TABLE OF CONTENTS

Task II Work Plan for the

FORMER MANUFACTURED GAS PLANT SITE

NORWICH, NY

Submitted To:

NEW YORK STATE ELECTRIC & GAS COMPANY
4500 VESTAL PARKWAY EAST
P.O. BOX 3607
BINGHAMTON, N.Y. 13902-3607

Prepared by:

ENGINEERING-SCIENCE, INC.
290 Elwood Davis Road
Suite 312
Liverpool, New York 13088

STATE OF NEW YORK
WILLIAM GARY CHRISTOPHER
61930
LICENSED PROFESSIONAL ENGINEER

OCTOBER 1991

KLB/SY236.10.01/NORWICH1

SECTION 1

INTRODUCTION

This Task II Work Plan identifies objectives and methods for additional investigation at the former manufactured gas plant (MGP) site in Norwich, N.Y. A site screening and prioritization program (Task I) previously conducted by Engineering-Science, Inc. (ES) revealed the presence of volatile organic compounds (VOCs) and carcinogenic polycyclic aromatic hydrocarbons (cPAHs) in subsurface soils at the Norwich MGP site. ES recommended additional investigation at the site due to the possible presence of MGP residue sources beneath the ground surface, the potential for groundwater contamination, and the residential land use adjacent to the former MGP site.

This section of the Work Plan describes the Task II objectives, the site history and background, the environmental setting and the results of previous investigations. Section 2 describes the Task II scope of work including an expanded historical search, geophysical investigation, hydrogeologic investigation, groundwater investigation, soil investigation, indoor air sampling, and preliminary risk assessment. Section 3 presents the project schedule and costs, and Section 4 lists the references used in this work plan. Appendix A presents the Health and Safety Plan, Appendix B presents the Quality Assurance Project Plan, Appendix C provides NYSEG's "Installation Procedures for Monitoring Wells and Piezometers at Generating Stations and Ash Landfills" and Appendix D provides NYSEG's "Submission Guidelines for Contractors Doing Groundwater Sampling for NYSEG".

OBJECTIVES

The objectives of Task II are to: 1) determine the extent of residue by-products in the on-site environment related to the operation of the former MGP, and determine if the residue presents a potential significant threat to human health or the environment, and; 2) delineate the presence of the former tar well and other former MGP structures which may be sources of MGP residue.

NORWICH SITE HISTORY AND BACKGROUND

Based on existing Sanborn map information, the MGP at Norwich was operating by 1887. The actual facility start-up date cannot be determined on the basis of existing information. The facility, under the name Norwich Gas Light Company, consisted of a large coal storage area, a 35,000-cubic-foot gas storage vessel (gasometer), and the main production building situated over a tar well. The facility contained six retorts on two "benches", along with a repair shop. Coke storage facilities were also present along with several other buildings.

In 1892, the facility was unchanged except it was now called the Norwich Illuminating Company. On the 1903 map, ownership of the facility was the same, but minor modifications in on-site structures had been made. The map notations are not clear enough to determine the nature of these modifications.

By 1917, map information indicates the facility was operating under the name Norwich Gas and Electric Company. Major expansions had been made to the facility by this time. Both a water gas plant and an electric plant were noted on the map. Modifications included construction of two steel gas holders (26,000 and 100,000 cubic feet), three oil tanks (approximately 10,000 gallons each), wells, a purifier building and additional coal storage along the railroad siding.

A 1926 map and an updated 1937 map show the plant owned by the New York Gas and Electric Co. Additional oil storage capacity had been added at the southeast corner of the property. By 1939, the site was identified as NYSEG property (Brown Crosby & Co., Inc. map dated June 1939). The updated map from September 1947 confirms the existence of a tar pit on the west side of the purifier building. Map notes for the purifier building document oxide storage, indicating that the gas cleansing process was used. The 1947 map also indicates a generator room along with the presence of regulators, indicating that the plant had been converted to a natural gas operation. The site is currently being used by NYSEG, primarily for equipment storage (Figure 1.1). The eastern portion of the property is now a NYSEG substation. Based on historical maps, it appears that the substation is adjacent to the former MGP and is not constructed over any of the former MGP facilities.

Years of Operation

The plant was in operation prior to 1887, although the exact date cannot be determined. It is likely that plant capacity expanded substantially through 1917, when mapping information documents past major facility expansion. Actual gas production operations appear to have continued through at least 1942.

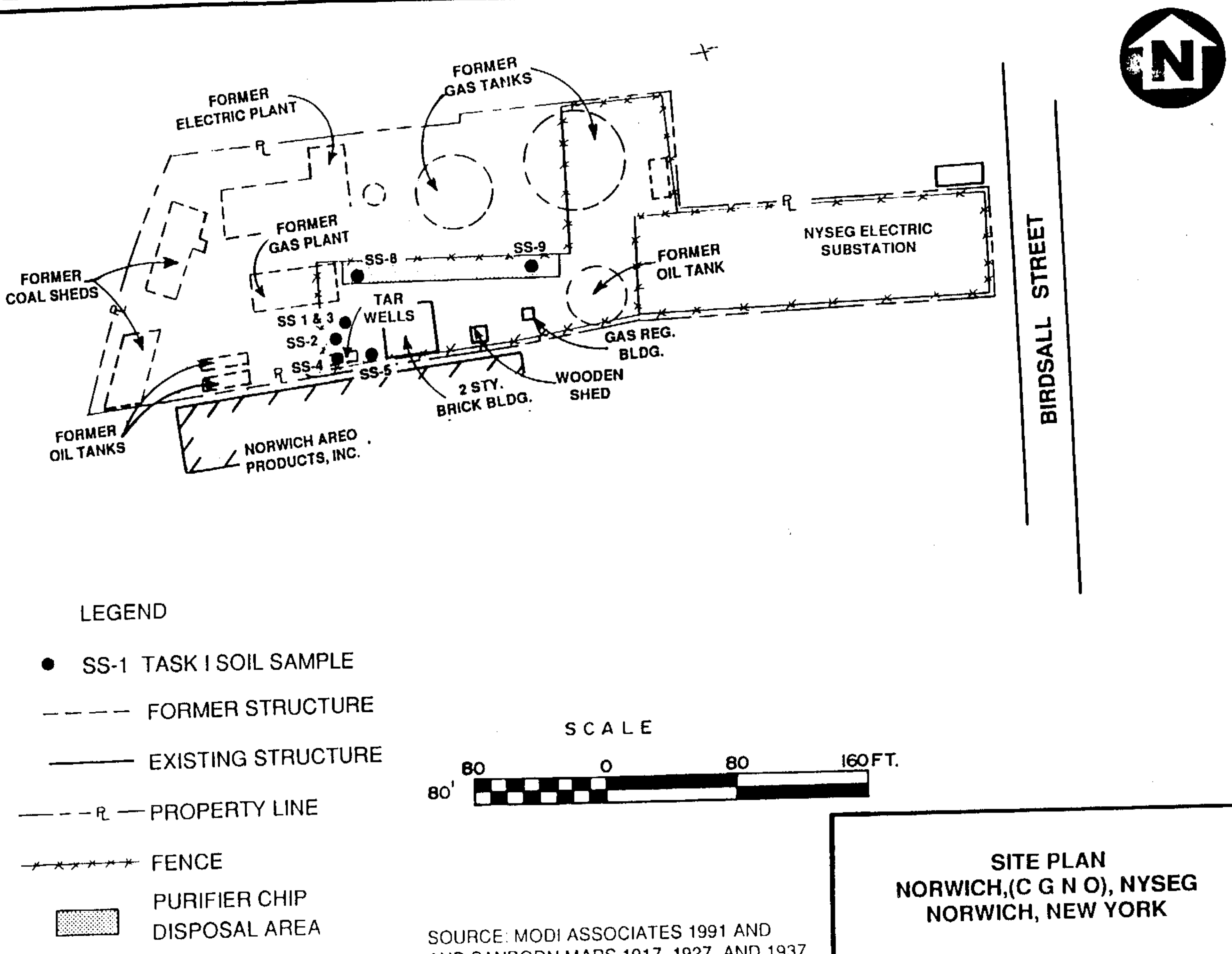
Processes Used

Early maps indicate both coal and coke storage on-site, indicating that either coal gas, water gas, or carburetted water gas (CWG) was being produced. A 1917 Sanborn map specifies a water gas plant. This map also shows a carburetor in the producer building and substantial oil storage on-site, indicating CWG was the most likely process at that time. There is no documentation of by-product disposal on the property, however a tar well is shown on historical Sanborn maps, and a purifier chip disposal area was identified by NUS Corporation through an interview with a former employee.

Land Use History

The land use around the plant was characterized by increasing residential and commercial development over the years. Historical maps show surrounding land use included commercial activities such as a laundry and carpet cleaning business (1926), a bottling company (1926), a lumber yard (1903-1917), ice manufacturing (1926) and a printing business (1937). The area can be characterized as residential

FIGURE 1.1



SOURCE: MODI ASSOCIATES 1991 AND
AND SANBORN MAPS 1917, 1927, AND 1937

SITE PLAN
NORWICH,(C G N O), NYSEG
NORWICH, NEW YORK

and light commercial/industrial throughout its history. The site is presently used by NYSEG for equipment storage, and the easternmost portion of the property, adjacent to the former MGP facilities, is an electrical substation.

ENVIRONMENTAL SETTING

The Norwich MGP site is located at 20 Birdsall Street, in the Village of Norwich, Chenango County, New York. The one acre, former MGP site is bounded by a commercial warehouse facility to the north, a NYSEG electrical substation and residences to the east, residences and the Norwich Aero Products facility to the south and railroad tracks to the west. The former MGP site is owned by NYSEG and is used for equipment storage, and a portion (on the north side) is leased for use as a truck parking area by Victory Markets, Inc..

Most of the former MGP site is surrounded by a fence which restricts access to the site. The former purifier building, a two-story brick structure, remains on-site, as does a small wooden shed and a small wood-frame gas regulator building. Most of the ground surface is covered with gravel.

The topography of the former MGP site and adjacent areas is flat, corresponding to the floor of the north-south trending Chenango River valley. The tops of the adjacent hills are approximately 500 feet above the valley floor. The Chenango River is the closest surface water body, flowing in a southerly direction approximately 2,500 feet southeast of the site. Approximately 3,000 feet to the southwest is the southerly-flowing Canasawacta Creek, which joins the Chenango River at a point 4,000 feet south of the site. The surface waters downstream of the site are classified Class B, suitable for bathing, fishing and fish propagation. Surface water is not used as a drinking water source within three miles downstream of the site.

The source of drinking water for the municipal water supply system is groundwater. The nearest municipal well is located 4,000 feet northeast (and upgradient) of the site, across the Chenango River. Site-specific groundwater data for the site does not exist, however based on the ground surface elevation and the elevation of the Chenango River, the depth to groundwater beneath the site is probably 15 feet or less. The nearest sensitive environment is a freshwater wetland located 2.3 miles downstream of the site. The site is located near the center of the village; the population of the Village of Norwich is approximately 12,000. The site is situated within a mostly residential/commercial neighborhood.

RESULTS OF PREVIOUS INVESTIGATIONS

In 1990, ES performed an assessment of data previously collected for the Norwich MGP site. In June 1990, NUS Corporation, under contract to the U.S. EPA, collected seven subsurface soil samples to determine whether a potential release of contaminants attributable to the site could occur to groundwater and to determine if a potential exists for direct contact with contaminants in the soil. Five samples were collected near a former tar well and two samples were collected in the suspected location of a purifier chip disposal area. The sample depths ranged from less than one foot to 4.5 feet below ground surface. (Figure 1.1).

Benzene, toluene, ethylbenzene, and total xylenes are principal constituents of MGP tar residues and were present in the subsurface soil samples at elevated levels. The highest concentrations were present in samples collected nearest to the former tar well.

Twenty-one semivolatile organic compounds were detected in the soil samples. Most are polycyclic aromatic hydrocarbons (PAHs) which are typically associated with MGP residues. The total concentration of PAHs ranged from 228.2 parts per million (ppm) in Sample SS-8 to 3010.5 ppm in Sample SS-4. Samples SS-3, SS-4, and SS-5, collected near the underground tar well, contained the highest concentrations. Eight of the PAHs are potentially carcinogenic.

Twenty metals were detected in the soil samples, however none of the metals concentrations exceeded the naturally occurring ranges in New York soils. Arsenic, chromium, copper and lead had elevated concentrations in some samples compared to the other soil samples. These elevated concentrations may reflect the presence of MGP residues in the soils at this site, unless site-specific background data can be collected which show the background concentrations are also elevated. Total and amenable cyanide was detected in all the soil samples.

The types and concentrations of contaminants detected in subsurface soil samples collected near the former tar well suggest that MGP residue sources may exist beneath the site. An imminent direct contact threat was not identified because the ground surface is covered with gravel and most of the site is surrounded by a fence which limits access to the area. The possibility of contaminant migration to local groundwater exists and groundwater is a drinking water source in the village and surrounding area.

A Task II investigation has been designed by ES to address the potential presence of MGP residue sources in the subsurface and the potential migration of MGP residue constituents to groundwater.

SECTION 2

TASK II SCOPE OF WORK

This section provides details of the objectives, data uses and methods for each of the Task II activities. Table 2.1 presents a summary of the Task II scope of work for the Norwich MGP site. All work will be performed in accordance with the project Health and Safety Plan (Appendix A) and the Quality Assurance Project Plan (Appendix B).

TASK II.A - EXPANDED HISTORICAL SEARCH

Objectives

Determine chronology of property ownership for the former MGP, and the sequence of MGP operations at the site. Determine chronology of ownership for adjoining properties.

Data Uses

Use property ownership and operations information to help identify all possible MGP residue sources which could be investigated. Use chronology of adjoining property ownership to identify other possible contamination sources in the vicinity which could impact the on-site and surrounding environment. Use documentation of other sources to distinguish environmental impacts and public health risks attributable to the those sources from those attributable to the MGP residue.

Methods

Locate and review deeds for the former MGP site property and adjoining properties, focusing on identifying possible industrial or commercial land uses which could have served as contamination sources. Review available Sanborn maps and historical aerial photographs to identify industrial/commercial land uses in the vicinity which could be sources of contamination. Because the former MGP ended operations over 50 years ago, interviews with former employees may not be possible. However, local residents and employees of the subsequent gas distribution facility may have knowledge of the historical land use at the site and surrounding area. ES will attempt to identify and interview local residents and employees with such knowledge. These interviews will be coordinated in advance with the local and corporate NYSEG representatives. ES will also attempt to identify residences in the site vicinity which may have groundwater wells, posing possible exposure pathways.

TABLE 2.1

TASK II SCOPE OF WORK SUMMARY
NORWICH MGP SITE

Task	Objective	Activity
II.A. Expanded Historical Search	Determine chronology of site ownership and operations at the former MGP.	Locate and review deeds for MGP site and adjoining properties, interview local residents with knowledge of site area, review aerial photographs, etc.
II.B Geophysical Investigation	Determine the presence of former MGP structures, buried utilities, conductive contaminant plumes, and subsurface MGP residue sources.	EM-31 survey over former MGP site.
II.C Soil Investigation	Determine the presence of MGP residue in surface and subsurface soils on site. Confirm locations of former MGP structures.	Conduct soil borings over MGP site and collect surface and subsurface soil samples. Analyze selected samples for BTEX, PAHs, and cyanide.
II.D. Hydrogeologic Investigation	Determine depth to water table, aquifer thickness, groundwater flow gradient, direction and velocity, and physical characteristics of aquifer materials.	Install eight monitoring wells, one pair upgradient and three pairs downgradient. Perform slug tests and monthly water level measurements in all wells.
II.E. Groundwater Investigation	Determine groundwater quality characteristics and presence of MGP residue constituents.	Sample groundwater from eight monitoring wells and analyze for BTEX, PAHs and cyanide. Monitor quarterly for seasonal variations.

TABLE 2.1-CONTINUED

TASK II SCOPE OF WORK SUMMARY
WATERVILLE MGP SITE

Task	Objective	Activity
II.F. Indoor Air Sampling	Determine whether MGP residue constituents are present in indoor air samples collected from the former MGP structure.	Collect indoor air samples and analyze for BTEX, PAHs and napthalene.
II.G. Preliminary Risk Assessment	Determine the presence and magnitude of risks from exposure to MGP residues present in soil, groundwater and air at the site.	Use existing and Task II data to develop a preliminary risk assessment to identify imminent and high-level risks of exposure. Perform land use survey of site vicinity.
II.H. Report Preparation	Present Task II investigation results, interpretations, conclusions and recommendations	Prepare a Task II report in accordance with NYSEG's format.

TASK II.B - GEOPHYSICAL INVESTIGATION

Objectives

Determine the presence of MGP-related structures, such as the limits of the relief holder foundations and tar well which may exist on-site. Determine whether conductive ~~contaminant~~ plumes exist beneath or downgradient of the site. Determine whether buried utilities exist beneath the site or downgradient areas.

Data Uses

Use evidence of remaining MGP structures to further investigate potential sources of MGP residues. Use evidence of conductive contaminant plumes to focus the hydrogeologic and groundwater investigations on affected area(s). Use information on buried utilities to assess possible contaminant migration pathways, and to identify possible exposure risks to utility workers. Use evidence of buried utilities to modify locations for anticipated subsurface excavations, borings, wells, etc.

Methods

Perform an electromagnetic (EM) survey using a Geonics EM-31 or similar equipment. The survey will be conducted over a 20- by 20-foot grid tied to a permanent location on-site. Where evidence of a conductive plume or subsurface feature exists, readings will be taken at a closer spacing. An off-site station will be established for instrument calibration and background readings. The survey will cover, at a minimum, the grid area identified on Figure 2.1.

At the present time, it is anticipated that no off-site properties will be included; however surveying off-site may be necessary to track a plume or subsurface feature. These arrangements will be coordinated with NYSEG. The EM data will be plotted and contoured daily, so the survey coverage can be modified to further define suspected MGP structures, residue sources or conductive plumes. As an added measure, those areas suspected to have buried utilities will be surveyed with an electronic line locator so the location of the feature can be staked out and surveyed relative to an on-site datum for future reference. The survey grid and EM survey field work can be completed in five days.

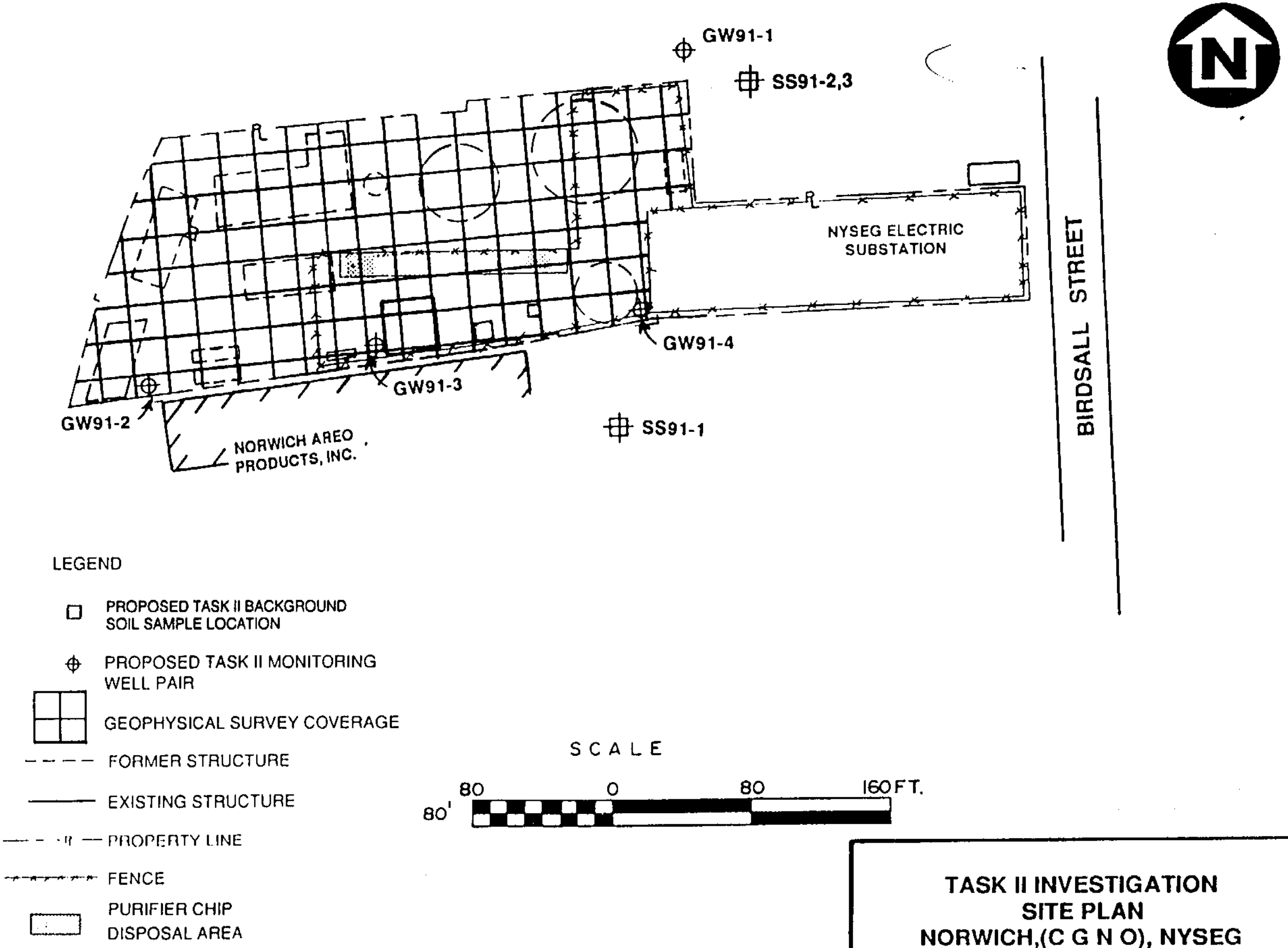
ES has also evaluated the use of Ground Penetrating Radar (GPR) at the site to locate subsurface anomalies associated with former MGP structures. The presence of the electrical substation, buried utilities and overhead lines create interferences which will preclude the use of GPR.

Upon completion of the field work and interpretation of the data, the subsequent investigation tasks will be modified as necessary to better achieve the task objectives and to avoid interferences with buried utilities.

TASK II.C - SOIL INVESTIGATION

Objectives

Determine the presence of visible MGP residues in surface and subsurface soils on-site. Confirm limits of former MGP structures in the subsurface. Determine



SOURCE: MODI ASSOCIATES 1991 AND
AND SANBORN MAPS 1917, 1927, AND 1937

TASK II INVESTIGATION
SITE PLAN
NORWICH,(C G N O), NYSEG
NORWICH, NEW YORK

whether MGP residues exhibit hazardous waste characteristics, or present a human health or environmental risk. Determine soil physical characteristics and depth to water table.

Data Uses

Use information on extent of visible MGP residues to establish the limits of the visibly contaminated area, and to assess the associated migration pathways, possible environmental threats and possible human risks. Use information on limits of former MGP structures to design a remedial action, and to modify the hydrogeologic and groundwater investigations as necessary. Use information on physical characteristics of soil and depth to water table to modify the hydrogeologic and groundwater investigations, and to design a remedial action.

Methods

Prior to any intrusive subsurface investigation, the underground utility locating service and NYSEG will be asked to locate all buried utilities. NYSEG will be responsible for securing access permission for all work. Split spoon soil borings will be drilled to whichever of the following is encountered first: the water table; undisturbed, native soil; auger refusal; or a maximum depth of ten feet. The borings will be conducted in the center of the former relief holders, tar well, and any other suspected former MGP structures as indicated by the geophysical survey and historical information. Although not presently budgeted, borings may also be necessary outside the site property lines, if visual evidence suggests MGP residues may extend beyond the site property lines. Off-site borings will be recommended only if there is geophysical or visual evidence of MGP residues, and with the concurrence of NYSEG. A maximum of 30 borings has been budgeted to be drilled within the property lines to define the locations of former MGP structures and to ensure adequate visual characterization of the soils.

While drilling the borings, the soil will be sampled continuously for visual inspection. Information on soil moisture, color, texture, structure and visual or other evidence of MGP residue will be noted in a field book. Visual evidence of MGP residue will be confirmed by monitoring the open split-spoon with a photoionization detector (PID) for the presence of VOCs. Budget estimates include the use of a tripod and portable drilling rig.

Selected soil samples will be retained for chemical analysis by NYSEG's laboratory. Based on the Task I subsurface soil sample results, the indicator analyses for all Task II soil samples will be benzene, toluene, ethylbenzene and total xylenes (BTEX), PAHs and cyanide.

A total of 39 soil sample analyses have been budgeted (Table 2.2). Two background soil samples will be collected off-site to establish ambient concentrations of BTEX, PAHs and cyanide in the site vicinity. The background samples will be collected at a depth of three to five feet below ground surface, for comparison with the on-site samples collected from the subsurface.

One background and four other samples will be collected randomly in the area outside the fence, but within the site property lines. The background sample will be

TABLE 2.2

TASK II SAMPLING AND ANALYSIS SUMMARY
NORWICH MGP SITE

Matrix (# of Samples)	Sample Designation	Location	Sample Type	Analyses
Soil				
(1)	SS91-1	South of the former MGP (subsurface)	Background	BTEX, PAHs, Cyanide
(1)	SS91-2	Northeast of the former MGP (subsurface)	Background	BTEX, PAHs, Cyanide
(1)	SS91-3	Northeast of the former MGP (surface)	Background	BTEX, PAHs, Cyanide
(4)	SS-4 through SS-7	Outside the fenced area, but within the property line. Samples collected from beneath the gravel cover (approximately 6-12 inches)	Random	BTEX, PAHs, Cyanide
(4)	SB91-? (Depends on which borings samples are taken from)	Samples of visibly contaminated material will be collected.	Source	BTEX, PAHs, Cyanide, TCLP and waste characteristics
(22)	SB91-?	Samples will also be collected at the bottom and outer limit of the visibly contaminated zone to define the lateral and vertical extent of contamination	Outside Source	BTEX, PAHs, Cyanide (11), PAHs only (11)
(6)	SS91-9 through SS91 – 14	Two samples from each of the three deep downgradient well borings (GW91-2,3,4)	Downgradient	BTEX, PAHs, Cyanide
(1)	SC91-1	Composite sample of visibly contaminated soil cuttings from well borings	Composite	TCLP, Waste Characteristics
Groundwater				
(8)	GW91-1S/1D	Shallow (S) and deep (D) well pair located northeast of former MGP. Sample quarterly.	Upgradient	BTEX, PAHs, Cyanide
(8)	GW91-2S/2D	Well pair at southwest corner of former MGP. Sample quarterly.	Downgradient	BTEX, PAHs, Cyanide

TABLE 2.2-CONTINUED

TASK II SAMPLING AND ANALYSIS SUMMARY
NORWICH MGP SITE

Matrix (# of Samples)	Sample Designation	Location	Sample Type	Analyses
(8)	GW91-3S/3D	Well pair near tar well on south side of former MGP. Sample quarterly.	Downgradient	BTEX, PAHs, Cyanide
(8)	GW91-4S/4D	Well pair at southeast corner of former MGP. Sample quarterly.	Downgradient	BTEX, PAHs, Cyanide
Air				
(3)	Purifier Bldg.	Two samples inside purifier building, one outside.	Continuous	BTEX, Napthalene

Note: Cyanide refers to total cyanide. If total cyanide is detected, amenable cyanide will also be analyzed.

collected at a depth of 6 to 12 inches at one of the previously designated background locations. The random samples will be collected from immediately beneath the gravel cover, at about 6 to 12 inches beneath the surface. These results are intended to demonstrate whether the shallow subsurface soils outside the fence are contaminated. Based on these data, a decision can be made regarding extending the fence to the property line. These samples will be analyzed for BTEX, PAHs and cyanide.

Thirty-two samples have been budgeted to be collected from the soil borings; four from residue sources and 22 from the outer and lower limits of the residue sources. Sample locations will be chosen at the discretion of the on-site geologist to provide characterization of visibly contaminated soils and MGP residue sources and to define the outer and lower limits of that contamination. The latter objective will be achieved by selecting samples from below the visibly contaminated zone to determine the lower extent of contamination. Samples will also be collected adjacent to the visibly contaminated zone (i.e. another boring five or ten feet away) to determine the lateral extent of contamination. This information will be used to estimate the volume of any MGP residue sources and/or the amount of contaminated soil.

The MGP residue and visibly contaminated samples will be analyzed by the Toxicity Characteristic Leaching Procedure (TCLP) and for waste characteristics (ignitability, corrosivity, reactivity). These analyses will demonstrate whether the residues or soils are characteristically hazardous or toxic. Only one sample from each distinct residue source will be analyzed. Eleven of the 22" near source" samples will be analyzed for BTEX, PAHs and cyanide, and eleven will be analyzed for PAHs only.

Finally, six subsurface soil samples will be collected from the three downgradient well borings as described in the next subsection (Task II.D).

All soil samples will be discrete samples collected with stainless steel split spoons or bucket augers. Due to the large number of samples, dedicated equipment will not be feasible and the equipment will be decontaminated between samples by steam cleaning or with successive rinses of Alconox detergent, distilled water, methanol, and distilled water. All decontamination water will be contained in drums for subsequent disposal by NYSEG. Details of the analytical protocols and quality assurance/quality control (QA/QC) procedures are described in the subsection titled "Sample Analysis/Data Quality" found in another subsection of this work plan. Soil samples will be collected in bottles provided by ES, labeled, sealed, packed in ice and shipped to the laboratory via overnight delivery under chain of custody protocols. All pertinent data will be recorded in the field log book.

TASK II.D - HYDROGEOLOGIC INVESTIGATION

Objectives

Characterize the uppermost aquifer in terms of the depth to water, groundwater flow direction, gradient and velocity, aquifer thickness, depth to confining layer, and the physical characteristics of the aquifer materials.

Data Uses

These data will be used to determine the potential for MGP residue constituents to migrate to the water table, and the direction and speed with which dissolved constituents may migrate off-site. Water level elevations in well pairs will be compared to determine, in part, how certain constituents may behave within the aquifer (i.e. sink or float). These data will be used in combination to assess the potential risks of exposure to residents downgradient of the site who may use groundwater as a source for drinking water, cooking, bathing, etc.

Methods

Four monitoring well pairs will be installed into the uppermost aquifer. The well locations will be confirmed after the geophysical and soil investigations. Two downgradient well pairs will be placed within identified conductive plumes and/or downgradient of significant sources of MGP residues (i.e. tar well and former relief holders). One upgradient well pair will be installed in an area shown by the EM survey to be outside any identified conductive plumes. The well pairs will be positioned to monitor the upper and lower portions of the aquifer. Due to density differences the BTEX would be expected in the upper portion of the aquifer and the PAHs in the lower portion.

The well borings will be drilled with hollow-stem augers and soil samples will be collected continuously (i.e. two-foot samples collected at two-foot intervals) in the deepest boring at each well pair location. One sample from each deep boring will be analyzed for grain size characteristics and Atterberg limits to characterize the aquifer materials. The depth of the sample will be at the discretion of the on-site geologist. The upgradient boring will be drilled first and will proceed through the aquifer to a maximum depth of 60 feet, unless the lower boundary of the aquifer or the top of a confining zone is identified. The deep well screen will be set at the bottom of the aquifer, or the top of a confining zone or between 55 and 60 feet. Upon completion of the deep well, the shallow well will be drilled approximately ten feet away. The depth of the shallow well boring is estimated to be 20 feet, and the screen will intersect the water table. The two downgradient well pairs will be drilled and positioned in the same manner as the upgradient pair.

Two soil samples will be collected from each of the three deep downgradient well borings and analyzed for BTEX, PAHs and cyanide (Table 2.2). As the borings are continuously split-spoon sampled during drilling, the samples will be placed in jars, sealed with aluminum foil and allowed to equilibrate. The intake of the PID will be inserted through the foil and the headspace will be measured for total VOCs. The sample with the highest headspace reading (above background) from each boring will be retained for analysis. The second sample will be from near the bottom of the screened section of the well.

All wells will be constructed with two-inch, inside diameter, flush-joint, stainless steel "prepacked" screen and casing. The well borings and well installations will be completed in general accordance with NYSEG's required installation procedures for monitoring wells (Appendix C). If possible, the wells will be installed with curb boxes flush with the ground surface. Locks will be provided by ES. If necessary, the wells will have a stand pipe extending two to three feet above ground and be protected by guard posts. ES will also develop the wells and install dedicated stainless steel bailers. For well development, ES may employ a centrifugal pump or the Waterra system. The Waterra system is an inertial pump, using dedicated high density polyethylene tubing and foot valve to surge the well and remove water at the same time.

Following installation and development, water levels in the wells will be measured (after stabilization) and slug tests will be performed to determine the horizontal hydraulic conductivity. Appropriate field test and data analysis methods will be selected based on the aquifer configuration. Water levels in the wells will be monitored monthly thereafter for a period of at least twelve months.

The rims of the well casings will be surveyed to determine reference elevations tied to an on-site datum.

All downhole materials and equipment will be steam cleaned between well borings. A temporary decontamination pad will be constructed on-site (within the fenced area) and decontamination water will be contained in drums for subsequent disposal by NYSEG based on the first round of groundwater results. Visibly contaminated soil cuttings or those with PID readings above 5 ppm over background will be contained in drums. At the completion of Task II.D, a composite sample of the soil cuttings will be collected and analyzed by TCLP and waste characteristics methods to determine whether these materials are hazardous. Upon receipt of those results, a recommendation will be made regarding disposition of the material. In the interim, the drums will be labeled as non-hazardous with a description of the contents and the origin.

TASK II.E - GROUNDWATER INVESTIGATION

Objectives

Characterize groundwater quality in the uppermost aquifer upgradient and downgradient of the former MGP site, and determine whether MGP residue constituents are migrating to groundwater.

Data Uses

Compare upgradient and downgradient concentrations to identify impacts on groundwater quality attributable to the former MGP. Compare sample concentrations to groundwater standards to identify regulatory violations. These data will be used in the preliminary risk assessment to estimate the quantitative health risk to downgradient groundwater users. These data will also establish whether groundwater remediation may be warranted.

Methods

The first round of groundwater samples will be collected no sooner than two weeks after development. Collection of quarterly groundwater samples will begin by measuring water level elevations in all wells on-site. The total length of the water column in the well will be measured and the volume of water in the well will be calculated. A minimum of three well volumes will be removed from each well by bailing, pumping or using a dedicated sampling device. The temperature, specific conductivity and pH of the purge water will be monitored to ensure these parameters stabilize.

After the water level in the well recovers to at least 80% of this pre-purging level, a sufficient quantity of water will be removed from the well to satisfy the analytical requirements. The upgradient well will be sampled first. Sample bottles will be provided by ES. The groundwater samples will be removed by bailing or with the dedicated sampling device. A separate aliquot will be collected and analyzed in the field for pH, temperature and specific conductivity. Table 2.2 summarizes the groundwater sampling and analysis program. The sample bottles will be sealed, labeled, packed in ice and shipped under chain of custody protocols to the NYSEG laboratory via overnight delivery. A complete record of all pertinent information and data will be compiled in the field log book. The overnight shipping manifest number will be noted on the chain of custody form and receipt of the samples will be confirmed with the laboratory on the following day.

