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EXECUTIVE SUMMARY

This Remedial Investigation (RI) Report provides an overview of the site history and previous site investigations details the procedures used in conducting the investigation, presents findings on the physical and chemical characteristics of the site, and provides an overview of fate and transport processes. The RI has been performed as documented in Work Plans, a Sampling and Analysis Plan, a Quality Assurance Project Plan, and a Site Operations Plan that have been reviewed and approved by the USEPA. The RI consisted of the following:

- Literature searches to document previous geological, geotechnical, hydrogeological, hydrological, and climatological studies applicable to the Hunterstown Road Site.

- Identification of current designated uses of groundwater and surface water.

- Characterization of site geologic conditions based on field mapping, coreholes, and borehole geophysical logging to allow for an understanding of subsurface lithology and structure.

- Assessment of bedrock fractures by means of a fracture trace analysis.

- Investigation of the site hydrogeology, including vertical and lateral flow gradients and water quality by installing monitoring wells, measuring water levels, and analyzing groundwater samples. The RI included the installation of 38 monitoring wells.
• Assessment of whether nearby streams are currently serving as migration pathways from the site based on sampling and analyses of surface water and sediment samples.

• Evaluation of potential on-site source areas by surface geophysical methods, and through an extensive sampling and analysis program.

• Evaluation of fate and transport processes.

• Quantitative risk assessment considering both potential human health and ecological effects.

Based on the above studies, the following findings can be summarized:

• The bedrock underlying the site consists of hornfels with numerous igneous intrusives. The strata strike at N41° E with a dip of 26° NW.

• The fracture traces and lineaments assessed in this study appear to mainly reflect bedding, with a secondary trend nearly perpendicular to bedding of unknown origin, but which could be strike-slip faulting. Although the joint azimuths appear to be reflected in the pattern of fracture traces, most of the fracture traces or lineaments do not appear to be joint controlled.

• Groundwater movement is characterized by fracture flow. Groundwater appears to flow horizontally in the shallow, weathered bedrock. In the vertical plane, downward hydraulic gradients combine with anisotropic hydraulic conductivities to produce groundwater movement that is primarily within bedding planes and near vertical joints within the bedding.

• In the former Borrow Area, lead, copper, and zinc were detected at levels above background concentrations in the western portion of the area,
between the center pile of debris and the East Stream. The only organic compound of interest (COI) detected at levels above practical quantitation limits was bis(2-ethylhexyl)phthalate (BEHP), near the bottom of a center pile of debris. Asbestos was not detected.

- In the former Lagoon Area, surface soils contained levels of heavy metals (antimony, chromium, copper, lead, mercury, and zinc) above background concentrations. One of three surface soil samples also contained volatile organic compounds (VOC) (ketones, chlorinated aliphatic hydrocarbons, and aromatic hydrocarbons) above practical quantitation limits. Subsurface soils in and around the Lagoon Area contained levels of copper, lead, zinc, and ketones above background concentrations, with low levels of chlorinated aliphatics and aromatic hydrocarbons.

- In the Cornfield Area, levels of barium and copper above background concentrations were identified in both Phase I and Phase II soil samples. Levels of chromium, lead, mercury, selenium, zinc, and VOC above practical quantitation limits were detected primarily in soil samples from within one foot of the ground surface. Deeper soil samples do not display this pattern. The levels of lead, barium, selenium, and zinc that were detected appear to have originated from the white, clay-like material located near the ground surface. The RI samples collected and analyzed have defined the horizontal and vertical limits of impacted soil.

- In the Stressed Vegetation Area, locations of barium, chromium, copper, lead, and zinc above background concentrations are found to the south and west, with the highest levels found immediately within the area and attenuating beyond in the perimeter. Levels of VOC above practical quantitation limits were found inside the area in 1988 but are not currently detected beyond the perimeter.
• Former Drum Burial Area 1 appears to contain levels of VOC above practical quantitation limits (aromatic and chlorinated aliphatic hydrocarbons) in surficial soil shortly after waste removal. Perimeter subsurface soil sample results indicate that VOC are not present at the soil-bedrock interface. Trace VOC were measured in the soil sample from the soil-bedrock interface directly beneath the former disposal area. Based on the RI results, the area is no longer considered a current source of VOC and the previous interim removal action was successful.

• Former Drum Burial Area 2 does not contain levels of COI above practical quantitation limits.

• Surface water in the East Stream contains levels of lead above background concentrations and chlorinated aliphatics above practical quantitation limits. Copper was slightly above background. These COI are contained within 400 feet from the former Borrow Area, the Stressed Vegetation Area, and the former Lagoon Area; and shallow groundwater discharge associated with these three areas. East Stream sediments contained chromium, copper, lead, and zinc above background concentrations. Low levels of xylenes and chlorinated aliphatics were also detected in East Stream sediments. As with the inorganics, organics in East Stream sediments are limited to the reaches downstream of the former Lagoon Area and upstream of Shealer Road.

• Surface water in the Middle Stream contains low levels of lead and zinc limited to the areas upstream of Shealer Road. Middle Stream sediments contain zinc, lead, and cyanide above background concentrations and BEHP above practical quantitation limits, all restricted to the reach above Shealer Road.

• West Stream surface water and sediments contain no levels of COI above upstream reference levels.
Groundwater associated with the former Lagoon Area, former Drum Burial Area 1, and former Drum Burial Area 2 contained VOC above practical quantitation limits. Each area appears to impact both shallow and deep flow zones. In the shallow zones, VOC attenuate quickly with distance downgradient. In the deep zones, VOC follow the dip of the bedrock. The deep groundwater plume from the Lagoon Area is bounded laterally, but not vertically in the areas of HMW-2BL and HMW-5CL. The deep groundwater plume from former Drum Burial Area 2 is bounded in all directions. The deep groundwater plume from former Drum Burial Area 1 is not bounded laterally.

The chemical characteristics of the former Lagoon Area groundwater plume are different from the chemical characteristics of the plumes associated with the two drum burial areas. The two former drum burial area plumes are similar to each other with respect to chemical characteristics. This finding is consistent with the disposal histories.

Remediation has occurred at four potential source areas. The remediation based on RI samples, collected appears to have successfully removed the waste materials in these areas and most of the soils having detectable levels of COI.

An alternative water supply is present in the vicinity of the site.

This report documents the existence of five operable units and appropriate general response actions. Additional data needs, i.e., a treatability study to enable design of remedial measures for plume containment, have been identified and are currently being addressed.
1.0 INTRODUCTION


1.1 PURPOSE OF REPORT

This report details investigative activities and the resulting physical and chemical characterization of the site performed for the RI portion of the overall RI/FS study. It also includes a baseline risk assessment and identification of preliminary remedial objectives.

The RI was performed in two phases. Phase I of the RI placed emphasis on assessing the geotechnical, geological, and hydrogeological characteristics of the site and identifying chemicals of interest (COI). Specifically, the first phase included:

- Review of existing data;
- A fracture trace analysis;
- Drilling and logging of borings;
- Installation of groundwater monitoring wells;
- Groundwater, soil, surface water, and sediment sampling and analysis;
- Physical and chemical site characterization;
- Evaluation of contaminant fate and transport; and
- Identification of additional data needs.
Phase II was designed to fill data gaps identified by Phase I, assess the nature and extent of contamination, and provide the additional data necessary for the performance of a baseline risk assessment and evaluation of remedial alternatives. Field activities in the second phase included:

- Installation of additional groundwater monitoring wells;
- Sampling and analysis of new and existing groundwater monitoring wells;
- A residential well survey;
- Additional sampling and analysis of surface soils;
- Additional sampling and analysis of subsurface soil;
- Sampling and analysis of surface water and sediment; and
- A magnetometer survey in the area of a suspected diabase dike.

An aquifer performance test has been conducted and data is being evaluated. The results of the test will be submitted to the USEPA.

1.2 REPORT ORGANIZATION

This report is organized in a manner that summarizes the field and laboratory investigations undertaken as part of this study and integrates the new information into the previously existing data. The format of the presentation generally follows the suggested RI report format provided in OSWER Directive 9355.3-01 (USEPA, 1988). The balance of Section 1.0 includes the site history and summarizes previously existing data. Section 2.0 summarizes the scope of the Phase I and Phase II site investigations, including drilling and monitoring well installation, geophysics, field mapping, sampling, and laboratory testing. Section 3.0 summarizes the physical characteristics of the site, including surface features, meteorology, surface water hydrology, geology, soils, groundwater, demography and land use, and ecology. Section 4.0 summarizes and evaluates the laboratory test results of the surface soil, subsurface soil, surface water, sediment, and groundwater samples obtained during Phases I and II. Section 5.0 presents an overview of fate and transport mechanisms. Section 6.0 presents a
Supporting material related to the discussions in the text has been included as appendices. Specifically, Appendix A contains logs of borings drilled during this study. Appendix B contains installation details of the Phase I and Phase II monitoring wells. Appendix C contains the field collection reports for soil, surface water, groundwater, and sediment samples, as well as chain-of-custody forms. Appendix D contains a sample residential well survey form and cover letter sent to area residents, and the response from area residents. Appendix E contains a calculation of the strike and dip of the sedimentary rocks at the site. Appendix F contains Phase II laboratory test results. Appendix G contains grain size distribution curves for sediments from streams at the site. Appendix H contains the results of the stream bioassay program. Appendix I contains a summary of data validation. The USEPA comments on the Draft RI Report with the associated Westinghouse responses are in Appendix J. Appendix K contains the baseline risk assessment.

This RI Report has been organized into seven volumes. Volume I contains the text, tables, and figures. Volumes II, III, IV, V and VI contain Appendices A through J. Volume VII contains the baseline risk assessment (Appendix K).

1.3 ABBREVIATIONS

The following abbreviations and acronyms are used repeatedly throughout this report.

General Acronyms

<table>
<thead>
<tr>
<th>Acronym</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>AWQC</td>
<td>Clean Water Act-Ambient Water Quality Criteria</td>
</tr>
<tr>
<td>COI</td>
<td>Compounds of Interest</td>
</tr>
<tr>
<td>MCL</td>
<td>Safe Drinking Water Act-Maximum Contaminant Levels</td>
</tr>
<tr>
<td>MSL</td>
<td>Above Mean Sea Level</td>
</tr>
<tr>
<td>PADER</td>
<td>Pennsylvania Department of Environmental Resources</td>
</tr>
<tr>
<td>RI</td>
<td>Remedial Investigation</td>
</tr>
<tr>
<td>Acronym</td>
<td>Description</td>
</tr>
<tr>
<td>---------</td>
<td>-------------</td>
</tr>
<tr>
<td>RI/FS</td>
<td>Remedial Investigation/Feasibility Study</td>
</tr>
<tr>
<td>SAP</td>
<td>Sampling and Analysis Plan (Rizzo Associates, 1990b)</td>
</tr>
<tr>
<td>TAL</td>
<td>Target Analyte List</td>
</tr>
<tr>
<td>TCL</td>
<td>Target Compound List</td>
</tr>
<tr>
<td>TCLP</td>
<td>Toxicity Characteristic Leaching Procedures</td>
</tr>
<tr>
<td>USEPA</td>
<td>United States Environmental Protection Agency</td>
</tr>
<tr>
<td>USGS</td>
<td>United States Geological Survey</td>
</tr>
<tr>
<td>USSCS</td>
<td>United States Soil Conservation Service</td>
</tr>
<tr>
<td>VOC</td>
<td>Volatile Organic Compounds</td>
</tr>
</tbody>
</table>

**Organic Compounds**

<table>
<thead>
<tr>
<th>Compound</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>BEHP</td>
<td>Bis(2-ethylhexyl) phthalate</td>
</tr>
<tr>
<td>1,1-DCA</td>
<td>1,1-Dichloroethane</td>
</tr>
<tr>
<td>1,2-DCA</td>
<td>1,2-Dichloroethane</td>
</tr>
<tr>
<td>1,1-DCE</td>
<td>1,1-Dichloroethene</td>
</tr>
<tr>
<td>1,2-DCEs</td>
<td>1,2-Dichloroethenes (cis- and trans- isomers)</td>
</tr>
<tr>
<td>1,2-trans DCE</td>
<td>1,2-trans-Dichloroethene</td>
</tr>
<tr>
<td>DDD</td>
<td>Dichlorodiphenyldichloroethane</td>
</tr>
<tr>
<td>DDT</td>
<td>Dichlorodiphenyltrichloroethane</td>
</tr>
<tr>
<td>PCBs</td>
<td>Polychlorinated biphenyls</td>
</tr>
<tr>
<td>PCE</td>
<td>Tetrachloroethene</td>
</tr>
<tr>
<td>1,1,1-TCA</td>
<td>1,1,1-Trichloroethane</td>
</tr>
<tr>
<td>1,1,2-TCA</td>
<td>1,1,2-Trichloroethene</td>
</tr>
<tr>
<td>TCE</td>
<td>Trichloroethene</td>
</tr>
</tbody>
</table>

**Units of Measure**

<table>
<thead>
<tr>
<th>Unit</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>cfs</td>
<td>cubic feet per second</td>
</tr>
<tr>
<td>cm/s</td>
<td>centimeters per second</td>
</tr>
<tr>
<td>mg/kg</td>
<td>milligrams (of chemical) per kilogram (of soil)</td>
</tr>
<tr>
<td>mg/l</td>
<td>milligrams (of chemical) per liter (of water)</td>
</tr>
<tr>
<td>ug/kg</td>
<td>micrograms (of chemical) per kilogram (of soil)</td>
</tr>
<tr>
<td>ug/l</td>
<td>micrograms (of chemical) per liter (of water)</td>
</tr>
</tbody>
</table>
1.4 SITE BACKGROUND

1.4.1 Site Description

The site is located about 1.5 miles northeast of downtown Gettysburg in Straban Township, Adams County, Pennsylvania. A site location map is provided as Figure 1-1. Topography in the area is gently rolling. The site and surrounding areas are semirural with both farmlands and residences.

The site occupies an approximate area of 22 acres, and portions of the site lie both east and west of Hunterstown Road, as shown on Figure 1-2. The coordinates of the site are latitude 39° 51' 6" and longitude 77° 12' 18".

There are three unnamed tributaries of Rock Creek which flow adjacent to portions of the site. These are referred to herein as the West Stream, Middle Stream, and East Stream, as indicated on Figure 1-2. The West and Middle Streams join just north of Shealer Road, and the East Stream joins the other combined streams approximately 0.2 miles south of Shealer Road.

There are six identified areas of specific interest at the site. Drum Burial Area 1 is located west of Hunterstown Road. The other areas are located east of the road. These are shown on Figure 1-2 and are briefly described as follows:

- **Drum Burial Area 1**
  This area is located just east of the West Stream, and has an approximate length of 440 feet and a width averaging 90 feet.

- **Drum Burial Area 2**
  This area lies north of the access road and immediately west of the Middle Stream. The approximate dimensions are 180 feet by 50 feet.
• **Cornfield Area**
This area is comprised of the North and South Cornfields. The North Cornfield is a roughly triangular open field located north of the access road. This field is approximately 500 feet wide at the base and about 800 feet in length. The South Cornfield is a roughly square open field located south of the access road. This field has approximate dimensions of 400 feet by 400 feet.

• **Lagoon Area**
This area is described as sloping, with approximate dimensions of 100 feet by 150 feet. It is enclosed by a chain-link fence.

• **Stressed Vegetation Area**
This area is located east of the South Cornfield and roughly southwest of the Lagoon. It has approximate dimensions of 50 feet by 100 feet.

• **Borrow Area**
This area is located along the east bank of the East Stream. It has approximate dimensions of 175 feet by 175 feet.

1.4.2 Site History

This subsection presents an outline of site history as compiled from the various referenced sources. The primary source was Rizzo Associates (1988).

Wastes were placed at the Hunterstown Road site by Mr. Fred Shealer, who owns the property and transported the material from various sources. Reported disposal operations at each area of the site are described below.
• **Lagoon**
  Paint sludges from drums and colored pigmented clay sludges from tanker trucks were placed in the Lagoon Area. Sludges with a high liquid content were discharged into small depressions (pools) created by mounding the drier residual solids into embankments.

• **Cornfield Area**
  Tank truck loads of liquid wastes, including a white clay-like material and domestic septic tank sludges, were sprayed onto the ground.

• **Stressed Vegetation Area**
  Tank truck loads of pigmented clay sludges were reportedly discharged into depressions remaining after the removal of the top soil.

• **Borrow Area**
  Drums of waste, construction debris and bundles of insulation board containing asbestos were disposed of at the surface.

• **Drum Burial Areas 1 and 2**
  Drums of paint sludges and solvents, insulation board containing asbestos, and some construction debris were placed in depressions about four to five feet deep. These depressions were previously created when soil was excavated and used in the manufacturing of field tile.

Investigation by the Pennsylvania Department of Environmental Resources (PADER) into the dumping on the Shealer property was initiated as a result of a complaint from the Adams County Community Environmental Control Office. According to the complaint, drums containing waste generated by the Westinghouse Elevator Manufacturing Plant in Gettysburg were deposited on the Shealer property in 1975.
In January 1984, the PADER requested assistance from the USEPA to investigate the disposal site. The PADER also requested aid in implementing any necessary immediate removal or remedial response measures.

On March 22, 1984, the USEPA issued a CERCLA Section 106 unilateral Administrative Order (Order) to Westinghouse. Westinghouse was required to provide, within seven days of the effective date of the Order, a sufficient temporary potable water supply to all households where the USEPA On-Scene Coordinator deemed such remedial action was needed. The Order required Westinghouse to remove all sludges and liquid materials from the Lagoon. The Order was supplemented on August 8, 1984 by a request to provide potable water to additional homes in the site area.

In April 1984, Westinghouse contracted O.H. Materials of Findlay, Ohio, to remove drums from the Borrow Area and Lagoon, and to remove the Lagoon embankment and sludge material. A chain-link fence was also installed.

At the conclusion of the removal, the USEPA initiated a site investigation. Based on the results of this investigation, the site was proposed for the National Priorities List in October 1984. Its listing was finalized in June 1986.

In December 1986, Westinghouse removed two piles of bulk asbestos from the Borrow Area. On March 10, 1987, the USEPA and Westinghouse signed a Consent Order requiring Westinghouse to conduct an RI/FS at the site.

In April and May 1987, Westinghouse undertook a series of site modifications, including: installing a security fence around the Lagoon and eastern portion of the South Cornfield, installing straw-bale dikes around the lower half of the Lagoon and around the Stressed Vegetation Area, applying lime to the Lagoon and Stressed Vegetation Area, covering the Lagoon with mulch, covering the Stressed Vegetation Area with mulch and plastic sheeting, regrading the southwest corner of the Lagoon, installing a silt barrier on the chain-link fence, removing contaminated debris from the East Stream channel, and removing a culvert and reshaping the channel in the East Stream.
In August 1987, REMCOR, Inc. of Pittsburgh, Pennsylvania conducted an assessment of the volumes and types of waste found within the two buried drum areas (REMCOR, 1987). Based on this assessment, Westinghouse hired Associated Chemical and Environmental Services (ACES) of Horsham, Pennsylvania to conduct a removal of the buried drums from December 1988 through May 1989.

In December 1988, Westinghouse initiated Phase I RI activities. In August 1989, Westinghouse submitted the Phase I Report for the RI/FS (Rizzo Associates, 1989). In July 1990, Westinghouse submitted Revision 1.0 of the Work Plan (Rizzo Associates, 1990a) and a Sampling and Analysis Plan (Rizzo Associates, 1990b) detailing Phase II field activities designed to fill data gaps identified in the Phase I RI/FS Report. Phase II was initiated in September 1990.

With USEPA and PADER approval, C.E. Williams, Inc. of Gettysburg, Pennsylvania, in August and September 1990, treated ponded water from the two drum burial areas using an air stripper (operated by R.E. Wright Associates of Harrisburg, Pennsylvania) and discharged the treated water into the Middle and West Streams. Discharge requirements were provided by the PADER and were met. The excavations were then lined with a geotextile to differentiate between backfill and existing soil and backfilled with clean fill. The disturbed stream segments were restored to pre-existing conditions, as feasible, and reseeded.

1.5 SUMMARY OF PREVIOUS INVESTIGATIONS

Prior to the RI/FS, previous investigations related to the Hunterstown Road Site have involved sampling and analysis of waste materials, soil, surface water, sediment, and residential wells. These investigations are summarized in Table 1-1.

1.5.1 Waste Materials

Sampling of waste materials has been limited to drums and materials found in the Lagoon Area, Borrow Area, and Drum Burial Areas 1 and 2. The results are summarized in Table 1-2.
REMCOR’s excavation of test pits in the Drum Burial Areas indicated that Area 1 was about 440 feet long, 90 feet wide, four to six feet deep, and was found to contain demolition debris, rubbish, septic tanks, oil, rusted drums, and other waste material; and Area 2 was about 180 feet long, 50 feet wide, four to six feet deep, and also contained demolition debris, rubbish, rusted drums, and other waste material.

On May 9 and 10, 1984, a site inspection and sampling and analysis effort was conducted by the USEPA Region III Field Investigation Team (FIT). In an attempt to identify buried drum areas, a gradiometer survey was conducted. The survey did not indicate any additional unidentified buried drum areas at the site.

1.5.2 Soil

During previous investigations, ten surface soil samples were collected between May 1984 and May 1986: six from within or near the Lagoon, one from the edge of the South Cornfield, two from the Stressed Vegetation Area, and one from Drum Burial Area 1. The results are summarized in Table 1-3. No samples from background locations were analyzed prior to this study.

Samples of stained surface soil collected by NUS in May 1984 from the Lagoon after removal of the sludge were reported to contain VOC such as TCE, 1,2-DCEs, toluene, 1,1,1-TCA, xylenes, ethylbenzene, and naphthalene. Metals such as lead, copper, chromium, and zinc were also detected.

Additional Lagoon surface soil sampling was performed outside the fenced area. 1,1,1-TCA and 1,2-DCEs were detected between the fence and the stream. Samples from the slope west of the fence did not contain VOC but did contain heavy metals such as lead, copper, chromium, and zinc.

A surface soil sample collected from the lower corner of the South Cornfield did not contain VOC, but did contain heavy metals, including lead. Two samples collected from the Stressed Vegetation Area contained phthalates and heavy metals, especially lead.
One surface soil sample collected near Drum Burial Area 1 contained chrysene, benzo(a)anthracene, and 1,2-DCEs. Heavy metals were also detected, but at relatively low concentrations compared to the levels found in other site areas sampled.

1.5.3 Surface Water and Sediment

Twenty-two surface water and 11 related sediment samples from the site have been analyzed during previous investigations. The dates, sampling organizations, and results are summarized in Table 1-4.

VOC have been found in surface water samples collected in and downstream from the Lagoon. These compounds include methylene chloride; 1,2-DCEs; TCE; 1,1,1-TCA; 1,1-DCA ethylbenzene; xylenes; toluene; and naphthalene. Aqueous samples collected from puddles outside the fence on the west slope did not contain organic compounds above quantitation limits.

Samples of sediment were obtained from the East Stream in 1986. Levels of lead were measured at 5,000 to 8,900 mg/l at the culvert located immediately downstream from the Lagoon and 100 mg/l farther downstream; chromium concentrations were 1,213 to 1,625 mg/l at the culvert and 1,849 mg/l farther downstream. Phthalates were also detected in sediment collected from the East Stream.

Two samples were collected from the pond near Drum Burial Area 1 in 1984 and 1985. Analyses showed the presence of methylene chloride, 1,2-DCEs, TCE, 1,1-DCA, and 1,1,1-TCA.

Samples of surface water from the West Stream contained VOC. The compounds included methylene chloride, 1,1,1-TCA, 1,1-DCA, 1,2-DCA, 1,2-DCEs, and TCE. Sediment in the West Stream, downstream from Drum Burial Area 1, contained organic compounds but not heavy metals. The organics detected were 1,1,1-TCA and 1,2-DCEs.
1.5.4 Residential Wells

Seventy-six groundwater samples have been collected from 42 residential wells in the vicinity of the site. A list of the well owners, addresses, and available construction data is provided in Table 1-5. Residential well locations and the location of the Gettysburg Municipal Authority water line are shown on Figure 1-3. Sampling dates, organizations performing the sampling, and analytical data are presented in Table 1-6.

Water samples from the residential wells were analyzed for VOC. Fourteen samples contained at least one compound with a concentration of at least 1.0 ug/l. The most commonly detected compounds and their ranges in concentration are listed below:

<table>
<thead>
<tr>
<th>COMPOUND</th>
<th>NO. OF WELLS IN WHICH COMPOUND WAS DETECTED</th>
<th>RANGE IN CONCENTRATION (ug/l)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1,1,1-TCA</td>
<td>14</td>
<td>1.1 - 500</td>
</tr>
<tr>
<td>TCE</td>
<td>10</td>
<td>1.1 - 500</td>
</tr>
<tr>
<td>1,1-DCE</td>
<td>9</td>
<td>1.6 - 95</td>
</tr>
<tr>
<td>1,2-DCEs</td>
<td>6</td>
<td>1.2 -&gt; 150</td>
</tr>
<tr>
<td>1,1-DCA</td>
<td>5</td>
<td>1.0 - 63</td>
</tr>
<tr>
<td>PCE</td>
<td>3</td>
<td>1.0 - 1.6</td>
</tr>
</tbody>
</table>

Due to the differing dates on which samples were taken and different or unknown well depths, trends in concentration data are difficult to interpret. However, evaluation of the results of residential well samples and RI monitoring well samples is presented in Section 4.4.3.
2.0 SITE INVESTIGATIONS

The RI of the Hunterstown Road Site consisted of two phases. Phase I of the RI, as defined in the October 1988 Work Plan (Rizzo Associates, 1988), was conducted to determine the COI and site physical characteristics, such as geology, hydrology, soils, and geotechnical conditions. Phase II of the RI, as defined in the July 1990 Work Plan, Revision 1.0 (Rizzo Associates, 1990a) and the July 1990 Sampling and Analysis Plan (Rizzo Associates, 1990b), was conducted to assess the extent of contamination and to obtain the additional data necessary for the performance of a baseline risk assessment and the development and evaluation of remedial alternatives.

In order to generate the necessary data, the following investigations were conducted under Phases I and II of the RI:

- A literature search to assess previous geological, geotechnical, hydrogeological, hydrological, and climatological studies that may be applicable to the Hunterstown Road Site.

- Characterization of site geological conditions based on field mapping, surface geophysics, coreholes, and borehole geophysical logging.

- Characterization of bedrock fractures by means of a fracture trace analysis.

- A survey of residential well owners.

- Characterization of the hydrogeological conditions by installing monitoring wells, measuring water levels, pressure testing coreholes, and analyzing groundwater samples.

- Determination of the horizontal extent of soil contamination.
• Assessment of whether nearby streams are currently serving as migration pathways from the sites based on sampling and analysis of stream water and sediment samples.

The details of these investigations are provided in the following sections.

2.1 SURFACE FEATURES

Surface features of the site were assessed by visual reconnaissance from the ground and aerial photography. In addition, pertinent surface features were previously documented as part of the preparation of the topographic map of the site by Eastern Mapping, Inc. of Pittsburgh, Pennsylvania. This information, as well as other maps previously compiled, was utilized to document the topography, landforms, buildings, drainage, utilities, etc. that comprise the surface features of the site. It should be noted that the topography and surface water drainage have been somewhat altered since the time of mapping due to the 1988/1989 waste removal program.

