WORK PLAN
FIELD INVESTIGATION
WAITE ROAD SITE

Prepared for:

GENERAL ELECTRIC COMPANY
1 Nott Road
Schenectady, New York 12345

Prepared by:

WOODWARD-CLYDE CONSULTANTS
201 Willowbrook Boulevard
Wayne, New Jersey 07470

December 1986

85C4337

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TABLE OF CONTENTS

FIGURES

TABLES

APPENDIX A
WOODWARD-CLYDE CONSULTANTS STANDARD OPERATING PROCEDURES

1.0 GEOTECHNICAL BORING INSTALLATION

2.0 PIEZOMETER AND GROUND WATER MONITORING
WELL INSTALLATION AND DEVELOPMENT PROCEDURES

3.0 STATIC WATER LEVEL MEASUREMENTS

4.0 GROUND WATER SAMPLING

5.0 SAMPLE QUALITY ASSURANCE

6.0 SAMPLE CLASSIFICATION, PACKAGING AND SHIPMENT

7.0 DOCUMENTATION AND QUALITY ASSURANCE

8.0 FIELD TESTS FOR CONTAMINATION

9.0 DECONTAMINATION PROCEDURES

SECTION I

INTRODUCTION

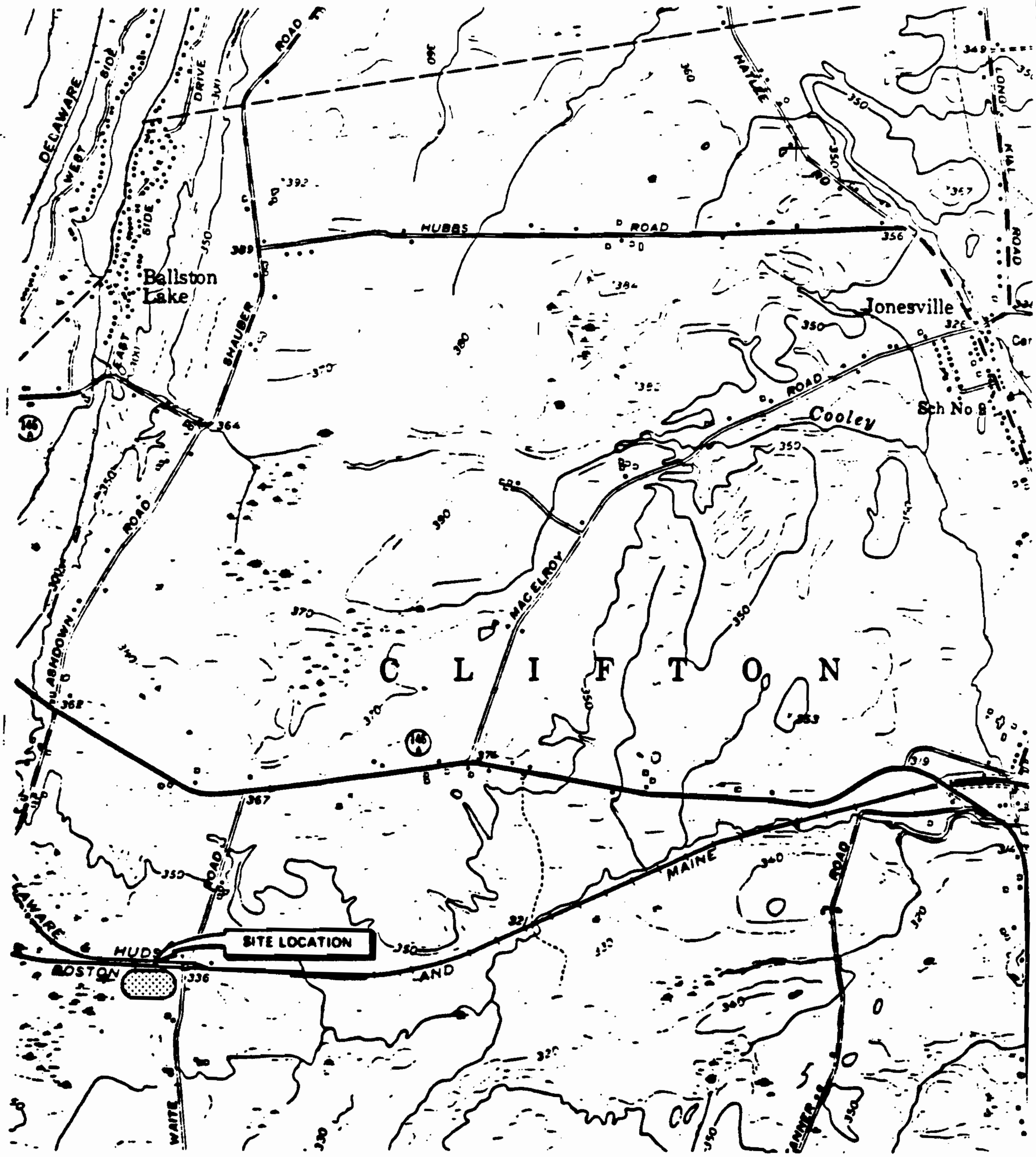
1.1 BACKGROUND

The Waite Road Site is located in Clifton Park, New York at the junction of Waite Road and the Boston and Maine railroad tracks (Figure 1-1). The site is the location of a former oil recovery operation (Albany Waste Oil) and contains several above-ground storage tanks and a lagoon (Figure 1-2). In response to a reported oil spill in the fall of 1981, the New York State Department of Transportation (NYSDOT) contracted to have the free product and contaminated soil removed from the site. It was observed during the final stages of the clean-up operation that some petroelum products were located at the surface of the weathered bedrock underlying the site. During late 1981 and early 1982 Dunn Geosciences Corporation (hydrogeologic consultants to Hanson Well Drilling Company under contract with NYSDOT) performed a field investigation to determine the type of petroleum product and the extent of contamination of the bedrock aquifer underlying the site. In late 1982 the NYS Department of Environmental Conservation (NYSDEC) collected and analyzed additional water and soil samples to further delineate the type and extent of contamination of the bedrock aquifer. NYSDEC conducted a second, but more limited, field investigation of the Waite Road Site in September 1984.

1.2 OBJECTIVES

Available data indicate contamination of the Waite Road Site by petroleum hydrocarbons, chlorinated solvent residues, metals, and PCBs. However, due to limited sampling conducted to date, limited documentation of sampling locations, and discrepancies in reported results, the extent of contamination of the site is not defined accurately or reliably. This study is intended, in part, to supplement the information already gathered for the site. Hence, the specific objectives of the Field Investigation are:

- o to evaluate the extent of ground-water contamination by volatile organic compounds in the overburden/weathered bedrock water bearing zone;
- o to evaluate if ground water in the non-weathered bedrock water bearing zone has been impacted;
- o to evaluate the extent of free petroleum product around monitoring wells H-3 and S-9; and
- o to evaluate the areal extent of soil contamination by petroleum hydrocarbons and PCBs.



0 2000 4000 FT.

SCALE

SOURCE: ROUND LAKE QUADRANGLE

LOCATION MAP WAITE ROAD SITE CLIFTON PARK, N.Y.		
WOODWARD—CLYDE CONSULTANTS CONSULTING ENGINEERS, GEOLOGISTS AND ENVIRONMENTAL SCIENTISTS WAYNE, NEW JERSEY		
DR. BY: TJD	SCALE: AS SHOWN	PROJ. NO.: 85C4337
CK'D. BY: MN	DATE: 20 JUNE 1986	FIG. NO.: 1-1

SECTION 2
FIELD INVESTIGATION

2.1 PRELIMINARY SITE VISIT

An initial site visit will be conducted prior to the initiation of field activities. The purpose of this visit is to examine the site, establish the sampling grid, and mark the locations of the proposed monitoring wells and soil borings.