Four rounds of quarterly groundwater sampling are currently planned for Task II to determine whether seasonal variations in water levels and groundwater quality exist. The samples will be analyzed for BTEX, PAHs and cyanide; where possible, the laboratory will utilize a modified purge procedure which will allow lower detection limits to be achieved for the BTEX analysis.

Quarterly groundwater sampling will be completed in two days or less during each quarter (December 1991, March 1992, June 1992 and September 1992). Groundwater samples will be collected for the first time no sooner than 14 days following well installation and development, in accordance with standard New York State Department of Environmental Conservation (NYSDEC) procedures.

TASK II.F - INDOOR AIR SAMPLING

Objective

Determine whether MGP residue constituents are present in indoor air samples collected from the former purifier building.

Data Use

Used to estimate the quantitative health risk via exposure to MGP residue constituents, and to identify whether some form of remedial action is warranted.

Methods

Auto-samplers will be placed in the structure for a period of 8-24 hours after NYSEG arranges for removal of possible VOC sources and the building is ventilated. Two samples from different parts of the building and one from outside the building will be retrieved and shipped via overnight delivery to the Galson Laboratory under chain of custody protocols. The indoor air sample will be analyzed by NIOSH Method 1500/1501 (BTEX and naphthalene) and NIOSH Method 5506 (16 PAHs). Details of the analytical protocols and QA/QC requirements are provided in the subsection on sample analysis/data quality and

Appendix B. A summary of the indoor air sampling and analysis is provided on Table 2.2.

TASK II.G - PRELIMINARY RISK ASSESSMENT

Objective

Determine the potential for, and magnitude of, health risks from exposure to MGP residue constituents present in soil, air and groundwater at the site.

Data Use

These data will allow identification of chronic and acute exposure risks which dictates the necessity for remedial action.

Methods

Task I and Task II results will be used to prepare a preliminary risk assessment, including identification of the contaminants of concern, the exposure pathways, the exposure concentrations and the potential receptors. As part of the identification of receptors, a land use survey of the area within one-half mile of the site will be performed. The survey will present, in graphical form, the type and location of all sensitive environments/receptors (day-care facilities, hospitals, etc.) and possible contaminant sources other than the MGP site which could impact environmental quality or public health.

OTHER ACTIVITIES

ES has evaluated several other activities which were considered but not included in the Task II investigation planning. There are no surface water bodies nearby which could be impacted by run-off from the site; therefore sampling of stream water and sediment has not been included in Task II. Soil vapor survey techniques could be used at the site, based on the shallow water table and the presence of BTEX in a seep sample. However, the relatively small size of the former MGP site makes direct measurements via soil borings and groundwater sampling more desirable and cost-effective and the compacted surface soil makes driving vapor probes difficult. Similarly, test pit excavations were considered but not recommended due to the difficulty in controlling air releases should a relatively large MGP residue source be exposed. The site is very close to several residences, and the soil borings and non-intrusive geophysical techniques are a safer choice. Test pits may be suitable as a Task III activity should the presence and location of structures be indicated during Task II.

Agreed

SAMPLE ANALYSIS/DATA QUALITY

The analytical program summary is presented in Table 2.3. All sample analyses will be conducted by NYSEG's laboratory. All analyses and analytical reporting will be in accordance with the Category B reporting deliverables for the NYSDEC Analytical Services Protocol (ASP) dated September 1989. The ASP specifies QA/QC requirements which the laboratory must follow for all calibrations, instrument tunes, surrogate, spike and blank sample analyses, documentation and

TABLE 2.3

ANALYTICAL PROGRAM SUMMARY
NORWICH SITE

			Field Quality Control Samples*			Laboratory Quality Control Samples**		
Analytical Method	Sample Matrix	No. of Field Samples	Trip Blanks(1)	Field Duplicates	Wash Blanks(2)	MS Blanks	MS/MSD	VHB
BTEX	Soil	28	0	2	2	2	4	2
PAHs	Soil	39	0	2	2	2	4	0
Cyanide	Soil	28	0	2	2	2	4	0
TCLP, W.C.	Soil	5	0	0	0	0	0	0
BTEX	Water	32	4	4	0	4	8	4
PAHs	Water	32	0	4	0	4	8	0
Cyanide	Water	32	0	4	0	4	8	0
NIOSH Method 1500/1501, 5506	Air	3	0	2	0	0	0	0

1. Trip blanks are water samples analyzed for BTEX only. Trip blanks are collected with water samples only.

2. Wash blanks are water samples analyzed for same parameters as field samples.

MS/MSD: Matrix Spike/Matrix Spike Duplicate samples. NYSDEC will provide guidance on the QC requirements for TCLP.

VHB: Volatile holding blank, analyzed at a frequency of one per calendar week, per storage area.

* Each analyzed at a frequency of about 1 per 20 field samples per event (5%).

** Each analyzed at a frequency of 1 per 20 field samples per event (5%).

W.C.: Waste Characteristics.

deliverables. ASP methods and requirements have been specified due to the likelihood that NYSDEC will review the Task II report at some time. Utilizing the ASP will ensure that an appropriate level of QA/QC has been incorporated into the Task II program and that the data will be of known, documentable quality.

All analytical data packages received by ES will be fully validated for compliance with the project analytical program and the ASP requirements for analysis and reporting. The data will also be validated for usability to ensure that all data incorporated in the Task II program are valid. The data validation will follow the functional guidelines published by the U.S. EPA for organic and inorganic analyses. Data validation will result in the data being accepted, rejected or flagged to alert the data user to qualifications on data use.

Details of the analytical methods, protocols and reporting requirements are specified in the Project Quality Assurance Plan (Appendix B). The laboratory will provide a summary of the analytical results on a computer disk. ES will convert that data to NYSEG's groundwater database format.

TASK II.H - TASK II REPORTING

A Task II investigation report will be prepared in accordance with NYSEG's report format, which includes the following sections:

- Introduction
- Summary of Previous Investigations
- Site Activities
- Site Characterization
- Chemical Distribution of Contaminants On and Off Site
- Physical and Chemical Data Assessment
- Preliminary Identification of Exposure Risks
- Conclusions and Recommendations
- Schedule and Costs (for Task III, if necessary)
- References
- Appendices

The analytical groundwater data will be provided on floppy disk in the format specified by NYSEG (Appendix D). Task II reporting will begin on an intermittent basis after the soil investigation (Task II.C). The draft Task II report will be completed after the first round of groundwater sampling and after all data has been validated and the preliminary risk assessment is completed (Task II.G). Data validation costs have been included in the reporting task. After completing the preliminary risk assessment, the draft Task II report will be compiled within one week. Our schedule allows one week for internal review by the ES Technical Directors and one week for addressing internal review comments. Three copies of the draft report will be prepared for NYSEG's review. Our budget estimate includes one meeting with NYSEG in Binghamton to discuss the draft report.

As the quarterly groundwater sampling rounds are completed, letter reports of the results will be submitted to NYSEG. Upon completion of all sampling rounds, and the receipt of draft report comments, a final Task II report will be prepared.

SECTION 3

SCHEDULE AND BUDGET

The Task II investigation schedule is presented on Figure 3.1. The Task II investigation budget is presented on Table 3.1. The budget includes labor rates which are currently identified in Contract 90-395. Analytical costs are not included; all analyses will be performed by the NYSEG laboratory, with the exception of the indoor air analyses.

The draft Task II report will be submitted in 25 weeks, after the first round of quarterly groundwater data have been received, validated and reviewed. Letter reports summarizing the results of subsequent quarterly groundwater sampling rounds will also be submitted. The final report will incorporate the draft report review comments and all rounds of groundwater sampling data.

The budget for Task II.H includes project management throughout the project. Tasks II.G and II.H are "lump sum" tasks for which labor charges will be billed 20% upon submission of the first invoice as a project start-up milestone, 20% at completion of the first round of groundwater sampling, 40% upon submission of the draft Task II report, 10% upon submission of the final Task II report and 10% upon approval of the final report. Other direct costs will be billed on a time and materials basis, with supporting documention.

PROJECT SCHEDULE
TASK II INVESTIGATION
NORWICH SITE

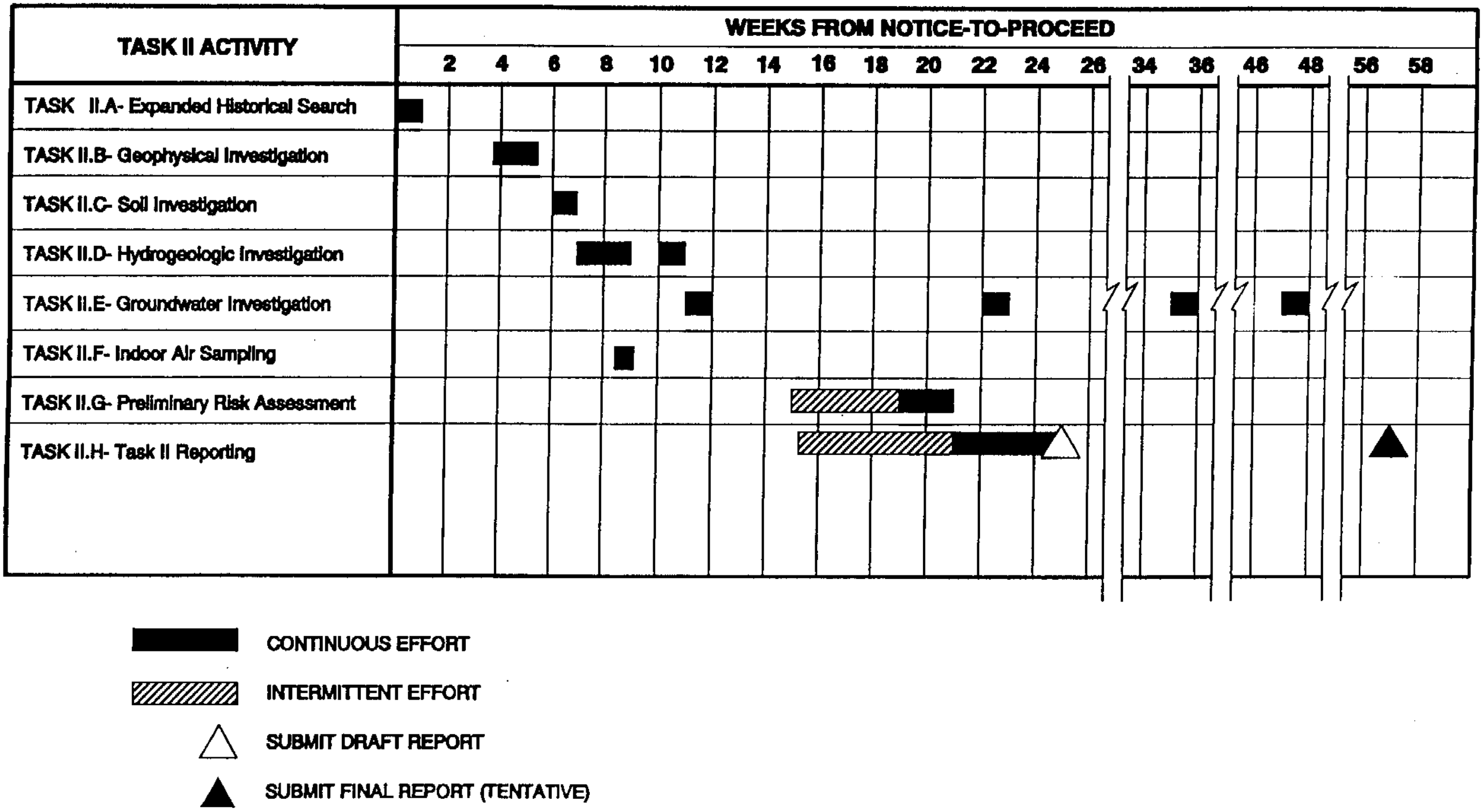


FIGURE 3.1

NYSEG Norwich MGP Site

Table 3.1 : Task II Investigation Costs

Labor Categories

PART A : LABOR COST ESTIMATES Work Task Description		(95) Principal Eng./Sci.I	(90) Principal Eng./Sci.II	(85) Principal Eng./Sci.III	(80) Supervis. Eng./Sci.I	(75) Supervis. Eng./Sci.II	(70) Senior Eng./Sci.I	(65) Senior Eng./Sci.II	(60) Staff Eng./Sci.I	(55) Staff Eng./Sci.II	(50) Assoc. Eng./Sci.I	(45) Assoc. Eng./Sci.II	(30) Senior Specist. I	(25) Senior Specist. II	(20) Specist. I	(15) Specist. II	Total Labor
	Hrly Rate -->	$89	$89	$79	$71	$59	$54	$47	$42	$37	$34	$29	$46	$38	$29	$24	
Task IIA – Historical Search	Hrs. ----->	0	0	0	0	0	16	0	0	0	0	0	0	0	0	0	16
	Dollars --->	$0	$0	$0	$0	$0	$864	$0	$0	$0	$0	$0	$0	$0	$0	$0	$864
Task IIB – Geophysical Investigation	Hrs. ----->	0	0	8	0	0	40	0	0	40	0	0	0	0	0	0	88
	Dollars --->	$0	$0	$632	$0	$0	$2,160	$0	$0	$1,480	$0	$0	$0	$0	$0	$0	$4,272
Task IIC – Soil Investigation	Hrs. ----->	0	20	24	0	0	48	0	0	48	0	0	0	0	0	0	140
	Dollars --->	$0	$1,780	$1,896	$0	$0	$2,592	$0	$0	$1,776	$0	$0	$0	$0	$0	$0	$8,044
Task IID – Hydrogeologic Investigation	Hrs. ----->	0	0	24	0	0	80	0	32	80	0	0	0	0	0	0	216
	Dollars --->	$0	$0	$1,896	$0	$0	$4,320	$0	$1,344	$2,960	$0	$0	$0	$0	$0	$0	$10,520
Task IIE – Groundwater Investigation	Hrs. ----->	0	0	24	0	0	80	0	0	80	0	0	0	0	0	0	184
	Dollars --->	$0	$0	$1,896	$0	$0	$4,320	$0	$0	$2,960	$0	$0	$0	$0	$0	$0	$9,176
Task IIF – Indoor Air Samping	Hrs. ----->	0	0	2	0	0	4	0	0	0	0	0	0	0	0	0	6
	Dollars --->	$0	$0	$158	$0	$0	$216	$0	$0	$0	$0	$0	$0	$0	$0	$0	$374
Task IIG – Preliminary Risk Assessment	Hrs. ----->	1	4	2	4	80	0	0	0	0	0	0	0	0	2	2	95
	Dollars --->	$89	$356	$158	$284	$4,720	$0	$0	$0	$0	$0	$0	$0	$0	$58	$48	$5,713
Task IIH – Reporting	Hrs. ----->	22	84	136	290	24	292	120	40	136	40	0	0	64	98	80	1426
	Dollars --->	$1,958	$7,476	$10,744	$20,590	$1,416	$15,768	$5,640	$1,680	$5,032	$1,360	$0	$0	$2,432	$2,842	$1,920	$78,858
	Sub-Totals	23	108	220	294	104	560	120	72	384	40	0	0	64	100	82	2171
		$2,047	$9,612	$17,380	$20,874	$6,136	$30,240	$5,640	$3,024	$14,208	$1,360	$0	$0	$2,432	$2,900	$1,968	$117,821

ODC Categories

Part B: Other Direct Costs (ODC's) Work Task Description		Mileage	Printing	Phone/ FAX	Meals	Mat'ls./ Supplies	Surface Travel	Computer Services	Equipment Purchase	Drilling	Postage/ Freight	Lodging	Survey	Equipmt. Rental	Word Process.	Sub-Contract.	Total ODCs	TOTAL PROJECT COSTS
Task IIA – Historical Search	Dollars --->	$0	$10	$25	$25	$10	$200	$0	$0	$0	$10	$0	$0	$0	$20	$0	$300	$1,164
Task IIB – Geophysical Investigation	Dollars --->	$70	$10	$25	$250	$50	$1,200	$200	$0	$0	$450	$500	$0	$2,100	$20	$0	$4,875	$9,147
Task IIC – Soil Investigation	Dollars --->	$70	$5	$25	$250	$1,835	$400	$0	$0	$0	$750	$500	$0	$3,650	$20	$0	$7,805	$15,849
Task IID – Hydrogeologic Investigation	Dollars --->	$150	$10	$70	$200	$275	$800	$100	$0	$33,600	$150	$400	$3,100	$1,350	$40	$750	$40,995	$51,515
Task IIE – Groundwater Investigation	Dollars --->	$30	$5	$15	$200	$200	$160	$0	$832	$0	$400	$0	$0	$650	$20	$0	$2,512	$11,688
Task IIF – Indoor Air Samping	Dollars --->	$0	$0	$0	$0	$0	$0	$0	$0	$0	$25	$0	$0	$900	$0	$1,360	$2,285	$2,659
Task IIG – Preliminary Risk Assessment	Dollars --->	$0	$5	$15	$0	$0	$0	$400	$0	$0	$0	$0	$0	$0	$20	$0	$440	$6,153
Task IIH – Reporting	Dollars --->	$0	$1,500	$150	$25	$25	$150	$1,200	$0	$0	$200	$0	$0	$100	$800	$0	$4,150	$83,008
	Sub-Totals	$320	$1,545	$325	$950	$2,495	$2,910	$1,900	$932	$33,600	$1,985	$1,400	$3,100	$8,650	$940	$2,110	$63,162	$180,983

EAF/RSY
10/18/91
09:54:25
disk rsy-orange label

SECTION 4

REFERENCES

1. Prioritization of Former Manufactured Gas Plant Sites, Norwich, N.Y., (Task I) report prepared by Engineering-Science, Inc. dated September, 1991.
2. Management of Manufactured Gas Plant Sites Volumes I and II, prepared by the Gas Research Institute, dated 1987.

APPENDIX A

HEALTH AND SAFETY PLAN

HEALTH AND SAFETY PLAN

For

NYSEG SITE
NORWICH, NEW YORK

Prepared By:

ENGINEERING-SCIENCE

290 ELWOOD DAVIS ROAD

LIVERPOOL, NY 13088

November 2, 1990

Reviewed and Approved By:

	Name	Date
Project Manager		11/3/90
ES H&S Officer		11/2/90

TABLE OF CONTENTS

TABLE OF CONTENTS
(CONTINUED)

LIST OF TABLES

LIST OF FIGURES

EMERGENCY CONTACTS

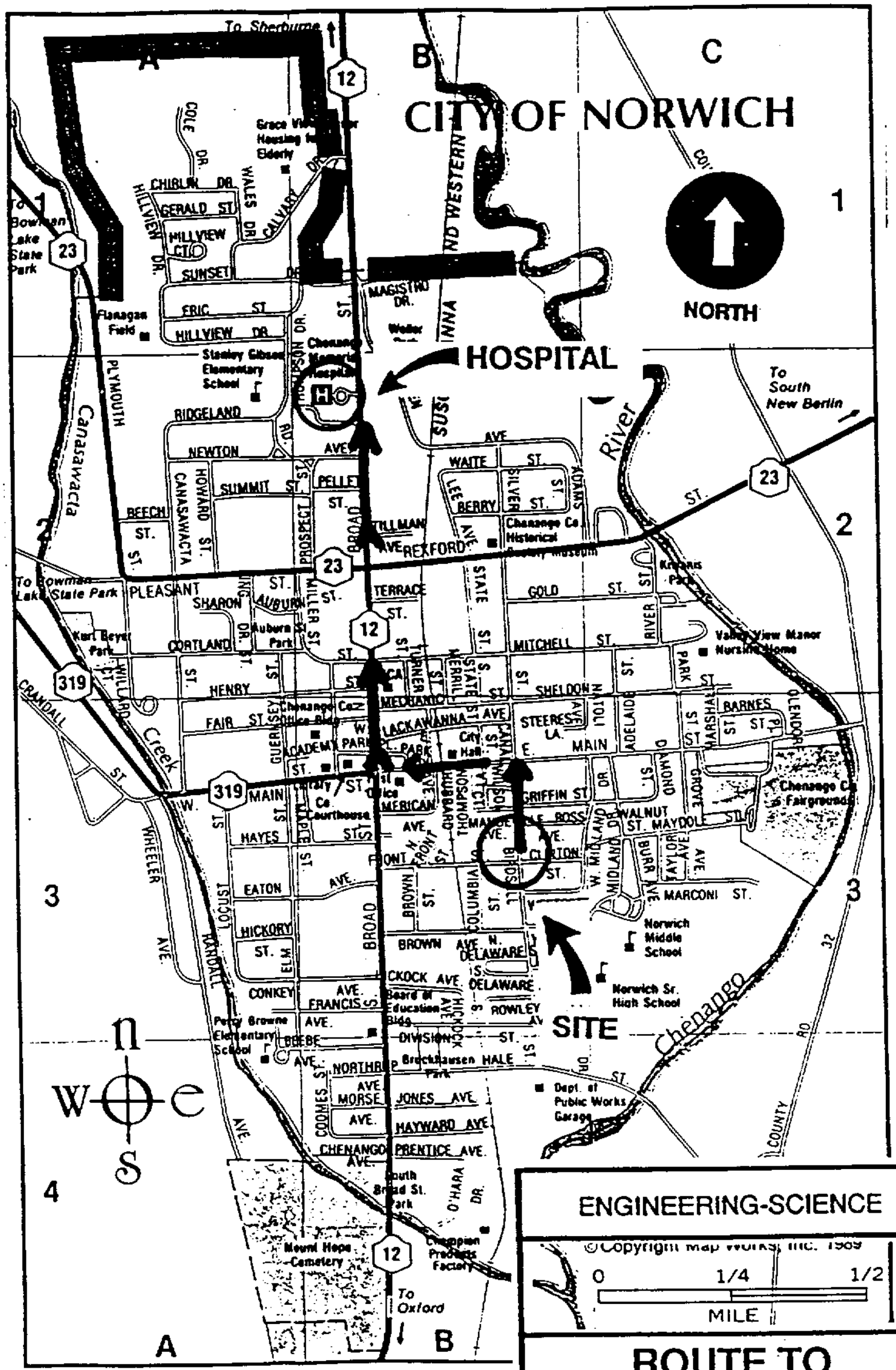
In the event of any situation or unplanned occurrence requiring assistance, the appropriate contact(s) should be made from the list below. For emergency situations, contact should first be made with the site coordinator who will notify emergency personnel who will then contact the appropriate response teams. This emergency contacts list must be in an easily accessible location at the site.

Contingency Contacts	Phone Number
Nearest phone located on-site	Use public phone
Fire Department	911
Poison Control Center	911
ES Contract Physician (IMA)	(315) 478-1977 or (315) 432-9705
NYSEG Local Manager Thomas Hoffman	(607) 334-2255
Medical Emergency	
Chenango Memorial Hospital	(607) 335-4111

ROUTE TO HOSPITAL: From the site, go north on Birdsall to first red light. Take a left on E. Main Street, go to next red light, and take a right (Broad Street). Go through two more red lights, and the Hospital is approximately 1 block up on the left (see figure attached).

ES Contacts

ES Project Manager:	
George Moreau (ES Syracuse)	(315) 451-9560 (Office)
ES Office Health and Safety Representative:	
W.L. Bradford	(315) 451-9560 (Office)



ENGINEERING-SCIENCE

0 1/4 1/2
MILE

ROUTE TO HOSPITAL

1. INTRODUCTION

The purpose of this health and safety plan is to establish personnel protection standards and mandatory safety practices and procedures for field investigation efforts. This plan assigns responsibilities, establishes standard operating procedures, and provides for contingencies that may arise while operations are being conducted at hazardous waste sites.

The provisions of the plan are mandatory for all on-site personnel. All ES personnel shall abide by this plan. Health and Safety plans must be prepared by subcontractors and they must conform to this plan as a minimum. Alternately, subcontractor personnel may choose to abide by the provisions of the ES plan. All personnel who engage in project activities must be familiar with this plan and comply with its requirements; these personnel must sign-off on the Plan Acceptance Form (Appendix A) prior to beginning work on the site. The plan acceptance form must be submitted to the Office Health and Safety Officer.

1.2 Site Description

Refer to Section 2 of the project work plan.

1.3 Scope of Work

Field tasks to be conducted at the site includes geophysical surveys, split spoon soil sampling, surface soil sampling, indoor air monitoring, monitoring well installations and groundwater sampling. Refer to Section 2 of the Work Plan for details of the scope of work.

1.4 Project Team Organization

Table 1 describes the responsibilities of all on-site personnel associated with this project. The names of principal on-site personnel associated with this project are delineated below:

Project Manager: G.H. Moreau

Field Team Leader: W.D. Lilley

Site Health and Safety Officer: W.D. Lilley

2. RISK ANALYSIS

2.1 Chemical Hazards

Potential contaminants which may be encountered while conducting field tasks at the site include heavy metals, polycyclic aromatic hydrocarbons (PAHs), volatile organics, and cyanide. Some relevant properties of these compounds are shown in Table 1. For protection against exposure to heavy metals, dust generation should be minimized. To minimize exposure to PAHs, dust generation should be minimized and disposable latex gloves will be worn. Direct contact with suspected wastes will be avoided.

In addition to the compounds which may be detected on site, some of the solvents used in the processing of samples are potentially hazardous to human

TABLE 1

CHARACTERISTICS OF CHEMICALS WHICH MAY BE DETECTED ON SITE

Compound	Method of Detection	Exposure Limit	IDLH	LEL	Odor Threshold
Benzene	PID(1)/CT(2)	1 ppm	2,000 ppm	1.3%	1-100 ppm
Cyanides	CT	5 mg/m3	50 mg/m3	NC(3)	NR(4)
1,2-Dichloroethylene	PID	200 ppm	4,000 ppm	9.7%	275 ppm
Lead	NA(5)	0.15 mg/m3	NR	NR	NR
PAHs	NA	0.2 mg/m3	400 mg/m3	NR	No
PCBs (54% Chlorine)	NA	0.5 mg/m3	5 mg/m3	NC	NR
Trichloroethylene	PID	50 ppm	1,000 ppm	11%	10-120 ppm
Vinyl Cloride	PID/CT	1 ppm6	NR	3.6%	> 1,000 ppm
Zinc (Zinc Oxide Dust)	NA	5 mg/m3	NR	NR	NR

(1) Photoionization Detector

(2) Colorimetric Tube

(3) Not combustible.

(4) Not reported

(5) None Available

(6) Value is an ACGIH TLV.

health if they are not used properly. Decontamination solvents will not be used on-site since only dedicated sampling apparatus will be used. Material Safety Data Sheets for these sample processing compounds are included in Appendix B. Some or all of these compounds may be used in the tasks to be performed at the site.

2.2 Physical Hazards

2.2.1 Heat Stress

The use of protective equipment, if required, may create heat stress. Monitoring of personnel wearing personal protective clothing should commence when the ambient temperature is 70°F or above. Table 2 presents the suggested frequency for such monitoring. Monitoring frequency should increase as ambient temperature increases or as slow recovery rates are observed. Heat stress monitoring should be performed by a person with a current first aid certification who is trained to recognize heat stress symptoms. For monitoring the body's recuperative abilities to excess heat, one or more of the following techniques will be used. Other methods for determining heat stress monitoring, such as the wet bulb globe temperature (WBGT) Index from American Conference of Governmental Industrial Hygienist (ACGIH) TLV Booklet can be used.

To monitor the worker, measure:

- Heart rate. Count the radial pulse during a 30-second period as early as possible in the rest period.
- If the heart rate exceeds 100 beats per minute at the beginning of the rest period, shorten the next work cycle by one-third and keep the rest period the same.
- If the heart rate still exceeds 100 beats per minute at the next rest period, shorten the following work cycle by one-third.
- Oral temperature. Use a clinical thermometer (3 minutes under the tongue) or similar device to measure the oral temperature at the end of the work period (before drinking).
- If oral temperature exceeds 99.6°F (37.6°C), shorten the next work cycle by one-third without changing the rest period.
- If oral temperature still exceeds 99.6°F (37.6°C) at the beginning of the next rest period, shorten the following cycle by one-third.
- Do not permit a worker to wear a semipermeable or impermeable garment when oral temperature exceeds 100.6°F (38.1°C).

2.2.2 Prevention of Heat Stress

Proper training and preventative measures will aid in averting loss of worker productivity and serious illness. Heat stress prevention is particularly important because once a person suffers from heat stroke or heat exhaustion, that person may be predisposed to additional heat related illness. To avoid heat stress the following steps should be taken:

TABLE 2

SUGGESTED FREQUENCY OF PHYSIOLOGICAL MONITORING FOR FIT AND ACCLIMATIZED WORKERS[a]

Adjusted Temperature[b]	Normal Work Ensemble[c]	Impermeable Ensemble
90°F (32.2°C) or above	After each 45 minutes of work	After each 15 minutes of work
87.5°F -90°F (30.8° - 32.2°C)	After each 60 minutes of work	After each 30 minutes of work
82.5°F -87.5°F (28.1° - 30.8°C)		After each 60 minutes of work
77.5°F -82.5°F (25.3° - 28.1°C)		After each 90 minutes of work
72.5°F -77.5°F (22.5° - 25.3°C)		After each 120 minutes of work

[a] For work levels of 250 kilocalories/hour.

[b] Calculate the adjusted air temperature (ta adj) by using this equation: ta adj °F = ta °F + (13 x 5 sunshine). Measure air temperature (ta) with a standard mercury-in-glass thermometer, with the bulb shielded from radiant heat. Estimate percent sunshine by judging what percent time the sun is not covered by clouds that are thick enough to produce a shadow. (100 percent sunshine = no cloud cover and a sharp, distinct shadow; 0 percent sunshine = no shadows.)

[c] A normal ensemble consists of cotton overalls or other cotton clothing with long sleeves and pants.

- Adjust work schedules.
  - Modify work/rest schedules according to monitoring requirements.
  - Mandate work slowdowns as needed.
  - Perform work during cooler hours of the day if possible or at night if adequate lighting can be provided.
- Provide shelter (air-conditioned, if possible) or shaded areas to protect personnel during rest periods.
- Maintain worker's body fluids at normal levels. This is necessary to ensure that the cardiovascular system functions adequately. Daily fluid intake must approximately equal the amount of water lost in sweat, i.e., eight fluid ounces (0.23 liters) of water must be ingested for approximately every eight ounces (0.23 kg) of weight lost. The normal thirst mechanism is not sensitive enough to ensure that enough water will be drunk to replace lost sweat. When heavy sweating occurs, encourage the worker to drink more. The following strategies may be useful:
  - Maintain water temperature 50° to 60°F (10° to 16.6°C).
  - Provide small disposable cups that hold about four ounces (0.1 liter).
  - Have workers drink 16 ounces (0.5 liters) of fluid (preferably water or dilute drinks) before beginning work.
  - Urge workers to drink a cup or two every 15 to 20 minutes, or at each monitoring break. A total of 1 to 1.6 gallons (4 to 6 liters) of fluid per day are recommended, but more may be necessary to maintain body weight.
- Train workers to recognize the symptoms of heat related illness.

2.2.3 Cold-Related Illness

If work on this project begins in the winter months, thermal injury due to cold exposure can become a problem for field personnel. Systemic cold exposure is referred to as hypothermia. Local cold exposure is generally labeled frostbite.

Hypothermia. Hypothermia is defined as a decrease in the patient core temperature below 96°F. The body temperature is normally maintained by a combination of central (brain and spinal cord) and peripheral (skin and muscle) activity. Interferences with any of these mechanisms can result in hypothermia, even in the absence of what normally is considered a "cold" ambient temperature. Symptoms of hypothermia include: shivering, apathy, listlessness, sleepiness, and unconsciousness.

Frostbite. Frostbite is both a general and medical term given to areas of local cold injury. Unlike systemic hypothermia, frostbite rarely occurs unless the ambient temperatures are less than freezing and usually less than 20°F. Symptoms of frostbite are: a sudden blanching or whitening of the skin;

the skin has a waxy or white appearance and is firm to the touch; tissues are cold, pale, and solid.

2.2.4 Prevention of Cold Related Illness

- Educate workers to recognize the symptoms of frostbite and hypothermia
- Identify and limit known risk factors:
- Assure the availability of enclosed, heated environment on or adjacent to the site.
- Assure the availability of dry changes of clothing.
- Develop the capability for temperature recording at the site.
- Assure the availability of warm drinks.

Monitoring

Start (oral) temperature recording a the job site:

- At the Field Team Leader's discretion when suspicion is based on changes in a worker's performance or mental status.
- At a worker's request.
- As a screening measure, two times per shift, under unusually hazardous conditions (e.g., wind-chill less than 20°F, or wind-chill less than 30°F with precipitation).
- As a screening measure whenever any one worker on the site develops hypothermia.

Any person developing moderate hypothermia (a core temperature of 92°F) cannot return to work for 48 hours.

3. PERSONNEL PROTECTION AND MONITORING

3.1 Medical Surveillance

Engineering-Science will utilize the services of a licensed occupational health physician with knowledge and/or experience in the hazards associated with the project to provide the medical examinations and surveillance specified herein.

Personnel involved in this operation have undergone medical surveillance prior to employment at ES, and thereafter at 12-month intervals. The 12-month medical examination includes a complete medical and work history and a standard occupational physical, examination of all major organ systems, complete blood count with differential (CBC), and a SMAC/23 blood chemistry screen which includes calcium, phosphorous, glucose, uric acid, BUN, creatinine, albumin, SGPT, SGOT, LDH, globulin, A/G ratio, alkaline phosphates, total protein, total bilirubin, triglyceride, cholesterol, and a creatinine/BUN ratio. Additionally a pulmonary function test will be performed by trained personnel to record Forced Vital Capacity (FVC) and Forced Expiratory Volume in second ($FEV_{1.0}$). An audiogram and visual acuity measurement, including color perception, is provided. The medical exam is performed under the direction of a licensed Occupational Health Physician. A medical certification as to the fitness or unfitness for employment on hazardous waste projects, or any restrictions on his/her utilization that may be indicated, is provided by the physician. This evaluation will be repeated as indicated by substandard performance or evidence of particular stress that is evident by injury or time loss illness on the part of any worker.

3.2 Site Specific Training

The Site Health and Safety Officer will be responsible for developing a site specific occupational hazard training program and providing training to all ES personnel that are to work at the site. This training will consist of the following topics:

- Names of personnel responsible for site safety and health.
- Safety, health, and other hazards at the site.
- Proper use of personal protective equipment.
- Work practices by which the employee can minimize risk from hazards.
- Safe use of engineering controls and equipment on the site.
- Acute effects of compounds at the site.
- Decontamination procedures.

3.3 Personal Protective Equipment and Action Levels

3.3.1 Conditions for Level D

Level D protection will be worn for initial entry on-site and initially for all activities. Level D protection will consist of:

- Coveralls
- Safety boots
- Nitrile outer and PVC inner gloves (must be worn during all sampling activities)
- Hard hat (must be worn during drilling activities)
- Splash goggles (must be worn if a splash hazard is present)
- 5-minute escape SCBA

3.3.2 Conditions for Level C

If any exposure limit is exceeded the personnel will retreat.