2.2 CHARACTERIZATION OF POTENTIAL SOURCE AREAS

As discussed in Section 1.4.1, previous investigations have identified six potential source areas. Surface soil samples and deep soil samples were collected and analyzed to obtain the additional information on the potential source areas necessary to assess the extent of impact and, if necessary, remedial options related to source removal, source treatment, and source control.

2.2.1 Phase I Soil Samples

During Phase I, surface soil samples were collected from areas previously identified as containing or having received wastes. Waste removal and other emergency response activities had been performed for most of these areas. The samples were analyzed to evaluate these areas and to determine COI, if any. The sampling strategy and procedures are based on the approved Phase I Work Plan dated October 1988.
On December 6 and 7, 1988, eight composite soil samples were collected: three from the North Cornfield, three from the South Cornfield (plus one duplicate), one from the Lagoon Area, and one from the Borrow Area. Five soil/waste samples and one duplicate were collected from the Stressed Vegetation Area. One sample of sludge material encountered in the Cornfield Area ("Cornfield Sample") was also taken. Finally, a background soil sample was taken from a cornfield along Hunterstown Road 0.3 miles northeast of the site.

Samples were submitted to Lancaster Laboratories of analyses of the Target Compound List (TCL) organic compounds and Target Analyte List (TAL) inorganic parameters. The sample from the Borrow Area was also analyzed for asbestos. The laboratory results are included in Appendix F.

Soil samples were collected by visual selection of points within blocks defined by a grid presented in the Work Plan. Samples were obtained from depths of approximately 8 to 12 inches within each block and composited. Several proposed grid locations were not included in the compositing due to conflict with the waste removal program or wooded areas.

Soil samples were collected by digging with a hand shovel to the specified sampling depth. The hole was then scanned with an HNU photoionization detector (10.2 eV lamp) or Foxboro Organic Vapor Analysis (OVA) meter and measurements were recorded on Soil Sample Field Collection Reports (Appendix C). After scanning the hole, the soil sample was removed with a stainless steel trowel. Where composite samples were obtained, approximately equal volumes of subsamples from grid locations were collected and composited in a stainless steel bowl. After sample collection, excavated material was returned to the hole and firmly tamped in place.

Each composite sample consisted of approximately two quarts of material which was then transferred to appropriate containers supplied by the laboratory. The sample containers were labeled with the pertinent information, including sample identification, date, time, and the initials of the sampling personnel. The duplicate composite sample was collected using the same procedures as described for the other composite samples except twice the volume of soil was collected and composited in a stainless steel bowl. The composite sample was then divided and transferred into two sets of appropriately
labeled sample containers. The background soil sample and the samples from the
Stressed Vegetation Area were collected using the same procedures except that
compositing was not performed.

On April 13, 1989, 36 samples were collected from the excavation created after the
removal of buried drums from Drum Burial Area 1. The sampling strategy, as
presented in the USEPA-approved Sampling and Analysis Plan (Rizzo Associates,
1990b), divided each excavation into four 100-foot by 100-foot sections. In each
section, four shallow (zero to six inches) and four deep (12 to 18 inches) grab samples
were collected and analyzed for TCL volatiles. In addition, the four shallow samples
from each section were composited and analyzed for all TCL/TAL parameters. The
locations of the samples from Drum Burial Area 1 are shown on Figure 2-1.

On May 23, 1989, ten samples were collected from the excavation created after the
removal from Drum Burial Area 2. The sampling strategy in this area was identical to
that for Drum Burial Area 1, except only two shallow grab samples were used in each
composite sample. Sampling methods for the Drum Burial Area 1 and Drumi Burial
Area 2 post-excavation samples were the same as for the other Phase I soil samples
described previously. The locations of the samples from Drum Burial Area 2 are
shown on Figure 2-2. Although the shallow soil sample results from the two drum
burial areas are included in this RI report, the samples were required by the separate
removal action.

Soil samples collected during Phase II were submitted to Lancaster Laboratories, Inc.
of Lancaster, Pennsylvania for analysis. Filled sample containers were placed in
insulated coolers with ice during sampling and while transported to Lancaster
Laboratories. Aqueous trip blanks (VOC analysis only) were included in the
appropriate insulated coolers during transit. Chain-of-Custody records and sample
collection reports were maintained for each soil sample obtained at the site and are
included as Appendix C.
2.2.2 Phase II Shallow Soil Samples

During Phase II, 111 shallow soil samples were collected on November 19-21 and November 29-30, 1990. These include the following: 57 samples from the Cornfield Area (including five duplicates), 23 from the Stressed Vegetation Area (including one matrix spike, one matrix spike duplicate, and a composite sample of the waste), 11 samples from the Borrow Area (including one duplicate and an aqueous matrix equipment blank), and 20 background or reference samples (including one duplicate).

2.2.2.1 Cornfield Area

Fifty-seven shallow soil samples, including five duplicates, were collected from 16 Cornfield Area locations during Phase II. The soil samples were collected on November 19 and 20, 1990. Twelve of the sample locations were selected randomly within the established Cornfield Area grid. The other four locations were selected from areas adjacent to the Cornfield Area boundaries. The 16 locations of the Cornfield Area soil samples are depicted on Figures 2-3 (the North Cornfield) and 2-4 (the South Cornfield).

Cornfield Area soil samples were obtained utilizing a backhoe to expose the sampling area. Soil samples were then collected with a stainless steel trowel and placed in appropriately labeled sample containers. Samples were collected at 16 to 20, 28 to 32, and 40 to 44 inches below the ground surface. In addition, at the four stations outside of the Cornfield Area grid, samples were also taken from four to eight inches below the ground surface. Soil samples from the Cornfield Area were analyzed for barium, cadmium, chromium, copper, lead, mercury, selenium, and zinc. In addition, each soil sample was screened for volatile organic compounds using an HNU photoionization detector and the headspace technique. The headspace measurements were recorded on soil sample field collection reports (Appendix C). The soil sample with the highest headspace reading at each station was analyzed for TCL VOC. If none of the samples at each location exhibited a headspace reading above background, the sample centered at a depth of 30 inches was analyzed for TCL VOC.
2.2.2.2 Stressed Vegetation Area

Twenty-three shallow soil samples (including a matrix spike, a matrix spike duplicate, and a composite sample of the waste) were collected from the Stressed Vegetation Area during Phase II. The soil samples were collected on November 29 and 30, 1990. The samples are labeled SV-6 through SV-21, and BW-1A, BW-2A, BW-3A, and BW-3B. Sample locations from the Stressed Vegetation Area are depicted on Figure 2-5.

Four samples were collected from within the Stressed Vegetation Area. Prior to sample collection, a hand shovel was utilized to expose the sample area. Soil samples were collected using a clean, stainless steel trowel and placed in appropriately labeled sample containers. Once the depth of visible waste was determined with the hand shovel, attempts were made to collect soil samples as described in the Sampling and Analysis Plan (SAP). This sampling was to be performed at five locations in one-foot intervals to a depth of two feet below the visible waste. Soil sampling at some of the locations and depths described in the SAP was not possible due to infiltration of water at the sampling location.

Eighteen surface soil samples surrounding the Stressed Vegetation Area were collected in Phase II. These perimeter samples were collected at distances of one to two feet from the Stressed Vegetation Area (as well as a matrix spike and matrix spike duplicate). A total of four samples were collected along each side of the Stressed Vegetation Area. These perimeter soil samples were to be centered at a 12-inch depth, in accordance with the SAP. This depth was not achieved at all of the perimeter soil sampling locations due to water infiltrating several of the excavations. Soil samples from the Stressed Vegetation Area were analyzed for antimony, barium, cadmium, chromium, copper, lead, mercury, selenium, zinc, p,p'-dichlorodiphenyl trichloroethane (DDT), and TCL VOC.

A composite sample of the waste was collected from five locations in the Stressed Vegetation Area. The composite sample was analyzed for TCLP characteristics and disposal characteristics, including BTU values and ash content.
2.2.2.3  Borrow Area

Eleven shallow soil samples, including one duplicate, were collected from the Borrow Area during Phase II. The soil samples were collected on November 19, 1990. The samples from the Borrow Area are labeled BA-1 through BA-7, BA-5D, BA-8A, BA-8B, and BA-9. Sample locations for the Borrow Area are depicted on Figure 2-6.

Eight soil samples, including duplicate BA-5D, surrounding the center pile in the Borrow Area were collected. The center pile was comprised of building material and various debris, as well as soil. A composite sample (BA-9) was collected from the four corners of the center pile. These nine soil samples were collected at a depth of six inches with a stainless steel trowel. A backhoe was utilized as needed to expose the soil for sampling.

A test pit was to be excavated in the middle of the center pile, as described in the SAP. Due to access problems, the test pit was excavated into the side of the soil pile to a depth of eight feet. Soil Samples BA-8A and BA-8B were collected at respective depths of three and six feet within the test pit. All of the samples collected from the Borrow Area were analyzed for copper, lead, zinc, asbestos, bis(2-ethylhexyl) phthalate (BEHP), and TCL VOC.

2.2.2.4  Background

Nineteen background or reference samples, including one duplicate, were collected on November 21, 1990 at six locations during Phase II. The samples were collected from depths of 16 to 20, 28 to 32, and 40 to 44 inches below ground surface from an agricultural area similar to the Cornfield Area, located in the field west of the West Stream. These background soil samples were collected and analyzed using the same procedures as outlined above for the Cornfield Area samples. In addition, an aqueous matrix equipment blank was collected to verify that the sampling equipment was properly decontaminated prior to sample collection.
2.2.3 Phase II Deep Soil Samples

Thirty-four Phase II test borings were drilled at the Hunterstown Road Site between October 24 and 31, 1990, in the two Drum Burial Areas and the Lagoon Area. The borings are identified as HTB-4 through HTB-37, and were advanced to bedrock by means of hollow-stem augers. The locations of the borings are depicted on Figures 2-1, 2-2, and 2-7. The logs of the borings are included as Appendix A.

Eichelbergers, Inc. of Mechanicsburg, Pennsylvania performed the drilling services under the technical direction of Rizzo Associates. Soil samples were collected using clean standard two-inch O.D. split-barrel soil samplers driven in compliance with ASTM Specification D-1586-84 for the Standard Penetration Test. As sample volume permitted, each split-barrel soil sample was tested for headspace organic vapor readings using an HNU photoionization detector. Headspace results are included on the boring logs.

Equipment blanks were collected on site using a clean split-spoon sampler which was rinsed with deionized water supplied by the laboratory. The water (rinseate) was then collected in a pre-cleaned glass container and transferred to the appropriate sample containers. The above steps proceeded until sufficient sample volume was collected. Specific conductance, pH, and temperature were measured and recorded at the time of collection.

2.2.3.1 Drum Burial Area 1

In Phase II, eight test borings were drilled around the perimeter of Drum Burial Area 1 and two test borings were drilled within the backfilled portion of the former excavation. The drilling was performed on October 29 through 31, 1990. The purpose of these samples was to evaluate the lateral extent of COI from Drum Burial Area 1 along the soil-bedrock interface. These ten test borings are identified as HTB-28 through HTB-37. The locations of the borings are depicted on Figure 2-1.
Soil samples were collected for laboratory analysis from the soil-bedrock interface in each of the borings. In the eight perimeter borings, samples were also collected approximately midway through the soil column. Also, duplicates were collected from the soil-bedrock interface sample of HTB-35 (HTB-35D) and from the midway sample of HTB-28 (HTB-28D) concurrently with the initial samples. These collected samples were analyzed for TCL VOC and polychlorinated biphenyls (PCBs).

2.2.3.2 Drum Burial Area 2

Four test borings were drilled around the perimeter of Drum Burial Area 2 and one test boring was drilled within the backfilled portion of the former excavation area during Phase II. The drilling of these test borings was performed on October 29 through 31, 1991. The purpose of these samples was to evaluate the lateral extent of COI from Drum Burial Area 2 along the soil-bedrock interface. These five Drum Burial Area 2 borings are identified as HTB-23 through HTB-27. The locations of the borings are shown on Figure 2-2.

Soil samples were collected from the soil-bedrock interface in the five borings for laboratory analysis. Samples were also collected for laboratory analysis approximately midway between the ground surface and the top of the bedrock in the four perimeter samples. The Drum Burial Area 2 samples were analyzed for TCL VOC.

2.2.3.3 Lagoon Area

Nineteen test borings (HTB-4 through HTB-22) were drilled on October 24 and 25, 1990 in the vicinity of the former Lagoon area. The locations of these borings are depicted on Figure 2-7. In test Borings HTB-4 through HTB-13, soil samples were retrieved on 2 1/2-foot centers from the ground surface to the top of bedrock. Samples collected at the soil-bedrock interface were analyzed for the following COI: antimony, cadmium, chromium, copper, lead, mercury, zinc, and TCL VOC. In addition, two surface soil samples, Surface 1 and Surface 2, were collected at a depth of zero to seven inches below ground surface from within the former Lagoon area. These were likewise analyzed for the Lagoon Area COI listed above.
Test Borings HTB-14 through HTB-22 were drilled to determine the thickness of the soil remaining above bedrock at the lagoon. Soil samples were retrieved at varying depths from the ground surface to the top of bedrock. Each soil sample from these nine borings was also tested for headspace readings.

2.3 METEOROLOGY

Meteorological information was compiled based on data gathered by the Pennsylvania Geological Survey as published in their groundwater assessment of Adams County (Taylor and Royer, 1981). The source utilized was the U.S. Department of Commerce Environmental Data Service.

2.4 SURFACE WATER AND SEDIMENT SAMPLES

2.4.1 Phase I

On December 14, 1988 and January 16, 1989, three surface water and five sediment samples were collected from locations in three adjacent streams. These streams are identified as the East Stream, the Middle Stream, and the West Stream. The locations of these samples are shown on Figure 2-8. The water samples were collected during typical flow conditions and the sediment samples were collected concurrently with the corresponding water samples (except SD-4). In addition, duplicate samples of the surface water and sediment were collected from SW-3 and SD-3 on the West Stream. The locations for SD-2 and SW-2 were moved approximately 120 feet downstream from their planned locations due to stream modifications performed by ACES during the 1988/1989 waste removal program. The samples were submitted to Lancaster Laboratories for analyses of the TCL/TAL parameters. The laboratory results are included in Appendix F.

Grab samples were collected from each surface water location by gently submerging a collection container below the water surface. The collection container was then turned in the upstream direction. The container was rinsed several times with stream water and then used to fill the appropriate sample containers. Collection of suspended particles (e.g., leaves) was minimized. The volatile organic analysis vials were filled by directly placing the vials into the stream and filling as described above. Containers
prepared with the appropriate preservatives were shaken to assure uniform mixing. Field screening for pH, specific conductance, and temperature was performed at the time of collection and the results recorded on Water Sample Field Collection Reports (Appendix C).

After collection of the water sample, a sediment sample was collected in an undisturbed area of the stream bed slightly upstream of the water sample location. A stainless-steel hand trowel was inserted into the sediment to a depth of approximately five to six inches or to trowel refusal. The trowel was lifted through the water and the sample was immediately placed into sample containers. The volatile organic analysis container was filled first, followed by the other parameter containers. An attempt was made to minimize the amount of free water, stones, gravel, and leaves in the sample.

One duplicate surface water and one duplicate sediment sample were collected using the same procedures as previously described. Duplicate samples were collected at the same time and in the same manner as the initial samples.

Containers for surface water and sediment samples were labeled with the appropriate information, including sample identification, date and time of sampling, and the initials of the sampling personnel. Filled containers were placed in a cooler containing ice during the sampling period and while transported to Lancaster Laboratories. In addition, an aqueous trip blank (for VOC analysis only) supplied by Lancaster Laboratories was included with the stream and sediment samples. Sample collection reports were maintained for all surface water and sediment samples and have been included as Appendix C.

2.4.2 Phase II

On October 15 through 19, 1990 and on November 21, 1990, surface water and sediment samples were collected from the three above referenced streams which flow adjacent to the waste disposal areas at the site. The samples collected in November 1990 were collected at locations where there was no water present on the October sampling dates. The stream surface water sampling locations (Figure 2-8) are identified as SW-6, SW-7, SW-10, SW-14 through SW-21, SW-23 through SW-27, and HA-2. (Sample SW-15 was mislabeled during collection as SW-1. All data...
related to this sample have been referred to as SW-15.) Duplicate samples were collected from SW-10 and SW-18 and are identified as SW-10D and SW-18D. Nineteen surface water samples were collected from these three streams. A surface water sample (SW-22) was also collected from the pond that is adjacent to Drum Burial Area 1 and the West Stream. Additionally, a reference surface water sample, REF-1, was collected from an unnamed tributary to Rock Creek at Hunterstown Road, approximately 1.2 miles north-northwest of the intersection of Shealer and Hunterstown Roads.

Phase II surface water grab samples were collected from each location by gently submerging a pre-cleaned glass collection container below the water surface; the collection container was then turned in the upstream direction. Similar precautions were used during the collection of SW-22 from the pond near Drum Burial Area 1. The collection container was rinsed several times with the surface water and then used to fill the appropriate sample containers. Collection of suspended particles (e.g., leaves) was minimized. Containers prepared with preservatives were shaken to assure uniform mixing. Field measurements of pH, specific conductance, and temperature were performed at the time of collection. The results of the field measurements were recorded on Water Sample Field Collection Reports (Appendix C).

Concurrently with the surface water sampling, sediment samples were collected. At the three site streams, sediment samples were collected from SD-6 through SD-21, SD-23 through SD-27, and HA-2. (Sample SD-15 was mislabeled during collection as SD-1. Data related to this sample is referred to as SD-15 in this report.) A duplicate sediment sample, SD-11D, was collected at location SD-11, resulting in a total of 23 Phase II sediment samples collected from these three streams. In addition, duplicate sediment samples were collected from the pond that is adjacent to the West Stream, and a sediment sample was collected from REF-1, described above. Samples from locations HA-2 and REF-1 were collected for the stream bioassay program (Section 2.4.3). Twenty-five of the sediment samples were also analyzed for grain size distribution.

At locations where sediment samples and surface water samples coincided, each sediment sample was collected immediately after its corresponding surface water sample in an undisturbed section of the stream bed. Sediment sampling locations with
no corresponding surface water samples were collected in the appropriate area of the stream described in the SAP. Sediment Sample SD-22 and its duplicate, SD-22D, were collected concurrently with the surface water sample from the pond.

During collection, a stainless steel trowel was inserted into the sediment to a depth of approximately six inches or to trowel refusal. The trowel was lifted carefully through the water and the sample was immediately placed into appropriately labeled sample containers. The volatile organic analysis container was filled first, followed by the other parameter containers. An attempt was made to minimize the amount of free water, stones, gravel, and leaves in the sample.

Duplicate surface water and sediment samples were collected with their corresponding samples using the same procedures as previously described. Containers for surface water and sediment samples were labeled with the appropriate information, including sample identification, date and time of sampling, and the initials of the sampling personnel. Filled sample containers were placed in insulated coolers containing ice during the sampling period and during transportation to the laboratory for analysis. Trip blanks were placed in appropriate insulated coolers during transit. Grain size distribution samples were sent to Geotechniques, Inc. of Pittsburgh, Pennsylvania. Other sediment samples and surface water samples were transported to Lancaster Laboratories, Inc. of Lancaster, Pennsylvania for analysis. Chain-of-Custody records and sample collection reports were maintained for each surface water and sediment sample obtained at the site and are included as Appendix C.

2.4.3 Stream Bioassay

The SAP specified that chronic toxicity bioassay tests were to be performed on both surface water sediment and sediment elutriate samples from the three streams. A qualitative stream survey was also to be performed. At the initiation of the Phase II field activities, the streams in the vicinity of the site were dry. Because of this condition, the USEPA and Westinghouse agreed to modify the stream bioassay program. The modification consisted of collection of samples from two locations: one downstream location (HA-2) and one reference location (REF-1) (Figure 2-8 "notes"). Surface water samples were collected on October 15, 17, and 19, 1991 while sediment
samples were collected on October 17, 1991. Samples were shipped on ice to the USEPA laboratory in Wheeling, West Virginia and to Free-Col Laboratories of Meadville, Pennsylvania the day of collection.

2.5 GEOLOGY

Phase I investigations of the geology of the Hunterstown Road Site included extensive review of previously-published information, drilling and logging test borings, geophysical logging of boreholes, inspection of rock outcrops, and a fracture trace analysis. Two types of borings were drilled, one with soil sampling and rock coring techniques, the other with destructive drilling (air rotary) techniques. Borehole geophysical logging was conducted in both types of borings.

The goal of the geological studies was to investigate the geological framework to better understand groundwater flow systems beneath the site. From this standpoint, the investigations of geology were closely tied with the soil and groundwater sampling and analytical programs. The individual tasks related to the geological investigation are discussed separately.

2.5.1 Drilling and Subsurface Soil Sampling

Phase I drilling activities at the Hunterstown Road Site were conducted from December 14, 1988 to May 1, 1989. Pennsylvania Drilling Company of Pittsburgh, Pennsylvania, and Eichelbergers, Inc. of Mechanicsburg, Pennsylvania performed the Phase I drilling services. Phase II drilling activities were conducted from September 6, 1990 through November 2, 1990. Two additional deep monitoring wells were drilled and installed from June 26, 1991 through July 10, 1991. Eichelbergers, Inc. provided the drilling services for Phase II. Observation of field work during Phase I and Phase II was performed by Rizzo Associates.

During Phase I, three test borings (HTB-1, HTB-2, and HTB-3) were drilled using hollow-stem augers and diamond rotary coring methods. An additional 18 borings were drilled using air-rotary techniques. A groundwater monitoring well was installed in each of these borings with the exception of HTB-1, which was grouted to the surface. During Phase II, 35 test borings (HTB-4 through HTB-37) were drilled using
hollow stem augers. These test borings were discussed in Section 2.2.2. An additional 19 borings were drilled using air-rotary techniques during Phase II. A groundwater monitoring well was installed in each of the Phase II air-rotary borings including well PW-1 which is anticipated to be utilized in any groundwater treatability study. The location of the borings and wells is shown on Figure 2-9. Boring logs are provided in Appendix A.

2.5.1.1 Diamond Rotary Coring Techniques During Phase I

A Mobile B-57 truck-mounted drill was utilized for soil sampling and rock coring at locations HTB-1, HTB-2, and HTB-3 (Figure 2-9). The borings were advanced through the unconsolidated soil using eight-inch O.D. hollow-stem augers.

Soil samples were retrieved continuously at two-foot intervals from the ground surface to the top of bedrock using split-barrel samplers. These were driven in compliance with ASTM Specification D-1586-84 for the Standard Penetration Test. The on-site geologist recorded the number of blows required to drive the sampler each six-inch interval. In addition, the soil type, color, and cohesiveness were recorded. Soil sampling was terminated at the top of bedrock and temporary four-inch steel casing was installed in each boring to case off the unconsolidated soil.

These borings were advanced through bedrock to a depth of 150 feet using NQ wireline diamond rotary coring techniques. Water was used as the drilling fluid. Upon completion of each core run, the core barrel was retrieved from the boring using the wireline. The core barrel was opened by the drillers and the rock core was classified by the on-site geologist. The rock core was measured for percentage of recovery and rock quality designation (RQD), defined as the total length of unweathered rock segments greater than or equal to four inches in length divided by the total length of the core run. Particular attention was paid to the joint spacing, fracture partings, joint infilling, broken rock layers, soft or weathered rock layers, and staining. The rock core was then carefully removed from the core barrel and placed in labeled wooden core boxes in the sequence of recovery. Following completion of each boring, the rock core was photographed. The core boxes were then stored inside the Westinghouse Elevator Plant at Gettysburg, Pennsylvania. In September 1991 the rock core was disposed of with USEPA approval.
Wells HMW-6BL and HMW-8BF were subsequently installed in Borings HTB-2 and HTB-3, respectively. In accordance with the Phase I Work Plan (Rizzo Associates, 1988), a well was not installed in Boring HTB-1, which was grouted upon completion from the bottom to the surface with a cement-bentonite grout using the tremie method. The grout was composed of a cement-bentonite mixture consisting of one 94-pound bag of cement and approximately four pounds of powdered bentonite for each seven gallons of water.

2.5.1.2 Air-Rotary Techniques

During Phase I, a Drilltech Model D25k air-rotary rig was utilized for destructive air-rotary drilling of the soil and bedrock for monitoring well installation at 20 locations. A six-inch diameter tri-cone roller bit was used to advance the boring and air was used to remove cuttings from the borehole. During Phase II, a Schramm Model 450 air-rotary drill rig was used to drill 16 borings for monitoring well installation. An additional three wells (including PW-1) were drilled with an Ingersoll-Rand Model T-4 drill rig. Monitoring well locations are presented on Figure 2-9. The borings were advanced using a six-inch diameter downhole air-hammer bit. On occasion, temporary eight-inch steel surface casing was installed to maintain the integrity of the borehole, preventing the collapsing of unconsolidated soils to enter. When surface casing was needed, an eight-inch downhole air-hammer bit was utilized to advance the eight-inch temporary steel casing. No lubrication was used for the downhole air-hammer system.

During Phase I and Phase II, water was occasionally added to the air circulation to reduce the amount of dust produced from drilling and to facilitate removal of heavier particles from the boring. Each boring was checked for inflow of groundwater as the boring progressed by temporarily stopping the drilling, blowing the boring with air, and recording the flow of water from the boring. In addition, the on-site geologist noted the rock type, rock color, hardness, occurrence of minerals, weathered zones, and fractured units based on observation of the rock chips and the behavior of the drilling rig.
2.5.1.3 Air Monitoring

Real-time air monitoring was performed during Phase I and Phase II drilling activities using a calibrated HNU organic photoionization detector (10.2 eV lamp). Results were recorded on the daily field logs and the boring logs. The meter was periodically calibrated in accordance with the manufacturer's instructions. No sustained measurements above one part per million (ppm) of total VOC in the breathing zone were observed during drilling.

Personnel monitoring was also performed. A 3M Model 3500 passive monitor was worn by a worker for an entire shift while drilling Boring HMW-7BL. The monitor was then analyzed for 38 common solvents, including 1,1,1-TCA and TCE. These solvents were not detected above quantitation limits.

2.5.2 Borehole Geophysical Logging

Borehole geophysical logging was performed immediately after completion of drilling and prior to monitoring well installation. The purpose of performing geophysical logging was to aid in stratigraphic interpretation and monitoring well design. A brief description of each logging tool utilized as part of the site investigation is provided in the following sections. The results of the logging program have been plotted on the boring logs provided in Appendix A.

During Phase I, a Mount Sopris Model 1000-C portable logger was used to run temperature, single-point resistance, spontaneous potential, fluid resistivity, and natural gamma logs in each of the three cored borings, each deep monitoring well boring, and in the borehole for HMW-2AS. However, equipment malfunctions prevented the logging of Borings HMW-5BL, HMW-7BL, and HMW-9BF.

During Phase II operations, a Mount Sopris Model 2500 logger replaced the Model 1000-C in running the same geophysical logs at each of the 19 new borings. The Model 2500 is a more advanced unit which records data by a direct digital format interfacing with an on-site lap-top computer. The Model 2500 has a 1,000-foot wireline cable which is raised and lowered in the borehole by a motorized winch that
allows the operator to regulate the logging speed. Data are transferred from each
logging probe through the cable and into the computer. The Model 2500 also allows
visual inspection of the log in a strip chart format on the computer screen as the probe
is raised or lowered in the borehole.

