**Chem-Solv, Inc. Site**
Cheswold, Kent County, Delaware

# Remedial Investigation Report

## Volume 1

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BCM
Engineers, Planners, Scientists
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REPORT

# DRAFT REMEDIAL INVESTIGATION REPORT

FOR

CHEM-SOLV, INC. SITE
CHESWOLD, KENT COUNTY, DELAWARE

SUBMITTED TO

DELAWARE DEPARTMENT OF NATURAL RESOURCES AND ENVIRONMENTAL CONTROL

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY REGION III

JULY 1990

BCM PROJECT NO. 00-6012-02

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# 1.0 INTRODUCTION

## 1.1 SITE BACKGROUND

### 1.1.1 Site Description

The Chem-Solv, Inc. (Chem-Solv) site is located in Cheswold, Kent County, Delaware, approximately 3 miles north of Dover on the west side of U.S. Route 13 (DuPont Highway) just south of Delaware Route 42 (Figure 1-1). The Chem-Solv facility occupied the southern third of a 1.5-acre property and consisted of a one-story concrete block building, a distillation process building, and a concrete pad (Figure 1-2). A concrete-paved skateboard park was formerly located adjacent to the office building, but was partially dismantled in 1988. A two-story wood frame apartment building, a storage barn, and a wood shed occupy the northern two thirds of the property. In the past, a mobile home had been located in the northwestern corner of the property.

Surrounding land use is agricultural, residential, and commercial. Strip development, consisting of commercial establishments and private residences, is found on both sides of Route 13 in the immediate vicinity of the site. A truck stop/gasoline station previously operated immediately north of the property, adjacent to Route 13.

The Chem-Solv site is located in an area zoned for agricultural, light commercial, and residential land use.

### 1.1.2 Site History

The Chem-Solv facility was in operation from 1982 to 1984. At the facility, spent industrial solvents were distilled and purified. The recovered product was then returned to the original generator for reuse. The residues generated during the distillation process, referred to as "still bottoms," were collected in 55-gallon drums. These drums were stored on the concrete pad awaiting disposal as hazardous waste. Chem-Solv was, therefore, classified as a hazardous waste generator, transporter, and storage facility that had a Resource Conservation and Recovery Act (RCRA) interim status.

On September 7, 1984, an explosion and fire occurred at the facility. The State of Delaware Department of Natural Resources and Environmental Control (DNREC) was notified of the incident and immediately initiated a site investigation to determine the nature and extent of potential soil and groundwater contamination. A memorandum dated September 18, 1984, was generated by DNREC outlining initial investigatory activities (Appendix A-1). The memo stated that a firefighter at the fire scene had

"...observed a chemical-like material running off the concrete pad towards the ground." Subsequent visual inspections by DNREC personnel indicated contaminated soil adjacent to the location of the fire. Indeed, DNREC-conducted vapor monitoring at the site and chemical analysis of the soil confirmed the existence of volatile organic compound (VOC) contamination of the soil.

During more detailed analysis of the waste and material handling practices at Chem-Solv, DNREC concluded that the facility had other violations of Delaware's Regulations Governing Hazardous Waste. DNREC, consequently, issued a Cessation of Operation Order (Order) to Chem-Solv dated *September 21, 1984 (Appendix A-2). The Order outlined* DNREC's belief that spillage of hazardous wastes onto the ground had occurred during the fire on September 7, 1984, and prior to the incident. DNREC ordered Chem-Solv to halt all hazardous waste handling operations with the exception of those associated with cleanup of the site. In addition, the Order required Chem-Solv to remove contaminated soil from the site as well as to initiate a groundwater monitoring program. The subsequent sections summarize the investigation undertaken by DNREC to characterize the extent and nature of soil and groundwater contamination associated with the Chem-Solv facility. Included with this discussion is a description of actions undertaken by DNREC in an attempt to remediate contaminated soil and groundwater at the site.

## 1.2 PREVIOUS INVESTIGATION

### 1.2.1 Source/Soil Investigation

As stated in the memo referenced in the previous section, DNREC conducted a limited soils investigation immediately following the September 7, 1984, fire and explosion at the Chem-Solv facility. Subsequently, the owners of Chem-Solv excavated approximately 10 cubic yards (cy) of contaminated soil and placed this soil into 30 55-gallon drums. Although the DNREC soil investigation primarily consisted of vapor monitoring using a portable photoionization device, one soil sample was apparently obtained from a depth of 7 feet below ground surface. This sample was transported to a laboratory for VOC analysis, but the results of this analysis are unknown. It is believed that this soil sample allowed DNREC to conclude that the VOC contamination primarily consisted of trichloroethene (TCE); 1,1,1-trichloroethene; 1,2-dichloroethane; 1-chloroethelene; ethylbenzene; and toluene. Table 1-1 summarizes all Pre-RI soil investigation and cleanup activities.

During April 1985, a large portion of the drum storage pad was removed and 1,300 cy of contaminated soil were excavated by DNREC. The soil was removed to the depth of the local water table and was staged onsite for later remediation/disposal. Later that month, DNREC contracted with SMC Martin Inc. (SMC Martin), an environmental consultant, to evaluate remedial alternatives for onsite treatment of the excavated soil.

SMC Martin conducted two initial rounds of soil sampling on May 1, 1985, and May 10, 1985. The sampling scheme was designed in order to determine:

1. Whether any contaminated soil remained in the sidewalls or floor of the excavation

2. The range of concentrations of contaminants in the soil stockpile for the evaluation of viable remedial alternatives

3. Whether any compounds other than VOCs had contaminated the soils

A total of 15 samples were collected during this sampling effort:

1. Six samples from the sidewalls of the pit
2. three samples from the floor of the pit
3. five samples from the stockpiled soil
4. one sample from the drainage way

The results of these sampling events are discussed in Section 4.2.1. Apparently, SMC Martin utilized the results from the May 1985 sampling to conclude that soil shredding/aeration was the appropriate alternative for remediation of the soil and issued "Evaluation of Remedial Alternatives for Soil and Groundwater Cleanup at the Chem-Solv Solvent Recovery Facility, Cheswold, Delaware," on May 18, 1985.

On August 16, 1985, an additional 37 soil samples were collected for the purpose of:

1. Determining baseline concentrations of VOCs in the soil

2. Identifying the presence of compounds untreatable by soil shredding/aeration

Thirteen of these samples were taken from the in-place soil surrounding the soil stockpile. The other 24 samples were collected directly from the stockpile. The results of this round of sampling are also contained in Section 4.2.1.

The soil shredding process began on September 9, 1985, and continued until November 7, 1985. The stockpiled soils were repeatedly passed through the soil shredder equipment. Samples of the soil were taken before and after shredding and were analyzed for VOC concentration, moisture content, grain size, and pH. When analytical results indicated "acceptable levels" of VOCs in the soil after shredding, the soil was placed into the excavated pit and compacted. Otherwise, the soil was returned to the shredder for another pass. Confirmatory soil sampling was completed on November 11, 1985.

SMC Martin then published the findings of the soil shredding operation in the report entitled "Removal of Volatile Organic Contaminants from Soils at the Chem-Solv Solvent Recovery Facility, Cheswold, Delaware," on May 20, 1986. The report concluded that the soil shredding process employed at the site had been successful in removing VOC contamination from granular soils.

### 1.2.2 Hydrogeologic Investigation

DNREC also conducted an extensive investigation into groundwater contamination associated with the Chem-Solv facility. Between September 1984 and June 1986, 43 monitoring and 7 recovery wells were installed either on or around the site. Samples of groundwater from these and domestic wells in the vicinity of Chem-Solv were collected and analyzed for organic priority pollutants, primarily VOCs, up until November 1988. A discussion of all historical groundwater monitoring data is contained in Section 4.3.1.

Information gathered during this investigation allowed DNREC to assess the general hydrogeologic conditions underlying the site and to delineate the plume of VOC-contaminated groundwater. An attempt was made to capture the plume by pumping and treating the contaminated groundwater by air stripping. Groundwater reclamation was conducted from December 1985 to September 1988.

Given the amount of data collected by DNREC and the prolific amount of activity that had occurred during the hydrogeologic investigation, Table 1-2 was developed in order to summarize this information. Several sources were available as a means to this end, but these sources were not always consistent. For the most part, the Sample Data Summary Target Compound sheets provided by DNREC (Appendix B) were utilized for groundwater sampling events. These DNREC data sheets were compared to the Water Quality Data Sheets contained as Attachment J in "Groundwater Decontamination, Chem-Solv Solvent Recovery Facility, Cheswold, Delaware," prepared by CABE Associates Inc. (CABE) in March 1987 (Appendix C). In general, the DNREC data sheets and those contained in the CABE report correlated, but exceptions are noted on the table at the end of the appropriate entry (see September 12, 1985; February 19, 1986; and May 13, 1986). Likewise, well installation dates were obtained from the limited number of well drilling logs contained as Attachment A in the CABE report. For wells which had no existing logs, the installation dates were obtained from Exhibits I-9 and I-10 in the CABE report. Without the logs, however, it was impossible to double check the dates on Exhibits I-9 and I-10 for typographical errors, mistranslations, etc.

Other sources included the May 20, 1986, SMC Martin report and the "Draft Work Plan for Remedial Investigation/Feasibility Study, Chem-Solv Inc. Site, Cheswold, Kent County, Delaware," issued by BCM Engineers, Inc. (BCM) in October 1989. Similar to the well installation dates, several dates of events as referenced in either of these reports could not be confirmed by cross checking field logs, field data sheets, etc. In these instances, the document from which the event and date were obtained is referenced at the end of the appropriate entry. Verbal communication with DNREC to confirm dates was utilized when possible.

In September 1984, DNREC installed five observation wells (OB-1A through OB-5A) at the site to monitor the shallow water table aquifer above an identified low-permeability horizon (Figure 1-2). Well OB-1A was installed immediately adjacent to the site of the September 1984 incident. Wells OB-2A through OB-5A were installed around the perimeter of the site. During that same month, DNREC also sampled domestic wells in the vicinity of the Chem-Solv facility, but found no contaminants (SMC Martin, 1986).

DNREC took the first round of groundwater samples from the monitoring wells OB-1A through OB-5A on October 3, 1984. Analytical results of this sampling event verified VOC contamination of the shallow aquifer, with TCE being the most prevalent compound. DNREC also measured groundwater table elevations twice in October 1984. These data indicated a northeasterly hydraulic gradient.

During November 1984, DNREC installed seven more monitoring wells (OB-6B, OB-7A and -B, OB-8A and -B, and OB-9A and -B), screened both above and below the shallow confining layer and established a consistent well identification system. All monitoring wells screened above the shallow confining bed were denoted with the letter "A" (e.g., OB-1A) and all monitoring wells screened below the shallow confining bed in the intermediate zone of the water table aquifer were denoted with the letter "B" (e.g., OB-7B).

Groundwater from onsite monitoring wells and offsite domestic wells was sampled on December 5 and 6, 1984, January 29, 1985, and April 22, 1985. One of the original five wells, OB-1A, had to be removed during the excavation of 1,300 cy of contaminated soil.

In April 1985, DNREC retained SMC Martin to evaluate alternatives for groundwater and soil remediation at the site. As part of the assessment of groundwater cleanup alternatives, SMC Martin conducted a hydrogeologic investigation at the site (CABE, 1987) and issued a report entitled "Evaluation of Remedial Alternatives for Soil and Groundwater Cleanup at the Chem-Solv Recovery Site, Cheswold, Delaware," on May 18, 1985. This SMC Martin report was not available to BCM at the time the RI report was being written, but it is assumed that the results of SMC Martin's hydrogeologic assessment are contained in this report.

Based on SMC Martin's findings, DNREC agreed that groundwater recovery by pumping and treatment of the recovered groundwater by air stripping was to occur at the facility. CABE Associates Inc. was retained on August 5, 1985, to design and implement the recovery and treatment system. From August to October 1985, 23 monitoring wells, five recovery wells, and one replacement domestic well were installed in and around the site. Likewise, numerous groundwater samples were collected from monitoring, recovery, or domestic wells and two pump tests were conducted to further facilitate design of the recovery and treatment system.

On November 26, 1985, untreated and treated water was collected from the recovery and treatment system during a test run of the equipment. By December 11, 1985, the system was fully operational, after some minor mechanical problems earlier in December. The first round of sampling for treatment efficiency monitoring was conducted on January 2, 1986, with continued sampling occurring at least every other month in 1986. In addition, groundwater sampling from monitoring and domestic wells continued into November 1986 to assess the system's effectiveness in capturing the plume of contaminated groundwater.

On June 9 and 10, 1986, two additional recovery wells were installed. One of these wells (OB-43AR) was later added to the recovery system. The other well, OB-44AR, was not used for recovery, but was utilized as a monitoring well, called OB-44A. Later in June, a monitoring well (OB-45B) was installed in the intermediate aquifer. This well's ability to yield water was tested on June 18, 1986, during a pump test.

A point-of-use carbon treatment system was installed at a nearby home that had a contaminated well sometime before July 14, 1986. Unfortunately, the exact date of this installation could not be confirmed, but DNREC sampled the water both before and after treatment on this date. Based on verbal communication with DNREC, the contaminated well had apparently been installed by DNREC as a replacement of the property's original well. This replacement well was installed to a depth of 50 feet on September 11, 1985, but subsequent sampling of this 50-foot well indicated unacceptable levels of VOCs. It is believed that the contaminated 50-foot well was later replaced with a deeper well installed by DNREC in May 1987. This well was apparently free from contamination, although no raw data was available to confirm this.

Apparently, no groundwater or treatment system monitoring sampling occurred during the first half of 1987. From June 8 through 16, 1987, however, groundwater was again sampled from 17 monitoring and nine domestic wells. No other groundwater sampling occurred until December 22, 1987, with the exception of untreated water from the recovery system and two domestic wells. Thereafter, monitoring and domestic wells and recovery system untreated groundwater were sampled quite frequently in 1988.

In September 1988, the air stripping tower collapsed, at which time recovered groundwater was no longer discharged to the air stripping unit. DNREC, however, continued to discharge recovered groundwater to the Kent County sewer system until November 1988. No groundwater pumping or treating, at that scale, has occurred at the site since then.

## 1.3 REMEDIAL INVESTIGATION SUMMARY

In September 1988, an Administrative Consent Order (ACO) was signed by the United States Environmental Protection Agency (EPA), DNREC, and several of the Chem-Solv Principle Responsible Parties (PRPs). The ACO consisted primarily of an agreement to perform a Remedial Investigation/ Feasibility Study (RI/FS) in accordance with the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) as amended by the Superfund Amendments Reauthorization Act (SARA). The Chem-Solv site was proposed to be included on the National Priority List (NPL). DNREC is the Lead Agency for the site.

Table 1-3 contains a summary of regulatory activities occuring up until the present. The Chem-Solv PRP Committee retained BCM to carry out the requirements of the RI/FS. A Draft Work Plan for the RI was prepared in December 1988 as revised July 1989 and October 1989. The Work Plan was approved by DNREC on December 1, 1989, and was implemented between December 4, 1989, and March 12, 1990. This report is a discussion of the findings of the Remedial Investigation.

The implementation scheme of the RI was divided into nine separate tasks as follows:

- Task 1: Project Planning
- Task 2: Air Investigation
- Task 3: Soils Investigation
- Task 4: Stratigraphic Investigation
- Task 5: Groundwater Investigation
- Task 6: Data Evaluation
- Task 7: Endangerment Assessment
- Task 8: Treatability Study Pilot Testing
- Task 9: Remedial Investigation Report

The subsequent nine sections summarize the activities conducted to complete each of the nine tasks.

### 1.3.1 Project Planning

The purpose of this task was to prepare various documents and plans prior to initiation of field work. Activities conducted as part of this task were:

- Initial site reconnaissance
- Preparation of specifications and selection of subcontractors (i.e., driller and surveyor)
- Arranging for site access
- Review of agency files
- Surveying of site and preparation of a topographic base map at a scale of 1 inch = 100 feet with a 2-foot contour interval
- Coordinating with DNREC prior to the initiation of any sampling and laboratory analysis

### 1.3.2 Air Investigation

The air investigation was conducted onsite prior to initiating sampling or intrusive exploration. The purpose of this task was to evaluate the health and safety needs at the site and, as part of the site Endangerment Assessment (Task 7), to estimate onsite and offsite exposure. Breathing zone monitoring was conducted using an HNu or OVA at 12 onsite locations. Two of the sampling locations were in the former spill area.

### 1.3.3 Soils Investigation

Seven test borings (CSB-6 to CSB-12) were completed onsite to identify the horizontal and vertical extent of subsurface soil contamination. Three soil samples were obtained from each boring and analyzed for all Target Compound List (TCL) and Target Analyte List (TAL) fractions in order to identify the suite of contaminants present in the site soils. The borings were advanced until the confining silt layer which separates the shallow and intermediate zones of the water table aquifer was encountered, or 35 feet below grade, whichever was first. The sampling intervals included the 0.5 to 2.0-foot interval, the 2-foot interval immediately above the water table, and the 2-foot interval encountered immediately above the silt layer.

The borings were located in areas of the site where hazardous material had been either stored or was suspected of having been spilled. These areas included the former distillation building, shredded soil excavation, and former contaminated soil stockpile areas. In addition, two soil borings were located immediately adjacent to the former concrete-paved area in order to investigate the presence/absence of contamination which may have resulted from runoff from the pad. The boring locations were surveyed for both horizontal and vertical control. More details of the soil boring program are contained in Section 4.2.2.

### 1.3.4 Stratigraphic Investigation

Five test borings (CSB-1 to CSB-5) were completed offsite to the bottom of the silt/clay confining layer to depths ranging from 26 to 43 feet. The locations were selected to fill in data gaps regarding the presence/absence of the confining layer onsite and hydraulically downgradient of the site. Shelby tube samples were obtained from two of these test borings.

### 1.3.5 Groundwater Investigation

Seven groundwater monitoring wells were installed as part of this investigation. These wells were identified by "MWS" or "MWI" representing whether the well was finished within the shallow aquifer zone or the intermediate aquifer zone, respectively. Groundwater samples were obtained from these wells, and from seven existing wells. Analytical data from the groundwater sampling was evaluated in order to determine the horizontal and vertical extent of groundwater contamination in both the shallow and intermediate zones of the water table aquifer (see Section 4.3.1). All groundwater samples were analyzed for all TCL/TAL parameters.

#### Shallow Zone Wells

The locations of the shallow and intermediate-zone monitoring wells are discussed in Section 2.4.1.1. Wells completed in the shallow-zone aquifer were located in an effort to delineate the extent of shallow groundwater contamination downgradient (north-northeast) of the site.

#### Intermediate Zone Wells

In addition to determining the extent of shallow contamination, the distribution of contamination in the intermediate zone was assessed via installation of three intermediate-zone monitoring wells. One of these wells was used to evaluate the quality of groundwater in the intermediate-zone upgradient of the site. The remaining two intermediate-zone wells were located in order to determine the extent of contamination, downgradient of the Chem-Solv facility.

#### Well Survey

All the newly installed monitoring wells were surveyed to horizontally and vertically locate the wells to a known datum. Horizontal control for each of the newly installed monitoring wells was obtained to the nearest 0.1 foot. Vertical control was obtained to the nearest 0.01 foot. All surveying was performed by a Delaware-licensed professional land surveyor. The survey for the newly installed wells was tied into the same coordinate system used for the existing monitoring well locations.

Well Development

The monitoring wells were developed after installation to remove fines from around the well screen. The wells were developed by overpumping. Development and purge water was discharged directly to the ground since organic vapor levels as measured with an HNu did not exceed 20 units above background.

Groundwater Sampling

The newly installed wells were allowed to equilibrate for a 2-week period following installation prior to collection of groundwater samples. The groundwater samples were obtained using the protocols described in Section 4.3.2 of the QAPjP. A sample was collected from each of the seven new monitoring wells. Each sample was analyzed for all TCL/TAL parameters. Samples were also taken from existing shallow zone wells 22A, 26A, 33A, 39A, and 41A. Analytical data generated from the newly installed shallow zone wells and existing shallow zone wells 26A, 33A, 39A, and 41A were used to characterize the magnitude and extent of the contaminated groundwater which exists downgradient of the site in the shallow zone.

Existing intermediate zone wells 5B and 9B were also sampled as part of this investigation. Data generated from the three newly-installed and two existing intermediate zone wells were used to evaluate the magnitude and extent of contamination, if any, in the intermediate zone. Analytical data generated from existing shallow zone well 22A and the newly installed intermediate zone well (MWI-1-43) in the vicinity of well 22A were used to evaluate the quality of groundwater in each zone entering the site from the hydraulically upgradient direction. Analytical data generated from the recovery system sampling were used to evaluate the magnitude of contamination remaining onsite in the shallow zone.

Water Level Measurements

Two rounds of water level data were collected from all accessible existing monitoring wells to determine the hydraulic head distribution in the shallow and intermediate aquifer zones. All measurements were taken to the nearest 0.01 foot using an electric water level indicator. The top of the well casing was used as a reference point. Piezometric surface contour maps were constructed from these measurements for the intermediate and shallow zones. The horizontal hydraulic gradient, magnitude, and direction were determined for both the shallow and intermediate zones. In addition, the vertical hydraulic gradient, magnitude, and direction between the shallow and intermediate zones were determined at each well couplet location.

### 1.3.6 Data Evaluation

The objectives of this task were to organize the validated data as detailed in the QAPjP into a working format for analysis and to perform the necessary evaluations and interpretations to meet the overall project objectives. Task 6, therefore, had two distinct components: data reduction and data evaluation. Following are brief descriptions of each component.

#### 1.3.6.1 Data Reduction

Data obtained from the various field investigations were condensed and organized to facilitate evaluation and presentation. Reduction of hydrogeologic data resulted in the production of various tables, figures, and drawings which describe and summarize the pertinent site features. These include:

- Figures displaying boring and monitoring well locations and elevations
- Hydrogeologic cross sections
- Groundwater contour maps
- Boring log descriptions
- Monitoring well as-built construction diagrams

Appropriate tables, maps, and figures were produced to summarize the occurrence and distribution of contaminants at the site and adjacent environs. These are referenced in Section 4.0.

#### 1.3.6.2 Data Review

BCM reviewed the reduced form of the data obtained during the RI to evaluate whether the RI/FS project objectives were met. The results of this data evaluation are contained in Section 4.0. In conjunction with this evaluation, we determined recommendations for additional investigative work. They are detailed in Section 6.0.

### 1.3.7 Endangerment Assessment

The endangerment assessment (EA) was used to determine the probability and magnitude of risk, if any, to human health and the environment due to actual or probable releases of chemicals associated with the Chem-Solv site.

The EA is a formalized process consisting of four tasks: (1) hazard identification, (2) exposure assessment, (3) toxicity assessment, and (4) risk assessment.

The procedures used in this EA were consistent with the Endangerment Assessment Handbook (PRC, 1985). The risk evaluation was based on the Superfund Public Health Evaluation Manual (SPHEM) (EPA, 1986).

### 1.3.8 Treatability Study/Pilot Testing

The need for treatability studies and/or pilot testing was evaluated following completion of the data validation/evaluation and the initial screening of remedial technologies. Discussion of identified treatability studies and/or pilot testing will be provided in the Feasibility Study Report.

### 1.3.9 Remedial Investigation Report

Task 9 encompasses the preparation of this draft and final version of the Remedial Investigation Report. The RI report includes the results of the previously discussed tasks including the following:

- Site surface and subsurface conditions
- Extent and nature of soil contamination, if any
- Extent and nature of groundwater contamination, if any
- Analytical data and QA/QC backup
- Results of the public health and environmental assessments

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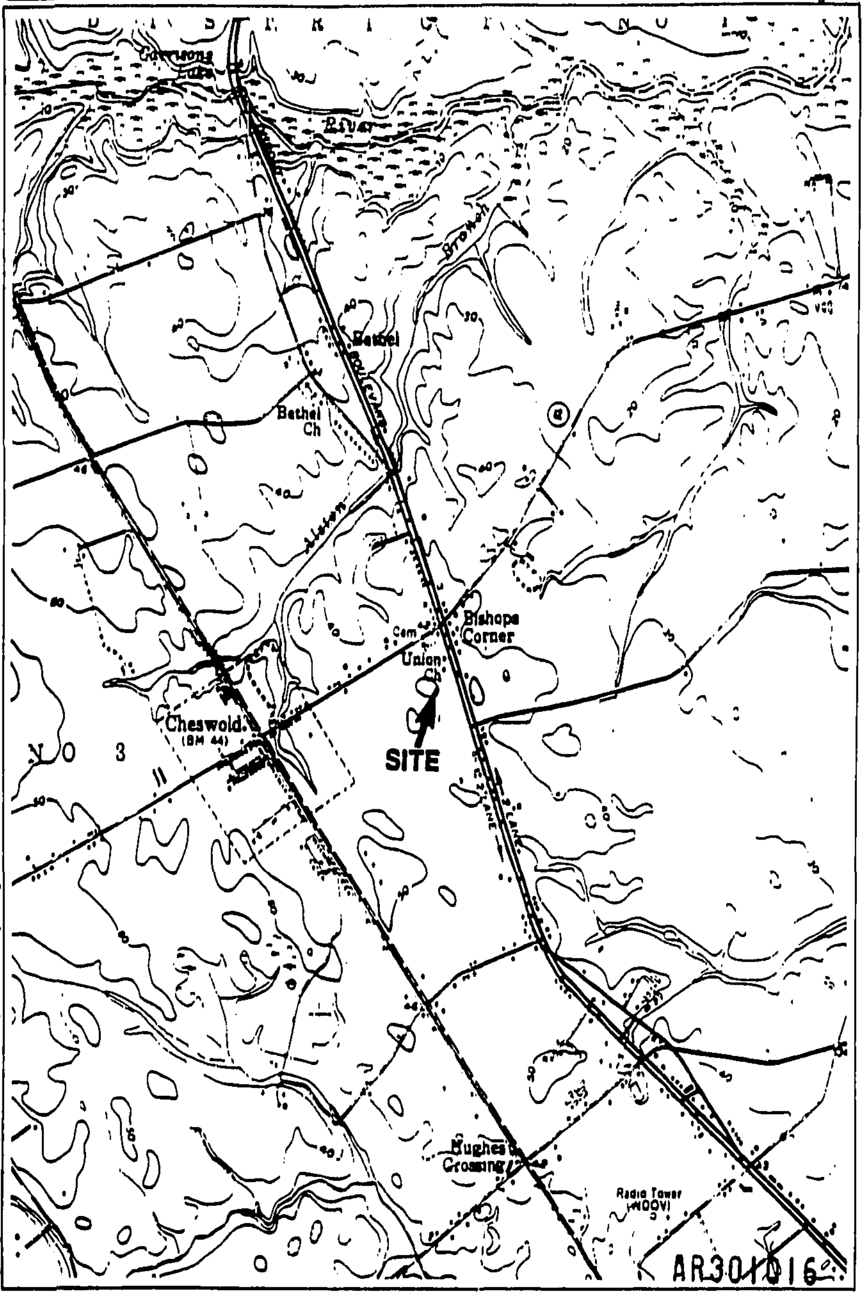
# SECTION 1.0
# FIGURES



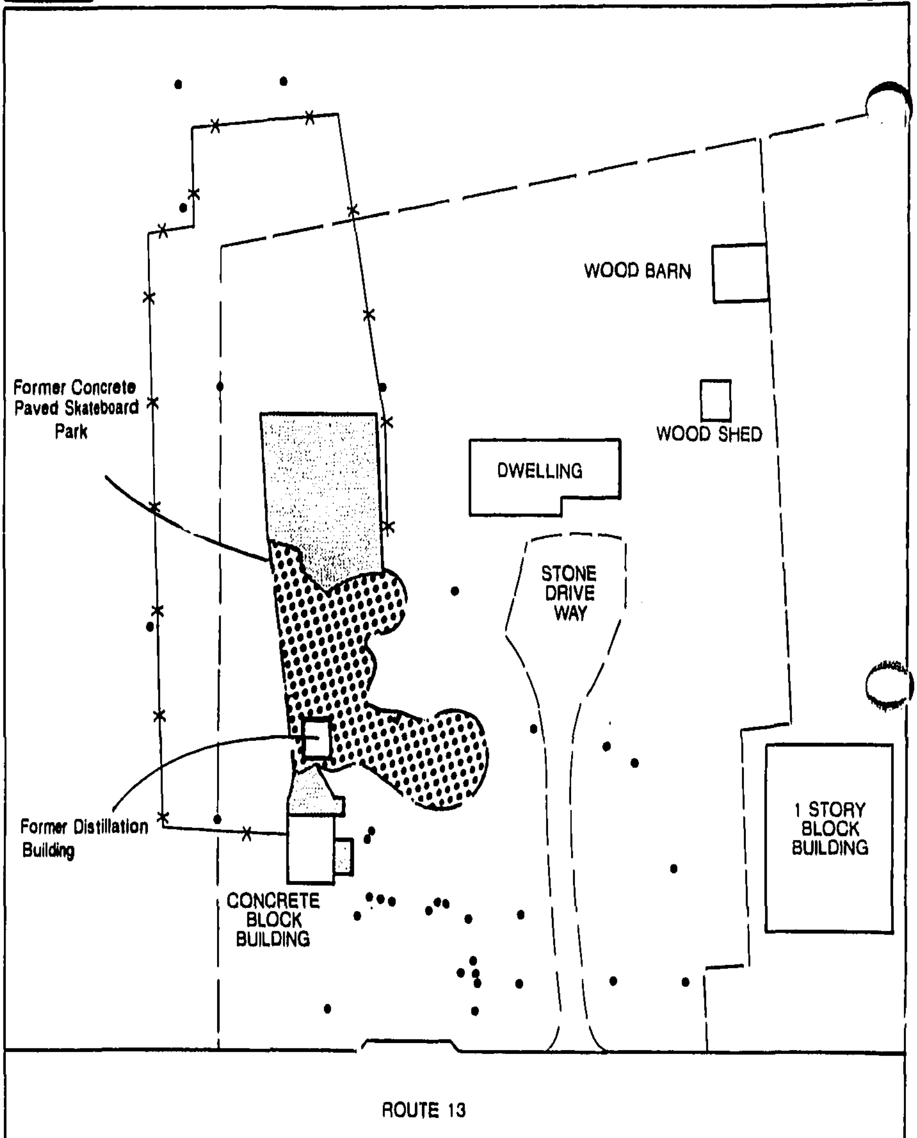
Source: U.S.G.S. Topo. Quad: Dover, Delaware (1956)

BCM Project No. 00-6012-02

Figure 1-1
Site Location Map

BCM

CHEM-SOLV, INC. SITE
Remedial Investigation



SOURCE: March 11, 1988 Survey (Robert L. Larimore, Wyoming, Delaware); June 4 and 5, 1990 Survey (J. G. Park Associates, Inc., Washington Crossing, Pennsylvania).

