, was the RRF acceptable based on the use of an alternate IS (see ICAL)? **Yes / No.**

Was a continuing calibration check performed every 12 hours following tuning verification of the instrument? **Yes / No**. If no, list below all the affected samples.

Were the target analytes recovered within the expected retention time window based upon the initial calibration (i.e., drift of instrument was acceptable)? **Yes / No**.

Did the continuing calibrations meet Table 5, Exhibit E criteria for verification of %D? **Yes / No**. If no, list below the outliers and the affected samples.

Action: If the %D > - criteria and the CCAL RRF ≥ minimum (i.e., instrument more sensitive to detection of the compound on the day of CCAL relative to the ICAL), estimate (J) positive detects and accept non-detected results without qualification. If the %D > + criteria, and RRF > minimum, estimated positive and non-detect results (J and UJ) for samples analyzed following this standard for the compound(s) that was outside of calibration. If the RRF <minimum, but ICAL RRF > minimum, qualify positive results as estimated (J) and reject (R) non-detected results as unusable.

Comments:

CCAL Check: Standard ID______________ Compound Checked ______________________________

Responses	RRF	avg. RRF ICAL	% Difference
Cpd:			
IS:	▨	▨	▨

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5. Laboratory and Field Blank Results

Laboratory and field blank results (equipment and trip blanks) are reviewed to assess the presence of contaminants, which affect the accuracy and sensitivity of the results. See Table 1a. where the Holding Time and Associated QC Table was completed for the samples within this SDG.

Was a Trip Blank associated with each sampling event for volatiles? **Yes / No**. If no, list below affected samples.
Was an equipment blank associated with the samples in this SDG? **Yes / No.**

Was each sample analysis associated with the appropriate method blank, *ie*., correct matrix, correct matrix level, same batch? **Yes / No**. If no, list below affected samples.

Review the reporting forms for each method, equipment, and trip blank. Were any target compounds in the method blanks detected? **Yes / No**. If yes, were methylene chloride, acetone or 2-butanone the only compounds reported above the RL? **Yes / No.** If yes, were these "common laboratory contaminants" < 5 times the RL? **Yes / No.**

Action: - Blanks should not contain contaminants above the RL except for methylene chloride, acetone and 2-butanone which must not be present above 5 times the RL. The Blank Action Level is defined as five times the highest level seen in the blanks associated with an analysis, except if methylene chloride, acetone or 2-butanone are present, in which case the Blank action is ten times the level observed for these compounds in the blank. The following actions should be taken if conditions warrant:

1. If the blank is not matrix matched, qualify all sample data, for the contaminant associated with this blank, with TB or EB, as appropriate.
2. If the reported result in a sample is below the reporting limit (sample < RL) and if a matrix-matched blank contains a result above the sample-equivalent level reported, the result in the sample should be negated (U) and raised to the sample-specific RL for that sample
3. If the sample result is between the reporting limit and the blank Action Level (RL < sample < Action Level), the result for the sample is negated (U) at the level found in the sample. Based on the level of contamination suspected in the sample, the reporting limit may be elevated. Professional judgment will be used in assessing the action needed.
4. If the sample result is greater than the RL and the blank Action Level, no action is taken.

Comments:
Blanks evaluated:

5. Laboratory and Field Blank Results - continued

Blank ID	Contaminant / Level	Matrix Related	Action Level	Sample/Reported Result	Corrected Result

6. Surrogate Spike Recoveries

The surrogate spike recoveries are reviewed to assess the accuracy of the results relative to laboratory performance and specific sample matrix.

Review the Surrogate Recovery information for each field and quality control sample. For one sample, verify that the recoveries reported correspond to the raw data and that the recovery calculation was done properly. Were the recovery data reported properly? **Yes / No**.

Were the surrogate recoveries within QAPP defined or NYSDEC ASP 2000 Exhibit E accuracy limits? **Yes / No**. If no, were the affected samples reanalyzed? **Yes / No**. List below the affected samples.

Action - If one or more volatile surrogate recoveries exceed the upper limit, estimate (J) positive due to a potential high bias of the results; no action is required for non-detect results. If one or more volatile surrogate recoveries is below the lower accuracy limit but above 10% recovery, estimate (J and UJ) the positive and non-detect results due to a potential low bias in the results. If any surrogate recovery is below 10%, reject (R) non-detect results and estimate positive results (J) due to potential false negatives and low bias in the results, respectively. List below the affected samples and required actions.