2.5.2.1 Temperature Log

Temperature logs are continuous records of temperature versus depth of the fluid in a
borehole. If there is no flow in or adjacent to a borehole, the temperature will
gradually increase with depth due to the natural geothermal gradient. If rapid flow
occurs along a fracture, either upward or downward, the temperature of the water in
the fracture may be different from the ambient ground temperature. In such instances,
the temperature log can indicate intervals of water-producing fractures.

2.5.2.2 Single-Point Resistance Log

The single-point resistance log is the simplest electric logging system. A single lead
electrode attached to an insulated cable is lowered into the boring. The return path for
the current flow is furnished by the ground electrode, also made of lead. The single-
point resistance log is useful for geologic correlation because of its unique response to
changes in lithology and the vertical detail obtained in formations of low to moderate
resistance. The single-point resistance log is also sensitive to the presence of water-
filled fractures.

2.5.2.3 Spontaneous Potential Log

The spontaneous potential log is a graphic plot of the small differences in voltage that
develop at the contact between the borehole fluid, the bedrock and/or soil, and the
formation fluids. The spontaneous potential is used to aid in geologic correlation and
assessment of unit thickness. During Phase I the spontaneous potential log was run in
conjunction with the single-point resistance log. As mentioned above, the single-point
resistance log is useful in identifying water-filled fractures. Thus, streaming potential
may be generated in zones gaining or losing water, which can sometimes be detected
on the spontaneous potential curve by sudden oscillations or by departures from the
more typical response in a particular environment.
2.5.2.4 Natural Gamma Log

Natural gamma logs are records of the amount of natural gamma radiation emitted. The principal use of natural gamma logs is for the identification of lithology and stratigraphic correlation. This log proved to be a very useful tool for correlating lithology between borings for this investigation.

2.5.2.5 Fluid Resistivity Log

Fluid resistivity logs record the resistance to electric current of the borehole fluid. Logs of fluid resistivity provide data related to the concentration of dissolved solids in the fluid column. Changes in fluid resistivity with respect to depth were interpreted as potential groundwater inflow zones into the borehole.

2.5.3 Permeability Tests

To aid in designing the monitoring wells installed at the Hunterstown Road Site, bedrock permeability tests were conducted in Borings HTB-1 (later grouted), HTB-2 (converted into HMW-6BL), HMW-2AS, and HMW-6AS. The permeability tests utilized a double packer system to isolate 5-1/2-foot test zones, one at a time, throughout the length of the borings as shown on Figure 2-10. The packers were inflated with nitrogen to isolate the test zone and hold the packer system in place. Once the packers were inflated, water was pumped into the test zone via a perforated pipe, and the volume of water and the water pressure were recorded. Readings were generally taken at one-minute intervals. The test began with a ground surface water pressure of 15 psi, which was increased to 30 psi. The test was terminated once the data indicated that the formation was "taking water" at a constant rate or if there was no water taken at 30 psi ground surface water pressure. Before each use, the packers and associated pipe were decontaminated as described in Section 2.7.3.

2.5.4 Fracture Trace Analysis

A fracture trace analysis was conducted to identify the location and general orientation of fracture traces and other linear features, as observed on satellite imagery and aerial

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photographs, that would relate to bedrock fractures, including faults, joints, bedding planes, etc., that in turn could relate to groundwater flow. A literature search was conducted that identified previously published work locating lineaments and fracture traces by satellite. Fracture traces were independently identified as part of this study from aerial photography at scales of 1:24,000, 1:12,000, and 1:8,400. Stereo pairs of the photographs were used to identify the fracture traces.

Once the fracture traces had been identified, field measurements of joint orientation were made from outcrops at and near the site using a hand-held compass. These orientations were compared to those of the fracture traces. Results of the fracture trace analysis are discussed in Section 3.0.

2.6 SOILS

Geotechnical information on soils was obtained from the boreholes drilled at the site using procedures described in Section 2.5. Information pertaining to the various types of soils present at the site as well as their distinct characteristics was obtained from the Soil Survey of Adams County, Pennsylvania, performed by the U.S. Soil Conservation Service (USSCS, 1967).

2.7 GROUNDWATER

The Phase I groundwater investigation included the installation of 20 monitoring wells. The Phase II investigation involved the installation of 19 additional monitoring wells (including PW-1 which was utilized in the groundwater treatability study). Placement of the screen section for each well was based on permeability tests, borehole geophysical logs, site stratigraphy, and direct observations of groundwater inflow. The locations of the wells are provided on Figures 2-9 and 4-2, and the details of well construction are provided in Appendix B. Details of the monitoring well installation, well development, equipment decontamination procedures, and groundwater sampling are discussed in the following sections.
2.7.1 Monitoring Well Design

Monitoring wells were constructed with two-inch I.D. flush joint Schedule 40 PVC riser pipe and two-inch I.D. Schedule 40 PVC screen with No. 10 (0.010-inch) slots. Joints were sealed with O-rings. Two-inch I.D. stainless steel centralizers were installed at the top and bottom of the screened interval to center the screen section in the six-inch boring. PVC end caps were placed at the bottom of the screen and the top of the riser pipe. Well PW-1 was constructed using four-inch I.D. flush joint schedule 40 PVC and four-inch I.D. type 304 stainless steel riser pipe and type 304 stainless steel wire wrapped screen (0.02"). Four-inch stainless steel centralizers were installed at the top and bottom of the screened interval. Materials used in construction were thoroughly steam cleaned prior to use.

For monitoring wells where the well screen was not placed at or near the bottom of the boring, the borehole was backfilled with pea gravel to approximately five feet below the projected screen interval and a two to three-foot bentonite seal was installed. The two-inch I.D. PVC screen and riser pipe were then placed in the borehole, and Morie No. 1 filter pack sand was placed around the screen. Care was taken to not place the well screen directly on the lower bentonite seal. A bentonite seal was placed above the filter pack material, and a cement-bentonite grout was tremied from above the seal to the ground surface. A four-inch square locking steel casing or an eight-inch flush mount with locking cap was placed over the PVC riser pipe and fixed in position with concrete.

2.7.2 Monitoring Well Development

Each monitoring well installed as part of this investigation was developed using alternating surging and air lifting techniques. Surging was accomplished by attaching a block which had a diameter just under two inches to a one-inch PVC pipe. The surge block was dropped rapidly on the downstroke, forcing water contained in the well casing out through the screen and into the surrounding sand pack and formation. On the upstroke, water was lifted by the surge block, allowing the flow of water and fine sediments into the well screen. The residual sediments were removed from the wells using air lifting techniques. The air lift was powered by compressed nitrogen which
was forced down 1/4-inch polyethylene tubing to the bottom of the well and up the inside of a 3/4-inch I.D. PVC discharge pipe. Development water was collected and contained in 55-gallon drums until properly disposed off site at a licensed disposal facility.

2.7.3 Decontamination of Equipment

A decontamination area was established within site boundaries for cleaning drill rigs and associated equipment, monitoring well materials, and well development and packer test equipment. Prior to starting work at the Hunterstown Road Site and after completion of each boring, the drill rig and associated equipment were moved to the decontamination area and steam cleaned.

PVC well screen, riser pipe, end caps, and stainless steel centralizers were placed on plastic sheeting and thoroughly steam cleaned at the decontamination area prior to installation in borings. Decontamination activities were conducted under the technical direction of Rizzo Associates.

2.7.4 Groundwater Sampling

Following Phase I well installation and development, groundwater samples were collected May 23 through 26, 1989 from the 20 monitoring wells installed at the Hunterstown Road Site. A duplicate, from Well HMW-8BF, and an equipment blank were also collected during the sampling event. In addition, trip blanks (for VOC analysis only) supplied by Lancaster Laboratories were included with the groundwater samples. The samples were sent to Lancaster Laboratories for analysis for the TCL and TAL parameters. The laboratory results are included in Appendix F.

During Phase II, groundwater samples from the 20 existing Phase I monitoring wells and the 16 new Phase II monitoring wells were collected and analyzed to further characterize the site groundwater quality. Samples from all wells, except HMW-10CL, HMW-20AW, and HMW-20BF were collected November 12 through 14, 1990. Well HMW-10CL was sampled on February 18, 1991 and Wells HMW-20AW and HMW-20BF were sampled July 17, 1991. As described in the SAP, the installation, development, and sampling of HMW-10CL was contingent upon the groundwater level.
characteristics of HMW-18CL. Due to this contingency, HMW-10CL was installed after the other Phase II wells. Wells HMW-20AW and HMW-20BF were installed at a later date in order to more accurately define the extent of COI in groundwater associated with Drum Burial Area 1. Duplicate samples were collected from Wells HMW-6BL, HMW-7AE, and HMW-15AW, and three equipment blanks were also collected during the sampling event. In addition, three trip blanks (for VOC analysis only) supplied by Lancaster Laboratories were included with the groundwater samples. Samples were analyzed for barium, chromium, lead, mercury, BEHP, and TCL VOC. Field measurements for pH, temperature, and specific conductance were performed at the time of the collection.

The primary consideration in sampling the monitoring wells was to obtain a sample considered representative of the quality of groundwater in the surrounding formation. Water that has remained in the well for a lengthy period may be stagnant and may have undergone some chemical alterations, and may therefore be considered unrepresentative. Therefore, to safeguard against collection of a nonrepresentative stagnant water sample, the standing water column in each monitoring well was removed (purged) before sampling. Prior to purging, the static water level in each well was measured using an electronic M-scope or sounder to determine the well volume. A minimum of three well volumes was then purged by bailing or pumping water from each well prior to sample withdrawal. Purge water from each well was collected and contained in 55-gallon drums until properly disposed at an off-site, licensed treatment and disposal facility.

Well purging equipment consisted of a clean stainless steel bailer with new polypropylene rope, or a portable pump system. During Phase I, the pump system consisted of a compressed-air, gas-driven, positive displacement, stainless-steel submersible pump equipped with concentric polyethylene tubes for air supply and groundwater discharge. During Phase II, the pump consisted of a Keck Instruments, Inc., Model SP-84 submersible pump, which features a progressive cavity pumping head, and a Grunfos 2" diameter electric submersible pump. Samples from Wells HMW-1BL, HMW-3BL, HMW-6BL, HMW-13BL, HMW-20AW, and HMW-20BF were obtained using the submersible pumps. The remaining samples were collected
with stainless steel bailers. Groundwater collected during well purging activities was contained in 55-gallon drums until properly disposed at an off-site, licensed treatment and disposal facility.

After purging, a sample was collected from each well using the following stepwise procedure:

• A polypropylene rope was attached to a clean, bottom-loading, stainless steel bailer.

• The bailer was lowered slowly until it contacted the water surface.

• The bailer was allowed to sink and fill with minimal water surface disturbance.

• The bailer was slowly raised to the surface.

• The bailer was tipped to allow the sample to flow gently down the side of a precleaned, pre-preserved sample bottle with minimal entry turbulence. The volatile organic analysis vials were filled first followed by the other containers for the remaining analytical parameters.

• The above steps were repeated as needed to acquire sufficient volume for all sample containers.

• The specific conductance, pH, and temperature were measured and recorded in the field.

The sample aliquot collected for metals analysis was filtered at the time of collection, prior to preservation, using a 0.45-micron filter.

The duplicate groundwater sample obtained during Phase I from HMW-8BF and the duplicate groundwater samples obtained during Phase II from HMW-6BL, HMW-7AE, and HMW-15AW were collected at the same times and in the same manner as the initial samples. The Phase I and Phase II equipment blanks were collected on site using a clean bailer. To collect the equipment blanks, a clean bailer was filled with water.
supplied by the laboratory. The water (rinseate) was then transferred to the appropriate sample containers. The above steps were repeated until sufficient sample volume was collected. Specific conductance, pH, and temperature were measured and recorded at the time of collection. The sample volume for metals analysis was filtered at the time of collection, prior to preservation, using a 0.45-micron filter.

Filled containers were placed in a cooler with ice during the sampling period and while transported to Lancaster Laboratories. Sample collection reports were maintained for the samples and have been included as Appendix C.

2.7.5 Residential Well Survey

A residential well survey was conducted as part of the Phase II groundwater assessment at the site. A well survey form (Appendix D) was mailed to 24 landowners residing in the vicinity of the Hunterstown Road Site. The responses received from residents are included in Appendix D. Those residents who did not return well survey questionnaires were contacted by phone. A summary of the results of the residential well survey is presented in Table 2-1. The location of each resident who responded is shown on Figure 2-11.

2.8 MAGNETOMETER SURVEY

In the Phase I report, it was speculated that a subsurface dike may exist in the vicinity of the East Stream. To verify the presence of an igneous dike in the area between Monitoring Wells HMW-3BL and HMW-4B, a magnetometer survey was performed in that area on December 8, 1990. Magnetometer readings were recorded on 10-foot intervals along two established survey lines oriented north-south and east-west. Magnetometer readings observed were very consistent along both survey lines, indicating the lack of a prominent igneous intrusive between Wells HMW-3BL and HMW-4B.

2.9 DEMOGRAPHY AND LAND USE

Demography and land use of the property surrounding the Hunterstown Road Site were assessed using information previously compiled for the site, the 1980 census, and a
literature search. Aerial photography and visual observations were also used to qualitatively evaluate the current demographic and land use environment. Results of the assessment are presented in Section 3.7.

2.10  ECOLOGY

The evaluation of ecology in the vicinity of the Hunterstown Road Site was conducted on the basis of a literature search and visual observations. A bioassay on stream water and sediments, and field investigations of ecology (by the USEPA) were performed. Results related to the ecology of the Hunterstown Road Site are presented in Section 3.8.

2.11  MISCELLANEOUS ACTIVITIES

In accordance with the SAP, an investigation into the identification of the source of the backfill material around Mr. Donald Waddell's house on Shealer Road was performed. According to Mr. Waddell, the fill material was obtained in 1982 from an area north of his house where the middle stream crosses his property.

Surface drainage from the septic tank at the Sanders' residence on Shealer Road was sampled (Figure 2-8). Results are described in Section 4.2.4.
3.0 PHYSICAL CHARACTERISTICS OF THE SITE

3.1 SURFACE FEATURES

The Hunterstown Road Site is located in an area of generally low relief where the land surface slopes to the northwest with grades typically less than 5 percent (see Figure 1-2). Natural drainage in the vicinity of the site is by means of three intermittent streams (designated as the East, Middle, and West Streams), which flow south to southwest. Upon merging 1,200 feet south of Shealer Road, flow is to the southwest, eventually reaching Rock Creek, which is the main drainage control for the Gettysburg area. The locations of these streams, the Hunterstown Road Site, and other physical features are shown on Figure 1-2. However, stream locations in the vicinity of Drum Burial Areas 1 and 2 have been slightly altered by the 1988/1989 waste removal program.

3.2 METEOROLOGY/CLIMATE

The climate in the Gettysburg area is mild and humid, with well-defined seasons. Average precipitation varies from month to month, but is, in general, evenly distributed throughout the year. The long-term average annual precipitation is 39.3 inches (Taylor and Royer, 1981). Much of the summer rain comes as intense thundershowers of short duration. About one-tenth of the total precipitation is snow. The mean annual temperature is about 52° F with a summer mean of approximately 72° F and winter mean of 30° F.

Evapotranspiration, a collective term that describes evaporation from water bodies, wetted surfaces, and moist soil in combination with vapor that transpires from plants, is related to temperature, length of the growing season, the amount and timing of precipitation, and other climatological factors. The amount of water lost to evapotranspiration is greatest during the summer when temperature is greatest and plants are in foliage. At this time, the evapotranspiration normally exceeds the precipitation, causing a decrease in stream flow and a corresponding drop in
groundwater levels. This situation reverses during the winter. Taylor and Royer (1981) report that average water loss to evapotranspiration in the site vicinity is about 24 inches, or 61 percent of precipitation.

3.3 SURFACE WATER HYDROLOGY

The Hunterstown Road Site is located within the watershed of Rock Creek, a small southward-flowing stream that joins Monocacy Creek, which in turn enters the Potomac River. Rock Creek is the only large stream with headwaters in the Gettysburg plain, the relatively flat land corresponding to the Gettysburg Basin, a geological province further discussed in Section 3.4. The East, Middle, and West Streams drain the Hunterstown Road Site on an intermittent basis.

Quantitative stream flow data were not available for Rock Creek. The nearest gauging stations are located on Marsh Creek, which flows into Monocacy Creek downstream from Rock Creek, and White Run, a tributary to Rock Creek that enters southeast of Gettysburg. Neither of these stations are continuously monitored and average flow data are not available. However, Taylor and Royer (1981) estimate that annual discharge in the county accounts for about 14.8 inches of annual precipitation based on stream flow data obtained from other areas of Adams County. This estimate is consistent with the 15.3-inch difference between average precipitation and evapotranspiration. Of this flow, Taylor and Royer (1981) estimate that about 8.9 inches originate as direct surface runoff and that 5.9 inches are due to base flow from groundwater.

The watershed areas above Shealer Road for the West Stream, Middle Stream, and East Stream have been estimated, by inspection of the USGS topographic map for the Gettysburg quadrangle, to be approximately 0.14, 0.12, and 0.20 square miles, respectively. Based on these areas, and using the estimate of 14.8 inches of annual discharge, long-term average discharges in the three streams are expected to be 0.15, 0.14, and 0.21 cubic feet per second (cfs), respectively. Due to their intermittent nature, all three streams are expected to have 10-year, 7-day low flows of 0 cfs.

Grain size distribution curves for on-site and off-site sediments are included in Appendix G. Eleven sediment samples from the East Stream were analyzed for grain
size. In general, the stream bed in the East Stream is a clayey sand from the upstream area to below the Stressed Vegetation Area, where the streambed becomes significantly finer for about 300 feet, fairly gravelly before proceeding below Shealer Road, and then clayey again 500 feet downstream. Three sediment samples from the Middle Stream were analyzed for grain size, indicating a sandy clay bed. The West Stream starts out sandy upstream of Drum Burial Area 1, becoming clayey near Hunterstown Road, and then alternating between coarse and fine sediments further downstream. The pond near the West Stream has a clayey bottom.

3.4 GEOLOGY
3.4.1 Regional Geologic Setting

The Hunterstown Road Site is located within the Gettysburg Basin, one of a number of discrete elongate sedimentary basins parallel to the Appalachian orogen in eastern North America (Figure 3-1). These basins are of early Mesozoic age (Late Triassic and Early Jurassic) and are comprised largely of continental clastic rocks (primarily "red beds") and accompanying basic intrusive and extrusive igneous rocks referred to stratigraphically as the Newark Supergroup (Froelich and Olsen, 1985). These basins formed by the rifting of the crust which took place when North America and Europe began to drift apart, eventually to form the Atlantic Ocean.

The Gettysburg Basin, like the Newark Basin to which it is connected, appears to be a half-graben structure, i.e., the northwestern border is formed by faults with a predominantly normal movement and the southeastern border is formed as a flexure. This causes the bulk of the sediments within the basin to exhibit a predominantly northwest dip along strikes approximately parallel to the axis of the basin.

After rifting was initiated, continental sedimentation filled the developing basin. Most of the sediment appears to have originated from the southeast and was deposited in a fluvial-lacustrine environment, with alluvial fans providing incursions of coarse-grained sediments from the faulted northern border of the basin.

Following deposition, the strata were tilted, uplifted and eroded so that a representative portion of the entire section is exposed in a northwest-dipping homocline. The dip of
beds typically ranges from about 10° to 35°, with a median of about 20°. The total projected aggregate thickness of the sediments, computed from the dips and width of outcrops, is about 23,000 feet. However, in no place does this total thickness of strata occur (Stose, 1932).

The rifting of the crust which formed the Gettysburg Basin also allowed for molten rock deep in the crust to migrate towards the surface. Most of the rock is intrusive and is generally classified as diabase or dolerite, although local variations in composition are recognized. Where these rocks have intruded into the basin sediments they have a tendency to form as tabular sheets which are at least partially conformable to the sedimentary bedding. Other intrusives, such as dikes which cut across sedimentary bedding, and extrusive rocks are also found within the basin, but are not as common as the tabular sheet intrusives.

In summary, the overall evolution of the Gettysburg Basin can be described in terms of its development beginning with initial rifting along pre-existing faults found along its northwestern border. As rifting continued, continental sedimentation filled the evolving basin. Intrusion of diabase accompanied at least the late stages of sedimentation. As depicted in the hypothetical cross sections provided by Froelich and Gottfried (1985) and shown on Figure 3-2, post-Early Jurassic tilting and erosion produced the present-day land surface and rock exposures.

3.4.2 Local Geology

The rock exposed in the vicinity of the Hunterstown Road Site consists of northwest dipping sediments of the Gettysburg Formation. This formation has been intruded by igneous rock primarily in the form of sills, as is characteristic of igneous intrusives throughout the Gettysburg Basin.

The largest mapped igneous body near the Hunterstown Road Site is referred to as the Gettysburg Sill. This rock mass trends northeast and passes about 0.5 miles southeast of the site. The thickness of the sill is about 1,800 feet, assuming a typical outcrop width of about a mile and a northwest dip of 20° to 25° (Stose, 1932). Assuming that this dip persists, the Gettysburg Sill should be present at a depth of about 1,000 to
1,200 feet beneath the Hunterstown Road Site. However, the intensity of contact metamorphism with local sediments, the presence of numerous intrusives at the site, and the presence of magnetic anomalies over the Hunterstown Road area suggest that the Gettysburg Sill cuts across the bedding and is actually much closer to the ground surface. These observations are discussed in the following paragraphs.

Figure 3-4 shows the locations of four geologic cross sections. These cross sections are presented on Figures 3-5 through 3-8. The thin intrusives comprised of fine-grained igneous rock are fairly persistent across the site. The thickness of the sills varies from less than one foot to as much as eight feet, but generally averages two to five feet. Some intrusives do not correlate in cross section and it is unknown whether they are sills that pinch out or represent dikes which cut across the bedding.

The igneous intrusives encountered at the site are light in color, different from the dark diabase typically encountered in the Gettysburg area. For this reason, thin sections were obtained from the rock core from Boring HTB-3. The main constituent of phenocrysts present in the intrusives is olivine at various stages of alteration, and alteration of isotropic serpentine. The ground mass is primarily pyroxenes with some plagioclase and lesser amounts of hornblende and other mafics. A granitic phase was also observed in some of the intrusives encountered. It is primarily composed of microcline and olivine, with other minerals unable to be identified due to their small grain size. One of the more highly weathered, fractured, and water-bearing intrusions was comprised of serpentine, pyroxene, and abundant quartz. In general, the intrusives encountered at the Hunterstown Road Site are more acidic in composition than the Gettysburg Sill, suggesting that they are independent of the main igneous body, or, more likely, are a result of differentiation of the source magma.

Aeromagnetic mapping (Bromery, et al., 1961) shows the Hunterstown Road Site to be located in an area of high magnetic intensity. Two anomalously high areas of magnetic intensity, some of the highest recorded for the entire Gettysburg area, are present near the site as shown on Figure 3-9. These magnetic anomalies may represent the presence of a deep-seated source for the intrusives present beneath the site, and possibly the source of the Gettysburg Sill.
The igneous intrusives have altered the sedimentary rocks at the Hunterstown Road Site by increasing their hardness and changing their color and chemical composition. Such effects are a product of thermal metamorphism, where the changes are due to heat rather than heat and pressure or just pressure. In addition to the "baking" of the rock, hot water contained within the sedimentary rocks and/or provided by the magma also alters the mineralogy. The soft argillaceous red shale, typical of the Gettysburg Formation, is altered by this process to hard hornfels colored dark red to dark purple to black, as one moves closer to the intrusive. This color change is due to the reduction of the iron minerals. The contact metamorphism of the larger diabase masses generally penetrates wall rock a distance of 15 to 20 feet and in some cases as much as 100 feet (Stose, 1932). All of the sedimentary rock encountered in this investigation of the Hunterstown Road Site has been altered to hornfels, attesting to the proximity and pervasiveness of the igneous intrusives encountered at the site.

As discussed in Section 2.5, three diamond rotary continuous coreholes and 35 air rotary borings were drilled at the site as part of the RI. To facilitate correlation between these borings, suites of borehole geophysical logs were obtained. Due to the homogeneity of the hornfels encountered at the site, the geophysical logs, in particular the natural gamma log, offered the best information obtained from this investigation to establish lithologic correlation. Geologic sections based primarily on the interpretation of the occurrence of igneous intrusives (sills), as well as the natural gamma logs, are provided on Figures 3-5 through 3-8. The detailed boring logs and associated geophysical logs are provided in Appendix A to this report.

Borings HMW-1BL, HMW-2BL, and HMW-3BL were used in a three-point problem to estimate the attitude of bedrock at the Hunterstown Road Site. The estimated strike and dip calculated by using natural gamma correlations for these borings is N41°E dipping 26° NW defining azimuths within the Universal Transverse Mercator (UTM) system, with north located less than 1.5° counterclockwise of geographic north. Measurements from outcrops in the area show a fairly close agreement to the borehole measurements. The measurements from the boreholes are considered to be more reliable, as the strike and dip measured in this manner is likely to be more indicative of gross structure. Appendix E contains the details of this three-point problem for strike and dip calculation.
The rocks of the site have been classified as hornfels, which vary in color from medium to dark gray, purplish gray, and purplish brown. The hornfels are generally hard, compact, nonlaminated rocks that were produced by contact metamorphism of siltstones and claystones. Numerous igneous intrusions are also present, and in most cases appear to follow the bedding planes as sills. Igneous rock that was encountered but does not persist along the bedding planes may be dikes that cut across the bedding planes. However, the borings did not offer sufficient evidence to confirm this hypothesis.

The rocks encountered at the Hunterstown Road Site are fractured, as shown in the graphic discontinuities column of rock core Borings HTB-1, HTB-2, and HTB-3 (Appendix A). The rock core provides information regarding the joint spacing, dip, and minerals present along joint openings.

Joint orientation was measured in 16 joints encountered along a railroad cut 2,000 to 4,000 feet east of the Hunterstown Road Site. All joints dipped steeply, between 73° and vertical. For this reason, the orientations can be reasonably depicted by a joint frequency diagram as shown on Figure 3-10. The two predominant joint orientations are N15°E and N40°E. Other slightly less prominent orientations included N45°E and N100°E. The joint azimuth frequency diagram for all joints measured in the area on Figure 3-3 is provided on Figure 3-10 and further discussed in Section 3.4.3.

Two transverse faults (Figure 3-3) have displaced the Gettysburg Sill southeast of the site (Wood, 1980; Plate 1-Part 1). The fault trace for these two faults strike N 18° W and N 24° W. The net slip along these two faults is 1,900 feet and 4,000 feet, respectively. The presence of these two major fault systems indicates that other faults are likely to be present near the site. However, evidence was not encountered in this RI that would suggest the local presence of faults with large displacement of site stratigraphy.
3.4.3 Fracture Trace Analysis

A fracture trace is defined as a natural linear feature observable on aerial photographs or satellite imagery of a length less than one mile (Zall and Russel, 1979). Linear traces that are longer than a mile are called lineaments. A fracture trace analysis consists of mapping natural linear features observed on the ground from aerial photography and satellite imagery. The purpose of such an analysis relates to the observation that the linear features, that may be identified on the basis of color changes, topography, alignment of streams, etc., often relate to fracture zones in the subsurface. Such fractures, in turn, may play a critical role in controlling groundwater flow.