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0 50 Feet

NORTH

LEGEND
- ● Monitoring Well
- — — Property Line
- ░ Concrete
- ▨ Former Concrete Paved Skateboard Park

Figure
Site Plan

BCM

# SECTION 1.0

# TABLES

## TABLE 1-1

## SUMMARY OF PAST DNREC SOIL INVESTIGATION AND CLEANUP ACTIVITIES

## CHEM-SOLV, INC. SITE REMEDIAL INVESTIGATION
## CHESWOLD, DELAWARE

| Date | Event |
|---|---|
| September 1984 | Initial soils investigation - Chem-Solv excavated approximately 10 cubic yards of contaminated soil. |
| April 1985 | DNREC excavated 1,300 cubic yards of contaminated soil. Soil was stockpiled onsite. |
| April 19, 1985 | DNREC retained SMC Martin, Inc. (SMC Martin) to evaluate alternatives for soil and groundwater cleanup. |
| May 1 and 10, 1985 | SMC Martin conducted pre-soil shredding soil sampling in the excavation sidewalls and floor, staged soil stockpile, and nearby drainageway. |
| May 18, 1985 | SMC Martin issues "Evaluation of Remedial Alternatives for Soil and Groundwater Cleanup at the Chem-Solv Solvent Recovery Site, Cheswold, Delaware." |
| August 16, 1985 | SMC Martin conducted a round of pre-shredding soil sampling of in-place soil adjacent to the stockpile and of stockpiled soils. |
| September 9, 1985 | Guardian Construction Company began soil shredding process. |
| November 7, 1985 | Soil shredding completed. |
| November 11, 1985 | Post-shredding confirmatory soil sampling completed. |
| May 20, 1986 | SMC Martin issued "Removal of Volatile Organic Contaminants from Soils at the Chem-Solv Solvent Recovery Facility, Cheswold, Delaware." |

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Compiled by BCM Engineers Inc. (BCM Project No. 00-6012-02)

## TABLE 1-2

## SUMMARY OF PAST DNREC GROUNDWATER INVESTIGATION AND CLEANUP ACTIVITIES

## CHEM-SOLV, INC. SITE REMEDIAL INVESTIGATION
CHESWOLD, DELAWARE

| Date | Event |
|---|---|
| September 1984 | Five groundwater monitoring wells installed in the shallow aquifer.<br>Domestic wells sampled (SMC Martin, 1986). |
| October 3, 1984 | Five monitoring wells sampled. |
| October 1984 | Groundwater table elevations measured twice in five monitoring wells (SMC Martin, 1986). |
| November 28-30, 1984 | Seven monitoring wells installed. |
| December 5 and 6, 1984 | Ten monitoring wells and four domestic wells sampled. |
| January 29 and 31, 1985 | Nine monitoring wells sampled. |
| April 1985 | One monitoring well removed during soil excavation (SMC Martin, 1986). |
| April 22, 1985 | Eleven monitoring wells and six domestic wells sampled. |
| April 1985 to approx. August 1985 | SMC Martin conducted hydrogeologic investigation at site, including slug test (CABE, 1987). |
| May 18, 1985 | SMC Martin issues "Evaluation of Remedial Alternatives for Soil and Groundwater Cleanup at the Chem-Solv Solvent Recovery Site, Cheswold, Delaware." |
| August 5, 1985 | CABE retained to help implement the groundwater recovery and treatment system. |

TABLE 1-2 (Continued)

| Date | Event |
|---|---|
| August 13-22, 1985 | Eleven monitoring wells and one recovery well installed. |
| August 14, 1985 | One (of the original five) monitoring well sampled. |
| August 22, 1985 | The eleven monitoring wells most recently installed were sampled. |
| August 26, 1985 | Pump test conducted; pumped and sampled OB-5AR (CABE, 1987). |
| August 28, 1985 | Ten monitoring wells sampled. |
| September 11, 1985 | New domestic well installed at Gearhart property, finished at 50 feet (Appendix C). |
| September 12, 1985 | Four monitoring wells sampled (Attachment J; CABE, 1987). |
| September 18 and 26, 1985 | Nine monitoring wells and one recovery well installed. |
| October 4, 1985 | Eight monitoring wells sampled. |
| October 9, 1985 | One monitoring and one recovery well sampled. |
|  | Pump test conducted on wells OB-5A, OB-20AR, and OB-32AR (CABE, 1987). |
| October 24, 1985 | Two recovery wells sampled. |
| October 25, 1985 | Pump test conducted on well OB-34AR (CABE, 1987). |
| October 1985 | Three monitoring and four recovery wells installed. |
| November 26, 1985 | Untreated and treated water from the recovery system sampled to test air stripper efficiency. |
| December 11, 1985 | Recovery and treatment system fully operational and completed 24 hours of operation (CABE, 1987). |
| January 2, 1986 | Untreated and treated water from the recovery system sampled. |

TABLE 1-2 (Continued)

| Date | Event |
|---|---|
| February 19, 1986 | Thirteen domestic wells sampled (Attachment J; CABE, 1987). |
| February 27, 1986 | Untreated and treated water from the recovery system sampled. |
| March 11, 1986 | Twelve monitoring wells and one domestic well sampled; untreated water from the recovery system also sampled. |
| April 8, 1986 | Untreated and treated water sampled from one domestic well and the recovery system. |
| April 11, 1986 | Untreated and treated water sampled from one domestic well. |
| April 28, 1986 | Untreated and treated water sampled from the recovery system. |
| May 13, 1986 | Nine monitoring wells, untreated and treated water from the recovery system, and untreated water from one domestic well sampled.<br>Attachment J (CABE, 1987) indicates that 13 monitoring wells and untreated and treated water from the recovery system was sampled; untreated water from one domestic well was sampled twice. |
| June 9, 1986 | One recovery well (OB-43AR) installed. This well was later added to the recovery system. |
| June 10, 1986 | One recovery well (OB-44AR) installed. This well was not added to the recovery system; the well was later renamed monitoring well OB-44A. |
| June 11 and 16, 1986 | One monitoring well installed (OB-45B). |
| June 18, 1986 | Pump test conducted in well OB-45B (CABE, 1987). This well was also sampled. |
| June 30, 1986 | Pump test conducted on OB-43AR (1987, CABE). |
| July 1986 | Carbon point-of-use treatment system installed in home with contaminated domestic well (BCM, 1989). |

TABLE 1-2 (Continued)

| Date | Event |
|---|---|
| July 14, 1986 | Untreated and treated water from the recovery system and one domestic well sampled. |
| July 28 and 29, 1986 | Sixteen monitoring wells and untreated water from the recovery system sampled. |
| September 25, 1986 | Untreated and treated water from the recovery system sampled. |
| November 17 and 18, 1986 | Sixteen monitoring wells sampled. Three of these wells were sampled by both bailing and pumping. Three domestic wells sampled. Untreated and treated water from one domestic well and from the recovery system sampled. |
| March 1987 | CABE Associates issues final report for DNREC, "Groundwater Decontamination, Chem-Solv Solvents Recovery Facility, Cheswold, Delaware." |
| June 8-16, 1987 | Seventeen monitoring and nine domestic wells sampled. |
| August 1987 | Replacement domestic well had been installed at adjacent property (Appendix A-10). |
| September 4, 1987 | Untreated water from the recovery system sampled. |
| October 15, 1987 | Recovery system untreated water and one domestic well sampled. |
| December 1, 1987 | Recovery system untreated water and one domestic well sampled. |
| December 17, 1987 | Recovery system untreated water sampled. |
| December 22, 1987 | Four monitoring wells and recovery system untreated water sampled. |
| January 5 and 6, 1988 | Five monitoring wells, two domestic wells, and recovery system untreated water sampled. |
| March 21, 1988 | Nine monitoring wells, one domestic well, and recovery system untreated water sampled. |

TABLE 1-2 (Continued)

| Date | Event |
|---|---|
| April 14, 1988 | Three monitoring wells, one domestic well, and recovery system untreated water sampled. |
| May 17, 1988, and June 15, 1988 | Recovery system untreated water sampled. |
| July 26, 1988 | One monitoring well, five domestic wells, and recovery system untreated water sampled. |
| September 1988 | Air stripping tower collapsed. Continued pumping groundwater from the recovery system to the Kent County sewer system. |
| November 15, 1988 | One monitoring well, five domestic wells, and recovery system untreated water sampled. |
| November 1988 | Discharging of groundwater from the recovery system to sewer system halted. |

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Compiled by BCM Engineers Inc. (BCM Project No. 00-6102-02)

# TABLE 1-3

## SUMMARY OF REGULATORY ACTIVITIES

## CHEM-SOLV, INC. SITE REMEDIAL INVESTIGATION
## CHESWOLD, DELAWARE

| Date | Event |
|---|---|
| September 1988 | Administrative Consent Order signed. |
| September 1988 | BCM retained to conduct Remedial Investigation/Feasibility Study. |
| December 1988 | BCM issued "Draft Work Plan for Remedial Investigation/Feasibility Study, Chem-Solv Inc. Site, Cheswold, Delaware." |
| June 1989 | DNREC began quarterly monitoring of domestic wells. |
| December 1, 1989 | RI/FS Work Plan was approved by DNREC and EPA. |
| December 4, 1989 | BCM began implementation of the RI/FS Work Plan. |

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Source: BCM Engineers Inc. (BCM Project No. 00-6012-02)

# 2.0 REMEDIAL INVESTIGATION METHODOLOGY

## 2.1 AIR INVESTIGATION

BCM conducted an air investigation to evaluate health and safety needs at the site prior to initiating sampling or any intrusive activities. Data from this investigation was also designed to be used to estimate onsite and offsite exposure as part of the site Endangerment Assessment.

The investigation was conducted on October 16, 1989. Twelve sampling locations were set up around the perimeter of the site (Figure 2-1). Ambient organic vapor readings were recorded at each location using both an HNu Systems Photoionization Detector (HNu PI-101, 10.2 eV probe) and a Century Systems Organic Vapor Analyzer (OVA-128). At each location, the HNu and OVA instrument probes were directed inward, towards the former excavated area.

In addition, air monitoring with either the HNu or OVA and a combustible gas/oxygen/hydrogen sulfide meter (MSA Model 361) was performed continuously during all intrusive drilling activities. Air monitoring using either the HNu or OVA was performed continuously during well construction, well development, groundwater sampling, and water level measurement activities.

All monitoring equipment was calibrated to gas standards each day prior to use and recorded in a bound field log book.

## 2.2 SOILS/SOURCE INVESTIGATION

The soil investigation was designed to delineate the horizontal extent of the former source area. Eight borings from seven locations were placed around the edge of the former excavated area. Three soil samples from each location were retained for chemical analyses. In addition, split samples were retained for the EPA by personnel from CDM Federal Programs Corporation (CDM) and submitted for chemical analyses.

The soil investigation was conducted from December 4 through December 20, 1989, and from February 22 through February 28, 1990. Because of extreme weather conditions encountered during December 1989, work at the site was halted December 20, 1989. Freezing temperatures hampered decontamination of the sampling equipment and raised questions about the possibility of cross contamination of the soil samples. BCM notified DNREC of the work stoppage in a letter dated December 27, 1989, (Appendix A-3). DNREC approved the work stoppage in a letter dated January 22, 1990 (Appendix A-4).

Field activities were generally conducted in accordance with the procedures contained in the Work Plan. However, some modifications to the Work Plan were necessary due to conditions encountered during the investigation; these modifications are detailed in the following sections.

### 2.2.1 Sample Locations

Eight borings (CSB-6, CSB-7, CSB-8, CSB-8A, CSB-9, CSB-10, CSB-11, and CSB-12) were placed at seven locations around the edges of the former excavated area (Figure 2-2). Boring logs are contained in Appendix D. The soil in the former excavation area delineates the soils from around the former distillation building that were excavated, shredded, tested for indicator parameters, and placed back in the excavation during work performed by DNREC in 1985 prior to the RI. Since the soil was excavated to the top of the water table, the RI soil investigation was structured to delineate what contaminants, if any, remained in the unsaturated soils outside the excavation. A description of each boring location and the rationale for placement of the boring is provided below.

| Boring Name | Location Description | Location Rationale |
|---|---|---|
| CSB-6 | Southeastern side of excavation | Delineate soils south of the former distillation building |
| CSB-7 | Southcentral side of excavation | Delineate soils south of the former distillation building |
| CSB-8<br>CSB-8A | Southwestern edge of concrete pad | Delineate potential soil contamination due to runoff from former drum storage pad |
| CSB-9 | Northwestern edge of concrete pad | Delineate potential soil contamination due to runoff from former drum storage pad |
| CSB-10 | Eastern edge of concrete pad | Delineate potential soil contamination due to runoff from former drum storage pad |
| CSB-11 | Northcentral edge of concrete pad | Delineate soils north of former distillation building |
| CSB-12 | Between concrete pad and concrete block building | Delineate soils north of former distillation building |

Boring B-8 was abandoned at 16 feet due to difficulties keeping the borehole open during drilling; Boring B-8A was then drilled as a replacement boring for that location.

### 2.2.2 Sampling Protocol

#### 2.2.2.1 Soil Samples

The soil borings were drilled to depths ranging from 20 feet to 26 feet using a rotary drilling rig with 3-1/4-inch and 6-1/4-inch inner diameter (ID) hollow stem augers. Soil cores were obtained continuously throughout the soil borings using 2-foot long 2-inch or 3-inch outer diameter (OD) carbon steel split spoon samplers. The split spoons were driven using a 140 pound hammer.

As described in the Work Plan, the soil borings were to be completed to the top of the silt confining layer, if present, or to a maximum depth of 25 feet; split spoon samples were retained continuously throughout the boring column for lithologic descriptions and for chemical analyses. Two soil samples from each boring location were to be retained from the unsaturated zone and submitted for Target Compound List (TCL) organic and Target Analyte List (TAL) inorganic parameters. Soil samples were to be collected from the 0.5-foot to 2-foot interval and the 2-foot interval just above the top of the water table, unless elevated organic vapor readings were recorded from head space analyses. If elevated organic readings were encountered, the sample intervals were to be selected from the intervals with the highest levels. In addition, if the silt confining layer was encountered, one soil sample from the interval just above the silt was to be analyzed for TCL volatile compounds.

#### 2.2.2.2 Field Quality Control Samples

Field rinsate blanks, trip blanks, and field duplicate samples were submitted for chemical analyses with the soil samples in accordance with the protocol detailed in Section 9.2 of the Quality Assurance Project Plan (QAPjP).

### 2.2.3 Analytical Parameters and Methods

Twenty-three samples were submitted for chemical analyses. Of these samples, two were field duplicate samples. A sample summary table presenting the soil sample locations, depths, and analytical parameters is presented as Table 2-1. Sixteen samples were submitted to the Industrial and Environmental Analysts, Inc. (IEA) laboratory in Cary, North Carolina, for TCL organic and TAL inorganic analyses. Seven soil samples were submitted to IEA for TCL organic analyses.

All analyses were performed in accordance with the procedures contained in the Work Plan and QAPjP. In addition, a laboratory audit for inorganic analyses was performed by BCM on December 19, 1990. The laboratory audit report was submitted to DNREC January 4, 1990 (Appendix A-5).

## 2.3 STRATIGRAPHIC INVESTIGATION

The statigraphic investigation was conducted to provide offsite lithologic information, specifically to delineate the horizontal extent of the silt confining layer present at approximately 20 feet below the site. Five stratigraphic borings (CSB-1 through CSB-5) were drilled to a maximum depth of 43 feet. Boring logs for the stratigraphic borings are contained in Appendix D. In addition, two Shelby tube samples of the confining layer were obtained from borings CSB-2 and CSB-4; these samples were analyzed for physical parameters.

The stratigraphic borings were drilled from December 4 through 7, 1990, and from February 28 through March 8, 1990. Generally, the borings were conducted in accordance with the specifications contained in the Work Plan. Any deviations/modifications are addressed below.

### 2.3.1 Sample Locations

The stratigraphic borings were located along a line situated approximately parallel with the axis of the groundwater flow direction (Figure 2-2). A listing of the boring locations and a description of the location rationale are presented below.

| Boring Name | Location Description | Location Rationale |
|---|---|---|
| CSB-1 | Southeastern edge of property | Upgradient position |
| CSB-2 | American Roofing and Siding Co. property | Downgradient position |
| CSB-3 | Durham property | Farthest downgradient position |
| CSB-4 | Lambertson property | Nearest downgradient position |
| CSB-5 | Route 13 median near well 39A | Downgradient position |

Field boring locations were discussed with and approved by DNREC prior to initiation of field activities.

### 2.3.2 Sampling Protocol

The soil borings were drilled using 3-1/4-inch, 4-1/4-inch, and 6-1/4-inch hollow stem augers. Soil cores were obtained from each boring beginning at 10 feet using 2-foot-long 2-inch OD split spoons; the cores were obtained continuously from 10 feet to the bottom of the borehole, which was either the base of the confining layer, or 35 feet if the confining layer was not encountered.

All split spoon samples were scanned with an HNu or OVA as they were removed from the borehole and after each spoon was opened. Organic vapor readings from these scans are contained on the boring logs in Appendix D. In addition, head space readings were obtained for each sample.

Samples of the silt layer were obtained from CSB-2 and CSB-4 using 3-inch OD thin-walled Shelby tube samplers. These samples were analyzed at the Woodward-Clyde Laboratory in Plymouth Meeting, Pennsylvania, for vertical coefficient of permeability and grain size distribution. Since the confining layer was not encountered at the other locations, no Shelby tube samples were obtained from those borings.

### 2.3.3 Analytical Parameters and Methods

Samples CSB-1 (22-24) and CSB-2 (22-24) were analyzed for vertical coefficient of permeability and grain size distribution using ASTM methods. Immediately upon retrieval, both ends of the Shelby tube sampler were sealed with wax; the tubes were stored upright and delivered to the Woodward-Clyde Laboratory for analysis.

## 2.4 GROUNDWATER INVESTIGATION

The groundwater investigation included the installation of seven offsite monitoring wells and chemical analyses of groundwater from 14 onsite and offsite locations. Seven monitoring wells were installed from December 6, 1989, through March 12, 1990. Of these wells, four were designed to monitor the shallow sand aquifer and three were designed to monitor groundwater in the intermediate zone of the aquifer beneath the confining layer.

### 2.4.1 Monitoring Well Installation

Seven monitoring wells were completed as part of the remedial investigation (Figure 2-2). These wells were installed to provide additional information needed to more completely delineate the horizontal and vertical extent of the groundwater contaminant plume associated with the site. In addition, these wells may be used for future monitoring of the plume, if necessary.

### 2.4.1.1 Monitoring Well Designations and Locations

Well identification numbers (e.g., MWS-6-25) consist of four components. The first component ("MW") designates a monitoring well. The second component designates the aquifer zone monitored by the well; "S" designates a shallow zone well and "I" designates an intermediate zone well. The third component is a number from 1 through 7 indicating the location designation of the well. The fourth component is the bottom depth of the screened interval in that well.

A summary of the monitoring well locations, well depth, and location rationale is presented below.

| Well Name | Location Description | Location Rationale |
|---|---|---|
| MWI-1-43 | Southeastern corner of property | Upgradient, intermediate aquifer zone |
| MWI-2-40 | American Roofing and Siding Co. property | Downgradient, intermediate aquifer zone |
| MWS-3-17 | American Roofing and Siding Co. property | Downgradient, shallow aquifer zone |
| MWI-4-40 | Durham property | Downgradient, intermediate aquifer zone |
| MWS-5-18 | Durham property | Downgradient, shallow aquifer zone |
| MWS-6-25 | Stein property north of former Mobil Station | Downgradient, shallow aquifer zone |
| MWS-7-25 | Route 13 median north of Route 42 intersection | Downgradient, shallow aquifer zone |

Monitoring well locations were selected in the field with the approval of DNREC prior to initiation of field activities.

### 2.4.1.2 Monitoring Well Construction

Shallow Zone Wells

Shallow monitoring wells were drilled using 6-1/4-inch ID hollow stem augers. Soil cores were retained continuously throughout the boring using 2-inch OD split spoon samplers; these cores were scanned with an HNu and/or an OVA. Lithologic descriptions for each well are included in the well logs contained in Appendix E.

The specifications for the shallow zone monitoring wells were designed to provide information about the sand aquifer above the silt confining layer. The wells were to be screened above the confining layer, if present. If the confining layer was not encountered at a location, then the well would be constructed to screen a 10-foot interval from 15 feet to 25 feet below the ground surface. A schematic representation of monitoring well construction detail is shown on Figure 2-3.

After each boring was advanced to the required depth, the monitoring well was constructed using 2-inch ID schedule 40 polyvinyl chloride (PVC) casing and screen. All well screens were factory-slotted with 0.010-inch or 0.020-inch slots; the 0.010-inch screens were installed at locations were the aquifer contained significant fine material. The casing, screen, and bottom cap were connected with threaded flush joints; no glue was used. Between 7 and 10 feet of screen were used in each well depending upon lithologic conditions. The annulus (void between the well casing or screen and the boring wall) was packed to at least 1 foot above the screen with a clean silica sand.

A bentonite pellet seal was placed on top of the sand pack, above which a cement-bentonite grout was emplaced up to grade. A locking protective steel casing was inserted a minimum of 3 feet into the grouted annulus.

Intermediate Zone Monitoring Wells

Section 4.5.2 of the Work Plan contains specifications for construction of the three intermediate zone monitoring wells. However, only well MWI-1-43 was constructed as proposed in the Work Plan. The silt layer was not encountered or was too thin to seal off with an outer steel casing in the other two wells (MWI-2-40 and MWI-4-40). A schematic representation of monitoring well detail is shown on Figure 2-3.

To determine the depth and thickness of the silt confining layer at the MWI-1-43 location, a stratigraphic boring (CSB-1) was drilled using 6-1/4-inch hollow stem augers. This boring was abandoned and grouted to the surface. Well MWI-1-43 was then drilled using the mud rotary drilling method. A 10-inch diameter borehole was drilled to the top of the silt at 23 feet. A 6-inch steel outer casing was then driven one foot into the silt layer and set at 24 feet; the annulus between the casing and the borehole was tremie grouted with a cement/bentonite mixture. After allowing the grout to set overnight, the boring was advanced to 43 feet (15 feet below the bottom of the silt layer). The well was constructed using 10 feet of 2-inch ID schedule 40 PVC with 0.020-inch screen. A filter pack consisting of No. 1 Jessie Morie sand was installed from the base of the borehole to 31 feet. An 8-foot thick granular bentonite seal was installed above the filter pack; the annular space above the seal was tremie grouted with a cement/bentonite mixture.

Wells MWI-2-40 and MWI-4-40 were installed using specifications similar to those for shallow zone wells. Since the confining layer was not encountered at these locations, no outer steel casing was installed. Both wells were constructed using 10 feet of 0.010-inch screen which was set to a depth of 30 feet to 40 feet below the ground surface. Prior to modifying the well specifications, BCM contacted DNREC and received approval of these changes.

#### 2.4.1.3 Monitoring Well Development

All monitoring wells were developed by over-pumping using a centrifugal pump. As detailed in Section 4.5.4 of the Work Plan, each well was developed for a maximum time period of 1 hour or until sediment free flow was obtained. Only one well (MWI-4-40) was developed for less than one hour.

Several of the wells were also surged with a 5-foot long, 1-1/2-inch diameter PVC slug; the slug was moved up and down in the well to allow water to move into and out of the well through the well screen.

Development water was discharged into 55-gallon drums. Organic vapor readings were measured in the drum headspace using an OVA. No elevated OVA readings were encountered during development of any well. This water was then discharged to the ground.

### 2.4.2 Groundwater Sampling

Groundwater samples were retained for chemical analyses from 14 locations from April 4 through April 9, 1990. A groundwater sample summary, including well name, sampling methodology, and analyses performed, is presented as Table 2-2. Several modifications to the groundwater sampling protocol described in Section 4.5.5 of the Work Plan were made. Prior to initiation of sampling activities, BCM submitted an addendum to the Work Plan to DNREC on April 1, 1990 (Appendix A-6). Modifications contained in the Work Plan Addendum are discussed in the following sections.

### 2.4.2.1 Sampling Locations

Groundwater samples were obtained from eight offsite shallow wells (22A, 26A, 39A, 41A, MWS-3-17, MWS-5-17, MWS-6-25, and MWS-7-25), one onsite shallow well (33A), two onsite intermediate wells (5B and 9B), and three offsite intermediate wells (MWI-1-43, MWI-2-40, and MWI-4-40). In addition, field duplicate samples were obtained from wells 26A and 9B. Split samples were also obtained for EPA by CDM personnel from Wells 41A, MWS-5-18, and 9B; a field duplicate was also obtained from Well 9B. A groundwater sample summary for the EPA split samples is contained in Table 2-2.

These sampling locations were selected to provide groundwater quality information for several areas of the sand aquifer. The eight offsite shallow wells were used to characterize the magnitude and extent of the contaminated slug of groundwater which apparently exists downgradient of the site in the shallow zone. Data generated from the five intermediate wells were used to evaluate the magnitude and extent of contamination in the intermediate zone beneath the silt confining layer. Data from the shallow onsite well were used to evaluate the magnitude of contamination remaining onsite in the shallow zone.

Of these wells, 33A and 41A were not included in the sampling program contained in Section 4.5.5 of the Work Plan. Well 33A was sampled instead of the recovery system; the recovery system pump could not be started due to rust. Selection of well 33A as an alternate to the recovery system was jointly agreed to by BCM and DNREC on April 9, 1990. Well 41A was included in the sampling event as a replacement location for well 28A, which has been paved over with asphalt (Appendix A-6).

### 2.4.2.2 Sampling Protocol

Groundwater Samples

Wells were sampled in accordance with the procedures detailed in the Work Plan and the Work Plan Addendum. Due to the diameter of many of the DNREC monitoring wells (0.5-inch ID), these wells were purged and sampled using a peristaltic pump; wells with a sufficiently large diameter were sampled using 2-inch OD Teflon bailers (Table 2-2).

All volatile samples, except for trip blanks, were preserved with hydrochloric acid in the field by BCM personnel. Inorganic analyses were performed on both unfiltered and filtered samples at all locations. The samples were filtered in the field using a nitrogen pressure filtering unit with a 0.45 micron filter.

Field Quality Control Samples

Field rinsate blanks, trip blanks, and field duplicate samples were retained and submitted for analyses in accordance with the procedures detailed in Section 9.2 of the QAPjP.

### 2.4.2.3 Analytical Parameters and Methods

All groundwater samples were analyzed for TCL organic compounds and TAL inorganic compounds by IEA. Analyses were performed in accordance with the protocol contained in Attachment 5 of the QAPjP.

### 2.4.3 Well Elevation Survey

A survey to determine the horizontal location and vertical reference elevations of the seven monitoring wells was conducted by J.G. Park Associates, Inc. (J.G. Park) of Washington Crossing, Pennsylvania. The survey was performed June 4 and June 5, 1990. The reference elevations for the seven monitoring wells installed as part of this remedial investigation are provided on Table 2-3.

In addition to locating the newly installed monitoring wells, J.G. Park delineated site topography. A topographic contour map, with 1-foot topographic contours, was provided for this purpose. J.G. Park also resurveyed the existing onsite monitoring wells, the existing onsite buildings, and the location of Routes 13 and 42 in the vicinity of the site.

A site survey had been conducted for DNREC by Robert L. Larimore of Wyoming, Delaware, on March 11, 1986. This survey was used to construct the site maps included in the Work Plan. Information from both surveys was combined to construct the site maps included in this report. A summary of the well specifications for all monitoring wells installed by DNREC, including total depth, reference elevation, and status, is provided in Table 2-4.

### 2.4.4 Water Level Measurements

To determine the hydraulic head distribution in the shallow and intermediate aquifer zones, two rounds of water level data were collected from all existing monitoring wells. The water level measurements were obtained March 27, 1990, and April 4, 1990, for all existing monitoring wells.

The water level measurements were obtained in accordance with the procedures contained in Section 4.5.6 of the Work Plan. A summary of the measurement procedures is outlined below.

- The well cap was opened and the well head organic vapor readings were recorded using either an OVA or HNu.
- Depth-to-water measurements were recorded from the top of the inner casing (or from the top of the outer casing if only one casing was present) using an electronic water level instrument.
- As the probe and cable of the electronic water level recording instrument were removed from the well, they were scrubbed with a soap and deionized water solution and then rinsed with deionized water to prevent cross contamination between the wells.
- The well name, OVA reading, time, depth-to-water, and reference elevation, were recorded in a hound field book, which is stored in BCM central files.

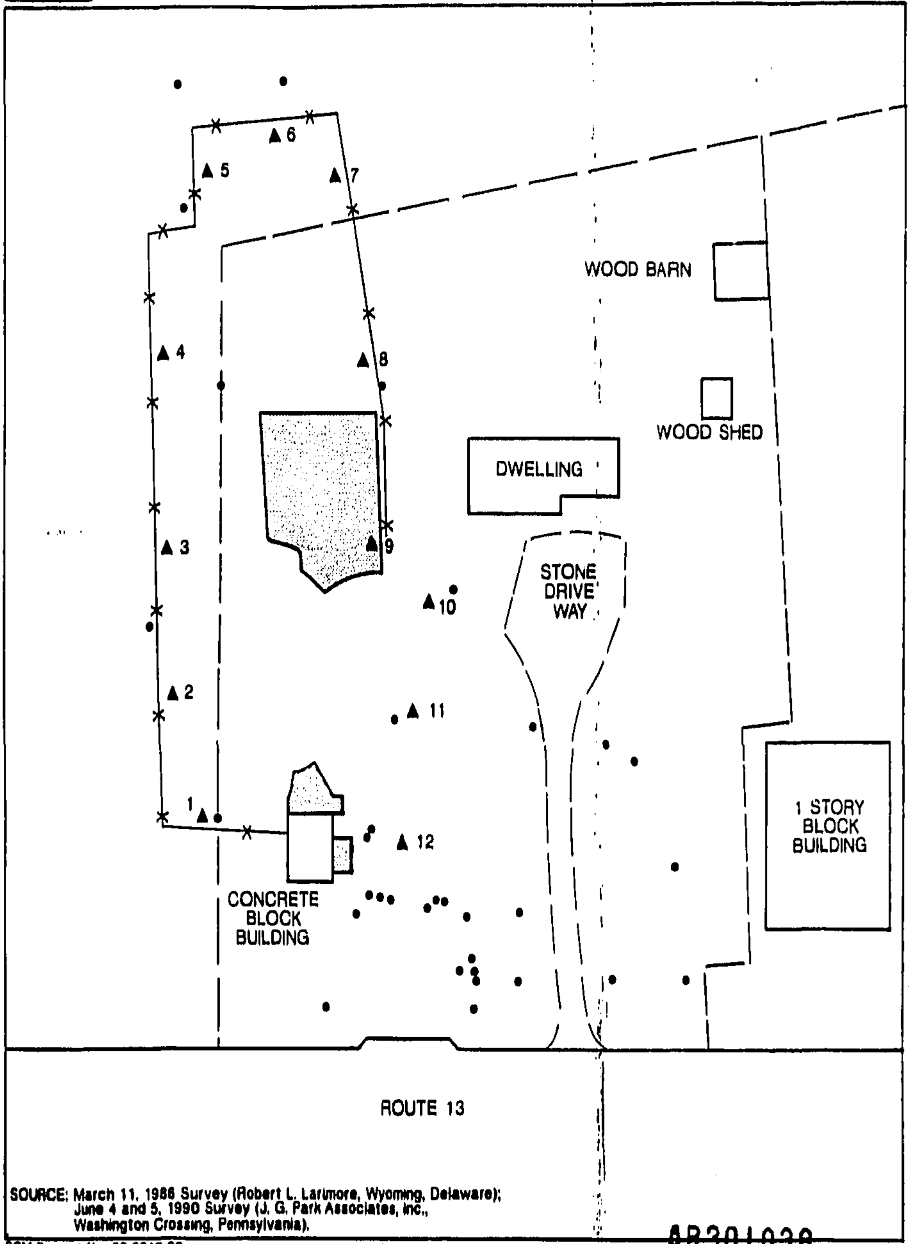
Potentiometric surface contour maps were constructed for the shallow and intermediate aquifers for both the March 27 and April 4 dates. Groundwater elevation data were calculated from the water level measurements and well reference locations; these data were then plotted on a map at the appropriate location and contour lines were plotted. Evaluation of these data is discussed in Section 3.2.2.

BCM

# SECTION 2.0
# FIGURES

BCM

CHEM-SOLV, INC. SITE
Remedial Investigation



SOURCE: March 11, 1986 Survey (Robert L. Larimore, Wyoming, Delaware); June 4 and 5, 1990 Survey (J. G. Park Associates, Inc., Washington Crossing, Pennsylvania).

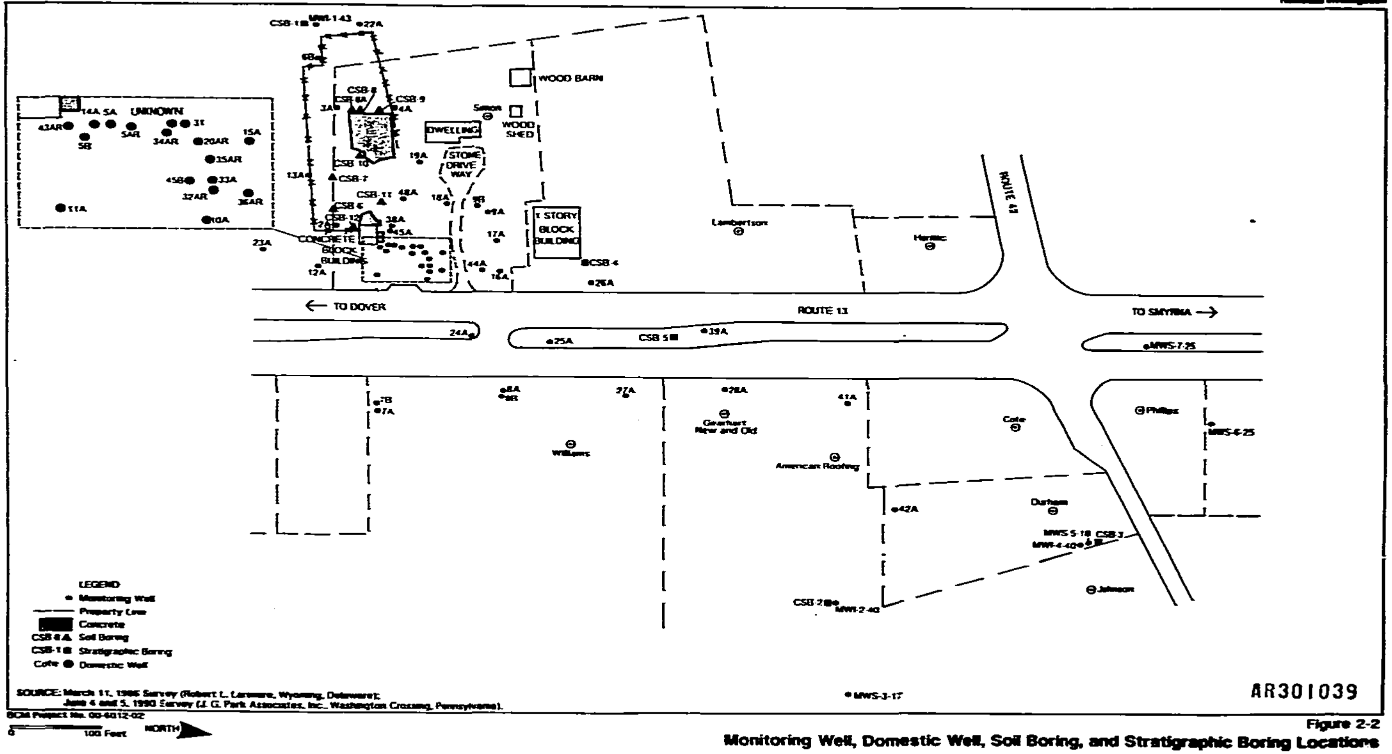
BCM Project No. 00-6012-02

0 50 Feet

NORTH

LEGEND
- ● Monitoring Well
- — — Property Line
- ▨ Concrete
- 1 ▲ Air Monitoring Location

Figure 2-1
**Onsite Perimeter Air Monitoring Locations**

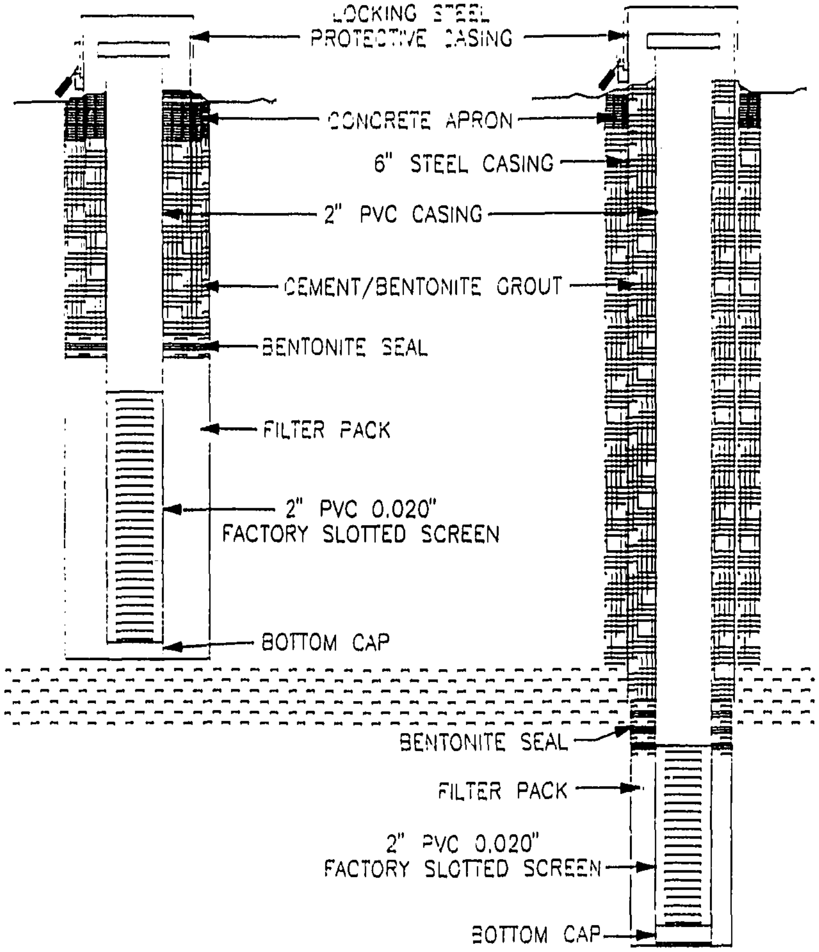


SOURCE: March 11, 1986 Survey (Robert L. Laramore, Wyoming, Delaware);
June 4 and 5, 1990 Survey (J. G. Park Associates, Inc., Washington Crossing, Pennsylvania).