3.4 Monitoring Requirements

Monitoring for organic vapors in the breathing zone will be conducted with a Photovac-TIP II photoionization detector. A Draeger bellows equipped with the appropriate tubes will be used to monitor for cyanide. Readings will be taken under the following circumstances.

- Upon initial entry onto the site.
- When weather conditions change.
- When work begins on another portion of the site.

Specific monitoring for carcinogenic compounds, namely vinyl chloride and benzene, will not be conducted because of the remote chance that these compounds could be present in significant quantity. Because of the volatility of these compounds, the long period of time (50+ years) since MGP operations ceased, and the fact that only non-intrusive sampling will be practiced, no measurable quantity of these compounds is expected. Furthermore, the subsurface structures in which air will be sampled are distant from the site of actual plant operations. Specific monitoring for vinyl chloride, benzene or other compounds is therefore not considered necessary beyond normal PID screening.

4. WORK ZONES AND DECONTAMINATION

4.1 Site Work Zones

To reduce the spread of hazardous materials by workers from the contaminated areas to the clean areas, zones will be delineated at the site. The flow of personnel between the zones should be controlled. The establishment of the work zones will help ensure that personnel are properly protected against the hazards present where they are working, work activities and contamination are confined to the appropriate areas, and personnel can be located and evacuated in an emergency.

4.1.1 Exclusion Zone

Exclusion zones will be established at the site during any activity when Level C protection is established as a result of conditions discussed in Section 3. Unprotected onlookers should be located 50 feet upwind of drilling or soil sampling activities. In the event that volatile organics are detected in the breathing zone as discussed in Section 3, all personnel within the exclusion zone must don Level C protection.

All personnel within the exclusion zone will be required to use the specified level of protection. No food, drink, or smoking will be allowed in the exclusion or decontamination zones.

4.1.2 Decontamination Zone

Should it be necessary to establish an exclusion zone, the decontamination zone will be utilized. This zone will be established between the exclusion zone and the support zone, and will include the personnel and equipment necessary for decontamination of equipment and personnel (discussed below). Personnel and equipment in the exclusion zone must pass through this zone before entering the support zone. This zone should always be located upwind of the exclusion zone.

4.1.3 Support Zone

The support zone will include the remaining areas of the job site. Break areas, operational direction and support facilities (to include supplies, equipment storage and maintenance areas) will be located in this area. No equipment or personnel will be permitted to enter the support zone from the exclusion zone without passing through the personnel or equipment decontamination station. Eating, smoking, and drinking will be allowed only in this area.

4.2 Decontamination

Due to the low level of contaminants expected, any water used will be disposed of on-site.

4.2.1 Decontamination of Personnel

Decontamination will not be necessary if only Level D protection is used. However, disposable gloves used during sampling activities should be removed and bagged; personnel should be encouraged to remove clothing and shower as soon as is practicable at the end of the day. All clothing should be machine-washed. All personnel will wash hands and face prior to eating and before and after using the restroom.

4.2.2 Decontamination of Equipment

Only dedicated sampling equipment will be used at each site (i.e. decontamination of equipment will not take place on-site, enough sampling equipment will be utilized to collect all samples in a single round of sampling).

Equipment decontamination will take place off-site and will consist of steam cleaning or successive rinses of clean water, alconox solution, clean water, methanol and clean water.

5. SAMPLE SHIPMENT

Samples collected in this study, with the exception of any drum samples, tank samples, or other concentrated wastes, will be classified as research samples. In general, samples collected from streams, ponds, or wells and are not expected to be grossly contaminated with high levels of hazardous materials.

The sample tag will be legibly written and completed with an indelible pencil or waterproof ink. The information will also be recorded in a log book. As a minimum, it will include:

- Exact location of sample
- Time and date sample was collected
- Name of sampler witnesses (if necessary)
- Project codes, sample station number, and identifying code (if applicable.
- Type of sample (if known)
- Tag number (if sequential tag system is used)

- Laboratory number (if applicable)
- Any other pertinent information (CFR 40 261.4)

Info to accompany samples:

1) Sample collectors name, address, phone
2) Laboratory name, address, phone
3) Quantity of sample
4) Date of shipment
5) Description of sample, (ie) Research sample-soil, Research sample-water

5.1 Environmental Samples

Environmental samples will be packaged and shipped according to the following procedure:

Packaging

1. Place sample container, properly identified as research samples and with a sealed lid, in a polyethylene bag, and seal bag;
2. Place sample in a fiberboard container or metal picnic cooler which has been lined with a large polyethylene bag.
3. Pack with enough noncombustible, absorbent, cushioning material to minimize the possibility of the container breaking.
4. Seal large bag.
5. Seal or close outside container

Marking/Labeling

Sample containers must have a completed sample identification tag and the outside container must be marked "Research Sample". The appropriate side of the container must be marked "This End Up" and arrows should be drawn accordingly. No DOT marking labeling is required.

Shipping Papers

No DOT shipping papers are required.

Transportation

There are no DOT restrictions on mode of transportation.

5.2 Hazardous Samples

Drum samples, tank samples, sludge samples, and grossly contaminated soil samples will be shipped as DOT Hazardous Materials. The designation "Flammable Liquid" or "Flammable Solid" will be used. The samples will be transported as follows:

1. Collect sample in a 16-ounce or smaller glass or polyethylene container with nonmetallic teflon-lined screw cap. Allow sufficient air space (approximately 10% by volume) so container is not liquid full at 54 °C (130 °F). If collecting a solid material, the container plus contents should not exceed 1 pound net weight. if sampling for volatile organic analysis, fill VOA container to septum but place the VOA container inside a 16-ounce or smaller container so the required air space may be provided. large quantities, up to 3.786 liters (1 gallon), may be collected if the sample's flash point is 23 °C (75 °F) or higher. In this case, the flash point must be marked on the outside container (e.g., carton, cooler), and shipping papers should state that "Flash point is 73 °F or higher."
2. Seal sample and place in a 4-mil-thick polyethylene bag, one sample per bag.
3. Place sealed bag inside a metal can with noncombustible, absorbent cushioning material (e.g., vermiculite or earth) to prevent breakage, one bag per can. Pressure-close the can and use clips, tape or other positive means to hold the lid securely.
4. Mark the can with:

   Name and address of originator

   "Flammable Liquid N.O.S. UN 1993"

   (or "Flammable Solid N.O.S. UN 1325)

   NOTE: UN numbers are now required in proper shipping names.
5. Place one or more metal cans in a strong outside container such as a picnic cooler or fiberboard box. Preservatives are not used for hazardous waste site samples.
6. Prepare for shipping:

   "Flammable Liquid, N.O.S. UN 1993" or "Flammable Solid, N.O.S. UN 1325"; "Cargo Aircraft Only (if more than 1 quart net per outside package); "Limited Quantity" or "Ltd. Qty."; "Laboratory Samples"; "Net Weight ~" or "Net Volume ~" (of hazardous contents) should be indicated on shipping papers and on outside of shipping container. "This Side Up" or "This End Up" should also be on container. Sign shipper certification.
7. Stand by for possible carrier requests to open outside containers for inspection or modify packaging. It is wise to contact carrier before packing to ascertain local packaging requirements and not to leave area before the carrier vehicle (aircraft, truck) is on its way.

6. ACCIDENT PREVENTION AND CONTINGENCY PLAN

6.1 Accident Prevention

All field personnel will receive health and safety training as required by 29 CFR 1910.120 prior to the initiation of any site activities. On a day-to-day basis, individual personnel should be constantly alert for indicators of potentially hazardous situations and for signs and symptoms in themselves and others that warn of hazardous conditions and exposures. Rapid recognition of dangerous situations can avert an emergency. Before daily work assignments, regular meeting should be held. Discussion should include:

- Tasks to be performed.
- Time constraints (e.g., rest breaks, cartridge changes).
- Hazards that may be encountered, including their effects, how to recognize symptoms or monitor them, concentration limits, or other danger signals.
- Emergency procedures.

6.2 Contingency Plan

6.2.1 Emergency Procedures

In the event that an emergency develops on site, the procedures delineated herein are to be immediately followed. Emergency conditions are considered to exist if:

- Any member of the field crew is involved in an accident or experiences any adverse effects or symptoms of exposure while on site.
- A condition is discovered that suggests the existence of a situation more hazardous than anticipated.

General emergency procedures, and specific procedures for personal injury and chemical exposure, are described in the health and safety plan.

6.2.2 Chemical Exposure

If a member of the field crew demonstrates symptoms of chemical exposure the procedures outlined below should be followed:

- Another team member (buddy) should remove the individual from the immediate area of contamination. The buddy should communicate to the Field Team Leader (via voice and hand signals) of the chemical exposure. The Field Team Leader should contact the appropriate emergency response agency.
- Precautions should be taken to avoid exposure of other individuals to the chemical.
- If the chemical is on the individual's clothing, the chemical should be neutralized or removed if it is safe to do so.
- If the chemical has contacted the skin, the skin should be washed with copious amounts of water.
- In case of eye contact, an emergency eye wash should be used. Eyes should be washed for at least 15 minutes.

- All chemical exposure incidents must be reported in writing to the Office Health and Safety Representative. The Site Health and Safety Officer or Field Team Leader is responsible for completing the accident report.

6.2.3 Personal Injury

In case of personal injury at the site, the following procedures should be followed:

- Another team member (buddy) should signal the Field Team Leader that an injury has occurred.
- A field team member trained in first aid can administer treatment to an injured worker.
- The victim should then be transported to the nearest hospital or medical center. If necessary, an ambulance should be called to transport the victim.
- For less severe cases, the individual can be taken to the site dispensary.
- The Field Team Leader or Site Health and Safety Officer is responsible for making certain that an accident report form is completed. This form is to be submitted to the Office Health and Safety Representative. Follow-up action should be taken to correct the situation that caused the accident.

6.2.4 Evacuation Procedures

- The Field Team Leader will initiate evacuation procedure by signalling to leave the site.
- All personnel in the work area should evacuate the area and meet in the common designated area.
- All personnel suspected to be in or near the contract work area should be accounted for and the whereabouts or missing persons determined immediately.
- Further instruction will then be given by the Field Team Leader.

6.2.5 Procedures Implemented in the Event of a Major Fire, Explosion, or On-Site Health Emergency Crisis

- Notify the paramedics and/or fire department, as necessary;
- Signal the evacuation procedure previously outlined and implement the entire procedure;
- Isolate the area;
- Stay upwind of any fire;
- Keep the area surrounding the problem source clear after the incident occurs;
- Complete accident report for and distribute to appropriate personnel.

APPENDIX A

HEALTH AND SAFETY PLAN ACCEPTANCE FORM

PLAN ACCEPTANCE FORM

PROJECT HEALTH AND SAFETY PLAN

I have read and agree to abide by the contents of the Health and Safety Plan for the following project:

NYSEG - Norwich

W. Lilley
Name (print)

W Lilley
Signature

11/30/90
Date

Return to Office Health and Safety Representative <u>before</u> starting to work on subject project work site.

APPENDIX B

MATERIAL SAFETY DATA SHEETS

File 1; Entry 1; Accession No. 132015

J.T.BAKER INC. 222 RED SCHOOL LANE, PHILLIPSBURG, NJ 08865

MATERIAL SAFETY DATA SHEET

24-HOUR EMERGENCY TELEPHONE -- (201) 859-2151

M2015 -05
EFFECTIVE: 09/14/87
0/27/87

METHANOL

ISSUED: 1

SECTION I - PRODUCT IDENTIFICATION

PRODUCT NAME: METHANOL
FORMULA: CH_3OH
FORMULA WT: 32.04
CAS NO.: 67-56-1
NIOSH/RTECS NO.: PC1400000
COMMON SYNONYMS: METHYL ALCOHOL; WOOD ALCOHOL; CARBINOL; METHYLOL; WOOD SPIRIT
PRODUCT CODES: 9049,9072,9075,9076,9071,5217,9074,P704,9093,5536,9068,9073
9091,9263,9069,9070,5370,9127

PRECAUTIONARY LABELLING

BAKER SAF-T-DATA(TM) SYSTEM

HEALTH - 3 SEVERE (POISON)
FLAMMABILITY - 3 SEVERE (FLAMMABLE)
REACTIVITY - 1 SLIGHT
CONTACT - 1 SLIGHT
HAZARD RATINGS ARE 0 TO 4 (0 = NO HAZARD; 4 = EXTREME HAZARD).

LABORATORY PROTECTIVE EQUIPMENT

GOGGLES & SHIELD; LAB COAT & APRON; VENT HOOD; PROPER GLOVES; CLASS B EXTINGUISHER

PRECAUTIONARY LABEL STATEMENTS

POISON DANGER
FLAMMABLE
HARMFUL IF INHALED
CANNOT BE MADE NON-POISONOUS

MAY BE FATAL OR CAUSE BLINDNESS IF SWALLOWED
KEEP AWAY FROM HEAT, SPARKS, FLAME. DO NOT GET IN EYES, ON SKIN, ON CLOTHING.
AVOID BREATHING VAPOR. KEEP IN TIGHTLY CLOSED CONTAINER. USE WITH ADEQUATE VENTILATION. WASH THOROUGHLY AFTER HANDLING. IN CASE OF FIRE,

USE ALCOHOL FOAM, DRY CHEMICAL, CARBON DIOXIDE - WATER MAY BE INEFFECTIVE.
FLUSH SPILL AREA WITH WATER SPRAY.

SAF-T-DATA(TM) STORAGE COLOR CODE: RED (FLAMMABLE)

==

SECTION II - HAZARDOUS COMPONENTS

==

COMPONENT	%	CAS NO.
METHANOL	90-100	67-56-1

==

SECTION III - PHYSICAL DATA

==

BOILING POINT: 65 C (149 F)
VAPOR PRESSURE(MM HG): 96

MELTING POINT: -98 C (-144 F)
VAPOR DENSITY(AIR=1): 1.11

SPECIFIC GRAVITY: 0.79 (H2O=1)
EVAPORATION RATE: 4.6 (BUTYL ACETATE=1)

SOLUBILITY(H2O): COMPLETE (IN ALL PROPORTIONS)
% VOLATILES BY VOLUME: 100

APPEARANCE & ODOR: CLEAR, COLORLESS LIQUID WITH CHARACTERISTIC PUNGENT ODOR.

==

SECTION IV - FIRE AND EXPLOSION HAZARD DATA

==

FLASH POINT (CLOSED CUP 12 C (54 F)
NFPA 704M RATING: 1-3-0

FLAMMABLE LIMITS: UPPER - 36.0 % LOWER - 6.0 %

FIRE EXTINGUISHING MEDIA

USE ALCOHOL FOAM, DRY CHEMICAL OR CARBON DIOXIDE.
(WATER MAY BE INEFFECTIVE.)

SPECIAL FIRE-FIGHTING PROCEDURES

FIREFIGHTERS SHOULD WEAR PROPER PROTECTIVE EQUIPMENT AND SELF-CONTAINED BREATHING APPARATUS WITH FULL FACEPIECE OPERATED IN POSITIVE PRESSURE MODE.
MOVE CONTAINERS FROM FIRE AREA IF IT CAN BE DONE WITHOUT RISK. USE WATER TO KEEP FIRE-EXPOSED CONTAINERS COOL.

UNUSUAL FIRE & EXPLOSION HAZARDS

VAPORS MAY FLOW ALONG SURFACES TO DISTANT IGNITION SOURCES AND FLASH BACK.
CLOSED CONTAINERS EXPOSED TO HEAT MAY EXPLODE. CONTACT WITH STRONG OXIDIZERS MAY CAUSE FIRE.
BURNS WITH A CLEAR, ALMOST INVISIBLE FLAME.

TOXIC GASES PRODUCED

CARBON MONOXIDE, CARBON DIOXIDE, FORMALDEHYDE

SECTION V - HEALTH HAZARD DATA

TLV LISTED DENOTES (TLV-SKIN).

THRESHOLD LIMIT VALUE (TLV/TWA): 260 MG/M3 (200 PPM)

SHORT-TERM EXPOSURE LIMIT (STEL): 310 MG/M3 (250 PPM)

PERMISSIBLE EXPOSURE LIMIT (PEL): 260 MG/M3 (200 PPM)

TOXICITY: LD50 (ORAL-RAT)(MG/KG) - 5628
LD50 (IPR-RAT)(MG/KG) - 9540

LD50 (SCU-MOUSE)(MG/KG) - 9800
LD50 (SKN-RABBIT) (G/KG) - 20

CARCINOGENICITY: NTP: NO IARC: NO Z LIST: NO OSHA REG: NO

EFFECTS OF OVEREXPOSURE

INHALATION AND INGESTION ARE HARMFUL AND MAY BE FATAL.
INHALATION MAY CAUSE HEADACHE, NAUSEA, VOMITING, DIZZINESS, NARCOSIS,

AIR PURIFYING

RESPIRATOR LOG

SITE: ______________________________

LOCATION: ___________________________

DATES OF INVESTIGATION: ____________

User	Date of Use	Cleaned and Inspected Prior To Use (Initials)	Cartridges Changed Prior to Use (Yes, NO, N/A)	Total Hours on Cartridge

____

Site Health and Safety Officer or
ES Project Manager

Date

Return to Office Health and Safety Representative at the completion of field activities.

APPENDIX C

RESPIRATORY USAGE LOG

SECTION VII - SPILL AND DISPOSAL PROCEDURES

STEPS TO BE TAKEN IN THE EVENT OF A SPILL OR DISCHARGE

WEAR SELF-CONTAINED BREATHING APPARATUS AND FULL PROTECTIVE CLOTHING. SHUT OFF IGNITION SOURCES; NO FLARES, SMOKING OR FLAMES IN AREA. STOP LEAK IF YOU CAN DO SO WITHOUT RISK. USE WATER SPRAY TO REDUCE VAPORS. TAKE UP WITH SAND OR OTHER NON-COMBUSTIBLE ABSORBENT MATERIAL AND PLACE INTO CONTAINER FOR LATER DISPOSAL. FLUSH AREA WITH WATER.

J. T. BAKER SOLUSORB(R) SOLVENT ADSORBENT IS RECOMMENDED FOR SPILLS OF THIS PRODUCT.

DISPOSAL PROCEDURE

DISPOSE IN ACCORDANCE WITH ALL APPLICABLE FEDERAL, STATE, AND LOCAL ENVIRONMENTAL REGULATIONS.

EPA HAZARDOUS WASTE NUMBER: U154 (TOXIC WASTE)

SECTION VIII - PROTECTIVE EQUIPMENT

VENTILATION: USE GENERAL OR LOCAL EXHAUST VENTILATION TO MEET TLV REQUIREMENTS.

RESPIRATORY PROTECTION: RESPIRATORY PROTECTION REQUIRED IF AIRBORNE CONCENTRATION EXCEEDS TLV. AT CONCENTRATIONS ABOVE 200 PPM, A SELF-CONTAINED BREATHING APPARATUS IS ADVISED.

EYE/SKIN PROTECTION: SAFETY GOGGLES AND FACE SHIELD, UNIFORM, PROTECTIVE SUIT, RUBBER GLOVES ARE RECOMMENDED.

SECTION IX - STORAGE AND HANDLING PRECAUTIONS

SAF-T-DATA(TM) STORAGE COLOR CODE: RED (FLAMMABLE)

SPECIAL PRECAUTIONS

BOND AND GROUND CONTAINERS WHEN TRANSFERRING LIQUID. KEEP CONTAINER TIGHTLY CLOSED. STORE IN A COOL, DRY, WELL-VENTILATED, FLAMMABLE LIQUID STORAGE AREA.

SUFFOCATION, LOWER BLOOD PRESSURE, CENTRAL NERVOUS SYSTEM DEPRESSION.
LIQUID MAY BE IRRITATING TO SKIN AND EYES. PROLONGED SKIN CONTACT MAY

RESULT IN DERMATITIS. EYE CONTACT MAY RESULT IN TEMPORARY CORNEAL DAMAGE.
INGESTION MAY CAUSE BLINDNESS.
INGESTION MAY CAUSE NAUSEA, VOMITING, HEADACHES, DIZZINESS,
GASTROINTESTINAL IRRITATION, CENTRAL NERVOUS SYSTEM DEPRESSION AND
HEARING LOSS.
CHRONIC EFFECTS OF OVEREXPOSURE MAY INCLUDE KIDNEY AND/OR LIVER DAMAGE.

TARGET ORGANS

EYES, SKIN, CENTRAL NERVOUS SYSTEM, GI TRACT, RESPIRATORY SYSTEM, LUNGS

MEDICAL CONDITIONS GENERALLY AGGRAVATED BY EXPOSURE

EYE DISORDERS, SKIN DISORDERS, LIVER OR KIDNEY DISORDERS

ROUTES OF ENTRY

INHALATION, INGESTION, EYE CONTACT, SKIN CONTACT, ABSORPTION

EMERGENCY AND FIRST AID PROCEDURES

CALL A PHYSICIAN.
IF SWALLOWED, IF CONSCIOUS, GIVE LARGE AMOUNTS OF WATER. INDUCE VOMITING.
IF INHALED, REMOVE TO FRESH AIR. IF NOT BREATHING, GIVE ARTIFICIAL
RESPIRATION. IF BREATHING IS DIFFICULT, GIVE OXYGEN.
IN CASE OF CONTACT, IMMEDIATELY FLUSH EYES OR SKIN WITH PLENTY OF WATER FOR
AT LEAST 15 MINUTES WHILE REMOVING CONTAMINATED CLOTHING AND SHOES.
WASH CLOTHING BEFORE RE-USE.

==

SECTION VI - REACTIVITY DATA

==

STABILITY: STABLE HAZARDOUS POLYMERIZATION: WILL NOT OCCUR

CONDITIONS TO AVOID: HEAT, FLAME, OTHER SOURCES OF IGNITION

INCOMPATIBLES: STRONG OXIDIZING AGENTS, STRONG ACIDS, ZINC, ALUMINUM,
MAGNESIUM

DECOMPOSITION PRODUCTS: CARBON MONOXIDE, CARBON DIOXIDE, FORMALDEHYDE

==

APPENDIX B

QUALITY ASSURANCE PLAN

QUALITY ASSURANCE PROJECT PLAN

for the

INVESTIGATION OF A FORMER MANUFACTURED GAS PLANT SITE
NORWICH, N.Y.

Prepared For

NEW YORK STATE ELECTRIC AND GAS CORPORATION

Prepared by

ENGINEERING-SCIENCE, INC.
290 ELWOOD DAVIS ROAD, SUITE 312
LIVERPOOL, NEW YORK 13088

SECTION 1

TITLE PAGE

QUALITY ASSURANCE PROJECT PLAN
for the
INVESTIGATION OF A FORMER MANUFACTURED GAS PLANT SITE NORWICH, N.Y.

Prepared for

NEW YORK STATE ELECTRIC AND GAS CORPORATION

Prepared By:

ENGINEERING-SCIENCE
290 ELWOOD DAVIS ROAD, LIVERPOOL, NY 13088

CLIENT:	New York State Electric and Gas		
LOCATION:	Binghamton, New York		
CONTRACT NO.:			
Approved By: (Project Manager)	G.H. Moreau (Name)	GH Moreau (Signature)	9/5/91 (Date)
Approved By: (NYSEG Project Manager)	J.C. Hylind (Name)	(Signature)	(Date)
Approved By:	K.E. Leonard (Name)	K.E. Leonard (Signature)	9/5/91 (Date)

SECTION 2
TABLE OF CONTENTS

TABLE OF CONTENTS
(CONTINUED)

TABLE OF CONTENTS
(CONTINUED)

LIST OF TABLES

LIST OF FIGURES

SECTION 3

PROJECT DESCRIPTION

3.1 INTRODUCTION

NYSEG wishes to take a responsible approach in addressing threats associated with past MGP operations by undertaking a site investigation at the former MGP site in Norwich, N.Y. This program will involve data compilation, field sampling and inspection at the site, followed by a Preliminary Risk Assessment. The field sampling program will be focused on characterizing and, to the extent possible, quantifying possible exposure pathways at the site.

3.2 OBJECTIVES

The goal of the program is to determine the extent of residue by-products in the environment relating to the operation of the former manufactured gas plant and determine if the residue presents a potential significant threat to human health or the environment.

3.3 SCOPE OF WORK

The scope of work consists of a series of investigative activities as follows:

Task II.A - Expanded Historical Search
Task II.B - Geophysical Investigation
Task II.C - Soil Investigation
Task II.D - Hydrogeologic Investigation
Task II.E - Groundwater Investigation
Task II.F - Indoor Air Sampling
Task II.G - Preliminary Risk Assessment

These activities parts are described in the project Work Plan which also provides site-specific information for the Norwich, New York site. The site specific information includes information on the site location, size, history, and the number, location, and rationale for collection of samples.

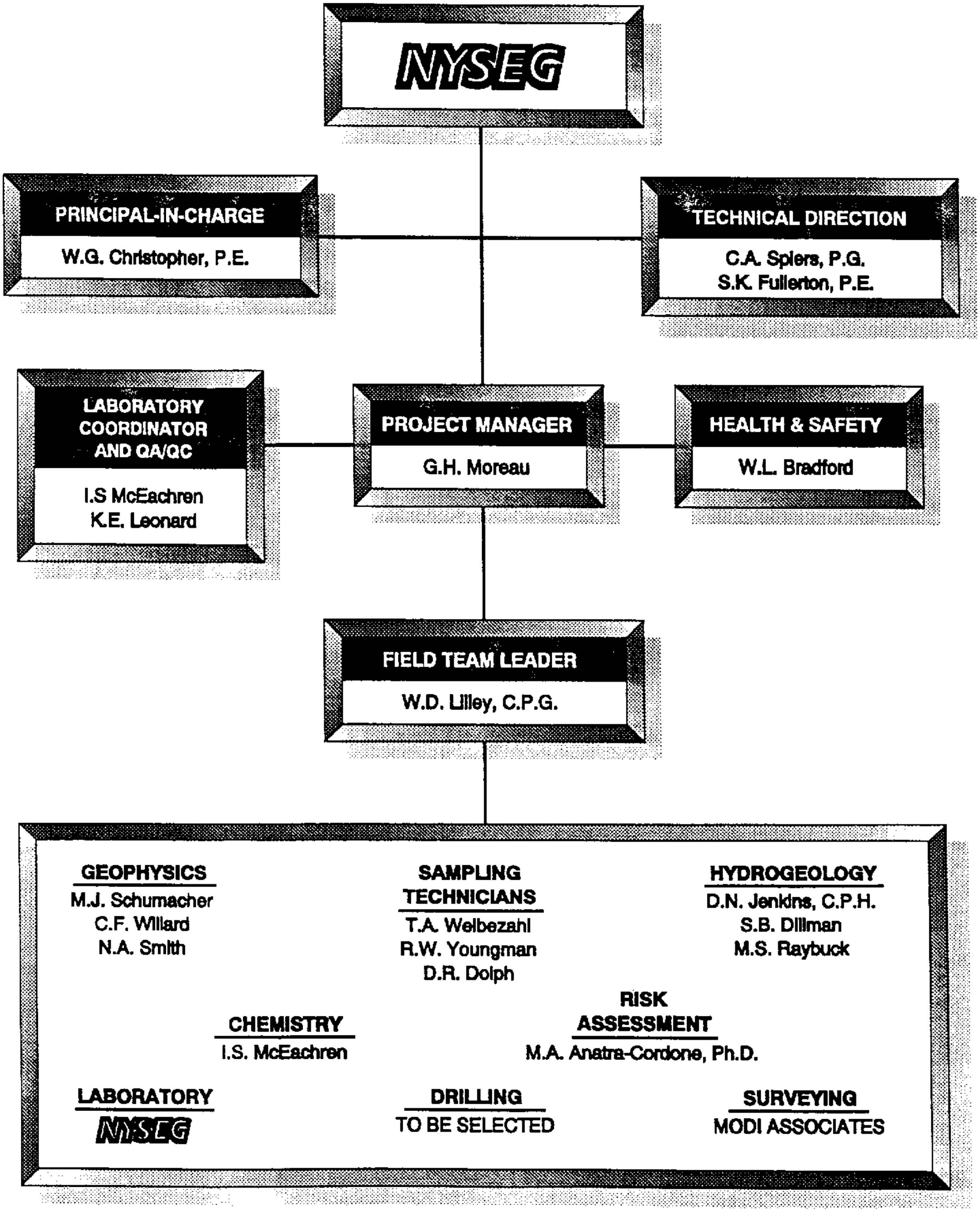
SECTION 4

PROJECT ORGANIZATION

The organization of the project management team and areas of responsibility are shown in Figure 4.1. Specific responsibilities for each key member of the project management team are described in the Management Plan for the project which is available in ES files.

FIGURE 4.1

PROJECT ORGANIZATION CHART



SECTION 5

QA/QC OBJECTIVES FOR MEASUREMENT OF DATA

The quality assurance/quality control objectives for all measurement data include representativeness, completeness, comparability, precision, and accuracy. The QA objectives for each of these areas in relation to the operation of field instrumentation are summarized on Table 5.1. Quality Assurance Procedures for the field instruments are presented in Table 5.2. QA objectives related the laboratory chemical analysis are discussed below.

5.1 REPRESENTATIVENESS

Samples taken must be representative of the population, and where appropriate, the population will be characterized statistically to express the degree to which the data accurately and precisely represent a characteristic of a population, parameter variations at a sampling point, a process, or environmental condition.

Sampling devices will be precleaned before entering a site by steam cleaning or by rinsing successively with Alconox detergent/water, tap water, methanol and a final rinse with distilled water. Decontamination will not take place on-site, enough precleaned (dedicated) sampling equipment will be brought to the site to allow collection of all samples.

Two types of field "blanks" will be collected at each site and submitted to the laboratory for analysis as follows:

> Trip Blank - A trip blank will be prepared by the laboratory before the sample bottles are sent to the site. It consists of a sample of deionized water which accompanies the other sample bottles into the field and back to the laboratory. A trip blank will be included where sampling and analysis of aqueous samples for TCL volatiles is planned. The trip blank will be analyzed daily for TCL volatile organic compounds as a measure of the internal laboratory procedures and shipping effects on the sample integrity.
>
> Wash (or sampler) Blank - To determine the effectiveness of the decontamination procedures for sampling equipment, one wash blank will be collected per 20 samples. It is a sample of deionized water, provided by the laboratory, which has passed through a decontaminated bailer or other sampling apparatus. It is usually collected as a last step in the decontamination procedure. The wash blank will be analyzed for the same parameters as the field samples.

All samples will be packed with ice in coolers and shipped via overnight delivery to the analytical laboratory.

TABLE 5.1

QA OBJECTIVES FOR FIELD INSTRUMENTS

	Parameter			
Objective	**pH**	**Temperature**	**Specific Conductivity**	**Photovac Tip**
Precision(1)	0.1 units	0.1 Degree	±15%	1 ppm
Accuracy scale	±0.05 units	0.5 Degree	±5% of Standard	±1% of the meter
Completeness	90%	90%	90%	90%
Representativeness	Field measurement of field blanks and duplicates(2)			
Comparability	Field measurement of duplicate samples(2)			

(1) Precision will be evaluated by calcuation and comparison of standard deviation.

(2) One duplicate sample per site.

TABLE 5.2
QUALITY ASSURANCE PROCEDURES FOR FIELD ANALYSIS AND EQUIPMENT

Parameter	General	Daily	Quarterly
1. **pH** Electrode Method	Enter the make, model, serial and/or ID number for each meter in a log book.	1. Calibrate the system against standard buffer solution of known pH value at the start of a sampling run. 2. Periodically check the buffers during the sample run and record the data in the log sheet or book. 3. Be on the alert for erratic meter response arising from weak batteries, cracked electrode, fouling, etc. 4. Check response and linearity following highly acidic or alkaline samples. Allow additional time for equilibration. 5. Check against the closest reference solution each time a violation is found. 6. Rinse electrodes thoroughly between samples and after calibration. 7. Recalibrate after every 5 to 10 samples or after very high or low readings.	Take all meters to the laboratory for maintenance, calibration and quality control checks.

TABLE 5.2--CONTINUED
QUALITY ASSURANCE PROCEDURES FOR FIELD ANALYSIS AND EQUIPMENT

Parameter	General	Daily	Quarterly
2. CONDUCTIVITY	Enter the make, model, serial and/or ID number for each meter in a log book.	1. Standardize with KCl standards having similar specific conductance values to those anticipated in the samples. Calculate the cell constant using two different standards. Cell Constant $= \frac{\text{Standard Value}}{\text{Actual Value}}$ Specific Conductance = Reading multiplied by Cell Constant 2. Rinse cell after each sample to prevent carryover. 3. Recalibrate after very high or low readings or after every 5 to 10 samples.	1. Take all meters to lab for maintenance, calibration and quality control checks. 2. Check temperature compensation. 3. Check date of last platinizing and replatinize if necessary. 4. Analyze NBS or EPA reference standard and record actual vs. observed readings in the log.
3. TIP-II*	Enter make, model and serial number for each instrument in a log book.	1. Zero instrument with span knob set on "5" well upwind of site. 2. Fill calibration bag and calibrate instrument with 100 ppm isobutylene. 3. If "low bat" indicator appears, recharge 16 hours. 4. Recalibrate at mid-day and at the end of the day.	Take all instruments to the laboratory for maintenance, calibration, and quality control checks.

---

*Total ionizables present.

Adapted from "Handbook for Sampling and Sample Preservation of Water and Wastewater," EPA 600/4-82-029, September 1982.

To assess the representativeness of the sample collection procedures, one sample per 20 field samples will be collected in duplicate. One of the duplicates will be given a "coded" or false sample identifier, and both it and the original sample will be analyzed. Comparisons of the results from the original sample and its coded field duplicate will allow for an evaluation of the representativeness of the sampling methods.

5.2 COMPLETENESS

The analyses performed must be appropriate and inclusive. The parameters selected for analysis were chosen to meet the objectives of the study.

Completeness of the analyses will be assessed by comparing the number of parameters intended to be analyzed with the number of parameters successfully determined and validated. The project objectives are to achieve 95% completeness for laboratory data and 90% for field data.

5.3 COMPARABILITY

Consistency in the acquisition, preparation, handling, and analysis of samples is necessary in order for the results to be compared where appropriate. Additionally, the results obtained from analyses of the samples will be compared with the results obtained in previous studies, if available.

To ensure the comparability of analytical results with those obtained in previous or future testing, all samples will be analyzed by USEPA-approved methods. The method-specific holding times for various analyses will be strictly adhered to.

5.4 PRECISION AND ACCURACY

The validity of the data produced will be assessed for precision and accuracy. Analytical methods which will be used may include gas chromatography/mass spectrometry (GC/MS), gas chromatography (GC), calorimetry, atomic absorption spectroscopy (AAS), and gravimetric and titrametric techniques. The following outlines the procedures for evaluating precision and accuracy, routine monitoring procedures, and corrective actions to maintain analytical quality control.

The requirements of QA/QC are both method-specific and matrix-dependent. The procedures to be used are described on this basis in Sections 8 and 11. The number of duplicate, spiked, and blank samples analyzed will be dependent upon the total number of samples of each matrix to be analyzed. The inclusion and frequency of analysis of field blanks, trip blanks, and duplicate samples will be on the order of one of each type per site.