A literature search revealed fracture traces for the entire southern portion of the Gettysburg Basin identified by C.R. Wood and D.R. Miller as published in Wood (1980). Many of the fracture traces identified by these researchers were also identified during this study. However, Wood (1980) did not identify fracture traces in the immediate vicinity of the Hunterstown Road Site. Lineaments identified based on satellite imagery have been reported by Kowalik (1975) for the entire state of Pennsylvania. However, these were not further evaluated, as the only ones identified in the Gettysburg area were of marginal quality.

In this study, fracture traces and lineaments were mapped over the area shown on Figure 3-4 on the basis of aerial photographs taken in February 1968 at a scale of 1:24,000. The Hunterstown Road Site was also evaluated using aerial photographs taken in 1987 at a scale of 1:8,400 and in 1984 at a scale of 1:12,000. A total of five local fracture traces were identified in this study (Figure 3-4). Two significant fracture traces trending approximately N15°E were identified, along with two fracture traces trending approximately N55°E. One fracture trace of limited extent was mapped trending N150°E. Each of the fracture traces identified at the site is closely reflected in the joint patterns measured in outcrop near the site.

The fracture traces and lineaments identified on Figures 3-3 and 3-4 are depicted in the azimuth frequency diagrams provided on Figure 3-10. The two regional trends at
N20°E and N35°E appear to be due to bedding. The strongest single fracture trace/lineament trend is N120° E. This trend is not reflected in the joint pattern measured at the site nor in any of the joints measured in the area covered by the fracture trace, but could be due to the strike-slip faulting that developed perpendicular to the axis of the Gettysburg Basin as a result of rifting.

In summary, the fracture traces and lineaments assessed in this study appear to mainly reflect bedding, with a trend nearly perpendicular to the bedding of unknown origin, but which could be strike-slip faulting. Although the joint azimuths appear to be reflected in the pattern of fracture traces, most of the fracture traces or lineaments do not appear to be joint controlled.

3.5 SOILS

The natural soils of the Hunterstown Road Site have been classified by the U.S. Soil Conservation Service (USSCS, 1967) as part of the Klinesville-Abbottstown-Readington-Penn Association. These soils are moderately eroded, gently to moderately sloping, very shallow to deep shaley soils primarily derived from the underlying Triassic red beds. These soils vary from somewhat poorly drained to well drained.

Results from the test pits performed in 1987 by REMCOR and the RI subsurface explorations indicate that natural soil encountered was typically two to twenty feet thick consisting of gray silty clay/clayey silt with rock fragments.

3.6 GROUNDWATER

3.6.1 Regional Groundwater Setting

Several studies of regional groundwater conditions covering the Gettysburg area have been published, including those by Hall (1934), Wood (1980), Taylor and Royer (1981), and Lehigh University (1982). Groundwater in the Gettysburg area is utilized by rural, municipal, and industrial consumers and considerable effort has been made to evaluate its occurrence. Subsequent sections discuss regional groundwater characteristics in greater detail.
3.6.1.1 Water-Bearing Characteristics of Gettysburg Basin Rocks

The Gettysburg Formation is one of the principal aquifers within the Gettysburg Basin. Reported well yields range from 1 to 630 gallons per minute (gpm) with medians for domestic and nondomestic wells of 12 gpm and 69 gpm, respectively (Taylor and Royer, 1981). Wood (1980) reports a median well yield of 144 gpm for the shales and 50 gpm for the sandstones within the Gettysburg Formation, with median specific capacities of 2.0 gpm/ft and 0.47 gpm/ft, respectively.

Outcrops of diabase occur extensively in the Gettysburg Formation. Wells in the diabase rarely yield sufficient water for more than a domestic supply. Fractures in the diabase close rapidly with depth and do not yield significant amounts of water below 150 feet (Wood, 1980). The very low permeability of the diabase implies that this rock may in effect tend to act as a barrier to groundwater flow within the Gettysburg Formation.

The rocks of the Gettysburg Formation have little effective primary porosity, and water is principally stored and transmitted through an interconnected system of fractures consisting of the bedding plane partings and steeply dipping joints discussed in Section 3.4. The degree to which fractures have developed is interpreted by Wood (1980) to depend largely on the composition and texture of the rocks and the intensity of the forces that have acted upon the rocks. Examination of outcrops shows that where there are thin, hard beds of sandstone between beds of soft shale, the shales tend to deform under stress without breaking, whereas the hard sandstone tends to develop fractures and joints. However, in thick sandstones, fewer joints are developed. This relationship suggests that the Gettysburg Formation would tend to have alternating tabular preferential flow zones dipping to the northwest. Evidence for this condition is based on the observation of pumping tests in the Gettysburg indicating area that the maximum drawdown during pumping is parallel to the strike of bedding (Wood, 1980). The degree of interconnection between the flow zones would depend on the continuity of fracturing and the presence or absence of igneous intrusives.

Regional shallow groundwater occurs as an unconfined water table flow system. The configuration of the water table is generally a subdued replica of the land surface.
topography and water moves slowly from upland recharge areas to discharge points in adjacent stream valleys. However, water in the unconfined aquifer can recharge thin artesian (confined) aquifers in the more permeable northwest-dipping units of the Gettysburg Formation, and fresh water can be produced from multiaquifer systems from depths as great as 1,000 feet or more (Wood, 1980).

3.6.1.2 Groundwater Recharge

The amount of groundwater recharge occurring at any given time is a complex function of temperature, rainfall, amount of vegetative cover, and other factors. Maximum infiltration occurs from late fall to early spring when water losses through evapotranspiration are minimal. The groundwater reservoir is usually fully charged by December (Taylor and Royer, 1981). Declining water levels occur when discharge from the groundwater reservoir exceeds recharge, either from natural base flow or pumping. Typically, groundwater levels exhibit a decline from March through August, when evapotranspiration is greatest.

Long-term average recharge is estimated to be approximately six inches per year to balance with the base flow contribution to total stream discharge, as discussed in Section 3.3.

3.6.1.3 Groundwater Quality

Water from the Gettysburg Formation is chiefly of the calcium bicarbonate type with a median dissolved solid concentration (hardness) between about 150 and 200 milligrams per liter (mg/l). Except for zinc, that was present at concentrations of 0.1 to 3.3 mg/l in samples reported by Wood (1980), trace element concentrations are generally rather low. High sulfate values are occasionally encountered naturally in the groundwater, especially within confined aquifers where the presence of sulfate indicates a longer residence time and greater solution of sulfate-bearing minerals in water involved in a deep flow system. Very deep wells have also encountered brine within the Gettysburg Basin (Root, 1988).
3.6.1.4 Groundwater Usage

As of 1979, the total water use in Adams County averaged 8.7 million gallons per day and this rate was increasing. Of this amount, 79 percent was supplied by groundwater and future increases have been projected to be met by groundwater (Taylor and Royer, 1981). The largest use of groundwater is for domestic supplies, with public supplies second.

The largest single user of groundwater in the Gettysburg area is the Municipality of Gettysburg, which currently uses three wells to supply 40 percent of the town's water supply. These wells are all within the Gettysburg Formation. The nearest of these wells is about 1.2 miles south-southwest of the site (Figure 1-3). Residences not served by the Gettysburg municipal water system rely on private wells. The location of the Gettysburg Municipal Authority waterline in the vicinity of the Hunterstown Road Site is shown on Figure 1-3.

3.6.2 Site Groundwater

The Hunterstown Road Site is located in an area of moderate groundwater usage. As discussed in Section 1.0, previous investigations detected the presence of VOC in groundwater samples from nearby residential wells.

To obtain more information on site-specific groundwater conditions, a total of 39 monitoring wells were installed, as shown on Figure 2-9. Details of the well installation were provided in Section 2.7. Well installation details are presented in Appendix B. The shallow wells ranged from 30 to 62 feet below ground surface and monitor the uppermost water-bearing unit in bedrock. The monitored zone in the intermediate and deep wells ranged from 70 to 500 feet below ground surface. Four hydrogeologic sections of the site are shown on Figures 3-11 through 3-14.

Two letters follow each monitoring well number to clarify the depth and potential source area targeted for each monitoring well. The first letters consist of A, B, and C.
and represent shallow, intermediate, and deep monitoring zones, respectively. The second letter in the well identification refers to a potential source area in which the well is monitoring.

The letters and their corresponding source area are as follows:

- L - Lagoon and Borrow Areas,
- S - Stressed Vegetation Area and South Cornfield,
- E - Drum Burial Area 2 (east),
- W - Drum Burial Area 1 (west), and
- F - Shealer garage area.

Therefore, Monitoring Well HMW-3AL represents a shallow-depth well monitoring chemical constituents from the Lagoon and Borrow Areas. Well HMW-3AL monitors bedrock which subcrops in the area of the former Lagoon and Borrow Areas.

### 3.6.2.1 Shallow Wells

A total of 14 monitoring wells (HMW-1AL through HMW-11AL, HMW-13AE, HMW-14AE, and HMW-15AW) were installed in the shallow (weathered) bedrock at the site (depths less than 65 feet from the ground surface). Each of the wells is selectively screened in the hornfels and some intercept igneous intrusives. Elevations of monitored zones (screen plus sand pack) range from 480 to 550 feet above mean sea level (MSL).

Groundwater elevations for June, 28, 1989; July 20, 1989; November 12, 1990; February 4, 1991; and May 21, 1991 in these 14 shallow monitoring wells are presented in Table 3-1 and contoured for February 4, 1991 on Figure 3-15. Based on these contours, the overall horizontal direction of shallow groundwater flow is west to southwest, generally towards Rock Creek with on-site tributaries apparently acting as localized discharge points. Based on a comparison of groundwater levels in the shallow (weathered) bedrock unit and surface water levels, it appears that the East Stream and the Middle Stream are in hydraulic connection with the shallow bedrock flow.
The pond near Drum Burial Area 1 appears to have only a minor relationship with groundwater levels, and shallow groundwater flow in that area appears to bypass the West Stream. The results from surface water sampling events on the West Stream indicated that shallow groundwater containing VOC (related to Drum Burial Area 1) is not affecting the surface water which further indicates that shallow groundwater in the area of the West Stream is not in hydraulic connection with surface waters. This relationship may change during periods of increased precipitation. The alignment of the West Stream was slightly modified during drum removal activities in the Spring of 1989.

The horizontal component of the hydraulic gradient in the shallow bedrock zone varies from approximately 0.02 in the vicinity of HMW-3AL and HMW-1AL, flattening out to 0.01 across the South Cornfield between HMW-2AS and HMW-6AS, and steepening again to 0.05 across Drum Burial Area 1 between HMW-9AW and HMW-8AF.

Bedrock permeability test data were obtained from Borings HTB-1, HTB-2 (HMW-6BL), HMW-2AS, and HMW-6AS. The most permeable zones were generally observed to be within the upper 22 feet of bedrock. Hydraulic conductivity values calculated for test zones 5.5 feet in length in the upper portions of these boreholes ranged from less than $6 \times 10^{-6}$ to $1 \times 10^{-4}$ centimeters per second (cm/s). Bedrock permeability results are shown on the appropriate boring logs in Appendix A.

For the purpose of preliminary calculations, the arithmetic mean conductivity in each borehole was calculated. The geometric mean of these average conductivities was then taken as a rough measure of the large-scale effective homogeneous conductivity of the shallow aquifer on site. This geometric mean is $4 \times 10^{-5}$ cm/s.

Based on this average hydraulic conductivity and the gradient of 0.01 across the South Cornfield, the average horizontal specific discharge through the upper, weathered portion of the bedrock is expected to be approximately $4 \times 10^{-7}$ cm/s, or $10^{-3}$ feet per day (ft/d). The actual seepage velocity associated with this fluid flux depends strongly upon the porosity of the formation. Typical values for bedrock range from 0.1 to 2 percent. Using this range in porosities, the seepage velocity of groundwater in the shallow bedrock regime is expected to range from $2 \times 10^{-6}$ to $4 \times 10^{-4}$ cm/s, or 0.05 to
1 ft/d. This is the average velocity at which dissolved constituents would be transported in the absence of environmental attenuation factors such as adsorption, diffusion, dispersion, and degradation.

3.6.2.2 Deep Wells

Twenty-five intermediate and deep (depths greater than 70 feet) monitoring wells were installed in the bedrock on site. Each of the wells is selectively screened in the hornfels with some screened across igneous intrusives. Elevations of the monitored intervals is quite variable ranging from 65 to 490 feet above MSL.

Water levels for June 28, 1989; July 20, 1989; November 12, 1990; February 4, 1991; and May 21, 1991 for these monitoring wells are presented in Table 3-1, and are shown for February 4, 1991 on Figure 3-16. The levels are not contoured because the flow is not considered two dimensional in the horizontal. Water level measurements were recorded under steady state conditions with the exception of monitoring well HMW-12BE on November 12, 1990. The groundwater elevation of 405.14 ft, msl was recorded prior to complete recovery following Phase II purging and sampling activities.

The general pattern of piezometric levels in the deep wells consists of high heads (525 to 546 feet MSL) along the eastern portion of the site, an area of relatively uniform low head (485 to 493 feet MSL) across the central portion of the site from the Lagoon Area to Hunterstown Road, and another area of relatively uniform low head, albeit at a somewhat higher level (512 to 516 feet MSL), in the western portion of the site. The lower head levels in deep monitoring wells west of the Lagoon Area and east of Hunterstown Road is interpreted as a response to a possible groundwater "sink" believed to be associated with a mapped fracture trace along the Middle Stream. The fracture trace is oriented N 56° E (Figure 3-4) and is interpreted as a zone of preferential groundwater flow due to increased fracturing along this trace.

In the vertical plane, the hydraulic gradient is generally straight down, as shown on Figure 3-14. However, the hydraulic conductivity of the formation is expected to be extremely anisotropic, with maximum bulk conductivities parallel to the bedding planes perhaps 100 to 10,000 times the minimum conductivities orthogonal to the bedding planes. Assuming that the dip of the bedding planes is 26 degrees (see Section 3.4.2),
a vertically downward gradient in a formation with an anisotropy ratio of 100 would produce flow lines with a dip of 27.1 degrees. Under an anisotropy ratio of 10,000, the angle between the bedding planes and the flow lines would be much less than one degree. Therefore, even though the hydraulic gradient is vertically downward, flow is expected to occur essentially along the bedding planes and open near vertical joints within individual beds, occasionally crossing the bedding through open near-vertical joints or locations where the more impermeable igneous intrusives may not persist.

There is a large difference in water levels between HMW-4BL and HMW-3BL. This difference is difficult to explain unless an area of lower permeability exists at depth in the vicinity of the Borrow Area and Lagoon Area. A magnetometer survey was performed in this area to aid in evaluating for the possible presence or absence of an igneous intrusive dike that would act as a barrier to groundwater flow. It was felt that the identification of the location of a hydraulic barrier would be important in the actual placement of future source recovery wells. The magnetometer survey did not indicate the presence of magnetic anomalies that would be associated with a major igneous dike in this area of the site. However, this survey did not rule out other kinds of hydraulic anomalies in this area such as an area of low permeability due to natural heterogeneity.

A review of equipotential lines plotted on Figure 4-3 indicates a significant change in potential for vertical groundwater flow as you move from the eastern limits of the site to the western limits of the site. These equipotential lines are interpreted as an overall increase in permeability (fracturing) as you move east to west across the site.

Regionally, deep groundwater at the site is anisotropic, with flow downdip along bedding planes to the northwest, with some directional component occurring along strike to the southwest. Deep groundwater flow is affected by igneous intrusives which cross bedding planes and may act as hydraulic barriers to groundwater flow. The deep groundwater flow regime is also affected by the presence of mapped fracture traces oriented primarily N 15° E and N 55° E, which may act as preferential flow paths for groundwater flow to the southwest.
3.7 DEMOGRAPHY AND LAND USE

According to the U.S. Census for 1980, 68,282 people reside in Adams County. Additional information was gathered by using 1973 photorevised USGS Topographic Quadrangles for Gettysburg, Biglerville, Arendtsville, and Fairfield to count the number of houses within a one-quarter, one, and three-mile radius of the Hunterstown Road Site. Based on this review, and assuming four people to a household, approximately 88 people live within one-quarter mile, 1,172 people live within one mile, and 7,956 people live within a three-mile radius of the site.

Land use in the area near the Hunterstown Road Site is agricultural, commercial, and residential. Rock Creek is used for recreational purposes, primarily fishing. Rock Creek also serves as a discharge point for the Gettysburg Sewage Treatment Facility, east of Gettysburg. Schools, recreational areas, parks, wildlife refuges or other special use areas are not present in the vicinity of the site.

The Pennsylvania Bureau of Historic Preservation was contacted for information related to historic and or archaeological resources. Based on the available information, the bureau stated that there are no national register eligible or listed historic or archaeological properties in the area of the Hunterstown Road Site.

3.8 ECOLOGY

Regional topography is characterized by rolling hills rising from broad valleys with mild to moderate slopes. The broad valleys are widely used for farming.

The Hunterstown Road Site consists of grassy farm fields with adjacent forested areas. Tree cover in this area consists largely of broad-leafed deciduous varieties, particularly hickory, walnut, and remnants of the Appalachian Oak Forest (USCS, 1965). Scrub shrub vegetation is located in the understory of the forested areas and boundaries between forests and farms. The USEPA in May 1989 performed a wetland assessment at the Hunterstown Road Site (USEPA, 1989a). This assessment identified the following dominant vegetation:
• White Oak,
• Pin Oak,
• Red Maple,
• Shag Bark Hickory,
• Black Cherry,
• Red Maple,
• Poison Ivy,
• Wild Mustard and,
• Various grasses.

A copy of the USEPA assessment is provided in Appendix J.

The Pennsylvania Department of Environmental Resources Bureau of Forestry reviewed the Hunterstown Road Site for the presence of natural resources of special concern using the Pennsylvania Natural Diversity Inventory (PNDI) information system. The PNDI information system includes data descriptive of plant and animal species of special concern, exemplary natural communities and unique geological features. The review did not reveal any natural resources of special concern at the Hunterstown Road Site (PADER, 1991).

The Gettysburg area supports a variety of mammals, birds, fishes, reptiles, and amphibians. Mammals common to the Gettysburg Area include cottontail rabbits, squirrels, woodchucks, raccoons, mice, moles, and white-tailed deer. Common species of birds include hawks, ringneck pheasants, ruffed grouse, mourning doves, quail, robins, blackbirds, crows, and a large variety of other common birds. Eastern wood bullfrog, northern dusky salamander, eastern milksnake, and northern fence lizard are several of the common species of amphibians and reptiles located in the area.

The Pennsylvania Game Commission (Game Commission) reviewed the Hunterstown Road Site for the presence of threatened and endangered species of birds and mammals. The Game Commission determined that except for occasional transient individuals, endangered or threatened species of birds and mammals protected by the Federal Endangered Species Act of 1973 or recognized by the Game Commission are not affected (Pennsylvania Game Commission, 1991).
The United States Department of the Interior Fish and Wildlife Service (Fish and Wildlife Service) reviewed the Hunterstown Road Site for the presence of federally listed or proposed endangered and threatened species within the Hunterstown Road Site. Based on an office review, the Fish and Wildlife Service determined that except for occasional transient specimens, no federally listed or proposed threatened or endangered species are known to exist in the project area (U.S. Department of the Interior, 1991).

An office review of the U.S. Department of the Interior’s National Wetland Inventory maps showed no wetlands on the Hunterstown Road Site. The 1989 USEPA assessment identified wetlands at the site. The wetlands are confined to the vicinity of the streams (USEPA, 1989a).

As described in Section 2.4.3, a stream bioassay program on surface water and sediments was performed. At the initiation of the Phase II activities, the streams in the vicinity of the site were dry. Because of this condition, the USEPA and Westinghouse agreed to modify the stream bioassay program. The modification consisted of collection of samples from two locations: one downstream location (HA-2) and one reference location (REF-1). HA-2 is located 0.3 miles downstream of the site below the confluence of the East, West and Middle stream. Sample REF-1 was collected from Rock Creek at Hunterstown Road, approximately one mile north of the site. Surface water and sediment samples were used in acute and chronic toxicity tests. The following three tests were performed:

- Chronic *Ceriodaphnia dubia* Survival and Reproduction Test;
- Chronic *Ceriodaphnia dubia* Elutriate Survival and Reproduction Test; and
- Acute *Hyalella azteca* Sediment Toxicity Test.

The bioassay report by Free-Col Laboratories, Inc., including the methods and results of the tests, is included in Appendix H. Based on the bioassay analyses, there are no significant statistical differences between the reference samples taken at Station REF-1
and the samples taken downstream of the site at HA-2. Written USEPA results have not been received. However, based on verbal discussions with USEPA personnel, their results are in agreement with those of Free-Col Laboratories, Inc.
This section describes the results of the environmental sampling and analysis program (Section 2.0) conducted for this RI. Phase I samples were analyzed for TCL/TAL parameters. Analytical data from the Phase I sampling and previous investigations were used in defining the COI for Phase II. Therefore, Phase II samples were analyzed for various subsets of the TCL/TAL list, depending on their medium and location. Table 4-1 summarizes the COI for each environmental medium. As described in Section 2.0, additional samples were taken that were not specified in the Work Plan (Phase I) or Sampling and Analysis Plan (Phase II), including a Phase I sample of the Cornfield Area sludge (analyzed only for inorganics and volatiles), Phase I soil samples from the excavations created during waste removal from Drum Burial Areas 1 and 2 (grab samples analyzed for volatiles and composites analyzed for full TCL/TAL parameters), and Phase II surface soil samples collected from the Lagoon (analyzed for TCL VOC and the inorganic COI identified for the Lagoon Area).

Other parameters for which analyses were performed included asbestos and waste characteristics for samples from the Borrow Area, BEHP for Phase II groundwater samples, and field screening parameters (pH, specific conductivity, and temperature) for aqueous matrix samples. Asbestos and BEHP were also considered Phase II COI. Total organic carbon and grain size distribution analyses were also performed on Phase II sediment samples.

Samples collected at the Hunterstown Road Site were submitted to Lancaster Laboratories for analysis of the respective COI in accordance with the Quality Assurance Project Plan (QAPP) (Rizzo Associates, 1988). The QAPP set forth data quality objectives, and established sample collection strategies, data analysis procedures, and other procedures to ensure that the data quality objectives were met. A Quality Assurance (QA) Data Validation Summary Report for the Phase I quality control data was submitted in 1989. Appendix I contains a summary of the data.
validation results for the RI. These reports detail the results of performance and system audits, quality control problems encountered, corrective actions taken, and QAPP modifications, if any.

Phase I laboratory data were submitted in the Phase I RI Report. All Phase II laboratory data are presented in Appendix F. Where results are summarized in the following sections, concentrations in solid matrix samples are reported on a dry-weight basis.

4.1 POTENTIAL SOURCE AREAS

Soil samples were collected from background locations and potential source areas to identify COI present, if any, provide an indication of the extent of contamination, and evaluate whether migration from these areas has occurred. These potential source areas include:

- Former Borrow Area;
- Former Lagoon Area;
- Cornfield Area;
- Stressed Vegetation Area;
- Former Drum Burial Area 1; and
- Former Drum Burial Area 2.

4.1.1 Background Soil Samples

A single background sample, SS-BG, was collected in Phase I from a cornfield 0.3 miles northeast of the site. Nineteen Phase II background soil samples were collected from a nearby off-site cornfield, approximately 0.2 miles west of the Cornfield Area. It is believed that neither of these locations has been impacted by waste disposal activities. The nearest disposal area to the cornfield used for Phase II background samples is Drum Burial Area 1, which is a few hundred feet away and downslope of the background cornfield. The samples from this background cornfield were collected at depths corresponding to those of the Cornfield Area samples and were analyzed for the same organic and inorganic constituents as were the Cornfield Area samples (Section 2.2.2).
The following inorganic constituents were detected in the 19 Phase II background soil samples: barium, chromium, copper, lead, mercury, selenium, and zinc. The analytical results for the background samples are summarized in Table 4-2. Barium was detected up to 148 mg/kg; chromium up to 43 mg/kg; copper up to 31 mg/kg; lead up to 108 mg/kg; mercury up to 0.06 mg/kg; selenium up to 0.70 mg/kg; and zinc was detected at up to 124 mg/kg. Upper limit depth-specific and all-depths-combined background levels were calculated using analysis of variance (ANOVA) statistical methodology (Sokal and Rohlf, 1981). These calculations were based on a one-tail test with a 95 percent confidence limit. The results are shown in Table 4-3. In the case of lead, the highest concentration in a background sample (965 mg/kg) was regarded as an outlier and was not used in the calculations. These site-specific background levels are within their respective global ranges of background levels described by Levinson (1980) and included in Table 4-3.

Cornfield Area samples were compared with the corresponding depth-specific background levels. The soil samples collected from other waste areas were compared to the background levels calculated from data for all of the depths.

Seven of the background samples were analyzed for VOC. The only organic compounds detected were methylene chloride and acetone. Both of these compounds are recognized as common laboratory contaminants. Acetone was detected in all seven of the samples, at a maximum concentration of 36 ug/kg. Although acetone is produced naturally by a number of plants, due to the volatility and its rapid biodegradation in soils (Howard, 1990), it is likely that the acetone detected in the background samples is a laboratory artifact. Methylene chloride was detected in five of the samples, at a maximum concentration of 15 ug/kg. Since both of these concentrations are relatively low, these samples were used as reference matrix blanks. According to the Risk Assessment Guidance for Superfund (USEPA, 1989),

"if the blank contains detectable levels of common laboratory contaminants, then the sample should be considered as positive results only if the concentration in the samples exceed ten times the maximum"
amount detected in any blank. If the concentration of a common laboratory contaminant is less than ten times the blank concentration, then conclude that the chemical was not detected in the particular sample…"

Therefore, concentrations of acetone and methylene chloride in soil at less than 360 ug/kg and 0.15 mg/kg, respectively, are considered to be unrelated to site waste disposal activities.

4.1.2 Former Borrow Area

From the results of previous sampling and the Phase I Borrow Area soil analyses (SS-1), it was determined that the COI are copper, lead, zinc, asbestos, TCL VOC, and BEHP. Analytical results for SS-1 and the Phase II Borrow Area soil samples are summarized in Table 4-4. Figure 2-6 depicts the sample locations of the Borrow Area.

The site-specific background concentrations of copper (19.6 mg/kg), lead (57.6 mg/kg), and zinc (113 mg/kg) were calculated from soil samples collected from an adjacent off-site cornfield (Section 4.1.1). The background samples were collected at depths ranging from 16 to 44 inches below surface. Except for Samples BA-8A and BA-8B, which were collected in the center pile, the Borrow Area Samples were collected at depths of four to nine inches below the ground surface. However, soils from the adjacent off-site cornfield were considered sufficiently similar in composition to the Borrow Area soil to be used as background. Borrow Area Samples BA-3, BA-8B, and BA-9 exceeded the background concentration of each of the three inorganic COI. Sample BA-4 exceeded the site-specific background level for copper (1,190 mg/kg) and zinc (209 mg/kg), but not for lead (48.8 mg/kg). Sample BA-2 exceeded the background concentration for copper only (188 mg/kg), BA-8A exceeded the background concentration for copper (29 mg/kg) and lead (93.9 mg/kg), and Sample BA-5D exceeded the site-specific background for zinc (128 mg/kg) only. Sample BA-5 exceeded the background concentration for zinc only (114 mg/kg). The duplicate of BA-5D, BA-5, did not contain any COI above background concentrations. These
levels of inorganics are consistent with those of the surface soil sample taken during Phase I, which exhibited levels of copper (70 mg/kg), lead (336 mg/kg), and zinc (129 mg/kg) above background concentrations.