BCM Project No. 00-6012-02

Figure 2-2

Monitoring Well, Domestic Well, Soil Boring, and Stratigraphic Boring Locations



BCM Project No. 00-6012-02

NOT TO SCALE

Figure 2-3
**Monitoring Well Construction Detail**

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## SECTION 2.0
## TABLES

BCM

## TABLE 2-1

## SOIL SAMPLE SUMMARY

## CHEM-SOLV, INC. SITE REMEDIAL INVESTIGATION
## CHESWOLD, DELAWARE

| SAMPLE NAME* | SAMPLE DATE | ANALYTICAL PARAMETERS |
|---|---|---|
| CSB-1 (22-24) | 12/05/89 | GRAIN SIZE; COEFFICIENT OF PERMEABILITY |
| CSB-4 (20-22) | 03/07/90 | GRAIN SIZE; COEFFICIENT OF PERMEABILITY |
| CSB-6 (0.5-2) | 12/14/89 | TCL ORGANICS; TAL INORGANICS |
| CSB-6 (6-7.3) | 12/14/89 | TCL ORGANICS; TAL INORGANICS |
| CSB-6 (19.6-19.9) | 12/15/89 | TCL VOLATILE ORGANICS |
| CSB-7 (4-6) | 12/13/89 | TCL ORGANICS; TAL INORGANICS |
| CSB-7 (8-10) | 12/13/89 | TCL ORGANICS; TAL INORGANICS |
| CSB-7 (20.5-20.8) | 12/14/89 | TCL VOLATILE ORGANICS |
| CSB-8 (0.5-2)** | 02/22/90 | TCL ORGANICS; TAL INORGANICS |
| CSB-8D (0.5-2)** | 02/22/90 | TCL ORGANICS; TAL INORGANICS |
| CSB-8 (2-4) | 02/22/90 | TCL ORGANICS; TAL INORGANICS |
| CSB-8A (18-20) | 02/26/90 | TCL VOLATILE ORGANICS |
| CSB-9 (2-4) | 02/27/90 | TCL ORGANICS; TAL INORGANICS |
| CSB-9 (4-5.5) | 02/27/90 | TCL ORGANICS; TAL INORGANICS |
| CSB-9 (19.5-20) | 02/27/90 | TCL VOLATILE ORGANICS |
| CSB-10 (0.5-2) | 02/27/90 | TCL ORGANICS; TAL INORGANICS |
| CSB-10 (2-4)** | 02/27/90 | TCL ORGANICS; TAL INORGANICS |
| CSB-10 (18-18.5)** | 02/27/90 | TCL VOLATILE ORGANICS |
| CSB-11 (0.5-2) | 12/19/89 | TCL ORGANICS; TAL INORGANICS |
| CSB-11D (0.5-2) | 12/19/89 | TCL ORGANICS; TAL INORGANICS |
| CSB-11 (6-8) | 12/19/89 | TCL ORGANICS; TAL INORGANICS |
| CSB-11 (20.4-20.7) | 12/20/89 | TCL VOLATILE ORGANICS |
| CSB-12 (0.5-2) | 12/18/89 | TCL ORGANICS; TAL INORGANICS |
| CSB-12 (2-4) | 12/18/89 | TCL ORGANICS; TAL INORGANICS |
| CSB-12 (21.7-22) | 12/19/89 | TCL VOLATILE ORGANICS |

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TAL Target analyte list
TCL Target compound list
* Sample name denotes the boring location and the depth, in feet, below the ground surface that the sample was obtained from.
** EPA split sample retained by CDM for analyses

Source: BCM Engineers Inc. (BCM Project No. 00-6012-02)

BCM

# TABLE 2-2

## GROUNDWATER SAMPLING SUMMARY

## CHEM-SOLV, INC. SITE REMEDIAL INVESTIGATION
## CHESWOLD, DELAWARE

| WELL SAMPLED* | | PURGE METHOD | SAMPLE METHOD | DATE SAMPLED | ANALYTICAL PARAMETERS |
|---|---|---|---|---|---|
| BCM | CDM | | | | |
| 22A | – | PERISTALTIC PUMP | PERISTALTIC PUMP | 04/04/90 | TCL ORGANICS; TAL INORGANICS |
| 26A** | – | PERISTALTIC PUMP | PERISTALTIC PUMP | 04/05/90 | TCL ORGANICS; TAL INORGANICS |
| 33A | – | PERISTALTIC PUMP | PERISTALTIC PUMP | 04/09/90 | TCL ORGANICS; TAL INORGANICS |
| 39A | – | PERISTALTIC PUMP | PERISTALTIC PUMP | 04/05/90 | TCL VOLATILE ORGANICS |
| | | | | 04/09/90 | TCL ORGANICS (EXCEPT VOLATILES); TAL INORGANI |
| 41A | 41A | PERISTALTIC PUMP | PERISTALTIC PUMP | 04/05/90 | TCL ORGANICS; TAL INORGANICS |
| 5B | – | CENTRIFUGAL PUMP | PERISTALTIC PUMP | 04/04/90 | TCL ORGANICS; TAL INORGANICS |
| 9B** | 9B** | CENTRIFUGAL PUMP | TEFLON BAILER | 04/06/90 | TCL ORGANICS; TAL INORGANICS |
| MWI-1-43 | – | CENTRIFUGAL PUMP | TEFLON BAILER | 04/09/90 | TCL ORGANICS; TAL INORGANICS |
| MWS-2-40 | – | CENTRIFUGAL PUMP | TEFLON BAILER | 04/06/90 | TCL ORGANICS; TAL INORGANICS |
| MWS-3-17 | – | CENTRIFUGAL PUMP | TEFLON BAILER | 04/06/90 | TCL ORGANICS; TAL INORGANICS |
| MWI-4-40 | – | CENTRIFUGAL PUMP | TEFLON BAILER | 04/05/90 | TCL ORGANICS; TAL INORGANICS |
| MWS-5-18 | MWS-5-18 | CENTRIFUGAL PUMP | TEFLON BAILER | 04/05/90 | TCL ORGANICS; TAL INORGANICS |
| MWS-6-25 | – | CENTRIFUGAL PUMP | TEFLON BAILER | 04/06/90 | TCL ORGANICS; TAL INORGANICS |
| MWS-7-25 | – | CENTRIFUGAL PUMP | TEFLON BAILER | 04/05/90 | TCL ORGANICS; TAL INORGANICS |

AR3

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* Split samples obtained from 3 wells by personnel from CDM Federal Programs Corporation

** Field duplicate samples obtained at these locations

– Not sampled

TCL Target Compound List

TAL Target Analyte List

Source: BCM Engineers Inc. (BCM Project No. 00-6012-02)

BCM

## TABLE 2-3

## MONITORING WELL SPECIFICATIONS

## CHEM-SOLV, INC. SITE REMEDIAL INVESTIGATION
## CHESWOLD, DELAWARE

| Well | Total Well Depth (ft., below ground) | Screened Interval (ft., below ground) | Reference Elevation (ft., NGVD) | | |
|---|---|---|---|---|---|
| | | | Outer Steel Casing | Inner PVC Casing | Ground Surface |
| MWI-1-43 | 43 | 33 - 43 | 49.88 | 49.67 | 48.20 |
| MWI-2-40 | 40 | 30 - 40 | 43.11 | 42.61 | 43.04 |
| MWS-3-17 | 17 | 4 - 17 | 40.17 | 39.81 | 40.13 |
| MWI-4-40 | 40 | 30 - 40 | 41.01 | 40.90 | 41.01 |
| MWS-5-18 | 18 | 5 - 18 | 40.92 | 40.37 | 40.91 |
| MWS-6-25 | 25 | 15 - 25 | 41.41 | 40.90 | 41.45 |
| MWS-7-25 | 25 | 15 - 25 | 41.04 | 40.25 | 41.08 |

NGVD National Geodetic Vertical Datum

Source: BCM Engineers Inc. (BCM Project No. 00-6012-02)

TABLE 2-4

## WELL SPECIFICATIONS
## DNREC MONITORING WELLS AND DOMESTIC WELLS

CHEM-SOLV, INC. SITE REMEDIAL INVESTIGATION
CHESWOLD, DELAWARE

| WELL | DRILLER | DATE INSTALLED | DIAMETER (inches) | MATERIAL (casing/screen) | SCREEN LENGTH (feet) | TOTAL DEPTH (feet) | REFERENCE ELEVATION (ft., NGVD) | FINAL SERVICE | STATUS AS OF 04/90 |
|---|---|---|---|---|---|---|---|---|---|
| 1A | Handex | 09/27/84 | 4.0 | pvc/pvc | 15.0 | 20.0 | 45.58 | Monitoring | Destroyed |
| 2A | Handex | 09/27/84 | 4.0 | pvc/pvc | 10.0 | 17.0 | 46.00 | Monitoring | Active |
| 3A | Handex | 09/27/84 | 4.0 | pvc/pvc | 10.0 | 16.0 | 46.88 | Monitoring | Active |
| 4A | Handex | 09/27/84 | 4.0 | pvc/pvc | 10.0 | 17.0 | 47.49 | Monitoring | Active |
| 5A | Handex | 09/27/84 | 4.0 | pvc/pvc | 10.0 | 17.0 | 45.42 | Monitoring | Active |
| 5AR | Earth Data | 08/20/85 | 4.0 | steel/pvc | 10.0 | 20.0 | 44.65 | Recovery | Active |
| 5B | Earth Data | 08/12/85 | 1.5 | steel/pvc | 20.0 | 50.0 | 45.63 | Monitoring | Active |
| 6B | Burns | 11/28/84 | 4.0 | pvc/pvc | 10.0 | 40.0 | 46.27 | Monitoring | Active |
| 7A | Burns | 11/30/84 | 4.0 | pvc/pvc | 10.0 | 16.0 | 40.89 | Monitoring | Missing |
| 7B | Burns | 11/30/84 | 4.0 | pvc/pvc | 10.0 | 50.0 | 41.15 | Monitoring | Missing |
| 8A | Burns | 11/29/84 | 4.0 | pvc/pvc | 10.0 | 16.0 | 42.30 | Monitoring | Active |
| 8B | Burns | 11/29/84 | 4.0 | pvc/pvc | 10.0 | 50.0 | 42.30 | Monitoring | Active |
| 9A | Burns | 11/28/84 | 4.0 | pvc/pvc | 10.0 | 25.0 | 46.24 | Monitoring | Active |
| 9B | Burns | 11/29/84 | 4.0 | pvc/pvc | 10.0 | 50.0 | 46.00 | Monitoring | Active |
| 10A | Earth Data | 08/16/85 | 0.5 | steel/pvc | 1.5 | 17.5 | 43.46 | Monitoring | Active |
| 11A | Earth Data | 08/16/85 | 0.5 | steel/pvc | 1.5 | 17.5 | 43.45 | Monitoring | Active |
| 12A | Earth Data | 08/16/85 | 0.5 | steel/pvc | 1.5 | 17.5 | 43.32 | Monitoring | Destroyed* |
| 13A | Earth Data | 08/13/85 | 0.5 | steel/pvc | 1.5 | 18.0 | 45.43 | Monitoring | Active |
| 14A | Earth Data | 08/13/85 | 0.5 | steel/pvc | 1.5 | 17.5 | 44.28 | Monitoring | Active |
| 15A | Earth Data | 08/22/85 | 0.5 | steel/pvc | 1.5 | 17.0 | 45.59 | Monitoring | Active |
| 16A | Earth Data | 08/22/85 | 0.5 | steel/pvc | 1.5 | 17.0 | 43.83 | Monitoring | Active |
| 17A | Earth Data | 08/22/85 | 0.5 | steel/pvc | 1.5 | 17.5 | 45.24 | Monitoring | Active |
| 18A | Earth Data | 08/22/85 | 0.5 | steel/pvc | 1.5 | 17.0 | 47.28 | Monitoring | Destroyed* |
| 19A | Earth Data | 08/22/85 | 0.5 | steel/pvc | 1.5 | 17.0 | 46.68 | Monitoring | Active |
| 20AR | Earth Data | 09/18/85 | 1.25 | steel/pvc | 10.0 | 18.5 | 43.97 | Recovery | Active |
| 21A | Earth Data | 09/18/85 | 0.5 | steel/pvc | 1.5 | 16.0 | UN | Monitoring | Destroyed |
| 22A | Earth Data | 09/18/85 | 0.5 | steel/pvc | 1.5 | 17.0 | 48.11 | Monitoring | Active |
| 23A | Earth Data | 09/26/85 | 0.5 | steel/pvc | 1.5 | 17.0 | 42.90 | Monitoring | Destroyed* |
| 24A | Earth Data | 09/26/85 | 0.5 | steel/pvc | 1.5 | 17.0 | 42.47 | Monitoring | Active |
| 25A | Earth Data | 09/26/85 | 0.5 | steel/pvc | 1.5 | 17.5 | 42.68 | Monitoring | Active |
| 26A | Earth Data | 09/26/85 | 0.5 | steel/pvc | 1.5 | 17.5 | 42.34 | Monitoring | Active |
| 27A | Earth Data | 09/26/85 | 0.5 | steel/pvc | 1.5 | 17.5 | 42.91 | Monitoring | Destroyed* |
| 28A | Earth Data | 09/26/85 | 0.5 | steel/pvc | 1.5 | 18.5 | 44.42 | Monitoring | Destroyed |
| 29A | Earth Data | 09/26/85 | 0.5 | steel/pvc | 1.5 | 17.0 | 46.73 | Monitoring | Destroyed |
| 30A | Earth Data | 10/07/85 | 0.5 | steel/pvc | 1.5 | 17.0 | UN | Monitoring | Destroyed |
| 31A | Earth Data | 10/04/85 | 1.25 | steel/steel | 10.0 | 20.0 | 45.68 | Monitoring | Active |
| 32AR | Earth Data | 10/04/85 | 2.0 | steel/pvc | 10.0 | 20.5 | 43.53 | Recovery | Active |
| 33A | Earth Data | 10/07/85 | 0.5 | steel/pvc | 1.5 | 17.0 | 44.70 | Monitoring | Active |
| 34AR | Earth Data | 10/23/85 | 2.0 | steel/pvc | 10.0 | 20.0 | 44.42 | Recovery | Active |
| 35AR | Earth Data | 10/16/85 | 2.0 | steel/pvc | 10.0 | 20.0 | 43.63 | Recovery | Active |
| 36AR | Earth Data | 10/16/85 | 2.0 | steel/pvc | 10.0 | 18.0 | 45.83 | Recovery | Active |
| 37A | Earth Data | 06/18/85 | 0.5 | steel/pvc | 1.5 | 18.0 | 44.92 | Monitoring | Missing |
| 38A | Earth Data | 06/18/86 | 0.5 | steel/pvc | 1.5 | 18.0 | 44.07 | Monitoring | Active |
| 39A | Earth Data | 06/18/86 | 0.5 | steel/pvc | 1.5 | 18.0 | 42.61 | Monitoring | Active |
| 40A | Earth Data | 06/18/86 | 0.5 | steel/pvc | 1.5 | 18.0 | UN | Monitoring | Destroyed |
| 41A | Earth Data | 06/18/86 | 0.5 | steel/pvc | 1.5 | 18.0 | 42.85 | Monitoring | Active |
| 42A | Earth Data | 06/18/86 | 0.5 | steel/pvc | 1.5 | 18.0 | 42.90 | Monitoring | Active |
| 43AR | Earth Data | 06/09/86 | 4.0 | steel/steel | 12.0 | 20.0 | 46.00 | Recovery | Active |
| 44A | Earth Data | 06/10/86 | 4.0 | steel/steel | 2.0 | 18.0 | 45.68 | Monitoring | Active |
| 45A | UN | UN | 1.0 | pvc/pvc | UN | UN | UN | Monitoring | Active |
| 45B | Earth Data | 05/10/86 | 4.0 | steel/pvc | 10.0 | 49.0 | 42.05 | Monitoring | Active |
| 46A | UN | UN | UN | UN | UN | UN | UN | Monitoring | Missing |
| 47A | UN | UN | UN | UN | UN | UN | UN | Monitoring | Missing |
| 48A | UN | UN | 1.0 | pvc/pvc | UN | UN | UN | Monitoring | Active |
| Simon | UN | UN | UN | UN | UN | UN | UN | Domestic | Active |
| Lamberson | UN | UN | UN | UN | UN | UN | UN | Domestic | Active |
| Harmic | UN | UN | UN | UN | UN | UN | UN | Domestic | Active |
| Phillips | UN | UN | UN | UN | UN | UN | UN | Domestic | Active |
| Killen | Johns Well | 04/83 | UN | UN | UN | 35.0 | UN | Domestic | Active |
| Gearh-Curley | UN | UN | UN | UN | UN | UN | UN | Domestic | Active |
| Johnson | Rudy Byler | 02/18/72 | UN | UN | UN | 32.0? | UN | Domestic | Active |
| Durham | Lifetime | 1970 | UN | UN | UN | 60.0 | UN | Domestic | Active |
| Cote | UN | UN | UN | UN | UN | UN | UN | Domestic | Active |
| Am. Roofing | UN | 04/84 | UN | UN | UN | 40.0 | UN | Domestic | Active |
| Gearhart-Old | UN | UN | UN | UN | UN | UN | UN | Domestic | Destroyed |
| Gearhart-New | John Fuhr | 09/11/85 | 2.0 | pvc/pvc | 5.0 | 50.0 | UN | Domestic | Active |
| Williams | Lifetime | 1974? | UN | UN | UN | 70.0? | UN | Domestic | Active |
| Gasseway | UN | UN | UN | UN | UN | UN | UN | Domestic | Active |
| Wickes | UN | UN | UN | UN | UN | UN | UN | Domestic | Active |

* Protective casing missing or destroyed; well exists, but can not be sampled.
UN Unknown
NA Not applicable

Sources: Cabe Associates, Inc., March 1987
BCM Engineers Inc. (BCM Project No. 00-6012-02)

# 3.0 ENVIRONMENTAL SETTING

## 3.1 REGIONAL SETTING

### 3.1.1 Physiography

The Chem-Solv site is located within the Atlantic Coastal Plain physiographic province, which is characterized as a series of unconsolidated or partially consolidated sand, gravel, silt, and clay layers. These sediments form a wedge which dips and thickens to the southeast. The thickness of the Coastal Plain sediments is approximately 3,300 feet in the vicinity of the site. This section of sediments consists of the Miocene Calvert Formation of the Chesapeake Group which is overlain by the surficial Columbia Formation. Regional geologic information is addressed with the local geologic setting in Section 3.2.1.

### 3.1.2 Climate

Climatological data for the region is available from the Dover, Delaware, weather station.

Long-term climatological data are available from the National Oceanic and Atmospheric Administration's (NOAA) Dover, Delaware, observation station. A monthly summary of average temperature, precipitation, and wind data for 1989 is provided in Tables 3-1 through 3-3.

### 3.1.3 Demographics

The total population of Kent County, Delaware, is 105,200, based on 1986 U.S. Census data. With a land area of 595 square miles, the number of people per square mile averages 176.8. The ratio of males to females in the county in 1984 was 94.7:100. Per capita personal income was $10,585.00 in 1984.

### 3.1.4 Land Use

The Chem-Solv site is located in an area zoned for agricultural, commercial, and residential land use. Strip development, consisting of commercial establishments and private residences, is found on both sides of Route 13 in the immediate vicinity of the site (Figure 3-1).

Immediately south of the site, also on the west side of Route 13, is an abandoned field which was part of a former drive-in theatre. The field extends behind the site to the west. South of this field is a lumber yard.

A one-story block building is located immediately to the north of the site. This structure was associated with a former truck stop/restaurant/fueling establishment. It is believed that this truck stop may have operated two underground storage tanks (USTs) during its lifetime. The remainder of the truck stop property is vacant. An antique furniture/refinishing store is located to the north of the former truck stop on the extreme southwestern corner of Routes 13 and 42 intersection. A church and cemetery are adjacent to the furniture store to the west. Across from the church, on the north side of Route 34, is a gasoline station/convenience store. A vacant lot, which used to be the site of a used car business, is located next to the convenience store on the extreme northwestern corner of the intersection of Routes 13 and 42.

An abandoned gasoline station is located on the northeastern corner of the intersection of Routes 13 and 42. A furniture store is located on the southeastern corner of this intersection, but both DNREC personnel and local residents indicated that a gasoline station was formerly located there. It is uncertain, but likely, that USTs were utilized to store fuel at both former gasoline stations.

Both sides of Route 42 proceeding east from Route 13 contain private homes, with the exception of the cases described above. A roofing business, a residential home, and a used truck business are all located across Route 13 from the site (proceeding south along Route 13 from the furniture store).

A Pennsylvania railroad line is located approximately 3,000 feet west of the Chem-Solv site. The rail line runs in a north-south direction.

## 3.2 SITE SETTING

### 3.2.1 Geology

The Chem-Solv site is located within the Coastal Plain Physiographic Province which is characterized as a series of unconsolidated or partially consolidated sand, gravel, silt, and clay layer. These sediments form a wedge which dips and thickens to the southeast. The thickness of the Costal Plain sediments is approximately 3,300 feet in the vicinity of the site. This section of sediments consists of the Miocene Calvert Formation of the Chesapeake Group overlain by the surficial Columbia Formation. Figure 3-2 shows a general profile of the geologic section under the site.

Local geologic conditions are summarized in the following sections. Available DNREC monitoring well logs are provided in Appendix F. Logs for the wells and borings installed for this remedial investigation are provided in Appendices D and E.

#### 3.2.1.1 Soils

The Columbia Formation, a non-marine fluvial deposit, outcrops at the Chem-Solv site. This formation is locally characterized by unconsolidated, moderately-to-poorly sorted, coarse to fine, brown to orange quartz sand. Thin clay, silt, and gravel interbeds are common within the formation.

The surficial sediments of the Columbia Formation are immediately underlain by the Miocene-age sediments of the Chesapeake Group. These sediments are characterized by gray to bluish-gray silts that are commonly fossiliferous, and sometimes sandy. This wedge of sediments begins just south of Middletown, Delaware, and reaches a maximum thickness of 1,550 feet at Fenwick Island (Sundstrom and Pickett, 1968). The nature of these sediments suggests that they were deposited through a series of marine transgressive and regressive sequences.

#### 3.2.1.2 Stratigraphy

The Columbia Formation ranges in thickness from 20 to 40 feet in the vicinity of the site. Wells and borings at the site have encountered a silty confining layer (approximately 1 to 6 feet thick) at approximately 18 to 23 feet below grade at the site. This confining layer separates the upper and lower portions of the water table aquifer.

This confining layer extends offsite to the Route 13 median. The silt layer was encountered in boring CSB-4 and MWS-3-17, located on the Lambertson property and the American Roofing property, respectively. This confining layer was not encountered at any other offsite location. A second silt confining layer was encountered at shallower depths (approximately 14 feet below grade) at borings CSB-2 and CSB-3 and well MWS-6-25. This confining layer is not laterally continuous with the silt layer encountered beneath the Chem-Solv site.

### 3.2.2 Hydrogeology

The average depth to groundwater is approximately 8 feet below ground surface at the site. Due to its limited saturated thickness, only domestic well water needs can be met from this aquifer. However, the aquifer is a source of recharge for deeper artesian aquifers and provides baseflow to local streams. The Columbia Formation is underlain by a dark clayey silt of Miocene age. The clayey silt acts as a confining layer between the Columbia Formation and the underlying Cheswold aquifer of the Calvert Formation.

Groundwater level measurements were obtained March 27 and April 4, 1990. Water level measurements and the resulting groundwater elevations are provided in Table 3-3. Potentiometric surface contour maps of the water table (shallow zone) aquifer are provided as Figures 3-3 and 3-4. Potentiometric surface contour maps for the intermediate zone aquifer are provided as Figures 3-5 and 3-6.

Water levels in the intermediate zone are slightly deeper under non-pumping conditions than levels in the shallow zone. A difference in head of between 0.59 and 0.70 feet was commonly observed.

Calculated water table gradients of the shallow zone varied from 0.0014 and 0.0035 in previous investigations (CABE, 1987); these gradients ranged from 0.013 to 0.0017 in March and April 1990. Groundwater flow direction is roughly north to northeast; however, groundwater movement in the intermediate zone is roughly parallel to that in the shallow zone (in a northeast direction). Previously calculated horizontal gradients of the piezometric surface of the intermediate zone varied between 0.00025 and 0.0009 (CABE, 1987); gradients in the intermediate zone varied between 0.0025 and 0.00091 in March and April 1990.

CABE conducted pumping tests in six wells to determine the hydraulic properties of the shallow zone. Because of the varying duration of the tests, the varying distances between pumping and observation wells and the nature of the aquifer, there was a significant diversity of response in the observation wells. In some instances, the tests indicated a response typical of a confined aquifer. In others, the response was similar to a water-table aquifer. Where possible, values of transmissivity (T) and storativity (S) were calculated from straight line segments of semi-logarithmic plots.

CABE calculated transmissivity values which ranged from 1,429 gallons per day per foot (gpd/ft) to 11,330 gpd/ft. Calculated storage coefficients ranged from 0.008 to 0.159. Using a transmissivity of 2,200 gpd/ft, a value of 9.5 feet for the average saturated thickness of the shallow zone, then the average hydraulic conductivity (K) is calculated to be 232 gpd/ft$^2$ or 31.0 ft/day.

A groundwater flow velocity for the shallow zone was calculated by CABE that ranges between 0.30 and 0.75 ft/day. This calculation is based on an average hydraulic conductivity of 31 ft/day (K), a gradient between 0.0014 and 0.0035 and an average porosity of 0.15. For the March and April 1990 data, using a horizontal gradient between 0.013 and 0.0017 produces flow velocities ranging from 0.35 to 2.7 ft/day.

CABE conducted one pumping test in a well finished in the intermediate flow zone (OB-45B). The well was pumped for 1 hour at a rate of 21.4 gpm on June 18, 1986. A transmissivity value of 31,386 gpd/ft and a storativity value of $1.45 \times 10^{-5}$ was calculated from the test data.

Because the thickness of the intermediate zone is not known, CABE could not directly calculate a hydraulic conductivity (K) for the zone from the transmissivity value. Assuming that the aquifer is approximately 50 feet thick, the average hydraulic conductivity would be approximately 600 gpd/ft or 80 ft/day. If the effective porosity of the formation is 0.15, the average groundwater velocity in the intermediate zone under non-pumping conditions is approximately 0.2 feet/day. CABE concluded that the relatively low velocity is a direct result of low hydraulic gradients. For the March and April 1990 data, using a horizontal gradient between 0.0025 and 0.00091 produces flow velocities ranging from 0.19 to 0.52 ft/day.

CABE concluded that the clay layers separating the shallow and intermediate zones had continuity and possible areal extent. Information obtained during the stratigraphic investigation indicates that the clay layer has a limited areal extent. The layer is present under the Lambertson property (Boring CSB-4) from 19.5 to 23.2 feet below grade and the American Roofing property (Well MWS-3-17). However, a thin (approximately 1 foot thick), discontinuous clay lens was found extending from the Route 13 median to the northeast corner of the intersection of Routes 13 and 42 (Borings CSB-3 and CSB-5, and Well MWS-6-25); this layer is shallower than the silt layer beneath the Chem-Solv site (approximately 13 feet below grade). The clay found beneath the Chem-Solv site has continuity in the immediate vicinity of the site, but the areal extent is limited to the Route 13 median.

### 3.2.3 Surface Features

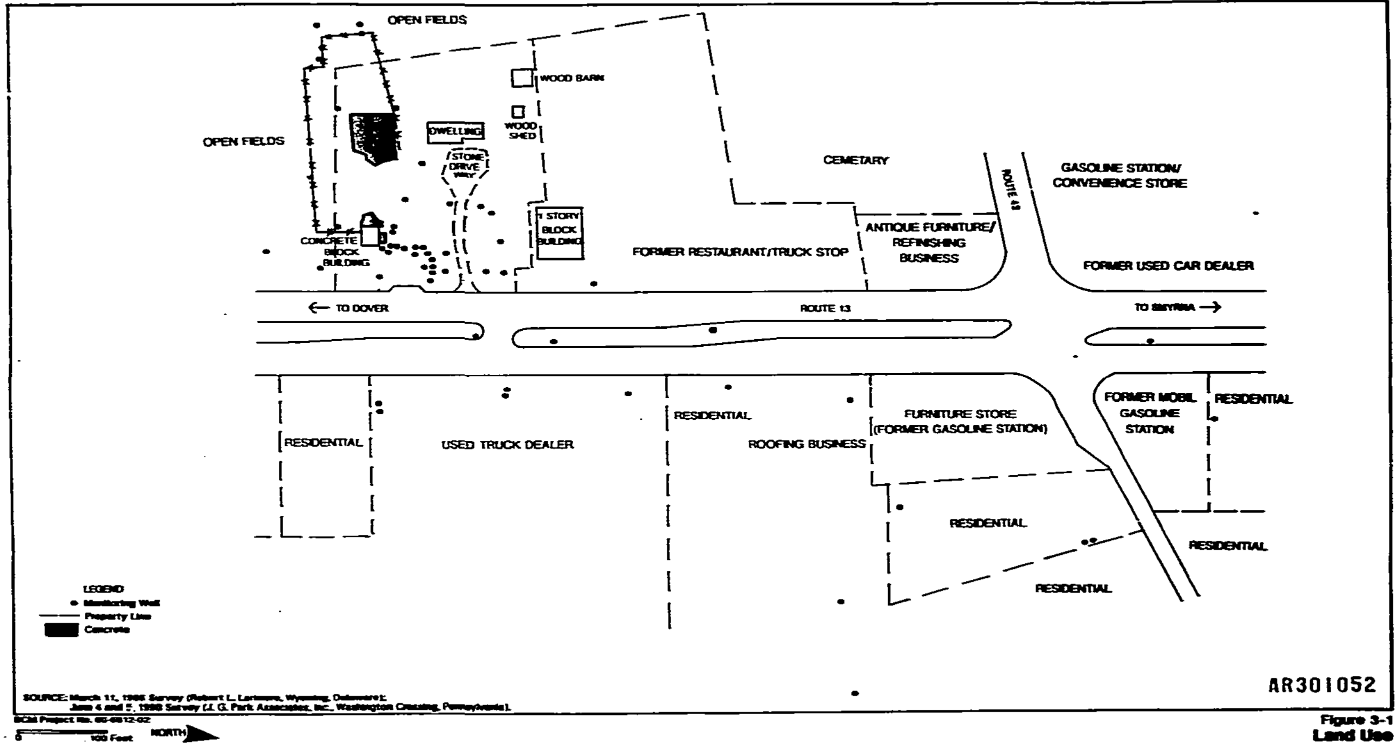
The principal regional surface water features include the Leipsic River, Garrisons Lake, Masseys Millpond, St. Jones River, and Silver Lake (Figure 3-7). The Leipsic River, which runs approximately east-west, is located 1.3 miles north of the site; the Alston Branch runs north-south, approximately 0.4 miles from the site. Masseys Millpond and Garrisons Lake, which are located along the Leipsic River, are situated approximately 2.5 miles and 1.5 miles northwest of the site. Silver Lake, which is located along the St. Jones River, is located 3.2 miles southeast of the site. The St. Jones River runs approximately north-south along the eastern edge of Dover, Delaware.