Comments:

7. Matrix Spike/Matrix Spike Duplicate (MS/MSD) Recovery and Precision

The matrix spike/matrix spike duplicate (MS/MSD) recoveries are reviewed to assess the accuracy of the results relative to the specific sample matrix and the relative percent differences (RPDs) are reviewed to assess the precision of the results relative to the specific sample matrix.

Review the unspiked sample, Matrix Spike, and Matrix Spike Duplicate (MS/MSD) raw data and recovery results. Were the recoveries for the MS/MSD calculated properly? **Yes / No**.

Did the laboratory perform MS/MSDs for each matrix and matrix level analyzed for each analytical batch prepared for analysis? **Yes / No**. If no, list below the affected samples.

Were the MS/MSD recoveries within QAPP defined or NYSDEC ASP 2000 Exhibit E limits? **Yes / No.** Were the RPDs between the MS/MSD within the QAPP/NYSDEC ASP precision criteria? **Yes / No**. If no, list below the affected compounds. Was the spiking level for the MS/MSD appropriate for the matrix? **Yes / No**

Was the %RSD for non-spiked compounds in the unspiked sample, MS and MSD ≤ 50%? **Yes / No / NA**

Action: No action is taken to the entire data set based on MS/MSD results alone. The unspiked sample may be qualified based on MS/MSD results as follows: if the MS/MSD recoveries were greater than the upper accuracy limit, estimate (J) positive results due to potential high bias; no action is required for non-detect results; if the MS/MSD recoveries were below the lower accuracy limit but above 10%, estimate (J and UJ) positive and non-detect results due to potential low bias; if a MS/MSD compound was recovered below 10%, estimate (J) positive results due to potential low bias and evaluate the non-detected results to determine whether estimation (UJ) or rejection (R) of the unspiked sample data is warranted. If the RPD between the MS and MSD > criteria, estimate (J and UJ) positive and non-detected results in the unspiked sample. If the %RSD, for a non-spiked compound, between the unspiked sample, MS, and MSD >50%, estimate (J) positive results and use professional judgment to qualify other detected and non-detected analytes. If the laboratory spiked more analytes than listed in the QAPP, evaluate acceptance of recovery results using professional judgment.

Comments:

8. Laboratory Control Sample and Standard Reference Material Analysis

The Laboratory Control Samples (LCS) and/or Standard Reference Material (SRM) are reviewed to assess the accuracy of the results relative to the analytical procedure.

Review the raw data and recovery information for the LCS/SRM.

Did the laboratory perform a LCS or SRM for each matrix and matrix level analyzed? **Yes / No**. Was the LCS from a different source than the calibration standards? **Yes / No**. If no, list below the affected samples.

Were the LCS or SRM recoveries within QAPP defined or NYSDEC ASP 2000 Exhibit E accuracy requirements for recovery? **Yes / No**. If no, list below the affected compounds.

Action: . If the LCS or SRM recoveries are above criteria, estimate (J) positive results due to potential high bias, no qualification of non-detected results is necessary. If the LCS or SRM recoveries are between 10% and the lower recovery limit, estimate (J and UJ) positive and non-detect results for the samples associated with the analytical batch due to potential low bias in the results. If the recovery in the LCS or SRM is less than 10%, estimate (J) positive results due to low bias and reject (R) non-detect results due to potential false negatives.

Comments:

9. Performance Evaluation Sample Analysis

The external PE sample results are reviewed to assess the accuracy of the results relative to the analytical procedure.

Did the laboratory perform an external PE with this project? **Yes / No**. Was this PE sent to the laboratory from the field? **Yes / No / NA**

Were all compounds contained within the PE sample positively identified by the lab (i.e., qualitative accuracy)? **Yes / No.** Were there compounds positively identified by the laboratory that were not within the PE sample? **Yes / No.** Were these "extra" compounds common laboratory contaminants (e.g., acetone, 2-butanone, methylene chloride)? **Yes/ No**

Action: . If a compound is certified as being present in the PE sample and is not detected by the laboratory, estimate (J) positive results for this compound and reject (R) non-detects. Immediately notify the QAO of this issue so that corrective action at the laboratory can occur. If the PE recoveries are above criteria, estimate (J) positive results due to potential high bias, no qualification of non-detected results is necessary. If the PE recoveries are between 10% and the lower recovery limit, estimate (J and UJ) positive and non-detect results for the samples associated with the analytical batch due to potential low bias in the results. If the recovery in the PE is less than 10%, estimate (J) positive results due to low bias and reject (R) non-detect results due to potential false negatives.