Acetone was detected in four of the samples, at up to 36 ug/kg (BA-7). Likewise, methylene chloride was detected in each Borrow Area sample, with a maximum concentration found in Sample BA-9 (120 ug/kg). Both acetone and methylene chloride are identified as common laboratory contaminants and were detected at levels less than ten times the respective background levels. Therefore, at this concentration acetone is considered to be unrelated to site waste disposal activities. Methylene chloride was the only volatile found in the Phase I Borrow Area soil sample, but is likewise considered to be a laboratory artifact due to its low concentration (20 mg/kg). Two other TCL VOC were detected in the Borrow Area soil samples. Trichloroethene was detected in Sample BA-9 at 7 ug/kg, which was also the quantitation limit for this sample. Toluene was detected in Sample BA-1 at 8 ug/kg, marginally above the quantitation limit of 6 ug/kg. In none of the other nine Borrow Area samples were TCL VOC detected. No volatile organics (aside from acetone and methylene chloride) were found in any of the background soil samples.

In addition to the TCL volatiles, one TCL semivolatile organic compound, BEHP, was detected in two of the Borrow Area soil samples. BEHP is a common laboratory contaminant, but was detected in none of the background samples, nor was it detected in the Phase I Borrow Area sample. Both of these samples in which this semivolatile was detected, BA-8B and BA-9, were located in the center pile of the Borrow Area. The center pile was observed to contain building material and miscellaneous debris. Sample BA-9, a composite from four locations at the edge of the center pile, was collected at depths of 4 to 9 inches and demonstrated the highest concentration of BEHP (8,240 ug/kg). Sample BA-8B exhibited a detectable level of the compound (680 ug/kg), whereas BA-8A did not. BA-8A was collected from 29 to 33 inches below the top of the pile; BA-8B was collected beneath BA-8A, 59 to 75 inches below the top of the pile and approximating the ground level of the area surrounding the pile. Therefore, the highest concentration of BEHP was detected near the base of the pile.
The Borrow Area soil samples were also analyzed for asbestos, previously identified as a COI. No asbestos was detected in any of the Phase II Borrow Area samples at a detection limit of 1 percent; neither was any fibrous material detected.

In evaluating the analytical results for all of the COI for the Borrow Area, the following observations can be made:

- The inorganic COI exceed site-specific background concentrations in several of the samples, especially those near the base of the center pile (BA-8B and BA-9);

- Although toluene and trichloroethene were each detected in one of the 11 samples, concentrations of TCL VOC are very low in the Borrow Area; and

- BEHP was detected in the center pile, near its base.

Upon evaluating the results of the inorganic COI, it is observed that the two samples near the base of the center pile (BA-8B and BA-9) contain two of the three highest concentrations of copper, and the two highest concentrations of lead. Sample BA-9 exhibits the highest concentration of zinc found in the Borrow Area. Other samples with relatively high levels of inorganic COI include BA-3 (copper, lead, and zinc) and BA-4 (copper and zinc). Sample BA-3 was collected west of the center pile, the direction toward which the ground slopes downward. Adjacent to BA-3, Sample BA-4 is also located near a smaller pile which is similar in appearance to the center pile (i.e., consisting of building material and debris). It is possible that runoff from this smaller pile was responsible for the high level of copper (1,190 mg/kg) found in BA-4.

Sample BA-2, also adjacent to BA-3 and downslope from the center pile, exhibited a level of copper (188 mg/kg) above that of the calculated site-specific background (19.6 mg/kg).
Samples demonstrating no COI above site-specific background levels include BA-1, BA-6, and BA-7. Each of these was taken from an elevation higher than the base of the center pile. Sample BA-5 is the only sample upslope of the center pile base that exhibits a COI (zinc) above its site-specific background level.

In summary, the analytical data indicate that the center pile contains levels of copper, lead, zinc, above soil background levels and BEHP above its practical quantitation limit, especially near its base. Soil samples collected downslope of the center pile base also exhibited above background levels of inorganic COI. Of the soil samples collected upslope of the base of the central pile, only BA-5D exhibited above background concentrations of any COI. However, BA-5D was located downslope of another pile, similar in appearance to the center pile. The analytical data in conjunction with the topography of the Borrow Area, suggest that the center pile and perhaps other similar piles are sources of COI in the soil samples. Some areas downslope of the pile(s) show above background levels of inorganic COI, probably due to surface water runoff.

### 4.1.3 Former Lagoon Area

It was determined from previous sampling results, including Phase I analytical results, that the following constituents are COI for the Lagoon Area: antimony, cadmium, chromium, copper, lead, mercury, zinc, and the TCL VOC. Ten soil samples (and one duplicate) from ten borings were collected in the Lagoon Area during Phase II. Two borings (HTB-7 and HTB-9) were drilled inside the fence, which is believed to surround the former lagoon. The eight others were collected from within 40 feet of the enclosed area. The samples were collected at the soil-bedrock interface. Nine other borings (HTB-14 through HTB-22) were drilled on a 3 x 3 grid inside the Lagoon area to determine the depth to bedrock. No analytical samples were collected from these borings, although soil jar headspace VOC concentrations were measured. Two surface soil samples were also collected in Phase II. Sampling locations are depicted on Figure 2-7 and analytical results are summarized in Table 4-5.
The Lagoon Area samples were taken at the soil-bedrock interface from depths ranging from 2.5 to 12 feet, whereas the site-specific background samples were collected at a depth of 1.3 to 3.7 feet. However, due to the similarity of the soil profiles, the site-specific background levels are used as a reference for the Lagoon Area soil samples.

Although both antimony and mercury were included as Phase II COI for the Lagoon Area, neither constituent was detected in any of the eleven soil samples collected from the borings. Also, mercury and antimony were not detected in the Phase I composite surface soil sample. Trace levels of these two metals were measured in the Phase II surface samples.

Cadmium was detected in Samples HTB-9 (0.8 mg/kg), HTB-4 (0.7 mg/kg), and HTB-5 (0.7 mg/kg), but at levels marginally above the quantitation limit (0.6 mg/kg). Cadmium was also detected in HTB-11D at 0.52 mg/kg (but not its duplicate), HTB-7 at 0.46 mg/kg, and HTB-12 at 0.40 mg/kg. For comparison, studies have shown that Ohio farm soils have a maximum of 2.9 mg/kg (Logan and Miller, 1983), Pittsburgh soils average 1.21 mg/kg (USEPA, 1981), and representative U.S. topsoils range in cadmium concentration from 0.1 to 1.0 mg/kg (Carey, 1979). Therefore, the level of cadmium detected in Lagoon Area soils appears to be within that of typical U.S. topsoil and would not appear to be representative of waste disposal activities.

None of the Lagoon Area soil samples exceeded the site-specific background level for chromium (48.0 mg/kg). The only inorganic constituents found at levels exceeding the site-specific background are copper, lead, and zinc. This is in agreement with the analytical results from Phase I. The composite surface soil sample collected in Phase I (SS-1) exhibited levels of chromium (72 mg/kg), copper (60 mg/kg), and lead (118 mg/kg) above the site-specific background levels for soils in Phase II.

Samples HTB-4 (81 mg/kg), HTB-7 (28 mg/kg), HTB-8 (67 mg/kg), HTB-9 (44 mg/kg), HTB-11 (21 mg/kg), HTB-11D (50 mg/kg) and HTB-12 (321 mg/kg) were found to have copper concentrations exceeding the site-specific background level (19.6 mg/kg). Samples HTB-8 (106 mg/kg) and HTB-12 (240 mg/kg) also exhibited levels of lead exceeding the site-specific background level (57.6 mg/kg). Although lead was detected in Sample HTB-11D at 325 mg/kg, its duplicate (HTB-11) was
observed to have a lead concentration of only 14.8 mg/kg, well below the site-specific background level for lead. A similar observation was made concerning these duplicates with respect to copper. Sample HTB-5 was demonstrated to contain zinc at a concentration (134 mg/kg) above that of the site-specific background level (113 mg/kg). One other soil sample, HTB-6 (118 mg/kg), was found to marginally exceed the site-specific background concentration for zinc.

The following TCL VOC were detected in the Lagoon Area borings: acetone, 2-butanone, 4-methyl-2-pentanone, toluene, ethylbenzene, xylenes, methylene chloride, and 1,1,1-TCA. Each of these was detected at least once among the 11 samples collected from borings. It is noted that acetone, 2-butanone, methylene chloride, and toluene are regarded as common laboratory contaminants.

Methylene chloride was found in the following samples: HTB-7 (75 ug/kg); HTB-8 (9 ug/kg); HTB-9 (21 ug/kg); HTB-12 (9 ug/kg); and HTB-13 (22 ug/kg). None of these samples contained a methylene chloride concentration that is greater by a factor of ten than that found in the background soil samples (15 ug/kg). This was also the case in the Phase I sample, in which methylene chloride was the only organic detected, but at a sufficiently low level (20 ug/kg) to be considered unrelated to site waste disposal activities. Methylene chloride, acetone, and 2-butanone were measured in trip and method blanks (Appendix I). Therefore, none of the methylene chloride results for the Lagoon Area samples are regarded as representative of site environmental conditions.

Acetone was reported in the following Lagoon Area samples: HTB-4 (13 ug/kg); HTB-5 (220 ug/kg); HTB-7 (2,600 ug/kg); HTB-9 (180 ug/kg); HTB-10 (49 ug/kg); HTB-11 (14 ug/kg); HTB-11D (14 ug/kg); and HTB-12 (22 ug/kg). The background soil samples contained acetone in concentrations up to 36 ug/kg. Of the Lagoon Area samples, only Sample HTB-7 exceeds the background concentration by a factor of ten. Therefore, the only sample in which acetone is considered above background is Sample HTB-7. The others are regarded as unrelated to site waste disposal activities.

2-butanone was detected in Samples HTB-5 (96 ug/kg); HTB-7 (560 ug/kg); and HTB-9 (35 ug/kg). Toluene was detected in only one sample, HTB-5, at 42 ug/kg.
In addition to trace compounds which are considered common laboratory contaminants, four other TCL VOC were reported. 4-Methyl-2-pentanone was detected in two Lagoon Area subsurface soil samples, HTB-5 (190 ug/kg) and HTB-7 (350 ug/kg). Likewise, xylenes were detected in both Samples HTB-5 (1,200 ug/kg) and HTB-8 (35 ug/kg), but were not detected in any of the other samples. Sample HTB-5 was also the only subsurface soil sample in which ethylbenzene (230 ug/kg) was detected. In one of the samples (HTB-8) 1,1,1-TCA was detected, but at a concentration (8 ug/kg) only marginally above the quantitation limit (6 ug/kg).

In summary, the following COI were detected in Lagoon Area subsurface soil samples at concentrations above site-specific background levels: copper, lead, zinc, acetone, 2-butanone, 4-methyl-2-pentanone, toluene, ethylbenzene, xylenes, and 1,1,1-TCA.

No correlation was noted between samples exceeding background for the inorganic COI and those in which organic COI were detected. For example, Samples HTB-5 and HTB-7 contained the highest concentrations of organic COI, but HTB-7 had no inorganic COI above background. Only zinc was slightly above background in Sample HTB-5. Likewise, those samples which showed relatively higher levels of inorganic COI did not contain higher concentrations of organic COI.

Two samples, HTB-7 and HTB-9, were collected from within the fenced area. Acetone, 2-butanone, and 4-methyl-2-pentanone were detected in Sample HTB-7. However, no inorganic COI were detected above background. 2-Butanone was the only organic compound detected in Sample HTB-9.

Borings HTB-14 through HTB-22 were drilled within the Lagoon Area on a 3 x 3 grid to determine the thickness of surficial soils. The thickness of the soil was quite variable, ranging from 2.0 feet to 15.0 feet. Subsurface soil samples from these borings were screened for VOC using an HNU photoionization detector with a 10.2 eV lamp. The results of the screenings are included on the boring logs in Appendix A.
Three borings, HTB-17, HTB-20, and HTB-21, all located near the northern corner of the Lagoon Area, contained soils with detectable levels of VOC at up to 310 ppm in the soil jar headspace. There was a monotonic increase in headspace VOC with depth in all of these borings, indicating that VOC may have migrated downward.

This pattern is consistent with the observations of VOC in subsurface soils from the nearby Borings HTB-5, HTB-7, and HTB-8, as well as with the identification of the Lagoon Area as a former source of VOC in shallow and deep groundwater.

In addition to the soil samples collected from borings, two surface soil samples were collected from within the Lagoon Area at a depth of zero to seven inches (Surface 1 and Surface 2). These samples were collected to provide updated data on the surface soils in the Lagoon. Analytical results for these two samples are summarized in Table 4-4.

The following inorganic COI were detected in both Surface 1 and Surface 2: antimony (18 mg/kg and 10 mg/kg); chromium (1,600 mg/kg and 680 mg/kg); copper (2,370 mg/kg and 1,510 mg/kg); lead (5,020 mg/kg and 1,830 mg/kg); mercury (0.14 mg/kg and 0.13 mg/kg); and zinc (442 mg/kg and 493 mg/kg). Antimony and mercury were detected in both of these surface soil samples; neither constituent was detected in any of the subsurface soil samples. Antimony was not detected in the off-site background cornfield samples; mercury was detected in only two of the 20 background samples and at a maximum concentration of 0.06 mg/kg. Each of the other inorganic constituents referenced above is found at greater concentrations in both Surface 1 and Surface 2 than in any of the other subsurface soil samples. The concentration of inorganics in these two surface samples also exceeded those of the composite soil sample, SS-2, taken from the Lagoon Area in Phase I. The observation of higher levels of the inorganic COI near the surface (at least in the Phase II samples), and lower concentrations in deeper soils, may be indicative of an attenuation mechanism. However, a trend of attenuation with respect to inorganic COI is not apparent among the boring samples. For instance, only one of the three samples collected from a depth
of four feet or less exhibited levels of any inorganics that were above background, whereas in four of the five samples collected from a depth of greater than seven feet, at least one inorganic COI was detected at a concentration exceeding background. No strong spatial trend could be observed from a lateral perspective.

The following organic constituents were detected in the sample identified as Surface 1:

- Vinyl chloride (610 ug/kg);
- Chloroethane (600 ug/kg);
- Methylene chloride (190 ug/kg);
- Acetone (260 ug/kg);
- 1,1-DCE (290 ug/kg);
- 1,1-DCA (6,000 ug/kg);
- 1,2-DCEs (21,000 ug/kg);
- 1,2-DCA (38 ug/kg);
- 1,1,1-TCA (1,100 ug/kg);
- TCE (330 ug/kg);
- 1,1,2-TCA (290 ug/kg);
- 4-Methyl-2-pentanone (150 ug/kg);
- PCE (170 ug/kg);
- Toluene (530 ug/kg); and
- Xylenes (300 ug/kg).

It is noted that of the above listed compounds, acetone, methylene chloride, and toluene are regarded as common laboratory contaminants. Since the level of acetone in Surface 1 (260 ug/kg) is less than ten times that found in background soil (36 ug/kg), the acetone in Surface 1 is not considered representative of environmental conditions. Methylene chloride (190 ug/kg) in Surface 1 is greater than ten times the concentration found in background soil (15 ug/kg). Toluene was not detected in any of the background soil samples. The methylene chloride concentration may be due to sample dilution which could magnify any laboratory-induced contamination.

Of the volatiles detected in Surface 1, 4-methyl-2-pentanone, toluene, xylenes, and 1,1,1-TCA were found in subsurface soils as well. The remaining ten volatiles (except
acetone) were not detected in any of the eleven subsurface soil samples. Also, 2-butanone and ethylbenzene were detected in at least one of the subsurface samples, but were not found in Surface 1.

Methylene chloride was the only TCL volatile found in Surface 2 (20 ug/kg) and in Phase I composite surface sample SS-2 (20 ug/kg). Because the level of methylene chloride (a common laboratory contaminant) in these two samples is less than ten times that detected in background soil (15 ug/kg), it is not considered representative of site environmental conditions in the particular vicinities of these sampling locations.

Seven different organic constituents were found in subsurface soil samples collected from the Lagoon Area. Fourteen different organic constituents were detected in the Lagoon Area surface soil sample Surface 1. The five constituents common to both Surface 1 and the subsurface samples were detected at higher concentrations in Surface 1. However, no volatile organics were detected in Surface 2.

Based on the respective volatile organic content of the Phase I and two Phase II surface soil samples, that were collected approximately 50 feet apart, VOC appear to be located in distinct areas of the Lagoon Area. This is further evidenced by the disparity of volatile organics detected among the subsurface soil samples. This disparity is observed both in the number of volatile organics observed, as well as the particular compounds. Perhaps most noteworthy is the fact that VOC were detected in only four of the eleven subsurface soil samples.

The occurrence of above background levels of inorganic constituents does not generally coincide with that of organic constituents. For instance, Surface 1 was observed to contain relatively high levels of organic constituents whereas no organic constituents were detected in Surface 2. Both surface soil samples exhibited similar levels of inorganic COI. Moreover, detectable levels of three organic compounds were detected in the subsurface sample from HTB-7, but no inorganic constituents exceeding background levels were detected in this sample. Therefore, it may be stated that based on the analytical results of the Lagoon Area surface and subsurface soil samples, above background levels of both organic and inorganic constituents in the Lagoon Area soils are somewhat randomly distributed.
The COI found in the soil borings at concentrations above soil background levels include the inorganics copper, lead, and zinc; and the organics acetone, 2-butanone, 4-methyl-2-pentanone, toluene, ethylbenzene, xylenes, and 1,1,1-TCA. In seven of the eleven subsurface soil samples, no VOC were detected and in eight of these samples, one or less inorganic constituents were found at above background levels. However, due to the discontinuous nature of the constituents in the soil, as demonstrated by the relatively large number of volatile organic COI in Surface 1 and their absence in Surface 2, it is difficult to compile a representative unit-wide list of COI detected in the Lagoon Area from the analytical data.

Based on the perimeter subsurface soil samples, soil does not appear to be impacted at the soil bedrock interface. Based on headspace measurements of subsurface soil directly beneath the lagoon, it is expected that trace levels of VOC are present in these soils.

4.1.4 Cornfield Area

The results of the inorganic and organic analyses for the Phase I and Phase II Cornfield Area soil samples are summarized in Table 4-6. Sampling locations are shown on Figures 2-3 and 2-4.

Phase I samples include composite Samples SS-3 through SS-8 and the duplicate SS-5D. Sample SS-3 contained higher metal concentrations than any of the other Cornfield Area samples. Metals observed included copper, zinc, lead, chromium, calcium, mercury, sodium, cadmium, selenium, and silver. Copper concentrations in Samples SS-3, SS-4, SS-6, SS-7 and SS-8 were higher than background (19.6 mg/kg). (The background levels cited are those calculated in Phase II (Table 4-3), except as noted, due to the much larger number of background samples collected in Phase II.) Zinc concentrations were also consistently higher than the background level of 113 mg/kg in the same samples, but were highest in SS-3, at 585 mg/kg. Lead concentrations were higher than background (57.6 mg/kg) in the samples from the North Cornfield (SS-6, SS-7, and SS-8), ranging from 173 to 246 mg/kg, and in SS-3, which contained 1770 mg/kg lead. The lead concentration in Sample SS-4 was only
slightly higher than background. Chromium, with a background concentration of 48 mg/kg was found in Samples SS-3 (313 mg/kg) and SS-8 (62 mg/kg) in concentrations above this value. Calcium (not analyzed for in Phase II) and mercury were detected at levels higher than background in SS-3, at 6460 and 0.51 mg/kg, respectively.

Sodium was not detected in the Phase I background sample, SS-BG, but was found in samples from five Phase I samples (SS-3, SS-4, SS-5, SS-6 and SS-7) ranging from 60 to 240 mg/kg. Cadmium and silver were detected at low concentrations in SS-3, but not in any of the other Phase I Cornfield Area samples or any of the background samples. Likewise, a relatively low concentration of selenium was detected in SS-3, but not in any other Phase I Cornfield Area samples. Selenium was detected in one of the Phase II background samples.

Barium, beryllium, and cyanide were the only inorganics detected in Cornfield Area samples at concentrations exceeding background in which SS-3 did not contain the maximum levels of these constituents. Barium was detected in the Cornfield Area composite samples at concentrations ranging from 170 mg/kg in Sample SS-4 to 950 mg/kg in Sample SS-7. These levels were higher than the background of 158 mg/kg. Beryllium was not detected in SS-BG, but was found in four Cornfield Area samples at a range of 0.6 to 0.8 mg/kg. Cyanide was detected only once, in SS-8, at 0.7 mg/kg.

During the collection of the composite samples from the Cornfield Area, it was noted that at numerous locations a white clay-like material was found at varying depths from the ground surface. A sample of this material, the "Cornfield Sample," was collected from the area of SS-5 and submitted for TAL metals and TCL volatiles analyses. Concentrations of barium (7,030 mg/kg), calcium (11,900 mg/kg), cobalt (169 mg/kg), lead (6,550 mg/kg), nickel (294 mg/kg), sodium (2,230 mg/kg), and zinc (2,940 mg/kg) were higher than concentrations detected in all other cornfield samples, including SS-3. Concentrations of chromium (65 mg/kg) and copper (188 mg/kg) were less than concentrations detected in SS-3 but greater than concentrations detected in the other Cornfield Area samples. The concentrations of cadmium (1.2 mg/kg) and mercury (0.31 mg/kg) were approximately equal to those detected in all other samples.
The volatiles detected in Phase I Cornfield Area samples include one ketone (acetone), one aromatic hydrocarbon (toluene), and three chlorinated aliphatic hydrocarbons (methylene chloride, TCE, and PCE). Of these, however, acetone and methylene chloride were detected in higher concentrations in Phase I and several of the Phase II background samples than in SS-3 through SS-8. Methylene chloride and acetone were present in samples, including the background samples, at concentrations that are relatively low and uniform. It should be noted that methylene chloride and acetone, especially at the levels detected, are commonly laboratory-induced contaminants. Thus, these compounds may not be representative of site waste disposal activities.

TCE, PCE, and toluene were detected only in SS-3, at concentrations of 11, 6, and 14 ug/kg, respectively. PCE was also detected in the Phase I background sample (SS-BG) at 0.010 mg/kg. Volatiles were not detected in the Cornfield Sample.

One semivolatile, BEHP, was found in the Cornfield Area samples at 0.42 ug/kg in SS-3. One pesticide, DDT, was found in the Cornfield Area at 29 ug/kg in SS-7. The occurrence of DDT could be related to past agricultural uses of the site and not to waste disposal activities.

From analytical results of previous investigations and the Phase I study, the following constituents have been identified as Phase II Cornfield Area COI: barium, cadmium, chromium, copper, lead, mercury, selenium, zinc, and TCL VOC.

Site-specific background concentrations were calculated from samples taken during Phase II from the adjacent cornfield described in Section 4.1.1. Soil samples were collected from the background cornfield at depth intervals corresponding to those of the Cornfield Area. Therefore, a background mean concentration for each inorganic constituent, at each respective depth, was calculated (Table 4-3). The depths at which the samples were collected are designated by the letters A (four to eight inches), B (16 to 20 inches), C (28 to 32 inches), and D (40-42 inches). Because the four "A" depth (four to eight inches) samples collected from just outside the Cornfield Area boundary have no corresponding background samples at the same depth, these were compared to
the site-specific overall background mean depths. Also, due to the wide disparity of lead concentrations in the background soil samples, the overall mean (not including the highest concentration of 965 mg/kg) was used as the reference level for lead.

Neither chromium nor lead were detected above background concentrations in any of the Phase II Cornfield Area soil samples. The highest chromium level was detected in Sample C2-D at 44 mg/kg. This compares with a depth-specific concentration of 52.3 mg/kg for chromium in background soils. Sample B4-B exhibited the highest lead concentration among the Cornfield Area samples, at 54.9 mg/kg. The background level for lead in soil was calculated as 57.6 mg/kg. The remaining inorganic COI for which site-specific background levels exist include barium, copper, and zinc. Neither of these three inorganic constituents were found at levels exceeding background among the perimeter soil samples collected at the A depth.

At the "B" depth (16 to 20 inches) the site-specific background level for barium was 124 mg/kg. Barium concentrations in AC-1B (154 mg/kg), A4-B (174 mg/kg), B4-B (160 mg/kg), and D-11B (169 mg/kg) were found to marginally exceed this background concentration. Sample B4-BD, a duplicate of B4-B, contained a barium concentration (107 mg/kg) less than the background level. However, the mean of these two barium levels would be 133.5 mg/kg, still somewhat above background. None of the Cornfield Area soil samples taken from depth "C" (28 to 32 inches) exceeded the corresponding barium background level (183 mg/kg). At the "D" depth (40 to 44 inches), three samples exceeded the depth-specific background level for barium (169 mg/kg). These include Samples A4-D (220 mg/kg), C2-D (183 mg/kg), and C10-D (353 mg/kg). Although Sample D4-D (172 mg/kg) is marginally above background, its duplicate is less than the depth-specific level for barium. The mean of these two samples is 147 mg/kg, less than the depth-specific level for barium.

At the "B" depth (16 to 20 inches) the site-specific background level for copper was 15.8 mg/kg. Copper concentrations in A4-B (17 mg/kg), BA-2B (17 mg/kg), B4-B (64 mg/kg), B4-BD (23 mg/kg), C3-B (16 mg/kg), D4-B (22 mg/kg), D9-B (16 mg/kg), D-11B (38 mg/kg), and D12-B (31 mg/kg) were found to exceed this background concentration. At the C level, only D4-C (at 67 mg/kg) and D9-C (at 51 mg/kg) contained copper above the corresponding background level (48.4 mg/kg).
The analytical results show that BA-2D (19 mg/kg), CA-3D (56 mg/kg), C1-D (14 mg/kg), C-100 (2.6 mg/kg), D4-D (161 mg/kg), D4-DD (147 mg/kg), DB-5D (39 mg/kg), D9-D (44 mg/kg), D-11D (44 mg/kg), D-11DD (69 mg/kg), D-12D (39 mg/kg), and D-12DD (60 mg/kg) are above the site specific background level for copper at the "D" level (13.7 mg/kg).

No Cornfield Area soil sample was demonstrated to have a zinc level greater than its respective depth-specific background level. The remaining inorganic COI detected in Cornfield Area soil samples are cadmium, mercury, and selenium. Cadmium was detected in 15 samples up to 0.8 mg/kg in CA-3D. These levels are within those typical of U.S. top soil (see Section 4.1.3) and are therefore not considered representative of site waste disposal activities. Mercury was detected in 21 soil samples in concentrations of up to 0.60 mg/kg (at B4-B). Selenium was detected in Samples C2-D (at 0.7 mg/kg) and C10-D (at 0.8 mg/kg).

With respect to inorganic COI, no strong spatial or depth-specific trends were observed. None of the COI were found at levels above background concentrations at the A depth (four to eight inches) in samples collected outside of the Cornfield area. It is noted that the highest barium levels were detected in samples collected at 40 to 44 inches below ground surface (D depth) and copper was found at its highest levels in samples taken at 16 to 20 inches below ground surface (B depth).