Quality assurance audit samples will be prepared and submitted by the laboratory QA manager when required by the analytical method. The degree of accuracy and the recovery of analyte to be expected for the analysis of QA samples and spiked samples is dependent upon the matrix, method of analysis, and compound or element being determined. The concentration of the analyte relative to the detection limit is also a major factor in determining the accuracy of the measurement. The lower end of the analytical range for most analyses is generally accepted to be five times the detection limit. At or above this level, the determination of spike recoveries for metals in water samples will be expected to range from 75 to 125 percent. The recovery of organic surrogate compounds and matrix spiking compounds determined by GC/MS will be compared to the guidelines for recovery of individual compounds as established by the applicable USEPA method protocol.

The quality of results obtained for inorganic ion parameters will be assessed by comparison of QC data with laboratory control charts for each test as applicable.

SECTION 6

SAMPLING PROCEDURES

6.1 INTRODUCTION

Representative sampling of soil, groundwater and air will be conducted as described in the project work plan. Additional activities that may not be in the Work Plan are included herein in case additional activities are added during the investigation. The sampling program has been developed for these investigations to provide data necessary to identify the extent and severity of environmental contamination and to determineor contact with contaminated media. All samples will be handled in accordance with the site-specific Health and Safety Plan and this Quality Assurance Project Plan.

The number of samples collected, the type of container and the sample preservation method depends upon the sample matrix and the analytical parameters desired. The required sample preservation and analytical holding times for water and soil samples will be consistent with those required by the USEPA methods. These holding times, unless otherwise noted, apply to verified time of sample receipt by the analytical laboratory.

The necessary sample containers and preservatives will be provided by the laboratory. Water samples for volatile organic analysis will be collected in glass vials with no air bubbles remaining. Sample labels will be affixed to all containers to identify the sample identification number, the date of collection and any sample preservatives.

After the bottles for a given sample location have been filled, they will be placed in a shipping cooler. Samples requiring cooling (4°C) will be covered with crushed ice in plastic bags or ice packs. Containers will be packed carefully in the cooler to prevent breakage. Each cooler will then be sealed for overnight shipment to the laboratory.

A chain of custody record will be filled out and shall accompany each sample to provide documentation and to track sample possession. Chain of custody procedures are discussed in Section 7.

The following parameters will be measured in the field for water samples: pH, temperature and specific conductivity. Temperature will be measured immediately upon sample collection, as it is subject to the most rapid change. Conductivity and pH will be measured with electronic probes, which will be rinsed with distilled water between each sample.

6.2 SURFACE SOIL SAMPLES

The surface soil samples will be collected from the top six inches of soil using a bucket auger or stainless steel spatula or deeper with a split spoon sampler which has been decontaminated with Alconox detergent/water, tap water, methanol and final rinse with distilled water. The sampling location and sample description will be recorded on the Field Surface Sample Record (Figure 6.1). Background soil samples will be collected wherever possible for comparison of contaminant levels.

6.3 AIR QUALITY MONITORING

Air quality monitoring for organic vapors with a Photovac Tip II photoionization detector will be implemented at each location, before, during, and after sampling. The purpose of air quality monitoring is three-fold: 1) to determine whether the use of respirators is needed while on-site, 2) to locate potential "hot-spots" from which vapors may emanate, and 3) to provide evidence regarding the locations of the areas of high contamination.

Indoor air monitoring will be conducted as described in the Work Plan. Air samples will only be taken in enclosed structures and only where there is a distinct odor of MGP residues as confirmed by on-scene NYSEG representatives. This method is considered acceptable by NYSEG since the odor threshold for many coal tar residues is well below existing analytical limits. The sampling method is described in Attachment 1.

6.4 MONITORING WELL SAMPLES

Monitoring well sampling consists of three procedures: well evacuation, sample collection, and analytical field tests. Each of these procedures is described below.

Prior to sampling a monitoring well, the static water level will be measured from the rim of the PVC well with a Slope Indicator Model 51453 electric water level indicator to the nearest 0.01 feet and recorded. The wells will then be evacuated to assure that the water in the well is truly representative of the groundwater. All well data will be recorded on the field sampling record (Figure 6.2). For shallow wells, or deep wells with a relatively low static water level, evacuation will be accomplished by using a decontaminated stainless steel, teflon, or dedicated disposable polyethylene bailer with a ball check valve at its lower end. Alternatively, a Waterra pump, consisting of dedicated polyethylene tubing and a teflon ball check valve, or a dedicated Geomon sampling device provided by NYSEG, may be used. A decontaminated positive displacement pump or the Geomon, or the Waterra pump may be used to evacuate the deeper wells having a high water level at a rate of approximately 1 gpm. The method utilized for

FIGURE 6.1

FIELD SURFACE SAMPLING RECORD

Site ______________________ Site No. __________ Date: __/__/__

Samplers: ______________________ of ______________________

______________________ of ______________________

SAMPLING: Time __________ ____ a.m.

____ p.m.

Sample Type: ______________________

Sampling Method: ______________________

Depth of Sample: ______________________

Description of Sampling Point:

Drainage Direction: ______________________

Upstream From: ______________________

Downstream From: ______________________

Physical Appearance/Odor: ______________________

____

Wildlife Observed: ______________________

Sampling Description:

Suspended Matter: ______________________

Color/Stain: ______________________

Odor: ______________________

Other: ______________________

Texture: ______________________

Analyze for: ______________________

Refrigerated: Date: __/__/__ Time ____ a.m.

____ p.m.

Field Tests:

Temperature (C°/°F)	________	Weather	________
pH	________		________
Conductivity	________		________

Comments: ______________________

____

FIELD SAMPLING RECORD

Site ____________ Site No. ____________ Date: __/__/__

Well ____________

Samplers: ____________ of ____________

____________ of ____________

Initial Static Water Level. . . . . ____________
(from top of well casing)

Evacuation:

Using: Submersible ______ Centrifugal ______

Airlift ______ Positive Displacement ______

Bailed ______ ____________ Times

Well Volume Calculation:

2" Casing: ______ ft. of water x .16 = ______ gals.

3" Casing: ______ ft. of water x .36 = ______ gals.

4" Casing: ______ ft. of water x .65 = ______ gals.

Depth to intake from top of protective well casing ______

Volume of water removed ____________ Gals. (> 3 Well Volumes)

Sampling: Time ____________ ____ a.m.

____ p.m.

Bailer Type: Stainless Steel ______

Teflon ______

From Pos. Dis. Pump Discharge Tube ______

Other ____________ ______

	No. of Bottles Filled	I.D. No.	Analyses
Trip Blank			
Field Blank - Wash/Atmospheric. .(circle one)			
Ground-water Sample			

Physical Appearance and Odor ____________

____

____

Refrigerate: Date __/__/__/ Time ____________

Field Tests:

Temperature (C°/°F)		
pH		
Spec. Conduc (umhos/cm)		

Weather ____________

Comments ____________

____

____

evacuating the wells will be decided by the Field Team Leader; if bailing will likely take more than one hour, a pump may be used.

A centrifugal pump may be used in cases where the water level is less than 20 feet, measured vertically, from the pump discharge. A dedicated length of polyethylene or PVC tubing will be used as the suction line to prevent cross-contamination between wells. A decontaminated foot valve will be attached to the suction line to prevent backdraining of pumped water into the well. The suction line intake will typically be set just above the screened section of the well. The suction line will be measured as it is lowered into the well until the depth of the screen is reached.

Groundwater samples will be collected according to the procedure summarized on Table 6.1. Samples will be collected using a dedicated polyethylene or a decontaminated stainless steel or teflon bailer with a ball check valve at its lower end or the Geomon. Incorporation of a check valve onto the bailers assures that a sample is representative of the depth to which the bailer is lowered. All samples will be removed from a depth just above the well screen to further assure a representative groundwater sample.

Upgradient wells will be sampled first. Prior to filling the sample bottles, a 250-ml glass beaker will be filled with groundwater. The sample will be immediately analyzed for temperature (°C), specific conductance (umhos/cm), and pH. Specific conductance and pH will be measured by precalibrated electronic probes. Temperature will be measured by precalibrated probe or thermometer.

TABLE 6.1
SAMPLING PROCEDURE FOR MONITORING WELLS*

---

1. Initial static water level recorded with an electric contact probe accurate to the nearest 0.01 ft.
2. Sampling device (bailer) and electric contact probe decontaminated. It is not necessary to decontaminate a dedicated bailer.

   Sampling device (bailer) and probe are Alconox detergent/water washed, rinsed with tap water, rinsed with methanol and finally rinsed with distilled water.

   Solvent and distilled water rinses are collected into a large funnel which empties into a 5-gallon container.
3. Sampling device (bailer) lowered into well.

   Bailer constructed of stainless steel, PVC, polyethylene, or teflon.

   Bailer lowered by dedicated PVC or polypropylene line.
4. Atmospheric blank is opened when appropriate.
5. Sample taken.

   Sample is collected by inserting a piece of dedicated PVC, polyethylene, or teflon tubing into the check valve end of the bailer and the sample bottle tilted so that aeration and turbulence are minimized.

   Duplicate sample is collected when appropriate.
6. Samples are capped, labelled, and placed in ice filled coolers provided by the laboratory.
7. Atmospheric blank is capped.
8. All equipment is cleaned with successive rinses of detergent/water, tap water, methanol and distilled water as necessary.

   Dedicated line and bailer are disposed of, or left at well site.
9. Equipment/Wash Blanks are collected when appropriate.
10. Chain-of-custody forms are completed in triplicate.

    The original and one of the copies is put into a zip-lock bag and placed into the cooler. The original will be returned following sample analysis.

    The second copy is kept on file.
11. Cooler is sealed with strapping tape and chain-of-custody seals to assure integrity and to prevent tampering of samples.

---

* In cases where the dedicated Geomon device is not used.

SECTION 7

SAMPLE CUSTODY

The program for sample custody and sample transfer is in compliance with the applicable USEPA methods. Sample chain-of-custody is initiated by the laboratory with selection and preparation of the sample containers. To reduce the chance for error, the number of personnel handling the samples is minimized.

On-site monitoring data will be controlled and entered in permanent log books. Personnel involved in the chain-of-custody and transfer of samples will be trained in the proper procedures prior to implementation.

7.1 FIELD SAMPLE CUSTODY

Sample custody and documentation procedures described in this section will be followed throughout all project sample collection efforts. Components of sample custody procedures include the use of field log books, sample labels and chain-of-custody forms.

7.1.1 Field Log Books

The Project Manager will control all field log books. Each field log book will receive a serialized number and be issued to the field team leader. Field log books will be maintained by the field team leader and other team members to provide a daily record of significant events, observations, and measurements during the field investigation. All entries will be signed and dated.

All information (except chain-of-custody forms) pertinent to field survey and sampling activities will be recorded in the log books. The books will be bound with consecutively numbered pages. Entries in the log book, supplemented by the sampling records, will include at a minimum the following information:

- Name and title of author, date and time of entry, and physical/environmental conditions during field activity.
- Purpose of sampling activity.
- Location of sampling activity.
- Name and address of field contact.
- Name and title of field crew.
- Name and title of any site visitors.
- Sample media (e.g., soil, sediment, ground water etc.).
- Sample collection method.
- Number and volume of sample(s) taken.
- Description of sampling point(s).

- Preservatives used.
- Date and time of collection.
- Sample identification number(s).
- Sample distribution (e.g., laboratory).
- Field observations.
- Any field measurements made, such as pH, temperature, conductivity, water level, etc.
- References for all maps and photographs of the sampling site(s).
- Information pertaining to sample documentation such as:
  - Bottle lot numbers
  - Dates and method of sample shipments
  - Chain-of-Custody Record numbers
  - Federal Express (or other carrier) shipment number, location of shipper, and date and time of shipment.

All original data recorded in Field Log Books and Chain-of-Custody Records will be written with waterproof ink. None of these accountable serialized documents will be destroyed.

If an error is made on an accountable document assigned to one individual, that individual will make all corrections simply by crossing a line through the error and entering the correct information. The erroneous information will not be erased. Any subsequent error discovered on an accountable document will be corrected by the person who made the entry. All subsequent corrections will be initialed and dated.

7.1.2 Custody Seals

When sample bottles are shipped to the laboratory, they will be placed in containers sealed with signed custody seals. Clear tape will be placed over the seals to ensure that seals are not accidentally broken during shipment.

7.2 CHAIN-OF-CUSTODY RECORDS

All samples will be accompanied by a chain-of-custody record, an example of which is shown on Figure 7.1. A chain-of-custody record accompanies each sample container from initial selection and preparation at the laboratory, to the field for sample containment and preservation, and through its return to the laboratory. If samples are split and sent to different laboratories, a copy of the chain-of-custody record will be sent with each sample.

FIGURE 7.1

CHAIN OF CUSTODY RECORD

PROJECT NO.	PROJECT NAME					NO. OF CONTAINERS						REMARKS
SAMPLERS (Signatures)												
STA. NO.	DATE	TIME	COMP.	GRAB	STATION LOCATION							

Relinquished by: (Signature)	Date/Time	Received by: (Signature)	Relinquished by: (Signature)	Date/Time	Received by: (Signature)
Relinquished by: (Signature)	Date/Time	Received by: (Signature)	Relinquished by: (Signature)	Date/Time	Received by: (Signature)
Relinquished by: (Signature)	Date/Time	Received for lab. by: (Signature)	Date/Time	Remarks	

ENGINEERING-SCIENCE INC.
290 Elwood Davis Road, Suite 312
Liverpool, New York 13088
Telephone: (315) 451-9560

The "remarks" column on this form is used to record specific considerations associated with sample acquisition such as: sample type, container type, and sample preservation methods. The analyses to be performed are written in the diagonal spaces at the top of the form. The number of containers for each type of analysis are written in the appropriate column under the analysis to be performed. When transferring samples, individuals relinquishing and receiving the samples will sign, date and note the time on the record.

The laboratory will maintain one file copy of each record, and the completed original will be returned to the Project Manager. This record will be used to document sample custody transfer from the sampler to a shipper, and to the laboratory.

7.3 SHIPPING OF SAMPLES

Samples will be delivered to the designated laboratory for analysis as soon as practical after collection, and generally within 24 hours of sample collection. Prior to sample shipment, the Field Team Leader (or a designee) will contact the laboratory to inform them of shipments. Shipments will be sent for overnight delivery by common carrier and a bill of lading (such as a Federal Express Airbill) will be used to document sample shipment to the laboratory. Bills of lading will be retained as part of the permanent documentation (as per 40 CFR 261.4).

7.4 LABORATORY SAMPLE CUSTODY

The Project Manager will notify the laboratory of upcoming field sampling activities and the subsequent transfer of samples to the laboratory. This notification will include information concerning the number and type of samples to be shipped as well as the anticipated date of arrival.

The laboratory sample custody program will, at a minimum, meet the following criteria:

- The laboratory will designate a sample custodian who is responsible for maintaining custody of the samples and for maintaining all associated records documenting that custody.
- Upon receipt of the samples, the custodian will check the original chain-of-custody and requests for analysis documents and compare them with the labeled contents of each sample container for correctness and traceability. The sample custodian signs the chain-of-custody and records the date and time received. Samples are then logged into a data management/sample tracking system.
- Care is exercised to annotate any labeling or descriptive errors. In the event of discrepant documentation, the laboratory will immediately contact the Project Manager as part of the corrective action process. A qualitative assessment of each sample container is performed to note any anomalies, such as broken or leaking bottles. This assessment is recorded as part of the incoming chain-of-custody procedure.

- The samples are stored in a secured area and at a temperature of approximately 4°C if necessary until analyses commence.
- A laboratory chain-of-custody record accompanies the sample or sample fraction through final analysis for control.
- A copy of the laboratory chain-of-custody form will accompany the analytical report and will become a permanent part of the project records.
- The pH of incoming water samples will be checked by the laboratory when preservatives have been used.

SECTION 8

CALIBRATION PROCEDURES AND FREQUENCY

8.1 FIELD INSTRUMENTS

All field analytical equipment will be calibrated immediately prior to each day's use. The calibration procedures will conform to manufacturer's standard instructions, ensuring that the equipment is functioning within the allowable tolerances established by the manufacturer and required by the project. Records of all instrument calibration will be maintained by the Field Team Leader. Copies of all of the instrument manuals will be maintained on-site by the Field Team Leader. Additional details of instrument calibration and maintenance may be found in Table 5.2.

8.1.1 Portable Photoionization Analyzer

The photoionization analyzer will be a Photovac TIP II, equipped with a 10.6 EV lamp. Calibration procedures are provided in Table 5.2. Calibration will be performed at the beginning and end of each day of use with a standard calibration gas of an approximate concentration of 100 parts per million of isobutylene. If the unit experiences abnormal perturbation or erratic readings additional calibration will be required. All calibration data will be recorded in field notebooks and on calibration log sheets to be maintained on-site.

A battery check will be completed at the beginning and end of each working day. If erratic readings are experienced, the battery will be checked for proper voltage. This information will also be recorded in field notebooks and on the calibration log sheets.

8.1.2 pH Meter

Calibration of the pH meter will be performed at the start of each day of use and as required during the work day as required by this plan. Standard buffer solutions, traceable to the National Institute of Standards and Technology (NIST, formerly the National Bureau of Standards), which bracket the expected pH range will be used. These standards will most likely be pH of 7.0 and 10.0 standard units. The use of the pH calibration and slope knobs will be used to set the meter to display the value of the standard being checked. The calibration data will be recorded in the field book. The meter will be recalibrated after very high (> 10) or very low (< 4) readings.

8.1.3 Specific Conductivity Meter

Calibration checks using the conductivity standard will be performed at the start of each day of use and as required during the work day as required by this plan. The portable conductivity meter will either be calibrated using a reference solution of

0.01 N KCl (specific conductance, 1413 umhos/cm at 25°C) or a calibration resistor on a daily basis. Readings within 5 percent are acceptable. If the unit has a thermometer, it will be calibrated against the field laboratory thermometer on a weekly basis. Specific methods for performing calibration of each of these instruments is provided in Table 5.2 of this plan.

8.2 LABORATORY INSTRUMENTS

Calibration of laboratory equipment will be based on approved, written procedures. Records of calibration, repairs, or replacement will be filed and maintained by the designated laboratory personnel performing quality control activities. These records shall be filed at the location where the work is performed and will be subject to QA audit. For all instruments, the laboratory shall maintain a factory-trained repair staff with in-house spare parts or shall maintain service contracts with vendors. Calibration procedures and frequencies specified by the NYSDEC ASP methods have precedence for instrument operation, maintenance, and internal Quality Assurance, unless procedures documented by the analytical laboratory are more stringent than the NYSDEC ASP methods <u>and</u> are acceptable to NYSDEC.

SECTION 9

ANALYTICAL PROCEDURES

Sample preparation and analytical procedures shall conform to the applicable NYSDEC ASP methods. The analytical laboratory proposed for this work is the NYSEG laboratory or a subcontract laboratory designated by NYSEG which is NYSDEC-approved. Table 9.1 lists the analytical methods.

9.1 VOLATILE ORGANICS (VOA)

For the analysis of water samples for volatile organic compounds (VOCs), no sample preparation is required. A measured portion of the sample is placed in the purge and trap apparatus and the sample analysis is performed by gas chromatography/mass spectrometry, EPA Method 8240. A modified (25 ml) purge procedure will be utilized to achieve lower detection limits. The modified purge procedure is described in Attachment 2 of this plan. Soil samples will be analyzed by Method 8240. The list of volatile organic compounds to be analyzed and the reporting limits to be used by the laboratory is presented in Table 9.2.

9.2 SEMIVOLATILE ORGANIC COMPOUNDS

The extraction procedures used for preparation of water samples for the analysis of semivolatile organic compounds are as described in EPA Method 8270 (and 610 at the discretion of the laboratory). Soil samples will be analyzed by Method 8270. The list of semivolatiles and their reporting limits are presented in Tables 9.3 and 9.4.

The samples will be analyzed as specified in the method. Instrument calibration, compound identification, and quantitation will be performed as described in Section 8 of this document, and in the EPA Method 8270 (and 610 as appropriate).

9.3 CYANIDE

Water and soil samples will be analyzed for cyanide as shown in Table 9.1.

TABLE 9.1

SUMMARY OF ANALYTICAL METHODS

Water Matrix	
(BTEX)	EPA Method 8240 (Modified purge for low detection limits
(PAHs)	EPA Method 8270 (and 610 at the discretion of the laboratory)
Cyanide (Total and Amenable)	NYSDEC ASP Method
Soil Matrix	
(BTEX)	EPA Method 8240
(PAHs)	EPA Method 8270
Cyanide (Total and Amenable)	NYSDEC ASP Method
Air Matrix	
BTEX and Naphthalene, PAHs	NIOSH Method 1500/1501, 5506

TABLE 9.2

REPORTING LIMITS FOR EPA METHOD 8240

Compound	Soil Reporting Limit (ppm)(1)
Chloromethane	0.010
Bromomethane	0.010
Vinyl Chloride	0.010
Chloroethane	0.010
Methylene Chloride	0.005
Acrolein	0.010
Acetone	0.100
Acrylonitrile	0.010
Carbon Disulfide	0.010
Trichlorofluoromethane	0.010
1,1-Dichloroethene	0.005
1,1-Dichloroethane	0.005
trans-1,2-Dichloroethene	0.005
Chloroform	0.005
1,2-Dichloroethane	0.005
2-Butanone	0.100
1,1,1-Trichloroethane	0.005
Carbon Tetrachloride	0.005
Vinyl Acetate	0.050
Bromodichloromethane	0.005
1,2-Dichloropropane	0.005
cis-1,3-Dichloropropene	0.005
Trichloroethene	0.005
Benzene	0.005
Dibromochloromethane	0.005
1,1,2-Trichloroethane	0.005
trans-1,3-Dichloropropene	0.005
2-Chloroethylvinylether	0.010
Bromoform	0.005
2-Hexanone	0.050
4-Methyl-2-pentanone	0.050
Tetrachloroethene	0.005
1,1,2,2-Tetrachloroethane	0.005
Toluene	0.005
Chlorobenzene	0.005
Ethylbenzene	0.005
Styrene	0.005
m/p-Xylene	0.005
o-Xylene	0.005
1,3-Dichlorobenzene	0.005
1,2/1,4-Dichlorobenzene	0.005

---

(1) Concentrations reported by laboratory in μg/l for water, μg/kg for soil. Refer to Attachment 2 for water reporting limits

TABLE 9.3

REPORTING LIMITS FOR EPA METHOD 8270 (WATER)

Compound	Reporting Limit (ppm)[1]
N-Nitroso-Dimethylamine	0.010
Phenol	0.010
bis(2-Chloroethyl)ether	0.010
2-Chlorophenol	0.010
1,3-Dichlorobenzene	0.010
1,4-Dichlorobenzene	0.010
Benzyl Alcohol	0.010
1,2-Dichlorobenzene	0.010
2-Methylphenol	0.010
bis(2-chloroisopropyl)Ether	0.010
4-methylphenol	0.010
N-Nitroso-Di-n-Propylamine	0.010
Hexachloroethane	0.010
Nitrobenzene	0.010
Isophorone	0.010
2-Nitrophenol	0.010
2,4-Dimethylphenol	0.010
bis(2-Chloroethoxy)methane	0.010
2,4-Dichlorophenol	0.010
Benzoic Acid	0.050
1,2,4-Trichlorobenzene	0.010
Naphthalene	0.010
4-Chloroaniline	0.010
Hexachlorobutadiene	0.010
4-Chloro-3-Methylphenol	0.010
2-Methylnaphthalene	0.010
Hexachlorocyclopentadiene	0.010
2,4,6-Trichlorophenol	0.010
2,4,5-Trichlorophenol	0.050
2-Chloronaphthalene	0.010
2-Nitroaniline	0.050
Dimethylphthalate	0.010
Acenaphthylene	0.010
2,6-Dinitrotoluene	0.010
3-Nitroaniline	0.050
Acenaphthene	0.010
2,4-Dinitrophenol	0.050
Dibenzofuran	0.010

TABLE 9.3

CONTINUED

Compound	Reporting Limit (ppm)(1)
4-Nitrophenol	0.050
2,4-Dinitrotoluene	0.010
Fluorene	0.010
Diethylphthalate	0.010
4-chlorophenyl-phenylether	0.010
4-Nitroaniline	0.050
4,6-Dinitro-2-methylphenol	0.050
N-Nitrosodiphenylamine	0.010
4-Bromophenyl-phenylether	0.010
Hexachlorobenzene	0.010
Pentachlorophenol	0.050
Phenanthrene	0.010
Anthracene	0.010
Di-n-Butylphthalate	0.010
Fluoranthene	0.010
Pyrene	0.010
Butylbenzylphthalate	0.010
Benzo(a)Anthracene	0.010
3,3'-Dichlorobenzidine	0.020
Chrysene	0.010
bis(2-Ethylhexyl)phthalate	0.010
Di-n-octylphthalate	0.010
Benzo(b)Fluoranthene	0.010
Benzo(k)Fluoranthene	0.010
Benzo(a)Pyrene	0.010
Indeno(1,2,3-cd)Pyrene	0.010
Dibenz(a,h)Anthracene	0.010
Benzo(g,h,i)Perylene	0.010

(1) Water concentrations reported by laboratory in μg/L.

TABLE 9.4

REPORTING LIMITS FOR EPA METHOD 8270 (SOIL)

Compound	Reporting Limit (ppm)(1)
N-Nitroso-Dimethylamine	0.330
Phenol	0.330
bis(2-Chloroethyl)ether	0.330
2-Chlorophenol	0.330
1,3-Dichlorobenzene	0.330
1,4-Dichlorobenzene	0.330
Benzyl Alcohol	0.330
1,2-Dichlorobenzene	0.330
2-Methylphenol	0.330
bis(2-Chloroisopropyl)Ether	0.330
4-Methylphenol	0.330
N-Nitroso-Di-n-Propylamine	0.330
Hexachloroethane	0.330
Nitrobenzene	0.330
Isophorone	0.330
2-Nitrophenol	0.330
2,4-Dimethylphenol	0.330
bis(2-Chloroethoxy)Methane	0.330
2,4-Dichlorophenol	0.330
Benzoic Acid	1.600
1,2,4-Trichlorobenzene	0.330
Naphthalene	0.330
4-Chloroaniline	0.330
Hexachlorobutadiene	0.330
4-Chloro-3-Methylphenol	0.330
2-Methylnaphthalene	0.330
Hexachlorocyclopentadiene	0.330
2,4,6-Trichlorophenol	0.330
2,4,5-Trichlorophenol	1.600
2-Chloronaphthalene	0.330
2-Nitroaniline	1.600
Dimethylphthalate	0.330
Acenaphthylene	0.330
2,6-Dinitrotoluene	0.330
3-Nitroaniline	1.600
Acenaphthene	0.330
2,4-Dinitrophenol	1.600
Dibenzofuran	0.330
4-Nitrophenol	1.600
2,4-Dinitrotoluene	0.330
Fluorene	0.330
Diethylphthalate	0.330

TABLE 9.4

CONTINUED

Compound	Reporting Limit (ppm)(1)
4-Chlorophenyl-Phenylether	0.330
4-Nitroaniline	1.600
4,6-Dinitro-2-Methylphenol	1.600
N-Nitrosodiphenylamine	0.330
4-Bromophenyl-phenylether	0.330
Hexachlorobenzene	0.330
Pentachlorophenol	1.600
Phenanthrene	0.330
Anthracene	0.330
Di-n-Butylphthalate	0.330
Fluoranthene	0.330
Pyrene	0.330
Butylbenzylphthalate	0.330
Benzo(a)Anthracene	0.330
3,3'-Dichlorobenzidine	0.660
Chrysene	0.330
bis(2-Ethylhexyl)phthalate	0.330
Di-n-octylphthalate	0.330
Benzo(b)Fluoranthene	0.330
Benzo(k)Fluoranthene	0.330
Benzo(a)Pyrene	0.330
Indeno(1,2,3-cd)Pyrene	0.330
Dibenz(a,h)Anthracene	0.330
Benzo(g,h,i)Perylene	0.330

(1) Soil concentrations reported by laboratory in µg/kg.

SECTION 10

DATA REDUCTION, VALIDATION AND REPORTING

10.1 DATA REDUCTION

10.1.1 Field Data

Field measurements will be made by competent field geologists, engineers, environmental scientists, and/or technicians.

Field data will be validated using four different procedures:

- Routine checks will be made during the processing of data.
- Internal consistency of a data set will be evaluated. This step will involve plotting the data and testing for outliers.
- Checks for consistency of the data set over time will be performed, by visually comparing data sets against gross upper limits obtained from historical data sets, or by testing for historical consistency. Anomalous data will be identified.
- Checks may be made for consistency with data sets obtained from the same volume of soil.

The purpose of these validation checks and tests is to identify outliers, observations that do not conform to the pattern established by other observations. Outliers may be the result of transcription errors or instrument breakdowns, or may be manifestations of a greater degree of spatial or temporal variability than expected.

After an outlier has been identified, a decision concerning its fate must be rendered. Obvious mistakes in data will be corrected when possible, and the correct value will be inserted. If the correct value cannot be obtained, the data may be excluded. An attempt will be made to explain the existence of the outlier. If no plausible explanation can be found for the outlier, it may be excluded, but a note to that effect will be included in the report. Also, an attempt will be made to determine the effect of the outlier when both included and excluded in the data set.

10.1.2 Laboratory Data

The procedures used for calculations and data reduction are specified in each analysis method referenced previously. Raw data are entered in bound laboratory notebooks. A separate book is maintained for each analytical procedure. The data entered are sufficient to document all factors used to arrive at the reported value for each sample. Calculations may include factors such as sample dilution ratios or conversion to dry-weight basis for solid samples. These data are stored in client files and traceable to original entries in bound notebooks. Instrument chart recordings and calculator print-outs are labeled and attached to their respective pages or are cross-referenced and stored in the project file.

About 10 percent of all calculations will be checked from the raw data to final value stages prior to reporting of a group of samples. Results obtained from extreme ends of standard curves generated by linear regression programs will be checked against graphically produced standard curves if the correlation coefficient of a program curve is less than 0.995.

Concentration units will be listed on reports and any special conditions noted. The analysis report includes the unique sample number given each sample, details of sample receipt and report preparation.

10.2 DATA REVIEW AND VALIDATION

Data will be reviewed and validated in terms of analytical holding times according to the analytical method requirements and using EPA guidance as published in:

- "Laboratory Data Validation: Functional Guidelines for Evaluating Inorganics Analyses," July, 1988.
- "Laboratory Data Validation: Functional Guidelines for Evaluating Organics Analyses," February, 1988.

10.3 REPORTING

For all analyses, as a minimum, the laboratory report will show traceability to sample analyzed, and will contain the following information:

- Project identification
- Field sample number
- Laboratory sample number
- Sample matrix description
- Date and time of sample collection
- Analytical method description and reference citation
- Individual parameter results
- Date of analysis (extraction, first run, and subsequent runs)
- Detection limits achieved
- Dilution or concentration factors

Completed copies of the original chain-of-custody records for the appropriate samples will be included in the analytical results reports. The following units shall be used in reporting. Parameters determined in water samples will be reported in units of ppm (mg/L). Organic parameters determined in soil and sediment samples will be reported in units of ppm (mg/Kg) dry weight. Inorganic parameters determined in soil and sediment samples will be reported in units of ppm (mg/Kg) dry weight. The percentage of moisture will be presented with the results of the soil and sediment samples.

Quality control reports will be prepared which summarize the results of samples analyzed by the laboratory for quality control purposes. These reports will summarize all the quality control data results for the samples, including results for method blanks, duplicates, and matrix spikes. Spike concentrations, percent recoveries and relative percent differences will be reported. These reports will be used to prepare a summary quality assurance report.

Completed copies of the chain-of-custody sheets accompanying each sample from time of initial bottle preparation to completion of analysis shall be attached to the report of analytical testing.

10.4 DATA HANDLING

Two copies of the analytical data will be provided by the laboratory, and sent to the ES-Syracuse office. The Project Manager will immediately arrange for filing of one package, as delivered. The second, or working copy, will be used to generate summary tables. These tables will form the foundation of a working database for assessment of the site contamination condition.

SECTION 11

INTERNAL QUALITY CONTROL CHECKS AND FREQUENCY

11.1 QUALITY ASSURANCE BATCHING

Each set of samples will be analyzed concurrently with blanks, matrix spike blanks, matrix spikes (MS) and matrix spike duplicates (MSD) (organic samples), spike duplicates (metals), surrogate spikes and replicates at the frequency required by the analytical methods. For planning purposes, it has been assumed that MS, MSD and spike duplicate samples will be collected for each sample matrix (soil, aqueous) at each site.

11.2 ORGANIC STANDARDS AND SURROGATES

As required by the NYSDEC ASP methods, all standard and surrogate compounds are checked by the method of mass spectrometry for correct identification and gas chromatography for degree of purity and concentration. When the compounds pass the identity and purity tests, they are certified for use in standard and surrogate solutions. Concentrations of the solutions are checked for accuracy before release for laboratory use. Standard solutions are replaced monthly or earlier based upon data indicating deterioration.

11.3 ORGANIC BLANKS, SPIKED BLANK, AND MATRIX SPIKE

Analysis of blank samples verifies that the analytical method does not introduce contaminants. The blank water can be generated by reverse osmosis and Super-Q™ filtration systems, or distillation of water containing $KMn0_4$. The spiked blank is generated by addition of standard solutions to the blank water. The matrix spike is generated by addition of surrogate standard to each sample.

11.4 TRIP AND FIELD BLANKS

Trip blanks and field blanks will be utilized in accordance with the specifications in Section 5 of this QA/QC Project Plan. These blanks will be analyzed to provide a check on sample bottle preparation and to evaluate the possibility of cross contamination of the samples.

11.5 FIELD MEASUREMENTS

Aqueous samples collected during this project will be measured in the field for pH, temperature and specific conductance. Quality control checks for the field instruments are presented in Table 5.2.

SECTION 12

QUALITY ASSURANCE PERFORMANCE AUDITS, SYSTEMS AUDITS, AND FREQUENCY

Quality assurance audits are performed by the project quality assurance group under the direction and approval of the Project Quality Assurance Manager (PQAM). Functioning as an independent body and reporting directly to company quality assurance management the PQAM will plan, schedule, and approve system and performance audits based upon company procedure customized to the project requirements. These audits will be implemented to evaluate the capability and performance of project and subcontractor personnel, items, activities, and documentation of the measurement system(s). At times, the PQAM may request additional personnel with specific expertise from company and/or project groups to assist in conducting performance audits. However, these personnel will not have responsibility for the project work associated with the performance audit.

12.1 SYSTEM AUDITS

System audits, performed by the PQAM or designated auditors, will encompass evaluation of measurement system components to ascertain their appropriate selection and application. In addition, field and laboratory quality control procedures and associated documentation may be system-audited. These audits may be performed at least once during the performance of the project. However, if conditions adverse to quality are detected between planned audits, or if the Project Manager requests the PQAM to perform unscheduled audits, these activities will be instituted.

12.2 PERFORMANCE AUDITS

Performance audits may be conducted to determine the accuracy and implementation of the measurement system(s) and parameter(s). As in system audits, the PQAM or assigned alternate will exercise planned and scheduled performance audits with the understanding that unplanned audits may be implemented for reasons stipulated in system audits above. Performance audits are most desirable and may be performed once the measurement systems are operational and initially generating measurement data.