Site topography is fairly flat (Figure 3-8). A surface depression runs east-west along the southern site boundary; this depression resulted from the excavation and processing of 1,300 cy of soil during site soil remediation activities in 1985. Because this soil has been mechanically reworked, it has different physical characteristics from the surrounding undisturbed soil. As a result, surface water tends to collect in this depression following rain.

The site is generally well vegetated. A description of vegetation types is provided in Section 5.6.3.

BCM

# SECTION 3.0
# FIGURES



SOURCE: March 11, 1986 Survey (Robert L. Larimore, Wyoming, Delaware);
June 4 and 5, 1990 Survey (J. G. Park Associates, Inc., Washington Crossing, Pennsylvania).

BCM Project No. 00-6812-02

Figure 3-1
Land Use

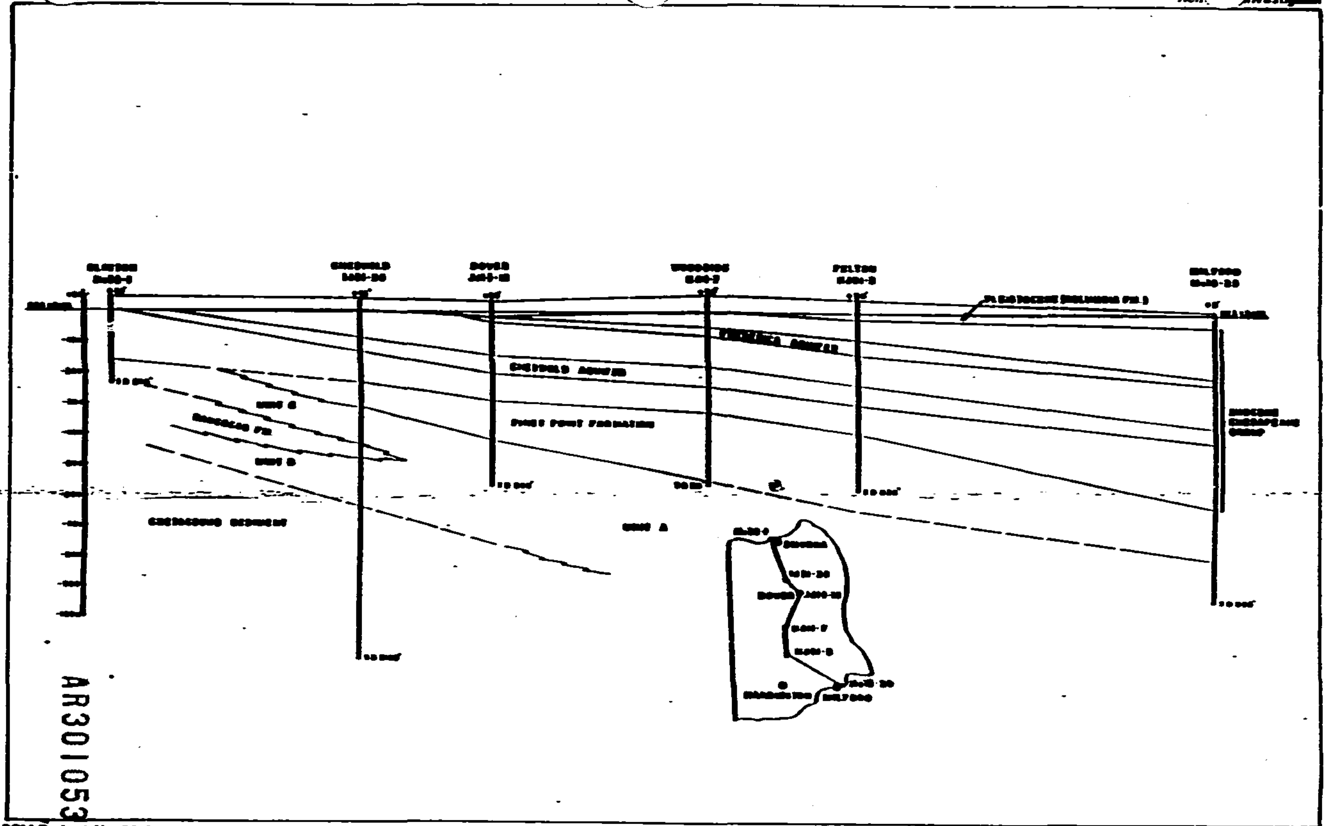
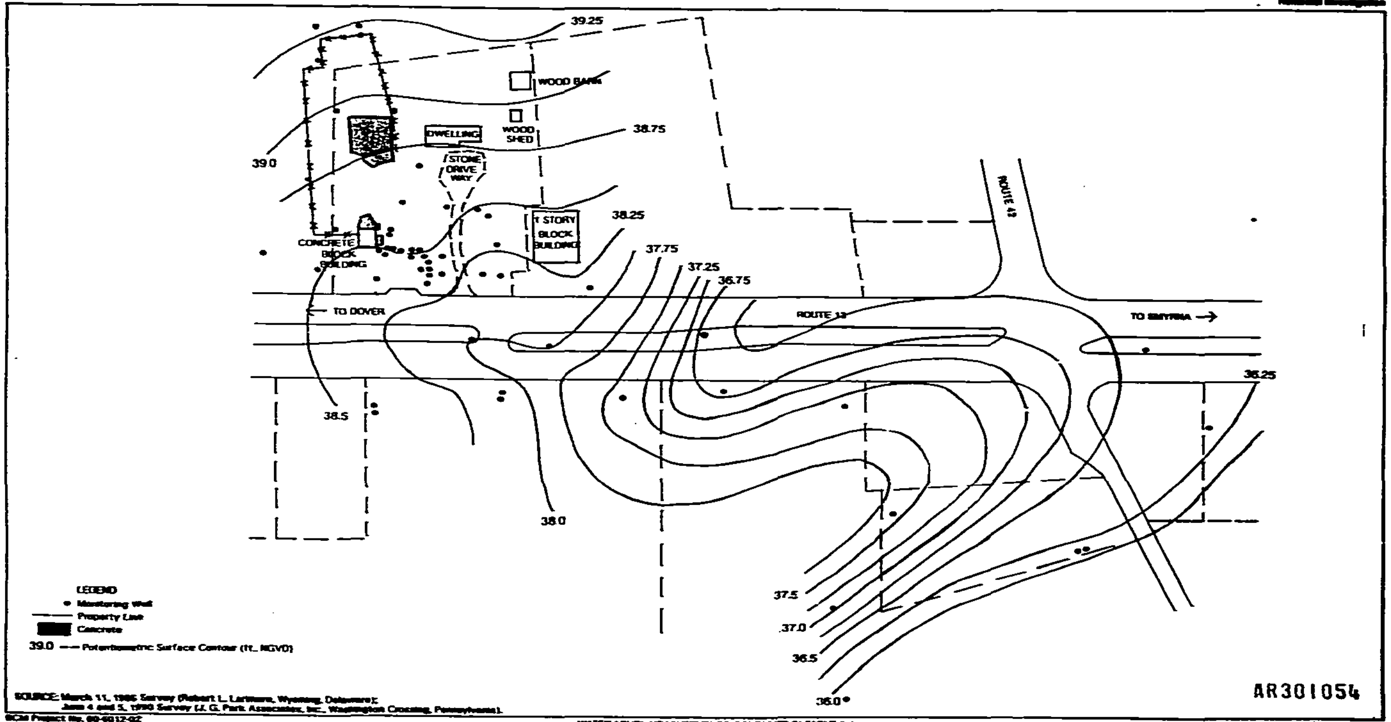


Figure 3-2
**Geologic Cross-Section of Kent County**



SOURCE: March 11, 1986 Survey (Robert L. Larimore, Wyoming, Delaware);
June 4 and 5, 1990 Survey (J. G. Park Associates, Inc., Washington Crossing, Pennsylvania).

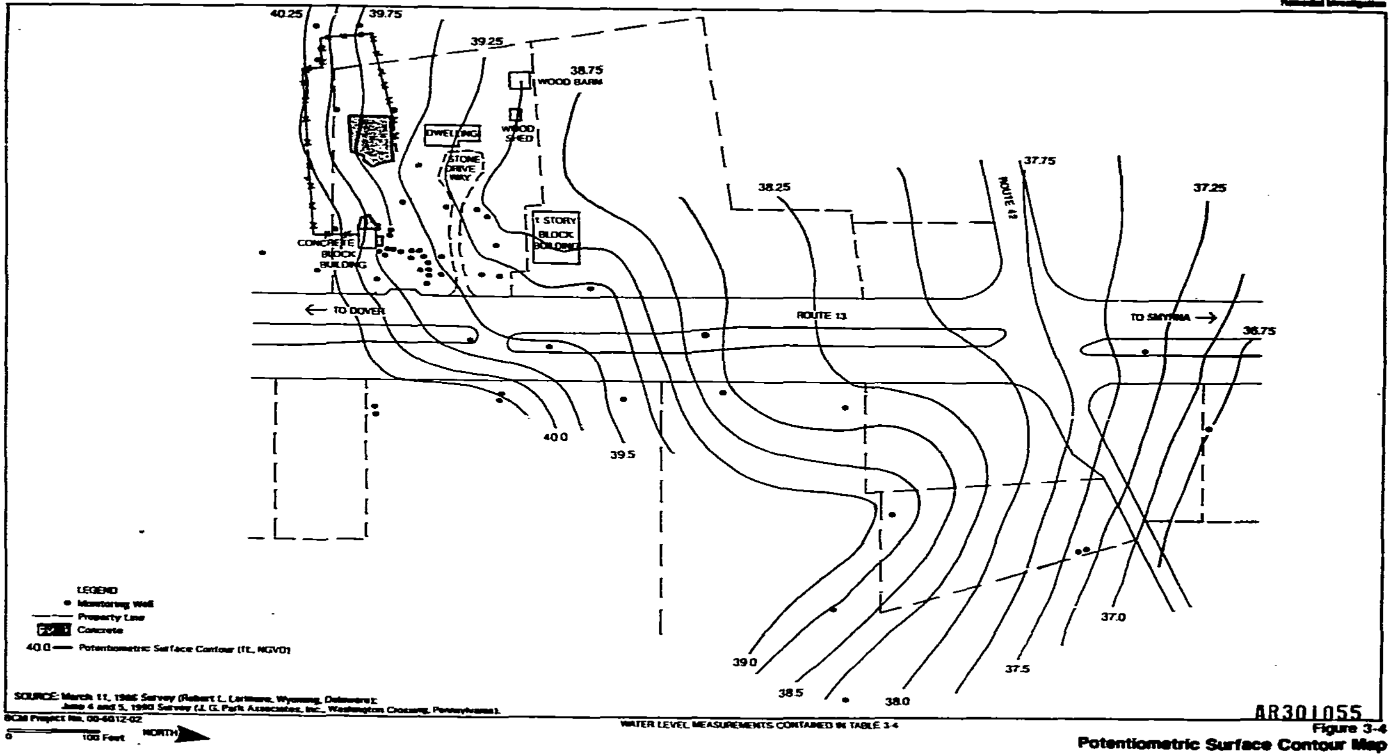
BCM Project No. 00-6012-02

WATER LEVEL MEASUREMENTS CONTAINED IN TABLE 3-4

Figure 3-3
Potentiometric Surface Contour Map
Shallow Wells-March 27, 1990

BCM

CHEM-SOLV, INC. SITE
Remedial Investigation



SOURCE: March 11, 1986 Survey (Robert L. Larimore, Wyoming, Delaware);
June 4 and 5, 1990 Survey (J. G. Park Associates, Inc., Washington Crossing, Pennsylvania).

BCM Project No. 00-6012-02

WATER LEVEL MEASUREMENTS CONTAINED IN TABLE 3-4

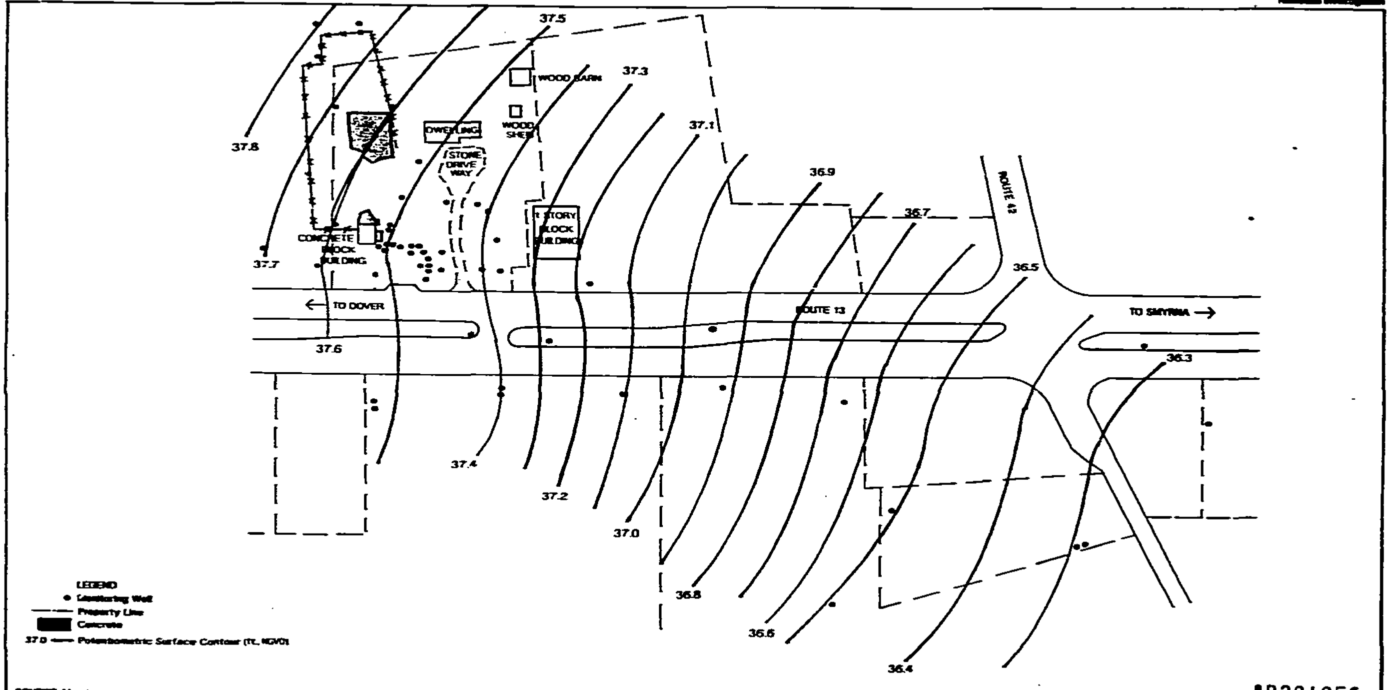
AR301055

Figure 3-4
Potentiometric Surface Contour Map
Shallow Wells-April 4, 1990

*If the page filmed in this frame is not as readable or legible as this label, it is due to substandard color or condition of the original page.*

BCM

CHEM-SOLV, INC. SITE
Remedial Investigation



AR301056

SOURCE: March 11, 1986 Survey (Robert L. Larimore, Wyoming, Delaware);
June 4 and 5, 1990 Survey (J. G. Park Associates, Inc., Washington Crossing, Pennsylvania).

BCM Project No. 00-0812-02

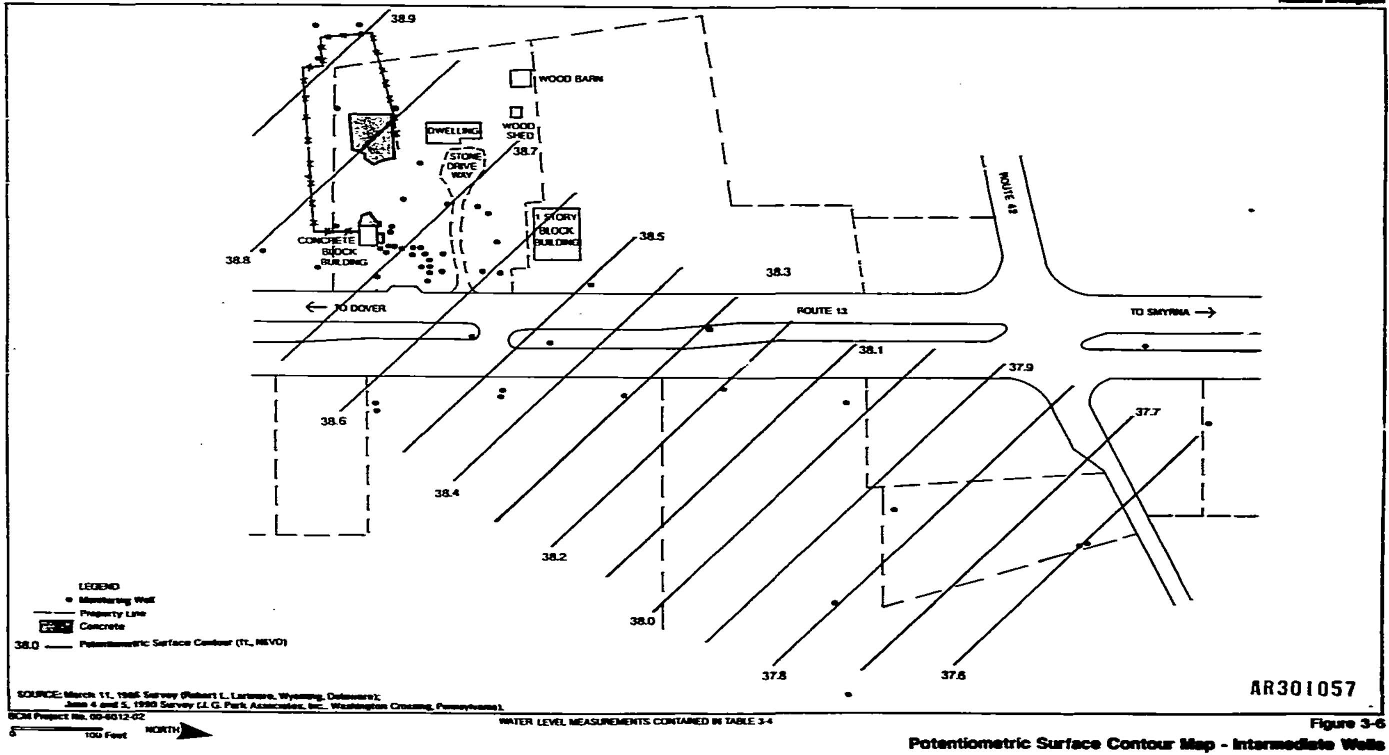
Water Level Measurements Contained in Table 3-4

Figure 3-5
Potentiometric Surface Contour Map
Intermediate Wells-March 27, 1990

*If the page filmed in this frame is not as readable or legible as this label, it is due to substandard color or condition of the original page.*

BCM

CHEM-SOLV, INC. SITE
Remedial Investigation



AR301057

SOURCE: March 11, 1986 Survey (Robert L. Larimore, Wyoming, Delaware);
June 4 and 5, 1990 Survey (J. G. Park Associates, Inc., Washington Crossing, Pennsylvania).

BCM Project No. 00-6812-02

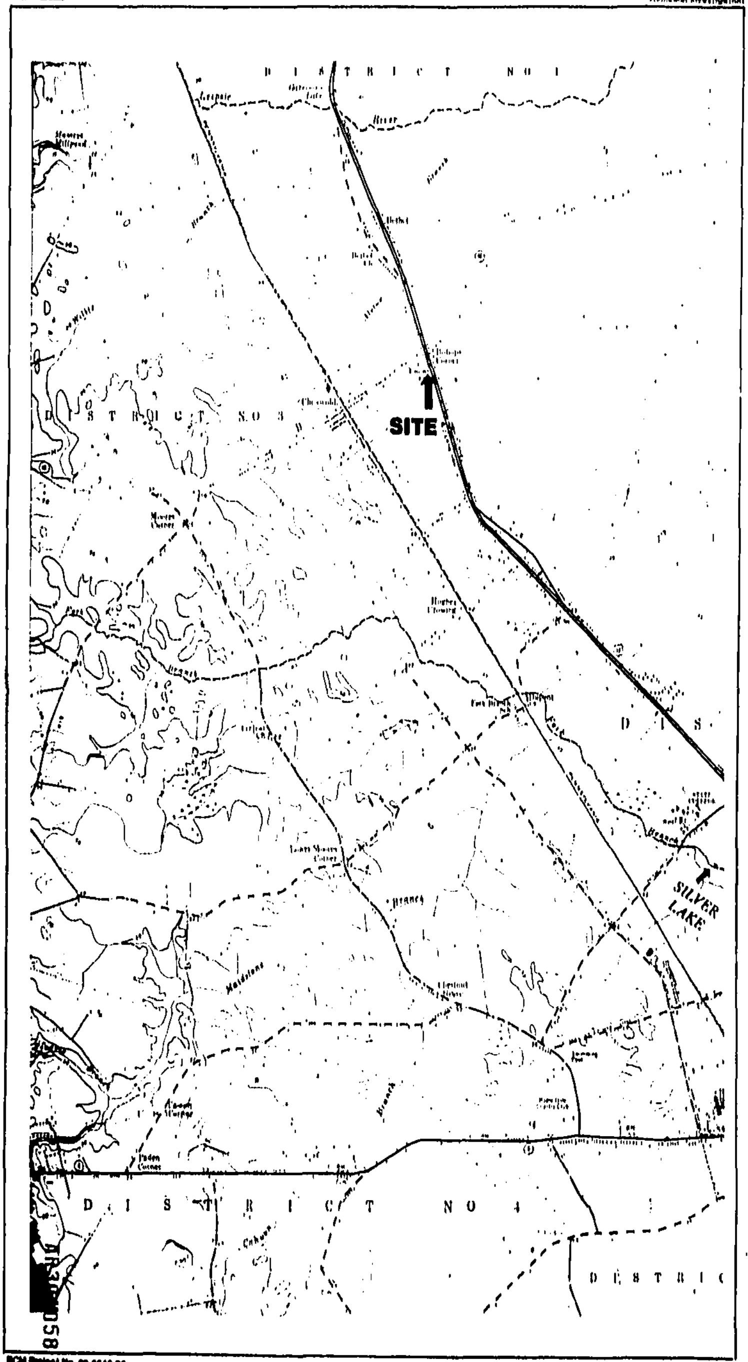
WATER LEVEL MEASUREMENTS CONTAINED IN TABLE 3-4

Figure 3-6

**Potentiometric Surface Contour Map - Intermediate Wells**

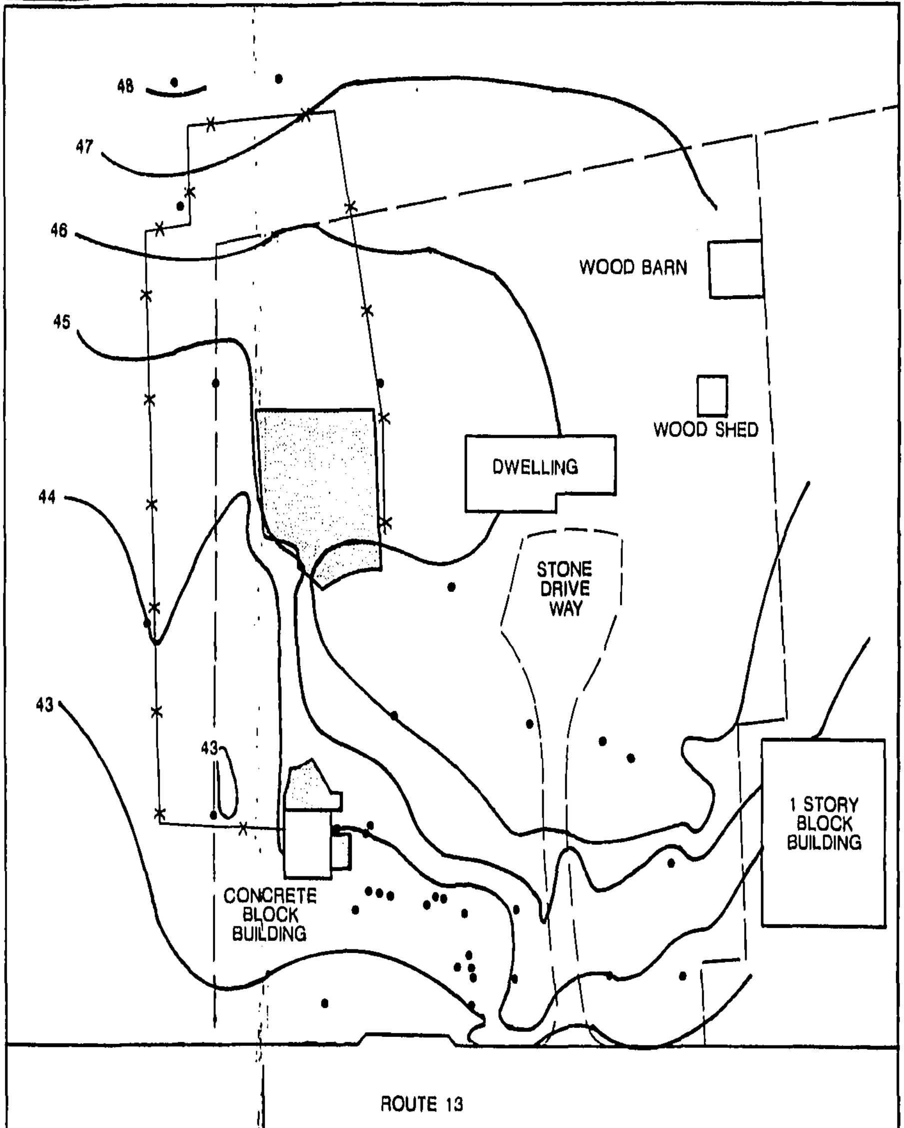
**April 4, 1990**

*If the page filmed in this frame is not as readable or legible as this label, it is due to substandard color or condition of the original page.*



BCM Project No. 00-6012-02

Figure 3-7
Regional Surface Water Bodies



Topographic survey performed by J.G. Park Associates Inc. of Washington Crossing, Pennsylvania on June 4, 5, 1990.

SOURCE: March 11, 1986 Survey (Robert L. Larimore, Wyoming, Delaware); June 4 and 5, 1990 Survey (J. G. Park Associates, Inc., Washington Crossing, Pennsylvania).

BCM Project No. 00-6012-02

0 50 Feet

NORTH

LEGEND
- ● Monitoring Well
- — — Property Line
- ▨ Concrete
- 44 —— Topographic Contour (ft, NGVD)

Figure 3-8
**Site Topography**

BCM

# SECTION 3.0
# TABLES

## TABLE 3-1

## AVERAGE MONTHLY TEMPERATURE DATA
## DOVER AIR FORCE BASE

## CHEM-SOLV, INC. SITE REMEDIAL INVESTIGATION
## CHESWOLD, DELAWARE

| Month | Average Temperature (°F)* |
|---|---|
| January | 33 |
| February | 36 |
| March | 43 |
| April | 53 |
| May | 63 |
| June | 72 |
| July | 76 |
| August | 75 |
| September | 68 |
| October | 58 |
| November | 47 |
| December | 37 |

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* Monthly averages compiled from December 1942 through August 1986.

Source: U.S. Department of Commerce
National Oceanic and Atmospheric Administration

BCM

## TABLE 3-2

## AVERAGE MONTHLY PRECIPITATION DATA
## DOVER AIR FORCE BASE

## CHEM-SOLV, INC. SITE REMEDIAL INVESTIGATION
## CHESWOLD, DELAWARE

| Month | Average Precipitation (inches)* |
|---|---|
| January | 3.0 |
| February | 3.0 |
| March | 3.9 |
| April | 3.2 |
| May | 3.4 |
| June | 3.2 |
| July | 4.3 |
| August | 4.4 |
| September | 3.5 |
| October | 3.0 |
| November | 3.5 |
| December | 3.5 |

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* Monthly averages compiled from December 1942 through August 1986.

Source: U.S. Department of Commerce
National Oceanic and Atmospheric Administration

BCM

## TABLE 3-3

## AVERAGE MONTHLY WIND DATA

## DOVER AIR FORCE BASE

## CHEM-SOLV, INC. SITE REMEDIAL INVESTIGATION
## CHESWOLD, DELAWARE

| Month | Prevailing Direction* | Average Speed* |
|---|---|---|
| January | WNW | 8 |
| February | NW | 7 |
| March | NW | 8 |
| April | WNW | 7 |
| May | SSW | 6 |
| June | SSW | 5 |
| July | SSW | 5 |
| August | SSW | 5 |
| September | N | 5 |
| October | N | 6 |
| November | W | 7 |
| December | WNW | 7 |

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* Monthly averages compiled from December 1942 through August 1986.

Source: U.S. Department of Commerce
National Oceanic and Atmospheric Administration

BCM

## TABLE 3-4

## WATER LEVEL MEASUREMENTS

## CHEM-SOLV, INC. SITE REMEDIAL INVESTIGATION
## CHESWOLD, DELAWARE

| Well | Reference Elevation (ft., NGVD) | Depth to Water (ft. below ground surface) 03/27/90 | Depth to Water (ft. below ground surface) 04/04/90 | Groundwater Elevation (ft., NGVD) 03/27/90 | Groundwater Elevation (ft., NGVD) 04/04/90 |
|---|---|---|---|---|---|
| 2A | 46.00 | 7.48 | 5.64 | 38.52 | 40.36 |
| 3A | 46.88 | 7.88 | 6.98 | 39.00 | 39.90 |
| 4A | 47.49 | 8.67 | 7.93 | 38.82 | 39.56 |
| 5A | 45.42 | 7.04 | 5.82 | 38.38 | 39.60 |
| 5AR | 44.65 | 6.32 | 5.05 | 38.33 | 39.60 |
| 5B | 45.63 | 8.11 | 6.90 | 37.52 | 38.73 |
| 6B | 46.27 | (1) | 7.35 | (1) | 38.92 |
| 8A | 42.30 | 4.09 | 2.01 | 38.21 | 40.29 |
| 8B | 42.30 | 4.90 | 3.86 | 37.40 | 38.44 |
| 9A | 46.24 | 7.95 | 7.22 | 38.29 | 39.02 |
| 9B | 46.00 | 8.57 | 7.32 | 37.43 | 38.68 |
| 10A | 43.46 | 5.90 | 3.79 | 37.56 | 39.67 |
| 11A | 43.45 | 5.02 | 3.51 | 38.43 | 39.94 |
| 13A | 45.43 | 6.59 | 5.04 | 38.84 | 40.39 |
| 14A | 44.28 | 5.80 | 3.68 | 38.48 | 40.60 |
| 15A | 45.59 | 7.21 | 6.13 | 38.38 | 39.46 |
| 16A | 43.83 | 5.65 | 4.45 | 38.18 | 39.38 |
| 17A | 45.24 | 6.98 | 6.14 | 38.26 | 39.10 |
| 18A | 47.28 | 8.50 | (2) | 38.78 | (2) |
| 19A | 46.68 | 8.02 | 7.24 | 38.66 | 39.44 |
| 20AR | 43.97 | (3) | (3) | (3) | (3) |
| 22A | 48.11 | 8.87 | 8.39 | 39.24 | 39.72 |
| 24A | 42.47 | 4.40 | 2.86 | 38.07 | 39.61 |
| 25A | 42.68 | 4.60 | 3.15 | 38.08 | 39.53 |
| 26A | 42.34 | 4.11 | 3.03 | 38.23 | 39.31 |
| 27A | 42.91 | (4) | (4) | (4) | (4) |
| 31A | 45.68 | 7.01 | 4.69 | 38.67 | 40.99 |
| 32AR | 43.53 | 5.19 | 3.86 | 38.34 | 39.67 |
| 33A | 43.70 | 5.34 | 4.14 | 38.36 | 39.56 |
| 34AR | 44.42 | 5.90 | (2) | 38.52 | (2) |
| 35AR | 43.63 | 5.34 | (5) | 38.29 | (5) |
| 36AR | 45.83 | 7.52 | 6.19 | 38.31 | 39.64 |
| 38A | 44.07 | 8.16 | 6.91 | 35.91 | 37.16 |
| 39A | 42.61 | 5.91 | 4.03 | 36.70 | 38.58 |
| 41A | 42.85 | 5.48 | 4.47 | 37.37 | 38.38 |
| 42A | 42.90 | 5.27 | 4.00 | 37.63 | 38.90 |
| 43AR | 46.00 | 7.61 | 6.28 | 38.39 | 39.72 |
| 44A | 45.88 | 7.67 | 6.49 | 38.21 | 39.39 |
| 45A | (6) | 8.62 | 6.89 | (6) | (6) |
| 45B | 42.05 | -- | 5.84 | -- | 36.21 |
| 46A | (6) | 9.24 | 7.67 | (6) | (6) |
| MWI-1-43 | 49.67 | 11.86 | 10.67 | 37.81 | 39.00 |
| MWI-2-40 | 42.61 | 6.11 | 4.82 | 36.50 | 37.79 |
| MWI-4-40 | 40.90 | 4.60 | 3.30 | 36.30 | 37.60 |
| MWS-3-17 | 39.81 | 3.77 | 1.59 | 36.04 | 38.22 |
| MWS-5-18 | 40.37 | 4.27 | 3.00 | 36.10 | 37.37 |
| MWS-6-25 | 40.90 | 4.56 | 4.16 | 36.34 | 36.74 |
| MWS-7-25 | 40.25 | 3.81 | 2.86 | 36.44 | 37.39 |

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(1) Well 6B was not located until April 4, 1990.
(2) Could not get probe of electric water level recorder down well casing.
(3) Well 18A found April 4, 1990, with outer casing uprooted and inner casing bent.
(4) Outer casing destroyed and inner casing plugged with soil.
(5) Could not unlock box to access well head.
(6) No reference elevation available.
NGVD National Geodetic Vertical Datum

Sources: BCM Engineers Inc. (BCM Project No. 00-6012-02) and Cabe Associates (March 199

# 4.0 NATURE AND EXTENT OF CONTAMINATION

## 4.1 AIR CHARACTERIZATION

BCM conducted an air investigation on October 16, 1989, to evaluate the health and safety needs at the site prior to initiating sampling or intrusive activities. Organic vapor readings from 12 locations positioned around the perimeter of the site were obtained using both an HNu and OVA. These results are presented in Table 4-1.