The only TCL VOC reported in the Phase II Cornfield Area soil samples were acetone and methylene chloride, two common laboratory contaminants. Of the 22 soil samples analyzed for VOC, acetone was detected in 13. The highest concentration found was 39 ug/kg in D-11D. Acetone was detected in the background samples up to 36 ug/kg. Since the concentration of acetone found in Sample D-11D is less than ten times that of the maximum background sample concentration, none of the Cornfield Area acetone results represent environmental conditions.

Methylene chloride was detected in 20 of the 22 soil samples that were analyzed for TCL volatile organics. The maximum concentration of methylene chloride found in
any of these samples was 38 ug/kg in B4-BD. Since this concentration is less than ten times that found in the background soil samples (15 ug/kg), none of the Cornfield Area methylene chloride results appear to represent environmental conditions.

In summary, 52 Phase II Cornfield Area soil samples and five duplicates were analyzed for the COI. Barium was found at levels above practical quantitation limits in three soil samples collected at the D depth. One of these samples, C10-D, had a barium concentration that was double that of the depth-specific background soil. The two D depth samples collected nearest to C10-D (D9-D and D11-D) had barium concentrations in the range of one-third to one-half that of the background limit. Therefore, barium does not appear to be widespread in the vicinity of C10-D. Samples A4-D and C2-D contained barium only slightly above the depth-specific background.

Barium was also detected in four B depth samples at concentrations above the depth-specific background. However, the background level of barium at the B depth is low relative to those of the C and D depths. Only one of the B depth samples slightly exceeded the D depth background level for barium, and none exceeded the C depth background. No C depth sample exhibited a level of barium above its depth-specific background.

The level of copper detected in two samples (D4-C and D9-C) collected at the C depth and nine samples at the B depth was above the respective depth-specific background levels. In addition, the concentration of copper detected in twelve samples collected at the D depth was above the depth-specific background level. However, the level of copper in these samples is well within the global background level for copper in soil, and copper at these concentrations is not otherwise considered to be a problem. Nor is there any indication that the copper found at these depths is related to waste disposal activities.

When comparing the soil analytical results of the Phase II study to those of the Phase I study for the Cornfield Area, it is observed that the Phase I samples, which were collected at a depth of 8 to 12 inches, generally had higher concentrations of the COI than in Phase II soil samples collected at deeper depths. Six composite samples (SS-3, SS-4, SS-5, SS-6, SS-7, and SS-8) were collected in Phase I from six different
sampling location areas within the Cornfield Area. The Phase I soil sample, SS-3, exhibited the highest concentrations of barium, cadmium, chromium, copper, lead, mercury, selenium, zinc, TCE, PCE, and BEHP. Phase II samples collected within the area encompassed by the SS-3 composite sample, but at greater depths, did not exhibit correspondingly high levels of COI. Other Phase I composite samples containing above background levels of COI, such as SS-7 and SS-8, did not exhibit these concentrations in Phase II Cornfield Area soil samples collected from within these respective areas. It is noted that the Phase I SS-4 and SS-5 samples exhibited levels of COI that approximate background levels. Since the Phase I composite samples were collected from the surface, the analytical results indicate that relatively higher concentrations of COI were detected in surface soils from the Cornfield Area. The white, clay-like material collected near the surface and analyzed as the "Cornfield Sample" in Phase I exhibited the highest concentrations of barium, lead, selenium and zinc. The white, clay-like material may be a potential source of these constituents in the Cornfield Area.

As mentioned, the highest concentrations of barium detected in Phase II were found at the D depth. Since the highest concentrations of barium (and other COI) found in the Cornfield Area from both studies were detected in the Phase I samples collected at a depth of 8 to 12 inches and because barium readily binds to soil, if significant leaching were occurring it would be expected that higher levels of barium would be detected at the B depth and C depth than at the D depth. Since this is not the case, it is unlikely that the barium present at the D depth is from leaching of waste material near the surface.

In conclusion, the highest concentrations of COI in the Cornfield Area were located within 12 inches of the surface and may potentially be related to the localized visible presence of the white, clay-like material. Significant leaching is not occurring and significant amounts of impacted soil are not found at or below a depth of sixteen inches. Also, levels of COI above practical quantitation limits were not detected in shallow samples collected just outside of the Cornfield Area. Therefore, soil most affected by COI appears to be contained within the area depicted on Figure 1-2.
4.1.5 Stressed Vegetation Area

Table 4-7 summarizes the results of the inorganic and organic analyses of soil samples from the Stressed Vegetation Area collected in Phases I and II. The five grab samples collected in Phase I are identified as SV-1 through SV-5. Based on physical appearance (multi-colored sludge), these five samples were considered to be comprised of the waste material. Although these samples were considered to be waste material, the results were compared to background soil concentrations (Table 4-3).

Maximum concentrations of inorganics in the Stressed Vegetation Area were found in Samples SV-1 and SV-4, from the southern portion of that area. Sample SV-2 also contained levels of some metals that were above background concentrations. Phase I and Phase II soil sampling locations are shown on Figure 2-5.

Chromium was detected above the background soil level (48.0 mg/kg) in SV-1 at 8,590 mg/kg and in SV-4 at 10,000 mg/kg. Lead levels in SV-1 and SV-4 also contained levels above background soil samples, at 54,300 and 24,400 mg/kg, respectively. The concentration of lead in SV-2 (1,820 mg/kg) was also higher than the background level of 57.6 mg/kg. The copper concentration in SV-1 was 2,820 mg/kg and 7,180 mg/kg in SV-4. These levels were higher than the background level of 19.6 mg/kg. Copper concentrations in SV-2 (889 mg/kg), SV-3 (122 mg/kg) SV-20 (45 mg/kg) and BW-3A (49 mg/kg) were lower than those detected in SV-1 and SV-4, but higher than background level. Concentrations of zinc were also found in SV-1 through SV-4 (547, 312, 207, and 1,030 mg/kg, respectively) above the background concentration (113 mg/kg). Barium was detected in SV-1 at 1,100 mg/kg and in SV-4 at 1,530 mg/kg, approximately ten times higher than the background concentration (158 mg/kg).

Antimony was detected only in SV-1 and SV-4 at 92 and 73 mg/kg, respectively. Both exhibited a mercury concentration of 1.5 mg/kg. Antimony was not detected in any of the background samples; mercury was detected in only two of the 20 background samples at a maximum concentration of 0.06 mg/kg. Cyanide was found in SV-1 at
2.0 mg/kg, in SV-3 at 0.16 mg/kg, and in SV-4 at 1.7 mg/kg. Cyanide was not analyzed for in the Phase II background samples and was not detected in SS-BG, the Phase I background sample.

VOC detected in Phase I soil samples from the Stressed Vegetation Area include a ketone (acetone), an aromatic hydrocarbon (toluene) and six chlorinated aliphatic hydrocarbons (methylene chloride; 1,1-DCA; 1,1,1-TCA; trans-1,2-DCE; TCE; and PCE).

The only organic compounds detected in SV-2, SV-3, and SV-5 were acetone (up to 25 ug/kg in SV-2) and methylene chloride (up to 33 ug/kg in SV-2), both of which were also found in the Phase II background samples at 36 and 15 ug/kg, respectively. Since these common laboratory contaminants were not detected at a concentration that is ten times greater than the background levels, the occurrence of acetone and methylene in these samples may not be representative of actual conditions in the areas from which the samples were obtained. For this reason, the occurrences of 53 ug/kg acetone in SV-1, and 29 ug/kg acetone and 36 ug/kg methylene chloride in SV-4 are most likely laboratory induced contaminants.

Sample SV-4 contained all eight VOC detected in the Stressed Vegetation Area, including 509 ug/kg 1,1,1-TCA and 93 ug/kg TCE, with a total concentration of chlorinated aliphatic compounds (not counting methylene chloride) of 699 ug/kg. Sample SV-1 contained 371 ug/kg total chlorinated aliphatics, including 194 ug/kg 1,1,1-TCA and 129 ug/kg TCE.

The only other organic compounds detected in Phase I soil samples from the Stressed Vegetation Area were the pesticides, p,p'-dichlorodiphenyldichloroethane (DDD) and DDT. These were both found only in SV-1, at respective concentrations of 229 and 670 ug/kg. The occurrence of these compounds on site may be related to past agricultural uses rather than to waste disposal activities.

From the analytical results of Phase I, the following were determined to be COI: antimony, barium, cadmium, chromium, copper, lead, mercury, selenium, zinc, DDT, and the TCL VOC. The Phase II samples were analyzed for these identified COI.
In Phase II, grab soil samples were taken from 16 locations (SV-6 through SV-21) along the perimeter of the Stressed Vegetation Area (Figure 2-5). The overall depth of the samples ranged from 4 to 14 inches below ground surface. Four additional soil samples (BW-1, BW-2, BW-3A, and BW-3B) were collected from below the waste, as described in Section 2.2.2.2. Three grab water samples from just below the surface were also collected. The soil and water results are summarized in Tables 4-7 and 4-8. In addition, a composite sample of the waste material was collected and analyzed using the Toxicity Characteristic Leaching Procedure (TCLP). Site-specific background soil levels of COI were calculated from the analytical results of soil samples taken from the nearby off-site cornfield (Section 4.1.1).

Three of the COI listed above, antimony, cadmium, and selenium, were not detected in any Phase II Stressed Vegetation Area soil samples. In Phase I, neither cadmium nor selenium were detected in any of the five composite surface soil samples. Antimony was detected in two of them at concentrations of 92 mg/kg and 73 mg/kg. Mercury was detected in only one of the 20 Phase II soil samples (0.12 mg/kg in SV-17). Barium did not exceed the calculated site-specific background soil level (158 mg/kg) in any Phase II sample.

In five of the samples, the site-specific background soil level for chromium (48.0 mg/kg) was exceeded. These included Samples SV-6 (50 mg/kg), SV-14 (129 mg/kg), SV-17 (363 mg/kg), SV-18 (118 mg/kg), and BW-1A (76 mg/kg). The Phase I samples containing chromium above background soil levels were SV-1 (8,590 mg/kg), SV-2 (120 mg/kg), and SV-4 (10,000 mg/kg). The levels in SV-1 and SV-4 are higher than those in the nearby perimeter samples, indicating strong attenuation with distance from the Stressed Vegetation Area. The site-specific background level for copper (19.6 mg/kg) was exceeded by the following eight Phase II samples: SV-6 (63 mg/kg), SV-13 (193 mg/kg), SV-14 (531 mg/kg), SV-15 (68 mg/kg), SV-17 (1,500 mg/kg), SV-18 (793 mg/kg), SV-19 (388 mg/kg), BW-1A (63 mg/kg). The highest copper concentrations in Phase I were in SV-1 (2,820 mg/kg) and SV-4.
(7,180 mg/kg), although SV-2, SV-3, SV-20 and BW-3A were also above the site-specific background level. These locations coincide with the locations of the highest copper concentrations in the Phase II perimeter samples, i.e., along the south and west sides.

Eight of the 20 Phase II samples were found to exceed the site-specific background concentration for lead (57.6 mg/kg). Two of these, Samples SV-17 and SV-18, contained levels of 3,560 mg/kg and 1,970 mg/kg, respectively. The six other samples found to exceed background lead levels include SV-13 (227 mg/kg), SV-14 (763 mg/kg), SV-19 (229 mg/kg), SV-20 (202 mg/kg), BW-1A (209 mg/kg), and BW-3A (92.9 mg/kg). Again, the highest levels are located along the southwestern corner of the area, with concentrations an order of magnitude less than the highest Phase I concentrations (54,300 and 24,400 mg/kg, in SV-1 and SV-4, respectively).

The analytical data also show that seven of the Stressed Vegetation Area soil samples had zinc concentrations above the background zinc level (113 mg/kg). These samples include SV-13 (129 mg/kg), SV-14 (139 mg/kg), SV-15 (119 mg/kg), SV-17 (461 mg/kg), SV-18 (417 mg/kg), SV-19 (349 mg/kg), and BW-3A (115 mg/kg). Samples SV-15 and BW-3A were only marginally in excess of the background level. Phase I samples contained zinc in SV-1 through SV-4 ranging from 1,030 mg/kg, slightly higher than the Phase II samples, and again coinciding with the southern and western perimeters.

The analytical results show a maximum concentration of acetone and methylene chloride for both phases of 81 ug/kg (at SV-18) and 36 ug/kg (at SV-4), respectively. Both of these compounds are common laboratory contaminants. The reported level of acetone in the background soil is 36 ug/kg, and the reported level of methylene chloride is 15 ug/kg. Methylene chloride and acetone were detected in method and trip blanks (Appendix I). Because the concentrations of the compounds reported in the Stressed Vegetation Area soil samples are less than ten times the respective concentrations of acetone and methylene chloride in the background samples, these results do not represent site conditions.
DDT was detected in Sample SV-17 at a concentration of 60 ug/kg. This compound was not found in any of the other 19 soil samples and constitutes the only organic compound detected in any of the Phase II Stressed Vegetation Area soil samples.

DDT and DDD were both found in Phase I in Sample SV-1, located approximately 30 feet from SV-17. Phase I Samples SV-1 and SV-4 (both containing maximum concentrations for several inorganic COI) were found to contain several chlorinated aliphatic hydrocarbons (including 1,1,1-TCA at up to 509 ug/kg in SV-4) and toluene (also in SV-4). As with the inorganics, the VOC detected in Phase I are found primarily in the southern and western portions of the area.

A composite sample of the waste material was collected and analyzed by the TCLP method. These analytical results are included in Appendix F. The only TCLP constituent detected was barium at 6.0 mg/l; the TCLP regulatory level for barium is 100 mg/l. No other TCLP constituents were found in this sample above the detection limit. Therefore the soil is not considered hazardous material based on this criterion. This sample was also analyzed for other disposal parameters, including BTU/lb, sulfur, ash, pH, and total organic halogens. These results are included in Appendix F as well.

Three water samples were collected just below ground surface. Although several COI were detected in at least one of these samples (Table 4-8), only chromium, copper, and lead were found in concentrations above Maximum Contaminant Levels (MCLs). VOC were all below their Safe Drinking Water Act MCLs, or were not considered representative of site conditions (acetone and methylene chloride). DDT and DDD were detected in one of the three samples (SW-3) at 0.7 and 0.2 ug/l, respectively, but were not detected in either of the other samples.

Eight of the sixteen Phase II perimeter soil samples taken from locations immediately adjacent to the Stressed Vegetation Area had levels of at least one COI above the respective site-specific background level. Two of the four soil samples collected from below the waste were found to have at least one COI above background.

The Phase II sampling locations with the highest detected levels of COI include: SV-13, SV-14, SV-17, SV-18, and SV-19. These locations are along the southern and western perimeters of the Stressed Vegetation Area. These locations also contained the
highest levels in Phase I at SV-1 and SV-4. Sample SV-2, collected from the middle of the Stressed Vegetation Area, contained lower levels of copper and lead than the levels found in SV-1 and SV-4 (Table 4-7). No COI were detected above soil background concentrations in SV-5, collected just inside the northern perimeter. COI were also detected in SV-3 located within the northwest corner of the Stressed Vegetation Area. BW-3A, collected at a depth of three to five inches, also contained COI above soil background levels. However, the values listed in Table 4-7 for BW-3A are estimates which are below the contract-required detection limits (CRDLS). The sample collected at this same location, but at a depth of 14 to 16 inches (BW-3B) did not exhibit levels of COI above soil background levels.

Based on the perimeter soil samples, COI were detected along the southwestern perimeter of the Stressed Vegetation Area. This also coincides with the topography of the immediate area. A migration pathway from the Stressed Vegetation Area for COI may potentially be surface runoff. East Stream sediment sampling locations SD-8 and SD-9 do not appear to be impacted by the Stressed Vegetation Area as indicated by the absence of COI. Sampling locations SD-8 and SD-9, based on topography, are cross gradient from the Stressed Vegetation Area. It is possible that the sediment and surface water at SD-10/SW-10, located approximately 100 feet downgradient of the Stressed Vegetation Area, are impacted by runoff from the Stressed Vegetation Area.

COI in soils in the Stressed Vegetation Area are present from ground surface to a few inches below ground surface. Material which appears to be paint waste can be found a few inches below ground surface. Based on Phase I sample results, this material is most likely the source of the COI measured in the southwestern perimeter samples. As demonstrated at location BW-3, attenuation of the COI occurs within 12 inches below the waste material as indicated by the results of samples collected below 12 inches.

4.1.6 Former Drum Burial Area 1

After excavation of the drums from Drum Burial Area 1, four composite soil samples and 32 grab samples were collected in April 1989 and analyzed in Phase I. The sampling locations are shown on Figure 2-1. Soil samples were collected at four to six-inch depths and 12 to 18 inch depths at each of 16 locations. The depths were
measured from the bottom of the excavation. In addition, four composite samples were collected, for a total of 36 soil samples. The analytical results for Phase I and Phase II are summarized in Table 4-9. In 13 of these, only common laboratory contaminants at low levels were detected. In a few of the remaining Phase I soil samples, xylenes (up to 410 mg/kg at 4BS), ethylbenzene (up to 46 mg/kg at IDS) and toluene (up to 11 mg/kg also at IDS) were detected. These samples were collected immediately after the former drum burial area was excavated. The excavation was left open for one year before it was backfilled. Although no soil samples were taken prior to backfilling, it is possible that nearly all of the xylenes, ethylbenzene, and toluene could have volatilized before backfilling. The highest concentrations of these compounds detected in Phase II subsurface samples were approximately three orders of magnitude less than in the Phase I surface soil samples.

Based on the Phase I analytical data and other investigations, TCL VOC and PCBs were identified as COI. In Phase II, soil from Drum Burial Area 1 was sampled from ten borings (HTB-28 through HTB-37) at depths ranging from 0 to 12 feet below ground surface. Eight of these are located around the perimeter of Drum Burial Area 1, and two (HTB-30 and HTB-34) are located in the center of the area. As described in Section 2.2.3.1, soil samples were collected at the soil-bedrock interface in each boring. The top of bedrock as determined from borings HTB-28 through HTB-37 ranged from 2.5 to 10.8 feet below ground surface. In the eight perimeter borings, samples were also collected approximately midway through the soil column. These are respectively referred to as the interface samples and midpoint samples. Including two duplicates, a total of 20 samples were collected and analyzed. The sample locations are shown on Figure 2-1 and the analytical results are summarized in Table 4-9.

No COI were detected in Borings HTB-31, HTB-32, HTB-33, and HTB-36. PCBs were not detected in any of the soil samples. Acetone and methylene chloride, both recognized as common laboratory contaminants, were reported for HTB-28 at concentrations of 29 ug/kg and 6 ug/kg, respectively. These concentrations are significantly less than ten times the background soil levels of these compounds (36 ug/kg and 15 ug/kg, respectively) and are not considered to represent site conditions.
The following nine TCL VOC were detected in soil samples from one or more of Borings HTB-29, HTB-30, HTB-34, HTB-35, and HTB-37 (included in parentheses is the number of samples in which each was detected): acetone (1); 2-butanone (3); 4-methyl-2-pentanone (2); toluene (2); ethylbenzene (2); xylenes (4); 1,1,2-TCA (1); 1,2-DCEs, and TCE (3).

All of the above compounds, with the exception of 1,2-DCEs, were detected in the sample from Boring HTB-34 located inside the former burial area (Figure 2-1). The sample collected from Boring HTB-34 was an interface sample and was collected at a depth of 10.0 to 12.0 feet below ground surface. HTB-34 also contained the highest concentration among the 20 samples for the following five compounds: acetone (930 ug/kg); 2-butanone (290 ug/kg); 4-methyl-2-pentanone (1,100 ug/kg); 1,1,2-TCA (10 ug/kg); and TCE (53 ug/kg). Acetone and 2-butanone are regarded as common laboratory contaminants. This boring is near several Phase I post-excavation sample locations found to contain levels of aromatic hydrocarbons above quantitation limits.

Two COI were found in the interface sample taken from HTB-30, also located in the center of Drum Burial Area 1. These two constituents are TCE and xylenes, detected at concentrations of 7 ug/kg and 9 ug/kg, respectively.

One interface sample from Boring HTB-35 (HTB-35D, S-4), collected at a depth of 7.5 to 9.5 feet, exhibited the maximum concentrations of the following constituents: 1,2-DCEs (34 ug/kg); ethylbenzene (34 ug/kg); toluene (20 ug/kg); and xylenes (380 ug/kg). However, in the duplicate of this sample (HTB-35, S-4), only 1,2-DCEs were detected (21 ug/kg). Therefore, the presence of the other three compounds in Boring HTB-35 at the soil-bedrock interface is questionable. HTB-35 is downgradient (in the shallow groundwater flow zone) of Phase I soil sampling Stations 1C and 1D, where detectable levels of VOC were indicated. In this same boring, 1,2-dichloroethene was also detected in the midpoint sample collected from a depth of the 2.5 to 4.5 feet.

In the soil-bedrock interface sample (7.5 to 9.5 feet) collected from HTB-37, 2-butanone (38 ug/kg), 4-methyl-2-pentanone (54 ug/kg), and xylenes (7 ug/kg) were detected. No COI were detected in the midpoint sample (five to seven feet) collected from HTB-37.
The only other boring in which COI were detected was HTB-29. In the midpoint sample (zero to two feet depth), TCE were detected at 7 ug/kg. No other COI were detected in this sample. No COI were found in the HTB-29 interface sample (collected at a depth ranging from five to seven feet).

An evaluation of the COI detected reveals that only one constituent, xylenes, was detected in more than three of the 20 Phase II Drum Burial Area 1 subsurface soil samples that were analyzed. 1,1,2-TCA was detected only in the sample from HTB-34. Because it was only detected in this sample at a relatively low concentration (10 ug/kg), the presence of 1,1,2-TCA in Drum Burial Area 1 is regarded as questionable. 1,1,2-TCA was not detected in the other interface sample collected beneath the former burial area, HTB-30.

It is noted that 2-butanone and toluene are considered common laboratory contaminants. However, neither compound was detected in the background soil samples. It is not likely that either of these compounds are present in soil from former Drum Burial Area 1 due to the fact that although Sample HTB-35D, S-4 was reported to contain both 2-butanone (56 ug/kg) and toluene (20 ug/kg), neither compound was detected in its duplicate (HTB-35, S-4).

The detected constituents may also be analyzed spatially. No COI were detected among the three borings (six samples) along the eastern perimeter of Drum Burial Area 1, nor in the two samples collected from HTB-28, the boring located along the southern perimeter. No COI were detected in HTB-32, the boring located just north of HTB-33. Only TCE was detected in Boring HTB-29, the southernmost of the borings along the western perimeter. In addition, only low levels of TCE and xylenes were found in Boring HTB-30, the more southerly of the two borings located in the center of Drum Burial Area 1.

The three remaining borings: HTB-34, HTB-35, and HTB-37 were shown to contain eight, four, and three COI, respectively. As seen on Figure 2-1, HTB-37 is located
northern perimeter, HTB-35 is northernmost of the borings along the western perimeter, and HTB-34 is the northernmost boring located in the center of the area. The northwestern area of the former drum burial area appears to have the most COI detected.

Of particular interest among the perimeter borings is a comparison of COI between the soil-bedrock interface samples and those samples collected midway through the soil profile. If it were found that substantially higher levels or a greater number of COI were detected at the soil-bedrock than within the soil profile, the soil-bedrock interface could be considered as a potential migration route. However, this was not found to be the case. In five of the eight perimeter borings, no COI were reported (except for low levels of methylene chloride and acetone, which are common laboratory induced contaminants). Of the remaining three perimeter borings, HTB-29 exhibited a higher level of TCE, the only COI detected in this boring, in the midpoint sample, whereas HTB-35 and HTB-37 showed higher COI levels in the interface sample. The analytical results of Boring HTB-35 were ambiguous due to the inconsistency of COI levels in the samples collected at the soil-bedrock interface.

In summary, significant concentrations of VOC do not appear to exist in subsurface soil or at the soil/bedrock interface beneath the former drum burial area. It is noted that the northwestern occurrence of COI coincides with the direction of shallow groundwater flow from former Drum Burial Area 1. As noted in Section 4.4, former Drum Burial Area 1 appears to have been a former source of VOC to shallow and deep groundwater. The remediation of the area appears to have successfully removed this source. Any VOC remaining in bedrock cracks may be a continuing source of COI in the groundwater.

### 4.1.7 Former Drum Burial Area 2

After the excavation of the drums from Drum Burial Area 2, Phase I soil samples were collected in May 1989. Soil samples were collected in each of four locations from a depth of four to six inches and from a depth of 12 to 18 inches. Depths were measured from the bottom of the excavation. In addition, two composite samples were collected. The sampling locations are shown on Figure 2-2. The Phase I analytical results,
4.2 SURFACE WATER

Three intermittent streams are located near the waste disposal areas at the site. These are identified as the East Stream, the Middle Stream, and the West Stream (Figure 2-8). Also, a pond is located near the West Stream. The West Stream meets the Middle Stream about 400 feet south-southwest of the Cornfield Area. The East Stream joins the Middle Stream at approximately 0.3 miles downstream. Analytical results for the surface water samples are presented in Table 4-11. For the purposes of this report, the Middle Stream is considered the primary stream flowing through the site. The East Stream and West Stream discharge into the Middle Stream as shown in Figure 1-3. Sampling locations below the confluence of the Middle Stream and the other streams are considered to be on the Middle Stream.

After review of previous investigations and the Phase I analytical data, the COI in surface water were determined to be antimony, cadmium, chromium, copper, lead, manganese, selenium, zinc, and TCL VOC. Each stream was sampled immediately upstream from the disposal areas, at various locations adjacent to the disposal areas, and at locations downstream from the site including locations upstream and downstream of the respective confluences (Figure 2-8). Each sample was analyzed for the COI listed above. The analytical results of the samples collected farthest upstream in each respective stream represent the background levels of the COI as the water enters the vicinity of that stream.

A background surface water sample (REF-1) from a reference stream was collected approximately 1.3 miles from the site (Figure 1-1). This sample was likewise analyzed for the COI and was used as a general background sample for comparison. The only COI detected in REF-1 were manganese (0.10 mg/l) and acetone (15 ug/l). Stream bioassay results for the surface water sample, HA-2, collected from the Middle Stream are included as Appendix H and summarized in Section 3.8.

4.2.1 East Stream

One Phase I surface water sample (SW-1) and five Phase II surface water samples were collected for chemical analyses from the East Stream. From upstream to downstream
these are: SW-6, SW-7, SW-10, SW-1, SW-14, and SW-26 (Figure 2-8). Based on location and topography, potential on-site sources of COI include runoff from the Lagoon Area, the Stressed Vegetation Area, the Cornfield Area, and the Borrow Area.

With respect to inorganics, SW-7 and SW-10 generally showed the highest concentrations. Aside from off-site SW-6, these two locations are the furthest upstream and may be in the vicinity of runoff from the Cornfield Area, the Lagoon, the Borrow Area, and the Stressed Vegetation Area. In general, concentrations of inorganic COI decrease downstream from SW-7 and SW-10.

Chromium was detected only in SW-10D and at a concentration of 0.02 mg/l. In its duplicate, SW-10, chromium was not detected. SW-7 and SW-10 were the only locations at which copper was detected. Copper was found in SW-7, SW-10, and SW-10D at concentrations of 0.04 mg/l, 0.02 mg/l and 0.04 mg/l, respectively.