The sampling grid to be used for this study is presented in Figure 2-1. The proposed grid is 30 by 30 feet. The locations for surface soil samples, monitoring wells and soil borings will be staked in the field in accordance with this grid system.

2.2 HYDROGEOLOGIC INVESTIGATION

2.2.1 Review of Existing Data

Existing hydrogeologic data will be reviewed to characterize the stratigraphy and ground-water flow conditions in the vicinity of the site to the extent possible. Existing data will also be used to assess the potential for off-site contamination of ground water. The data to be reviewed will include, but not be limited to, the following:

- o Maps and aerial photographs;
- o Well installation reports, boring logs, pump test data, and any other field investigation information on the site and in the vicinity;
- o Soils and geologic maps;
- o Ground water quality data;
- o Hydrogeologic reports, either published or unpublished; and
- o Data available from NYSDEC.

Waite Road Meeting
12/3/87 10 AM.

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ADDENDUM TO WORK PLAN FOR FIELD INVESTIGATION AT WAITE ROAD SITE

1. The additional deep bedrock well described at page 2-3 of the Work Plan will be installed. It is proposed that it will be installed in the approximate location shown in Figure 2-3. The exact location will be determined after the completion of additional study of the ground water flow direction and extent of contamination, and the decision will be made in consultation with the Department of Environmental Conservation.

2. Barium and silver will be included in the Series 200 Metal Analysis described at page 2-2.

3. PCB sampling will be conducted in new monitoring wells in addition to wells S-10 and H-3.

4. If free product infiltrates the trench described in Section 2.2.4 (page 2-5), it will be removed and disposed of in accordance with applicable state and federal law.

5. The surface soil investigation described in Section 2.3.1 of the Work Plan (page 2-6) states that "should results from samples collected along the perimeter of the site test positive for either PCBs or petroleum hydrocarbons, the [sampling] grid will be expanded offsite. Samples will be collected along the expanded grid until all zones of surface contamination emanating from the site have been delineated." By way of clarification, the grid set forth on Figure 2-4 will be expanded offsite adjacent to sampling points which test positive. Additional samples will be collected at each intersecting point on the expanded grid until the extent of contamination has been defined.

6. The soil investigation will include two soil samples from the drainage ditch to the east of the site. These will be analyzed for PCBs and petroleum hydrocarbons.

7. The sampling technique used to sample residential wells as described in Section 2.2.2 and Appendix A, Section 4.0 will be modified so that samples will be taken after the system has been allowed to run for two minutes. Samples will be collected from the tap closest to the well head and prior to processing by any water treatment device where feasible.

2.2.2 Ground and Surface Water Sampling and Analysis

Static water level measurements will be taken from existing monitoring wells (Figure 2-2). These wells along with eight residential wells (to be identified by the NYS Department of Health) will also be sampled on one occasion utilizing the techniques presented in Appendix A, Section 4.0 - Ground Water Sampling. Purge water removed from wells known to be contaminated will be pumped into 55 gallon drums and retained on-site until a proper disposal method is established. The disposal method will be based upon results from the analytical laboratory. Purge water from uncontaminated wells will be disposed of on the ground surface as specified in Appendix A, Section 4.0.

At the same time, surface water samples will be obtained from both the lagoon and swamp. A composite sample, through the water column, will be obtained from the lagoon near the edge of the pond closest to monitoring wells H3 and H4. Three samples from the swamp will be obtained in the vicinity of and north of monitoring wells S1 and S2.

Immediately following sample collection, all samples will be properly preserved and placed in sample coolers in accordance with procedures presented in Appendix A, Section 5.0. Within twenty-four (24) hours samples will be transported to ENSECO, Inc., Cambridge, Massachusetts in accordance with Appendix A, Section 6.0 - Sample Classification, Packaging and Shipment. Appropriate chain of custody procedures will be utilized as specified in Appendix A, Section 7.0 - Documentation and Quality Assurance.

Ground water samples collected for laboratory analysis will be analyzed for volatile organic compounds (EPA Methods 601 and 503.1), total petroleum hydrocarbons (EPA Method 418.1), and selected Series 200 metals (arsenic, cadmium, chromium, lead, and mercury). Analysis for PCBs (EPA Method 608) will be conducted on samples collected from monitoring wells S-10 and H-3. Approximately 10 percent of all samples will be collected in replicate to act as QA samples.

Appropriate field blanks will be used as specified in Appendix A, Section 5.0 - Sample Quality Assurance. Blanks will be analyzed for organic compounds (EPA Methods 601 and 503.1), PCBs (EPA Method 608), and selected metals (Series 200).

2.2.3 Installation of Monitoring Wells

Based on data collected by Dunn Geosciences, ground-water flow on site is believed to be in a south-westerly direction. Data also indicate that the plume of contamination extends beyond the present well network. It is therefore proposed that an additional well cluster be installed south of monitoring wells S-1 and H-3 at the approximate location shown in Figure 2-3. The new monitoring well cluster will consist of two, 2-inch O.D., PVC wells. The well cluster will be comprised of a shallow, overburden well and a shallow bedrock well screened through the weathered portion of the rock. It is also proposed that one additional deep bedrock well be installed if it is determined during the current ground water sampling round that contamination has reached this depth. This decision will be made based upon laboratory results for samples obtained from the existing deep bedrock wells and in consultation with the NYSDEC. If it is determined that an additional deep well is required, it is proposed that it be installed in the approximate location shown in Figure 2-3.

The shallow, overburden monitoring well will extend down to the top of bedrock or to an existing confining layer. It will be screened from one (1) foot below the surface to just above weathered bedrock or the confining stratigraphic layer. If necessary, the bottom of the borehole will be grouted to prevent leakage into the lower stratigraphic units. The well to be installed in the upper, fractured portion of the bedrock will be screened throughout the fracture zone, which varies from five to ten feet. The deep bedrock well, if required, will be installed to a depth corresponding to 25 feet below the highly fractured portion of the bedrock. The screen interval will be between 10 to 20 feet. Actual screen intervals of all wells will be determined in the field after consultation with the State's on-site representative.

Monitoring wells will be installed using rotary tricone drilling methods or other approved methods. Monitoring well construction procedures are presented in Appendix A, Section 2.0 - Piezometer and Ground Water Monitoring Well Installation and Development Procedures.

To obtain stratigraphic information, the shallow bedrock well is to be drilled first. Continuous split-spoon samples will be taken through the overburden in accordance with ASTM D1586-84, Method for Penetration Test and Split-Barrel Sampling of Soils, and as specified for soil sampling procedures described in Appendix A, Section 1.0 - Geotechnical Boring Installation. The field hydrogeologist will be responsible for retaining a portion of the sample in a glass jar labelled with the site name, blow count, boring number, interval sampled, date, and time of collection. (If a deep bedrock well is required, stratigraphic information will be obtained from its boring and not the shallow bedrock well.)

Continuous rock cores in accordance with ASTM 2113-83, Method for Diamond Core Drilling for Site Investigation, will be collected during the drilling of the bedrock monitoring well. Rock cores will be retained and stored in a core box for later examination.

The field hydrogeologist will supervise the drilling operation and prepare a boring log for the bedrock monitoring well. The log will consist of a visual description of each overburden sample in accordance with Appendix A, Section 1.0. Rock cores will be examined for fracture pattern and competency of the underlying bedrock in accordance with the procedures given in Appendix A, Section 1.0. All soil and rock samples will be retained for future reference.

Once the monitoring wells have been installed, they will be developed in accordance with the procedures given in Appendix A, Section 2.0. Well development will continue until the well yields relatively sediment-free water or stability is achieved with regard to the pH, temperature and conductivity of the water evacuated from the well during development. In either case, development will cease only after consultation with the State's on-site representative.