No elevated organic vapor readings were encountered during this investigation.

## 4.2 SOURCE CHARACTERIZATION

### 4.2.1 DNREC Investigation Results

Soils in the vicinity of the former distillation building were analyzed for various parameters by DNREC in previous investigations. Approximately 1,300 cy of soil were excavated, treated, analyzed, and placed back into the excavation.

As mentioned in Section 1.2.2, SMC Martin conducted two phases of soil sampling at the Chem-Solv facility. Although a soil sample was apparently collected shortly after the September 1984 fire (CABE, 1987), no data were available concerning this sample. All soil sampling discussed below took place after the 1,300 cy of contaminated soil had been excavated (Appendix G).

The first phase of soil sampling occurred prior to the initiation of the soil shredding/aeration remedial process in May and August of 1985. Sampling during phase one was designed to determine:

1. The extent and amount of contamination existing in the soil that had not been excavated either in the resultant pit or nearby in-place soil

2. The specific range of concentrations and type of compounds present in the excavated (stockpiled) soils

The second phase of soil sampling occurred during the shredding/aeration operation in September and November 1985. Phase Two sampling was utilized to determine whether the shredding/aeration process was reducing the amount of volatile organic compound (VOC) contamination in the excavated soil.

### 4.2.1.1 Phase One Soil Sampling

On May 1, 1985, SMC Martin collected 11 Phase One soil samples. Six of these were grab-sampled from 6 inches into the excavation sidewall, two were grab-sampled from 6 inches into the floor of the excavation, and three each were composite-sampled from separate 3-foot borings into the stockpiled soil. For details of sampling methodologies, the reader is referred to the 1986 SMC Martin report.

The 11 samples were analyzed for the following VOCs:

- trichloroethylene (trichloroethene or TCE)
- 1,1,1-trichloroethylene
- tetrachloroethylene (tetrachloroethene or PCE)
- chloroform
- toluene
- xylene

However, chloroform, toluene, and xylene were not detected in any of the May 1, 1985, samples.

Total VOC concentrations in three of six sidewall samples were 40 micrograms per kilogram (ug/kg), 41 ug/kg, and 120 ug/kg. In the other three sidewall samples, none of the above VOCs were detected. In the floor samples, total VOC levels were 132 ug/kg, and 3,640 ug/kg; in the stockpiled soil samples, the total VOC concentrations were 131 ug/kg, 244 ug/kg, and 26 ug/kg.

Four Phase One composited soil samples were collected on May 10, 1985. Two samples were obtained from a 0- to 3-foot interval bored into the stockpiled soil. One sample was collected from a boring at a depth of 0.5 to 3 feet in a nearby drainage way. The fourth sample was taken from a 6-inch boring into the floor of the excavated pit. These samples were analyzed for TCE, PCE, 1,1,1-trichloroethene, and chloroform, even though chloroform and PCE were not detected in the May 1, 1985, samples.

Total VOC concentrations in the stockpiled soil samples were 41 ug/kg and 93 ug/kg, while that in the excavation floor sample was 282 ug/kg. The sample collected from the drainage way did not contain any of the above VOCs.

On August 16, 1985, the last Phase One samples were collected. Thirteen samples were composited from a 0- to 3-foot interval bored into the in-place soils adjacent to the stockpiled soils. Six of these samples were analyzed for an indeterminable list of VOCs and seven samples were analyzed for certain VOCs and acid/base neutral organic compounds.

No acid/base neutral organic compounds were detected in any of the above samples. Two samples contained VOCs with the total concentrations of 31 ug/kg and 1.9 ug/kg.

Twenty-four samples were also collected from the soil stockpiles on August 16, 1986. These samples were composited from 3- to 4-foot intervals in boreholes up to 9 feet deep and were analyzed for VOCs. Fourteen samples had VOCs detected with total concentrations ranging from 1.1 ug/kg to 480 ug/kg.

From the above discussion, it is clear that some VOC contaminated soil had been left in the area where the 1,300 cy of soil was excavated. The excavation did not extend laterally far enough nor deep enough, although the soil was apparently removed to the water table. In addition, the in-place soil in the vicinity of the stockpiled soils appears to have some minor VOC contamination. The stockpiled soils contained significant levels of VOCs prior to soil shredding/aeration. A summary of the Phase Two sampling to determine the VOC removal efficiency of the remedial process is contained in the following section.

#### 4.2.1.2 Phase Two Soil Sampling

During the soil shredding/aeration process, soil samples were collected before and after passage through the system to evaluate VOC removal across the shredder. To facilitate easier handling of the material, the entire soil stockpile was divided into eleven lots. A total of 122 samples were collected as each of the eleven lots was passed through the shredder.

### 4.2.2 Remedial Investigation Results

During the RI investigation, samples of unsaturated soils from locations around the edge of the former excavation were analyzed for TCL organic and TAL inorganic parameters. Results from these soil samples were used to determine if the undisturbed soils adjacent to the excavation contained volatile contaminants associated with the site. In addition, previous sampling by DNREC concentrated on characterization of volatile organic compounds. Results of the additional organic and inorganic analyses were used to characterize these compounds at the site.

Sixteen soil samples, including two field duplicate samples, were retained from unsaturated soils at seven boring locations and submitted to the IEA laboratory for TCL organic and TAL inorganic analyses. These samples were obtained in December 1989 and February 1990. Seven soil samples, which were obtained from the interval just above the silt/clay layer, were analyzed for TCL volatile organic analyses. A summary of the analytical results is presented in Table 4-2. The distribution of organic compounds detected onsite is shown on Figure 4-1. All analytical data and accompanying documentation is contained in Appendices H and I. The data validation report for these samples is provided as Appendix J.

Four split samples from three locations were retained for EPA by CDM personnel for chemical analyses. A summary of this data is presented in Table 4-3. The EPA data validation reports which contain the analytical data and documentation are contained in Appendix K.

#### 4.2.2.1 Volatile Organic Compounds

Four volatile organic compounds, acetone, chloroform, methylene chloride, and trichloroethene (TCE), were detected in onsite soils. However, the presence of acetone and methylene chloride in the soils can not be positively attributed to the samples due to contamination of the associated blanks with these compounds. The distribution and concentration of chloroform and TCE are shown on Figure 4-1.

Chloroform was detected in three samples, CSB-6 (6-7.3), CSB-7 (8-10), and CSB-7 (20.5-20.8), at concentrations ranging from 4 micrograms per kilogram (ug/kg) to 8 ug/kg. TCE was detected in two surface samples, CSB-8 (0.5-2) and CSB-11D (0.5-2), at levels of 5 ug/kg and 6 ug/kg, respectively. TCE was not detected in the CSB-11 (0.5-2) duplicate sample; however, the detected concentration of TCE was at the quantitation limit for that compound and does not constitute a discrepancy in the data set.

One soil sample from among those collected in December 1989 contained one volatile organic tentatively identified compound (TIC) at an estimated concentration of 10.0 ug/kg. This sample was obtained from the 0.5- to 2-foot interval of Boring CSB-12.

#### 4.2.2.2 Semivolatile Organic Compounds

Three semivolatile organic compounds, benzoic acid, bis (2-ethylhexyl) phthalate, and isophrone, were detected in the soil samples. Benzoic acid was detected in one surface sample, CSB-12 (0.5-2) at 290 ug/kg. Bis (2-ethylhexyl) phthalate was found in five soil samples at concentrations ranging from 78 ug/kg to 510 ug/kg. Isophrone was detected in both samples of unsaturated soils retained from Boring CSB-10 at concentrations of 3,100 ug/kg in the shallow soil (0.5 to 2 feet) and 1,600 ug/kg in the deeper soil (2 to 4 feet).

The presence of semivolatile organic TICs in soils was far more widespread. Various TICs were detected in every boring. In general, unknowns were the most prevalent class of TICs detected, as each sample contained unknowns. In addition, unknown ketones were detected in 11 of 16 samples.

The lowest total concentrations of TICs were in the two borings (CSB-6 and CSB-7) located south of the former concrete drum storage pad near the property line. (see Figure 4-1). Likewise, the highest total TIC concentrations were detected in Borings CSB-10 and CSB-11, which were located in the area near the former distillation building. Although the CSB-11 (0.5-2) sample had the highest levels of total TICs (33,900 ug/kg), a duplicate of this sample contained almost 10 times fewer (3,800 ug/kg) total TICs. Especially suspect in this sample is the presence of dioctyl ester-hexanedioic acid at 20,000 ug/kg, which was also detected in the blank, but not detected in the duplicate sample.

No trends were apparent with respect to total TICs or compound variation with increasing depth. The boring nearest to the concrete office building (CSB-12) contained the greatest variety of TIC compounds. CSB-11 (0.5-2) also contained several different compounds, but the presence of one of these TICs as stated above, is suspect. It is apparent, however, that higher concentrations of total TICs are closer to the site of the September 1984 spill.

#### 4.2.2.3 Pesticides and PCBs

The pesticide 4,4'-DDT (DDT) and two of its associated breakdown products 4,4'-DDD (DDD) and 4,4'-DDE (DDE), were detected in the onsite soils. The distribution and concentration of these compounds in the soils is shown on Figure 4-1.

DDT was detected in 10 samples at concentrations ranging from 3.9 ug/kg to 99 ug/kg. DDE was detected in 11 samples at levels from 8.6 ug/kg to 310 ug/kg.

DDD was reported in Sample CSB-11 (0.5-2) and the field duplicate at levels of 20 ug/kg and 23 ug/kg. DDD was not reported for these samples by IEA; however, it was determined during the BCM data validation that these results should have been reported (see Appendix J).

Based on the distribution pattern of these compounds in the soil and the proximity of the site to former agricultural fields, DDT and the related compounds are not site-related. With the exceptions of Borings CSB-6 and CSB-7, DDT and its breakdown products were detected at similar levels throughout the samples. In all samples, DDT was found at lower concentrations than DDE, indicating a long residence time in the soils. In addition, DDT has been banned since 1974. Thus, DDT is not site-related.

#### 4.2.2.4 Inorganic Compounds

Nineteen metals were detected in onsite soils. Of these metals, the presence of beryllium and sodium cannot be confirmed in any sample due to contamination of the associated blanks for these parameters. In addition, the presence of nickel, potassium, and zinc in some samples was questioned during data validation. A discussion of the reasons leading to these conclusions may be found in the quality assurance review (Appendix J).

### 4.2.3 Summary

Based on an evaluation of the data, there are no compounds present in onsite soils at levels of concern. BCM submitted a preliminary review of this data to DNREC and EPA Region III in an Interim Document dated June 1, 1990 (Appendix A-7). EPA agreed with the conclusion that there were no chemicals of concern in site soils (Appendix A-8).

## 4.3 GROUNDWATER CHARACTERIZATION

Groundwater quality information for the site has been collected since October 1984. From 1984 until November 1988, DNREC conducted a quarterly groundwater monitoring program to characterize the constituents of and monitor the evolution of the plume. In addition, in December 1985 DNREC installed and operated a groundwater recovery system, and monitored groundwater quality of the untreated and treated water. DNREC resumed quarterly groundwater monitoring in June 1988; analytical data from June 1989 to the present is available. DNREC analytical results are presented in Appendices B, C, and L.

In April 1990, groundwater from 14 monitoring wells was sampled by BCM and analyzed for TCL organic compounds and TAL inorganic compounds. In addition, EPA split samples were retained by CDM personnel from three locations. BCM analytical results and accompanying documentation are contained in Appendix M; the quality assurance review of the groundwater sampling results is presented in Appendix N.

A discussion of groundwater quality for the shallow zone monitoring wells, the intermediate zone monitoring wells, and for nearby domestic wells is contained in Section 4.3.1; an assessment of groundwater quality in the vicinity of the site is provided in Section 4.3.2.

### 4.3.1 Groundwater Quality

The following sections presents groundwater quality information for the site from October 1984 to the present. DNREC analytical results are summarized in Tables 4-4 and 4-5; BCM analytical results for shallow zone and intermediate zone monitoring wells are summarized in Tables 4-6 through 4-9; and a summary of the analytical results for the EPA split samples is provided in Tables 4-10 and 4-11.

#### 4.3.1.1 Shallow Zone Monitoring Wells

DNREC Investigation Results

Analytical data collected by DNREC for the shallow aquifer has been evaluated over three time periods: (1) the period from October 1984, when the first monitoring wells were sampled, through November 1985, when the groundwater recovery system became operational, (2) the period from December 1985 through December 1988, when the recovery system was in operation, and (3) the period from December 1988 to the present, after groundwater treatment activities ceased. Summaries of groundwater analytical data from 1984 to 1985, from 1986 through 1988, and from 1988 through June 1990 are presented in Tables 4-4 and 4-5.

As illustrated in Table 4-4, VOCs were found in the shallow aquifer prior to initiation of the groundwater treatment system. Of these VOCs, trichloroethene (TCE) was identified as the major groundwater contaminant, along with other associated chlorinated hydrocarbons. Maximum detected concentrations of the VOCs ranged from 2.8 micrograms per liter (ug/l) of chlorobenzene to 130,000 ug/l of TCE. The other 12 VOCs and their maximum detected concentrations include: benzene (360 ug/l), chloroform (669 ug/l), 1,1-dichloroethane (414 ug/l), 1,1-dichloroethylene (3,200 ug/l), 1,2-dichloroethane (30 ug/l), trans-1,2-dichloroethylene (1,000 ug/l), ethylbenzene (1,100 ug/l), toluene (2,300 ug/l), 1,1,1-trichloroethane (1,800 ug/l), m-xylene (250 ug/l), o-xylene (106 ug/l), and p-xylene (111 ug/l). These data provide information regarding the suite of contaminants associated with the Chem-Solv site and with the evolution of the plume prior to initiation of the groundwater recovery and treatment system.

Initial sampling of monitoring wells 1A, 2A, 3A, 4A, and 5A in October 1985 showed total VOC concentrations ranging from not detected (Well 3A) to 1,774.1 ug/l in Well 1A (located immediately downgradient from the distillation building). By December 1985, total VOCs in Well 1A had increased to 112,730 ug/l, with a TCE level of 110,100 ug/l. The highest level of TCE detected in any of the wells was 130,000 ug/l at Well 1A in January 1985. Continued monitoring of groundwater quality indicated that by October 1985 the plume had migrated past the northeastern property boundary out to the edge of the Route 13 median; total VOC levels in Wells 24A and 25A, located in the median, were 223.8 ug/l and 418 ug/l, respectively.

In December 1985, the groundwater recovery system became operational; analytical results were obtained for both the untreated (RAW) and treated (TR) groundwater. In January 1986, total VOC levels in the untreated groundwater were 37,946 ug/l and 3.5 ug/l in the treated water. Total VOC concentrations in the untreated groundwater gradually decreased to a low of 1.7 ug/l in April 1988 and then increased to levels ranging from 49.4 ug/l in May 1988 to 173.2 ug/l in July 1988. Total VOC levels in the treated water ranged from not detected to 10.5 ug/l. Total VOC isoconcentration maps for November 1986 and June 1987 are shown on Figures 4-2 and 4-3.

After the groundwater recovery system was shut off in November 1988, the DNREC groundwater monitoring program was discontinued until June 1989. However, much of this sampling program is focused on monitoring local downgradient domestic wells. Since the recovery system was shut off, sampling of monitoring wells has been limited to an individual well in the area of the recovery system. No volatiles were detected in Well 5A in February 1990.

Remedial Investigation Results

Groundwater analytical results for samples obtained in April 1990 and analyzed for TCL organic compounds and TAL inorganic compounds are presented in Tables 4-6 through 4-9. Isoconcentration maps for total VOCs, total volatile tentatively identified compounds (TICs), and total semivolatile TICs are shown on Figures 4-4 through 4-6.

Seven volatile organic compounds, acetone, benzene, 1,2-dichloroethane (1,2-DCA), methylene chloride, tetrachloroethene (PCE), toluene, 1,1,1-trichloroethane (1,1,1-TCA), trichloroethene (TCE), and total xylenes, were found in five of the nine shallow wells (Table 4-6). Total VOC concentrations ranged from 5 ug/l in Well MWS-5-18 to 563 ug/l in Well 33A to 921 ug/l in Well MWS-7-25. Twelve volatile TICs were found in two of the wells at total concentrations of 6,800 ug/l and 2,660 ug/l for Well 26A and 2,640 ug/l for MWS-7-25.

The presence of 1,2-DCA in Well MWS-7-25 was questioned after a review of the supporting documentation (Appendix A-9).

Phenol was found in only one well (MWS-7-25) at an estimated concentration of 9 ug/l. Eleven semivolatile TICs were detected in three of the offsite shallow zone monitoring wells (26A, 41A, and MWS-7-25). No pesticides were found in any groundwater sample.

Both filtered and unfiltered groundwater samples were obtained from all wells and analyzed for TAL inorganic compounds. Twenty inorganics were detected in these samples (Table 4-7). These data were evaluated by comparing detected concentrations in the filtered versus the unfiltered samples for each well and by comparing detected concentrations versus the background levels found in Well 22A. Aluminum, barium, calcium, chromium, cobalt, iron, magnesium, manganese, potassium, selenium, sodium, and zinc were all found at higher levels in the filtered sample for at least one shallow well. EPA Region III QA guidance for groundwater filtration procedures and data evaluation (EPA, April 23, 1990) indicates that there may be several causes for this, specifically errors in sample labeling (when nearly all filtered sample concentrations are higher) and contamination from improperly cleaned filters (when iron, zinc, aluminum, and copper are higher in the filtered samples). Since the majority of the results for all samples show higher levels in the unfiltered samples, this does not appear to be a labeling error. To evaluate the possibility of contamination from improperly cleaned sampling equipment, results for the duplicate samples (Well 26A) and the field blanks were reviewed. With the exception of cobalt, all of the instances where a higher concentration was found in the filtered sample were not repeated in the duplicate sample.

In addition, arsenic, barium, calcium, cobalt, iron, magnesium, potassium, sodium, and zinc were found at higher levels in the filtered samples for at least one field blank. Thus, the cases with higher concentrations of inorganics in the filtered samples do not seem to represent sample labeling or equipment decontamination problems, but are probably a function of analytical method precision and accuracy.

Inorganic results were also compared with background groundwater quality, represented by Well 22A. Aluminum, barium, calcium, chromium, iron, manganese, mercury, potassium, sodium, vanadium, and zinc were found in at least one shallow well at levels significantly higher than background (greater than five times the background levels). Manganese and sodium were found in most or all of the downgradient wells at levels significantly greater than background. However, no other discernable pattern was detected for the compounds significantly above background groundwater quality levels.

Examination of Table 4-6 and Figures 4-4 through 4-7 shows the presence of two shallow groundwater plumes. A plume consisting primarily of TCE and other chlorinated solvents extends from the site to the Route 13 median. This configuration and the associated compounds found in groundwater in this area are in agreement with historical representations of the plume associated with the Chem-Solv site. In addition, the total VOC concentration for the onsite downgradient well (663 ug/l in Well 33A) is within the range of total VOC levels encountered in untreated groundwater from the recovery system prior to shutdown of the system in 1988.

Groundwater quality for Well MWS-7-25 does not agree with the groundwater quality associated with the site; the types and concentrations of the compounds detected in this well are dissimilar to the pattern associated with site groundwater contamination. Groundwater containing acetone, benzene, 1,2-DCA, and xylenes, as well as benzene-, pentane-, and hexane-related TICs was found in Well MWS-7-25. Benzene and xylenes are hydrocarbons generally associated with a fuel source, such as an underground storage tank, and not with the solvent source identified for the site. Benzene was found in MWS-7-25 at a concentration of 830 ug/l; the maximum benzene concentration found in groundwater onsite or near the site was 200 ug/l (Well 26A). In addition, the presence of benzene at in MWS-7-25 at concentrations much greater than levels found associated with the site as well as the fact that the maximum benzene concentration detected during the DNREC monitoring program was 360 ug/l, indicates that groundwater quality for this well has been influenced by additional source(s) other than the Chem-Solv site.

Groundwater quality associated with Well 26A appears to be a mixture of both plumes. While PCE, a compound associated with the site, was found in one of the two duplicate samples obtained from Well 26A at a concentration of 6 ug/l, acetone, benzene, toluene, and the benzene-, hexane- and pentane-substituted TICs were also in these samples. It is possible that a contamination source or sources, potentially underground storage tanks, located downgradient of the site between Wells 26A and MWS-7-25 could have impacted both wells.

EPA Split Sample Results

Split groundwater samples from Wells 41A and MWS-5-18 were provided to personnel from CDM Federal Programs Corporation (CDM) for analyses. A summary of these analytical results is contained in Tables 4-10 and 4-11. The EPA data validation reports containing the analytical results sheets and documentation are contained in Appendix O.

EPA split sample results for organic compounds generally agreed with the BCM data. Chloroform was detected by EPA in Well MWS-5-18 at an estimated concentration of 2 ug/l. Chloroform was undetected in the BCM data for this well; however, this does not represent a serious discrepancy due to the low level detected by EPA. Total semivolatile TICs found in the EPA and BCM data for Well 41A were at 48 ug/l and 86.1 ug/l, respectively. No pesticides were detected for any sample.

Detected concentrations of inorganic compounds for both the EPA and BCM data sets generally were within 10 percent. With the exception of antimony, which was not detected in any BCM result, the detected compounds for the split samples were the same. In addition, barium was detected in the filtered samples above the levels in the unfiltered samples for both wells. This pattern agrees with the pattern seen in the BCM data set and probably is a function of analytical precision and accuracy.

4.3.1.2 Intermediate Zone Monitoring Wells

DNREC Investigation Results

From October 1984 through November 1985, six volatile organic compounds were found in intermediate zone monitoring wells (Table 4-4). These compounds, chloroform, 1,1-dichloroethane (1,1-DCA), 1,2-dichloropropane, toluene, 1,1,1-trichloroethane (1,1,1-TCA), and TCE, were detected infrequently in onsite Wells 5B and 9B. No organic compounds were ever detected in the upgradient well (6B) or in the offsite side gradient and downgradient wells (7A and 8A). The maximum detected VOC levels detected were 1.3 ug/l chloroform, 1.2 ug/l 1,1-DCA, 38 ug/l 1,2-dichloropropane, 2.3 ug/l toluene, 2.1 ug/l 1,1,1-TCA, and 3.4 ug/l TCE. The presence of 1,2-dichloropropane in the intermediate zone (at Well 9B) is an anomaly since the compound was never detected in the upgradient well or in any of the shallow wells.

During groundwater remediation activities, the total VOC concentrations for the onsite intermediate zone wells ranged from not detected to 44.5 ug/l (Well 9B). No groundwater samples from the intermediate zone wells were obtained by DNREC after the groundwater recovery system was shut down in November 1988.

Remedial Investigation Results

Low concentrations of volatile and semivolatile compounds were found in the two onsite wells and the upgradient well (Table 4-8). TCE was detected in Well 5B at an estimated concentration of 5 ug/l and was undetected in Well 9B at the quantitation limit. Total semivolatile TICs were 10 ug/l in the upgradient well (MWI-1-43), 103 ug/l in Well 5B, and 60 ug/l in Well 9B. No volatile TICs, semivolatile organic compounds, or pesticides were detected in any groundwater sample.

EPA Results

Field duplicate samples were analyzed from Well 9B (Tables 4-10 and 4-11). No organic compounds were detected in either sample. Twelve inorganic compounds (aluminum, antimony, barium, calcium, iron, lead, magnesium, manganese, mercury, potassium, sodium, and zinc) were detected. Field duplicate results were generally within 20 percent of each other and with the BCM split samples. However, the aluminum concentration in Sample 9BD (227 mg/l) was twice the level in the duplicate sample (114 mg/l); aluminum concentrations for the BCM split samples were 428 mg/l and 398 mg/l.

#### 4.3.1.3 Domestic Wells

Up to 14 domestic wells located down or side gradient from the site have been monitored since October 1984. The majority of these wells collect water from deeper zones in the aquifer (greater than 100 feet below ground surface); however, the total depth of some of these wells is unknown (CABE, 1987). Analytical data indicates low concentrations of VOCs have been detected in some of the residential wells. A replacement well was installed on the Gearhart property because of the presence of VOCs; however, this well was apparently improperly installed and became contaminated with groundwater from the shallow aquifer. A new well was installed to a deeper depth.

### 4.3.2 Assessment of Groundwater Quality

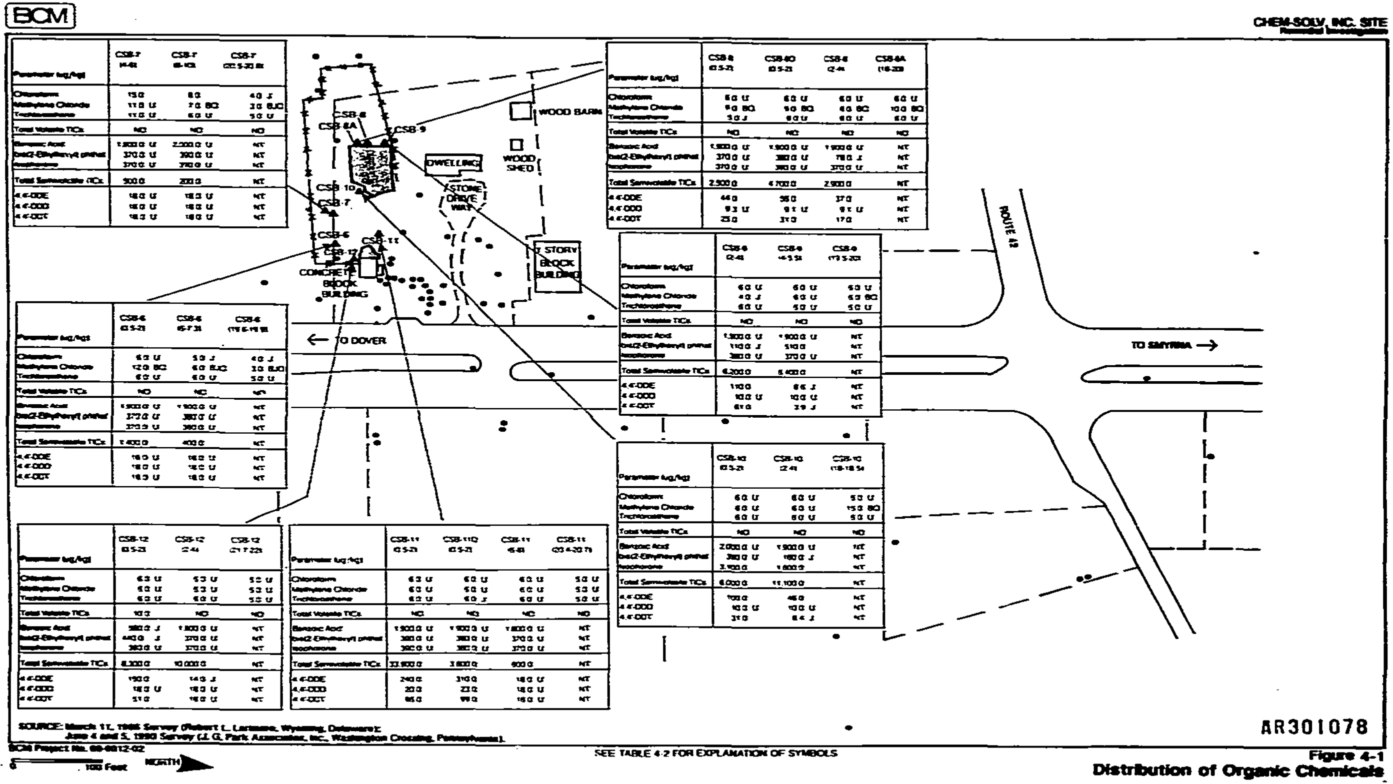
Data from the historic data base was used to evaluate the horizontal and vertical migration of the plume from a period shortly after the explosion and fire in October 1984 to November 1988, when the groundwater recovery system was shut down. Data collected during RI field activities was used to confirm the information collected by DNREC and monitor any further plume migration since the cessation of groundwater remediation activities. In addition, these data were used to provide additional data necessary to characterize semivolatile compounds, pesticides, and inorganic compounds in both the shallow and intermediate aquifer zones.

Groundwater quality information obtained during this and previous investigations indicates that groundwater from the shallow aquifer has been impacted with organic compounds, primarily TCE and related compounds. A groundwater plume extends in the shallow groundwater from the area below the former distillation building to the eastern edge of Route 13. Impact to the deeper zones of the aquifer has been limited by the presence of a silt layer approximately 20 feet below the ground surface in the vicinity of the site. However, some VOC contamination of the intermediate zone has occurred, as indicated by low levels of VOCs in the intermediate zone monitoring wells and nearby domestic wells.

In addition, a second plume has been identified just north of the intersection of Routes 13 and 42. Groundwater quality data and hydrogeologic information indicate that source(s) other than the Chem-Solv site are involved. The benzene, xylene, toluene, and other TICs located in Well MWS-7-25 have been interpreted to be representative of compounds found in the subsurface after gasoline or other petroleum hydrocarbons (No. 2 fuel oil or jet oil) are spilled (Appendix A-11). No compounds found in this well are associated with Chem-Solv. The benzene was detected at a concentration four times greater than the maximum levels detected in the historical data; 1,2-DCA, which was detected in this well at an estimated concentration of 16 ug/l, is not a degradation product of TCE (Appendix A-11).