12.3 QA MANAGEMENT ASSESSMENT

In addition to ongoing system and performance audits, quality assurance management assessments will be performed regularly by Engineering-Science. Such assessments will inform both company and project management that overall quality assurance requirements have been properly implemented and audited by the project QA group.

12.4 FORMALIZED AUDITS

Formalized audits refer to any system or performance audit that is documented and implemented by the QA group. These audits encompass documented activities performed by qualified lead auditors to a written procedure or checklists to objectively verify that quality assurance requirements have been developed, documented, and instituted in accordance with contractual and project criteria. Formalized audits may be performed on project and subcontractor work at various locations.

Audit reports will be written by lead auditors after gathering and evaluating all resultant data. Items, activities, and documents determined by lead auditors to be in noncompliance shall be identified at exit interviews conducted with the involved management. Noncompliances will be logged, documented, and controlled through audit findings which are attached to and are a part of the integral audit report. These audit finding forms are directed to management to satisfactorily resolve the noncompliance in a specified and timely manner. All audit checklists, audit reports, audit findings, and acceptable resolutions are approved by the PQAM prior to issue. QA verification of acceptable resolutions may be determined by re-audit or documented surveillance of the item or activity. Upon verification acceptance, the PQAM will close out the audit report and findings.

It is the Project Manager's overall responsibility to ensure that all corrective actions necessary to resolve audit findings are acted upon promptly and satisfactorily.

SECTION 13

PREVENTATIVE MAINTENANCE PROCEDURES AND SCHEDULES

13.1 PREVENTIVE MAINTENANCE PROCEDURES

Equipment, instruments, tools, gauges, and other items requiring preventive maintenance will be serviced in accordance with the manufacturer's specified recommendations and written procedure developed by the operators.

13.2 SCHEDULES

Written procedures where applicable will identify the schedule for servicing critical items in order to minimize the downtime of the measurement system. It will be the responsibility of the operator to adhere to this maintenance schedule and to arrange any necessary and prompt service as required. Service to the equipment, instruments, tools, gauges, etc. shall be performed by qualified personnel.

In the absence of any manufacturer's recommended maintenance criteria, a maintenance procedure will be developed by the operator based upon experience and previous use of the equipment.

13.3 RECORDS

Logs shall be established to record and control maintenance and service procedures and schedules. All maintenance records will be documented and traceable to the specific equipment, instruments, tools, and gauges. Records produced shall be reviewed, maintained, and filed by the operators at the laboratories and by the data and sample control personnel when and if equipment, instruments, tools, and gauges are used at the sites. The project QA group may audit these records to verify complete adherence to these procedures.

13.4 SPARE PARTS

A list of critical spare parts will be identified by the operator. These spare parts will be stored for availability and use in order to reduce the downtime. In lieu of maintaining an inventory of spare parts a service contract for rapid instrument repair or backup instruments will be available.

SECTION 14

ASSESSMENT PROCEDURES FOR DATA ACCEPTABILITY

Procedures used to assess data precision and accuracy are in accordance with the applicable EPA methods. Completeness is recorded by comparing the number of parameters initially analyzed for with the number of parameters successfully completed and validated.

Accuracy

The percent recovery (%) is calculated as below:

$$\% = \frac{S_s - S_o}{S} \times 100$$

S_s = Value obtained by analyzing the sample with the spike added.

S_o = The background value, i.e.; the value obtained by analyzing the sample.

S = Concentration of the spike added to the sample.

Precision

The relative percent difference (RPD) is calculated as below:

$$RPD = \frac{V_1 - V_2}{0.5(V_1 + V_2)} \times 100$$

V_1, V_2 = The 2 values obtained by analyzing the duplicate samples.

SECTION 15

CORRECTIVE ACTION

The following procedures have been established to assure that conditions adverse to quality, such as malfunctions, deficiencies, deviations, and errors, are promptly investigated, documented, evaluated, and corrected.

15.1 INITIATION OF CORRECTIVE ACTION

When a significant condition adverse to quality is noted at regional, site, laboratory, or subcontractor locations, the cause of the condition will be determined and corrective action taken to preclude repetition. Condition identification, cause, reference documents, and corrective action planned to be taken will be documented and reported to the site investigation team leaders, project managers, chief scientist, project QA manager, document control supervisors, and involved subcontractor management, as a minimum. Implementation of corrective action is verified by documented follow-up action. All project personnel have the responsibility, as part of the normal work duties, to promptly identify, solicit approved correction, and report conditions adverse to quality.

Corrective actions may be initiated as a result of:

- Nonattainment of predetermined acceptance standards.
- Determination of deficient procedures or data.
- Detection of faulty equipment or instrumentation.
- Poor sample custody documentation (samples and corresponding analytical results not clearly documented and tracked).
- Violation of quality assurance requirements.
- Circumvention of designated approvals.
- System and performance audits.
- Management assessment.
- Laboratory/field comparison studies.
- Data Validation Review.

15.2 PROCEDURE DESCRIPTION

Project management and staff, such as field investigation teams, remedial response planning personnel, and laboratory groups, monitor on-going work performance in the normal course of daily responsibilities.

Items, activities, or documents ascertained to be noncompliance with quality assurance requirements will be documented and corrective actions mandated through audit finding sheets attached to the audit report. Audit findings are logged, maintained, and controlled by the PQAM.

Technicians assigned quality assurance functions at the regional levels will also control noncompliance corrective actions by having the responsibility of issuing and controlling the appropriate Corrective Action Request Form. All project personnel can identify a noncompliance; however, the technician is responsible for documenting, numbering, logging, and verifying the closeout action. It is the Project Manager's responsibility to ensure that all recommended corrective actions are produced, accepted, and received in a timely manner.

The Corrective Action Request (CAR) identifies the adverse condition, reference document(s), and recommended corrective action(s) to be administered. The issued CAR is directed to the responsible manager in charge of the item or activity for action. The individual to whom the CAR is addressed returns the requested response promptly to the technician in charge, affixing his or her signature and date to the corrective action block, after stating the cause of the conditions and corrective action to be taken. The technician maintains the log for status control of CARs and responses, confirms the adequacy of the intended corrective action, and verifies its implementation. The technician will issue and distribute CARs to specified personnel, including the originator, responsible project management involved with the condition, the Project Manager, involved subcontractor, and the PQAM, as a minimum. CARs are transmitted to the project file for the records.

SECTION 16

QUALITY ASSURANCE REPORTS

The procedure for reporting results was described in Section 10. The frequency of the performance audits and the system audits was described in Section 12.

During the course of the project, the PQAM may prepare at least one quality assurance report which will discuss:

- The periodic assessment of measurement data accuracy, precision and completeness.
- Results of performance audits.
- Results of system audits.
- Significant QA/QC problems and action taken.

A final report prepared at the completion of the project may include a separate section summarizing data quality information.

ATTACHMENT 1

INDOOR AIR MONITORING METHODOLOGY

REAGENTS:

1. Eluent: Carbon disulfide*, chromatographic quality containing (optional) suitable internal standard.
2. Analytes, reagent grade*
3. Nitrogen or helium, purified
4. Hydrogen, prepurified.
5. Air, filtered.
6. Naphthalene calibration stock solution, 0.40 g/mL in CS_2.

*See Special Precautions.

EQUIPMENT:

1. Sampler: glass tube, 7 cm long, 6 mm OD, 4 mm ID, flame-sealed ends, containing two sections of activated (600 °C) coconut shell charcoal (front = 100 mg, back = 50 mg) separated by a 2-mm urethane foam plug. A silylated glass wool plug precedes the front section and a 3-mm urethane foam plug follows the back section. Pressure drop across the tube at 1 L/min airflow must be less than 3.4 kPa. Tubes are commercially available.
2. Personal sampling pumps, 0.01 to 1 L/min (Table 3), with flexible connecting tubing.
3. Gas chromatograph, FID, integrator, and column (page 1501-1).
4. Vials, glass, 1-mL, with PTFE-lined caps.
5. Pipet, 1-mL, and pipet bulb.
6. Syringes, 5-, 10-, 25- and 100-µL.
7. Volumetric flasks, 10-mL.

SPECIAL PRECAUTIONS: Carbon disulfide is toxic and extremely flammable (flash point = -30 °C); benzene is a suspect carcinogen. Prepare samples and standards in a well-ventilated hood.

SAMPLING:

1. Calibrate each personal sampling pump with a representative sampler in line.
2. Break the ends of the sampler immediately before sampling. Attach sampler to personal sampling pump with flexible tubing.
3. Sample at an accurately known flow rate between 0.01 and 0.2 L/min (to 1 L/min for naphthalene or styrene) for a total sample size as shown in Table 3. *
4. Cap the samplers with plastic (not rubber) caps and pack securely for shipment.

SAMPLE PREPARATION:

5. Place the front and back sorbent sections of the sampler tube in separate vials. Discard the glass wool and foam plugs.
6. Add 1.0 mL eluent to each vial. Attach crimp cap to each vial immediately.
7. Allow to stand at least 30 min with occasional agitation.

CALIBRATION AND QUALITY CONTROL:

8. Calibrate daily with at least five working standards over the appropriate range (ca. 0.01 to 10 mg analyte per sample; see Table 4).
   a. Add known amounts of analyte (calibration stock solution for naphthalene) to eluent in 10-mL volumetric flasks and dilute to the mark.
   b. Analyze together with samples and blanks (steps 11, 12 and 13).
   c. Prepare calibration graph (peak area of analyte vs. mg analyte).

See Appendix A

9. Determine desorption efficiency (DE) at least once for each batch of charcoal used for sampling in the calibration range (step 8). Prepare three tubes at each of five levels plus three media blanks.
    a. Remove and discard back sorbent section of a media blank sampler.
    b. Inject a known amount of analyte (calibration stock solution for naphthalene) directly onto front sorbent section with a microliter syringe.
    c. Cap the tube. Allow to stand overnight.
    d. Desorb (steps 5 through 7) and analyze together with working standards (steps 11, 12 and 13).
    e. Prepare a graph of DE vs. mg analyte recovered.
10. Analyze three quality control blind spikes and three analyst spikes to insure that the calibration graph and DE graph are in control.

MEASUREMENT:

11. Set gas chromatograph according to manufacturer's recommendations and to conditions given on page 1501-1. Select appropriate column temperature:

Substance[a]	Approximate Retention Time (min), at Indicated Column Temperature			
	50 °C	100 °C	150 °C	Programmed[b]
benzene	2.5			2.5
toluene	4.3	1.1		4.2
xylene (para)	7.0	1.4		5.2
ethylbenzene	7.0	1.4		5.5
xylene (meta)	7.2	1.5		5.6
cumene	8.3	1.6		6.0
xylene (ortho)	10	1.9		6.5
styrene	16	2.6		7.6
α-methylstyrene		3.2	1.0	8.1
vinyltoluene (meta)		3.8	1.2	8.5
naphthalene		25	4.3	12

[a] Data not available for p-tert-butyltoluene and p-vinyltoluene.
[b] Temperature program: 50 °C for 3 min, then 15 °C/min to 200 °C.

NOTE: Alternatively, column and temperature may be taken from Table 4.

12. Inject sample aliquot manually using solvent flush technique or with autosampler.
    NOTE: If peak area is above the linear range of the working standards, dilute with eluent, reanalyze and apply the appropriate dilution factor in calculations.
13. Measure peak area.

CALCULATIONS:

14. Determine the mass, mg (corrected for DE) of analyte found in the sample front (W_f) and back (W_b) sorbent sections, and in the average media blank front (B_f) and back (B_b) sorbent sections.
    NOTE: If $W_b > W_f/10$, report breakthrough and possible sample loss.

15. Calculate concentration, C, of analyte in the air volume sampled, V (L):

$$C = \frac{(W_f + W_b - B_f - B_b) \cdot 10^3}{V}, \text{ mg/m}^3.$$

EVALUATION OF METHOD:

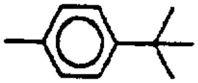
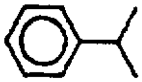
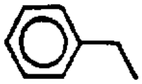
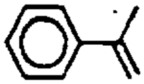
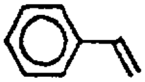
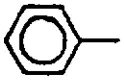
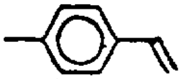
Precisions and biases listed in Table 3 were determined by analyzing generated atmospheres containing one-half, one, and two times the OSHA standard. Generated concentrations were independently verified. Breakthrough capacities were determined in dry air. Storage stability was not assessed. Measurement precisions given in Table 4 were determined by spiking sampling media with amounts corresponding to one-half, one, and two times the OSHA standard for nominal air volumes. Desorption efficiencies for spiked samplers containing only one compound exceeded 75%. Reference [12] provides more specific information.

REFERENCES:

[1] User check, UBTL, NIOSH Sequence #4121-S (unpublished, December 7, 1983).
[2] NIOSH Manual of Analytical Methods, 2nd. ed., V. 1, P&CAM 127, U.S. Department of Health, Education, and Welfare, Publ. (NIOSH) 77-157-A (1977).
[3] Ibid, V. 2, S22, S23, S25, S26, S29, S30, U.S. Department of Health, Education, and Welfare, Publ. (NIOSH) 77-157-B (1977).
[4] Ibid, V. 3, S292, S311, S318, S343, U.S. Department of Health, Education, and Welfare, Publ. (NIOSH) 77-157-C (1977).
[5] R. D. Dreisbach. "Physical Properties of Chemical Compounds"; Advances in Chemistry Series, No. 15; American Chemical Society, Washington (1955).
[6] Code of Federal Regulations; Title 29 (Labor), Parts 1900 to 1910; U.S. Government Printing Office, Washington (1980); 29 CFR 1910.1000.
[7] Update Criteria and Recommendations for a Revised Benzene Standard, U.S. Department of Health, Education, and Welfare, (August 1976).
[8] Criteria for a Recommended Standard....Occupational Exposure to Toluene, U.S. Department of Health, Education, and Welfare, Publ. (NIOSH) 73-11023 (1973).
[9] Criteria for a Recommended Standard....Occupational Exposure to Xylene, U.S. Department of Health, Education, and Welfare, Publ. (NIOSH) 75-168 (1975).
[10] *TLVs - Threshold Limit Values for Chemical Substances and Physical Agents in the Work Environment with Intended Changes for 1983-84*, ACGIH, Cincinnati, OH (1983).
[11] Criteria for a Recommended Standard...Occupational Exposure to Styrene, U.S. Department of Health and Human Services, Publ. (NIOSH) 83-119 (1983).
[12] Documentation of the NIOSH Validation Tests, S22, S23, S25, S26, S29, S30, S292, S311, S318, S343, U.S. Department of Health, Education, and Welfare; Publ. (NIOSH) 77-185 (1977).

METHOD REVISED BY: R. Alan Lunsford, Ph.D., and Julie R. Okenfuss; based on results of NIOSH Contract CDC-99-74-45.

Table 1. Synonyms, formula, molecular weight, properties [5].

Name/Synonyms	Structure	Empirical Formula	Molecular Weight	Boiling Point (°C)	Vapor Pressure @ 25 °C (mm Hg)	Vapor Pressure @ 25 °C (kPa)	Density @ 20 °C (g/mL)
benzene CAS #71-43-2		C_6H_6	78.11	80.1	95.2	12.7	0.879
p-tert-butyltoluene CAS #98-51-1 1-tert-butyl-4-methylbenzene		$C_{11}H_{16}$	148.25	192.8	0.7	0.09	0.861
cumene CAS #98-82-8 isopropylbenzene		C_9H_{12}	120.20	152.4	4.7	0.62	0.862
ethylbenzene CAS #100-41-4		C_8H_{10}	106.17	136.2	9.6	1.28	0.867
α-methylstyrene CAS #98-83-9 isopropenylbenzene (1-methylethenyl)-benzene		C_9H_{10}	118.18	165.4	2.5	0.33	0.911
naphthalene CAS #91-20-3		$C_{10}H_8$	128.18	80.2[a]	0.2	0.03	1.025
styrene CAS #100-42-5 vinylbenzene		C_8H_8	104.15	145.2	6.1	0.81	0.906
toluene CAS #108-88-3 methylbenzene		C_7H_8	92.14	110.6	28.4	3.79	0.867
vinyltoluene[b] CAS #25013-15-4 methylstyrene methylvinylbenzene	 (p-vinyltoluene)	C_9H_{10}	118.18	167.7	1.6	0.22	0.898
		(meta)		171.6	1.9	0.26	0.911
		(para)		172.8	1.8	0.24	0.911
		(ortho)		169.8	1.8	0.24	0.904
xylene[c] CAS #1330-20-7 dimethylbenzene	 (p-xylene)	C_8H_{10}	106.17				
		(ortho)		144.4	6.7	0.89	0.880
		(meta)		139.1	8.4	1.12	0.864
		(para)		138.4	8.8	1.18	0.861

---

[a] Melting point.

[b] Commercial mixture of meta and para isomers.

[c] Mixture of isomers.

Table 2. Permissible exposure limits, ppm [6-11].

Substance	OSHA			NIOSH		ACGIH			mg/m^3 per ppm
	TWA	C	Peak	TWA	C	TLV	STEL		
benzene	10	25	50^a	1		10**	25**		3.19
p-*tert*-butyltoluene	10					10	20		6.06
cumene	50 (skin)					50	75	(skin)	4.91
ethylbenzene	100					100	125		4.34
α-methylstyrene		100				50	100		4.83
naphthalene	10					10	15		5.24
styrene	100	200	600^b	50	100	50	100		4.26
toluene	200	300	500^a	100	200*	100	150	(skin)	3.77
vinyltoluene	100					50	100		4.83
xylene	100			100	200*	100	150		4.34

[a] Maximum duration 10 min in 8 hr.

[b] Maximum duration 5 min in any 3 hr.

**ACGIH: suspect carcinogen [10].

* 10-min sample.

Table 3. Sampling flowrate[a], volume, capacity, range, overall bias and precision [3,4,12].

Substance	Sampling			Breakthrough Volume @ Concentration		Range at VOL-NOM	Overall	
	Flowrate (L/min)	Volume (L) VOL-NOM	Volume (L) VOL-MAX^b	(L)	(mg/m^3)	(mg/m^3)	Bias (%)	Precision (s_r)
benzene	≤0.20	2^c	30	>45	149	42- 165	0.8	0.059
p-*tert*-butyltoluene	≤0.20	10	29	44	112	29- 119	-10.4	0.071^d
cumene	≤0.20	10	30	>45	480	120- 480	4.6	0.059
ethylbenzene	≤0.20	10	24	35	917	222- 884	-8.1	0.089^d
α-methylstyrene	≤0.20	3^f	30	>45	940	236- 943	-10.8	0.061^d
naphthalene^e	≤1.0	200	200	>240	81	19- 83	-0.5	0.055
styrene	≤1.0	5^g	14	21	1710	426-1710	-10.7	0.058^d
toluene	≤0.20	2^c	8	12	2294	548-2190	3.8	0.052
vinyltoluene	≤0.20	10	24	36	952	256- 970	-9.5	0.061^d
xylene	≤0.20	12	23	35	870	218- 870	-2.1	0.060

[a] Minimum recommended flow is 0.01 L/min.

[b] Approximately two-thirds the breakthrough volume, except for naphthalene.

[c] 10-min sample.

[d] Corrected value, calculated from data in Reference 12.

[e] Naphthalene shows poor desorption efficiency at low loading; 100-L minimum volume is recommended.

[f] 15-min sample.

[g] 5-min sample.

Table 4. Measurement range, precision and conditions[a] [3,4,12].

Substance	Desorption Volume (mL)	Measurement Range (mg)	Measurement Precision (s_r)	Carrier Flow (mL/min)	Column Parameters[b] t (°C)	Column Parameters[b] Length (m)	Column Parameters[b] Packing[c]
benzene	1.0	0.09- 0.35	0.036	50	115	0.9	A
p-*tert*-butyltoluene	0.5	0.27- 1.09	0.021[d]	50	115	3.0	B
cumene	0.5	0.86- 3.46	0.010	50	99	3.0	B
ethylbenzene	0.5	2.17- 8.67	0.010	50	85	3.0	B
α-methylstyrene	0.5	0.69- 3.57	0.011	50	115	3.0	B
naphthalene	1.0	4.96-19.7	0.019	30	125	3.0	C
styrene	0.5	2.17- 8.49	0.013[d]	50	109	3.0	B
toluene	1.0	1.13- 4.51	0.011	50	155	0.9	D
vinyltoluene	0.5	2.41- 9.64	0.008	50	120	3.0	B
xylene	1.0	2.60-10.4	0.010	50	180	0.9	D

[a] Injection volume, 5.0 µL; nitrogen carrier gas.

[b] All columns stainless steel, 3.2 mm outside diameter.

[c] A, 50/80 mesh Porapak P; B, 10% FFAP on 80/100 mesh Chromosorb W AW-DMCS; C, 10% OV-101 on 100/120 mesh Supelcoport; D, 50/80 mesh Porapak Q.

[d] Corrected value, calculated from data in [12].

FORMULA: Table 1

MW: Table 1

HYDROCARBONS, BP 36 – 126 °C

METHOD: 1500
ISSUED: 2/15/84

OSHA, NIOSH, ACGIH: Table 2

PROPERTIES: Table 1

COMPOUNDS: (Synonyms in Table 1)

benzene
cyclohexane
cyclohexene
n-heptane
n-hexane
methylcyclohexane
n-octane
n-pentane
toluene

SAMPLING

SAMPLER: SOLID SORBENT TUBE
(coconut shell charcoal,
100 mg/50 mg)

FLOW RATE, VOLUME: Table 3

SHIPMENT: no special precautions

SAMPLE STABILITY: at least 2 weeks

BLANKS: 2 to 10 field blanks per set

BULK SAMPLE: desirable, 1 to 10 mL; ship in separate containers from samples

ACCURACY

RANGE STUDIED,
BIAS and OVERALL PRECISION (s_r): Table 3

MEASUREMENT

TECHNIQUE: GAS CHROMATOGRAPHY, FID

ANALYTES: hydrocarbons listed above

DESORPTION: 1 mL CS_2; stand 30 min

INJECTION VOLUME: 5 µL

TEMPERATURE-INJECTION: 250 °C
-DETECTOR: 250 °C
-COLUMN: see step 11

CARRIER GAS: N_2 or He, 25 mL/min

COLUMN: glass, 3.0 m x 2 mm, 20% SP-2100 on 80/100 mesh Supelcoport

CALIBRATION: analytes in CS_2

RANGE AND PRECISION (s_r): Table 4

ESTIMATED LOD: 0.001 to 0.01 mg per sample with capillary column [1]

APPLICABILITY: This method is intended for determining the OSHA-regulated hydrocarbons included within the boiling point range of n-pentane through n-octane. It may be used for simultaneous measurements; however, interactions between analytes may reduce breakthrough volumes and change desorption efficiencies.

INTERFERENCES: At high humidity, breakthrough volumes may be reduced by as much as 50%. Other volatile organic solvents, e.g., alcohols, ketones, ethers, and halogenated hydrocarbons, are likely interferences. If interference is suspected, use a more polar column or change column temperature.

OTHER METHODS: This method is based on and supercedes Methods P&CAM 127, benzene and toluene [2]; S28, cyclohexane [3]; S82, cyclohexene [3]; S89, heptane [3]; S90, hexane [3]; S94, methylcyclohexane [3]; S311, benzene [4]; S343, toluene [4]; S378, octane [4]; and S379, pentane [4]. For benzene or toluene in complex mixture of alkanes ($\leq C_{10}$), Method 1501 (aromatic hydrocarbons) is more selective.

REAGENTS:

1. Eluent: Carbon disulfide*, chromatographic quality with (optional) suitable internal standard.
2. Analytes, reagent grade.*
3. Nitrogen or helium, purified.
4. Hydrogen, prepurified.
5. Air, filtered.

*See Special Precautions.

EQUIPMENT:

1. Sampler: glass tube, 7 cm long, 6 mm OD, 4 mm ID, flame-sealed ends, containing two sections of activated (600 °C) coconut shell charcoal (front = 100 mg, back = 50 mg) separated by a 2-mm urethane foam plug. A silylated glass wool plug precedes the front section, and a 3-mm urethane foam plug follows the back section. Pressure drop across the tube at 1 L/min airflow must be less than 3.4 kPa. Tubes are commercially available.
2. Personal sampling pump, 0.01 to 0.2 L/min, with flexible connecting tubing.
3. Gas chromatograph, FID, integrator and column (page 1500-1).
4. Vials, glass, 1-mL, with PTFE-lined caps.
5. Pipet, 1-mL, with pipet bulb.
6. Syringes, 5-, 10-, 25- and 100-µL.
7. Volumetric flasks, 10-mL

SPECIAL PRECAUTIONS: Carbon disulfide is toxic and extremely flammable (flash point = -30 °C); benzene is a suspect carcinogen. Prepare samples and standards in a well-ventilated hood.

SAMPLING:

1. Calibrate each personal sampling pump with a representative sampler in line.
2. Break the ends of the sampler immediately before sampling. Attach sampler to personal sampling pump with flexible tubing.
3. Sample at an accurately known flow rate between 0.01 and 0.2 L/min (0.01 to 0.05 L/min for n-pentane) for a total sample size as shown in Table 3.
4. Cap the samplers with plastic (not rubber) caps and pack securely for shipment.

SAMPLE PREPARATION:

5. Place the front and back sorbent sections of the sampler tube in separate vials. Discard the glass wool and foam plugs.
6. Add 1.0 mL eluent to each vial. Attach crimp cap to each vial immediately.
7. Allow to stand at least 30 min with occasional agitation.

CALIBRATION AND QUALITY CONTROL:

8. Calibrate daily with at least five working standards over the appropriate range (ca. 0.01 to 10 mg analyte per sample; see Table 4).
   a. Add known amounts of analyte to eluent in 10-mL volumetric flasks and dilute to the mark.
   b. Analyze together with samples and blanks (steps 11, 12 and 13).
   c. Prepare calibration graph (peak area of analyte vs. mg analyte).
9. Determine desorption efficiency (DE) at least once for each batch of charcoal used for sampling in the calibration range (step 8). Prepare three tubes at each of five levels plus three media blanks.
   a. Remove and discard back sorbent section of a media blank sampler.
   b. Inject a known amount of analyte directly onto front sorbent section with a microliter syringe.

c. Cap the tube. Allow to stand overnight.
d. Desorb (steps 5 through 7) and analyze together with working standards (steps 11, 12 and 13).
e. Prepare a graph of DE vs. mg analyte recovered.

10. Analyze three quality control blind spikes and three analyst spikes to insure that the calibration graph and DE graph are in control. Check for possible contamination during shipment of field samples by comparing results from field blanks and media blanks.

MEASUREMENT:

11. Set gas chromatograph according to manufacturer's recommendations and to conditions given on page 1500-1. Select appropriate column temperature:

Substance	Approximate Retention Time (min), at Indicated Column Temperature			
	40 °C	70 °C	100 °C	Programmed[a]
n-pentane	2.2	1.2		1.8
solvent (CS_2)	3.0	1.6		2.4
n-hexane	5.1	2.2		3.5
benzene[b]	7.7	3.2		4.5
cyclohexane[b]	8.4	3.4		4.7
cyclohexene	9.5	3.8		4.9
n-heptane	12	4.3		5.4
methylcyclohexane	14	5.2	2.2	5.9
toluene	17	6.5	2.6	6.5
n-octane	19	8.7	3.2	7.1

[a] Temperature program: 50 °C for 2 min, then 15 °C/min to 150 °C, 2-min final hold.
[b] Not completely resolved.

NOTE: Alternatively, column and temperature may be taken from Table 4.

12. Inject sample aliquot manually using solvent flush technique or with autosampler.
NOTE: If peak area is above the linear range of the working standards, dilute with eluent, reanalyze and apply the appropriate dilution factor in calculations.
13. Measure peak area.

CALCULATIONS:

14. Determine the mass, mg (corrected for DE) of analyte found in the sample front (W_f) and back (W_b) sorbent sections, and in the average media blank front (B_f) and back (B_b) sorbent sections.
NOTE: If $W_b > W_f/10$, report breakthrough and possible sample loss.
15. Calculate concentration, C, of analyte in the air volume sampled, V (L):

$$C = \frac{(W_f + W_b - B_f - B_b) \cdot 10^3}{V}, \text{ mg/m}^3.$$

EVALUATION OF METHOD:

Precisions and biases (Table 3) were determined by analyzing generated atmospheres containing one-half, one, and two times the OSHA standard. Generated concentrations were independently verified. Breakthrough capacities were determined in dry air. Storage stability was not assessed. Measurement precisions (Table 4) were determined by spiking sampling media with amounts corresponding to one-half, one, and two times the OSHA standard for nominal air volumes. Desorption efficiencies for spiked samplers containing only one compound exceeded 75%. Reference [12] provides more specific information.

REFERENCES:

[1] User check, UBTL, NIOSH Sequence #4213-L (unpublished, January 31, 1984).

[2] NIOSH Manual of Analytical Methods, 2nd. ed., V. 1, P&CAM 127 U.S. Department of Health, Education, and Welfare, Publ. (NIOSH) 77-157-A (1977).

[3] NIOSH Manual of Analytical Methods, 2nd. ed., V. 2, S28, S82, S89, S90, S94, U.S. Department of Health, Education, and Welfare, Publ. (NIOSH) 77-157-B (1977).

[4] NIOSH Manual of Analytical Methods, 2nd. ed., V. 3., S311, S343, S378, S379, U.S. Department of Health, Education, and Welfare, Publ. (NIOSH) 77-157-C (1977).

[5] R. D. Driesbach, "Physical Properties of Chemical Compounds"; Advances in Chemistry Series, No. 15; American Chemical Society, Washington (1955).

[6] R. D. Driesbach, "Physical Properties of Chemical Compounds - II"; Advances in Chemistry Series, No. 22; American Chemical Society, Washington (1959).

[7] Code of Federal Regulations; Title 29 (Labor), Parts 1900 to 1910; U.S. Government Printing Office, Washington, (1980); 29 CFR 1910.1000.

[8] Update Criteria and Recommendations for a Revised Benzene Standard, U.S. Department of Health, Education, and Welfare, (August 1976).

[9] Criteria for a Recommended Standard....Occupational Exposure to Alkanes (C5-C8), U.S. Department of Health, Education, and Welfare, Publ. (NIOSH) 77-151 (1977).

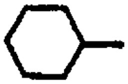
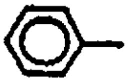
[10] Criteria for a Recommended Standard....Occupational Exposure to Toluene, U.S. Department of Health, Education, and Welfare, Publ. (NIOSH) 73-11023 (1973).

[11] TLVs—Threshold Limit Values for Chemical Substances and physical Agents in the Work Environment with Intended Changes for 1983-84, ACGIH, Cincinnati, OH (1983).

[12] Documentation of the NIOSH Validation Tests, S28, S82, S89, S90, S94, S311, S343, S378, S379, U.S. Department of Health, Education, and Welfare, Publ. (NIOSH) 77-185 (1977).

METHOD REVISED BY: R. Alan Lunsford, Ph.D., and Julie R. Okenfuss; based on results of NIOSH Contract CDC-99-74-45.

Table 1. Synonyms, formula, molecular weight, properties.

Name Synonyms	Structure	Empirical Formula	Molecular Weight	Boiling Point (°C)	Vapor Pressure @ 25 °C (mm Hg)	Vapor Pressure @ 25 °C (kPa)	Density @ 20 °C (g/mL)
benzene[a] CAS #71-43-2		C_6H_6	78.11	80.1	95.2	12.7	0.879
cyclohexane[a] CAS #110-82-7 hexahydrobenzene hexamethylene		C_6H_{12}	84.16	80.7	97.6	13.0	0.779
cyclohexene[a] CAS #110-83-8 tetrahydrobenzene		C_6H_{10}	82.15	83.0	88.8	11.8	0.811
n-heptane[b] CAS #142-82-5		C_7H_{16}	100.21	98.4	45.8	6.1	0.684
n-hexane[b] CAS #110-54-3		C_6H_{14}	86.18	68.7	151.3	20.2	0.659
methylcyclohexane[a] CAS #108-87-2		C_7H_{14}	98.19	100.9	46.3	6.2	0.769
n-octane[b] CAS #111-65-9		C_8H_{18}	114.23	125.7	14.0	1.9	0.703
n-pentane[b] CAS #109-66-0		C_5H_{12}	72.15	36.1	512.5	68.3	0.626
toluene[a] CAS #108-88-3 methylbenzene		C_7H_8	92.14	110.6	28.4	3.8	0.867

[a] Properties from [5].
[b] Properties from [6].

Table 2. Permissible exposure limits, ppm [7-11].

Substance	OSHA TWA	OSHA C	OSHA Peak	NIOSH TWA	NIOSH C	ACGIH TLV	ACGIH STEL	mg/m³ per ppm @ NTP
benzene*	10	25	50[b]	1		10	25	3.19
cyclohexane	300					300	375	3.44
cyclohexene	300					300		3.36
n-heptane	500			85	440	400	500	4.10
n-hexane[a]	500			100	510	50		3.52
methylcyclohexane	500					400	500	4.01
n-octane	500			75	385	300	375	4.67
n-pentane	1000			120	610	600	750	2.95
toluene	200	300	500[b]	100	200[c]	100	150 (skin)	3.77

---

[a] The ACGIH recommendation for other hexane isomers is: TLV 500, STEL 1000.

[b] Maximum duration 10 min in 8 hr.

[c] 10-min sample.

*ACGIH: suspect carcinogen

Table 3. Sampling flowrate[a], volume, capacity, range, overall bias and precision [2-4, 12].

Substance	Sampling Flowrate (L/min)	Sampling Volume (L) VOL-NOM	Sampling Volume (L) VOL-MAX[b]	Breakthrough Volume at Concentration (L)	Breakthrough Volume at Concentration (mg/m³)	Range at VOL-NOM (mg/m³)	Overall Bias (%)	Overall Precision (s_r)
benzene	≤0.20	2[c]	30	>45	149.1	41.5 - 165	0.8	0.059
cyclohexane	≤0.20	2.5	5	7.6	1650	510 - 2010	5.4	0.060[d]
cyclohexene	≤0.20	5	7	10.4	2002	510 - 2030	9.0	0.073
n-heptane	≤0.20	4	4	6.1	4060	968 - 4060	-6.5	0.056
n-hexane	≤0.20	4	4	5.9	3679	877 - 3679	-3.8	0.062
methylcyclohexane	≤0.20	4	4	6.1	3941	940 - 3941	5.5	0.052
n-octane	≤0.20	4	4	6.5	4612	1050 - 4403	-5.2	0.060
n-pentane	≤0.05	2	2	3.1	5640	1476 - 6190	-9.7	0.055
toluene	≤0.20	2[c]	8	11.9	2294	548 - 2190	3.8	0.052

---

[a] Minimum recommended flow is 0.01 L/min.

[b] Approximately two-thirds the breakthrough volume.

[c] 10-min sample.

[d] Corrected value, calculated from data in [12].

Table 4. Measurement range, precision, and chromatographic conditions [2-4,12].