Approximately two weeks after well development, a second synoptic round of static water level measurements will be taken. At this time samples will be obtained from the new wells and analyzed for the constituents specified in Section 2.2.2.

Appropriate field blanks will be used as specified in Appendix A, Section 5.0 - Sample Quality Assurance. Blanks will be analyzed for volatile organic compounds according to EPA Methods 601 and 503.1, PCBs (EPA Method 608), and selected Series 200 metals.

It will be assumed, initially, that the new monitoring wells are outside any zone of contamination. Therefore, drilling fluids, purge water and development water will be discharged to the ground surfaced. Should at any time during the installation, development or sampling of a new monitoring well visual signs or field instrument measurements indicate a well to be contaminated, this practice will cease immediately. Subsequent waste fluids will be containerized and stored on site until a proper disposal method can be defined.

2.2.4 Free Product Investigation

In order to investigate the extent of free petroleum product that may exist in the vicinity of monitoring wells S-9 and H-3, it is proposed that a trench be excavated in the vicinity of both wells. The length of each trench will be determined based upon field observation of the amount of visible product in the side wall. The depth of a trench will be based on the depth of contamination in the side walls. A detailed log of each trench wall will be kept by the field hydrogeologist. The logs will consist of stratigraphic information, depths of visible contamination, plus the delineation of any seepage zones.

Mary Barone 716-691-2600

2.3 SOIL INVESTIGATION

2.3.1 Surface Soil

In order to investigate the extent of soil contamination by petroleum hydrocarbons and PCBs, a field screening for surface soil and sediment contamination will be conducted on site. Approximately 80 sample stations have been established based on the sampling grid depicted in Figure 2-4 and known areas of surface contamination. From each location, a surface soil or sediment sample will be taken through the depth interval of 0-6 inches below ground surface using a stainless steel trowel. Replicate samples will be obtained from approximately 10 percent of these stations to act as QA samples for the field screening procedures.

Each sample will be analyzed for petroleum hydrocarbons utilizing a Horiba OCMA 220 Oil Content Analyzer, and for PCBs using the McGraw Edison PCB test kit. Procedures for these field tests are presented in Appendix A, Section 8.0 - Field Tests for Contamination. The results will be used to plot the approximate aerial extent of soil contamination found on site.

Approximately 30 percent of the samples will be split with the testing laboratory for analysis of petroleum hydrocarbons and PCBs. Sample splits to be sent to the laboratory will be biased in favor of positive field screening results for PCBs. In addition, approximately 10 percent of the laboratory samples will be replicated for QA purposes.

As shown in Figure 2-4, the initial sampling grid is confined to the site. However, should results from samples collected along the perimeter of the site test positive for either PCBs or petroleum hydrocarbons, the grid will be expanded off-site. Samples will be collected along the expanded grid until all zones of surface contamination emanating from the site have been delineated.

2.3.2 Soil Borings

In order to delineate the vertical extent of soil contamination by petroleum hydrocarbons and PCBs, eight soil borings will be completed throughout the areas showing surface staining (see Figure 2-5). Soil borings will be drilled in accordance with the procedures given in Appendix A, Section 1.0. Continuous soil samples will be collected down to bedrock using a 3.5-inch O.D. split spoon. Field screening for petroleum hydrocarbons and PCBs will be conducted on samples obtained from each split spoon using techniques described in Appendix A, Section 8.0. Results of the field screening will be used to select soil samples for more detailed chemical analysis. At least one sample from each boring will be selected for laboratory analysis.

2.3.3 Off-Site Sampling

An additional fourteen (14) surface soil/sediment samples will be obtained to the south and to the east of the Waite Road Site. Within the wooded area east of Waite Road, six (6) surface soil samples will be collected at locations approved by the State's on-site representative. All six samples will be initially screened for petroleum hydrocarbons and PCBs using the techniques specified in Appendix A, Section 8.0. Based upon the results of the field analyses, two samples will be split with the analytical laboratory for laboratory determination of petroleum hydrocarbons and PCBs.

To the south of the Waite Road site four soil and four sediment samples will be collected and sent to the analytical laboratory. Samples will be collected from a small stream that flows south and east of the site. Sediment samples will be collected at the locations approved by the State's on-site representative. Sediment samples will be collected at the mid-point through the cross-section of the stream. Soil samples will be obtained from the bank between the stream and the Waite Road Site. All eight samples will be analyzed for petroleum hydrocarbons and PCBs by the laboratory.

2.4 LEVEL SURVEY

Concurrent with sampling existing wells, a level survey will be conducted to remeasure the top of riser pipe and ground elevation to reestablish vertical control. Upon completion of field activities, a second level survey will be conducted to establish the location of each new monitoring well and soil boring. In addition, the top of riser pipe and ground elevation will be measured for the new wells.

2.5 AIR SAMPLING

Inasmuch as air sampling will be conducted during site surface cleanup (i.e., tank removal, etc.) under the sponsorship of NYSDEC, the need for any additional air sampling will be discussed by the parties responsible for conducting this Field Investigation and NYSDEC upon completion of the surface cleanup.

2.6 DELIVERABLES

Following the completion of the field investigation all field data will be compiled into a Final Report. The report will include:

A. Data Presentation

1. A summary of existing information and the assessment of the validity of the existing data.

2. Results of all analyses on laboratory data sheets and the required quality assurance documentation.

3. Summary tables of all analyses.

4. Stratigraphic logs including grain-size and field instrument readings during drilling of each soil boring and monitor well.

5. As-built construction diagrams for each soil boring and monitor well.

6. Well casing elevations to the nearest hundredth (0.01) foot above mean sea level, taken at the top of casing with cap removed.

7. Depth to ground water to the nearest hundredth (0.01) foot above mean sea level, taken at the top of well casing prior to sampling with cap removed.

8. All support data including graphs, equations, references, raw data, etc.

B. Maps

1. Site Map:

a. Site property boundary;
b. Structures; and
c. Surface water bodies;

2. Sample Location Map(s):

a. Monitor well locations and casing elevations;
b. Sample collection locations; and
c. Soil boring locations.

3. Soil quality contour map and cross section(s).

C. Discussion of Data

1. Contaminant characterization, including probable quantities of the contaminant, by type.

2. Levels of soil and ground-water pollution as compared to applicable standards, guidelines or background levels, where pertinent.

3. Probable extent of soil and ground-water pollution on site.

4. Pollutant behavior, stability, biological and chemical degradation, mobility and any other relevant factors pertinent to the investigation.

5. Identification of possible pollution sources.

6. Identification of critical pollutants.

D. Recommendations for Additional Investigations.

SECTION 3
REMEDIAL ALTERNATIVES

A limited evaluation of remedial action alternatives will be developed for the Waite Road Site, based upon data collected during the site investigation described in Section 2. The site investigation plan has been developed to provide input for the three general areas which may require remediation:

- o free petroleum product in the soil;
- o soil contamination by hydrocarbons and PCBs; and
- o potential ground water contamination.

Based upon available data, several candidate remediation technologies are most likely to apply to the types of contamination observed at the site. These technologies are briefly summarized in Table 3-1.

WCC will screen these candidate remedial alternatives, and the no-action alternatives, for applicability to the Waite Road Site. The lowest cost technology that is technologically feasible and reliable and that adequately protects (or mitigates damage to) public health, welfare, or the environment will be considered the cost-effective technology.

WCC will recommend remedial actions for the site. It is possible that the recommended action will involve a combination of technologies identified on Table 3-1 to address the various concerns in a cost effective manner. In the event that during the course of site investigations, WCC discovers conditions significantly different from those anticipated based upon available data, WCC will identify additional candidate remedial alternatives, if necessary to address these conditions.

Deliverables:

- A limited evaluation of remedial alternatives, including those identified above. The evaluation will include justification of recommended actions, and a preliminary cost estimate for implementation.