Comments:

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10. Internal Standards

The Internal Standard (IS) response in the samples and standards is evaluated to ensure that the analytical system was in control during analysis.

Were the IS areas for each sample and standard analyzed within -50 to + 100% of the continuing calibration? **Yes / No**. Were the retention times for the IS within ±30 seconds from the retention time established in the continuing calibration? **Yes / No**.

Action: If an IS area is greater than +100% compared to the continuing calibration, qualify positive results as estimated (J), non-detects do not require action. If the IS area is below - 50% but not lower than - 80%, estimate positive and non-detected results (U and UJ). If the area drop off or retention time shift for the IS is too severe (> - 80%), non-detected results may require rejection (R). Professional judgment must be used in evaluating the data associated with poor IS performance.

Comments:

11. Sample Reporting /Quantitation Limits

Review raw data and reporting forms. Did the sample-specific RLs meet the QAPP RLs? **Yes / No.** Did the laboratory accurately adjust sample RLs to account for sample-specific preparation and analysis conditions? **Yes / No. If No, contact lab for a resubmittal of data.**

Were all components reported in the samples quantitated within the calibration region of the instrument for the detected analytes? **Yes/No.** Were the relative retention times for all components reported within the retention time windows established during initial calibration? **Yes / No.**

For soils/bedrock, were both low-level and medium-level analyses performed? **Yes / No**. If yes, are the medium-level and low-level analyses comparable? **Yes / No.** If low- and medium-level analyses for a sample were conducted, describe below data acceptance strategy for usability assessment. If medium-level VOCs were reported, was the moisture contribution from the sample used to adjust the extract volume in the calculation of concentration by the lab? **Yes / No.**

Action - If the quantitation limits for non-detect results are lower than the lowest calibration standard, or if a positive result is detected outside of the calibration range, estimate positive and non-detected results (J and UJ).

Comments:

12. Sample Reporting of Results

Review raw data and reporting forms.

Did the laboratory report all QAPP compounds requested? **Yes / No.** Were there additional compound reported? **Yes / No**. If yes, were these TICs? **Yes / No.**

Evaluate the positively detected target analytes in each sample: Were the RRTs for target compounds within ± 0.06 RRT units of the compound RRTs in the calibration verification (last 12 hours standard)? **Yes / No.** Looking at the mass spectrum for the compound and reference standard, were all ions in the reference with abundance > 10% present in the sample? **Yes / No.** Do the relative intensities of the characteristic ions in the sample agree to ± 30% of the reference spectrum? **Yes / No.**

Were TICs reported for this project? **Yes / No**. If yes, do all TICs have data qualifiers (i.e, "N" or "J")? **Yes / No.** If No, list below**.** Scan TICs, did the lab report the results properly? **Yes / No.**

Action – Professional judgment must be used to verify the target and TIC reporting of results. If the data assessor feels the identifications are in error, action may be taken to negate (U), estimate (J) or reject (R) data. In addition, "J", "N", and "NJ" qualifiers may be added to the TIC data, as necessary.

Comments:

13. Field Duplicate Precision

Field duplicate samples are reviewed to assess representativeness of the sample aliquot to the area sampled and the precision of the results relative to field sampling techniques.

Review analytical results for the duplicate sample analyses.

Action: If field duplicate precision exceeded 30% RPD for aqueous samples or 50% RPD for soil/bedrock samples for any compound, estimate (J and UJ) positive and non-detect results for the affected compounds in both samples. If severe imprecision was noted in the field duplicate sample (i.e., RPD >100%), qualify the remainder of the associated field sample data based on sound technical judgment.

Comments:

Field Duplicate Samples: ______________________ __________________________

14. Additional QA/QC Issues

Were the percent solids for the samples >50%. **Yes / No / NA.**

List any additional issues which may affect the quality of the results. List the affected samples, QA/QC issue, and necessary actions taken in the comments section below.

IV. Example Sample Calculations

Review of one sample per data package is performed to determine if sample results and quantitation limits were correctly calculated and reported.