Substance	Measurement[a] Range (mg)	Precision (s_r)	Carrier Gas	Flow (mL/min)	Column Parameters[b] t (°C)	Length (m)	Diameter (mm)	Packing[c]
benzene	0.09-0.35	0.036	N_2	50	115	0.9	3.2	A
cyclohexane	1.3 - 5.3[d]	0.024	N_2	50	210	1.2	6.4	B
cyclohexene	2.4 - 9.7[d]	0.021	N_2	50	205	1.2	6.4	B
n-heptane	4.08-16.3	0.016	He	30	80	3.0	3.2	C
n-hexane	3.56-14.5	0.014	He	30	52	6.1	3.2	D
methylcyclohexane	3.98-16.1	0.012	He	30	55	6.1	3.2	D
n-octane	4.75-18.9	0.009	He	30	52	6.1	3.2	D
n-pentane	2.98-11.8	0.014	He	30	52	6.1	3.2	D
toluene	1.13-4.51	0.011	N_2	50	155	0.9	3.2	B

[a] Injection volume, 5.0 µL; desorption volume, 1.0 mL, except cyclohexane and cyclohexene, 0.5 mL.

[b] All columns stainless steel. Diameter is outside dimension.

[c] A, 80/80 mesh Porapak P; B, 50/80 mesh Porapak Q; C, 10% OV-101 on 100/120 mesh Supelcoport; D, 10% FFAP on 80/100 mesh Chromosorb W AW-DMCS.

[d] Corrected value, calculated from data in [12].

FORMULA: Table 1

MW: Table 1

POLYNUCLEAR AROMATIC HYDROCARBONS

METHOD: 5506
ISSUED: 5/15/85

OSHA: proposed for B[a]P: 0.2 µg/m³
ACGIH: suspect carcinogen (B[a]P)

PROPERTIES: Table 1

COMPOUNDS:

- acenaphthene
- acenaphthylene
- anthracene
- benz[a]anthracene
- benzo[b]fluoranthene
- benzo[k]fluoranthene
- benzo[ghi]perylene
- benzo[a]pyrene
- benzo[e]pyrene
- chrysene
- dibenz[a,h]anthracene
- fluoranthene
- fluorene
- indeno[1,2,3-cd]pyrene
- naphthalene
- phenanthrene
- pyrene

SYNONYMS: PAH; PNA; also see Table 2.

SAMPLING

SAMPLER: FILTER + SORBENT
(2-µm, 37-mm PTFE + washed XAD-2, 100 mg/50 mg)

FLOW RATE: 2 L/min

VOL-MIN: 200 L
-MAX: 1000 L

SHIPMENT: transfer filters to culture tubes; wrap sorbent and culture tubes in Al foil; ship @ 0 °C

SAMPLE STABILITY: unknown; protect from heat and UV radiation

FIELD BLANKS: 10% (≥3) of samples
MEDIA BLANKS: 6 to 10

AREA SAMPLES: 8 replicates on preweighed filters for solvent selection

ACCURACY

RANGE STUDIED, BIAS, AND OVERALL PRECISION (s_r): not measured

MEASUREMENT

METHOD: HPLC, FLUORESCENCE/UV DETECTION

ANALYTE: compounds above

EXTRACTION: 5 mL organic solvent appropriate to sample matrix (step 7)

COLUMN: 15 cm x 4.6 mm, reverse phase, 5-µm C_{18}

INJECTION VOLUME: 10 to 50 µL

MOBILE PHASE: H_2O/CH_3CN gradient @ ambient temperature

FLOW RATE: 1.0 mL/min

DETECTORS: UV @ 254 nm; Fluorescence @ 340 nm (excitation), 425 nm (emission)

CALIBRATION: external standards in CH_3CN

RANGE, LOD AND PRECISION (s_r): EVALUATION OF METHOD

APPLICABILITY: The working range for B[a]P is 1 to 50 µg/m³ for a 400-L air sample. Specific sample sets may require modification in filter extraction solvent, choice of measurement method, and measurement conditions (see EVALUATION OF METHOD).

INTERFERENCES: Any compound which elutes at the same HPLC retention time may interfere. Heat, ozone, NO_2, or UV light may cause sample degradation.

OTHER METHODS: This revises P&CAM 206 and 251 [1]. The spectrophotometric methods, P&CAM 184 and 186 [1], have not been revised. Also see Method 5515 (GC).

REAGENTS:

1. Filter extraction solvent: benzene,* cyclohexane, methylene chloride, or other appropriate solvents, pesticide grade grade (step 7).
2. Water, distilled, deionized, degassed.
3. Acetonitrile, HPLC grade, degassed.
4. PAH reference standards,* appropriate to the PAH-containing matrix sampled.
5. Calibration stock solution, 0.25 mg/mL.* Check purity of each PAH reference standard by GC/FID, HPLC/fluorescence and/or melting point. Purify, if necessary, by recrystallization. Weigh 25 mg of each PAH into a 100-mL volumetric flask; dilute to volume with acetonitrile. Stable six months if refrigerated and protected from light.

*See SPECIAL PRECAUTIONS.

EQUIPMENT:

1. Sampler:
   a. Filter. PTFE-laminated membrane filter, 2-µm pore size, 37-mm diameter (ZEFLOUR, Membrana, Pleasanton, CA or equivalent), backed by a gasket (37-mm OD, 32-mm ID) cut from a cellulose support pad, in cassette filter holder.
      NOTE 1: If sampling is to be done in bright sunlight, use opaque or foil-wrapped cassettes to prevent sample degradation.
      NOTE 2: Take filters to be preweighed from the filter package and allow to equilibrate 24 hrs with laboratory atmosphere before taring.
   b. Sorbent tube, connected to filter with minimum length PVC tubing. Plastic caps are required after sampling. Washed XAD-2 resin (front = 100 mg; back = 50 mg) (Supelco ORBO 43 or equivalent). Pressure drop at 2 L/min airflow 1.6 to 2 kPa (15 to 20 cm H_2O).
2. Personal sampling pump capable of operating for 8 hrs at 2 L/min, with flexible connecting tubing.
3. Aluminum foil.
4. Vial, scintillation, 20-mL, glass, PTFE-lined cap.
5. Refrigerant, bagged.
6. Culture tubes, PTFE-lined screw cap, 13-mm x 100-mm.
7. Forceps.
8. Filters, 0.45-µm, PTFE or nylon (for filtering sample solutions).
9. Pipet, 5-mL.
10. Syringe or micropipets, 1- to 100-µL.
11. Ultrasonic bath.
12. HPLC, with gradient capability, fluorescence (excitation @ 240 nm, emission @ 425 nm) and UV (254 nm) detectors in series, electronic integrator, and column [HC-ODS-SILX (Perkin-Elmer Corp.), Vydac 201TP (The Separations Group) or equivalent; see page 5506-1].
13. Volumetric flasks, 10- and 100-mL.
14. Lighting in laboratory: incandescent or UV-shielded fluorescent.
15. Kuderna-Danish extractor.

SPECIAL PRECAUTIONS: Treat benzene and all polynuclear aromatic hydrocarbons as carcinogens. Neat compounds should be weighed in a glove box. Spent samples and unused standards are toxic waste. Regularly check counter tops and equipment with "black light" for fluorescence as an indicator of contamination by PAH.

SAMPLING:

1. Calibrate each personal sampling pump with a representative sampler in line.
2. Take personal samples at 2 L/min for a total sample size of 200 to 1000 L. Take a concurrent set of eight replicate area samples at 2 to 4 L/min on preweighed, 2-µm PTFE filters in an area of highest expected PAH concentration.
   NOTE: The area samples are needed for solvent selection (step 7).
3. Immediately after sampling, transfer the filter carefully with forceps to a scintillation vial. Hold filter at edge to avoid disturbing the deposit. Cap the scintillation vial and wrap it in aluminum foil.
   NOTE: This step is necessary to avoid loss of analytes due to sublimation and degradation by light.
4. Cap the sorbent tube and wrap it in aluminum foil.
5. Ship to laboratory in insulated container with bagged refrigerant.

SAMPLE PREPARATION:

NOTE: UV light may degrade PAH. Use yellow, UV-absorbing shields for fluorescent lights or use incandescent lighting.

6. Refrigerate samples upon receipt at laboratory.
7. Determine optimum extraction solvent.
   a. Allow the preweighed area filter samples to equilibrate 24 hrs with the laboratory atmosphere.
   b. Weigh the area filters. Determine total weight collected on each.
   c. Extract the first pair of area filters with acetonitrile, the second with benzene, the third with cyclohexane, and the fourth with methylene chloride, according to step 8.
      NOTE: Use alternate solvents, if appropriate. PAH of interest may be entrained within, and adsorbed by, particulate matter collected on the filter. It is necessary to determine the solvent which maximizes recovery of the PAH from each sample matrix. For example, methylene chloride [2,3] and benzene:ethanol (4:1 v/v) [4] have been recommended for extraction of PAH from diesel exhaust particulate.
   d. Analyze the extracts for the PAH of interest (steps 10 through 18). Normalize the total mass of PAH found to the mass of sample collected.
   e. Choose the solvent which gives the highest recovery of PAH of interest. Use the solvent chosen to extract the personal filter samples.
8. Extract filters.
   a. Add 5.0 mL of the solvent chosen in step 7 to each scintillation vial containing a filter. Start media and reagent blanks at this step.
   b. Cap and let sit 15 to 20 min in an ultrasonic bath.
      NOTE 1: Soxhlet extraction may be required when large amounts of highly adsorptive particulate matter (e.g., fly ash or diesel soot) are present.
      NOTE 2: The sample must be dissolved in acetonitrile for chromatography. If needed, perform solvent exchange as follows:
      CAUTION: To avoid loss of volatile components, do not allow the sample to go to dryness at any time.
      (1) After filtration (step 10), take the sample to near dryness in a Kuderna-Danish extractor.
      (2) Add ca. 1 mL acetonitrile, take to near dryness, and adjust final volume to 1.0 mL with acetonitrile and filter again.
9. Desorb PAH from sorbent.
   a. Score each sorbent tube with a file in front of the front (larger) sorbent section. Break tube at score line.

b. Transfer glass wool plug and front sorbent section to a culture tube. Discard the foam plug. Transfer back sorbent section to a second culture tube.
c. Add 5.0 mL acetonitrile to each culture tube. Cap the culture tubes.
d. Allow samples to sit for 30 min. Swirl occasionally.

10. Filter all sample extracts through an 0.45-µm membrane filter.

CALIBRATION AND QUALITY CONTROL:

11. Calibrate daily with at least five working standards.
    a. Dilute aliquots of calibration stock solution with acetonitrile in 10-mL volumetric flasks (e.g., to 2.5, 0.5, 0.1, 0.02, and 0.002 µg/mL).
    b. Intersperse working standards and samples in the measurements.
    c. Prepare calibration graphs (peak area vs. µg of each PAH per sample).
12. Recovery and desorption efficiency.
    a. Determine recovery (R) from filters and desorption efficiency (DE) from sorbent tubes at least once for each lot of filters and sorbent tubes used in the range of interest.
        (1) Filters. Using a microliter syringe or micropipette, spike four filters at each of five concentration levels with a mixture of the analytes. Allow the filters to dry in the dark overnight. Analyze the filters (steps 8, 10, and 14 through 16. Prepare graphs of R vs. amounts found.
        NOTE: This step may not be used for some highly adsorptive particulate matrices for which calibration by the method of standard additions may be more accurate.
        (2) Sorbent tubes. Transfer an unused front sorbent section to a culture tube. Prepare a total of 24 culture tubes in order to measure DE at five concentration levels plus blanks in quadruplicate. Using a microliter syringe or micropipette, add calibration stock solution directly to sorbent. Cap culture tubes and allow to stand overnight. Analyze (steps 9, 10, and 14 through 16). Prepare graphs of DE vs. amounts found.
    b. Check R and DE at two levels for each sample set, in duplicate. Repeat determination of R and DE graphs if checks do not agree to within ±5% of DE graph.
13. Analyze at least three field blanks for each sample medium.

MEASUREMENT:

14. Set HPLC according to manufacturer's recommendations and to conditions on page 5506-1. Equilibrate column at 60% CH_3CN/40% H_2O at 1.0 mL/min for 15 min before injecting first sample.
15. Inject sample aliquot. Start mobile phase gradient:
    a. Linear gradient 60% CH_3CN to 100% CH_3CH, 20 min.
    b. Hold at 100% CH_3CN for 20 min.
    NOTE: Hold longer if necessary to prevent carryover of background, e.g., from coal dust.
    c. Linear gradient to initial condition, 5 min.
16. Measure peak areas.
    NOTE 1: Approximate retention times appear in Table 3.
    NOTE 2: If peak area is above the calibration range, dilute with appropriate solvent, reanalyze, and apply dilution factor in calculations.
    NOTE 3: If sample has many interferences, additional sample cleanup may be necessary. Many cleanup procedures have been published. Liquid-liquid partitioning between cyclohexane and nitromethane [5,6] is widely used, but other techniques may be more appropriate for specific samples.

CALCULATIONS:

17. Read the mass, µg (corrected for R or DE) of each analyte found on the filter (W) and front sorbent (W_f) and back sorbent (W_b) sections, and on the average media blank filter (B) and front sorbent (B_f) and back sorbent (B_b) sections from the calibration graphs.
18. Calculate concentration, C (µg/m³), in air as the sum of the particulate concentration and the vapor concentration using the actual air volume sampled, V (L).

$$C = \frac{(W - B + W_f + W_b - B_f - B_b) \cdot 10^3}{V}, \ \mu g/m^3.$$

NOTE: W_f and W_b include analyte originally collected on the filter as particulate, then volatilized during sampling. This can be a significant fraction for many PAH (e.g., fluoranthane, naphthalene, fluorene, anthracene, phenanthrene).

EVALUATION OF METHOD:

The fluorescence detector used in this method is both sensitive and selective. The detector can "see" as little as 50 pg of many PAH injected on the column. LODs for the 17 analytes range from 50 to 350 ng per sample. It does not respond to non-fluorescent molecules such as aliphatics. The method is, therefore, most amenable to determination of trace amounts of PAH in mixtures of aliphatic compounds. Successful applications include: aluminum reduction facilities, asphalt fume, coal gasification plants, coal liquefaction plants, coal tar pitch, coke oven emissions, creosote treatment facilities, diesel exhaust, graphite electrode manufacturing, petroleum pitch, and roofing tearoff operations.

This method has been evaluated by analyzing spiked filters, spiked sorbent tubes, and complete spiked sampling trains through which were drawn 500 L of air [7]. Each of the three groups was spiked with each analyte at two concentration levels in sextuplicate. Particular note should be made that the effect of particulate matter has not been evaluated, and every sampling matrix is unique. The data on the following page were obtained on spiked samplers stored refrigerated in the dark for three months followed by measurement with HPLC.

COMPOUND	CALIBRATION RANGE (µg per sample)	LOD (µg per sample)	MEASUREMENT PRECISION SPIKED[a]	SPIKED + AIR[b]
1. ACENAPHTHENE	2.0 - 13	0.8	.058 S	.093 (50)
2. ACENAPHTHYLENE	1.0 - 100	0.35	.032 S	.075 (100)
3. ANTHRACENE	0.4 - 13	0.05	.039 S	.037 (5)
4. BENZ[a]ANTHRACENE	0.4 - 13	0.15	.032 F	.084 (5)
5. BENZO[b]FLUORANTHENE	0.4 - 12	0.1	.027 F	.028 (10)
6. BENZO[k]FLUORANTHENE	0.4 - 13	0.15	.025 F	.027 (1)
7. BENZO[ghi]PERYLENE	0.5 - 25	0.2	.031 F	.029 (10)
8. BENZO[a]PYRENE	0.4 - 14	0.2	.027 F	.029 (5)
9. BENZO[e]PYRENE	0.5 - 13	0.2	(c)	(c)
10. CHRYSENE	0.4 - 12	0.15	.039 F	.024 (5)
11. DIBENZ[a,h]ANTHRACENE	0.5 - 25	0.2	.026 F	.029 (10)
12. FLUORANTHENE	0.4 - 13	0.15	.026 S	.050 (10)
13. FLUORENE	0.7 - 13	0.25	.031 S	.090 (10)
14. INDENO[1,2,3-cd]PYRENE	0.5 - 12	0.2	.044 F	.032 (10)
15. NAPHTHALENE	0.6 - 13	0.25	.041 S	.125 (50)
16. PHENANTHRENE	0.4 - 13	0.1	.036 S	.070 (2)
17. PYRENE	0.5 - 13	0.2	(c)	(c)

---

[a] RSD for filter (F) where volatilization is nil or for sorbent (S) where substantial volatilization may occur during sampling.

[b] RSD determined at the µg level shown in parenthesis for a spiked filter followed by a sorbent tube. After spiking, laboratory air was drawn through the sampling train at 2 L/min for 4 hrs.

[c] Not determined.

REFERENCES:

[1] NIOSH Manual of Analytical Methods, 2nd ed., Vol. 1, U.S. Department of Health, Education, and Welfare, Publ. (NIOSH) 77-157-A (1977).

[2] Breuer, G. M. *Anal. Lett.*, 17(A11), 1293-1306 (1984).

[3] Zweidinger, R. B., S. B. Tejada, D. Dropkins, J. Huisingh, and L. Claxton. "Characterization of Extractable Organics in Diesel Exhaust Particulate," paper presented at Symposium on Diesel Particulate Emissions Measurement Characterization, Ann Arbor, MI (1978).

[4] Swarin, S. J. and R. L. Williams. "Liquid Chromatographic Determination of Benzo[a]pyrene in Diesel Exhaust Particulate: Verification of the Collection and Analytical Methods," *Polynuclear Aromatic Hydrocarbons: Physical and Biological Effects*, Bjorseth, A. and Dennis, Eds., Battelle Press, 771-790 (1980).

[5] Wise, S. A., *et al*. "Analytical Methods for the Determination of Polycyclic Aromatic Hydrocarbons on Air Particulate Matter," *Polynuclear Aromatic Hydrocarbons: Physical and Biological Chemistry*, Cooke, Dennis and Fisher, Eds., Battelle Press, 919-929 (1982).

[6] Novotny, M., M. L. Lee and K. D. Bartle. *J. Chromatog. Sci.*, *12*, 606-612 (1974).

[7] Backup Data Report for Method 5506, Analytical Report for NIOSH Sequence 4170 (NIOSH, unpublished, March 16, 1984).

[8] Studt., P., *Liebigs Ann. Chem.*, 528 (1978).

[9] Clar, E. *Polycyclic Hydrocarbons*, Academic Press (1964).

[10] Handbook of Chemistry and Physics, 62nd ed., CRC Press (1982).

METHOD REVISED BY: B. R. Belinky and E. J. Slick, NIOSH/DPSE.

Table 1. Formulae and physical properties.

COMPOUND (by M.W.)	EMPIRICAL FORMULA	MOLECULAR WEIGHT	DETECTOR	MELTING POINT (°C)	BOILING POINT (°C)*	REF.
1. NAPHTHALENE	$C_{10}H_8$	128.17	UV	80	218	[9]
2. ACENAPHTHYLENE	$C_{12}H_8$	152.20	UV	92-93	265-275	[10]
3. ACENAPHTHENE	$C_{12}H_{10}$	154.21	UV	96.2	279	[10]
4. FLUORENE	$C_{13}H_{10}$	166.22	UV	116	293-295	[9]
5. ANTHRACENE	$C_{14}H_{10}$	178.23	UV	218	340	[9]
6. PHENANTHRENE	$C_{14}H_{10}$	178.23	UV	100	340	[9]
7. FLUORANTHENE	$C_{16}H_{10}$	202.26	FL	110	—	[9]
8. PYRENE	$C_{16}H_{10}$	202.26	FL	156	399	[9]
9. BENZ[a]ANTHRACENE	$C_{18}H_{12}$	228.29	FL	158-159	—	[9]
10. CHRYSENE	$C_{18}H_{12}$	228.29	UV	255-256	—	[9]
11. BENZO[b]FLUORANTHENE	$C_{20}H_{12}$	252.32	FL	168	—	[9]
12. BENZO[k]FLUORANTHENE	$C_{20}H_{12}$	252.32	FL	217	480	[10]
13. BENZO[a]PYRENE	$C_{20}H_{12}$	252.32	FL	177	—	[9]
14. BENZO[e]PYRENE	$C_{20}H_{12}$	252.32	FL	178-179	—	[9]
15. BENZO[ghi]PERYLENE	$C_{22}H_{12}$	276.34	FL	273	—	[9]
16. INDENO[1,2,3-cd]PYRENE	$C_{22}H_{12}$	276.34	FL	161.5-163	—	[8]
17. DIBENZ[a,h]ANTHRACENE	$C_{22}H_{14}$	278.35	FL	262	—	[9]

*Many of these compounds will sublime.

Table 2. Synonyms.

COMPOUND (alphabetically)	SYNONYMS
1. ACENAPHTHENE	CAS# 83-32-9
2. ACENAPHTHYLENE	CAS# 208-96-8
3. ANTHRACENE	CAS# 120-12-7
4. BENZ[a]ANTHRACENE	1,2-benzanthracene; benzo[b]phenanthrene; 2,3-benzophenanthrene; tetraphene; CAS# 56-55-3
5. BENZO[b]FLUORANTHENE	3,4-benzofluoranthene; 2,3-benzofluoranthene; benz[e]acephenanthrylene; B[b]F; CAS# 205-99-2
6. BENZO[k]FLUORANTHENE	11,12-benzofluoranthene; CAS# 207-08-9
7. BENZO[ghi]PERYLENE	1,12-benzoperylene; CAS# 191-24-2
8. BENZO[a]PYRENE	3,4-benzopyrene; 6,7-benzopyrene; B[a]P; BP; CAS# 50-32-8
9. BENZO[e]PYRENE	1,2-benzopyrene; 4,5-benzopyrene; B[e]P; CAS# 192-97-2
10. CHRYSENE	1,2-benzophenanthrene; benzo[a]phenanthrene; CAS# 218-01-9
11. DIBENZ[a,h]ANTHRACENE	1,2,5,6-dibenzanthracene; CAS# 53-70-3
12. FLUORANTHENE	benzo[jk]fluorene; CAS# 206-44-0
13. FLUORENE	CAS# 86-73-7
14. INDENO[1,2,3-cd]PYRENE	2,3-phenylenepyrene; CAS# 193-39-5
15. NAPHTHALENE	naphthene; CAS# 91-20-3
16. PHENANTHRENE	CAS# 85-01-8
17. PYRENE	benzo[def]phenanthrene; CAS#129-00-0

Table 3. Approximate PAH retention times.

	COMPOUND	RETENTION TIME (min)*
1.	NAPHTHALENE	2.4
2.	ACENAPHTHALENE	2.8
3.	ACENAPHTHENE	3.6
4.	FLUORENE	3.9
5.	PHENANTHRENE	4.7
6.	ANTHRACENE	5.8
7.	FLUORANTHENE	6.8
8.	PYRENE	7.7
9.	BENZ[a]ANTHRACENE	11.2
10.	CHRYSENE	12.1
11.	BENZO[e]PYRENE	14.0
12.	BENZO[b]FLUORANTHENE	14.8
13.	BENZO[k]FLUORANTHENE	16.5
14.	BENZO[a]PYRENE	17.3
15.	DIBENZ[a,h]ANTHRACENE	20.0
16.	BENZO[ghi]PERYLENE	20.0
17.	INDENO[1,2,3-cd]PYRENE	21.2

*NOTE: Determined with a Perkin-Elmer HC-ODS-SILX column. Actual retention times will vary with individual columns and column age.

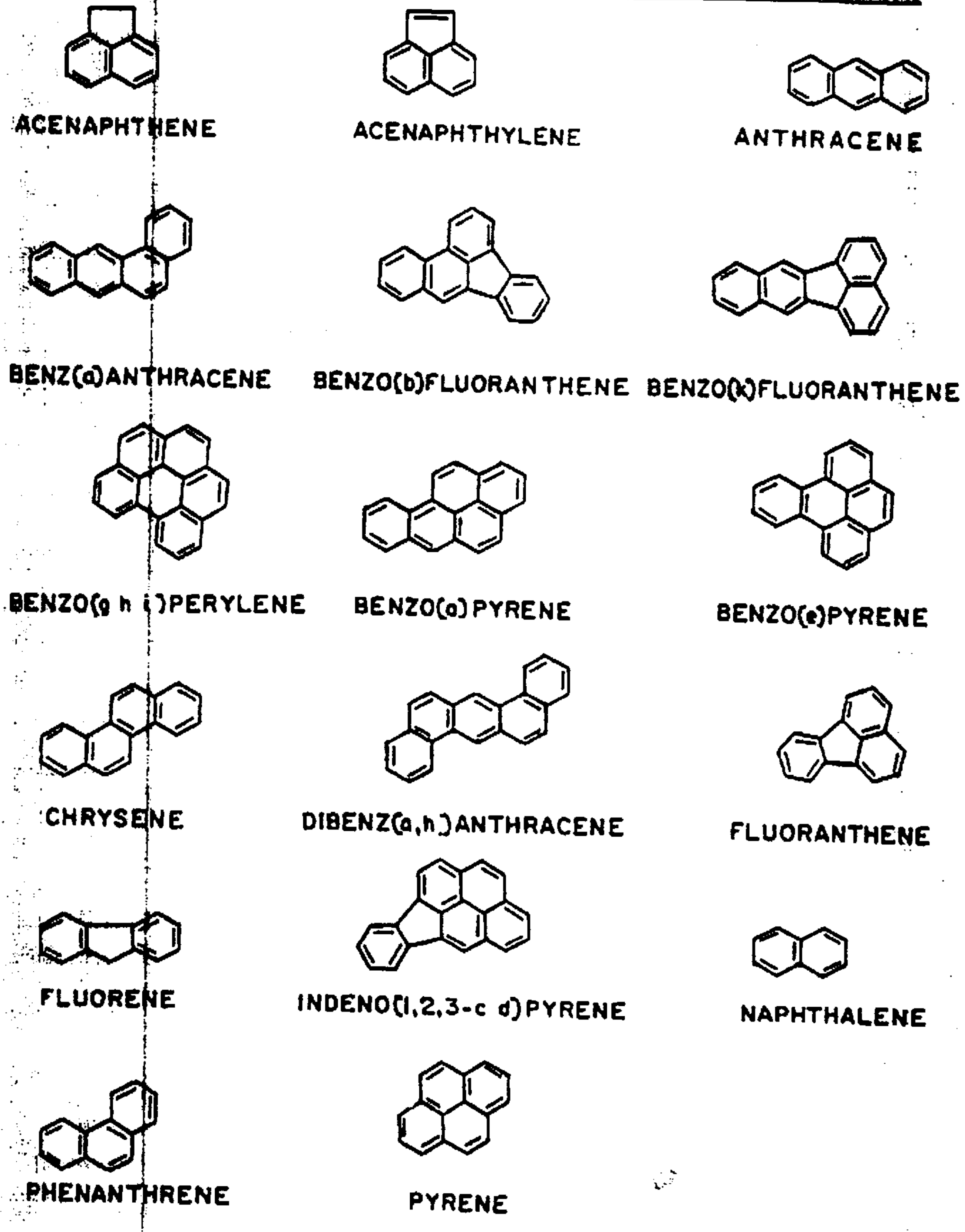

ACENAPHTHENE
ACENAPHTHYLENE
ANTHRACENE
BENZ(a)ANTHRACENE
BENZO(b)FLUORANTHENE
BENZO(k)FLUORANTHENE
BENZO(g h i)PERYLENE
BENZO(a)PYRENE
BENZO(e)PYRENE
CHRYSENE
DIBENZ(a,h)ANTHRACENE
FLUORANTHENE
FLUORENE
INDENO(1,2,3-c d)PYRENE
NAPHTHALENE
PHENANTHRENE
PYRENE

Figure 1. Structures of PAH.

STANDRAD OPERATING PROCEDURE

FOR

THE ANALYSIS OF VOLATILE ORGANICS WITH LOW DETECTION LIMITS IN RESIDENTIAL WELL WATER SAMPLES USING GAS CHROMATOGRAPHY/MASS SPECTROMETRY

PREPARED BY

Cheng-Wen Tsai

October 1987

Revised January 1989

As received by Engineering-Science from USEPA
Region V Quality Assurance Section (QAS)

ANALYSIS OF VOLATILE ORGANICS WITH LOW DETECTION LIMITS

BY

PURGE AND TRAP GAS CHROMATOGRAPHY/MASS SPECTROMETRY METHOD

(PREPARED BY CHENG-WEN TSAI)

REVISED JANUARY 1989

1.0 SCOPE AND APPLICATION

1.1 This standard operating procedure describes the method for the analysis of volatile organics in private well, municipal water supply and domestic well samples.

1.2 This is a purge and trap gas chromatography/mass spectrometry (GC/MS) method applicable to the determination of 38 compounds (See Table 1) in municipal water supply, and private well water samples.

1.3 The required method detection limit (MDL) for each compound is listed in Table 1.

1.4 This method is restricted to use by or under the supervision of analysts experienced in the operation of a purge and trap system, and gas chromatography/mass spectrometry, and in the interpretation of mass spectra. Each analyst must demonstrate the ability to generate acceptable results with this method using the procedure described in Section 10.

2.0 SUMMARY OF METHOD

2.1 An inert gas is bubbled through a 25-ml water sample contained in a specially designed purging chamber at ambient temperature. The purgeables are efficiently transferred from the aqueous phase to the vapor phase. The vapor is swept through a sorbent trap where the purgeables are trapped. After purging is completed, the trap is heated and backflushed with the inert gas to spectrometer that allows the continuous acquisition and storage on machine-readable media of all mass spectra obtained through the duration of the chromatographic program. The computer must have the software that allows searching any GC/MS data file for spectra m/z (masses) and plotting such m/z abundance versus time or scan number. Software must also allow integrating the abundance in any Extracted Ion Current Profile (EICP) between specific time or scan number limits.

5.3.6 Syringe and Syringe Valves

5.3.6.1 Syringes - 5-ml and 25-ml glass hypodermic with luerlock tip (two each).

5.3.6.2 Micro Syringes - 25- and 100-ul.

5.3.6.3 Gas Syringes - 1.0 and 5.0 ml gas tight, with shut-off valve.

5.3.7 Miscellaneous

5.3.7.1 Standard Storage Containers - 3.7 ml screw cap amber vilas.

5.3.7.2 Mininert Valves - Screw cap.

6.0 REAGENTS

6.1 Methanol, demonstrated to be free of analytes (spike 100 ul into 25 ml of reagent water and analyze. Result should be less than detection limits.).

6.2 Reagent water, producing less than detection limits of those compounds that are monitored. Prepared by boiling distilled or natural waters for 15 minutes followed by 1 hour purge with inert gas while temperature is held at 90^{0}C or carbon filtered. Store in clean, narrow mouthed crip top PTFE-lined septa bottles.

6.3 Stock Standards - Commerical mixed stock solutions are available (Supelco Purgeeables A, B, and C) that contain most of the compounds of interest at a concentration of 0.2 mg/ml. Stock solutions must be prepared from neat, as folows for those compounds not included prepared as above, the solution will contain each analyte at a concentration of 5 ng/ul.

6.4.3 Separate secondary dilution standard mixture should be prepared weekly for the gases from the Supelco purgeable C mix.

6.4.4 Store secondary dilution standards in 3-ml glass vials equipped with PTFE mininert valve screw tops. Storage conditions and time described for stock standary solutions (6.3.4) also apply to the secondary dilution standard solutions.

6.5 Working Aqueous Calibration Standards

Using the secondary dilution standards to prepare five calibration standards at concentrations of 5, 10, 20, 40 and 60 ug/L for all volatile compounds except the acrolein and acrylonitrile, which should be at concentrations of 25, 50, 75, 100 and 125 ug/L.

6.6 Continuing Calibration Check Standard

Prepare the aqueous continuing calibration check standard solution at concentration of 20 ug/L for all compounds except acrolein and acrylonitrile, which should be at concentration of 50 ug/L.

6.7 Sample matrix Spiking Solution

Prepare a matrix spiking solution containing all compounds of interest in methanol using the procedures described in Section 6.3 and 6.4. It is recommended that the secondardy dilution standard be prepared at a concentration of 50 ug/mL for all compounds except acrolein and acrylonitrile, which shall be at a concentration of 125 ug/mL. The addition of 10 uL of such standard solution to 25 mL of reagent water or samples would be equivalent to 20 ug/L. Store at 0^{0}C. The sample matrix spiking solution should be discarded after 1 month.

6.8 Internal Standard Solution

in the commerical mixes(NOTE 1).

6.3.1 Place 24.4 ml of methanol in a 25-ml volumetric flask. Allow flask to stand unstoppered for 10 minutes or until all alcohol-wetted surfaces have dried, and then tare.

6.3.2 Using a 100-ul syringe, add 50 mg of assayed reference material to the flask. Be sure that the drops fall directly into the alcohol without contacting the neck of the flask. Retare the flask and add 50 mg of the next compound. Repeat the process until all compounds have been added.

6.3.3 Dilute to volume, and stopper. Mix by inverting flask several times. The resulting solution will contain each analyte at a concentration of 2.0 mg/ml.

6.3.4 Store stock standard solutions in 3-ml vials equipped with PTFE mininert valve tops at 0^0C. All standards must be replaced each month.

NOTE 1: The following compounds must be made from neat Cis-1,2-dichloroethene, trans-1,2-dichloroethe O-xylene, m-xylene, p-xylene, 1,3-dichlorobenzene, 1,4-dichlorobenzene, styrene, 1,2-dichlorobenzene.

6.4 Secondary Dilution Standards

Using stock standards to prepare secondary dilution standards in methanol. The secondary dilution standards are prepared at concentrations that can be easily dilut to prepare aqueous calibration standards that will bracket the working range of the method.

6.4.1 To prepare secondary dilution standards, place 9.0 ml of methanol into a 10-ml volumetric flask

6.4.2 Inject exactly 250 ul of the speclco purgeable A and purgeable B stock solution, and 250 ul of the stock solution prepared from neat (6.3) into the methanol. When the standard solution is

Prepare a spiking solution containing Bromochloromethan 1,4-Difluorobenzene, and chlorobenzene-d5 in methanol using the procedures described in Section 6.3 and 6.4. It is recommended that the secondary dilution standard be prepared at a concentration of 50 ug/mL of each internal standard compound. The addition of 10 uL of such a standard to 25 mL of sample or calibration standard would be equivalent to 20 ug/L.

6.9 Surrogate Spike Standard Solution

Prepare a surrogate spiking solution containing Toluene-d8, Bromofluorobenzene, and 1,2-dichloroethane-d4 in methanol using the procedures described in Section 6.3 and 6.4. It is recommended that the secondary dilution standard be prepared at a concentration of 50 ug/mL of each surrogate spike compound. The addition of 10 uL of such as standard to 25 mL of sample or calibration standard would be equivalent to 20 ug/L.

6.10 4-BORMOFLUOROBENZENE (BFB) Solution

Prepare a 25 ug/mL solution of bromofluorobenzene in methanol. This solution would be used for MS tuning.