## SECTION 4.0

## FIGURES



| Parameter (ug/kg) | CSB-7 (4-6) | CSB-7 (8-10) | CSB-7 (20.5-22.8) |
|---|---|---|---|
| Chloroform | 15.0 | 8.0 | 4.0 J |
| Methylene Chloride | 11.0 U | 7.0 BQ | 3.0 BJQ |
| Trichloroethene | 11.0 U | 6.0 U | 5.0 U |
| Total Volatile TICs | ND | ND | ND |
| Benzoic Acid | 1,800.0 U | 2,200.0 U | NT |
| bis(2-Ethylhexyl) phthalate | 370.0 U | 390.0 U | NT |
| Isophorone | 370.0 U | 390.0 U | NT |
| Total Semivolatile TICs | 500.0 | 200.0 | NT |
| 4,4'-DDE | 18.0 U | 18.0 U | NT |
| 4,4'-DDD | 18.0 U | 18.0 U | NT |
| 4,4'-DDT | 18.0 U | 18.0 U | NT |

| Parameter (ug/kg) | CSB-8 (0.5-2) | CSB-8D (0.5-2) | CSB-8 (2-4) | CSB-8A (18-20) |
|---|---|---|---|---|
| Chloroform | 6.0 U | 6.0 U | 6.0 U | 6.0 U |
| Methylene Chloride | 9.0 BQ | 9.0 BQ | 4.0 BQ | 10.0 BQ |
| Trichloroethene | 3.0 J | 6.0 U | 6.0 U | 6.0 U |
| Total Volatile TICs | ND | ND | ND | ND |
| Benzoic Acid | 1,800.0 U | 1,900.0 U | 1,900.0 U | NT |
| bis(2-Ethylhexyl) phthalate | 370.0 U | 380.0 U | 78.0 J | NT |
| Isophorone | 370.0 U | 380.0 U | 370.0 U | NT |
| Total Semivolatile TICs | 2,500.0 | 4,700.0 | 2,900.0 | NT |
| 4,4'-DDE | 44.0 | 95.0 | 37.0 | NT |
| 4,4'-DDD | 9.3 U | 9.1 U | 9.1 U | NT |
| 4,4'-DDT | 25.0 | 31.0 | 17.0 | NT |

| Parameter (ug/kg) | CSB-9 (2-4) | CSB-9 (4-5.5) | CSB-9 (17.5-20) |
|---|---|---|---|
| Chloroform | 6.0 U | 6.0 U | 5.0 U |
| Methylene Chloride | 4.0 J | 6.0 U | 6.0 BQ |
| Trichloroethene | 6.0 U | 5.0 U | 5.0 U |
| Total Volatile TICs | ND | ND | ND |
| Benzoic Acid | 1,800.0 U | 1,900.0 U | NT |
| bis(2-Ethylhexyl) phthalate | 110.0 J | 510.0 | NT |
| Isophorone | 380.0 U | 370.0 U | NT |
| Total Semivolatile TICs | 6,200.0 | 6,400.0 | NT |
| 4,4'-DDE | 110.0 | 66 J | NT |
| 4,4'-DDD | 10.0 U | 10.0 U | NT |
| 4,4'-DDT | 61.0 | 3.9 J | NT |

| Parameter (ug/kg) | CSB-10 (0.5-2) | CSB-10 (2-4) | CSB-10 (18-18.5) |
|---|---|---|---|
| Chloroform | 6.0 U | 6.0 U | 5.0 U |
| Methylene Chloride | 6.0 U | 6.0 U | 15.0 BQ |
| Trichloroethene | 6.0 U | 6.0 U | 5.0 U |
| Total Volatile TICs | ND | ND | ND |
| Benzoic Acid | 2,000.0 U | 1,900.0 U | NT |
| bis(2-Ethylhexyl) phthalate | 380.0 U | 180.0 J | NT |
| Isophorone | 3,900.0 | 1,600.0 | NT |
| Total Semivolatile TICs | 6,000.0 | 11,100.0 | NT |
| 4,4'-DDE | 100.0 | 46.0 | NT |
| 4,4'-DDD | 10.0 U | 10.0 U | NT |
| 4,4'-DDT | 31.0 | 8.4 J | NT |

| Parameter (ug/kg) | CSB-6 (0.5-2) | CSB-6 (6-7.5) | CSB-6 (19.5-19.8) |
|---|---|---|---|
| Chloroform | 6.0 U | 5.0 J | 4.0 J |
| Methylene Chloride | 12.0 BQ | 6.0 BJQ | 3.0 BJQ |
| Trichloroethene | 6.0 U | 6.0 U | 5.0 U |
| Total Volatile TICs | ND | ND | NT |
| Benzoic Acid | 1,800.0 U | 1,800.0 U | NT |
| bis(2-Ethylhexyl) phthalate | 370.0 U | 380.0 U | NT |
| Isophorone | 370.0 U | 380.0 U | NT |
| Total Semivolatile TICs | 1,400.0 | 400.0 | NT |
| 4,4'-DDE | 18.0 U | 18.0 U | NT |
| 4,4'-DDD | 18.0 U | 18.0 U | NT |
| 4,4'-DDT | 18.0 U | 18.0 U | NT |

| Parameter (ug/kg) | CSB-12 (0.5-2) | CSB-12 (2-4) | CSB-12 (21-22) |
|---|---|---|---|
| Chloroform | 6.0 U | 5.0 U | 5.0 U |
| Methylene Chloride | 5.0 U | 5.0 U | 5.0 U |
| Trichloroethene | 6.0 U | 6.0 U | 5.0 U |
| Total Volatile TICs | 10.0 | ND | ND |
| Benzoic Acid | 380.0 J | 1,800.0 U | NT |
| bis(2-Ethylhexyl) phthalate | 440.0 J | 370.0 U | NT |
| Isophorone | 380.0 U | 370.0 U | NT |
| Total Semivolatile TICs | 8,300.0 | 10,000.0 | NT |
| 4,4'-DDE | 190.0 | 14.0 J | NT |
| 4,4'-DDD | 18.0 U | 18.0 U | NT |
| 4,4'-DDT | 51.0 | 18.0 U | NT |

| Parameter (ug/kg) | CSB-11 (0.5-2) | CSB-11D (0.5-2) | CSB-11 (6-8) | CSB-11 (20.4-20.7) |
|---|---|---|---|---|
| Chloroform | 6.0 U | 6.0 U | 6.0 U | 5.0 U |
| Methylene Chloride | 6.0 U | 5.0 U | 6.0 U | 5.0 U |
| Trichloroethene | 6.0 U | 6.0 J | 6.0 U | 5.0 U |
| Total Volatile TICs | ND | ND | ND | ND |
| Benzoic Acid | 1,900.0 U | 1,900.0 U | 1,800.0 U | NT |
| bis(2-Ethylhexyl) phthalate | 380.0 U | 380.0 U | 370.0 U | NT |
| Isophorone | 380.0 U | 380.0 U | 370.0 U | NT |
| Total Semivolatile TICs | 33,900.0 | 3,600.0 | 600.0 | NT |
| 4,4'-DDE | 240.0 | 310.0 | 18.0 U | NT |
| 4,4'-DDD | 20.0 | 23.0 | 18.0 U | NT |
| 4,4'-DDT | 65.0 | 99.0 | 18.0 U | NT |

SOURCE: March 11, 1985 Survey (Robert L. Larimore, Wyoming, Delaware);
June 4 and 5, 1990 Survey (J. G. Park Associates, Inc., Washington Crossing, Pennsylvania).

BCM Project No. 00-6012-02

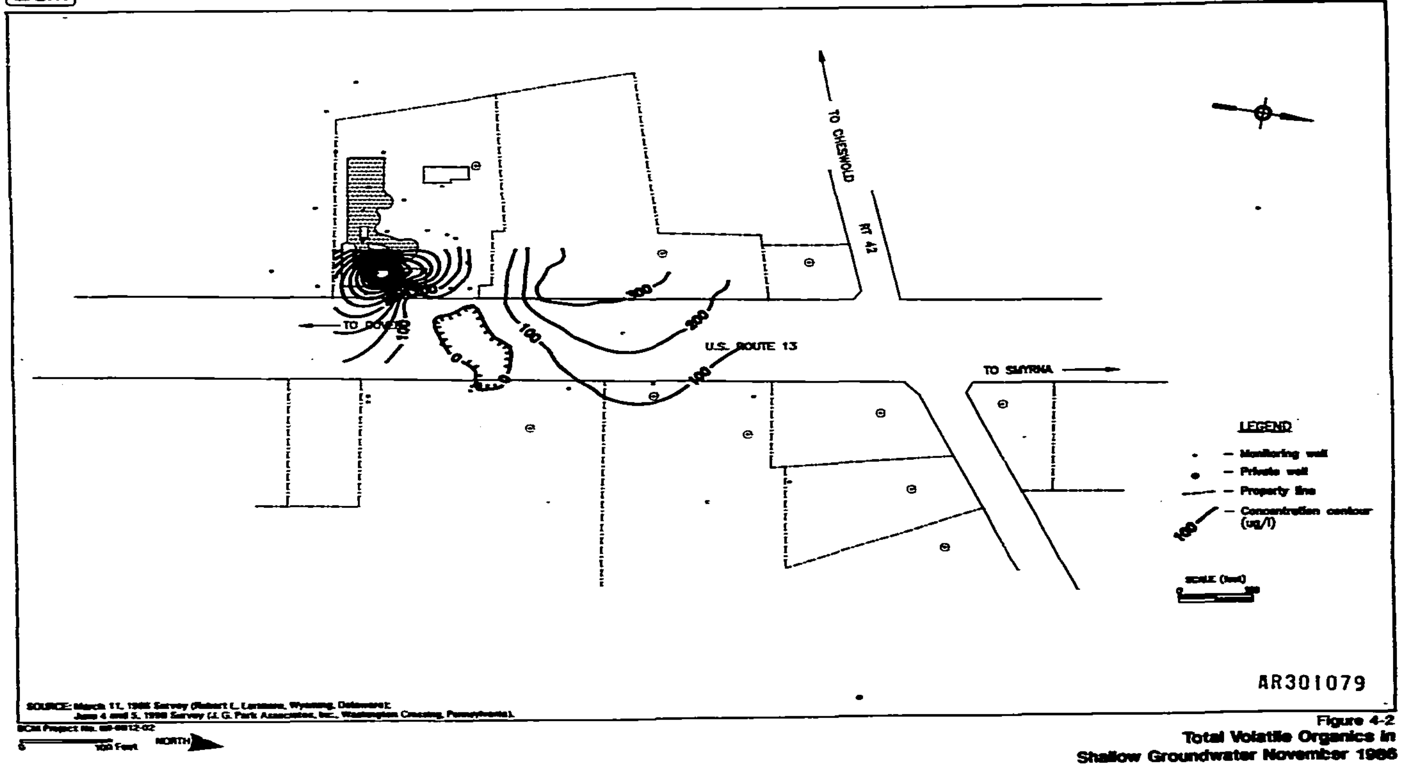
0 — 100 Feet NORTH

SEE TABLE 4-2 FOR EXPLANATION OF SYMBOLS

Figure 4-1
Distribution of Organic Chemicals in Onsite Soils

BCM

CHEM-SOLV, INC. SITE
Remedial Investigation

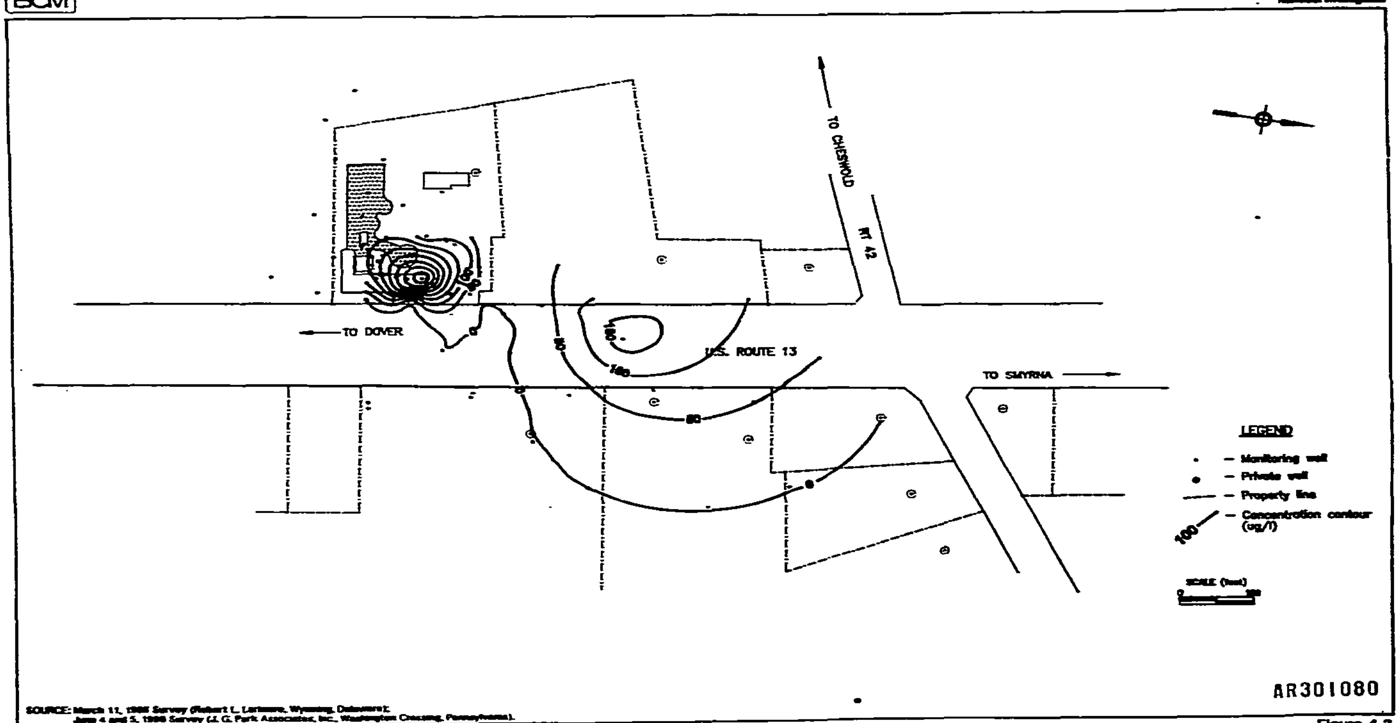


SOURCE: March 11, 1986 Survey (Robert L. Larimore, Wyoming, Delaware);
June 4 and 5, 1986 Survey (J. G. Park Associates, Inc., Washington Crossing, Pennsylvania).
BCM Project No. 00-0812-02

Figure 4-2
Total Volatile Organics in
Shallow Groundwater November 1986

BCM

CHEM-SOLV, INC. SITE
Remedial Investigation

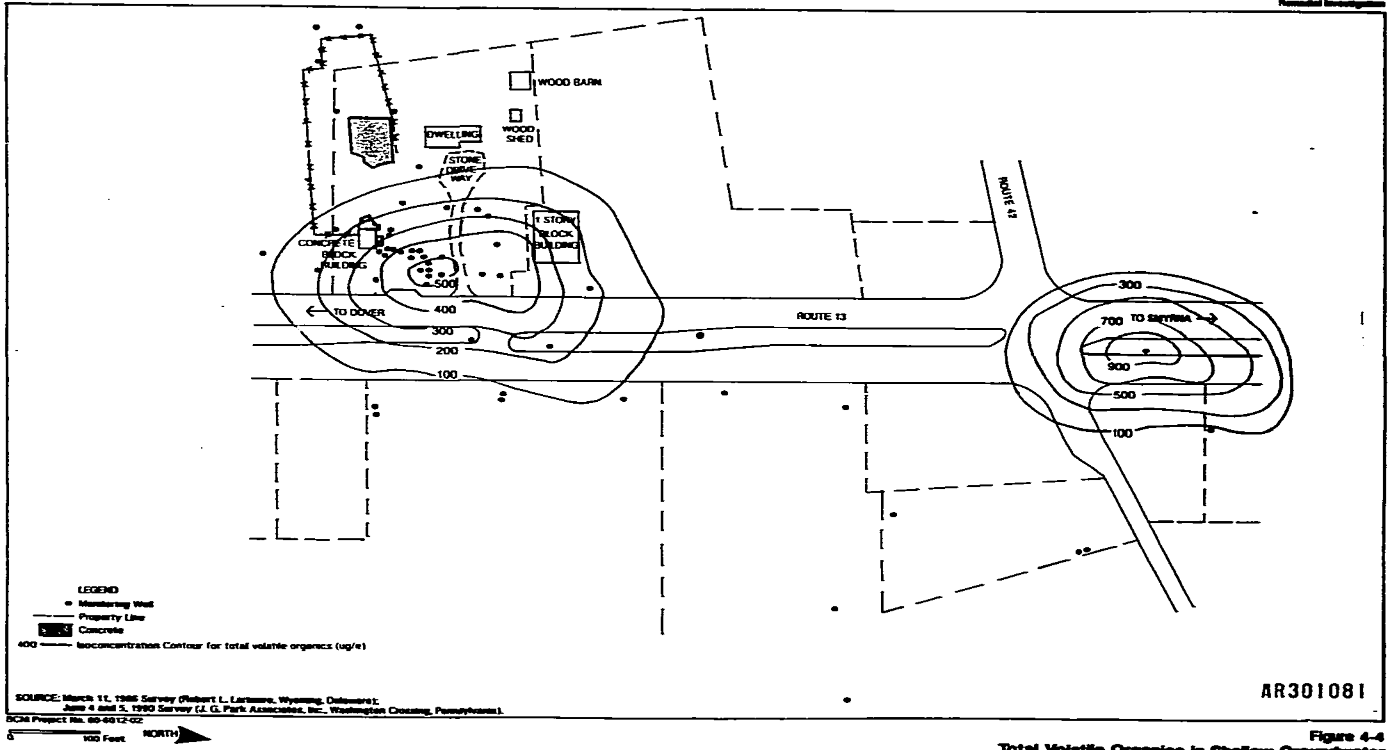


SOURCE: March 11, 1986 Survey (Robert L. Larimore, Wyoming, Delaware); June 4 and 5, 1986 Survey (J. G. Park Associates, Inc., Washington Crossing, Pennsylvania).
BCM Project No. 00-6812-02

Figure 4-3
Total Volatile Organics in
Shallow Groundwater June 1987

BCM

CHEM-SOLV, INC. SITE
Remedial Investigation



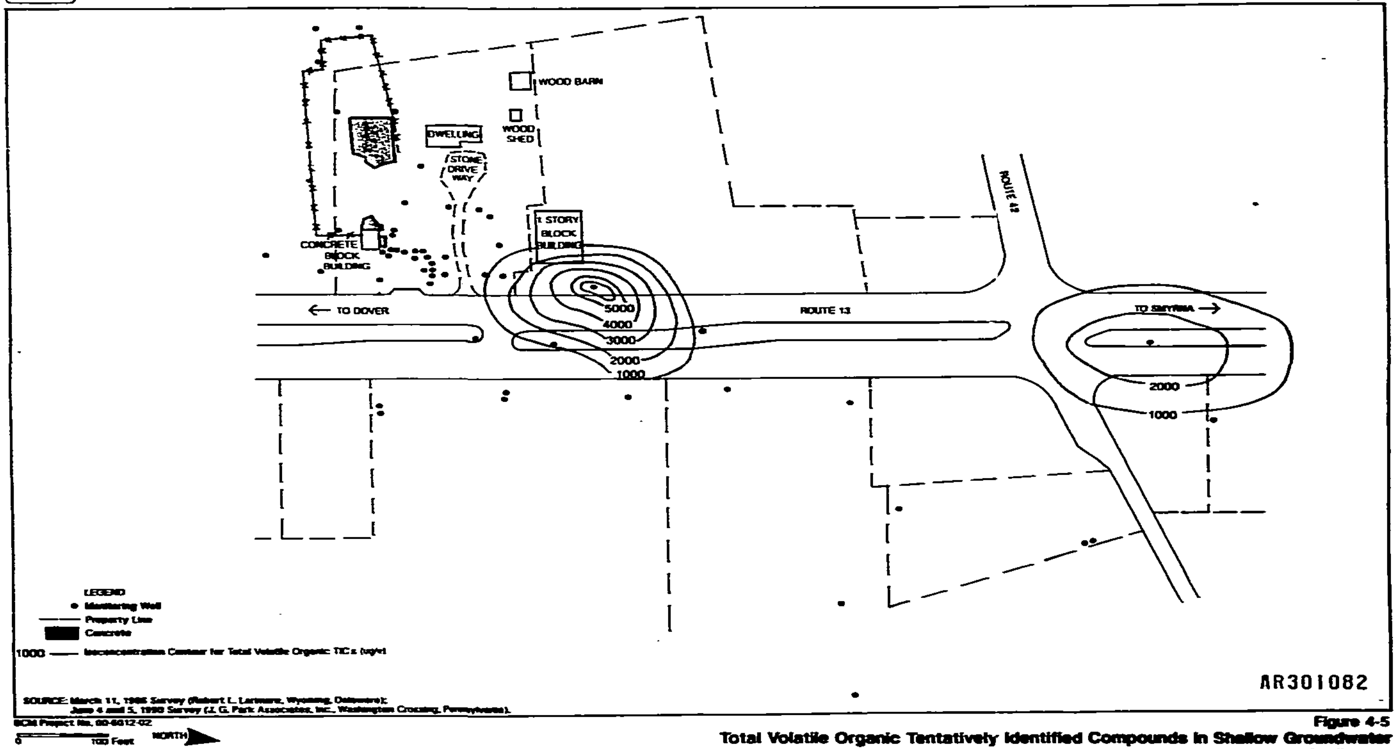
SOURCE: March 11, 1986 Survey (Robert L. Larimore, Wyoming, Delaware);
June 4 and 5, 1990 Survey (J. G. Park Associates, Inc., Washington Crossing, Pennsylvania).

BCM Project No. 00-6012-02

Figure 4-4
Total Volatile Organics in Shallow Groundwater
April 1990

BCM

CHEM-SOLV, INC. SITE
Remedial Investigation



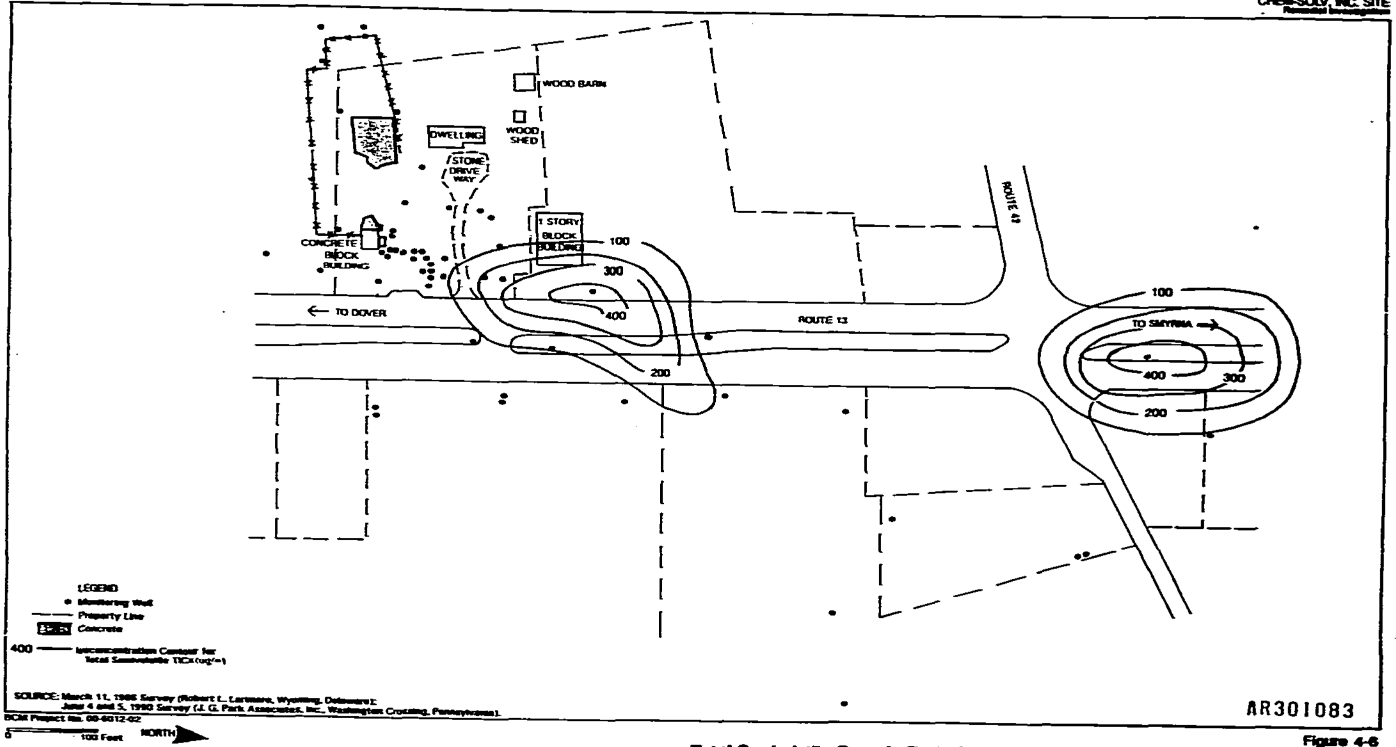
SOURCE: March 11, 1988 Survey (Robert L. Larimore, Wyoming, Delaware);
June 4 and 5, 1990 Survey (J. G. Park Associates, Inc., Washington Crossing, Pennsylvania).

BCM Project No. 00-6012-02

Figure 4-5
Total Volatile Organic Tentatively Identified Compounds in Shallow Groundwater
April 1990

BCM

CHEM-SOLV, INC. SITE
Remedial Investigation



SOURCE: March 11, 1988 Survey (Robert L. Larimore, Wyoming, Delaware);
June 4 and 5, 1990 Survey (J. G. Park Associates, Inc., Washington Crossing, Pennsylvania).
BCM Project No. 00-6012-02

Figure 4-6
Total Semivolatile Organic Tentatively Identified Compounds in Shallow Groundwater
April 1990

BCM

# SECTION 4.0

# TABLES

BCM

## TABLE 4-1

## AIR MONITORING RESULTS

## CHEM-SOLV, INC. SITE REMEDIAL INVESTIGATION
## CHESWOLD, DELAWARE

| | ORGANIC VAPOR READINGS | | |
|---|---|---|---|
| LOCATION | TIME | OVA | HNu |
| 1 | 1145 | 0.4 | NIR |
| 2 | 1147 | 0.4 | NIR |
| 3 | 1148 | 0.6 | NIR |
| 4 | 1148 | 0.8 | NIR |
| 5 | 1149 | 0.8 | NIR |
| 6 | 1149 | 1.0 | NIR |
| 7 | 1150 | 1.0 | NIR |
| 8 | 1151 | 1.2 | NIR |
| 9 | 1152 | 1.5 | NIR |
| 10 | 1153 | 1.6 | NIR |
| 11 | 1154 | 1.7 | NIR |
| 12 | 1155 | 1.9 | NIR |

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NIR No instrument response

Air monitoring survey performed October 16, 1989.
All organic vapor readings recorded above background levels.

Source: BCM Engineers Inc. (BCM Project No. 00-6012-02)

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## TABLE 4.2

### SUMMARY OF SOIL ANALYTICAL RESULTS

### CHEM-SOLV, INC. SITE REMEDIAL INVESTIGATION
### CHESWOLD, DELAWARE

| IEA Organic Sample No.: | BCM07 | BCM08 | BCM11 | BCM05 | BCM06 | BCM12 | BCM28 | BCM29 | BCM30 | BCM33 | BCM36 | BCM37 | BCM43 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| IEA Inorganic Sample No.: | BCM07 | BCM08 | -- | BCM05 | BCM06 | -- | BCM28 | BCM29 | BCM30 | -- | BCM36 | BCM37 | -- |
| BCM Sample No.: | 000844 | 000845 | 000848 | 000839 | 000840 | 000849 | 004996 | 004997 | 004998 | 005268 | 006791 | 006792 | 006793 |
| Sample Date: | 12/14/89 | 12/14/89 | 12/15/89 | 12/13/89 | 12/13/89 | 12/14/89 | 02/22/90 | 02/22/90 | 02/22/90 | 02/26/90 | 02/27/90 | 02/27/90 | 02/27/90 |
| Sample Name: | CSB-6<br>(0.5-2) | CSB-6<br>(6-7.3) | CSB-6<br>(19.6-19.9) | CSB-7<br>(4-6) | CSB-7<br>(8-10) | CSB-7<br>(20.5-20.8) ** | CSB-8<br>(0.5-2) | CSB-8D<br>(0.5-2) | CSB-8<br>(2-4) | CSB-8A<br>(18-20) | CSB-9<br>(2-4) | CSB-9<br>(4-5.5) | CSB-9<br>(19.5-20) |
| Parameter (Units) | | | | | | | | | | | | | |
| Volatile Organics (ug/kg) | | | | | | | | | | | | | |
| Acetone | 12.0 BQ | 73.0 BQ | 13.0 BQ | 400.0 BQ | 89.0 BQ | 56.0 BQ | 10.0 BJQ | 12.0 BQ | 12.0 BQ | 12.0 BQ | 16.0 BQ | 18.0 BQ | 15.0 BQ |
| Chloroform | 6.0 U | 5.0 J | 4.0 J | 15.0 | 8.0 | 4.0 J | 6.0 U | 6.0 U | 6.0 U | 6.0 U | 6.0 U | 6.0 U | 6.0 U |
| Methylene Chloride | 12.0 BQ | 6.0 BJQ | 3.0 BJQ | 11.0 U | 7.0 BQ | 3.0 BJQ | 9.0 BQ | 9.0 BQ | 8.0 BQ | 10.0 BQ | 4.0 J | 6.0 U | 6.0 BQ |
| Trichloroethene | 6.0 U | 6.0 U | 5.0 U | 11.0 U | 6.0 U | 5.0 U | 5.0 J | 6.0 U | 6.0 U | 6.0 U | 6.0 U | 6.0 U | 6.0 U |
| Total Volatiles | ND | 5.0 | 4.0 | 15.0 | 8.0 | 4.0 | 5.0 | ND | ND | ND | 4.0 | ND | ND |
| Volatile Organic Tentatively Identified Compounds (ug/kg) | | | | | | | | | | | | | |
| Hexane | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND |
| Pentane, 2-methyl- | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND |
| Pentane, 3-methyl- | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND |
| Silanol, trimethyl- | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND |
| Unknown (Total) | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND |
| Unknown Hydrocarbon | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND |
| Total Volatile TICs | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND |
| Semivolatile Organics (ug/kg) | | | | | | | | | | | | | |
| Benzoic Acid | 1,900.0 U | 1,900.0 U | NT | 1,800.0 U | 2,000.0 U | NT | 1,900.0 U | 1,900.0 U | 1,900.0 U | NT | 1,900.0 U | 1,900.0 U | NT |
| bis(2-Ethylhexyl) phthalate | 370.0 U | 380.0 U | NT | 370.0 U | 390.0 U | NT | 370.0 U | 380.0 U | 78.0 J | NT | 110.0 J | 510.0 | NT |
| Isophorone | 370.0 U | 380.0 U | NT | 370.0 U | 390.0 U | NT | 370.0 U | 380.0 U | 370.0 U | NT | 380.0 U | 370.0 U | NT |
| Total Semivolatiles | ND | ND | NT | ND | ND | NT | ND | ND | 78.0 | NT | 110.0 | 510.0 | NT |
| Semivolatile Organic Tentatively Identified Compounds (ug/kg) | | | | | | | | | | | | | |
| 1-Hexanol, 2-ethyl- | ND | ND | NT | ND | ND | NT | ND | ND | ND | NT | ND | ND | NT |
| DOS-Isomer (27.65) | ND | ND | NT | ND | ND | NT | ND | ND | ND | NT | ND | ND | NT |
| Hexanedioic acid, dioctyl es (29.27) | ND | ND | NT | ND | ND | NT | ND | ND | ND | NT | ND | ND | NT |
| M[illegible]amine (15.65) | ND | ND | NT | ND | ND | NT | ND | ND | ND | NT | ND | ND | NT |
| Substituted Phenol (Total) | ND | ND | NT | ND | ND | NT | ND | ND | ND | NT | ND | ND | NT |
| Trichloropropene Isomer (10.42) | ND | ND | NT | ND | ND | NT | ND | ND | ND | NT | ND | ND | NT |
| Unknown (Total) | 1,100.0 | 400.0 | NT | 500.0 A | 200.0 | NT | 600.0 | 1,000.0 | 2,000.0 | NT | 1,200.0 | 1,800.0 | NT |
| Unknown Aromatic (36.27) | ND | ND | NT | ND | ND | NT | ND | ND | ND | NT | ND | ND | NT |
| Unknown Chlorocarbon (13.38) | ND | ND | NT | ND | ND | NT | ND | ND | ND | NT | ND | ND | NT |
| Unknown Acid | ND | ND | NT | ND | ND | NT | ND | ND | ND | NT | 200.0 J | ND | NT |
| Unknown Hydrocarbon (9.45) | ND | ND | NT | ND | ND | NT | ND | ND | ND | NT | ND | ND | NT |
| Unknown Ketone (Total) | 300.0 | ND | NT | ND | ND | NT | 1,900.0 | 3,700.0 | 900.0 | NT | 5,000.0 | 4,600.0 | NT |

*If the page filmed in this frame is not as readable or legible as this label, it is due to substandard color or condition of the original page.*