Sample ID: __________________________ was selected for review in this data package.

A. Form 1 Review

1. Were the Form 1s completed according to the method/QAPP requirements? **Yes / No**. If no, list below the affected fields.

2. Reproduce the reporting limit for VOC in one of the samples, did the laboratory correctly calculate the reporting limits? **Yes / No**. If no, list below.

Quantitation Review

Reproduce a calculation for one volatile analyte in one of the samples that contained a positive result and compare the calculated result to the result reported by the laboratory.

Analyte Checked: ___________________________________

Laboratory Result: __________________ Calculated Result: _____________________

Example Calculation:

Data Summary Key for Data Usability Checklist Review

J	-	The associated numerical value is an estimated quantity due to quality control criteria exceedance(s). The value is usable for project decisions as an estimated result.
U	-	The compound was analyzed for, but was not detected. The associated numerical value is the sample detection/quantitation limit. The value is usable for project decisions as a non-detect result at the reported detection/quantitation limit.
UJ	-	The compound was analyzed for, but was not detected. The associated numerical value is the sample detection/quantitation limit and is an estimated quantity. The value is usable for project decisions as a non-detect result at the estimated detection/quantitation limit.
R	-	Reject data due to severe or cumulative exceedance of quality control criteria. The value is unusable (compound may or may not be present) for project decisions.
N	-	The analysis indicates the presence of an analyte for which there is presumptive evidence to make a "tentative identification". The value is usable for project decisions as an estimated result.
NJ	-	The analysis indicates the presence of an analyte that has been "tentatively identified" and the associated numerical value represents an estimated concentration. The value is usable for project decisions as an estimated result.
EB	-	The compound was detected in a non-matrix matched Equipment Blank.
TB	-	The compound was detected in a non-matrix matched Trip Blank.
NA	-	Not Analyzed

Validation Checklist Review Acronyms

ASP	-	Analytical Services Protocol
BB	-	Bottle Blank
CCAL	-	Continuing Calibration
CLP	-	Contract Laboratory Program
%D	-	Percent Difference = (A – B)/A x 100)
%Drift	-	Percent Drift = Percent Recovery = ((True-Found)/True X 100)
DQO	-	Data Quality Objective
EB	-	Equipment Blank (Rinsate)
EPA	-	Environmental Protection Agency
FB	-	Field blank
FD	-	Field Duplicate
g	-	gram
GC/MS	-	Gas Chromatography/Mass Spectrometry
ICAL	-	Initial Calibration
Kg	-	kilogram
L	-	liter
LCS	-	Laboratory Control Sample
MDL	-	Method Detection Limit
MS	-	Matrix Spike
MSD	-	Matrix Spike Duplicate
mg	-	milligram
NA	-	not applicable
ND	-	non-detect
QA	-	Quality Assurance
QC	-	Quality Control
RL		Reporting Limit
RPD	-	Relative Percent Difference ([(| A-B |)/ ½ (A + B)] X 100)
%RSD	-	Percent Relative Standard Deviation (SD/Average Value X 100)
SRM	-	Standard Reference Material
SVOC	-	Semivolatile Organic Compound
TCL	-	Target Compound List
TIC	-	Tentatively Identified Compounds
µg/Kg	-	micrograms per kilogram
µg/L	-	micrograms per liter

Attachment B
Example Usability Checklist Review - Second Stage Stream-lined Approach

Lab: ______________________________

Date Sampled: ____________________

Method of Analysis: 8260B

Lab Project #: ____________________

No. Samples ____________________

Matrix: ____________________

		Preservation & HT		Surrogate		LCS		MS		FD		ICALs CCALs		IS'		RL & Quant. Correct		Other Issues
All Samples in Project																		
Except:																		

Comments:

Attachment B
Example Usability Checklist Review - Second Stage Stream-lined Approach

Lab: ____________________________ Lab Project #: ____________________
Date Sampled: ___________________ No. Samples ____________________

Method of Analysis: 8260B Matrix: ____________________
Associated Blanks: ____
____

Blank ID	Contaminant / Level	Matrix Related ?		Action Level / Action		Sample result	Corrected Result