Lead was detected in surface water entering the site (SW-6) at a level of 0.004 mg/l. The level of lead increased downstream in SW-7 (0.031 mg/l), SW-10 (0.036 mg/l), and SW-10D (0.077 mg/l). Detectable levels of lead were encountered in soil samples collected from the Lagoon Area, the Borrow Area, the Cornfield Area, and the Stressed Vegetation Area, all of which may drain into the East Stream in this vicinity. The next sample downstream, SW-14, contained a lead concentration of 0.003 mg/l. For comparison, the Phase I sample, SW-1, was located about 50 feet downstream of SW-10 and contained a lead level of 0.01 mg/l. Lead was not detected in samples collected downstream of SW-14.

Manganese was detected in every surface water sample collected from the East Stream. Although the concentrations of manganese in SW-7 (0.06 mg/l), SW-10 (0.11 mg/l) and SW-10D (0.24 mg/l) are higher than those found in the samples collected most immediately upstream (SW-6, 0.06 mg/l) and downstream (SW-14, 0.04 mg/l), the highest concentration of manganese was detected in SW-26 (0.52 mg/l). SW-27, the next downstream sample collected on the Middle Stream had a manganese concentration of 0.04 mg/l. Among sediment samples (Section 4.1.3), the lack of concentration pattern with regard to the upstream and downstream locations is likewise noted for manganese. The highest concentration of zinc was found in the upstream
Sample SW-6 (0.12 mg/l). With the minor exception of SW-26 (0.2 mg/l) and SW-14 (not detected), the level of zinc in the East Stream decreases from upstream to downstream. Zinc was not detected in SW-1, the Phase I sample collected in this stream.

The East Stream surface water samples were also analyzed for TCL VOC. The analytical results indicate that SW-6 (13 ug/l) and SW-7 (16 ug/l) contained acetone. However, it must be noted that acetone is recognized as a common laboratory induced contaminant and that in addition to the upstream surface water Sample SW-6, the off-site surface water sample from the reference stream, REF-1, also contained acetone (24 ug/l). As noted on Table 4-11, acetone was detected in several samples but not at levels substantially above the concentrations measured in the blanks. A common laboratory contaminant is considered to be "detected" if the level shown by the analytical results is greater than the level detected in the blank by a factor of 10. REF-1 serves as the reference matrix blank. Therefore, since acetone was not detected in any of the samples at a concentration of 240 ug/l and was also detected in the off-site reference stream sample, acetone is considered a laboratory induced contaminant.

Samples SW-7, SW-10, and SW-10D are the only Phase II East Stream samples in which organics have been detected. The following organic COI were detected in both SW-10 and its duplicate SW-10D: 1,1-DCA (25 ug/l and 29 ug/l); 1,1-DCE (5 ug/l and 6 ug/l); 1,2-DCEs (35 ug/l and 40 ug/l); 1,1,1-TCA (65 ug/l and 76 ug/l); and TCE (17 ug/l and 20 ug/l).

Two organic COI were detected in SW-7 and at higher concentrations than those found in SW-10 and SW-10D (TCE at 310 ug/l and 1,2-trans-DCE at 280 ug/l). TCE (24 ug/l), 1,1,1-TCA (8 ug/l), and 1,2-trans-DCE (24 ug/l) were detected in the Phase I sample, SW-1.

In summary, surface water from sampling locations, SW-7 and SW-10, was found to have COI above upstream background concentrations. Sample SW-7 was found to have detectable levels of copper; lead; 1,2-trans-DCE, and TCE. Detectable levels of these same four constituents as well as 1,1-DCA; 1,1-DCE; and 1,1,1-TCA, were reported in Samples SW-10 and SW-10D. Chromium was detected in SW-10D, but...
was not detected in its duplicate. No organics were detected in the next downstream sample, SW-14, or in any of the other downstream samples. Inorganics were not detected at levels above those of the upstream Sample SW-6 in SW-14 or other samples downstream (except manganese which was discussed previously). Therefore, it may be concluded that detectable levels of COI in the East Stream surface water samples are reported only for Samples SW-6 and SW-14.

The East Stream receives surface runoff from the Lagoon Area and the Borrow Area in the vicinity of SW-7. These are both regarded as potential sources of copper and lead at SW-7. Although trichloroethene was detected in the Borrow Area, it was found in only one sample and at too low of a concentration to be regarded as a source of trichloroethene at the levels detected in the East Stream samples. However, trichloroethene was detected in one of the surface soil samples collected from the Lagoon Area, Surface 1. 1,2-DCEs were likewise detected in Surface 1 from the Lagoon Area at detectable concentrations. Runoff from the Lagoon Area may be a potential source of the 1,2-trans-DCE in East Stream surface water.

In the vicinity of sampling location SW-10, the East Stream also receives runoff from the Stressed Vegetation Area. Although the Stressed Vegetation Area may be a potential source of copper and lead, no organics were detected in soil samples from the Stressed Vegetation Area.

Each of the organics detected in SW-10 and SW-10D was also found in Surface 1, a surface soil sample collected from the Lagoon Area. However, it is noted that according to the general topography, sampling location SW-7 is more likely to receive direct surface water runoff from the Lagoon Area than is SW-10. Only two of these five organics were detected in surface water Sample SW-7, higher concentrations than were detected in SW-10. Generally higher concentrations of organics would be expected in SW-7 than in SW-10 if surface water runoff from the Lagoon Area is indeed the source of COI. Natural variability may also account for these anomalies.

As mentioned in Section 3.6.2.1, the East Stream is in hydraulic connection with shallow groundwater, and is acting as a localized discharge point for groundwater associated with the Lagoon Area, the Borrow Area, and the Stressed Vegetation Area. Monitoring Wells HMW-3AL and HMW-5AS located near the East Stream contain

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detectable levels of VOC as discussed in Section 4.4. Therefore, seasonal shallow groundwater discharge to the East Stream, particularly from the Lagoon Area, may be contributing to VOC levels at SW-7 and SW-10.

4.2.2 Middle Stream

Six surface water samples were collected from the Middle Stream in Phase I and Phase II, upstream of its discharge to the West Stream. From upstream to downstream these are: SW-15, SW-16, SW-2, SW-17, SW-18, SW-19, and HA-2. Sample SW-2 was collected in Phase I at the same sample location as SW-17. Sample SW-20 was collected just downstream of the confluence with the West Stream. SW-27 was collected just downstream of the confluence of the three streams. HA-2 was also sampled as part of the stream bioassay program located 0.3 miles downstream of the confluence. Figure 2-8 shows the sampling locations.

Zinc (0.03 mg/l) was the only inorganic COI detected in the upstream sample (SW-15). The highest levels of four of the five inorganic COI detected in surface water samples from the Middle Stream were reported in SW-16 and SW-17.

Chromium was detected in three Middle Stream samples, SW-16, SW-17, and SW-19, at concentrations of 0.3, 0.01, and 0.2 mg/l, respectively. Copper was detected in the same three samples, at 0.02, 0.01, 0.01 mg/l, respectively. Lead was detected in SW-16 at 0.014 mg/l, in the next sample downstream, SW-17, at 0.007 mg/l and was not detected in the next sample downstream, SW-18. The only other Middle Stream sample in which lead was detected was SW-19 at 0.006 mg/l. Lead was not detected in the Phase I Sample SW-2 which was collected from approximately the same location as SW-17.

Manganese was detected in SW-19 at 0.19 mg/l. Surface water collected from SW-17 contained a manganese concentration of 0.27 mg/l. With each sample further downstream, the concentration of manganese decreases, with the exception of SW-25 (0.06 mg/l) and SW-27 (0.07 mg/l). Surface water from the sample location furthest downstream, HA-2, contained a manganese concentration of 0.04 mg/l. Sample SW-2 contained a manganese level of 0.08 mg/l.
Zinc was detected in SW-15 at 0.03 mg/l. It was also detected in the next downstream sample, SW-16, at 0.08 mg/l. Zinc was detected further downstream in SW-17 at 0.33 mg/l. SW-18 and SW-19 at a concentration of 0.06 and SW-20 at 0.03. Zinc was not detected in any of the samples downstream of SW-20. The Phase I sample, SW-2, collected near the SW-17 Phase II sample, was reported to have a zinc level of 0.08 mg/l; this was the highest concentration of zinc found among Phase I samples.

To summarize, the inorganics in the Middle Stream, levels of chromium, copper, lead, and zinc in Samples SW-16, SW-17, SW-18, and SW-19 exceeded those of upstream Sample SW-15. The concentrations of these inorganics are lower than those detected in surface water from the East Stream. Since none of the samples from SW-20 or further downstream exhibited levels of inorganics above background, it can be stated that levels of inorganics above background were detected only in SW-16 and SW-20. The Middle Stream may potentially receive surface water runoff from the Cornfield Area, where above soil background levels of copper and zinc were reported in soil samples. Although certain surface water samples from the Middle Stream had concentrations of inorganics exceeding those of the upstream Sample SW-15, these levels are not considered to be particularly high.

Two organic compounds, acetone and 1,1,1-TCA, were detected in Middle Stream surface water samples. As discussed previously, acetone is considered a common laboratory contaminant, and is not regarded as representative of the site conditions at the level measured.

The other organic detected, 1,1,1-TCA, was reported in two Middle Stream samples, SW-17 and SW-20, at concentrations of 7 ug/l and 8 ug/l, respectively. It is noted that even though surface water runoff from Drum Burial Area 2 and the Cornfield Area may reach this stream, 1,1,1-TCA was not found in soil samples from either of these former waste disposal areas. No organic compounds were detected in SW-2, collected during Phase I from the same location as SW-17.

As mentioned in Section 3.6.2.1, the Middle Stream is in hydraulic connection with shallow groundwater, and acts as a localized discharge point for groundwater associated...
with the Cornfield Area and Drum Burial Area 2. Seasonal discharge of shallow groundwater to the Middle Stream may be a potential source of 1,1,1-TCA. 1,1,1-TCA has been measured in Well HMW-6AS. Well HMW-6AS is located near the Middle Stream about half way between SW-17 and SW-20. It is noted that the two surface water samples closest to HMW-6AS did not contain 1,1,1-TCA.

4.2.3 West Stream

Four surface water samples were collected during Phase I and Phase II from the West Stream, upstream from the confluence with the Middle Stream. These include, with decreasing distance downstream, SW-21, SW-3, SW-23, and the furthest downstream location, SW-24. In addition, SW-22 was collected from the pond which is adjacent to SW-23. The pond is not connected surficially to the West Stream. Phase I sample SW-3 and Phase II sample SW-23 were collected at approximately the same location.

Sample SW-21 is upstream of the only former waste disposal area, Drum Burial Area 1. Two inorganics, manganese (2.61 mg/l) and zinc (0.02 mg/l), were detected in SW-21. This is the highest level of manganese detected among the West Stream samples.

Chromium (0.02 mg/l), copper (0.03 mg/l), and lead (0.004 mg/l) were detected only in SW-24. These inorganics were not detected in SW-23, located most immediately downstream of Drum Burial Area 1, nor in the sample collected from the adjacent pond, SW-22. Neither chromium, copper, nor lead were detected in Phase I Sample SW-3, collected from approximately the same location as SW-23. Given the close proximity to Hunterstown Road, it is probable that these three inorganics detected in SW-24 are either vehicle-related or originate from sources such as materials discarded along the road.

Manganese was detected in all samples collected from the West Stream, including those downstream of the confluence with the West Stream. Manganese was detected in the farthest upstream sample, SW-21 at a concentration of 2.61 mg/l, 0.42 mg/l in SW-23, and 0.11 mg/l in SW-24, the third and final stream sample collected above the Middle Stream confluence. Further downstream, manganese concentrations decrease with...
distance. The pond sample, SW-22, located adjacent to SW-23 was reported to have a manganese level (0.56 mg/l) similar to that of SW-23. Manganese was also the only inorganic COI detected in Phase I Samples SW-3 (0.11 mg/l) and SW-3D (0.10 mg/l).

Zinc was detected in SW-24, SW-20, SW-23, and as mentioned earlier, SW-21. The presence of the maximum concentration of zinc in SW-24 (0.06 mg/l) would indicate that Drum Burial Area 1 is not a source of zinc in surface water. This correlates with the fact that no inorganics were identified as COI in Drum Burial Area 1 soils. Given the locations of SW-24 and SW-20 with respect to Hunterstown and Shealer Roads, it is possible that the zinc found in these samples may be related to materials or activities associated with the road.

Two organic compounds were detected in West Stream Phase II samples, acetone and 1,1,1-TCA. Acetone was found in SW-21 (23 ug/l), the upstream sample, and also in SW-23 (23 ug/l), pond Sample SW-22 (22 ug/l), SW-24 (19 ug/l), and SW-20 (20 ug/l). However, since none of the samples had a concentration greater than the off-site reference stream, REF-1, by more than a factor of ten, the West Stream surface water acetone results are considered laboratory contaminants. Therefore, the only organic compound detected among the West Stream Phase II samples is 1,1,1-TCA, found in SW-20 at a concentration of 8 ug/l. It is noted that this sampling location is downstream from the confluence with the Middle Stream and that 1,1,1-TCA was also detected in a Middle Stream sample (SW-17) upstream from the confluence. 1,1,1-TCA was not detected in Drum Burial Area 1 soil samples (Section 4.1.6).

Four organic compounds were detected in the Phase I West Stream duplicate surface water Samples SW-3 and SW-3D. These include 1,1-DCA (11 ug/l; 11 ug/l), 1,2-trans-DCE (8 ug/l; 8 ug/l), methylene chloride (7 ug/l; 8 ug/l), and 1,1,1-TCA (37 ug/l; 38 ug/l). None of these were detected in Phase II Drum Burial Area 1 soil samples. (It is noted that methylene chloride was identified in the laboratory analysis of Drum Burial Area 1 Phase II soil samples but is a known laboratory induced contaminant and was subsequently identified as not detected).

As mentioned in Section 3.6.2.1, the West Stream does not appear to be hydraulically connected to shallow groundwater associated with Drum Burial Area 1.
4.2.4 Sanders' Septic Drainage

A surface water sample was collected of the surface drainage from the Sanders' septic area (Figure 2-8). The sample was analyzed for TCL VOC by USEPA method 524.2 and the CLP VOC methods. The following COI were detected:

- Acetone (55 ug/l),
- Toluene (15 ug/l),
- 1,2 Dichloropropane (0.7 ug/l), and
- 1,4 Dichlorobenzene (0.8 ug/l).

The associated trip blank contained the following COI:

- Acetone (14 ug/l),
- Toluene (2 ug/l),
- Methylene chloride (1.0 ug/l), and
- Xylenes (1.7 ug/l).

The acetone and toluene results are qualified as laboratory induced contamination. The toluene results of the sample were qualified due to the concentration of toluene detected in the method blank (3 ug/l). Also, the acetone results were qualified due to the concentration of acetone detected in the trip blank.

4.3 SEDIMENTS

Twenty-nine stream locations were sampled for sediment. Five locations were sampled in Phase I. From previous investigations and the Phase I analytical data, the following COI for sediments were identified: antimony, arsenic, cadmium, chromium, copper, lead, selenium, zinc, cyanide, TCL VOC, and BEHP.

Sediment was sampled from the East Stream, the Middle Stream, and the West Stream at various locations upgradient of the disposal areas and at locations downgradient from the site, including locations upstream and downstream of the two confluences. Also, sediment samples were collected from the pond adjacent to Drum Burial Area 1.
(SD-22), from downstream location HA-2, and from a reference stream located approximately 1.2 miles from the site (REF-1). At most of the locations, surface water samples were also collected concurrently. The identification numbers of the two sets of samples of the two media correspond (e.g., SD-18 and SW-18 were collected from the same location). The sediment sampling locations are likewise shown on Figure 2-8. A total of 26 Phase II sediment samples were collected and analyzed for the COI listed above. The analytical data are included as Appendix F and are summarized in Table 4-12.

The laboratory results of the sediment sample collected furthest upstream in each respective stream represents the background sediment COI concentration of each stream. Also, the off-site REF-1 sediment sample was used as a general background sample for comparison and served as the reference matrix blank.

4.3.1 East Stream

Eleven sediment samples were collected from the East Stream in Phase II. Beginning upstream, these are SD-6 through SD-14 and SD-26. Duplicates were taken at one location (SD-11 and SD-11D). Two sediment samples (SD-1 and SD-5) were collected in Phase I. Two other Phase II samples were collected downstream of the confluence with the Middle Stream. These are SD-27, sampled just below the confluence and HA-2, sampled approximately 0.3 miles downstream of the confluence.

Arsenic was detected in three of the Phase II samples collected from the East Stream, SD-8, SD-11D, and SD-14. Although arsenic was reported in SD-11D (10 mg/kg), it was not detected in its duplicate. Arsenic was detected in the off-site reference sample, REF-1 (11 mg/kg), as well. It was also detected in two Phase I East Stream sediment samples, SD-5 (6 mg/kg) and SD-1 (3 mg/kg). These Phase I sampling locations correspond to those of Phase II Samples SD-7 and SD-11, respectively.

Cadmium was reported in four East Stream sediment samples (SD-6, SD-10, SD-11, and SD-14) at concentrations at or below the quantitation limit (0.7 mg/kg).
Chromium, copper, lead, manganese, and zinc were detected in all of the East Stream sediment samples. Chromium was found at its highest concentration in SD-7 (994 mg/kg). Phase I Sample SD-5 was collected from this same location and had a concentration of only 50 mg/kg. The chromium concentrations of the next two downstream samples, SD-8 (50 mg/kg) and SD-9 (45 mg/kg), had similar concentrations as the upstream sample, SD-6 (39 mg/kg). Detectable levels of chromium were also observed in SD-10 (200 mg/kg), SD-11 (191 mg/kg), SD-11D (291 mg/kg), SD-12 (282 mg/kg), and SD-13 (168 mg/kg). SD-14 and the three samples further downstream exhibited chromium concentrations that are less than that of SD-6 (SD-25, 22 mg/kg; SD-26, 24 mg/kg; SD-27, 20 mg/kg). Above soil background chromium concentrations were noted in the two surface soil samples collected from the Lagoon Area (Section 4.1.3). The East Stream may receive surface runoff from the Lagoon Area in the vicinity of SD-7.

As in the case of chromium, copper was also detected at its greatest concentration in SD-7 (426 mg/kg). Detectable concentrations were also reported in SD-10 (259 mg/kg), SD-11 (326 mg/kg), SD-11D (373 mg/kg), SD-12 (307 mg/kg) and SD-13 (292 mg/kg). Much lower concentrations were detected in SD-8 (33 mg/kg) and SD-9 (52 mg/kg) than in SD-7. The copper concentration of samples downstream from SD-13 decrease considerably to approximate the copper concentration of the upstream sample, SD-6 (13 mg/kg). Above background levels of copper were reported in the Borrow, Lagoon, and Stressed Vegetation Area soils.

Similar to the spatial concentration trends of the two preceding inorganics, i.e., decreasing concentrations downstream, lead was detected at its highest concentration in SD-7 (4,300 mg/kg), 987 mg/kg in SD-10, at 999 mg/kg in SD-11, at 1,150 mg/kg in SD-11D, at 1,520 mg/kg in SD-12, at 341 mg/kg in SD-8, and 128 mg/kg in SD-9. It is also noted that Phase I Sample SD-5 contained a lower lead level (194 mg/kg) than did its corresponding Phase II sample, SD-7. Downstream from SD-12, the sediment samples decreased with respect to lead concentration; downstream Samples SD-26 (15.7 mg/kg), SD-27 (22.7 mg/kg) and HA-2 (18.8 mg/kg) exhibited lower lead levels than did upstream Sample SD-6 (60 mg/kg).
As mentioned, the maximum concentration of lead was detected in SD-7 (4,300 mg/kg). Soil lead levels of up to 5,020 mg/kg and 932 mg/kg were detected in soil samples from the Lagoon and Borrow Areas, respectively. The East Stream may potentially receive surface runoff from both of these former waste disposal areas in the vicinity of SD-7.

Unlike the observations made regarding concentrations of chromium, copper, and lead levels with respect to sampling location, no such pattern was evident for manganese concentrations in East Stream sediment samples. The maximum concentration of magnesium in the sediment samples was found in SD-27 (10,500 mg/kg), located just downstream from the confluence of the East Stream and the West Stream. It is noted that other East Stream, West Stream, nor Middle Stream sample were reported to have manganese concentrations much lower than that of SD-27. The next highest concentrations of manganese in East Stream sediment samples were detected in SD-14 (2,290 mg/kg) and upstream Sample SD-6 (1,440 mg/kg), respectively. It is unlikely that disposal activities have impacted the sediment samples with regard to manganese.

The occurrence of zinc in Phase II sediment samples from the various locations was similar to the occurrence of chromium, copper, and lead. Sample SD-7 (237 mg/kg) exhibited a zinc level above that of the upstream sample, SD-6 (94 mg/kg). Its corresponding Phase I sample had a similar level of zinc (269 mg/kg in SD-5). The next two samples downstream from SD-7, SD-8 (103 mg/kg) and SD-9 (85 mg/kg), had zinc concentrations similar to that of SD-6. Samples SD-10 through SD-14 had zinc concentrations higher than that of the upstream sample. SD-13 (409 mg/kg) and SD-14 (383 mg/kg) exhibited the highest zinc concentrations. The three samples downstream from SD-14 all had zinc levels equal to or less than that of SD-6. The source of zinc in the East Stream sediment may potentially be runoff from the Borrow, Lagoon, and Stressed Vegetation Areas.

Cyanide was also identified as an inorganic COI for sediments from Phase I analytical data. Cyanide was not detected in any Phase II samples, but was found at 0.1 mg/kg in Phase I Sample SD-1.
The organic constituents detected in the Phase II sediment samples are shown on Table 4-12. Acetone, a common laboratory contaminant, was reported in eight of the twelve East Stream sediment samples, with a maximum concentration of 88 ug/kg detected in SD-13. However, the analytical results show that the off-site sample used as a matrix blank, REF-1, had 14 ug/l of acetone. Since none of the sediment samples showed an acetone concentration that exceeded that of the matrix blank by more than a factor of ten (140 ug/kg), acetone was determined to be a laboratory induced contaminant.

Methylene chloride, also considered a common laboratory contaminant in many cases, was detected in only one East Stream Phase II sediment sample, SD-9, and at a concentration of 12 ug/kg. Methylene chloride was also detected in the method blank associated with this sample. Phase I Samples SD-1 and SD-5 were also observed to contain low levels of methylene chloride, but Phase II samples collected in approximately the same locations were not.

1,1-DCA was detected in SD-10 (12 ug/kg) and SD-11 (12 ug/kg). However, 1,1-DCA was not detected in the duplicate sample for SD-11, nor was it detected in SD-1, the Phase I sediment sample collected from the same location as SD-11.

1,2-DCEs (total) were found in four East Stream Phase II sediment samples (SD-7, SD-8, SD-10, and SD-11). The highest level was detected in SD-7 (130 ug/kg). 1,2-DCEs were also detected in SD-5, the Phase I sample collected from this same location (50 ug/kg). 1,1-DCE was detected in one of the Lagoon Area surface soil samples (see Section 4.1.3) at a concentration of 21,000 ug/kg. The East Stream may potentially receive runoff from the Lagoon Area in the vicinity of SD-7. It is also noted that trans-1,2-DCE was detected in the corresponding surface water sample, SW-7. The three other Phase II sediment samples in which 1,2-DCA was detected include SD-8 (20 ug/kg), SD-10 (15 ug/kg), and SD-11 (21 ug/kg). 1,2-DCEs were not detected in the duplicate of SD-11.

TCE was detected in two East Stream Phase II sediment samples, SD-7 (42 ug/kg) and SD-8 (18 ug/kg), and two Phase I sediment samples, SD-5 (81 ug/kg) and SD-1 (28 ug/kg). SD-5 is the Phase I sediment sample collected in approximately the same
location as the Phase II Sample SD-7. In the corresponding surface water sample, SW-7, TCE was detected at 310 ug/l. TCE was also detected in one of the surface soil samples in the Lagoon Area (330 mg/kg) (Section 4.1.3).

Vinyl chloride (96 ug/kg) and xylenes (29 ug/kg) were detected in SD-7, but in none of the other sediment samples, including those collected in the West Stream and Middle Stream. Both of these compounds were likewise detected in soil samples from the Lagoon Area. A soil sample from the Lagoon Area identified as Surface 1 reportedly contained 610 ug/kg vinyl chloride and 300 ug/kg xylenes. Runoff from the Lagoon Area may be a potential source of each of these constituents in East Stream sediments. Adsorption from shallow groundwater discharging to the East Stream may also be a source of VOC in East Stream sediments.

One semivolatile organic compound, BEHP, was identified as a COI in East Stream sediments from Phase I. It was detected in Sample SD-11D at a concentration of 2,900 ug/kg in Phase II. However, because BEHP was not detected in the duplicate of this sample (SD-11), and because it is recognized as a common laboratory induced contaminant, its presence in the East Stream is questionable. However, BEHP was detected in soil samples collected from the Borrow Area, which is regarded as a possible source of this compound.

Potential sources of the compounds detected in the East Stream sediment samples are surface runoff from the Lagoon, Stressed Vegetation Area, Borrow Area, and South Cornfield and seasonal discharge of shallow groundwater.

4.3.2 Middle Stream

Five sediment samples were collected from the Middle Stream in Phase II (SD-15, SD-16, SD-17, SD-18, and SD-19) and one sediment sample in Phase I (SD-2). These sediment samples include an upstream sample, SD-15, and Samples SD-16 through SD-19. SD-17 was collected from approximately the same location as Phase I Sample SD-2. In addition, Sample SD-20 was collected just downstream of the location where the West Stream flows into the Middle Stream, and SD-25 was collected just upstream
of the confluence with the East Stream. Two more samples collected along the Middle Stream are SD-27 and HA-2, both located downstream of the confluence with the East Stream.

Arsenic was detected in five of the Phase II sediment samples, including the sample collected upstream, SD-15 (2 mg/kg). The sample with the highest concentration, SD-27 (15 mg/kg), is located just downstream of the confluence with the East Stream. Other Phase II sediment samples in which arsenic was detected include SD-16 (6 mg/kg), SD-17 (6 mg/kg), and the sample collected just downstream of the confluence with the West Stream, SD-20 (7 mg/kg). In Phase I, Sample SD-2, collected from approximately the same location as SD-17, contained arsenic at 14 mg/kg.

Cadmium was detected in only one Middle Stream sediment sample, SD-17, at 0.68 mg/kg.

All of the sediment samples from the Middle Stream contained chromium and copper at concentrations slightly above detection limits. Upstream Sample SD-15 had a chromium concentration of 24 mg/kg. The maximum concentration detected in a Phase II sediment sample from the Middle Stream was only 35 mg/kg in SD-19. Sample SD-19 also contained the maximum level of copper (80 mg/kg) from Middle Stream samples. However, by comparison, six East Stream samples had concentrations of copper that were over three to five times greater than this level. The second highest copper concentration was 38 mg/kg, found in SD-17. The upstream sediment sample, SD-15, had a copper level of 23 mg/kg. The Phase I Sample SD-2 contained chromium and copper at 49 mg/kg and 55 mg/kg, respectively.