TABLE 3-1

CANDIDATE REMEDIAL TECHNOLOGIES FOR THE WAITE ROAD SITE

Area of Concern	Candidate Technologies
Free petroleum product	Product recovery wells
Contaminated soil	Excavation/Off-site disposal On-Site biological treatment Capping
Contaminated ground water	Pump and treat (on-site or off-site treatment)

F348.T3-1/310

SECTION 4
PROJECT SCHEDULE

The proposed project schedule is illustrated in Figure 4-1. The anticipated length of time required to complete the field investigation is 22 weeks.

SECTION 5
HEALTH AND SAFETY PLAN

Prior to the initation of field activities a Health and Safety Plan will be developed in accordance with WCC's Hazardous Waste Mangement Practice - Health and Safety Manual, October 1985. A Table of Contents for the Health and Safety Plan is included as Table 5-1.

TABLE 5-1 (continued)

Appendix A

APPENDIX A

WOODWARD-CLYDE CONSULTANTS
STANDARD OPERATING PROCEDURES

APPENDIX A

WOODWARD-CLYDE CONSULTANTS STANDARD OPERATING PROCEDURES

1.0 GEOTECHNICAL BORING INSTALLATION

PURPOSE

Geotechnical borings will be installed to: (1) define the stratigraphy and structure beneath the site; (2) obtain representative samples of subsurface soil and/or obtain rock core; (3) provide access for aquifer test equipment; and (4) install piezometers or monitoring wells. Borings are usually advanced using power drilling systems such as truck, trailer, crawler, or skid-mounted drilling rigs, although manual techniques may also be used.

The following discussion is divided into two sections: procedures for soil drilling and procedures for rock drilling.

SOIL DRILLING AND SAMPLING

General Procedures

- o The field geologist will locate and stake each boring location.
- o The Project Manager will review the scope of work with the drilling subcontractor to assure that proper equipment is available, and that the field operations and health and safety requirements are understood.
- o Underground cable and power line locations will be determined before boring activity.
- o A WCC geologist will be on-site during all drilling operations to inspect soil samples and to maintain an accurate geologic log for each boring. The inspector will be responsible for ensuring that the drilling performed by the contractor is in accordance with project specifications. All information regarding the boring activities will be recorded in a field notebook.
- o The Inspector shall instruct the driller to position the drill rig over the staked location of the boring. If the actual location of the drill hole is changed from

the stake, the displacement shall be indicated on the boring log and the boring location plan.

- All depths and lengths shall be measured and recorded to the nearest 0.1 ft. The Inspector shall not rely completely on the driller's measurements, and shall check these measurements on his/her own.

- The geologist will describe any changes in lithology, color, or odor of subsurface materials, and will note ground water level data on boring log forms.

- Standard Penetration Tests will be performed, and split-spoon samples collected in accordance with ASTM-D-1586-84 when boreholes are advanced through unconsolidated deposits.

- All cuttings or materials brought up during drilling, will be disposed of in a manner specified in the sampling plan.

Preparation of Boring Logs

A legible, concise and complete record of all significant information pertaining to drilling and sampling operations within each borehole must be maintained concurrent with the advancement of the hole. This information shall be recorded on the field boring log. In general, there are two types of boring logs used in the NY Metro Office-soil data intensive logs and rock data intensive logs. It is the responsibility of the Inspector to make certain that the selection of logs is consistent with project needs and approved by the project manager. The format should be followed closely so that completed boring logs look consistent in presentation of data. The source of description, if not based on the recovered soil sample, shall be noted on the boring log.

Required information on the boring log shall include the following:

- description of soil samples;

- location of piezometer screen and seal;
- depth or elevation of strata changes;
- number of blows per 6 inch of penetration of the split-spoon during the Standard Penetration Test;
- number of blows per 6 inch or one foot of penetration of steel casing;
- location and number of split-spoon and undisturbed tube samples;
- length of recovered sample.

In addition to the required information indicated on the boring log, the remarks section of the boring log will include such pertinent information as:

- offset (magnitude and direction) of as-drilled location from staked location;
- depth and condition of casing;
- depth of introduction of drilling mud and type of drilling mud;
- loss of samples;
- change in color of drilling fluid and characteristics of soil cuttings;
- upward boiling of bottom of borehole;
- loss of drilling fluid;
- change in resistance to rotary drilling;
- artesian conditions;
- occurrence and depth of obstructions, including cobbles and boulders;
- stoppage and resumption of drilling operations; and
- conditions of undisturbed samples.

Separating lines between different soil strata shall be drawn as follows:

- a solid line if a change is observed in the splitspoon;
- a dashedline at an intermediate location between samples or based on the depth of observed change in soil cuttings with drilling fluid, or change in drilling effort if soil change is not observed in the splitspoon.

Separating lines shall be drawn only when changes in major soil component occur.

Soil Sampling

- o Shelby tube samples will be collected where appropriate at the discretion of the Project Manager. Shelby tube samples will be collected in accordance with ASTM-D-1587-83.
- o Soil samples will be identified in the field using the Unified Soil Classification System.
- o Samples will be examined and stored in air-tight glass sample jars with screw-cap lids. One soil sample will be collected from each split-spoon except when changes in soil type are observed within the sample interval. When this occurs, soils of each type will be stored in separate jars. All sample jars will be labelled.
- o The split-spoon sampler will be decontaminated before each use as described in WCC's Standard Operating Procedure Number 9.0.
- o Soil samples will be transferred from the split-spoon sampler to the sample jar using a stainless steel spoon, which will be decontaminated before each sample designated for chemical analysis.
- o Selected soil samples from the test borings will be analyzed for the chemical parameters specified. All samples selected for analysis will be stored in specially-prepared jars, labelled, and kept on ice in designated containers.
- o Selected soil samples obtained from borings intended for subsequent monitoring well installation will be sent to the WCC laboratory for geotechnical testing as specified in the field investigation section.
- o In borings intended for subsequent monitoring well installation, continuous split-spoon samples will be collected to the top of bedrock. Drilling below the water table will be performed by holow-stem auger or mud-rotary methods, at the discretion of the Site Manager.
- o Test borings not intended for monitoring well installation will be backfilled with a cement-bentonite grout.

8. Miscellaneous descriptions.
9. Water content descriptive term.
10. Geological name, if known, or other names (in parenthesis).
11. Other project specific classifications (i.e. New York City building code).

Examples of soil descriptions:

- SP; medium dense, brown c-f SAND, some silt, trace f. gravel, with mica, moist (UPPER KIRKWOOD)

- CL; very stiff green silty CLAY, trace f. sand, moist (MANASQUAN FORMATION)

ROCK DRILLING

General Procedures

The following procedures describe methods for inspection of core and non-core rock drilling, handling and labeling of core, preparation of boring logs, and rock description.

As with soil boring logs, rock boring logs should be as comprehensive as possible under field conditions, yet be terse and precise. The level of detail should be keyed to the purpose of the investigation as well as to the intended user of the prepared logs. Although the same basic information should be presented on all rock boring logs, an appropriate level of detail should be determined by the project manager based on project needs. Borings for a building foundation may require more detail concerning degree of weathering than rock structure. For a proposed tunnel excavation, the opposite might be true. Extremely detailed descriptions of rock mineralogy may mask features significant to engineer but may be critical for a geologist performing power plant siting studies.

The boring log should be an objective record of the Inspector's observations and should not include engineering judgments and evaluations (e.g. "will probably need blasting," "should make good riprap," etc.) Such judgments are difficult to make without extensive experience with the subsurface conditions under investigation, and even then may not be reliable with only limited borehole information. Speculations regarding the geologic history of a core sample should likewise be limited and included only if relevant.

Non-Core Drilling

Non-core rock drilling may be used when an intact rock sample is not required and a borehole is to be advanced relatively quickly and inexpensively. Types of non-core drilling include air-track drilling, down-the-hole percussive drilling, rotary tricone (roller bit) drilling, rotary drag bit drilling, and, in very soft rocks, augering. Drilling fluid may be water, mud, or compressed air.