BCM

Table 4-2 (Continued)

| IEA Organic Sample No.: | BCM07 | BCM08 | BCM11 | BCM05 | BCM06 | BCM12 | BCM28 | BCM29 | BCM30 | BCM33 | BCM36 | BCM37 | BCM43 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| IEA Inorganic Sample No.: | BCM07 | BCM08 | -- | BCM05 | BCM06 | -- | BCM28 | BCM29 | BCM30 | -- | BCM36 | BCM37 | -- |
| BCM Sample No.: | 000844 | 000845 | 000848 | 000839 | 000840 | 000849 | 004996 | 004997 | 004998 | 005268 | 006791 | 006792 | 006793 |
| Sample Date: | 12/14/89 | 12/14/89 | 12/15/89 | 12/13/89 | 12/13/89 | 12/14/89 | 02/22/90 | 02/22/90 | 02/22/90 | 02/26/90 | 02/27/90 | 02/27/90 | 02/27/90 |
| Sample Name: | CSB-6 | CSB-6 | CSB-6 | CSB-7 | CSB-7 | CSB-7 | CSB-8 | CSB-8D | CSB-8 | CSB-8A | CSB-9 | CSB-9 | CSB-9 |
| Parameter (Units) | (0.5-2) | (6-7.3) | (19.6-19.9) | (4-6) | (8-10) | (20.5-20.8) ** | (0.5-2) | (0.5-2) | (2-4) | (18-20) | (2-4) | (4-5.5) | (19.5-20) |
| Pesticides (ug/kg) | | | | | | | | | | | | | |
| 4,4'-DDE | 18.0 U | 18.0 U | NT | 18.0 U | 18.0 U | NT | 44.0 | 56.0 | 37.0 | NT | 110.0 | 8.6 J | NT |
| 4,4'-DDD | 18.0 U | 18.0 U | NT | 18.0 U | 18.0 U | NT | 9.3 U | 9.1 U | 9.1 U | NT | 10.0 U | 10.0 U | NT |
| 4,4'-DDT | 18.0 U | 18.0 U | NT | 18.0 U | 18.0 U | NT | 25.0 | 31.0 | 17.0 | NT | 61.0 | 3.9 J | NT |
| Inorganic Compounds (mg/kg) | | | | | | | | | | | | | |
| Aluminum | 17,900.0 | 15,100.0 | NT | 15,700.0 | 11,300.0 | NT | 10,700.0 | 14,500.0 | 13,000.0 | NT | 10,800.0 | 15,400.0 | NT |
| Arsenic | 2.0 B | 0.69 B | NT | 1.6 B | 0.67 B | NT | 3.5 | 2.7 | 4.0 | NT | 10.7 | 2.1 | NT |
| Barium | 49.0 | 34.0 B | NT | 29.5 B | 33.8 B | NT | 42.0 | 50.5 | 59.8 | NT | 100.0 | 44.5 B | NT |
| Beryllium | U | U | NT | U | U | NT | 0.13 U | 0.67 BQ | 0.63 BQ | NT | 0.89 BQ | 0.55 BQ | NT |
| Cadmium | 0.62 U | 0.65 U | NT | 0.7 U | 0.71 U | NT | 0.61 U | 1.7 | 1.7 | NT | 1.5 | 1.2 | NT |
| Calcium | 576.0 BJ | 236.0 BJ | NT | 272.0 BJ | 215.0 BJ | NT | 509.0 B | 595.0 B | 593.0 B | NT | 1,880.0 | 461.0 B | NT |
| Chromium | 15.8 | 7.1 | NT | 8.8 | 9.0 | NT | 8.2 | 12.6 | 12.1 | NT | 11.2 | 8.0 | NT |
| Cobalt | 3.3 B | 2.2 B | NT | 4.1 B | 2.4 U | NT | 3.7 B | 5.4 B | 5.8 B | NT | 6.1 B | 6.0 B | NT |
| Copper | 4.6 B | 1.8 B | NT | 3.8 B | 2.5 B | NT | 5.7 | 6.5 | 5.2 | NT | 14.0 | 3.9 B | NT |
| Iron | 15,600.0 | 8,630.0 | NT | 9,590.0 | 7,460.0 | NT | 8,430.0 | 11,900.0 | 12,700.0 | NT | 11,600.0 | 10,000.0 | NT |
| Lead | 7.0 | 5.3 | NT | 7.0 | 5.8 | NT | 19.6 | 24.2 | 23.0 | NT | 34.1 | 6.9 | NT |
| Magnesium | 1,030.0 | 411.0 B | NT | 465.0 B | 940.0 B | NT | 578.0 B | 852.0 B | 803.0 B | NT | 707.0 B | 408.0 B | NT |
| Manganese | 75.7 | 61.9 | NT | 88.9 | 69.6 | NT | 126.0 | 129.0 | 138.0 | NT | 255.0 | 101.0 | NT |
| Nickel | 8.8 | 7.9 B | NT | 8.3 BQ | 7.8 BQ | NT | 4.4 BQ | 4.9 BQ | 4.5 BQ | NT | 5.9 B | 4.9 B | NT |
| Potassium | 531.0 BQ | 374.0 BQ | NT | 521.0 BQ | 765.0 BQ | NT | 433.0 BQ | 456.0 BQ | 507.0 BQ | NT | 469.0 BQ | 570.0 BQ | NT |
| Selenium | 0.26 U | 0.25 U | NT | 0.26 U | 1.4 U | NT | 0.26 U | 0.25 U | 0.27 B | NT | 0.21 U | 0.19 U | NT |
| Sodium | 19.6 BQ | 20.0 BQ | NT | 19.0 BQ | 29.1 BQ | NT | 69.1 BQ | 82.2 BQ | 102.0 BQ | NT | 127.0 BQ | 107.0 BQ | NT |
| Vanadium | 25.1 | 16.3 | NT | 17.2 | 13.3 | NT | 14.7 | 18.6 | 19.7 | NT | 13.5 | 16.2 | NT |
| Zinc | 20.8 | 13.6 Q | NT | 14.7 | 14.5 | NT | 24.0 J | 32.1 J | 25.5 J | NT | 73.9 J | 16.0 J | NT |

BCM

Table 4-2 (Continued)

| Parameter (Units) | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| IEA Organic Sample No.: | BCM39 | BCM38 | BCM42 | BCM20 | BCM21 | BCM22 | BCM25 | BCM16 | BCM17 | BCM26 | BCM01 | BCM02 | BCM03 | BCM04 | BCM09 |
| IEA Inorganic Sample No.: | BCM39 | BCM38 | | BCM14 | BCM15 | BCM16 | -- | BCM10 | BCM11 | -- | BCM01 | BCM02 | BCM03 | BCM04 | -- |
| BCM Sample No.: | 006794 | 006795 | 006796 | 000856 | 000857 | 000858 | 000861 | 000852 | 000853 | 000862 | 000847 | 000846 | 000841 | 000812 | 000850 |
| Sample Date: | 02/27/90 | 02/27/90 | 02/27/90 | 12/19/89 | 12/19/89 | 12/19/89 | 12/20/89 | 12/18/89 | 12/18/89 | 12/19/89 | 12/13/89 | 12/13/89 | 12/14/89 | 12/14/89 | 12/15/89 |
| Sample Name: | CSB-10 (0.5-2) | CSB-10 (2-4) | CSB-10 (18-18.5) | CSB-11 (0.5-2) | CSB-11D (0.5-2) | CSB-11 (6-8) | CSB-11 (20.4-20.7) | CSB-12 (0.5-2) | CSB-12 (2-4) | CSB-12 (21.7-22) ** | Field Blank * | Trip Blank * | Trip Blank * | Field Blank * | Trip Blank * |
| **Volatile Organics (ug/kg)** | | | | | | | | | | | | | | | |
| Acetone | 11.0 BJQ | 12.0 BJQ | 19.0 BQ | 12.0 U | 12.0 U | 11.0 U | 10.0 U | 11.0 U | 11.0 U | 10.0 U | 2,600.0 | 10.0 U | 10.0 U | 15.0 | 10.0 U |
| Chloroform | 6.0 U | 6.0 U | 6.0 U | 6.0 U | 6.0 U | 6.0 U | 5.0 U | 6.0 U | 6.0 U | 5.0 U | 120.0 U | 5.0 U | 5.0 U | 5.0 U | 5.0 U |
| Methylene Chloride | 6.0 U | 6.0 U | 15.0 BQ | 6.0 U | 6.0 U | 6.0 U | 5.0 U | 6.0 U | 6.0 U | 5.0 U | 120.0 U | 5.0 U | 4.0 J | 5.0 U | 5.0 U |
| Trichloroethene | 6.0 U | 6.0 U | 6.0 U | 6.0 U | 6.0 J | 6.0 U | 5.0 U | 6.0 U | 6.0 U | 5.0 U | 120.0 U | 5.0 U | 5.0 U | 5.0 U | 5.0 U |
| Total Volatiles | ND | ND | ND | ND | 6.0 | ND | ND | ND | ND | ND | 2,600.0 | ND | 4.0 | 15.0 | ND |
| **Volatile Organic Tentatively Identified Compounds (ug/kg)** | | | | | | | | | | | | | | | |
| Hexane | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | 30.0 J | ND |
| Pentane, 2-methyl- | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND |
| Pentane, 3-methyl- | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | 8.0 J | ND |
| Silanol, trimethyl- | ND | ND | ND | ND | ND | ND | ND | 10.0 J | ND | ND | ND | ND | ND | ND | ND |
| Unknown (Total) | ND | ND | ND | ND | ND | ND | ND | 10.0 J | ND | ND | ND | ND | ND | 14.0 | ND |
| Unknown Hydrocarbon | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND |
| Total Volatile TICs | ND | ND | ND | ND | ND | ND | ND | 10.0 | ND | ND | ND | ND | ND | 52.0 | ND |
| **Semivolatile Organics (ug/kg)** | | | | | | | | | | | | | | | |
| Benzoic Acid | 2,000.0 U | 1,900.0 U | NT | 1,900.0 U | 1,900.0 U | 1,800.0 U | NT | 580.0 J | 1,800.0 U | NT | 50.0 U | NT | NT | 50.0 U | NT |
| bis(2-Ethylhexyl) phthalate | 390.0 U | 160.0 J | NT | 390.0 U | 380.0 U | 370.0 U | NT | 440.0 J | 370.0 U | NT | 9.0 J | NT | NT | 10.0 | NT |
| Isophorone | 3,100.0 | 1,600.0 | NT | 390.0 U | 380.0 U | 370.0 U | NT | 380.0 U | 370.0 U | NT | 10.0 U | NT | NT | 10.0 U | NT |
| Total Semivolatiles | 3,100.0 | 1,760.0 | NT | ND | ND | ND | NT | 1,020.0 | ND | NT | 9.0 | NT | NT | 10.0 | NT |
| **Semivolatile Organic Tentatively Identified Compounds (ug/kg)** | | | | | | | | | | | | | | | |
| 1-Hexanol, 2-ethyl- | ND | ND | NT | ND | ND | ND | NT | ND | 300.0 J | NT | ND | NT | NT | ND | NT |
| DDE Isomer (27.65) | ND | ND | NT | 200.0 J | ND | ND | NT | ND | ND | NT | ND | NT | NT | ND | NT |
| Hexanedioic acid, dioctyl es (29.27) | ND | ND | NT | 20,000.0 BJ | ND | ND | NT | 4,000.0 BJ | 8,000.0 BJ | NT | ND | NT | NT | ND | NT |
| Methenamine (15.65) | ND | ND | NT | ND | ND | ND | NT | ND | ND | NT | ND | NT | NT | ND | NT |
| Substituted Phenol (Total) | ND | ND | NT | 200.0 | 200.0 | 200.0 | NT | ND | 200.0 | NT | 10.0 | NT | NT | 10.0 | NT |
| Trichloropropane Isomer (10.42) | ND | ND | NT | ND | ND | ND | NT | ND | ND | NT | ND | NT | NT | ND | NT |
| Unknown (Total) | 1,000.0 | 5,100.0 | NT | 7,500.0 | 2,400.0 | 400.0 | NT | 2,900.0 | 1,500.0 B | NT | 10.0 | NT | NT | 8.0 | NT |
| Unknown Aromatic (36.27) | ND | ND | NT | ND | ND | ND | NT | 200.0 J | ND | NT | ND | NT | NT | ND | NT |
| Unknown Chlorocarbon (13.38) | ND | ND | NT | ND | ND | ND | NT | ND | ND | NT | ND | NT | NT | ND | NT |
| Unknown Acid | ND | ND | NT | ND | ND | ND | NT | ND | ND | NT | ND | NT | NT | ND | NT |
| Unknown Hydrocarbon (9.45) | ND | ND | NT | ND | ND | ND | NT | ND | ND | NT | 10.0 J | NT | NT | ND | NT |
| Unknown Ketone (Total) | 5,000.0 | 6,000.0 | NT | 6,000.0 | 1,200.0 | ND | NT | 1,200.0 | ND | NT | ND | NT | NT | ND | NT |
| Total Semivolatile TICs | 6,000.0 | 11,100.0 | NT | 33,900.0 | 3,800.0 | 600.0 | NT | 8,300.0 | 10,000.0 | NT | 30.0 | NT | NT | 18.0 | NT |

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Table 4-2 (Continued)

| IEA Organic Sample No.: | BCM39 | BCM38 | BCM42 | BCM20 | BCM21 | BCM22 | BCM25 | BCM16 | BCM17 | BCM26 | BCM01 | BCM02 | BCM03 | BCM04 | BCM09 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| IEA Inorganic Sample No.: | BCM39 | BCM38 | | BCM14 | BCM15 | BCM16 | -- | BCM10 | BCM11 | -- | BCM01 | BCM02 | BCM03 | BCM04 | -- |
| BCM Sample No.: | 006794 | 006795 | 006796 | 000856 | 000857 | 000858 | 000861 | 000852 | 000853 | 000862 | 000847 | 000846 | 000841 | 000842 | 000850 |
| Sample Date: | 02/27/90 | 02/27/90 | 02/27/90 | 12/19/89 | 12/19/89 | 12/19/89 | 12/20/89 | 12/18/89 | 12/18/89 | 12/19/89 | 12/13/89 | 12/13/89 | 12/14/89 | 12/14/89 | 12/15/89 |
| Sample Name: | CSB-10 (0.5-2) | CSB-10 (2-4) | CSB-10 (18-18.5) | CSB-11 (0.5-2) | CSB-11D (0.5-2) | CSB-11 (6-8) | CSB-11 (20.4-20.7) | CSB-12 (0.5-2) | CSB-12 (2-4) | CSB-12 (21.7-22) ** | Field Blank * | Trip Blank * | Trip Blank * | Field Blank * | Trip Blank * |
| Parameter (Units) | | | | | | | | | | | | | | | |
| Pesticides (ug/kg) | | | | | | | | | | | | | | | |
| 4,4'-DDE | 100.0 | 46.0 | NT | 240.0 | 310.0 | 18.0 U | NT | 150.0 | 14.0 J | NT | 0.1 U | NT | NT | 0.10 U | NT |
| 4,4'-DDD | 10.0 U | 10.0 U | NT | 20.0 | 23.0 | 18.0 U | NT | 18.0 U | 18.0 U | NT | 0.1 U | NT | NT | 0.10 U | NT |
| 4,4'-DDT | 31.0 | 8.4 J | NT | 86.0 | 99.0 | 18.0 U | NT | 51.0 | 18.0 U | NT | 0.1 U | NT | NT | 0.10 U | NT |
| Inorganic Compounds (mg/kg) | | | | | | | | | | | | | | | |
| Aluminum | 8,590.0 | 8,510.0 | NT | 12,500.0 | 11,300.0 | 16,200.0 | NT | 10,200.0 | 8,680.0 | NT | 71.2 U | 71.2 U | 71.2 U | 71.2 U | NT |
| Arsenic | 5.3 | 5.6 | NT | 7.9 | 8.2 | 0.67 [] | NT | 6.2 | 1.5 [] | NT | 1.0 U | 1.0 U | 1.0 U | 1.0 U | NT |
| Barium | 72.9 | 53.9 | NT | 109.0 | 97.2 | 37.5 [] | NT | 58.8 | 28.5 [] | NT | 1.7 U | 1.7 U | 1.7 U | 1.7 U | NT |
| Beryllium | 0.65 []Q | 0.7 []Q | NT | U | U | U | NT | U | U | NT | U | U | U | U | NT |
| Cadmium | 0.61 U | 0.62 U | NT | 0.73 U | 0.74 U | 0.65 U | NT | 0.64 U | 0.67 U | NT | 3.2 U | 3.2 U | 3.2 U | 3.2 U | NT |
| Calcium | 656.0 [] | 784.0 [] | NT | 1,070.0 []J | 979.0 []J | 270.0 []J | NT | 1,130.0 J | 502.0 []J | NT | 41.7 [] | 8.2 U | 8.2 U | 44.8 [] | NT |
| Chromium | 10.6 | 11.9 | NT | 12.0 | 10.8 | 8.0 | NT | 10.9 | 7.4 | NT | 4.1 U | 4.1 U | 4.1 U | 4.1 U | NT |
| Cobalt | 4.4 [] | 3.0 [] | NT | 3.3 [] | 4.1 [] | 4.5 [] | NT | 2.6 [] | 9.0 [] | NT | 10.7 U | 10.7 U | 10.7 U | 10.7 U | NT |
| Copper | 11.2 | 8.2 | NT | 10.4 | 11.4 | 2.0 [] | NT | 6.2 | 3.3 [] | NT | 3.9 U | 3.9 U | 3.9 U | 3.9 U | NT |
| Iron | 8,390.0 | 8,720.0 | NT | 10,100.0 | 9,270.0 | 7,860.0 | NT | 9,310.0 | 9,080.0 | NT | 131.0 | 8.1 []Q | 12.5 []Q | 66.6 [] | NT |
| Lead | 38.1 | 33.8 | NT | 80.0 | 69.6 | 5.3 | NT | 35.9 | 9.7 | NT | 1.0 U | 1.0 U | 1.0 U | 1.0 U | NT |
| Magnesium | 623.0 [] | 591.0 [] | NT | 879.0 [] | 891.0 [] | 347.0 [] | NT | 757.0 [] | 399.0 [] | NT | 4.4 U | 4.4 U | 4.4 U | 4.4 U | NT |
| Manganese | 131.0 | 143.0 | NT | 242.0 | 258.0 | 173.0 | NT | 136.0 | 135.0 | NT | 4.0 U | 4.0 U | 4.0 U | 4.0 U | NT |
| Nickel | 6.2 [] | 4.4 [] | NT | 4.8 [] | 6.8 [] | 3.6 U | NT | 7.2 []Q | 3.7 U | NT | 18.6 [] | 18.0 U | 18.0 U | 18.0 U | NT |
| Potassium | 392.0 []Q | 345.0 []Q | NT | 781.0 [] | 703.0 [] | 451.0 [] | NT | 433.0 [] | 404.0 [] | NT | 1,100.0 []Q | 674.0 U | 1,030.0 []Q | 697.0 []Q | NT |
| Selenium | 0.26 U | 0.23 U | NT | 0.34 [] | 0.26 U | 0.26 U | NT | 0.25 U | 0.23 U | NT | 1.2 U | 1.2 U | 1.2 U | 1.2 U | NT |
| Sodium | 141.0 []Q | 79.9 []Q | NT | 31.7 []Q | 34.6 []Q | 38.1 []Q | NT | 27.1 []Q | 16.2 U | NT | 193.0 [] | 77.8 U | 84.3 [] | 195.0 [] | NT |
| Vanadium | 13.5 | 13.1 | NT | 16.6 | 16.4 | 13.4 | NT | 16.8 | 14.8 | NT | 8.1 U | 8.1 U | 8.1 U | 8.1 U | NT |
| Zinc | 91.0 J | 56.6 J | NT | 91.9 | 83.4 | 12.5 | NT | 44.2 | 14.9 | NT | 12.3 [] | 4.1 [] | 10.8 [] | 17.3 [] | NT |

20 - Pb average
from literature

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Table 4-2 (Continued)

| IEA Organic Sample No.: | BCM10 | BCM13 | BCM14 | BCM18 | BCM19 | BCM23 | BCM24 | BCM31 | BCM32 | BCM34 | BCM35 | BCM40 | BCM41 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| IEA Inorganic Sample No.: | -- | BCM09 | BCM14 | BCM12 | BCM13 | -- | -- | BCM31 | BCM32 | -- | -- | BCM40 | BCM41 |
| BCM Sample No.: | 000851 | 000855 | 000854 | 000859 | 000860 | 000863 | 000864 | 004999 | 005000 | 005269 | 005270 | 006798 | 006797 |
| Sample Date: | 12/15/89 | 12/18/89 | 12/18/89 | 12/19/89 | 12/19/89 | 12/20/89 | 12/20/89 | 02/22/90 | 02/22/90 | 02/26/90 | 02/26/90 | 02/27/90 | 02/27/90 |
| Sample Name: | Field Blank * | Field Blank * | Trip Blank * | Trip Blank * | Field Blank * | Trip Blank * | Field Blank * | Trip Blank * | Field Blank * | Trip Blank * | Field Blank * | Field Blank * | Trip Blank * |
| Parameter (Units) | | | | | | | | | | | | | |
| Volatile Organics (ug/kg) | | | | | | | | | | | | | |
| Acetone | 10.0 U | 10.0 U | 10.0 U | 10.0 U | 10.0 U | 10.0 U | 10.0 U | 10.0 U | 10.0 U | 10.0 U | 10.0 U | 10.0 U | 10.0 U |
| Chloroform | 5.0 U | 4.0 BJQ | 7.0 B | 5.0 U | 5.0 U | 5.0 U | 5.0 U | 5.0 U | 5.0 U | 5.0 U | 5.0 U | 5.0 U | 5.0 U |
| Methylene Chloride | 5.0 U | 5.0 U | 5.0 U | 5.0 U | 5.0 U | 5.0 U | 5.0 U | 5.0 U | 5.0 U | 5.0 U | 5.0 U | 5.0 U | 5.0 U |
| Trichloroethene | 5.0 U | 5.0 U | 5.0 U | 5.0 U | 5.0 U | 5.0 U | 5.0 U | 5.0 U | 5.0 U | 5.0 U | 5.0 U | 5.0 U | 5.0 U |
| Total Volatiles | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND |
| Volatile Organic Tentatively Identified Compounds (ug/kg) | | | | | | | | | | | | | |
| Hexane | 20.0 J | 20.0 J | ND | ND | 60.0 J | ND | 9.0 J | ND | ND | ND | ND | ND | ND |
| Pentane, 2-methyl- | ND | ND | ND | ND | 10.0 J | ND | ND | ND | ND | ND | ND | ND | ND |
| Pentane, 3-methyl- | ND | ND | ND | ND | 20.0 J | ND | ND | ND | ND | ND | ND | ND | ND |
| Silanol, trimethyl- | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND |
| Unknown (Total) | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND |
| Unknown Hydrocarbon | ND | ND | ND | ND | 20.0 J | ND | ND | ND | ND | ND | ND | ND | ND |
| Total Volatile TICs | 20.0 | 20.0 | ND | ND | 110.0 | ND | 9.0 | ND | ND | ND | ND | ND | ND |
| Semivolatile Organics (ug/kg) | | | | | | | | | | | | | |
| Benzoic Acid | NT | 50.0 U | NT | NT | 50.0 U | NT | NT | NT | 50.0 U | NT | NT | 50.0 U | NT |
| bis(2-Ethylhexyl) phthalate | NT | 10.0 U | NT | NT | 10.0 U | NT | NT | NT | 10.0 U | NT | NT | 10.0 U | NT |
| Isophorone | NT | 10.0 U | NT | NT | 10.0 U | NT | NT | NT | 10.0 U | NT | NT | 10.0 U | NT |
| Total Semivolatiles | NT | ND | NT | NT | ND | NT | NT | NT | ND | NT | NT | ND | NT |
| Semivolatile Organic Tentatively Identified Compounds (ug/kg) | | | | | | | | | | | | | |
| 1-Hexanol, 2-ethyl- | NT | ND | NT | NT | ND | NT | NT | NT | ND | NT | NT | ND | NT |
| DDE Isomer (27.65) | NT | ND | NT | NT | ND | NT | NT | NT | ND | NT | NT | ND | NT |
| Hex[illegible]oic acid, dioctyl es (29.27) | NT | ND | NT | NT | ND | NT | NT | NT | ND | NT | NT | ND | NT |
| Meth[illegible]mine (15.65) | NT | 100.0 J | NT | NT | ND | NT | NT | NT | ND | NT | NT | ND | NT |
| Subs[illegible]ed Phenol (Total) | NT | 100.0 J | NT | NT | ND | NT | NT | NT | 10.0 | NT | NT | ND | NT |
| Tric[illegible]propene Isomer (10.42) | NT | 10.0 J | NT | NT | ND | NT | NT | NT | ND | NT | NT | ND | NT |
| Un[illegible] (Total) | NT | 229.0 | NT | NT | 110.0 | NT | NT | NT | 8.0 | NT | NT | ND | NT |
| Unknown Aromatic (36.27) | NT | ND | NT | NT | ND | NT | NT | NT | ND | NT | NT | ND | NT |
| Un[illegible] Chlorocarbon (13.38) | NT | 10.0 BJ | NT | NT | ND | NT | NT | NT | ND | NT | NT | ND | NT |
| Un[illegible] Acid | NT | ND | NT | NT | ND | NT | NT | NT | ND | NT | NT | ND | NT |
| Un[illegible] Hydrocarbon (9.45) | NT | ND | NT | NT | ND | NT | NT | NT | ND | NT | NT | ND | NT |
| Un[illegible] Ketone (Total) | NT | ND | NT | NT | ND | NT | NT | NT | ND | NT | NT | ND | NT |
| Total Semivolatile TICs | NT | 349.0 | NT | NT | 110.0 | NT | NT | NT | 18.0 | NT | NT | NT | NT |

BCM

Table 4-2 (Continued)

| IEA Organic Sample No.: | BCM10 | BCM13 | BCM14 | BCM18 | BCM19 | BCM23 | BCM24 | BCM31 | BCM32 | BCM34 | BCM35 | BCM40 | BCM41 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| IEA Inorganic Sample No.: | -- | BCM09 | BCM14 | BCM12 | BCM13 | -- | -- | BCM31 | BCM32 | -- | -- | BCM40 | BCM41 |
| BCM Sample No.: | 000851 | 000855 | 000854 | 000859 | 000860 | 000863 | 000864 | 004999 | 005000 | 005269 | 005270 | 006798 | 006797 |
| Sample Date: | 12/15/89 | 12/18/89 | 12/18/89 | 12/19/89 | 12/19/89 | 12/20/89 | 12/20/89 | 02/22/90 | 02/22/90 | 02/26/90 | 02/26/90 | 02/27/90 | 02/27/90 |
| Sample Name: | Field Blank * | Field Blank * | Trip Blank * | Trip Blank * | Field Blank * | Trip Blank * | Field Blank * | Trip Blank * | Field Blank * | Trip Blank * | Field Blank * | Field Blank * | Trip Blank * |
| Parameter (Units) | | | | | | | | | | | | | |
| Pesticides (ug/kg) | | | | | | | | | | | | | |
| 4,4'-DDE | NT | 0.10 U | NT | NT | 0.10 U | NT | NT | NT | 0.10 U | NT | NT | 0.10 U | NT |
| 4,4'-DDD | NT | 0.10 U | NT | NT | 0.10 U | NT | NT | NT | 0.10 U | NT | NT | 0.10 U | NT |
| 4,4'-DDT | NT | 0.10 U | NT | NT | 0.10 U | NT | NT | NT | 0.10 U | NT | NT | 0.10 U | NT |
| Inorganic Compounds (mg/kg) | | | | | | | | | | | | | |
| Aluminum | NT | 71.2 U | NT | 71.2 U | 71.2 U | NT | NT | 71.2 U | 71.2 U | NT | NT | 71.2 U | 71.2 U |
| Arsenic | NT | 1.0 U | NT | 1.0 U | 1.0 U | NT | NT | 1.0 U | 1.0 U | NT | NT | 1.0 U | 1.0 U |
| Barium | NT | 2.1 [] | NT | 1.7 U | 1.7 [] | NT | NT | 1.9 []Q | 3.7 []Q | NT | NT | 2.2 []Q | 1.7 U |
| Beryllium | NT | U | NT | U | U | NT | NT | 0.7 U | 0.7 U | NT | NT | 0.87 []Q | 0.7 U |
| Cadmium | NT | 3.2 U | NT | 3.2 U | 3.2 U | NT | NT | 3.2 U | 3.2 U | NT | NT | 3.2 U | 3.2 U |
| Calcium | NT | 126.0 [] | NT | 137.0 [] | 208.0 [] | NT | NT | 80.4 [] | 157.0 [] | NT | NT | 221.0 [] | 69.5 []Q |
| Chromium | NT | 4.1 U | NT | 4.1 U | 4.1 U | NT | NT | 4.1 U | 4.1 U | NT | NT | 4.1 U | 4.1 U |
| Cobalt | NT | 10.7 U | NT | 10.7 U | 10.7 U | NT | NT | 10.7 U | 10.7 U | NT | NT | 10.7 U | 10.7 U |
| Copper | NT | 3.9 U | NT | 3.9 U | 3.9 U | NT | NT | 3.9 U | 3.9 U | NT | NT | 3.9 U | 3.9 U |
| Iron | NT | 29.1 []Q | NT | 15.9 []Q | 22.6 []Q | NT | NT | 9.2 []Q | 15.8 []Q | NT | NT | 47.7 [] | 5.1 []Q |
| Lead | NT | 1.0 U | NT | 1.0 U | 1.0 U | NT | NT | 1.0 U | 1.0 U | NT | NT | 1.0 U | 1.0 U |
| Magnesium | NT | 4.4 U | NT | 4.4 U | 4.4 U | NT | NT | 4.4 U | 4.4 U | NT | NT | 4.4 U | 4.4 U |
| Manganese | NT | 4.0 U | NT | 4.0 U | 4.0 U | NT | NT | 4.0 U | 4.0 U | NT | NT | 4.0 U | 4.0 U |
| Nickel | NT | 21.0 [] | NT | 18.0 U | 18.0 U | NT | NT | 24.8 []Q | 18.0 U | NT | NT | 18.0 U | 18.0 U |
| Potassium | NT | 674.0 U | NT | 781.0 []Q | 674.0 U | NT | NT | 674.0 U | 680.0 []Q | NT | NT | 710.0 []Q | 674.0 U |
| Selenium | NT | 1.2 U | NT | 1.2 U | 1.2 U | NT | NT | 1.2 U | 1.2 U | NT | NT | 1.2 U | 1.2 U |
| Sodium | NT | 644.0 [] | NT | 473.0 [] | 778.0 [] | NT | NT | 351.0 [] | 492.0 [] | NT | NT | 520.0 [] | 256.0 [] |
| Vanadium | NT | 8.1 U | NT | 8.1 U | 8.1 U | NT | NT | 8.1 U | 8.1 U | NT | NT | 8.1 U | 8.1 U |
| Zinc | NT | 4.0 U | NT | 4.0 U | 7.8 [] | NT | NT | 4.0 U | 4.4 [] | NT | NT | 5.6 [] | 6.6 [] |

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J Estimated value
B Analyte found in laboratory blank
[ ] Bracketed value; concentration is less than the contract required detection limit but greater than the instrument detection limit
Q Result questioned due to blank contamination
* Trip and field blanks reported in ug/l
Sample CSB-7 (20.5-20.8) obtained 12/14/89, but shipped 12/15/89, sample CSB-12 (21.7-22) obtained 12/19/89, but shipped 12/20/89
NT Not tested
IEA Industrial & Environmental Analysts, Inc

Source. BCM Engineers Inc. (Project No 00 6012 02)

PPM

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## TABLE 4-3

## SUMMARY OF SOIL ANALYTICAL RESULTS
## EPA SPLIT SAMPLES

CHEM-SOLV, INC SITE
CHESWOLD, DELAWARE

| EPA Organic Sample No.: | CCH16 | CCH17 | CCH57 | CCH58 | CCH18 | CCH59 |
|---|---|---|---|---|---|---|
| Sample Date: | 02/22/90 | 02/22/90 | 02/27/90 | 02/27/90 | 02/22/90 | 02/22/90 |
| EPA Sample Name: | SB01-01 | SB01-02 | SB03-02 | SB03-04 | SW001 | SW002 |
| Sample Location: | CSB-8<br>0.5-2' | CSB-8<br>0.5-2' | CSB-10<br>2-4' | CSB-10<br>16-18.5' | Trip Blank | Trip Blank |
| Parameter (Units) | | | | | | |
| Volatile Organics (ug/kg) | | | | | | |
| Acetone | 32.0 B | 60.0 B | 13.0 B | 27.0 B | 10.0 UJ | 13.0 B |
| Chlorobenzene | 1.0 J | 6.0 UJ | 6.0 UL | 6.0 UL | 5.0 U | 5.0 U |
| Chloroform | 6.0 U | 6.0 U | 6.0 U | 6.0 U | 4.0 J | 4.0 J |
| 1,2-Dichloroethene (Total) | 6.0 U | 6.0 U | 6.0 U | 6.0 U | 3.0 B | 5.0 U |
| Methylene Chloride | 30.0 B | 28.0 B | 25.0 B | 22.0 B | 3.0 B | 5.0 B |
| Toluene | 3.0 J | 6.0 UJ | 6.0 UL | 6.0 UL | 5.0 U | 5.0 U |
| Total Xylenes | 6.0 UJ | 6.0 UJ | 6.0 UL | 6.0 UL | 3.0 J | 5.0 U |
| Trichloroethene | 3.0 J | 4.0 J | 6.0 U | 6.0 U | 5.0 U | 5.0 U |
| Total Volatiles | 7.0 | 4.0 | ND | ND | 7.0 | 4.0 |
| Volatile Organic Tentatively Identified Compounds (ug/kg) | | | | | | |
| Hexane | ND | ND | ND | 7.0 J | ND | ND |
| Semivolatile Organics (ug/kg) | | | | | | |
| bis(2-Ethylhexyl) phthalate | 240.0 J | 210.0 J | 290.0 J | NT | NT | NT |
| Di-n-octylphthalate | 740.0 U | 170.0 J | 800.0 U | NT | NT | NT |
| Isophorone | 740.0 U | 740.0 U | 1,900.0 | NT | NT | NT |
| Total Semivolatiles | 240.0 | 380.0 | 2,190.0 | NT | NT | NT |
| Semivolatile Organic Tentatively Identified Compounds (ug/kg) | | | | | | |
| Unknown | 400.0 J | 500.0 J | 400.0 J | NT | NT | NT |
| Unknown Alkane (Total) | ND | ND | 1,800.0 J | NT | NT | NT |
| Total Semivolatile TICs | 400.0 | 500.0 | 2,200.0 | NT | NT | NT |
| Pesticides/PCBs (ug/kg) | | | | | | |
| 4,4'-DDE | 110.0 | 100.0 | 210.0 | NT | NT | NT |
| 4,4'-DDD | 36.0 U | 36.0 U | 32.0 J | NT | NT | NT |
| 4,4'-DDT | 57.0 J | 56.0 J | 33.0 J | NT | NT | NT |
| Total Pesticides | 167.0 | 156.0 | 275.0 | NT | NT | NT |
| Inorganic Compounds (mg/kg) | | | | | | |
| Aluminum | 12,600.0 | 13,600.0 | 10,800.0 | NT | NT | NT |
| Arsenic | 7.7 | 6.8 | 5.4 | NT | NT | NT |
| Barium | 75.6 | 71.4 | 58.4 | NT | NT | NT |
| Cadmium | 0.2 [] | | 0.5 [] | NT | NT | NT |
| Calcium | 717.0 [] | 671.0 [] | 1,650.0 [] | NT | NT | NT |
| Chromium | 11.8 | 12.4 | 17.6 | NT | NT | NT |
| Cobalt | 6.0 [] | 5.7 [] | 5.0 [] | NT | NT | NT |
| Copper | 10.8 | 10.0 | 11.7 | NT | NT | NT |
| Iron | 9,370.0 | 9,720.0 | 8,370.0 | NT | NT | NT |
| Lead | 33.8 | 26.0 | 49.6 | NT | NT | NT |
| Magnesium | 771.0 [] | 776.0 [] | 762.0 [] | NT | NT | NT |
| Manganese | 254.0 | 230.0 | 146.0 | NT | NT | NT |
| Nickel | 6.5 [] | 6.1 [] | 6.6 [] | NT | NT | NT |
| Potassium | 441.0 [] | 443.0 [] | 502.0 [] | NT | NT | NT |
| Sodium | 60.4 [] | 64.3 []B | 61.8 [] | NT | NT | NT |
| Vanadium | 18.0 | 19.2 | 17.8 | NT | NT | NT |
| Zinc | 44.1 | 41.2 | 154.0 | NT | NT | NT |

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B Not detected substantially above the level reported in laboratory or field blanks.
J Analyte present. Reported value may not be accurate or precise.
ND Not detected
NT Not tested
U Not detected. The associated number indicates approximate sample concentration necessary to be detected.
UJ Not detected; quantitation limit may be inaccurate or imprecise.
UL Not detected; quantitation limit is probably higher.
[] Analyte present. As values approach the instrument detection limit, the quantitation may not be accurate.