7.0 SAMPLE COLLECTION, PRESERVATION, AND STORAGE

7.1 Sample collection

7.1.1 Collect all samples in duplicate(2 40-ml glass vials). Fill sample bottles to overflowing. No air bubbles should pass through the sample as the bottle is filled, or be trapped in the sample when the bottle is sealed.

7.1.2 When sampling from a water tap, open the tap and allow the system to flush until water temperature has stabilized (usually about 10 minutes). Adjust the flow to about 500 ml/min. and collect duplicate samples from the flowing system.

7.1.3 When sampling from an open body of water, fill a 1-quart wide-mouth bottle or 1-liter beaker with sample from a respresentative area, and carefully fill duplicate sample bottles from the container.

7.2 Sample Preservation

7.2.1 Adjust the pH of the duplicate samples to <2 by carefully adding one drop of 1:1 HCl for each 20 ml of sample volume (See Reference No.6). Seal the sample bottles, PFTE-face down, and shake vigorously for one minutes.

7.2.2 The samples must be chilled to 4^{0}C on the day of collection and maintained at that temperature until analysis. Field samples that will not be packaged for shipment with sufficient ice to ensure that they will be at 4^{0}C on arrival at the laboratory.

7.3 Sample storage

7.3.1 Store samples at 4^{0}C until analysis. The sample storagearea must be free of organic solvent vapors.

7.3.2 Analyze all samples within 7 days of collection. Samples not analyzed within this period must be discarded and replaced.

8.0 CALIBRATION AND STANDARDIZATION

8.1 Tuning and GC/MS Calibration

8.1.1 The laboratory must establish that a given GC/MS system meet the standard spectral abundance criteria prior to initiating any on-going data collection. The GC/MS system must be hardware tuned to meet the abundance criteria listed in Table 3 for a maximum of a 50 ng injection of 4-Bromofluorobenzene (BFB). Add 50 ng of BFB solution to 25 ml of reagent water and analyze alone. BFB should NOT be analyzed simultaneously with any calibration standards or blanks. This criteria must be demonstrated dialy or for each twelve-hour (12) time period. If required, background substraction must be straight forwarc and designed only to eliminate column bleed or instrument background.

8.1.2 BFB criteria MUST be met before any standards, samples or blanks are analyzed.

8.1.3 Any action taken which may results in effecting the tuning criteria for BFB, the tune must be verified irrespective of the twelve-hour tuning requirement.

8.1.4 The laboratory shall document the GC/MS tuning and mass calibration each time the system is tun

8.2 Calibration of GC/MS System

8.2.1 Initial Internal Standard Calibration

8.2.1.1 Prior to the analysis of samples and required blanks and after tuning criteria have been met, the GC/MS syste must be initially calibrated at a minir of five concentrations to determine the linearity of response utilizing the initial calibration standard solutions containing all compounds listed in Tabl Once the system has been calibrated, the calibration must be verified after the initial calibration and each twelve hours time period for each GC/MS systen

8.2.1.2 Prepare calibration standards by spiking five portions of 25 ml reagent waters wit various amount of secondary dilution standard solution (6.4) to yield the following specific concentrations: 5, 10, 20, 40, and 60 ug/L for all compounds except acrolein and acrylonitrile, which have the specific concentrations at 25, 50, 75, 100 and 125 ug/L.

Internal standards and surrogate spike standards will be added to each each calibration standard solutions to yield a concentration of 20 ug/L. BFB will also b added in each calibration standard to yield a concentration of 50 ug/L.

8.2.1.3 Analyze each calibration standard solutio and tabulate the area of the primary characteristic ion againt concentration for each compound including all required internal standards and surrogate standard compounds. The relative retention time (RRT) of each compound in each calibratio run should agree within 0.06 RRT units.

8.2.1.4 Use Table 4 and Equation 1 to calculate the relative response factor (RRF) for each compound at each concentration level.

$$RRF = \frac{A_x}{A_{is}} \times \frac{C_{is}}{C_x} \qquad \text{Equation 1}$$

Where,

A_x = Area of the characteristic ion for the compound to be measured.

A_{is} = Area of the characteristic ion for the specific internal standards from Table 2.

C_{is} = Concentration of the internal standard (ng/UL).

C_x = Concentration of the compound to be measured (ng/uL).

TABLE 3

VOLATILE INTERNAL STANDARDS WITH CORRESPONDING TCL ANALYTES ASSIGNED FOR QUANTITATION

Bromochloromethane	1,4-Difluorobenzene	Chlorobenzene-d_5
Chloromethane	1,1,1-Trichloroethane	2-Hexanone
Bromomethane	Carbon Tetrachloride	4-Methyl-2-Pentanone
Vinyl Chloride	Vinyl Acetate	Tetrachloroethene
Chloroethane	Bromodichloromethane	1,1,2,2-tetrachloroethane
Methylene Chloride	1,2-Dichloropropane	Toluene
Acetone	Trans-1,3-dichloropropene	Chlorobenzene
Carbon Disulfide	Trichloroethene	Ethylbenzene
1,1-dichloroethene	Dibromochloromethane	Styrene
1,1-dichloroethane	1,1,2-Trichloroethane	Xylene (total)
1,2-Dichloroethene(Total)	Benzene	Bromofluorobenzene (Surrogate)
Chloroform	Cis-1,3-dichloropropene	Toluene-d_8(surrogate)
1,2-Dichloroethane	Boroform	
2-Butanone		
1,2-Dichloroethane-d_4 (surrogate)		

TABLE 2

CHARACTERISTIC IONS FOR VOLATILE ORGANIC COMPOUNDS

Parameters	Primary Ion	Secondary Ions
Chloromethane	50	52
Bromomethane	94	96
Vinyl Chloride	62	64
Chloroethane	64	66
Methylene Chloride	84	49, 51, 86
Acetone	43	58
Carbon Disulfide	76	78
1,1-Dichloroethene	96	61, 98
1,1-Dichloroethane	63	65, 83, 85, 98, 100
1,2-Dichloroethene	96	61, 98
Chloroform	83	85
1,2-Dichloroethane	62	64, 100, 98
2-Butanone	72	57
1,1,1-Trichloroethane	97	99, 117, 119
Carbon Tetrachloride	127	119, 121
Vinyl Acetate	43	86
Bromodichloromethane	83	85
1,1,2,2-Tetrachloroethane	83	85, 131, 133, 166
1,2-Dichloropropane	63	65, 114
Trans-1,3-Dichloropropene	75	77
Trichloroethene	130	95, 97, 132
Dibromochloromethane	129	208, 206
1,1,2-Trichloroethane	97	83, 85, 99, 132, 134
Benzene	78	-
Cis-1,3-Dichloropropene	75	77
Bromoform	173	171, 175, 250, 252, 254,
2-Hexanone	43	58, 57, 100
4-Methyl-2-pentanone	43	58, 100
Tetrachloroethene	164	129, 131, 166
Toluene	92	91
Chlorobenzene	112	114
Ethyl Benzene	106	91
Styrene	104	78, 103
Total Xylenes	106	91

The primary ion should be used unless interferences are present, in which case, a secondary ion may be used.

O-Xylene **	95-47-6	1.5
p-Xylene **	106-42-3	1.5

NOTE: * Common laboratory solvent. Control limits for blanks are 5 the method detection limits.

** m-Xylene, o-Xylene and p-Xylene are reported as a total of three.

TABLE 1

TARGET COMPOUND LIST (TCL) AND QUANTITATION LIMITS (QLs)

(FOR RESIDENTIAL WELL WATER SAMPLES)

VOLATILE ORGANICS	CAS NUMBER	QUANTITATION LIMITS
Benzene	71-43-2	1.5
Bromdichloromethane	75-27-4	1.5
Bromoform	75-25-2	1.5
Bromomethane	74-83-9	1.5
Carbon Tetrachloride	56-23-5	1.5
Chlorobenzene	108-90-7	1.5
Chloroethane	75-00-3	1.5
Chloroform	67-66-3	1.5
Chloromethane	74-87-3	1.5
Dibromochloromethane	124-48-1	1.5
1,1-Dichloroethane	75-34-3	1.5
1,2-Dichloroethane	107-06-2	1.5
1,1-Dichloroethene	75-35-4	1.5
1,2-Dichloroethene (Total)		1.5
1,2-Dichloropropane	78-87-5	1.5
Cis-1,3-Dichloropropene	10061-01-5	2.0
Trans-1,3-Dichloropropene	10061-02-6	1.0
Ethyl Benzene	100-41-4	1.5
Methylene Chloride (*)	75-09-2	1.0
1,1,2,2-Tetrachloroethane	79-34-5	1.5
Tetrachloroethene	127-18-4	1.5
Toluene (*)	108-88-3	1.5
1,1,1-Trichloroethane	71-55-6	1.5
1,1,2-Trichloroethane	79-00-5	1.5
Trichloroethene	79-01-6	1.5
Vinyl Chloride	75-01-4	1.5
Acrolein	107-02-8	25.0
Acetone (*)	67-64-1	5.0
Acrylonitrile	107-13-1	25.0
Carbon Disulfide	75-15-0	3.0
2-Butanone (*)	78-93-3	5.0
Vinyl Acetate	108-05-4	5.0
4-Methyl-2-Pentanone	108-10-1	1.5
2-Hexanone	519-78-6	5.0
Styrene	100-42-5	1.0
m-Xylene **	108-38-3	1.5

Monitoring and Support Laboratory, Cincinnati, Ohio,4526

14.6 Ho. J.S. Method Performance Data for Method 502.2, Unpublished Report, September, 1986.

14.7 "Gas Chromatographic Analysis of Purgeable Halocarbon a Aromatic Compounds in Drinking Water Using Two Detector in series," Kingsley, B.A., Gin, C., Coulson, D.M., and Thomas, R.F., Water Chlorination, Environmental Impact and Health Effects, Volume 4, Ann Arbor Science.

14.8 "EPA Method Validation Study 23, Method 601 (Purgeable Halocarbon)," U.S. Environmental Protection Agency, Environmental Monitoring and Support Laboratory, Cincinnati, Ohio 45268.

Calibration)

13.2.2.7 FORM VI (Initial Calibration Data)

13.2.2.8 FORM VII (Continuing Calibration D

13.2.2.9 FORM VIII (Internal Standard Area
Summary)

13.2.2.10 Raw Data

Raw data shall includes Reconstru
Ion Current (RIC) Chromatogram, M
spectrum (with and without backgr
substraction for all compounds
quantified,mass spectrum of tenta
identified compound including the
matched library standard spectra,
instrument printouts, etc.

14.0 REFERENCES

14.1 A. Alford-Stevens, J.W. Eichelberger, W.L. Budde,
"Purgeable Organic Compounds in Water by Gas Chrom
tography/Mass Spectrometry, Method 524." Environme
Monitoring and Support Laboratory, U.S. Environmen
Protection Agency, Cincinnati, Ohio, February 1983

14.2 Glaser, J. A., D. L. Foerst, G.D. McKee, S.A. Quav
W.L.Budde, "Trace Analyses for Wastewaters," Envir
Technol., 15, 1426, 1981.

14.3 "The Determination of Halogenated Chemicals in Wat
the Purge and Trap Method, Method 502.1, "Environ
Protection Agency, Environmental Monitoring and S
Laboratory, Cincinnati, Ohio 45268, April, 1981.

14.4 "Volatile Aromatic and Unstaturated Organic Compo
Water by Purge and Trap Gas Chromatography, Metho
Environmental Protection Agency, Environmental Mo
and Support Laboratory, Cincinnati, Ohio, April,

14.5 Bellar, T.A. and J.J. Lichtenberg, "The determina
Synthetic Organic Compounds in Water by Purge an
Sequential Trapping Capillary Column Gas Chromat
U.S.Environmental Protection Agency, Environment

C_{is} = Concentration of the internal standard, in ug/L.

12.3 Report results in ug/L. All QC data obtained should bereported with the sample results.

13.0 DATA REPROTING REQUIREMENTS

13.1 All reports and documentation must be legible,single-sided, and clearly labelled and paginated.

13.2 The sample data package must be consecutively paginated and shall include the cover pages, sample data, and the raw data as they are described in the following:

13.2.1 Cover Pages for the data package, including the project name; laboratory name; field sample number cross-referenced with laboratory ID number ; comments describing in details any problems encountered in processing the samples in the data package; and validation and signature by the Laboraotry Manager.

13.2.2 Sample Data

Sample data shall be reported using the Organic Analysis Data Reporting Forms (Attachment I) for all samples, arranging in increasing alphanumeric sample number order, followed by the QC analysis data, Quarterly verification of instrument parameters forms, raw data, and copie of the sample preparation logs.

13.2.2.1 FORM I (Organic Analysis Data Sheet)

13.2.2.2 FORM I (Tentatively Identified Compoun

13.2.2.3 FORM II (Surrogate Recovery)

13.2.2.4 FORM III (Matrix Spike/Matrix Spike Duplicate Recovery)

13.2.2.5 FORM IV (Method Blank Summary)

13.2.2.6 FORM V (GC/MS Tuning and Mass

maxima), appropriate analyte spectra and backg spectra can be selected by examining EICPs of characteriztic ions for tentatively identified components. When analytes coelute (i.e., only one GC peak is apparent), the identification criteria described in Section 11.1.2 can be me but each analyte spectrum will contain extrane ions contributed by the coeluting compound.

11.1.4 Structural Isomers that produce very similar mass spectra can be explicity identified only they have sufficiently different GC retention times. Acceptable resolution is achieved if th height of the valley between two isomer peaks less than 25% of the sum of the two peak heigh Otherwise, structural isomers are identified a isomeric pairs.

12.0 CALCULATION

12.1 When an analyte has been identified, the quantitation of that analyte should be based on the integrated abundance from the EICPs of the primary characteristic m/z given in Table____. If the sample produces an interference for the primary m/z, use a secondary characteristic m/z to quantitate. Instrument calibrati for secondary ions is performed, as necessary, using the data and procedures described in Section 8.2.

12.2 Calculate the concentration in the sample using the calibration curve or average response factor (RF) determined in Section 8.2.2 and Equation 3 :

$$\text{Concentration (ug/L)} = \frac{(A_s)\ (C_{is})}{(A_{is})\ (RF)} \qquad \text{Equ. 3}$$

Where,

A_s = Area of the characteristic m/z for the analyte to be measured;

A_{is} = Area of the characteristic m/z for the internal standard;

flow through the trap. When the trap is cool, the next sample can be analyz

10.5 TERMINATION OF DATA ACQUISITION

When sample components have eluted from the GC, terminat MS data acquisition and store data files on the data sys storage device. Use appropriate data output software to display full range mass spectra and appropriate EICPs. If any ion abundance exceeds the system working range, dilute the sample aliquot in the second syringe with reagent water and analyze the diluted aliquot.

11.0 QUALITATIVE IDENTIFICATION

11.1 IDENTIFICATION PROCEDURES CRITERIA

Tentatively identify a sample component by comparison of its mass spectrum (after background substraction) to a reference spectrum in a collection. Use the follwoing criteria to confirm a tentative identification:

11.1.1 The GC retention time of the sample component must be within 10 seconds of the time observed for that sample compound when a calibration solution was analyzed.

11.1.2 All ions that are present above 10% relative abundance in the mass spectrum of the standard must be present in the mass spectrum of the sample component and should agree within absolute 10%. For example, if an ion has a relative abundance of 30% in the standard spectrum, its abundance in the sample component should be in the range of 20 to 40%.

11.1.3 Identification is hampered when sample components are not resolved chromatographically and produce mass spectra containing ions contributed by more than one analyte. Because purgeable organic compounds are relatively small molecules and produce comparatively simple mass spectra, this is not a significant problem for most method analytes. When GC peaks obviously represent more than one sample component (i.e., broadened peak with shoulder(s) or valley between two or more bore capillary columns can be interfaced directly to the MS without a jet separator.

10.4.2.1 Sample Desorption

After the 11 minutes purge, attach the trap to the cyrogenically cooled interface at -15^{0}C and adjust the purge and trap system to the desorb mode. Introduce the trapped material to the interface by rapidly heating the trap to 180^{0}C while backflusing the trap with an inert gas at 4 ml/m for 5.0+0.1 min. While the extracted sample is being introduced into the interface,empty the purging device using the sample syringe and rinse t chamber with two 25-ml flushes of reagent water. After the purging device has been emptied, leave the syringe valve open to allow the purge gas to vent through the sample introduction needle. After desorbing for 5 minutes, flash heat the interf to 250^{0}C and quickly introduce the sample onto the chromatographic colu Start the temperature program sequen and initiate data acquisition.

10.4.2.2 Gas Chromatograph

Hold the column temperature at 10^{0}C for 5 minutes, then program at 6^{0}C/m to 70^{0}C and then at 15^{0}C/min to 145^{0}C.

10.4.2.3 Trap Reconditioning

After desorbing the sample for 5 minutes, recondition the trap by returning the purge and trap system the purge mode. Wait 15 seconds, the close the syringe valve on the purgi device to begin gas flow through the trap. Maintain the trap temperature at 180^{0}C. After approximately 15 minutes, turn off the trap heater an open the syringe valve to stop the g

10.4.1 Sample Desorption for Wide-Bore Capillary Colum

Undre most conditions,this type of column must interfaced to MS through a all-glass jet separat

10.4.1.1 After the 11-minute purge, attach the trap to the chromatograph, adjust the purge and trap system to the desorb mode and initiate the temperature program sequence of the gas chromatogr and start data aquisition. Introduce the trapped materials to the GC colum by rapidly heating the trap to 180^{0}C while backflushing the trap with an i gas at 15 ml/min for 4.0 + 0.1 min. While the extracted sample is being introduced into the gas chromatograph, empty the purging device using the sa syringe and wash the chamber with two 25-ml flushes of reagent water. After the purging device has been emptied, leave the syringe valve open to allow the purge gas to vent through the sam introduction needle.

10.4.1.2 Gas Chromatography - Hold the column temperature at 10^{0}C for 5 minutes, then program at 6^{0}C/min to 160^{0}C and hold until all analytes eluted.

10.4.1.3 Trap Reconditioning - After desorbing the sample for 4 min, recondition the trap by returning the purge and trap system to the purge mode. Wait 15 seconds, then closed the syringe valve on the purging device to begin gas flo through the trap. Maintain the trap temperature at 180^{0}C. After approximately 7 minutes, turn off the trap heater and open the syringe valve to stop the gas flow through the trap. When the trap is cool, the next sample can be analyzed.

10.4.2 Sample Desorption for Narrow-Bore Capillary Colu

Under normal operating conditions, most narrow-

10.2.1. The operating conditions for the gas chromatograph are summarized under Section 10.4.2.2 . Table 1 and Table 2 list the retention times and MDL that can be achieved under these conditions. Other columns or chromatographic conditions may be used if the requirements of Section 9.0 are met.

10.3 SAMPLE INTRODUCTION AND PURGING

10.3.1 Adjust the purge gas (nitrogen or helium) flo
rate to 40 ml/min. Attach the trap inlet to the purging device and open the syringe valve on the purging device.

10.3.2 Remove the plungers from two 25-ml syringes a
attach a closed syringe valve to each. Warm t
sample to room temperature, open the sample (
standard) bottle, and carefully pour the samp
into one of the syringe barrels to just short
overflowing. Replace the syringe plunger, inv
the syringe, and compress the sample. Open th
syringe valve and vent any residual air while adjusting the sample volume to 25.0 ml. Add 10 ul of the internal standard spiking soluti
(Section 6.8) and 10 ul of the surrogate spik
standard solution (Section 6.9) to the sample
through the syringe valve. Close the valve. F
the second syringe in an identical manner fro
the same sample bottle. Reserve the second syringe for a reanalysis if necessary.

10.3.3 Attach the sample syringe valve to the syring
valve on the purging device. Be sure that the trap is cooler than 25_0C, then open the sampl
syringe valve and inject the sample into the purging chamber. Purge the sample for 11.0 +0
min at ambient temperature.

10.4 SAMPLE DESORPTION

The mode of sample desorption is determined by the ty
of capillary column employed for the analysis. When using a wide-bore capillary column, follow thw desorp
conditions of Section 10.4.1 . The conditions for usi
narrow-bore capillary column is described in Section

NOTE: The larger number of analytes present a substantial probability that one or more wil fail at least one of the acceptance criteria when all analytes are analyzed.

9.2.5 When one or more of the analytes tested fail at le one of the acceptance criteria, the analyst must proceed according to Section 9.2.2 only for the analytes which fialed the test.

10.0 PROCEDURE OF SAMPLE ANALYSIS

10.1 DAILY GC/MS PERFORMANCE TESTS

10.1.1 At the beginning of each day that analyses are to be performed, the GC/MS system must be checked to see if acceptable performance criter are achieved for 4-Bromofluorobenzene (BFB). The performance test must be passed before any samples, blanks, or standard are analyzed.

10.1.2 At the beginning of each day, inject 2 ul (50 ng) of BFB solution directly onto the colum Alternatively, add 2 ul of BFB solution to 25.0 ml of reagent water or calibration standar and analyze the solution according to Section 1 Obtain a background-corrected mass spectrum of BFB and confirm that all the key m/z criteria i Table 3 are achieved. If all the criteria are not achieved, the analyst must re-tune the mass spectrometer and repeat the test until all criteria are achieved.

10.2 INITIAL CONDITIONS

10.2.1 Acquire GC/MS data for perfomance tests, standards and samples using the following instrumental conditions:

Electron Energy	:	70 V (Nominal)
Mass Range	:	35 to 300 amu
Scan Time	:	To give at least 5 scans per second, but not to excee 2 seconds per scan.

and correct the source of the problem a repeat the test for all compounds of interest beginning with 9.1.5.1.

9.1.6 The laboratory must maintain performance records to document the quality of data that is generate The following procedure should be performed:

9.1.6.1 It is recommeded that the laboratory adopt additional quality assurance practices for use with this method. The specific practices that are most produc depend upon the needs of the laboratory and the nature of the samples. As a min field duplicate samples must be analyze to assess the precision of the environm measurements.

9.2 To establish the ability to generate acceptable accurac and precision, the analyst must perform the following operations.

9.2.1 A quality control check sample concentrate conta each analyte at a concentration of 500 times the in methanol is required. The QC check sample mus prepared by the laboratorry using stock standard prepared independently from those used for calib

9.2.2 Analyze seven 25-ml QC check samples at 2 ug/L according to the method beginning in Section 10. Each sample is produced by injecting 10 ul of QC check sample concentrate into 25 ml of reagent w in a glass syringe through the syringe valve.

9.2.3 Calculate the average recovery (X) in ug/L, and standard deviation of the recovery (S) in ug/L for each analyte using the seven results. Calcul the MDL for each analyte as specified in Referen The calculated MDL must be less than the spike l

9.2.4 For each analyte, (X) must be between 90% and 11 the true value. Additionally, s must be <35% of If s and X for all analytes meet the criteria, t system performance is acceptable and analysis of actual samples can begin. If any s exceeds the precision limits or any X falls outside the rang for accuracy, the system performance is unaccept for that analyte.

9.1.4 The laboratory must, on an ongoing basis, demonstrate through the analyses of quality control check standards that the operation of the measurement system is in control. The frequency of the check standard analyses is equivalent ot 10% of all samples analyzed but at least two samples per month. Using the following procedure to analyze a quality control check sample for all analytes of interest at 10 ug/L:

9.1.4.1 Prepare a QC check sample by adding 50 ul of QC check sample concentrate to 25 ml of reagent water in a glass syringe.

9.1.4.2 Analyze the QC check sample according to Section 10, and calculate the recovery for each analyte. The recovery must be between 60% and 140% of the expected values.

9.1.4.3 If the recovery for any analyte falls outside the designated range,the analyte has failed the acceptance criteria. A check standard containing each analyte that failed must be re-analyzed.

9.1.5 On a weekly basis, the laboratory must demonstrate the ability to analyze low level samples. The following procedure should be used:

9.1.5.1 Prepare a low level check sample by spiking 10 ul of QCcheck sample concentrated to 25 ml of reagent water and analyze according to the method in Section 10.0 .

9.1.5.2 For each analyte, the recovery must be between 60% and 140% of the expected value

9.1.5.3 When one or more analytes fail the test, the analyst must repeat the test only for those analytes which failed to meet the criteria. Repeated failure, however, will confirm a general problem with the measurement system. If this occurs,locate

calibration is assumed to be valid. I
criteria are not met (>25.0% differen
for any one of the calibration check
compound, corrective action MUST be t
Problems similar to those listed unde
SPCC could affect this criteria. If n
source of the problem can be determin
after corrective action have been tak
a new initial five points calibration
be generated. These criteria MUST be
before sample analysis begins.

9.0 QUALITY CONTROL

9.1 Each laboratory that uses this method is required to operate formal quality control program. The minimum requirements of this program consists of an intial demonstration of laboratory capability and an ongoing analysis of spiked samples to evaluate and document data quality. The laboratory must maintain records to document the quality of data that is generated. Ongoin data quality checks are compared with established perfromance criteria to determine if the results of analysis meet the performance characteriztics of the method. A quality control check standard must be analyzed to confirm that the measurements were performed in an in-control mode of operation.

9.1.1 The analyst must make an initial, one-time, demonstration of the ability to generate acceptable accuracy and precision with this method. This ability is established as are described in Section 9.2 .

9.1.2 In recognition of advances that are occurring in chromatography, the analyst is permitted certain options (detailed in Section 10.2.2) to improve the separation or lower the cost of measurements Each time such a modification is made to the method, the analyst is required to repeat the procedure in Section 9.2 .

9.1.3 Each day, the analyst must analyze a reagent water blank to demonstrate that interferences from the analytical system are under control.

8.2.1.5 Use equation 2 and the relative respon factors (RRF) from the initial calibra tion to calculate the relative standar deviation (%RSD) for compounds labelle as calibration check compounds in Tabl

$$\%\text{RSD} = \frac{\text{SD}}{\text{X}} \times 100 \qquad \text{Equati}$$

Where,

RSD = Relative Standard Deviation

SD = Standard Deviation of initial relative response factors (per compound).

$$\text{Where : SD} = \overset{N}{\underset{i=1}{}} \quad \frac{(X_i - X)^2}{N-1}$$

X = Mean of initial relative response factors (per cc

The %RSD for each individual calibrati check compound must be less than or eq to 30.0%. This criteria must be met fc the initial calibration to be valid.

8.2.1.6 System Performance Check

A system performance check must be per to insure that minimum average relativ response factors are met before the ca tion curve is used. This is done by an five system check compounds (SPCCs): Chloromethane, 1,1-dichloroethane, brc 1,1,2,2-tetrachloroethane, and chlorob The minimum acceptable RRF for these c is 0.300 (0.150 for bromoform).

8.2.1.7 The initial calibration is valid only both the %RSD for calibration check cc

and the minimum RRF for SPCC have been m
Only after both of these criteria are me
sample analysis begin.

8.3 Continuing Calibration Check

8.3.1 A calibration standard(s) containing all volatile organics listed in Table 2, including all require surrogate compounds, must be analyzed each twelv hours during analysis. The concentration of each compound in the continuing calibration check (C is 20 ug/L except acrolein and acrylonitrile (50 ug/L). Compare the relative response facto data from the standards each twelve hours with t average relative response factor from the initia calibration for a specific instrument. A system performance check must be made each twelve hours. If the SPCC criteria are met, a comparison of relative response factors is made for all compoun

8.3.2 After the system performance check is met, use equation 4 to calculate the percent difference (% difference) for all calibration check compound in Table 4 in order to check the validity of the initial calibration.

8.3.2.1 Calculate the percent difference using Equation 4.

$$\%\text{Difference} = \frac{RRF_I - RRF_C}{RRF_I} \times 100 \qquad \text{Eq. 4}$$

Where

RRF_I = Average relative response factor from initial calibration.

RRF_C = Relative response factor from current calibration check.

8.3.2.2 If the percent difference for any compou is greater than 20%, the laboratory shou consider this a warning limit. If the percent difference for each CCC is less than or equal to 25.0%, the initial

APPENDIX C

INSTALLATION PROCEDURES FOR MONITORING WELLS AND PIEZOMETERS AT GENERATING STATIONS AND ASH LANDFILLS

NEW YORK STATE ELECTRIC & GAS CORPORATION

ENVIRONMENTAL MATTERS GROUP

INSTALLATION PROCEDURES FOR MONITORING WELLS AND PIEZOMETERS AT GENERATING STATIONS AND ASH LANDFILLS

REVISION 4
June 1989

PREPARED BY: J.D. Gray

APPROVED BY:

P.G. Carney
Manager, Environmental Matters

J.B. Marean
Supervisor, Remedial Investigations

T.M. Turner
Manager, Environmental Performance

INSTALLATION PROCEDURES
FOR
MONITORING WELLS AND PIEZOMETERS
AT
GENERATING STATIONS AND ASH LANDFILLS

jdg\rpt\1

1.0 GENERAL

These procedures have been developed to ensure that monitoring wells and piezometers at NYSEG's generating stations and ash landfills are installed in a consistent manner that both meets New York State regulations and provides representative groundwater measurements. All monitoring well and piezometer installations shall be done under the supervision of NYSEG or its Agent in accordance with these procedures.

2.0 PLACEMENT AND SPACING

2.1 Monitoring wells and piezometers may be placed individually or as clusters. Each well or piezometer grouped in a cluster must be installed in its own borehole.

2.2 Horizontal spacing of monitoring wells must not exceed 500 feet along the downgradient perimeter of a site. Upgradient or cross-gradient horizontal spacing must not exceed 1500 feet.

2.3 At a minimum, well spacing must provide at least one upgradient and three downgradient monitoring wells or well clusters for each waterbearing unit. The downgradient wells must be located as close as practically possible to the waste boundary to ensure early detection of any contaminant plume.

2.4 Upgradient wells should be installed first, if possible.

2.5 Monitoring wells that require a curb box-type installation shall not be located in low areas which are subject to flooding or ponding of surface runoff.

3.0 ON-SITE WELL ACCESS

3.1 Wells and piezometers should be located in areas that are accessible by vehicle with minimal disruption of the site.

3.2 If wells or piezometers must be located in areas accessible only on foot, a clear pathway must be constructed by the consultant or contractor. This may include planked crossings of small creeks or swampy areas.

3.3 Where necessary, a cleared area of sufficient size to allow development and sampling of the wells is to be provided by the consultant or contractor.

3.4 Private property adjacent to NYSEG's facilities shall not be entered or occupied by men, equipment, or materials without prior written consent of the landowner. Care shall be exercised in conducting operations on private property to minimize the amount of disturbance and damage related to gaining access to, and working at the locations.

4.0 DRILLING PRECAUTIONS

4.1 Contaminants must not be introduced into the borehole during drilling. Only potable water may be used when drilling or installing wells and piezometers unless otherwise approved by NYSEG.

4.2 All tools, materials and equipment that are placed into a borehole or well must be decontaminated with a steam cleaner. Decontamination must be done prior to the start of drilling, and between each hole.

4.3 Air systems or drilling lubricants must not introduce contaminants into a borehole.

4.4 The use of drilling muds should be avoided. If their use is unavoidable, no stray contaminants may be introduced into the subsurface along with the mud. Under no circumstances are drilling muds to be used within ten feet of the screened interval.

5.0 MATERIALS

5.1 Well casings and screens must be flush-jointed, schedule 40 Polyvinyl Chloride (PVC), with nominal 2-inch inside diameter. All casings and screens shall be of threaded and coupled construction. Well screens must be factory slotted.

5.2 Joints, caps and end plugs must be secured by welds, threads with teflon tape or force fittings. The use of solvents, glues or other adhesives is prohibited. Well caps must be vented.

5.3 Bentonite pellets or slurry must be used as well seal material. Other suitable, low-permeability material may be utilized if approved in advance by NYSEG.

5.4 Guard pipes must be schedule 40 PVC with nominal 6-inch inside diameter, unless otherwise specified by NYSEG.

5.5 Royer aluminum locking caps (Attachment A) are to be installed on each guard pipe. The cap locking hole must be redrilled to 7/16 inch.

5.6 Bollards (guard posts) must be galvanized steel, nominal 4-inch inside diameter (or greater) and filled with cement grout.

5.7 Well locks will be provided by NYSEG. Russwin Substation padlock stock room number 231-450-75 (short shank).

5.8 The filter pack surrounding a well screen must be clean, inert, siliceous material of relatively uniform size (Section 7.5.a).

5.9 Curb box wells should be provided with non-rusting (e.g., galvanized, brass) lockable riser caps capable of accepting a 7/16 inch diameter lock shank.

6.0 SAMPLING AND TESTING

6.1 Samples must be collected for all borings. In unconsolidated sediment, samples will be taken from each 5 feet of penetration at a minimum and at every change of formation. In bedrock, sample intervals will be specified by NYSEG.

6.2 For well clusters, the deepest well must be sampled at 5-foot intervals at a minimum and at every change in formation. Other wells in the cluster may be sampled at significant stratigraphic changes and at the screened interval.

6.3 Continuous sampling may be required in any boring that is necessary for determining the subsurface conditions of a site.

6.4 Samples shall be taken using a split-barrel sampler conforming to the requirements of ASTM D 1586. Other sampling methods must receive prior approval from NYSEG. Bedrock must be sampled by coring with NX-size or larger diameter core bits.

6.5 Samples must be retained in labeled glass jars or wooden core boxes and returned to NYSEG for storage. Unconsolidated samples will be retained for three years and cores will be retained for the life of a facility.

6.6 A representative number of undisturbed samples from soil borings must be analyzed in the laboratory for Atterberg limits, gradation curves, permeabilities, and visual descriptions.

6.7 Complete and accurate drilling logs must be provided for all soil borings. Logs must provide detailed soil classification according to the Unified Soil Classification System (USCS) (ASTM D 2487). Logs must record the date started and completed, descriptions of materials penetrated, depth to significant stratigraphic changes, elevation of water table, points where loss or gain of water occurred; penetration resistance (blow counts) of split spoon sampler; and other pertinent comments.

6.8 Rock core logs must describe the lithology, mineralogy, degree of cementation, color, grain size, and any other physical characteristics of the rock; percent recovery and the rock quality designation (RQD); other primary and secondary features, and contain all drilling observations and appropriate details required for soil boring logs. A clear photographic record of all labeled cores must also be taken and submitted with the logs.

6.9 Well completion diagrams must be submitted for all monitoring wells and piezometers. These must show details of well construction, description of materials, and elevations or depths of all well features.

6.10 In-situ hydraulic conductivity testing must be done in all monitoring wells and piezometers unless otherwise specified by NYSEG. Hydraulic conductivities may be determined by pump tests, packer tests, slug tests or other suitable methods.

7.0 CONSTRUCTION PROCEDURES

7.1 Well borings must have an inside diameter at least 2 inches larger than the outside diameter of the well casing to ensure proper placement of filter pack and annular seal.

7.2 Each monitoring well must be equipped with a 5-foot blank section of PVC casing (with end cap) below the well screen. This is intended to act as a sediment trap during well development. The annular space around the sediment trap will be backfilled with native material or bentonite.