The following information pertaining to drilling characteristics should be recorded in the remarks section of the boring log, (or where designated by the project manager):

- changes in penetration rate or drilling speed in minutes or seconds per foot;
- dropping of rods;
- changes in drill operation by driller (down pressures, rotation speeds, etc.);
- changes in drill bit condition;
- unusual drilling action (chatter, bouncing, binding, etc.)

When drilling with compressed air, there may or may not be return water depending on depth to the water table, rate of recharge, and heat generated by the drilling process. When drilling with water, characteristics of the return water can provide valuable information concerning subsurface conditions. The following information concerning fluid characteristics should be recorded in the remarks section of the boring log:

- depth to static water level (measure every morning before start of drilling);
- absence of return water;
- color and clarity of return water;
- changes in flow rate of return water, including loss of circulation and artesian flow.

Core Drilling

Core barrels may be single tube or more commonly, double tube, which offer better recovery by isolating the rock core from the water stream. For particularly friable or broken rock, triple tube barrels may be used. Double and triple tube core barrels may have split inner tubes to allow observation and removal of core with reduced disturbance.

Wire line drilling equipment allows the inner tube to be uncoupled from the outer tube and raised to the surface by means of a wire line passing through the drill rods. This equipment usually produces better recovery as well as better production rates.

Although NX (2 1/8-inch core diameter) is the size most frequently used for engineering investigations, larger and smaller sizes are in use. Generally, a larger core size will produce greater recovery. Because of their effect on core recovery, the size and type of coring equipment used should be carefully recorded in the appropriate places on the boring log. It should be noted that most standard correlations for RQD are based on measurements made on NX-size core.

Observations of drilling characteristics and fluid characteristics (including water levels) should be recorded in the remarks section of the boring log as described for non-core drilling.

Core should be handled carefully during transfer from barrel to box to preserve mating across fractures and fracture-filling materials. Deliberate breaks in the core should be avoided unless absolutely necessary.

Wooden blocks should be used to mark the drilled depth of the top and bottom of each run. Depths should also be marked at each end of the box's divided intervals. The core box lid should have identical markings both inside and out, and both ends of the box should be marked.

Rock core may be photographed as directed by the project manager.

For angled borings, depths marked on core boxes and boring logs should be "non-vertical depths," i.e., measured along the borehole's long axis.

Logging Procedures for Core Drilling

Rock descriptions should use technically correct geologic terms, although local terms in common general use may be acceptable if they help describe distinctive characteristics. Rock core should be logged when wet for consistency of color description and greater visibility of rock features. A minimum of one complete rock description should be given per page. Otherwise, "as above" with one or two modifications is acceptable.

Descriptive terms should be precisely defined, either as described in these procedures or as noted on the boring log (e.g. "thin" bedding, "moderately" fractured, etc.). Non-standard abbreviations should also be defined, with reference either to a standard list or as noted on the log itself.

The following terms refer to column headings given in the boring log.

- Recovery - The ratio of the length of core recovered to the total length of core drilled on a given run, expressed as both a fraction and as a percentage. Core length should be measured along centerline. Non-recovery should be assumed to be at the end of the run unless there is reason to suspect otherwise (e.g. weathered zone, drop of rods, etc.). Non-recovery should be marked on the boring log, and entries should not be made for bedding, fracturing, or weathering in that interval.

  Recoveries greater than 100% may occur if core which was not recovered during a run is subsequently recovered by a later run. These should be recorded as such; adjustments to data should not be made in the field.

- RQD (Rock Quality Designation) - The ratio of the total length of core pieces 4 inches or longer to the total length drilled on a given run, recorded on the log as both as a fraction and as a percentage. Core length should be measured along centerline.

- Bedding - stratification, foliation, and other significant non-fracture structural features should be sketched in this column. Veins, stringers, seams, etc. may be considered significant if they are parallel to fractures, planar, differentially weathered, repeated, or otherwise unusual. Stratification and foliation may be shown schematically, but indistinct structure should be so labeled on the log. Dip angles of the features should be measured down from the horizontal using a protractor or dipmeter, and marked on the log. For non-vertical borings, the angle should be measured and marked as if the boring were vertical.

- Fracture Sketch - Fractures should be sketched at the depth at which they are inferred to occur. Dip angles should be measured and marked as for bedding and foliation. If the rock is broken in many pieces less than one-half inch to one inch long, the log may be cross hatched in that interval, or fractures may be shown schematically.

- Fracture Condition - This column should be used to record crack fit of each fracture, using defined terms or abbreviations. Any staining or filling should also be indicated in parentheses, including the following:

  Fe (Iron)
  Ca (Calcite)
  Mn (Manganese)
  Cl (Chloride)
  Silt
  Clay
  Sand

- Weathering - The following table should be used to determine the degree of weathering.

Degree of Weathering

DESCRIPTIVE TERMS

CRITERIA	DEEPLY (D)	MODERATELY (M)	SLIGHTLY (S)	FRESH (F)
Physical Condition	Decomposed, friable to low hardness, friable to weak strength	Moderately decomposed, low to moderate hardness and weak to moderate strength	Slightly decomposed, moderately hard to hard, moderately strong to strong	Unaffected by weathering agents. No decomposition of minerals, no disintegration, no discoloration, no alterations on fracture surfaces, no physical decomposition, usually very hard and very strong.
Minerals	Completely decomposed	Moderate decomposition; extensively stained (particularly iron-rich minerals)	Slight decomposition; some surficial staining	
Disintegation	Disintegrated	Most of the cement is moderately disintegrated	Slight to no effect	
Rock Discoloration	Deep and thorough	Moderate or localized; may be intense	Slight, Intermittent, or localized	
Fractures	All are coated extensively with clay or silt, or stained with oxides or sulfides, or contain a carbonate or siliceous crust	±50% are coated with varying amounts of clay or silt, or stained with oxides or sulfides, or contain a carbonate or siliceous crust	±10% are slightly stained	

For most rock types, a sample can be considered deeply weathered when it can be broken between the fingers and fresh when it shows no staining or alteration at all. The appropriate symbol should be marked on the log and the interval blocked off in the weathering column.

- The blank column on the log may be used for permeability test results, joint roughness coefficients, drilling rates, or other information is designated by the project manager.

2.0 PIEZOMETER AND GROUND WATER MONITORING WELL INSTALLATION AND DEVELOPMENT PROCEDURES

MONITORING WELL INSTALLATION

Purpose

Monitoring wells will be installed to determine the hydrologic characteristics of aquifers underlying the site, and to obtain samples of ground water that can be considered representative of the chemical quality of ground water in the underlying aquifers. Boreholes for the monitoring wells will be drilled in accordance with the procedures outlined in Woodward-Clyde Consultants SOP Number 1.0.

General Considerations

Factors that will be considered in determining the method of well installation and particulars of well design include:

1. The expected nature of the materials to be encountered.
2. Diameter and depth of well casing.
3. Expected transmissivity and storage coefficient of the aquifers.
4. Water level conditions and trends.
5. Water quality, and type and concentrations of contaminants.

Monitoring well design will meet two basic criteria: (1) water must move freely into the well, and (2) vertical migration of surface water or undesired ground water to the well intake zone must be minimized. The well construction and dimensions will conform to the specifications described in the sampling plan.

Materials used in the construction of monitoring wells must remain essentially chemically inert with respect to the contaminants in the ground water for the duration of the monitoring program. Newly packaged stainless steel well casing and new PVC screens will be used in all the monitoring wells. Casing sections will have threaded joints so that a well-developed seal can be obtained. No grease will be used during drilling.