8260B Action Summary: see QAPP

HT Actions:	waters-	pH >2 or no HCl: 7d<HT≤14 d, J Aromatic det/R Aromatic NDs; Accept all Non-aromatics; pH < 2, 10d <HT< 20 d; J Aromatic det/R Aromatic NDs; J Non-aromatic det/J Non-aromatic ND
	soil/bedrock-	14d <HT< 28 d; J Aromatic det/R Aromatic NDs; J Non-aromatic det/J Non-aromatic ND
Surrogate Actions:		Recovery > Criteria, J det/Accept ND; 10%≤ Recovery <Criteria, J det/J NDs; Recovery <10%, J det/R NDs
Blank Actions:		Surrogates outside criteria - Use Judgment if isolated or analysis related Non-Matrix related Blank contamination, BB or EB contaminant in all samples associated with Blank If contamination in blank(s) exist, if Result < RL, U result at RL; RL<Result<Blank Action, U result at level reported
MS Actions:		%Rec<10%, J det/ R NDs; 10% <%Rec<Criteria, J det/ J NDs; %Rec >Criteria, J det/Accept NDs- Unspiked Sample only
LCS Actions:		%Rec<10%, J det/ R NDs; 10% <%Rec<Criteria, J det/ J NDs; %Rec >Criteria, J det/Accept NDs for all Batch by Compound

Attachment B
Example Usability Checklist Review - Second Stage Stream-lined Approach

Lab: ______________________________

Date Sampled: ____________________

Method of Analysis: 8260B

Lab Project #: ____________________

No. Samples ____________________

Matrix: ____________________

Blank Action Continued

Blank ID	Contaminant / Level	Matrix Related?		Action Level / Action		Sample result	Corrected Result

Attachment B
Example Usability Checklist Review - Second Stage Stream-lined Approach

Lab: ______________________________

Date Sampled: ____________________

Method of Analysis: 8260B

Lab Project #: ____________________

No. Samples ____________________

Matrix: ____________________

Additional Notes:

Attachment B
Example Usability Checklist Review - Second Stage Stream-lined Approach

Sample ID	Date Sampled	Field Blank	Trip Blank	Method Blank	LCS	Date Analyzed

NYSDEC Data Usability Summary Report (DUSR)

Client/Company:

Site/Project Name:

Laboratory:

SDG/Lab Project #:

Date(s) of Collection:

**Number and type
Samples & analyses:** Air samples for Method TO-15 analysis

Initial Data Reviewer: Dr. Nancy C. Rothman, New Environmental Horizons, Inc.

Senior Data Reviewer: Susan D. Chapnick, New Environmental Horizons, Inc.

Date Completed:

This Data Usability Summary Report (DUSR) is based on guidance developed by the New York State Department of Conservation (NYSDEC), June 1999, for technical review of analytical data in lieu of a full third party data validation. The objective of the DUSR is to determine whether or not the data as presented meet the site/project specific criteria for data quality and data use. Where site/project specific criteria were not available, NYSDEC ASP, EPA Region 2 Data Validation Guidelines, or EPA method QC acceptance criteria were used in this evaluation.

I. Required DUSR Questions

1. ***Is the data package complete as defined under the requirements for the NYSDEC ASP Category B or USEPA CLP deliverables?***

   Yes, the data package was complete with minor exceptions as detailed in Section III, below. These exceptions should not affect the usability of the data.

2. ***Have all holding times been met?***

   Yes, all TO-15 analyses were performed within holding times.

3. ***Do all the QC data: blanks, instrument tunings, calibration standards, calibration verifications, surrogate recoveries, spike recoveries, replicate analyses, laboratory controls and sample data fall within the protocol required limits and specifications?***

   TO-15 method criteria were met for the following QC data: blanks, instrument tunings, surrogate recoveries, and internal standard recoveries. Deviations for other criteria from QC protocols are noted in Section III, below.

4. ***Have all of the data been generated using established and agreed upon analytical protocols?***

   Yes, all air data were degenerate in accordance with Method TO-15 protocol. Deviations from EPA or NYSDEC ASP QC protocols are discussed in Section III.

5. ***Does an evaluation of the raw data confirm the results provided in the data summary sheets and quality control verification forms?***

   Yes, based on a calculation verification for one sample, evaluation of the raw data quantitation reports, and mass spectral identification of all target analytes reported, the data were reported properly.

II. Sample Descriptions and Analytical Parameters

The sample IDs, date of sampling, identification of MS/MSD/MD, FD, EB, TB, if applicable and the analytical parameters reviewed in this DUSR are listed in the following table. Any deviations noted for sample collection or receipt (*e.g.*, temperature or preservation issues) are included in Section III, below.