7.3 All casing and screens shall be straight as assembled and shall be installed true and vertical.

7.4 Screen Placement

a. Factory-slotted well screens are required for all monitoring wells. Piezometers may be field slotted if prior approval is obtained from NYSEG.

b. The slot size of the screen must be small enough to retain 90% of the filter pack (d_{10} grain size). In most installations, a 0.010 inch slot will be appropriate.

c. Well screens must be confined to discrete stratigraphic or hydrologic intervals and cannot be placed so that they act as conduits through aquicludes and aquitards.

d. Screens must be placed so that sampling can occur during seasonal water table variations.

e. Screen length will depend on water table depth variations, site stratigraphy, expected contaminant behavior and groundwater flow; but no well screen can exceed 20 feet in length.

7.5 Filter Pack Procedures

a. The filter pack must minimize the influx of fine material into the well while not inhibiting water inflow to the screen. The filter pack grain size should have a d_{30} that is 4 to 6 times greater than the d_{30} of the formation material to be screened. NYSEG may require a sieve analysis of the zone to be screened to determine correct filter pack grain size.

b. The uppermost 6 inches of the sand pack, between the sand and bentonite seal, must consist of a finer-grained sand. This capping layer must have 100% pass a #30 sieve and less than 2% pass a #200 sieve.

c. The filter pack must be placed using the tremie method to avoid bridging of the material. Alternate methods may be used if written procedures demonstrating their effectiveness are submitted and approved by NYSEG prior to filter pack placement.

d. The filter pack may not extend more than 2 feet above the top, or 6 inches below the bottom of the screen.

e. The filter pack level must be checked for proper placement with a weighted measuring tape or equivalent method.

7.6 Annular Seal Procedures

a. Bentonite pellets or slurry must be placed above the filter pack to form a seal at least 3 feet thick. The bentonite must be placed using the tremie method. NYSEG may approve other methods that avoid bridging of the bentonite seal, if written procedures are submitted prior to well installation.

b. The annular space from the bentonite seal to the surface must be completely filled with bentonite slurry or Volclay grout. Other low permeability material may be used if warranted by geologic or hydrologic conditions. NYSEG must approve the use of alternate material prior to its placement.

c. The annular seal must be placed as a slurry under pressure using the tremie method. Any grout mixture must set up without being diluted by formation water and must displace water in the annular space to ensure a continuous seal.

d. Auger flights or casing must be left in the borehole prior to slurry emplacement to prevent caving of formation material. Auger flights or casing are retracted as the borehole is filled.

7.7 Curb boxes should be left open at their bottoms to promote drainage of infiltrating surface water (see Attachment C for other details).

7.8 Curb box interiors should be provided with a gravel pack or a similar drainage medium to within approximately 4 inches of the riser top.

7.9 Curb boxes should be installed with their tops slightly above grade to prevent surface water infiltration. A sloped concrete apron should be constructed around the lip of the protruding curb box to prevent damage to tires or mowing machines.

8.0 PROTECTION MEASURES

8.1 Each monitoring well or piezometer must be enclosed in a protective casing or guard pipe (Attachment B).

a. The guard pipe will consist of 6-inch inside diameter schedule 40 PVC (Section 5.5) unless otherwise specified by NYSEG.

b. The guard pipe must be drilled with 3/4-inch diameter holes (minimum of 10) below grade to restrict movement prior to grout hardening. A single 3/8-inch diameter weep hole must be drilled just above grade to allow drainage of accumulated water. (Attachment B)

c. The guard pipe must be centered around the riser and extend no more than 2.5 feet ± 3 inches above grade. The riser top must be 8 inches ± 1 inch below the top of the guard pipe.

d. The guard pipe must be secured in place by a surface seal of cement grout. The grout must extend 2 feet below ground level to prevent heaving of the guard pipe.

8.2 Monitoring wells or piezometers installed near roadways or in areas affected by operation and maintenance activities may need additional protection. NYSEG may require the consultant or designated subcontractor to provide a minimum of 3 bollards or guard posts around each well or well cluster (Attachment D).

a. Bollards must consist of 4-inch (or greater) galvanized steel pipe filled with cement grout.

b. The cement grout must extend above the pipe and must be rounded to prevent accumulation of water in the bollard.

c. Bollards should be located from 5 to 10 feet from the well or well cluster.

d. Bollards must be set in a 2 feet x 2 feet x 2 feet deep concrete footing or grouted in a 6-inch diameter hole augered to a depth of 3 feet.

e. Bollards should extend 5 feet ± 6 inches above grade, and will be painted with yellow enamel suitable for outdoor machinery.

8.3 Monitoring wells and piezometers must be equipped with aluminum locking caps (Section 5.6) and locked as soon as possible after installation.

9.0 DEVELOPMENT AND SAMPLER INSTALLATION

9.1 All wells and piezometers will be developed as soon as possible after installation but not before the well seal has set. NYSEG Field Sampling Group will be responsible for all well development.

9.2 Development will be by surging with a block or bailer, or over pumping, with the goal of reducing turbidity below 5 NTU, as recommended by the USEPA RECRA Groundwater Technical Enforcement Guidance Document.

9.3 The consultant may observe the NYSEG well development operation.

9.4 Geomon gas-drive samplers will be installed in each monitoring well by NYSEG or the manufacturer (Aquifer Systems) after well development. Geomons will be installed within 1 foot of the bottom of the screened interval.

10.0 WELL IDENTIFICATION

10.1 Each well must be painted with red enamel paint suitable for outdoor machinery.

10.2 The exterior of each well must be marked in large white letters with its NYSEG I.D. code, which can be found on the field sampling request.

10.3 The locking cap and curb box lid (where appropriate) of each well also must be indelibly marked on its inside surface with the appropriate NYSEG I.D. Code.

10.4 A red-painted, 6-foot high metal stake or Carsonite marker must be placed adjacent to every well or cluster to ensure its visibility in deep snow or thick underbrush. Where this is not possible, measurements to nearby permanent landmarks are to be provided.

10.5 New monitoring wells and piezometers shall be surveyed to obtain precise elevations and locations. Vertical measurements of the ground surface elevation, and the elevation of top of the monitoring well casing or piezometer riser or the Geomon brass fitting must be accurate to the nearest one hundredth foot.

11.0 GUARANTEE AND INSPECTION

11.1 The contractor or consultant shall guarantee that materials and workmanship will be as specified and that unsatisfactory workmanship or materials will be repaired or replaced at his expense for one year after completion of work.

11.2 A NYSEG representative shall have the right to inspect all materials and observe all work during the installation.

11.3 A NYSEG representative will be notified of changes in work schedule or problems that arise on-site during the installation.

11.4 The contractor or consultant shall protect all structures on site such as walks, pipelines, trees, shrubbery, and lawns during the progress of this work; shall remove from the site all debris and unused materials; and shall, upon completion of the work, restore the site as nearly as possible to its original condition. Paper, cans, bags, and other trash shall be disposed of daily. Water displaced from the well during drilling or pumped from the well shall be conducted to a place where it will be possible to dispose of the water without damage to property or the creation of a nuisance.

11.5 Following completion of all items in this procedure, an acceptance inspection will be conducted by NYSEG (one member field sampling group, the project requestor and the field inspector).

ATTACHMENT A

Locking Well Cap

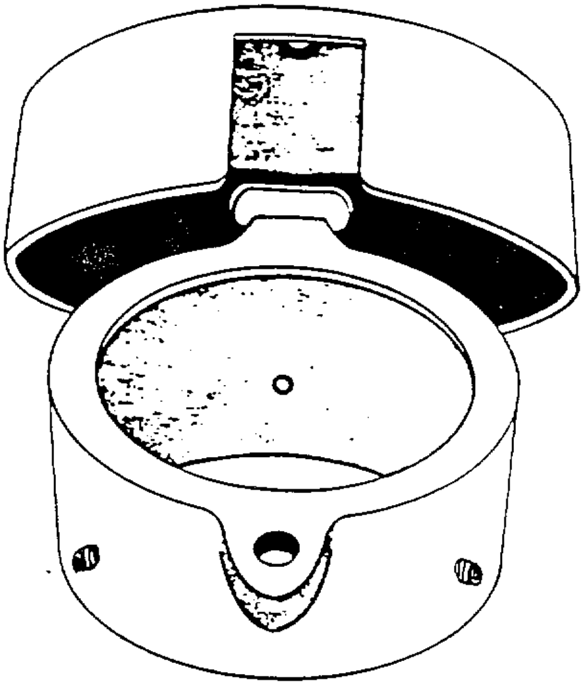
·Well Casing Cover Cap (Aluminum)

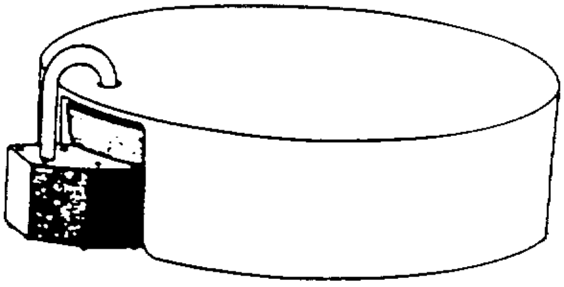
PREVENTS VANDALISAM

IDEAL FOR MONITORING WELLS

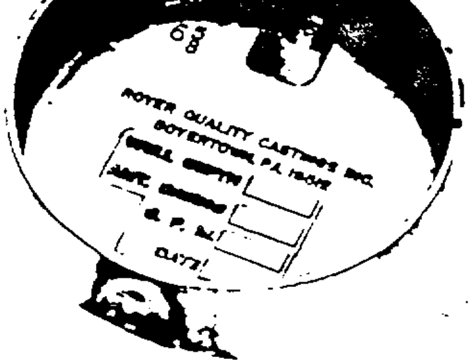
Royer

MARK OF QUALITY





FIVE SIZES AVAILABLE



NEW FEATURE • At no additional Cost

PERMANENT WELL LOG PAD

RECORDS ★ Well Depth
★ Amount of casing
★ Gallons per minute
★ Date

Use 3/16" Punch Set
Pad cast on inside of cap.

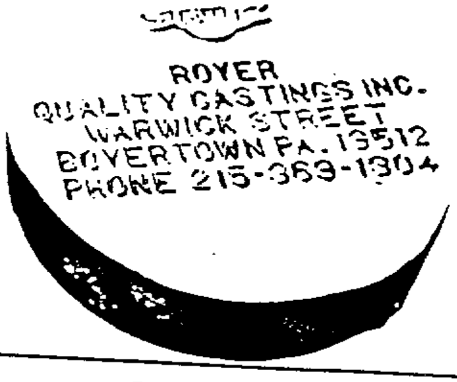
NO - MINIMUM ORDER REQUIRED FOR LOCKING CAPS

AVAILABLE • At a small additional cost.

PERSONALIZED IMPRINTING

YOUR - Name, Phone and Address cast as illustrated for a small additional charge per cap in addition to the plain cap price.

MINIMUM ORDER FOR IMPRINTED CAPS 50
A 10% deviation of order possible on imprinted caps.



IT'S SMART ADVERTISING AND IDENTIFICATION

SOLD IN U.S.A. AND CANADA

or additional information see your wholesaler or write direct for free catalog.

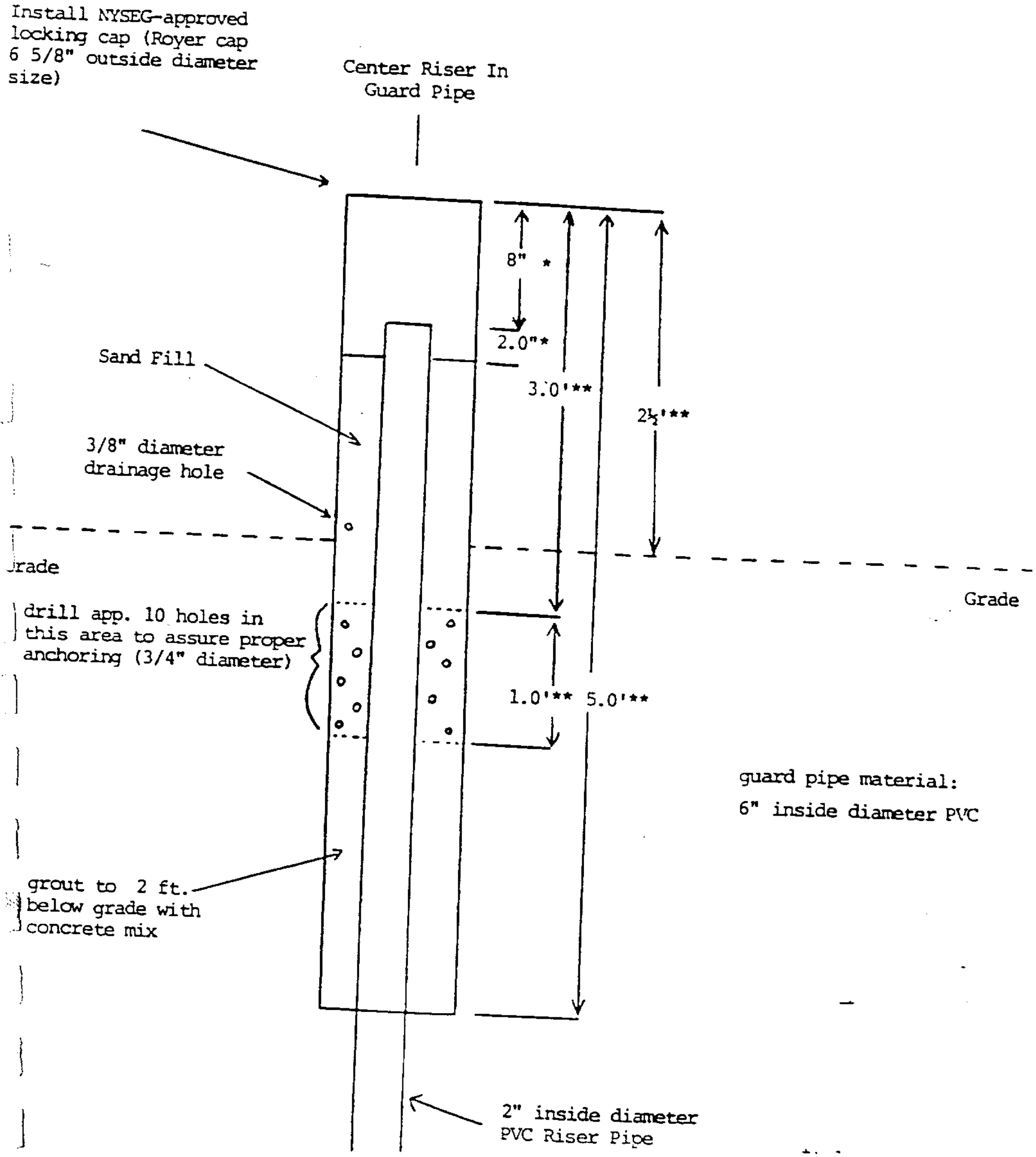
ROYER QUALITY CASTINGS. INC.
380 S. Reading Ave. (Rear)
Boyertown, PA. 19512 U.S.A

SIZES AVAILABLE
Order all sizes by O.D. of casing
Well Cap or Regular Well Cap

I.D. CASING OR PIPE	O.D. CASING OR PIPE	ORDER O.D. WELL CAP SIZE
4"	4½"	[illegible]
6" 6⅛" 6¼"	6⅝"	[illegible]
6⅜" 6½"	7"	[illegible]

ATTACHMENT B

MONITORING WELL AND PIEZOMETER GUARD PIPE INSTALLATION

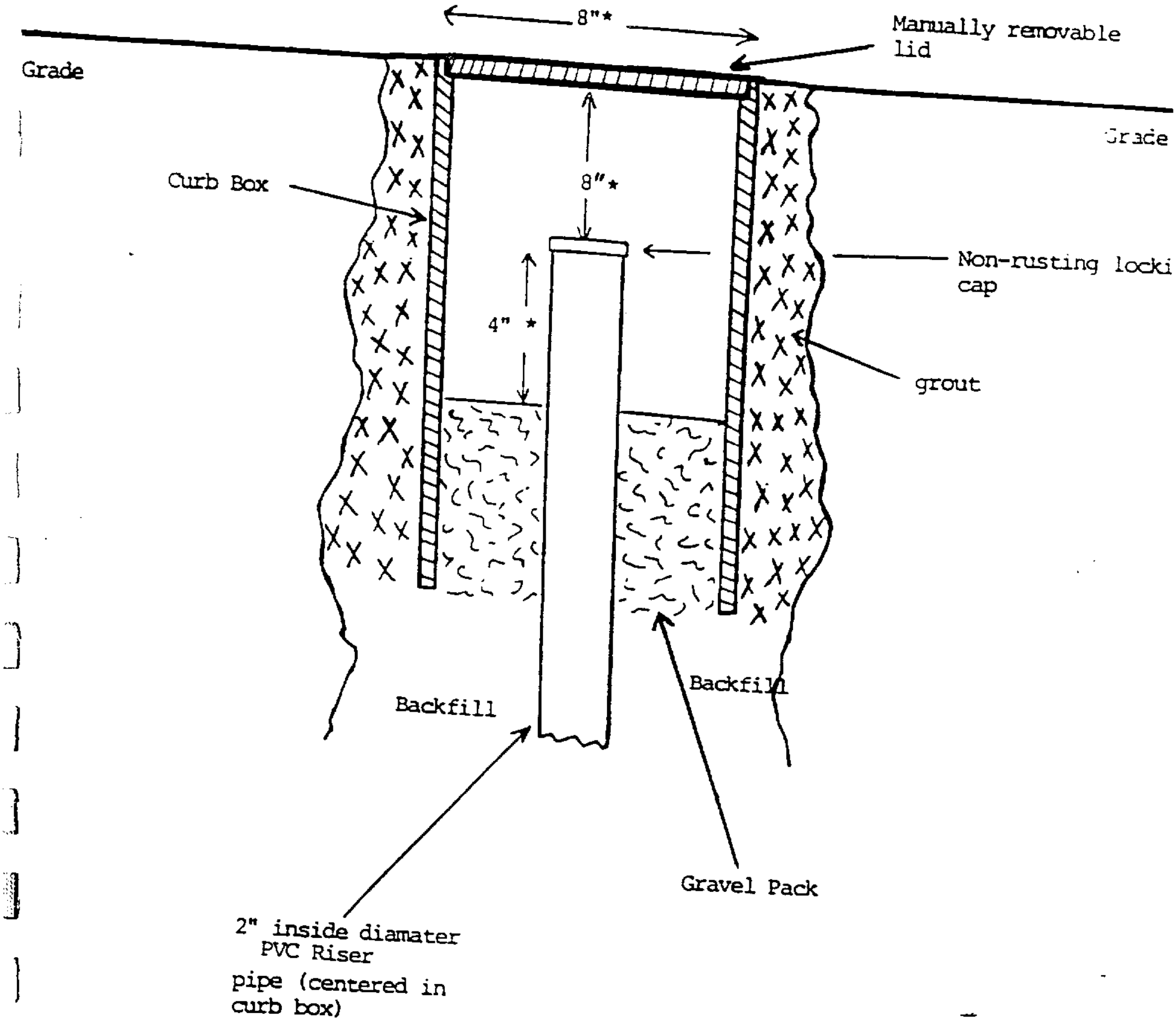


guard pipe material:

6" inside diameter PVC

ATTACHMENT C

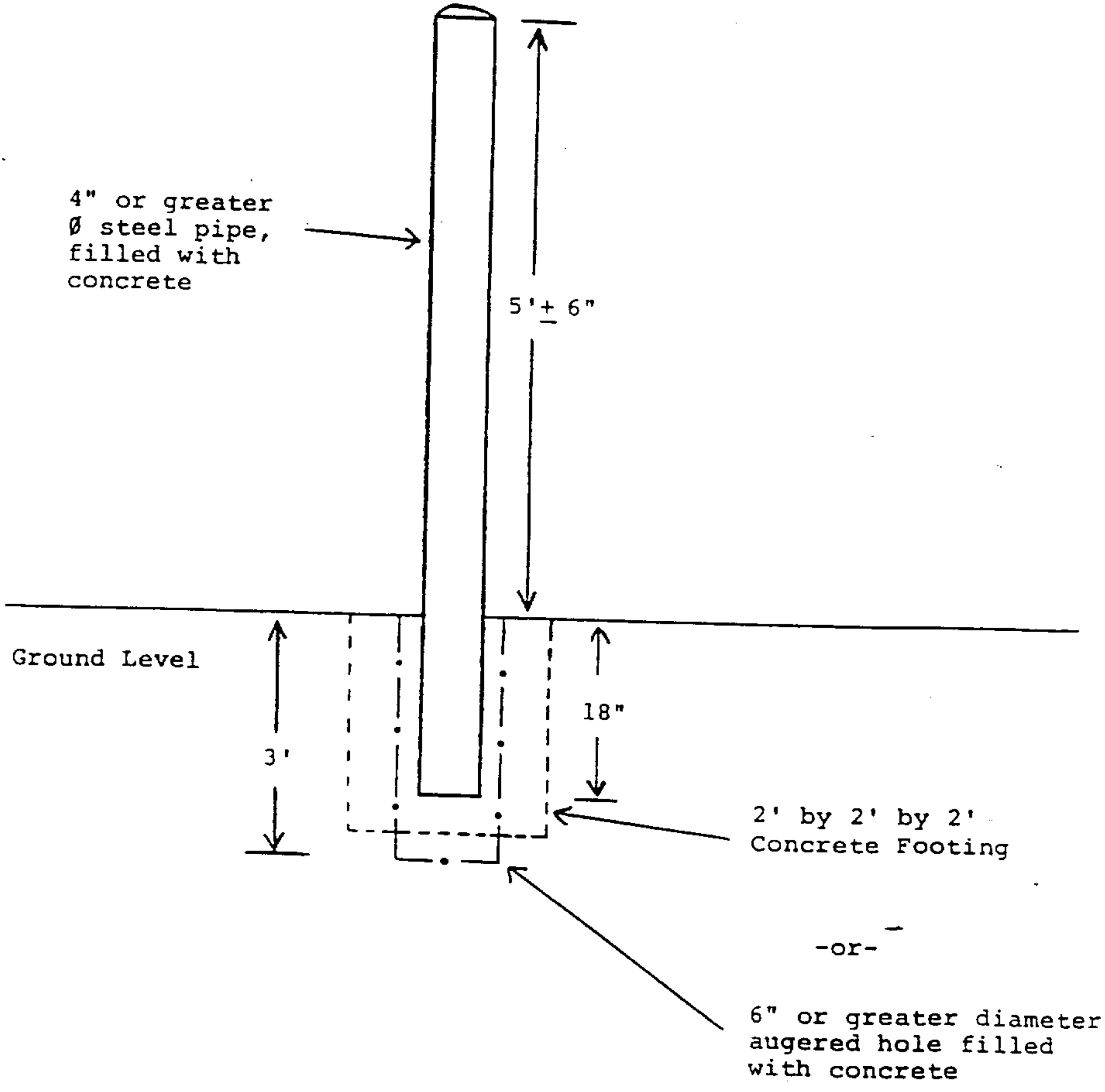
MONITORING WELL AND PIEZOMETER CURB BOX INSTALLATION



*tolerances + 1/2"

ATTACHMENT D

BOLLARD (GUARD POST) INSTALLATION



APPENDIX D

SUBMISSION GUIDELINES FOR CONTRACTORS DOING GROUNDWATER SAMPLING FOR NYSEG

Submission Guidelines for Contractors Doing Groundwater Sampling for NYSEG

Preparation of Sampling Event Data:

A. Analytical Data:

Groundwater sampling data obtained for NYSEG needs to be submitted to NYSEG in electronic form. After lab work has been performed, and the data has been blank-corrected, the results of these tests should be entered into a Lotus 1-2-3 spreadsheet form in the following order: (See Table 1)

DATE: The date of the sampling event.

SITEID: The 10-digit NYSEG code for this well.

WELLID: The MW site designator for the well (i.e., MW-1).

CLASS: The class of substance that this is, (i.e., PAH, VOLATILE AROMATIC, etc.) This field is discretionary.

CATEGORY: The category of substance that this sample belongs to. Categories include VOLATILE ORGANICS, SEMI-VOLATILE ORGANICS, OTHER VOLATILES, CYANIDES and METALS.

NAME: The commonly accepted name for this substance. For a list of approved spellings of these substances see Appendix A.

CONCENTRATION: The concentration in mg/l. Non-detects should report the minimum detection level and insert a "U" into the IsMDL field described below. Amounts detected but below the minimum detection level should be reported as actual values and insert a "J" into the IsMDL field.

CAS#: The CAS Number for this substance, as defined in the EPA Book of Lists, or as available from NYSEG. This number should omit any hyphens.

MDL: The minimum detection level in mg/l of your equipment for this substance. In the absence of any standard, the value reported in the 1988 EPA Book of Lists should be entered.

ISMDL: Indicate whether this sample resulted in a non-detect for this substance by entering a "U". If the sample exceeded your Minimum Detection Level then enter a "N". If the sampling resulted in a detection that was below your minimum detection level then enter a "J".

B. Groundwater Elevation/Monitoring Well Data:

Water elevation data from the wells should be made available for each sampling event:

SURFACE: The ground (not top of riser) elevation of this well, in feet above sea level.
TOP OF SCREEN: the top of the screening interval for this well, in feet above sea level.
WATER ELEVATION: the water elevation in the well, in feet above sea level.
BOTTOM OF SCREEN: The bottom of the screening interval, in feet above sea level.

Data shall be placed in the supplied template. Please enter ONLY blank-corrected data. Notify NYSEG if you are unable to blank-correct this information. Submit the results of one sampling event in a single spreadsheet. You will need to avoid submitting duplicate sampling data. Much work on your part can be avoided by using this template and filling it out with blank or default data, and then filling out the exceptions. Assistance can be made available in converting other reporting formats to this line-oriented version. The final finished report can be submitted in either 3.5" or 5.25", high or low density format as a Lotus version 2.2 .WK1 file. This file will be directly imported into NYSEG's database system, avoiding errors and lost information.

Appendix A

Substance	Class	Category	Cas#	Nysegcode
1,1,1-Trichloroethane			71556	1TCE
1,1,2,2,Tetrachlorethane			79345	2TRE
1,1,2,2,Tetrachloroethane			79345	2TRE
1,1,2,2-tetrachloroethane			79345	2TRE
1,1,2-trichloroethane			79005	2TCE
1,1-dichloroethane			75343	1DEA
1,1-dichloroethene			75354	1DCE
1,1-dichloroethylene			75354	1DCE
1,2,4-trichlorobenzene			120821	4TCB
1,2-dichlorobenzene			95501	2DCB
1,2-dichloroethane			107062	2DEA
1,2-dichloropropane			78875	2DCP
1,3-dichlorobenzene			541731	3DCB
1,4-dichlorobenzene			106467	4DCB
2,4 Dimethyl Phenol	OTHER SEMI-VOLATILE	SEMI-VOLATILE ORG	105679	4DMP
2,4,5-trichlorophenol			95954	
2,4,6-trichlorophenol			88062	
2,4-dichlorophenol			120832	
2,4-dimethylphenol			105679	
2,4-dinitrophenol			51285	
2,4-dinitrotoluene			121142	4DNT
2,6-dinitrotoluene	OTHER SEMI-VOLATILE	SEMI-VOLATILE ORG	606202	6DNT
2-4 Dimethylphenol	OTHER SEMI-VOLATILE	SEMI-VOLATILE ORG	105679	4DMP
2-butanone	OTHER VOLATILES	VOLATILE ORGANICS	78933	2BUT
2-chloroethylvinyl Ether			110758	2CEE
2-chloroethylvinylether			110758	2CEE
2-chloronaphthalene			91587	
2-chlorophenol			95578	2CPN
2-hexanone			591786	2HEX
2-methylnaphthalene	OTHER SEMI-VOLATILE	SEMI-VOLATILE ORG	91576	2MNP
2-methylphenol			95487	
2-nitroaniline			88744	
2-nitrophenol			88755	
3,3'-dichlorobenzidine			91941	
3-nitroaniline			99092	
4,4'-DDT			50293	DDT-
4,6-dinitro-2-methylphenol			534521	
4-bromophenyl-phenylether			101553	
4-chloro-3-methylphenol			59507	4C3M
4-chloroaniline			106478	
4-chlorophenyl-phenylether			7005723	
4-methyl-2-pentanone			108101	4M2P
4-methylphenol			106445	
4-nitroaniline			100106	
4-nitrophenol			100027	4NTP
Acenaphthene	PAH	SEMI-VOLATILE ORG	83329	ACEN
Acenaphthylene	PAH	SEMI-VOLATILE ORG	208968	ACYL
Acetaldehyde			75070	
Acetone	OTHER VOLATILES	VOLATILE ORGANICS	67641	ACET
Acrolein			107028	ACRL
Acrylonitrile			107131	ACNT
Aldrin			309002	ALDR
Amenable Cyanide	CYANIDE	OTHER CHEMICALS		CN-A
Anthracene	PAH	SEMI-VOLATILE ORG	120127	ANTH
Benzene	VOLATILE AROMATICS	VOLATILE ORGANICS	71432	BZ-

Benzo(A)Anthracene	PAHSEMI-VOLATILE ORG	56553	BZAN
Benzo(A)Pyrene	PAHSEMI-VOLATILE ORG	50328	BZPY
Benzo(B)Fluoranthene	PAHSEMI-VOLATILE ORG	205992	BZBF
Benzo(G,H,I)Perylene	PAHSEMI-VOLATILE ORG	191242	BZPE
Benzo(K)Fluoranthene	PAHSEMI-VOLATILE ORG	207089	BKFA
Benzoic Acid		65850	
Benzyl Alcohol		100516	
Bis(2-chloroethoxy)Methane		111911	
Bis(2-chloroethyl)Ether		111444	
Bis(2-chloroisopropyl)Ether		39638329	
Bis(2-ethylhexyl)Phthalate	OTHER SEMI-VOLATILESEMI-VOLATILE ORG	117817	BEHP
Bromodichloromethane		75274	BRDM
Bromoform		75252	BRFM
Bromomethane		74839	BRME
Butylbenzylphthalate		85687	
Carbon Disulfide	OTHER VOLATILESVOLATILE ORGANICS	75150	CS2-
Carbon Tetrachloride		56235	CTET
Carbon Tetrachloride	OTHER VOLATILESVOLATILE ORGANICS	56235	CTET
Chlorobenzene		108907	CLBZ
Chloroethane		75003	CLET
Chloroform		67663	CLFM
Chloromethane		74873	CLMT
Chrysene	PAHSEMI-VOLATILE ORG	218019	CRYS
Cis-1,3-dichloropropene		10061015	CDCP
Di-n-butyl Phthalate	OTHER SEMI-VOLATILESEMI-VOLATILE ORG	84742	DBPT
Di-n-butylphthalate		84742	
Di-n-octyl Phthalate		117840	
Dibenz(A,H)Anthracene		53703	
Dibenzo(A,H)Anthracene	PAHSEMI-VOLATILE ORG	53703	DBAH
Dibenzofuran	OTHER SEMI-VOLATILESEMI-VOLATILE ORG	132649	DBFU
Dibromochloromethane		124481	DBCM
Dieldrin		60571	DEDR
Diethyl Phthalate	OTHER SEMI-VOLATILESEMI-VOLATILE ORG	84662	DEPT
Diethylphthalate		84662	
Dimethyl Phthalate	OTHER SEMI-VOLATILESEMI-VOLATILE ORG	131113	DMPT
Endrin		72208	ENDR
Ethanol		64175	
Ethylbenzene	VOLATILE AROMATICSVOLATILE ORGANICS	100414	ETBZ
Ferro-ferri Cyanide	CYANIDEOTHER CHEMICALS		CNFE
Fluoranthene	PAHSEMI-VOLATILE ORG	206440	FLAN
Fluorene	PAHSEMI-VOLATILE ORG	86737	FLUR
Heptachlor		76448	HPCL
Hexachlorobenzene		118741	
Hexachlorobutadiene		87683	
Hexachlorocyclopentadiene		77474	
Hexachloroethane	OTHER SEMI-VOLATILESEMI-VOLATILE ORG	67721	HCET
Indeno(1,2,3,-cd)Pyrene	PAHSEMI-VOLATILE ORG	193395	INPY
Indeno(1,2,3-cd)Pyrene		193395	
Iron	DISSOLVED METALSOTHER CHEMICALS	7439896	FE-D
Isophorone		78591	
Lead	DISSOLVED METALSOTHER CHEMICALS	7439921	PB-D
Lindane		58899	GBHC
M - Xylene	VOLATILE AROMATICSVOLATILE ORGANICS	108383	M-XY
Methylene Chloride	OTHER VOLATILESVOLATILE ORGANICS	75092	MNCL
N-nitroso-di-n-propylamine	OTHER SEMI-VOLATILESEMI-VOLATILE ORG	621647	NDPA
N-nitrosodi-n-propylamine	OTHER SEMI-VOLATILESEMI-VOLATILE ORG	621647	NDPA
N-nitrosodimethylamine	OTHER SEMI-VOLATILESEMI-VOLATILE ORG	62759	NPMA
N-nitrosodiphenylamine	OTHER SEMI-VOLATILESSEMI-VOLATILE	86306	NPNA

N-nitrosodiphenylamine (1)		86306	
Naphthalene	PAHSEMI-VOLATILE ORG	91203	NAPT
Nitrobenzene		98953	
O - Xylene	VOLATILE AROMATICSVOLATILE ORGANICS	95476	O-XY
P - Xylene	VOLATILE AROMATICSVOLATILE ORGANICS	106423	P-XY
Pentachlorophenol		87865	PCPN
Phenanthrene	PAHSEMI-VOLATILE ORG	85018	PHAN
Phenol	OTHER SEMI-VOLATILESEMI-VOLATILE ORG	108952	PN--
Pyrene	PAHSEMI-VOLATILE ORG	129000	PYRN
Styrene	VOLATILE AROMATICSVOLATILE ORGANICS	100425	STYR
Tetrachloroethene		127184	TTCE
Tetrachloroethylene		127184	TTCY
Toluene	VOLATILE AROMATICSVOLATILE ORGANICS	108883	TOLN
Total Cyanide	CYANIDEOTHER CHEMICALS	57125	CN-T
Total Organic Carbon	OTHER CHEMICALOTHER CHEMICALS	1012	TOC-
Total Recoverable Phenolics	OTHER CHEMICALOTHER CHEMICALS		TRPH
Total Xylene	VOLATILE AROMATICSVOLATILE ORGANICS	1330207	XYLS
Trans-1,2-dichloroethene		156605	TDCE
Trans-1,2-dichloroethylene		156605	TDCE
Trans-1,3-dichloroproene		10061026	TDCP
Trans-1,3-dichloropropene		10061026	TDCP
Trichloroethene		79016	TCEE
Trichloroethylene		79016	TCEY
Trimethylbenzene	VOLATILE AROMATICSVOLATILE ORGANICS		TMB-
Vinyl Acetate		108054	VNAC
Vinyl Chloride		75014	VNCL
Zinc	DISSOLVED METALSOTHER CHEMICALS	7440666	ZN-D

Table 1

Sample Lotus Template for Reporting Groundwater Sampling Results

(Enclosed diskette contains sample template)

Date	SiteID	WellID	Class	Category	Name	Conc	Cas#	MDL	IsMDL	Surf	Top	Elev	Bot
9/12/89	CHGDSH8501	MW-1	PAH	SEMI-VOLATILE ORGANIC	ACENAPTHENE	0.01	83329	0.01	U	1024	1000	995	975