Installation Procedures

The type of well construction discussed is a deep well drilled through overburden and screened in bedrock:

A large diameter (10 or 12 inch diameter) boring is drilled through the overburden and then advanced 10 feet into bedrock. A stainless steel casing (6" or 8" diameter) is placed to the bottom of the hole and grouted with voloclay grout (9.4 lb/gal.) to prevent caving and to seal off the overburden. The steel casing extends about 3 feet above ground surface. The remainder of the borehole is advanced by reaming a 6" or 8" hole at least to the depth from which core was recovered. Potable water with a small amount of bentonite is used as drilling fluid.

A PVC screen with appropriate slot size and with an end fitting is lowered along with a PVC riser to the bottom of the borehole. A graded sand filter pack is placed in the annulus between the screen and the wall of the borehole so that the filter pack extends at least a few feet above the top of the screen. A voloclay grout (9.4 lb/gal) is placed on top of the filter pack in the annulus to three feet below the ground surface.

The top three feet of the outer annulus is cement grouted and completed with a sloping cement pad at the surface. The PVC riser has a threaded cap, and the stainless steel casing has a vent hole and a locking cap. The well identification data is pre-punched on the inner surface of the cap, and the well number is painted on the outer surface of the cap and/or the casing.

All well casings will be surveyed by a professional land surveyor to the nearest hundredth (0.01) foot above mean sea level and to an accuracy of one-tenth of a second latitude and longitude.

PIEZOMETER INSTALLATION

General Consideration

Piezometers are installed to observe water levels for synoptic water level measurements or during aquifer tests. Boreholes for piezometers will be drilled in accordance with the procedures outlined in WCC's SOP Number 1.0. The piezometer construction and dimensions will conform to specifications determined in the sampling plan.

Piezometer Installation

An 8" diameter borehole is advanced through the overburden to a specified depth. A PVC screen with an appropriate slot size and with an end fitting and PVC riser is lowered into the borehole. The PVC riser extends about 2 feet above ground level. A filter pack of graded sand is placed in the annulus between the screen and the wall of the borehole so that the filter pack extends to a few feet above the screen. A seal of bentonite pellets is placed on top of the filter pack and allowed to swell. The thickness of the seal will be at least 1 foot. If the top of the seal is less than about three feet below the ground surface, the remaining length of the annulus to within three feet of the surface must be tremic grouted with cement-bentonite grout. A three foot steel protective-casing with a locking cap is then cement grouted around the top of the piezometer.

WELL DEVELOPMENT

Purpose

Well development is performed subsequent to monitoring well installation to improve the hydraulic communication between the formation and monitoring wells and to assure representative ground-water samples. Wells should be developed for at least one (1) hour or until there is a turbid-free discharge from the well.

During the drilling process the side of the borehole may become smeared with clays or other fine sediments. This plugging action substantially reduces the permeability of the aquifer in the zone of the boring and retards the movement of water into the well. In addition, sediment may enter the filter pack or clog the well screen slots during installation of the well materials.

Well development is the process of flushing the interface between the aquifer and the well and cleaning the filter pack and the well or piezometer screen slots to permit ground water to flow into the monitoring well. Development is required: (1) to restore the natural permeability of the formation adjacent to the borehole, (2) to remove clay, silt and other fines from the filter pack and well screen so that subsequent water samples will not be abnormally turbid or contain undue suspended matter, and (3) to remove remnant drilling fluids from the well, filter pack and aquifer and contaminants introduced during the time of drilling.

The various methods that may be used to develop a well are discussed below. An appropriate method for developing the wells will be determined following completion of monitoring well installation.

Methods of Developing Wells

The development process is best accomplished by causing the natural formation water collected inside the well screen to be moved vigorously in and out through the screen in order to agitate the clay and silt and move these fines into the well where they can be removed. Use of water other than the natural formation water is not recommended due to the possibility of contributing contaminant or atypical water quality to the ground water. Any equipment used for well development must be thoroughly cleaned before use to prevent possible contamination of the well. The following procedures are available for developing monitoring wells.

Surge Block

A surge block is a round plunger with pliable edges (constructed of a material such as rubber belting) that will not catch on the well screen. Moving the surge block forcefully up and down inside the well screen causes the water to surge in and out through the screen accomplishing the desired cleaning action. Close monitoring of the amount of pressure generated must be made to prevent damaging the well casing or screen. If the surge block method is used, samples should not be taken less than two weeks after development of the well.

Air Lift

The air lift method involves pumping compressed air down a pipe placed inside the well casing. Due to its inert characteristic, nitrogen is the preferred gas for air lifting. The use of standard air for well development may affect ground water quality. Pressure applied intermittently and for short periods causes the water to surge up and down inside the casing. Once the desired washing is accomplished, continuously applied air pressure is used to blow water and suspended sediments upward out of the well.

Considerable care must be exercised to avoid injecting air directly through the well screen. Air can become trapped in the formation outside the well screen and affect subsequent chemical analyses of water samples and hydraulic conductivity measurements. The bottom of the air pipe should not be placed below the top of the screened section of casing.

Another restriction on the use of air is the submergence factor. Submergence is defined as the height of the water column above the bottom of the air pipe (in feet) divided by the total length of the air pipe. To result in efficient air lift operation, the submergence should be at least 20 percent. This may be difficult to achieve in shallow monitoring wells or wells which contain small volumes of water.

If the air lift method is used, samples should not be taken less than 1 week after development of the well.

Bailer and Pumping

A bailer which is heavy enough to sink rapidly through the water can be raised and lowered through the water column to produce an agitating action that is similar to that caused by a surge block. The bailer, however, has the added capability of removing turbid water and fines each time it is brought to the surface. Bailers can be custom-made and can be hand operated in shallow wells.

Pumping can be used effectively in wells where recharge is rapid. The type and size of the pump used is contingent upon the well design.

If the pumping method is used, samples should not be taken less than 2 weeks after development of the well.

3.0 STATIC WATER LEVEL MEASUREMENTS

Synoptic static water levels in each piezometer and monitoring well will be obtained at the time intervals prescribed. Static water levels will be measured with reference to a surveyed reference point to the nearest hundredth (0.01) of a foot, using an electrical depth gauge or a weighted tape. Static water levels from all monitoring wells and piezometers at the site will be obtained within a period of 8 hours or less.

4.0 GROUND WATER SAMPLING

MONITORING WELL SAMPLING

Well Purging

A submersible or centrifugal pump will be used to purge each well prior to sampling. A minimum of three well volumes will be removed by this means. If, however, the well recovery rate is very low, a reduced pumping rate may be used to purge as much water as possible (up to three volumes). Discharge water generated during purging will be discharged at least 10 feet downgradient of the well location. Water samples will be collected within 24 hours of well purging.

After purging each well, the outside of the pump will be washed with detergent water and then rinsed with potable water. Then, the pump will be operated and a sufficient amount of potable water will be pumped through it to rinse the inside of the pump. Hoses used for purging will be discarded after use.

Well Sampling

A dedicated stainless steel bailer with a teflon check valve assembly will be used to collect the ground-water samples. The suspension line attached to each bailer will consist of a stainless steel leader attached to a polypropylene cord. The cord will be discarded after a sample has been collected.

The method of sampling is to lower the bailer smoothly into the well to a point approximately opposite the middle of the well screen. At this point, the bailer should be gently worked up and down to ensure that water from that depth will enter the bailer. Substantial agitation of the water column is to be avoided as this could result in volatilization of volatile organic compounds. The number of bails used to fill the sample bottles should be minimized.

6.0 SAMPLE CLASSIFICATION, PACKAGING AND SHIPMENT

SAMPLE CLASSIFICATION

Samples will be classified on the basis of suspected concentration of contaminants. This classification determines subsequent packaging and labeling requirements, shipping procedures and laboratory handling of samples. Two categories of sample classification are used by the EPA which are based on the concentration of contaminants. Initially, concentrations of constituents are estimated based on knowledge of contaminant sources and the contaminant transport mechanisms. It is therefore necessary to be conservative in the estimate of contaminant concentration. Samples classification can be downgraded for subsequent samples.