Lead was also detected at relatively low concentrations in Middle Stream sediment samples. Two samples, SD-17 (87.8 mg/kg) and SD-18 (92.2 mg/kg), had lead levels that slightly exceeded that of the upstream sample SD-15 (18.6 mg/kg). For comparison, five of the East Stream sediment samples contained lead concentrations ranging from 987 to 4,300 mg/kg. Lead was detected in the Phase I sediment Sample SD-2 at 96.4 mg/kg, nearly the same concentration as Sample SD-17 which was collected from approximately the same location in Phase II.
As was the case with manganese levels in the East Stream sediment samples, no apparent pattern exists for manganese concentrations in sediment samples from the Middle Stream. Sediment Sample SD-27 contained the maximum level of manganese at 10,500 mg/kg. The maximum concentration of manganese detected among the Phase II Middle Stream samples collected upstream of the confluence was found in the upstream Sample SD-15 (1,180 mg/kg). In the Phase I Sample SD-2, manganese was detected at 1,900 mg/kg; this is double that reported in SD-17 (925 mg/kg), the Phase II sediment sample collected in approximately the same location.

Selenium was detected in only one Middle Stream sediment sample, SD-19, at 1.1 mg/kg.

Zinc was detected in each of the sediment samples collected from the Middle Stream. The zinc concentration of the upstream sample, SD-15, was reported as 59 mg/kg. Only two of the samples, SD-17 (294 mg/kg) and SD-18 (323 mg/kg), had zinc levels greater than that of SD-15. These are in the same general range as those of the seven East Stream sediment samples exhibiting zinc levels exceeding background levels. Based on topography and location, the Middle Stream may potentially receive surface runoff from the Cornfield Area and Drum Burial Area 2. However, from the analytical data, neither the Cornfield Area soils nor Drum Burial Area 2 soils were reported to contain above background levels of zinc.

Cyanide was detected in two Phase II sediment samples at 0.2 mg/kg in both SD-17 and SD-18. It was also detected in SD-2 at 0.22 mg/kg during Phase I.

The two organic compounds reported in Phase II Middle Stream sediments are acetone and BEHP. The greatest concentration of acetone detected was in the two samples furthest downstream, SD-27 and HA-2, which were reported at 26 and 27 mg/kg, respectively. This was less than 140 mg/kg, ten times the level found in the matrix blank (REF-1). Therefore, the occurrence of acetone is considered non-representative of the actual environmental quality of the Middle Stream sediment.
BEHP was detected in Samples SD-16 (3,800 ug/kg), SD-17 (790 ug/kg), and SD-18 (910 ug/kg). Although BEHP is likewise regarded as a common laboratory induced contaminant, it was not detected in the matrix blank (REF-1). It is noted that BEHP was not detected in SD-2, the corresponding Phase I sediment sample collected at approximately the same location as SD-17. BEHP was not detected in any of the corresponding surface water samples from the Middle Stream, nor was it detected in any of the soil samples from Drum Burial Area 2 or the Cornfield Area.

4.3.3 West Stream

A total of five sediment samples were collected from three locations of the West Stream. These include Phase II Samples SD-21 (which was collected upstream of any of the waste disposal areas), SD-23, and SD-24. Phase I duplicates, SD-3 and SD-3D, were collected from approximately the same location as SD-23. In addition, one Phase I sample, SD-4, and two duplicate Phase II samples (SD-22 and SD-22D) were collected from the pond adjacent to the West Stream in the vicinity of SD-23.

Other sediment samples related to the from the West Stream include SD-20 and SD-25 which were collected downstream of the confluence with the Middle Stream, and SD-27 and HA-2 which are located downstream of the confluence with the East Stream.

Levels of arsenic detected in Phase II sediment samples were: SD-23 (8 mg/kg), SD-20 (7 mg/kg) and SD-27 (15 mg/kg), and 11 mg/kg in the off-site reference sample (REF-1). In Phase I, duplicate sediment samples SD-3 and SD-3D were collected from approximately the same location as SD-23, contained arsenic at 6 mg/kg and 4 mg/kg, respectively. Arsenic was also detected in SD-22D (6 mg/kg), but not its duplicate. Arsenic was detected in the pond Sample SD-4 at 3 mg/kg.

Cadmium was detected only in the Phase II upgradient sample for the West Stream, SD-21, at 0.52 mg/kg.
The maximum chromium concentration detected among the West Stream sediment samples was 40 mg/kg in SD-24. Chromium was found in SD-21 at a concentration of 22 mg/kg. The chromium concentration for Phase I sediment samples was similar to the levels detected in Phase II sediment samples.

Copper was detected in the upstream sediment Sample SD-21 at 13 mg/kg. Although the copper level of SD-20 (34 mg/kg), located downstream of the confluence with the Middle Stream, was more than that of SD-21, none of the other Phase II West Stream sediment samples exhibited a copper concentration exceeding 17 mg/kg. The Phase II sediment samples corresponded well with the Phase I samples with respect to copper concentration.

None of the sediment samples in the West Stream contained lead exceeding that of upstream SD-21 (16.2 mg/kg). SD-20 exhibited the maximum lead level (26.9 mg/kg). Among the Phase II West Stream samples upstream from the confluence with the Middle Stream, none exceeded a lead concentration of 21.5 mg/kg. These levels for lead in sediment were generally confirmed by Phase I sediment samples collected at approximately the same locations.

The occurrence of maximum concentrations of chromium, copper, and lead at SD-24 and SD-20 indicates possible influences of Shealer and Hunterstown Roads. Both locations receive surface runoff from the roads.

The concentration of manganese in sediment from the West Stream was similar to that of the other two streams, both in the range of manganese concentrations and the apparent lack of any pattern with respect to concentration and relative position upstream. As discussed previously, SD-27 was found to contain the maximum concentration of manganese detected at the entire site. Among the other sediment samples collected from the West Stream, the upstream sample, SD-21 (2,820 mg/kg), contained the maximum concentration of manganese. Also, similar to the other two streams, was the lack of conformity between Phase I and Phase II sediment concentrations of manganese. Although the concentration of manganese in the Phase I sample from the pond, SD-4 (375 mg/kg), was fairly similar to those of the Phase II duplicates SD-22 (518 mg/kg) and SD-22D (542 mg/kg) collected from the pond, the
manganese concentrations of the Phase I duplicates SD-3 (582 mg/kg) and SD-3D (323 mg/kg) did not approach the level of manganese detected in corresponding Phase II Sample SD-23 (2080 mg/kg). Therefore, it would appear that the inconsistency in manganese concentrations observed in all three streams is due to natural sources and natural variability in the deposition of sediments.

Zinc was detected in the upstream sample, SD-21, at a concentration of 81 mg/kg. None of the sediment samples collected from the West Stream varied significantly from the background level; the West Stream samples ranged in zinc concentration from 47 to 99 mg/kg. The zinc concentration of the Phase I sediment samples collected from the West Stream within the range of the Phase II samples.

In addition to the inorganic parameters already mentioned, cyanide was detected in West Stream sediment Samples SD-21 and SD-23 at concentrations of 0.2 and 0.17 mg/kg, respectively. The upstream sediment sample, SD-21, contained a higher concentration of cyanide than SD-23.

Two organic compounds, acetone and methylene chloride, were detected in Phase II sediment samples from the West Stream. As noted on Table 4-12, both of these organics are recognized as common laboratory contaminants. The highest levels of acetone were detected in SD-22 (43 ug/kg) and SD-22D (37 ug/kg). Acetone was also detected in the matrix blank, REF-1 (14 ug/kg). Since the level of acetone in these two samples (and in all other West Stream samples) is less than ten times the concentration of the matrix blank (140 ug/kg), then all West Stream samples are considered not detected with respect to acetone.

Methylene chloride was detected in two Phase II West Stream samples, SD-23 (45 ug/kg) and SD-24 (9 ug/kg). Although methylene chloride is known to be a common laboratory contaminant, since it was not detected in the matrix blank both of the detections are regarded as valid. In addition, SD-3 and SD-3D, collected from approximately the same location as SD-23, also contained methylene chloride at 10 ug/kg. Low levels of BEHP were detected in SD-3 and SD-3D, but not in Phase II Sample SD-23 collected at approximately the same location.
Based on the analytical results, none of the inorganics were found to be substantially elevated above background. The only organic detected in Phase II was methylene chloride and at rather low concentrations.

4.4 GROUNDWATER

Groundwater was sampled in both phases of the RI. Locations of the groundwater monitoring wells are shown on Figure 2-9. Phase I samples were analyzed for TAL inorganics and TCL volatiles and semivolatiles. Phase II samples were analyzed for barium, chromium, lead, mercury, TCL volatiles, and BEHP. The results are included in Appendix F, and are summarized in Table 4-13. Wells HMW-4AL and HMW-4BL are considered representative of upgradient conditions.

4.4.1 Phase I

In Phase I, the following six dissolved metals were detected at concentrations exceeding those in the upgradient wells: aluminum, calcium, magnesium, chromium, copper, and mercury. The aluminum concentrations in the upgradient Wells HMW-4AL and HMW-4BL were 0.4 and 0.1 mg/l, respectively. In all other wells but one, the maximum aluminum concentration was 0.8 mg/l. However, in HMW-9AW, aluminum was found at 6.8 mg/l. Calcium and magnesium concentrations were generally higher in Wells HMW-8BF (and the duplicate sample from that well), HMW-9BF, and HMW-10BE, indicating a slight increase in hardness in that area west of Hunterstown Road. Chromium was detected in only one well, HMW-1AL, at 0.14 mg/l. Copper was detected only twice, at 0.02 mg/l in both HMW-9AW and HMW-10AL. Similarly, the only detections of mercury were in HMW-2BL and HMW-3AL, both at 0.0002 mg/l.

Organic compounds detected in Phase I groundwater samples included chlorinated aliphatic hydrocarbons (methylene chloride, chloroethane, 1,2-DCA, 1,1,1-TCA, vinyl chloride, 1,1-DCE, 1,2-DCEs, TCE, and PCE), aromatic hydrocarbons (toluene, 2,4-dinitrotoluene, and 2,6-dinitrotoluene), and the semivolatile BEHP.
The maximum concentration of total chlorinated aliphatics in Phase I was found in Well HMW-3AL, where a total of 119,970 ug/l was detected, primarily due to TCE (96,000 ug/l) and 1,2-DCEs (18,000 ug/l). This sample also contained the only reported concentrations of aromatics, with 60 ug/l toluene and 80 ug/l of each of the dinitrotoluenes. Other shallow wells in the eastern portion of the site containing volatiles include HMW-5AS, HMW-2AS, and HMW-7AE. The sample from Monitoring Well HMW-5AS contained 200 ug/l total chlorinated aliphatics. The sample from Monitoring Well HMW-2AL contained 10 ug/l 1,1,1-TCA. The sample from Monitoring Well HMW-7AE contained 137 ug/l total chlorinated aliphatics. In the western portion of the site, Wells HMW-8AF and HMW-10AF did not contain organic compounds. However, HMW-9AW contained 258 ug/l of chlorinated aliphatics, primarily 1,1,1-TCA and TCE. This well also contained 70 ug/l of BEHP. Well HMW-9A is immediately downgradient of Drum Burial Area 1.

Deep monitoring wells containing volatiles in Phase I included HMW-2BL, HMW-7BL, HMW-5BL, HMW-6BL, HMW-3BL, and HMW-9BL. The sample from HMW-2BL contained 15,730 ug/l of chlorinated aliphatics, primarily TCE (14,000 ug/l) and 1,1,1-TCA (1,200 ug/l). Monitoring Well HMW-7BL, contained 1,007 ug/l of total chlorinated aliphatics (primarily 1,1,1-TCA and TCE). Wells HMW-5BL and HMW-6BL contained 337 and 252 ug/l of total VOC, respectively. HMW-3BL contained 139 ug/l of VOC, and HMW-9BF contained 1,383 ug/l of VOC.

4.4.2 Phase II

Based on the Phase I results, Phase II inorganic parameters for groundwater analysis included dissolved barium, chromium, lead, and mercury. These metals were not detected in Phase II in the upgradient wells. Barium was detected only once, at 0.2 mg/l, in HMW-14BS. This is equal to the concentration of barium in samples from HMW-4AL and HMW-4BL during Phase I. Chromium was detected in eleven samples during Phase II (HMW-14BS, HMW-7AE, HMW-7AED, HMW-9AW, HMW-12BE, HMW-12CL, HMW-13BL, HMW-16AW, HMW-16BF, HMW-17AW, and HMW-17BF). These occurrences are all at or below the current MCL of 0.05 mg/l for chromium. Lead was detected in two wells during Phase II, at 0.003 mg/l in HMW-5BL and 0.005 mg/l in HMW-14BS. These concentrations are both below the current
MCL of 0.05 mg/l for lead, and are at or below the proposed MCL of 0.005 mg/l. Based on these results, heavy metals are not considered to be seriously impacting groundwater quality at the site.

Organic compounds detected in Phase II groundwater samples included chlorinated aliphatic hydrocarbons (methylene chloride, chloroethane, 1,1-DCA, 1,2-DCA, 1,1,1-TCA, 1,1,2-TCA, vinyl chloride, 1,1-DCE, 1,2-DCEs, TCE, and PCE), aromatic hydrocarbons (xylenes), a ketone (acetone), and the semivolatile BEHP (Table 4-13).

The distribution of organic compounds in deep wells is best understood by grouping wells according to the locations where the units in which they are screened outcrop. Three main former sources of VOC in groundwater can thus be identified: Drum Burial Areas 1 and 2 and the Lagoon Area. Shallow wells containing VOC are all downgradient of these sources. These relationships are shown in plan on Figures 4-1 and 4-2 and in section on Figures 4-3A and 4-3B.

The highest concentrations of VOC were found in wells screened in the units which outcrop at the Lagoon Area, with up to 62,638 ug/l of total VOC in HMW-3AL, primarily TCE. Other Lagoon Area wells containing over 1,000 ug/l included HMW-2BL (23,214 ug/l), HMW-5CL (21,748 ug/l), and HMW-19CL (4,177 ug/l).

The downgradient extent of contamination in the Lagoon Area wells is well-defined, with no VOC detected in HMW-10CL. The furthest downgradient wells from the Lagoon Area contained 18 ug/l in HMW-13BL and 29 ug/l in HMW-11AL. These wells contained chlorinated aliphatics at levels only slightly above their MCLs; therefore, additional plume delineation in this direction is not considered warranted. However, the vertical extent of contamination below HMW-2BL has not been defined, as illustrated on Figures 4-3A and 4-3B. In addition, the presence of concentrations exceeding 1,000 ug/l in HMW-5CL and HMW-19CL indicates that some lateral spreading of the Lagoon Area plume has occurred.

Groundwater potentially affected by Drum Burial Area 1 contains VOC at up to 1,147 ug/l in HMW-9AW. HMW-20AW and HMW-20BF, the wells farthest downdip
of Drum Burial Area 1 (i.e., in the direction of groundwater flow or downgradient), contained 390 ug/l and 1,733 ug/l total VOC, respectively. Detectable concentrations of VOC might be expected further downgradient of these wells.

Of the three source areas, Drum Burial Area 2 impacts groundwater the least, at only 134 ug/l total chlorinated aliphatics, in Well HMW-7AE, with concentrations decreasing rapidly to 18 ug/l in HMW-12BE in the deep zone and to 12 ug/l in HMW-13AE in the shallow zone. Concentrations of individual compounds in the latter wells are below or only marginally above their MCLs, again indicating that additional investigations would not be warranted as part of the RI/FS activities.

The three areas of groundwater impacted by VOC can be compared on a constituent-by-constituent basis. The analytical data from the four most impacted wells downgradient of the Lagoon Area were examined. By far, the most prevalent compound in those wells was TCE. Over 90 percent of the total volatiles detected in HMW-2BL, HMW-5CL, and HMW-19CL was due to TCE. In HMW-3AL, TCE was responsible for over 75 percent of the total VOC detected. A substantially higher percentage of 1,2-DCE was detected in HMW-3AL, the most immediate downgradient well from the Lagoon Area than in the other three wells examined. Also, HMW-3AL was the only monitoring well in which vinyl chloride (2.2 percent of the total VOC) was detected.

The monitoring well most immediately downgradient from Drum Burial Area 1, HMW-9AW, and the monitoring well most immediately downgradient from Drum Burial Area 2, HMW-7AE, exhibit very similar combinations of VOC and their relative concentrations. The most prevalent VOC in these two wells is 1,1,1-TCA which comprises 50 percent of the total VOC in HMW-9AW and 58 percent in HMW-7AE. TCE, by far the most abundant VOC in the groundwater downgradient from the Lagoon Area, accounts for less than 20 percent of the total VOC detected in each of these two monitoring wells. 1,1,1-TCA, on the other hand, only accounts for less than 6 percent of the total VOC in each of the samples collected downgradient from the Lagoon Area. It is noted that in monitoring wells HMW-16AW, HMW-16BF, HMW-20AW and HMW-20BF located downgradient from Drum Burial Area 1, TCE is the most prevalent VOC (66, 55, 97 and 87 percent of total VOC,
respectively) and 1,1,1-TCA is found at a much lower proportion with respect to total VOC. As mentioned earlier, vinyl chloride was not detected in any groundwater samples downgradient from either of the drum burial areas. Based on these differences, it appears that the characteristics of the source materials were different between the Lagoon and the Drum Burial Areas.

Several compounds detected in Phase II groundwater samples are present in concentrations which exceed MCLs. The MCL for TCE was exceeded in the most wells over 5 ug/l in 22 wells, followed by 1,1-DCE (over 200 ug/l in 13 wells), 1,2-DCEs (exceeding 7 ug/l in 13 wells), 1,1,1-TCA (over 200 ug/l in 5 wells), and vinyl chloride (over 2 ug/l in 1 well).

The semivolatile organic compound BEHP was detected in five Phase II samples at up to 75 ug/l (HMW-14AS). However, its occurrence was sporadic, both spatially and temporally (compare Phase I and Phase II results for HMW-5BL and HMW-9AW). Because this compound is considered a common laboratory contaminant, its occurrence in groundwater samples is not considered representative of site conditions.

In comparing the on-site groundwater quality data with the off-site residential wells data presented in Table 1-6, there would appear to be a general agreement between the two data sets in spite of the different times of sampling and sometimes unknown depths and conditions of the residential wells. For example, samples from the residential wells on properties located upgradient of the identified source areas contained little or no VOC. More importantly, the occurrence of over 100 ug/l of VOC in samples from wells along Shealer Road west of Hunterstown Road would tend to confirm the previous observation that the extent of VOC from Drum Burial Area 1 is not yet defined.

4.4.3 Historical Groundwater Sampling Results

As mentioned in Section 1.5.4, trends in concentration of VOC for residential wells sampled prior to RI activities are difficult to discern due to differing dates on which samples were collected, and unknown or different well depths. Over five years has elapsed between the collection of residential well samples by USEPA and PADER and
the RI Phase II samples. However, the general pattern of VOC in groundwater as determined from monitoring well sampling events (Figures 4-2 and 4-3) was compared to a general pattern of certain residential well sampling results as presented on Figure 1-3. By comparing the sampling results for residential wells with the monitoring wells, the tentative findings are as follows:

- Residential Wells 5, 6, 7, 8, 9, 11, 12, 13, and 13A (Figure 1-3) did not contain reportable quantities of VOC, and apparently were beyond the northern limit of VOC in groundwater related to Drum Burial Area 2 and the Lagoon at the time of sample collection.

- Residential Wells 45 and 45A (Figure 1-3) are both reportedly 220 feet deep. These wells each reportedly contain TCE, TCA, and 1,1 DCE. The ratios of these compounds is similar to groundwater plume associated with the Lagoon.

- Residential Well 39E (Figure 1-3) reportedly contained VOC above method detection limits. The depth of this well is not known.

- Residential Wells 39, 39C, 39A, 39G, and 37 did not contain reportable quantities of VOC. Limited information exists on the depth of these wells. It is possible that these wells are primarily shallow wells communicating with groundwater above the plumes associated with Drum Burial Area 2 and the Lagoon Area (Figure 4-3).

- Residential Wells 34, 35, 36 and 44A contained reportable quantities of VOC, primarily TCA. Little information is available on the depths of these wells. The ratio of TCE to TCA in these wells suggest a potential source could be the former Lagoon Area if the well depths correspond with the location of the plume. A shallow monitoring well (HMW-15AW) was drilled between the above mentioned wells and Drum Burial Area 1 and did not contain reportable quantities of VOC.
Residential Well 46 (Figure 1-3) contained reportable quantities of VOC during sampling in 1984, primarily TCE. This well is located approximately 1,000 feet south of the former Lagoon Area, and does not correlate with the concentrations presented on Figure 4-1. The well is considered to be in an upgradient position with respect to the Hunterstown Road Site.

These findings are extremely tentative and less tentative findings may be possible if residential well depths were known.
5.0 FATE AND TRANSPORT

The data gathered during the RI provided information on the geotechnical, geological, and hydrogeological characteristics of the Hunterstown Road Site, identified the types of compounds present, and the spatial extent of their distribution. A brief outline of fate and transport mechanisms is discussed here. Exposure pathways are discussed in Section 6.0.

The primary COI described in Section 4.0 can be broken down into three groups: metals, VOC, and the semi-volatile organic compound BEHP. Potential transport mechanisms include advection, diffusion, dispersion, dilution, degradation, volatilization, adsorption, gravity and particulate transport, and are described as follows:

- Advection consists of the transport of a dissolved species by virtue of the flow of the solvent (in this case, water).

- Diffusion is a mechanism whereby solute distributions within water spread due to random molecular movements. The overall effect is that the solute moves from areas of higher concentrations to areas of lower concentrations.

- Dispersion is a spreading mechanism produced by random velocity variations in the movement of water. In surface water, these variations are produced by turbulence. In groundwater, such variations are produced by the movement of groundwater around localized regions of lower hydraulic conductivity.

- Dilution is the process whereby the mixing of two streams of water containing unequal concentrations of dissolved species produces a single stream with an average concentration. For example, a small discharge of groundwater containing high concentrations of a contaminant into an
uncontaminated stream with a relatively high flow would produce in the stream a low concentration of that contaminant.

- Degradation is the process whereby compounds undergo transformation or other biological chemical reactions which destroy them.

- Volatilization consists of the evaporation of certain of the lighter compounds from water and soil into the gaseous phase, which can be either the atmosphere or soil gas.

- Adsorption is the process whereby dissolved compounds in fluids in contact with solid media become attached to the surface of the solid. Adsorption is often reversible. In groundwater, equilibrium reversible adsorption is responsible for the phenomenon known as retardation.

- Particulate transport consists of the movement of adsorbed compounds by virtue of the movement of the particles to which they are attached. Examples include the movement of dust by wind and sediment transport by surface water. In addition, recent scientific research has been conducted regarding to the possibility of transport of colloidal particles by groundwater.

- Gravity flow is a possible flow mechanism where dense non-aqueous phase liquids exist in undissolved form. The liquids, being more dense than water will tend to flow vertically until a lower permeability zone is encountered. The fluid will then pool and flow to low spots along the surface of the lower permeability unit until a fracture or some other high permeability zone is encountered.

The applicability of these transport mechanisms to each of the groups of COI discussed in the following sections.
5.1 METALS

In general, metals tend to remain tightly bound to soil particles unless they encounter low pH conditions. Therefore, the primary transport mechanism is likely to be particulate transport. This can take the form of fugitive dust emissions or sediment transport. Because the site is largely vegetated, air transport by dust is not considered to be significant. However, the occurrence of the metals in sediments in the East Stream is probably due to erosion from the source areas, primarily the Stressed Vegetation, Borrow, and Lagoon Areas, and their occurrence downstream is due to the transport of sediments by the action of the water in the stream.

To the extent that low concentrations of metals have been detected in surface water, they will be affected by advection, dispersion, and dilution as the streams flow and merge. However, it is likely that contact with sediments downstream with the potential for cation exchange will cause the metals to become adsorbed.

Volatilization is not a significant transport mechanism for metals. Metals do not degrade, although their speciation can change, often as a result of exposure to oxygen.

Overall, the transport mechanisms for the metals at the site are comparatively slow. Metal distribution is not expected to change significantly prior to remediation.

5.2 VOLATILE ORGANIC COMPOUNDS

In comparison with metals, the VOC at the site will tend to be transported more quickly. Where they are exposed to the atmosphere, as in source areas and surface water, some volatilization will tend to occur. Once in the atmosphere, these compounds are quickly degraded via photolysis and photo-oxidation. In the absence of other processes, volatilization would be detected as a gradual decline in concentrations. However, this process can not be distinguished from other attenuation factors.

In the case of solvents which are in the Dense Non-aqueous phase Liquids (DNAPLs) state, the primary transport mechanism is quantity flow. The DNAPL will tend to flow...
vertically until it reaches a lower permeability unit. Depending on the degree of saturation, DNAPLs may exist as relatively immobile globules and rivlettes which have sorbed onto the host medium or are held in place by surface tension.

In the saturated zone the DNAPL will flow until there is insufficient fluid to overcome surface tension. At that point the fluid will become immobile and will begin the slow process of dissolving into the groundwater.

The primary transport mechanism for dissolved VOC is advection via groundwater. VOC in shallow groundwater will be transported west to southwest, in the direction of the hydraulic gradient measured at the site. Some shallow groundwater may discharge to streams, from which the VOC will then volatilize. Shallow groundwater also recharges the deep groundwater flow system. In the deep flow system, the combination of a downward hydraulic gradient and anisotropic hydraulic conductivity causes groundwater to follow the bedding planes of the rock, flowing primarily northwest and downward at an approximate angle of 26 degrees from the horizontal with some directional component along strike to the southwest. Ultimately, this groundwater is believed to discharge as baseflow to Rock Creek, located approximately one mile southwest of the Hunterstown Road Site. The section of Rock Creek to which groundwater discharges is located North and East of the town of Gettysburg. Residential wells located between the Hunterstown Road Site and Rock Creek which could intercept this groundwater have either been sampled in the past, or are currently being evaluated for sampling.

At the Hunterstown Road Site, dispersion is expected to be a significant transport mechanism for VOC because the mean free path of groundwater velocity variations will be quite large as water is forced to move in fractures around large blocks of essentially impermeable rock. The effect of this dispersion is to reduce maximum concentrations of VOC and increase their lateral and vertical extent as groundwater moves away from the source areas.
VOC will adsorb to soil particles and sediments, although with differing equilibrium partitioning and degrees of reversibility for different compounds. Adsorption to rock surfaces can also occur, although its importance is difficult to calculate. The net effect of this adsorption and its counterpart, de-adsorption, is to retard the effective rate of both advection and dispersion.

Degradation of the chlorinated aliphatic hydrocarbons is expected to be significant in site groundwater. Under anaerobic conditions, microbes can slowly dechlorinate these compounds (Cline and Viste, 1984), producing dichloroethenes and vinyl chloride from TCE and dichloroethanes, and chloroethane from trichloroethanes (TCAs). This mechanism may be the method that some of the lesser-chlorinated compounds were detected in groundwater at the site, although they could also have been in the original waste. Vinyl chloride was detected in groundwater samples collected from the nearest downgradient well (HMW-3AL) at the Lagoon Area. No other monitoring well samples contained vinyl chloride above method detection limits. Cline and Viste (1984) also reported that field studies have shown that the presence of the degradation products relative to the parent compounds (i.e., TCAs and TCE) increases as distance increases downgradient from the source.

5.3 BEHP

The general pattern of transport for phthalates appears to be adsorption onto solids. Because of this attraction to solid materials, infiltration into the groundwater is unlikely. Phthalates are also relatively insoluble in water and have very low vapor pressure. This characteristic results in low volatilization rates.

In summary, BEHP has significantly lower vapor pressures, lower water solubilities, and a greater soil/sediment adsorption coefficient than VOC. These characteristics make BEHP much less susceptible to transport in the hydrologic cycle than migration via surface water convection of soil particles.