Sample ID	Collection Date	Matrix	Analytical Parameters	Sample Type
A	8/22/04	Air	TO-15	Field Sample
B	8/22/04	Air	TO-15	Field Sample
C	8/22/04	Air	TO-15	Field Sample
D	8/22/04	Air	TO-15	Field Sample
E	8/22/04	Air	TO-15	Field Sample
F	8/22/04	Air	TO-15	Field Sample
G	8/22/04	Air	TO-15	Field Sample

<u>Analytical method references:</u>

Compendium Method TO-15, *Determination Of Volatile Organic Compounds (VOCs) In Air Collected in Specially-Prepared Canisters And Analyzed By Gas Chromatography/Mass Spectrometry (GC/MS)*, January 1999.

NYSDEC ASP June 2000 does not specifically address the QC requirements for TO-15 analysis. Therefore, in addition to using the compendium TO-15 method, the USEPA Region 2 SOP HW-18, *Validating Canisters of Volatile Organics in Ambient Air*, Rev. 0, August 1994, was used for assessing data quality.

III. Data Deficiencies, Analytical Protocol Deviations, and Quality Control Problems

The following QC elements, as applicable to the analytical methods, were reviewed during this DUSR:

- Data package completeness and reporting protocols
- Sample receipt, holding times and preservation criteria
- Calibration criteria (instrument tuning, initial and continuing calibration verifications)
- Method and instrument blank results
- Laboratory Control Sample (LSC) or Matrix Spike Blank (MSB) recoveries
- Surrogate Recoveries
- Matrix Spike (MS) / Matrix Spike Duplicate (MSD) Recoveries
- MS/MSD, sample/Matrix Duplicate (MD), or sample/Field Duplicate (FD) Relative Percent Differences (RPDs)
- Sample result reporting (including reporting limits and units)
- Other method-specific QC if applicable and reported (e.g., interference check sample results and serial dilution results for ICP metals)
- Deficiencies or protocol deviations as noted in the Laboratory Narrative

All QC frequencies and results were acceptable, with the exceptions identified in this section. As required by the DUSR, the effects of these QC deviations on the data are discussed and any data qualifications applied as a result of this DUSR are documented below.

Data Package Completeness and Reporting Protocols

- Several samples were analyzed at secondary dilutions (dilution factor, DF =10) since one or more compounds in the undiluted (DF=1) analysis were reported at levels exceeding the instrument calibration range. For these samples, all results were reported from the undiluted analysis except for those compound results where secondary dilution was necessary (*i.e.,* a mix of DF=1 and DF=10 results are reported on the sample data sheet). The results reported from the secondary dilutions were reported with a "D" qualifier by the laboratory to identify this fact. These "D" qualifiers were not eliminated from the data presented in this DUSR; however, these "D" qualified data were verified and are considered usable (*i.e.,* the "D" could have been eliminated and the results reported without any data qualifier).

Sample receipt, holding times and preservation criteria

- USEPA Region 2 SOP HW-18 indicates that the field final canister vacuum and laboratory receipt vacuum should not differ by more than ± 10%. Based on the type of gauges used for vacuum measurements and the absolute vacuums measured, this was not deemed a reasonable QC criterion for this work. Instead, the TO-15 leak check criterion of 30 psi ± 2 psi (~ ± 4 "Hg) over 24-hours was used for this assessment. All canister receipt vacuums met this criterion.

Calibration Criteria

- Region 2 SOP HW-18 requires initial calibration at 2, 5, 10, 20, and 50 ppbV while the laboratory performed a six level initial calibration at 0.5, 1, 5, 10, 15, and 25 ppbV. No action was necessary except to note this difference.
- Region 2 SOP HW-18 criterion for calibration verification is %D < +25%. The laboratory instead used the Method TO-15 criterion of %D < ± 30% for calibration verification. No action was necessary except to note this difference.
- The initial calibration for Freon 12 (dichlorodifluoromethane) did not meet linearity criteria (%RSD ≤ 30%) based upon the responses for the six concentration levels of standards included in the initial calibration statistics. Elimination of the lowest concentration standard response (0.50 ppbV) yielded calibration within criteria (%RSD = 28.4%). Based upon this finding, the reporting limit for Freon 12 was raised from 0.50 ppbV to 1.0 ppbV in all seven air samples. Freon 12 was not positively detected in any of the associated samples; therefore, no additional action was required (*i.e.*, recalculation of results using a new average initial calibration response was not needed).
- Continuing calibration verification was not within criteria for acetonitrile, cis-1,2-dichloroethene, 4-methyl-2-pentanone, trans-1,3-dichloropropane, 2-hexanone, and benzyl chloride. For all six compounds, criteria were not met due to enhanced sensitivity to detection of these compounds during calibration verification as compared to the average instrument sensitivity to these compounds during initial calibration. Since these compounds were not positively detected in any of the samples, the non-detects were considered accurate as reported and no action was required based on this finding.