The two groupings of samples are defined below:

1. Environmental Samples are those which contain less than 10 parts per million (ppm) of any one contaminant. Samples collected on-site may be classed as environmental by the project manager. Samples collected off-side are considered to be environmental unless information to the contrary exists.

2. Hazardous Samples are subdivided into medium concentration and high concentration samples. Medium concentration samples are those expected to contain between 10 ppm and 15% (150,000 ppm) of any one contaminant. High concentration samples are those expected to contain greater than 15% of any one contaminant.

SAMPLE PACKING AND SHIPMENT

Samples will be packed and shipped to the analytical laboratory as soon as possible to allow initiation of analysis within the holding time limits specified for the particular analysis.

The materials used for packing and shipping sample containers will be provided by the analytical laboratory and will adequately protect the samples from accidental breakage and will be sufficient to prevent any spillage that may occur from escaping into the environment. The sample shipping container will contain ice or cold-packs necessary to maintain a cold temperature (4° or colder) during shipment.

Sample analysis request forms and chain of custody records will accompany the shipment. The method of packaging, labeling, and shipping sample will conform to Department of Transportation (DOT) Regulations 49 CFR 173.1300.

7.0 DOCUMENTATION AND QUALITY ASSURANCE

DOCUMENTATION PROCEDURES

Purpose

The purpose of establishing documentation procedures for waste investigations is to: (1) provide a complete record of procedures as performed in the field, (2) permit accurate identification of samples and tracking of their status in the field during shipment and at the laboratory, and (3) facilitate chain-of-custody and accountability procedures by providing legible, concise information. Accurate sample records and proper chain-of-custody procedures are imperative, especially during investigations involving sites which may be subject to legal action.

Field Notebooks

Notebooks comprise the documentary evidence for procedures as performed by field personnel. Each entry should be dated, legible, and contain accurate and complete documentation of the individual's activities. The level of detail should be sufficient to explain and reconstruct the operation should legal proceedings require it. Because the notebook is the form of documentation of field procedures, it should contain only facts and observations. Language should be objective, clear, concise, and free of personal interpretation of terminology which might be misconstrued. Each notebook should be signed by personnel making entries. A standard format as determined by the Project or Site Manager should be used to assure that all necessary information is included.

Photographs

Photographs may be taken to document site facilities, contaminant emissions, or effluent sources, to document the location of a sample, its appearance and proximity to site facilities, or to identify topographic features. Information about each photograph is entered into the notebook immediately after the photograph has been taken. Once the film has been developed, each slide or photographic print must be serialized, corresponding to its notebook entry, and labelled with the signature of the photographer, the time and date of the photograph and site location.

Chain-of-Custody and Quality Control Procedures

Decisions or recommendations concerning the degree of hazard, extent of contamination, remedial activities or further investigation of a site are based upon requests for analytical data derived from sampling (or other) procedures. Such judgements or conclusions will be no better than the data upon which they have been based. It is imperative that the quality of the data has been assured to the maximum extent possible. Collection of data which is scientifically and legally defensible and which has the required levels of precision should be monitored by a well documented quality assurance program.

Due to the complex nature of hazardous waste site investigations, it is difficult to develop procedures which anticipate every possible situation that may be encountered in the field. Personnel involved with such investigations must be thoroughly familiar with the goals of the quality assurance program and give adequate thought and planning to all procedures described in Woodward-Clyde Consultants Standard Operating Procedures prior to performing them in the field.

Sampling Protocol

A field sampling plan will be written for each site investigation and will contain at least the following information:

1. The criteria used for selecting sampling points and the system by which those samples will be identified and logged.

2. The criteria used to select the method of sampling including the type of equipment, the procedures to be followed, and a discussion of the limitations of the method which may affect the representative nature of the sample.

3. A description of the procedures and chemicals used to clean sampling equipment, machinery and well materials, both in the laboratory (if applicable) and in the field.

4. If provided by WCC, a description of the sample containers, the procedures used to clean them, the type and reason for the preservatives added, and a discussion of sample storage and shipment.

As few people as necessary should handle a sample and each transfer of custody will be recorded on the chain-of-custody form. When possible, samples should be obtained using established methods and equipment, the operation and accuracy of which are known and accepted in professional practice.

Field and trip blanks, a critical component of the QA Plan, are discussed in WCC's SOP Number 5.0.

Chain-of-Custody

Field sampling personnel are responsible for the care and security of samples from the time the samples are taken until they have been turned over to the shipper or laboratory. A sample is considered to be in one's custody if it is in plain view at all times, in the physical possession of the sampler, or stored in a locked place where tampering is prevented.

The chain-of-custody form provided by the laboratory will be used for sampling activities.

One copy of the chain-of-custody form will be placed in the site file. The second copy will accompany the samples during transportation to the carrier and, ultimately, the laboratory.

The chain-of-custody form will be signed by a WCC representative, sealed in a plastic bag, and placed in the shipping container prior to sealing the container for shipment.

Any person accepting responsibility for the sample(s) will sign and date the form on the date accepted and the date relinquished.

Corrections to Documentation

All entries are recorded in notebooks, sample tags, custody records or other data sheets. None of these accountable documents should be destroyed or thrown away, even if they are illegible or contain inaccuracies which require a replacement document or correction to the data.

If an error is made in recording data, the individual making the entry may make contemporaneous corrections by marking a line through the error and entering the correct information adjacent to it. Any error discovered subsequent to the field work should be corrected by the person who made the entry. The original entry should not be totally obscured and the reasons for making the subsequent change must be stated. The correction must be signed and dated.

Document Control System

The primary purpose of a document control system is to assure that all documents pertaining to or produced during an investigation will be accounted for at the conclusion of the project. This status of records is particularly important in projects that result in legal actions. Accountable documents include notebooks, correspondence, shipping papers, chain-of-custody forms, photographs and their negatives and any reports of test results or assessments of data.

Project Files

All project data, documentation, plans, and reports should be retained under conditions that minimize deterioration, facilitate retrieval, and provide control over access to documents. An individual should be assigned who has responsibility for filed information. Originals of all material should be kept in the file. These documents may be removed only after they have been logged out on a form that indicates the date removed, the name of the document, and the name of the person taking the document. Project personnel may retain copies of documents for reference after verifying that the original is in the file.

Confidential Information

Any information received with a request of confidentiality should be accompanied by supporting justification. Access to such information should be restricted to personnel on a "need-to-know" basis and should not be entered into a computer or data handling system, unless appropriate security measures have been implemented to allow only authorized users of the data to access those protected files.

Quality Assurance Records

Project records, such as correspondence, telephone conversations, notebooks, raw field and laboratory or test data, laboratory notebooks, data sheets, photographs, magnetic recordings, and computer disks and those records that furnish evidence that QA has been applied to the project, as required by the contract, shall be assembled, filed, indexed, and maintained during the life of the contract.

A quality assurance record is a document that furnishes evidence of the quality and completeness of data (including raw data), items, and activities affecting quality;

documents prepared and maintained to demonstrate implementation of the quality assurance program (e.g., audit, surveillance, and inspection reports); procurement documents; and project documents such as plans, correspondence, telephone conversations, specifications, and technical data.

Technical data are considered to be any recorded scientific or technical information, regardless of its form or characteristics. These data may, for example, document research or document experimental, developmental, test, demonstration, or engineering work; or they may be usable or used to characterize an area or a site, to define a design or process, or to procure, produce, support, maintain, or operate material. Technical data may consist of research and engineering data, raw data, design specifications, performance requirements, computer software and all related documents, geophysical notes and data, laboratory data, records of data reduction and analysis, and the results of peer review. The data may be in any form, such as laboratory notebooks, field notes, graphics, engineering drawings, photographic media, magnetic recordings, computer printouts, specification and process sheets, catalog information, referenced standards, manuals, and technical reports.

8.0 FIELD TESTS FOR CONTAMINATION

PETROLEUM HYDROCARBONS

Petroleum hydrocarbons can be determined in the field by the OCMA 220-Oil Content Analyzer made by Horiba Instruments, Ltd. of Japan. Horiba manufactures several oil-in-water analyzers for a variety of industrial and laboratory applications. The 220 is a portable version of the basic apparatus designed to determine the part-per-million concentration of oil in fresh and salt water or soils after extraction.

Principle of Operation

The basic principle of detection relies on the fact that petroleum hydrocarbons absorb infrared (IR) light. The carbon-hydrogen (C-H) bond absorbes IR light in the 3.4-3.5 micron wavelength range. All oils, greases, waxes and fats are mixtures of several different hydrocarbons. The number of C-H bonds present in any mixture will result in increasing absorption in the 3.4-3.5 micron range.

An actual part-per-milion reading is determined from the amount of 3.4-3.5 micron IR light absorbed. This is possible only after calibrating the span of detection with a standard solution (generally 160 ppm of Arabian Crude Heavy "B" Oil). Greater accuracy can be achieved if the specific contaminant of concern (such as gasoline) is used to make up the span calibration solution.

Since water also absorbs IR wavelengths of 3.4-3.5 microns, it is necessary to extract the hydrocarbons. The extraction solvents available are carbon tetrachloride and various chloro/fluorocarbons. A specific chloro/fluorocarbon known by its trade name Flon-316, is the solvent of choice due to its low toxicity and low volatility. In addition to its non-interference in IR absorption, Flon-316 is virtually insoluble with water, readily solubilizes hydrocarbons, and is heavier than water.

Procedure

Aqueous samples are analyzed in accordance with the instruction manual for the OCMM-220 provided with the instrument.

To utilize the OCMA 220 to detect petroleum hydrocarbons in soil requires the additional step of a soil extraction with Flon-316. The extraction consists of weighing 5 g of soil, placing it into a vial, and adding 10 ml of Flon. The vial is shaken for 30 seconds and the contents allowed to settle. A measured volume usually 0.1 to 10 ml) of the soil extraction fluid is injected into the instrument instead of a water sample. Total volume of solution is made up to 20 ml with clean solvent. The sample Flon and fresh Flon are mixed, allowed to settle, and the mixture is passed through the filters to the IR analyzer chamber. The instrument reading is multiplied by the dilution factor to calculate approximate soil hydrocarbon concentration. Dilution factor is calculated by dividing 10 ml by the actual volume of soil extract injected into the instrument.

Extraction of hydrocarbons from soil is most efficient with dry soil. However several factors argue against drying.

1. It is not always possible or expedient to dry the soil depending on time or field facility constraints.

2. Heating or even vacuum dessication may result in loss (through evaporation) of the contaminants of interest.

3. A truly representative sample of petroleum hydrocarbon contamination may require or imply the analysis of the complete soil/water matrix.

In cases where wet samples are to be extracted greater efficiency is possible with longer soil-solvent extraction time (24 hours is best) or the use of drying agents (such as M_gSO_4) depending on soil type. A minimum of 2 hours extraction time is recommended. If shorter times are to be used at a given site, sufficient samples should be analyzed after 24 hours extraction time to demonstrate that acceptable extraction efficiencies are being achieved.

PCB FIELD ANALYSES

PCBs in oils, soils, sediments, or other extractable matrices can be determined in the field using the McGraw Edison PCB Test Kit.

Principle of Operation

PCBs in oils, or in a solvent extract from solid matrices, are reacted with an agent which releases chloride ions from the PCB molecules. The chloride ion is extracted back into an aqueous, and determined by chloride specific ion electrode. The test kit manual provides a calibration for electrode readings to ppm of PCBs in oil and soils.

Procedures

Procedures identified in the PCB Test Kit - Operator Manual supplied with the instruments are to be followed. Particular attention must be given to scrupulous adherence to electrode calibration procedure, and to regular performance of check samples provided with the kit, as specified in the manual.

In addition to procedures specified in the manual soil samples should be dried prior to analysis to improve extraction efficiency and repeatability of analyses. The preferred drying method is via vacuum desiccation, although air drying, and low temperature (200^{o}F) oven drying are acceptable.

Results obtained for dried soil samples will be conservative (high) compared to the test kit calibration curves, which were developed for fresh soil samples.

Limitations

During the soil extraction, organic molecules, in addition to PCBs, may be extracted and dissolved in the organic phase. If chlorinated organics other than PCBs are present, they may be carried over to the reaction vials and produce positive chloride interference. Additional positive chloride interference is possible from inorganic chlorides on suspended soil particles inadvertently transferred with the organic extract to reaction vial.

9.0 DECONTAMINATION PROCEDURES

Equipment and personnel decontamination areas will be set up in an area determined to be uncontaminated but as near as possible to the work site. Determination of the decontamination area will be made by using an Organic Vapor Analyzer (OVA or HNU), site reconnaissance, or other determinative procedures.

DRILLING EQUIPMENT

Large equipment, such as, drill rigs, logging trucks and ancillary equipment will be decontaminated prior to leaving the site after work is completed with high pressure hot water/detergent or steam spray and brushing to remove encrusted material.

Field cleaning of well casing and well screening will consist of a manual scrubbing to remove foreign material and steam cleaning to remove all oil and grease.

Any of the drill rig tools that may have contacted contamination will be pressure cleaned after the completion of each well to minimize the potential for cross-contamination. Special attention should be given to decontaminating down-hole sampling devices prior to each use. Split-spoon, core barrels, or specialized samplers should be throughly cleaned under the supervision of the WCC inspector.

SAMPLING EQUIPMENT

All hand operated water sampling equipment (bailers) will be decontaminated by the lab prior to use and will be wrapped in autoclaved aluminum foil and labelled as clean. Decontamination in the lab and in the field between samplings will include the following procedures:

1. tap water wash with non-phosphate detergent
2. rinse with tap water

3. rinse with distilled/deionized water
4. rinse with distilled/deionized water
5. rinse with pesticide grade acetone
6. air dry
7. rinse with distilled/deionized water

All water-contact well tubing will be factory cleaned and wrapped. If on-site inspection reveals that it has not been properly cleaned or been soiled during transport, cleaning on-site will be done by high-pressure hot water/detergent. Well tubing used for purging will be dedicated for each well.

PERSONNEL

Decontamination of personnel will be conducted in an established Contamination Reduction Corridor and will consist of soap (Alconox or equivalent) and water washing of exterior protective gear followed by removal of the clothing. The procedure is as follows:

1. Place equipment and/or samples in area designated; move to next area.
2. Wash boots and outer gloves using (a) soap (Alconox or equivalent) in water solution and (b) potable water rinse. Store gloves in appropriate place.
3. Remove respirator, if used, and store in appropriate place, if still usable.
4. Remove outer coveralls and booties and dispose in appropriate containers.
5. Remove inner gloves, if used, and wash hands and face.
6. Check all reusable equipment for serviceability. Red-tag if contaminated. Mark for repair or disposal if damaged or inoperative.

Personnel and equipment working within an Exclusion Zone (contaminated area) may proceed directly to the Contamination Reduction Corridor upon completion of work. Personnel working at remote sampling locations which are not contiguous to the Exclusion Zone may perform partial decontamination of personnel which will consist of removal of booties and potable or distilled water rinse of exterior gloves, boots and any other protective gear suspected of contacting contaminated materials. Partial decontamination will also consist of a potable or distilled water rinse of all sampling and testing equipment. Final decontamination will take place at the designated decontamination areas in the Contamination Reduction Zone.