Laboratory Control Sample (LSC) or Matrix Spike Blank (MSB) recoveries

- Laboratory control sample recovery was not within criteria for 1,4-dioxane, 4-methyl-2-pentanone, and 2-hexanone. All three were recovery high as compared to criteria. Since these three compounds were not positively detected in any of the samples, the non-detects were considered accurate as reported and no action was deemed necessary based on this finding.

Sample Result reporting (including reporting limits and units)

- Toluene reported in client sample A was reported from a secondary dilution analysis (lab qualified results "D") at a concentration exceeding the instrument calibration range. This datum was also qualified "E" by the laboratory to indicated this fact. During this usability review, this "E" qualifier was eliminated on the sample data sheet and a "J" qualifier was added to toluene in this one sample to indicate that the result should be considered an estimated value. It is likely that this result may be biased low if the GC/MS detector was saturated in the DF-10 analysis.

Attachment D
Example NEH Tracking Sheet for Data Review

Client: XXX Site: Superfund, USA -- 2004

SDG #	Fraction	Number of Samples	Media	Date Rec'd Data Package	Date Rec'd Data Tables	Date Due to Client	Initial Review Completed	Senior Review Completed	Final Sent to Client	Comments
001	TAL metals	18	aqueous	21-Jan	6-Feb	19-Feb	12-Feb	17-Feb	17-Feb	Raw data missing - received 2/5
002	TAL metals	15	soil	21-Jan	21-Jan	9-Feb	27-Jan	31-Jan	2-Feb	Resubmittal NEH #1Metals
003	TCL organics	20	soil	21-Jan	21-Jan	9-Feb	27-Jan	2-Feb	3-Feb	
004	PAHs	12	soil	21-Jan	21-Jan	9-Feb	27-Jan	2-Feb	3-Feb	
005	PCBs	15	aqueous	23-Jan	26-Jan	9-Feb	27-Jan	31-Jan	2-Feb	Resubmittal NEH #2 PCBs
006	PCBs	18	soil	23-Jan	26-Jan	9-Feb	2-Feb	6-Feb	6-Feb	
007	VOCs	20	aqueous	5-Feb	6-Feb	19-Feb	16-Feb	18-Feb	18-Feb	

Appendix E
Example NEH Laboratory Resubmittal Request Form

New Environmental Horizons, Inc.
34 Pheasant Run Drive, Skillman, NJ 08558
2 farmer's Circle, Arlington, MA 02174
Phone: (908) 874-5686 ◊ (781) 643-4294 ◊ Fax: (908) 874-4786
Email: n.rothman@patmedia.net ◊ s.chapnick@comcast.net

E-mail

To:	[Insert laboratory contact]	From:	Susan D. Chapnick
E-mail:	[Insert e-mail address]	Pages:	1
Phone:		Date:	February 19, 2004
Re:	**Resubmittal Request - NEH # 1**	CC:	[Insert Client Contact]
	[Insert Project Name Here]		

√ Urgent ☐ For Review ☐ Please Comment ☐ Please Reply ☐ Please Recycle

NEH received a single data package (SDG # xxxx) from [laboratory name] on February 19, 2004. This data package contains results and QC summary tables for lead analyses. The package is missing all raw instrument data and raw laboratory preparation logs.

The data validation review of the lead results cannot proceed without the raw data. Please provide this information within 5 business days of this request.

Thank you for your prompt response to this resubmittal.

Please forward your response to:

Susan D. Chapnick
NEH, Inc.
2 Farmer's Circle
Arlington, MA 02174
Tele: (781) 643-4294; Fax: same #, call first.