Source: U.S. EPA Region III

Compiled by: BCM Engineers Inc. (BCM Project No. 00-6012-02)

## TABLE 4-4

## SUMMARY OF VOLATILE COMPOUNDS DETECTED IN GROUNDWATER 1984 THROUGH 1985

CHEM-SOLV, INC. SITE REMEDIAL INVESTIGATION
CHESWOLD, DELAWARE

| | SHALLOW ZONE MONITORING WELLS | | | INTERMEDIATE ZONE MONITORING WELLS | | | DOMESTIC WELLS | | |
|---|---|---|---|---|---|---|---|---|---|
| Volatile Organic Compound (VOC) | No. Samples Analyzed | No. Samples Compound Detected In | Maximum Concentration (ug/l) | No. Samples Analyzed | No. Samples Compound Detected In | Maximum Concentration (ug/l) | No. Samples Analyzed | No. Samples Compound Detected In | Maximum Concentration (ug/l) |
| Benzene | 45 | 2 | 360.0 | 13 | 0 | ND | 10 | 0 | ND |
| Bromoform | 45 | 0 | ND | 13 | 0 | ND | 10 | 0 | ND |
| Chlorobenzene | 45 | 1 | 2.8 | 13 | 0 | ND | 10 | 0 | ND |
| Chloroform | 45 | 12 | 669.0 | 13 | 1 | 1.3 | 10 | 0 | ND |
| 1,1-Dichloroethane | 45 | 11 | 414.0 | 13 | 1 | 1.2 | 10 | 0 | ND |
| 1,1-Dichloroethylene | 45 | 15 | 3,200.0 | 13 | 0 | ND | 10 | 0 | ND |
| 1,2-Dichloroethane | 45 | 2 | 30.0 | 13 | 0 | ND | 10 | 0 | ND |
| trans-1,2-Dichloroethylene | 45 | 11 | 1,000.0 | 13 | 0 | ND | 10 | 0 | ND |
| 1,2-Dichloropropane | 45 | 0 | ND | 13 | 2 | 38.0 | 10 | 1 | 2.9 |
| Ethylbenzene | 45 | 7 | 1,100.0 | 13 | 0 | ND | 10 | 0 | ND |
| 1,1,2,2-Tetrachloroethane | 45 | 0 | ND | 13 | 0 | ND | 10 | 0 | ND |
| Toluene | 45 | 17 | 2,300.0 | 13 | 1 | 2.3 | 10 | 0 | ND |
| 1,1,1-Trichloroethane | 45 | 28 | 1,800.0 | 13 | 1 | 2.1 | 10 | 0 | ND |
| Trichloroethylene | 45 | 39 | 130,000.0 | 13 | 3 | 3.4 | 10 | 0 | ND |
| m-Xylene | 11 | 2 | 250.0 | 4 | 0 | ND | 4 | 0 | ND |
| o-Xylene | 11 | 2 | 106.0 | 4 | 0 | ND | 4 | 0 | ND |
| p-Xylene | 11 | 1 | 111.0 | 4 | 0 | ND | 4 | 0 | ND |

ND Not detected

Source: Delaware Department of Natural Resources and Environmental Control
Compiled by BCM Engineers Inc. (BCM Project No. 00-6012-02)

TABLE 4-5

SUMMARY OF DNREC GROUNDWATER ANALYTICAL RESULTS
1986 THROUGH MAY 1990

CHEM SOLV, INC. SITE REMEDIAL INVESTIGATION
CHESWOLD, DELAWARE

| Lab ID: | 116 | 117 | 646 | 647 | H357 | H358 | H360 | H361 | H362 | H362 | H363 | H364 | H365 | H365 | H366 | H366 | H367 | H368 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Sample Date : | 01/02/86 | 01/02/86 | 01/02/86 | 01/02/86 | 02/19/86 | 02/19/86 | 02/19/86 | 02/19/86 | 02/19/86 | 02/19/86 | 02/19/86 | 02/19/86 | 02/19/86 | 02/19/86 | 02/19/86 | 02/19/86 | 02/19/86 | 02/19/86 |
| Sample Name : | Recovery RAW | Recovery TR | Recovery RAW | Recovery TR | Johnson | Durham | Killen | Phillips | Lambertson | Lambertson | Simon | Williams | American Roof | Gearh - Curley | Gearhart - New | Gearhart - Old | Cole | Harmic |
| Parameter (Units) | | | | | | | | | | | | | | | | | | |
| Volatile Organics (ug/l) | | | | | | | | | | | | | | | | | | |
| 1,1,1-Trichloroethane | 8,320.0 | 3.5 | 86.0 | ND | NR | NR | NR | NR | 0.5 | NR | NR | NR | 0.1 | NR | NR | NR | NR | NR |
| 1,1-Dichloroethane | NR | NR | NR | NR | NR | NR | NR | NR | NR | NR | NR | NR | NR | NR | NR | NR | NR | NR |
| 1,1-Dichloroethylene | 6.7 | ND | 143.0 | ND | NR | NR | NR | NR | NR | NR | NR | NR | NR | NR | NR | NR | NR | NR |
| 1,2-Dichloroethane | NR | NR | NR | NR | NR | NR | NR | NR | NR | NR | NR | NR | NR | NR | 31.0 | NR | NR | NR |
| 1,2-Dichloropropane | NR | NR | NR | NR | NR | NR | NR | NR | NR | NR | NR | NR | NR | NR | NR | NR | NR | NR |
| Benzene | NR | NR | NR | NR | NR | NR | NR | NR | NR | NR | NR | NR | NR | NR | NR | NR | NR | NR |
| Bromodichloromethane | NR | NR | NR | NR | NR | NR | NR | NR | NR | NR | NR | NR | NR | NR | NR | NR | NR | NR |
| Carbon Tetrachloride | NR | NR | NR | NR | NR | NR | NR | NR | NR | NR | NR | NR | NR | NR | NR | NR | NR | NR |
| Chlorobenzene | NR | NR | NR | NR | NR | NR | NR | NR | NR | NR | NR | NR | NR | NR | NR | NR | NR | NR |
| Chloroform | 337.0 | ND | NR | NR | NR | NR | NR | NR | NR | NR | NR | NR | NR | NR | NR | NR | NR | NR |
| Chloromethane | NR | NR | NR | NR | NR | NR | NR | NR | NR | NR | NR | NR | NR | NR | NR | NR | NR | NR |
| Ethylbenzene | NR | NR | NR | NR | NR | NR | NR | NR | NR | NR | NR | NR | NR | NR | NR | NR | NR | NR |
| Methylene Chloride | NR | NR | NR | NR | NR | NR | NR | NR | NR | NR | NR | NR | NR | NR | NR | NR | NR | NR |
| M-xylene | NR | NR | NR | NR | NR | NR | NR | NR | NR | NR | NR | NR | NR | NR | NR | NR | NR | NR |
| O-xylene | NR | NR | NR | NR | NR | NR | NR | NR | NR | NR | NR | NR | NR | NR | NR | NR | NR | NR |
| P-xylene | NR | NR | NR | NR | NR | NR | NR | NR | NR | NR | NR | NR | NR | NR | NR | NR | NR | NR |
| Tetrachloroethane | NR | NR | NR | NR | NR | NR | NR | NR | NR | NR | NR | NR | NR | NR | NR | NR | NR | NR |
| Tetrachloroethylene | NR | NR | NR | NR | NR | NR | NR | NR | NR | NR | NR | NR | NR | NR | NR | NR | NR | NR |
| Toluene | NR | NR | NR | NR | NR | NR | NR | NR | NR | NR | NR | NR | NR | NR | NR | NR | NR | NR |
| trans-1,2-Dichloroethylene | 2,283.0 | ND | 91.0 | ND | NR | NR | NR | NR | NR | NR | NR | NR | NR | NR | NR | NR | NR | NR |
| trans-1,3-Dichloropropene | NR | NR | NR | NR | NR | NR | NR | NR | NR | NR | NR | NR | NR | NR | NR | NR | NR | NR |
| Trichloroethylene | 27,006.0 | ND | 2,352.0 | 0.3 | 0.3 | ND | ND | ND | NR | 0.1 | ND | ND | NR | 0.6 | NR | 0.5 | ND | ND |
| Vinyl Chloride | NR | NR | NR | NR | NR | NR | NR | NR | NR | NR | NR | NR | NR | NR | NR | NR | NR | NR |
| Total Volatiles | 37,946.0 | 3.5 | 2,672.0 | 0.3 | 0.3 | ND | ND | ND | 0.5 | 0.1 | ND | ND | 0.1 | 0.6 | 31.0 | 0.5 | ND | ND |

Table 4-5 (Continued)

| Lab ID.<br>Sample Date:<br>Sample Name:<br><br>Parameter (Units) | 4197<br>1/18/86<br>OB-2A-pumped | 4198<br>11/18/86<br>OB-2A-pumped | 4199<br>11/18/86<br>OB-9A-bailed | 4203<br>11/18/86<br>OB-41A | 4204<br>11/18/86<br>OB-42A | 4205<br>11/18/86<br>Durham | 4206<br>11/18/86<br>Johnson | 4207<br>11/18/86<br>Gearh-Curley | 4208<br>11/18/86<br>Gearhart-new RA | 4209<br>11/18/86<br>Gearhart-new TR |
|---|---|---|---|---|---|---|---|---|---|---|
| Volatile Organics (ug/l) | | | | | | | | | | |
| 1,1,1-Trichloroethane | 3.8 | 5.5 | 2.9 | ND | ND | ND | ND | ND | ND | ND |
| 1,1-Dichloroethane | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND |
| 1,1-Dichloroethylene | 1.0 | ND | ND | ND | ND | ND | ND | ND | ND | ND |
| 1,2-Dichloroethane | NR | ND | ND | ND | ND | ND | ND | 1.3 | 30.0 | ND |
| 1,2-Dichloropropane | 30.0 | NR | 32.0 | 32.0 | ND | ND | ND | ND | 1.0 | ND |
| Benzene | NR | NR | NR | ND | ND | ND | ND | ND | ND | ND |
| Bromodichloromethane | NR | NR | NR | NR | NR | NR | NR | NR | NR | NR |
| Carbon Tetrachloride | NR | NR | NR | NR | NR | NR | NR | NR | NR | NR |
| Chlorobenzene | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND |
| Chloroform | 1.0 | ND | 1.0 | ND | ND | ND | ND | ND | ND | ND |
| Chloromethane | NR | NR | NR | NR | NR | NR | NR | NR | NR | NR |
| Ethylbenzene | NR | NR | NR | ND | ND | ND | ND | ND | ND | ND |
| Methylene Chloride | NR | NR | NR | NR | NR | NR | NR | NR | NR | NR |
| M-xylene | NR | NR | NR | NR | NR | NR | NR | NR | NR | NR |
| O-xylene | NR | NR | NR | NR | NR | NR | NR | NR | NR | NR |
| P-xylene | NR | NR | NR | NR | NR | NR | NR | NR | NR | NR |
| Tetrachloroethane | NR | NR | NR | NR | NR | NR | NR | NR | NR | NR |
| Tetrachloroethylene | NR | NR | NR | NR | NR | NR | NR | NR | NR | NR |
| Toluene | NR | NR | NR | ND | ND | ND | ND | ND | ND | ND |
| trans-1,2-Dichloroethylene | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND |
| trans-1,3-Dichloropropene | NR | NR | NR | NR | NR | NR | NR | NR | NR | NR |
| Trichloroethylene | 17.0 | 39.0 | ND | 7.3 | 1.0 | ND | ND | ND | ND | ND |
| Vinyl Chloride | NR | NR | NR | NR | NR | NR | NR | NR | NR | NR |
| Total Volatiles | 52.8 | 44.5 | 35.9 | 39.3 | 1.0 | ND | ND | 1.3 | 31.0 | ND |

ND Not detected, detection limit not specified
NR Not reported, parameter may or may not have been analyzed for

Source: Cabe Associates, Inc. March 1987

Compiled by: BCM Engineers Inc. (BCM Project No 00-6012-02)

BCM

TABLE 4-6

SUMMARY OF GROUNDWATER ANALYTICAL RESULTS
SHALLOW ZONE WELLS
ORGANIC COMPOUNDS

CHEM SOLV, INC SITE REMEDIAL INVESTIGATION
CHESWOLD, DELAWARE

| IEA Organic Sample No.: | BC045 | BC049 | BC050 | BC067 | BC052, BC065 | BC051 | BC061 | BC055 | BC062 | BC053 | BC047 | BC048 | BC056 | BC057 | BC063 | BC064 | BC068 | BC069 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| BCM Sample No.: | 010577 | 010548 | 010550 | 010543 | 010554, 010539 | 010552 | 010570 | 010559 | 010572 | 010555 | 010583 | 010581 | 010562 | 010561 | 010575 | 010574 | 010546 | 010545 |
| Sample Date: | 04/04/90 | 04/05/90 | 04/05/90 | 04/09/90 | 04/05, 09/90 | 04/05/90 | 04/06/90 | 04/05/90 | 04/06/90 | 04/05/90 | 04/04/90 | 04/04/90 | 04/05/90 | 04/05/90 | 04/06/90 | 04/06/90 | 04/09/90 | 04/09/90 |
| Sample Name: | 22A | 26A* | 28AD* | 33A | 39A** | 41A | MWS-3-17 | MWS-5-18 | MWS-6-25 | MWS-7-25 | Field Blank | Trip Blank | Field Blank | Trip Blank | Field Blank | Trip Blank | Field Blank | Trip Blank |
| Well Type: | Offsite UG | Offsite DG | Offsite DG | Onsite DG | Offsite DG | Offsite DG | Offsite DG | Offsite DG | Offsite DG | Offsite DG | | | | | | | | |
| Parameter (Units) | | | | | | | | | | | | | | | | | | |
| Volatile Organics (ug/l) | | | | | | | | | | | | | | | | | | |
| Acetone | 10.0 U | 10.0 U | 110.0 J | 50.0 U | 10.0 U | 10.0 U | 10.0 U | 10.0 U | 10.0 U | 51.0 | 10.0 U | 10.0 U | 10.0 U | 10.0 U | 10.0 U | 10.0 U | 10.0 U | 10.0 U |
| Benzene | 5.0 U | 200.0 J | 53.0 J | 25.0 U | 5.0 U | 5.0 U | 5.0 U | 5.0 U | 5.0 U | 830.0 | 5.0 U | 5.0 U | 5.0 U | 5.0 U | 5.0 U | 5.0 U | 5.0 U | 5.0 U |
| 1,2-Dichloroethane | 5.0 U | 5.0 U | 5.0 U | 25.0 U | 5.0 U | 5.0 U | 5.0 U | 5.0 U | 5.0 U | *** 16.0 J | 5.0 U | 5.0 U | 5.0 U | 5.0 U | 5.0 U | 5.0 U | 5.0 U | 5.0 U |
| Methylene Chloride | 5.0 U | 5.0 U | 5.0 U | 25.0 U | 5.0 U | 5.0 U | 5.0 U | 5.0 U | 5.0 | 25.0 U | 5.0 U | 5.0 U | 5.0 U | 5.0 U | 5.0 U | 5.0 U | 5.0 U | 5.0 U |
| Tetrachloroethene | 5.0 U | 5.0 U | 6.0 | 25.0 U | 5.0 U | 5.0 U | 5.0 U | 5.0 U | 5.0 U | 25.0 U | 5.0 U | 5.0 U | 5.0 U | 5.0 U | 5.0 U | 5.0 U | 5.0 U | 5.0 U |
| Toluene | 5.0 U | 3.0 J | 5.0 U | 25.0 U | 5.0 U | 5.0 U | 5.0 U | 5.0 U | 5.0 U | 25.0 U | 5.0 U | 5.0 U | 5.0 U | 5.0 U | 5.0 U | 5.0 U | 5.0 U | 5.0 U |
| 1,1,1-Trichloroethane | 5.0 U | 5.0 U | 5.0 U | 23.0 J | 5.0 U | 5.0 U | 5.0 U | 5.0 U | 5.0 U | 25.0 U | 5.0 U | 5.0 U | 5.0 U | 5.0 U | 5.0 U | 5.0 U | 5.0 U | 5.0 U |
| Trichloroethene | 5.0 U | 5.0 U | 5.0 U | 540.0 | 6.0 | 5.0 U | 5.0 U | 5.0 U | 5.0 U | 25.0 U | 5.0 U | 5.0 U | 5.0 U | 5.0 U | 5.0 U | 5.0 U | 5.0 U | 5.0 U |
| Xylene (Total) | 5.0 U | 5.0 U | 5.0 U | 25.0 U | 5.0 U | 5.0 U | 5.0 U | 5.0 U | 5.0 U | 24.0 J | 5.0 U | 5.0 U | 5.0 U | 5.0 U | 5.0 U | 5.0 U | 5.0 U | 5.0 U |
| Total Volatiles | ND | 203.0 | 169.0 | 563.0 | 6.0 | ND | ND | ND | 5.0 | #VALUE! | ND | ND | ND | ND | ND | ND | ND | ND |
| Tentatively Identified Volatile Organic Compounds (ug/l) | | | | | | | | | | | | | | | | | | |
| Benzene, Ethylmethyl | ND | ND | ND | ND | ND | ND | ND | ND | ND | 30.0 | ND | ND | ND | ND | ND | ND | ND | ND |
| Butane; 2-Methyl | ND | 2,000.0 | 1,000.0 | ND | ND | ND | ND | ND | ND | 900.0 | ND | NU | ND | ND | ND | ND | ND | ND |
| Cyclohexane | ND | 200.0 | 100.0 | ND | ND | ND | ND | ND | ND | 300.0 | ND | ND | ND | ND | ND | ND | ND | ND |
| Cyclohexane, Methyl | ND | 200.0 | 80.0 | ND | ND | ND | ND | ND | ND | 200.0 | ND | ND | ND | ND | ND | ND | ND | ND |
| Cyclopentane | ND | ND | ND | ND | ND | ND | ND | ND | ND | 500.0 | ND | ND | ND | ND | ND | ND | ND | ND |
| Cyclopropane, 1,1-Dimethyl | ND | 100.0 | 60.0 | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND |
| Pentane (Acn) | ND | ND | ND | ND | ND | ND | ND | ND | ND | 200.0 | ND | ND | ND | ND | ND | ND | ND | ND |
| Propane, 2-Methyl | ND | ND | ND | ND | ND | ND | ND | ND | ND | 70.0 | ND | ND | ND | ND | ND | ND | ND | ND |
| 2-Propanol | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | 5.0 | ND | ND | ND | ND | ND | ND | ND |
| Unknown (Total) | ND | 1,100.0 | 400.0 | ND | ND | ND | ND | ND | ND | 40.0 | ND | ND | ND | ND | ND | ND | ND | ND |
| Unknown Alkane (Total) | ND | 3,200.0 | 720.0 | ND | ND | ND | ND | ND | ND | 400.0 | ND | ND | ND | ND | ND | ND | ND | ND |
| Unknown Hydrocarbon | ND | ND | 300.0 | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND |
| Total Volatile TICs | ND | 6,800.0 | 2,660.0 | ND | ND | ND | ND | ND | ND | 2,640.0 | 5.0 | ND | ND | ND | ND | ND | ND | ND |

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Table 4-6 (Continued)

| Parameter (Units) | BC045 | BC049 | BC050 | BC067 | BC052, BC065 | BC051 | BC061 | BC055 | BC062 | BC053 | BC047 | BC048 | BC056 | BC057 | BC063 | BC064 | BC068 | BC069 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| IEA Organic Sample No.: | BC045 | BC049 | BC050 | BC067 | BC052, BC065 | BC051 | BC061 | BC055 | BC062 | BC053 | BC047 | BC048 | BC056 | BC057 | BC063 | BC064 | BC068 | BC069 |
| BCM Sample No.: | 010577 | 010548 | 010550 | 010543 | 010554, 010539 | 010552 | 010570 | 010559 | 010572 | 010555 | 010583 | 010581 | 010562 | 010561 | 010575 | 010574 | 010546 | 010545 |
| Sample Date: | 04/04/90 | 04/05/90 | 04/05/90 | 04/09/90 | 04/05, 09/90 | 04/05/90 | 04/06/90 | 04/05/90 | 04/06/90 | 04/05/90 | 04/04/90 | 04/04/90 | 04/05/90 | 04/05/90 | 04/06/90 | 04/06/90 | 04/09/90 | 04/09/90 |
| Sample Name: | 22A | 26A* | 26AD* | 33A | 38A** | 41A | MWS-3-17 | MWS-5-18 | MWS-6-25 | MWS-7-25 | Field Blank | Trip Blank | Field Blank | Trip Blank | Field Blank | Trip Blank | Field Blank | Trip Blank |
| Well Type: | Offsite UG | Offsite DG | Offsite DG | Onsite DG | Offsite DG | Offsite DG | Offsite DG | Offsite DG | Offsite DG | Offsite DG | | | | | | | | |
| **Semivolatile Organics (ug/l)** | | | | | | | | | | | | | | | | | | |
| Phenol | 10.0 U | 10.0 U | 10.0 U | 10.0 U | 10.0 U | 10.0 U | 10.0 U | 10.0 U | 10.0 U | 9.0 J | 10.0 U | NT | 10.0 U | NT | 10.0 U | NT | 10.0 U | NT |
| **Tentatively Identified Semivolatile Organic Compounds (ug/l)** | | | | | | | | | | | | | | | | | | |
| Benzene, (1-Methylethyl)- | ND | 50.0 | 50.0 | ND | ND | ND | ND | ND | ND | 20.0 | ND | NT | ND | NT | ND | NT | ND | NT |
| Benzene, (2-Methylpropyl)- | ND | ND | 8.0 | ND | ND | ND | ND | ND | ND | ND | ND | NT | ND | NT | ND | NT | ND | NT |
| Benzene, 1,3,5-Trimethyl- | ND | ND | ND | ND | ND | ND | ND | ND | ND | 30.0 | ND | NT | ND | NT | ND | NT | ND | NT |
| Diethylbenzene | ND | 20.0 | 9.0 | ND | ND | ND | ND | ND | ND | ND | ND | NT | ND | NT | ND | NT | ND | NT |
| 1H-Indene, 2,3-Dihydro-1-Met | ND | 40.0 | 50.0 | ND | ND | ND | ND | ND | ND | 30.0 | ND | NT | ND | NT | ND | NT | ND | NT |
| Substituted Benzene (Total) | ND | 29.0 | ND | ND | ND | ND | ND | ND | ND | ND | ND | NT | ND | NT | ND | NT | ND | NT |
| Substituted Phenol | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | NT | ND | NT | 8.0 | NT | ND | NT |
| Tetramethylbenzene | ND | 20.0 | 30.0 | ND | ND | ND | ND | ND | ND | 20.0 | ND | NT | ND | NT | ND | NT | ND | NT |
| Unknown (Total) | ND | 359.0 | 309.0 | 30.0 | ND | 78.1 | ND | ND | 9.0 Q | 396.0 | ND | NT | ND | NT | 8.0 | NT | ND | NT |
| Unknown Alcohol | ND | ND | ND | ND | ND | 8.0 | ND | ND | ND | ND | ND | NT | ND | NT | ND | NT | ND | NT |
| Unknown Hydrocarbon | ND | 10.0 | 20.0 | ND | ND | ND | ND | ND | ND | ND | ND | NT | ND | NT | ND | NT | ND | NT |
| Total Semivolatile TICs | ND | 528.0 | 466.0 | 30.0 | ND | 86.1 | ND | ND | ND | 496.0 | ND | NT | ND | NT | 16.0 | NT | ND | NT |
| Pesticides/PCBs (ug/l) | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | NT | ND | NT | ND | NT | ND | NT |

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* Field duplicate samples

** Well 38A was sampled for volatile organics April 5, 1990, and for semivolatile organics, pesticides/PCBs, and inorganics April 9, 1990

*** Presence of this compound questioned (see Appendix A 9)

U Analyte undetected at the instrument detection limit (IDL); value reported is the contract required detection limit (CRDL)

B Analyte detected in associated laboratory blank

Q Result questioned due to blank contamination

ND Not detected

NT Not tested

DG Downgradient

UG Upgradient (background)

IEA Industrial and Environmental Analysts, Inc.

Source: BCM Engineers Inc. (BCM Project No. 00-6012-02)

BCM

## TABLE 4-7

### SUMMARY OF GROUNDWATER ANALYTICAL RESULTS
SHALLOW ZONE WELLS
INORGANIC COMPOUNDS

CHEM SOLV, INC SITE REMEDIAL INVESTIGATION
CHESWOLD, DELAWARE

| | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| IEA Inorganic Sample No.: | BC_045 | DBC045 | BC_049 | DBC049 | BC_050 | DBC050 | BC_067 | DBC067 | BC_065 | DBC065 | BC_051 | DBC051 | BC_061 | DBC061 | BC_055 | DBC055 |
| BCM Sample No.: | 010577 | 010578 | 010548 | 010549 | 010550 | 010551 | 010543 | 010544 | 010539 | 010540 | 010552 | 010553 | 010570 | 010871 | 010559 | 010560 |
| Sample Date: | 04/04/90 | | 04/05/90 | | 04/05/90 | | 04/09/90 | | 04/09/90 | | 04/05/90 | | 04/06/90 | | 04/05/90 | |
| Sample Name: | 22A | | 26A* | | 26AD* | | 33A | | 39A | | 41A | | MWS-3-17 | | MWS-5-18 | |
| | Unfiltered | Filtered | Unfiltered | Filtered | Unfiltered | Filtered | Unfiltered | Filtered | Unfiltered | Filtered | Unfiltered | Filtered | Unfiltered | Filtered | Unfiltered | Filtered |
| Well Type: | Offsite UG | | Offsite DG | | Offsite DG | | Onsite DG | | Offsite DG | | Offsite DG | | Offsite DG | | Offsite DG | |
| Parameter (Units) | | | | | | | | | | | | | | | | |
| Inorganic Compounds ~~(ug/l)~~ | | | | | | | | | | | | | | | | |
| Aluminum | 95.0 J | 72.7 J | 71.9 U | 75.9 J | 76.4 J | 71.9 U | 71.9 U | 71.9 U | 71.9 U | 71.9 U | 97.4 J | 71.9 U | 47,000.0 | 204.0 | 33,100.0 | 71.9 U |
| Arsenic | 1.2 U | 1.2 U | 1.2 U | 1.2 U | 1.2 U | 1.2 U | 1.2 U | 1.2 U | 2.7 J | 1.2 U | 1.2 U | 1.2 U | 1.2 U | 1.2 U | 1.2 U | 1.2 U |
| Barium | 66.8 J | 98.6 J | 92.0 J | 102.0 J | 105.0 J | 94.9 J | 75.1 J | 71.7 J | 937.0 | 841.0 | 40.7 J | 60.0 J | 671.0 | 133.0 J | 162.0 J | 101.0 J |
| Beryllium | 1.7 J | 0.3 U | 1.5 J | 0.3 U | 1.5 J | 0.3 U | 0.3 U | 0.3 U | 0.5 J | 0.4 J | 1.7 J | 0.3 U | 4.4 J | 0.3 U | 3.2 J | 0.3 U |
| Cadmium | 3.8 U | 3.8 U | 3.8 U | 3.8 U | 3.8 U | 3.8 U | 3.8 U | 3.8 U | 4.0 J | 3.8 U | 3.8 U | 3.8 U | 4.7 J | 3.8 U | 15.0 | 3.8 U |
| Calcium | 9,530.0 | 9,220.0 | 31,500.0 | 34,200.0 | 37,200.0 | 34,300.0 | 19,000.0 | 18,900.0 | 13,800.0 | 13,000.0 | 23,400.0 | 27,000.0 | 21,000.0 | 2,720.0 J | 9,620.0 | 7,130.0 |
| Chromium | 6.4 U | 6.4 U | 7.1 J | 7.1 J | 6.4 U | 6.6 J | 6.4 U | 6.4 U | 6.4 U | 6.4 U | 6.4 U | 6.4 U | 16.3 | 6.4 U | 98.6 | 6.4 U |
| Cobalt | 12.6 U | 12.6 U | 16.3 J | 30.3 J | 19.6 J | 25.8 J | 12.6 U | 12.6 U | 50.5 | 38.4 J | 12.6 U | 17.2 J | 12.6 U | 12.6 U | 13.2 J | 16.5 J |
| Copper | 7.7 J | 6.8 U | 6.8 U | 6.8 U | 6.8 U | 6.8 U | 6.8 U | 6.8 U | 6.8 U | 6.8 U | 6.8 U | 6.8 U | 8.2 J | 6.8 U | 15.4 J | 6.8 U |
| Iron | 3,700.0 | 395.0 | 4,150.0 | 4,510.0 | 5,060.0 | 4,550.0 | 628.0 | 603.0 | 23,700.0 | 20,700.0 | 844.0 | 1,030.0 | 36,300.0 | 97.4 J | 110,000.0 | 6.2 U |
| Lead | 82.1 | 26.7 | 19.3 | 1.0 U | 3.8 | 1.0 U | 10.6 | 6.4 | 1.0 U | 1.0 U | 1.2 J | 1.0 U | 53.0 | 1.2 J | 18.9 | 1.0 U |
| Magnesium | 19,800.0 | 19,500.0 | 20,800.0 | 22,600.0 | 24,400.0 | 22,500.0 | 8,440.0 | 8,650.0 | 14,200.0 | 13,300.0 | 11,200.0 | 13,100.0 | 7,470.0 | 829.0 J | 4,260.0 J | 1,950.0 J |
| Manganese | 117.0 | 81.8 | 20,200.0 | 22,700.0 | 25,400.0 | 24,200.0 | 148.0 | 134.0 | 1,350.0 | 1,260.0 | 1,700.0 | 1,850.0 | 772.0 | 26.7 | 766.0 | 151.0 |
| Mercury | 0.2 U | 0.2 U | 0.2 U | 0.2 U | 0.2 U | 0.2 U | 0.2 U | 0.2 U | 0.2 U | 0.2 U | 0.2 U | 0.2 U | 0.2 U | 0.2 U | 0.3 | 0.2 U |
| Potassium | 2,460.0 J | 2,620.0 J | 13,400.0 | 15,000.0 | 16,000.0 | 14,500.0 | 3,310.0 J | 2,810.0 J | 7,980.0 | 7,720.0 | 4,310.0 J | 4,920.0 J | 2,430.0 J | 1,070.0 J | 5,280.0 | 5,330.0 |
| Selenium | 1.2 U | 1.4 J | 1.2 U | 1.2 U | 1.2 U | 1.2 U | 1.3 J | 2.1 J | 1.3 J | 1.2 U | 3.8 J | 4.6 J | 1.2 U | 1.8 J | 1.2 U | 1.5 J |
| Silver | 8.0 U | 8.0 U | 8.0 U | 8.0 U | 8.0 U | 8.0 U | 8.0 U | 8.0 U | 8.0 U | 8.0 U | 8.0 U | 8.0 U | 8.0 U | 8.0 U | 8.0 U | 8.0 U |
| Sodium | 2,990.0 J | 2,730.0 J | 24,700.0 | 23,200.0 | 29,300.0 | 23,000.0 | 22,200.0 | 24,000.0 | 70,600.0 | 73,500.0 | 75,900.0 | 73,500.0 | 30,000.0 | 27,900.0 | 74,800.0 | 79,200.0 |
| Vanadium | 10.3 U | 10.3 U | 10.3 U | 10.3 U | 10.3 U | 10.3 U | 10.3 U | 10.3 U | 10.3 U | 10.3 U | 10.3 U | 10.3 U | 39.5 J | 10.3 U | 89.3 | 10.3 U |
| Zinc | 29.6 | 27.0 | 63.3 | 104.0 | 139.0 | 82.3 | 3,810.0 | 3,910.0 | 57.4 | 49.9 | 13.0 J | 16.4 J | 119.0 | 54.4 | 134.0 | 32.8 |

AR301098

Table 4-7 (Continued)

| IEA Inorganic Sample No.: | BC_062 | DBC062 | BC_053 | DBC053 | BC_047 | DBC047 | BC_048 | BC_056 | DBC056 | BC_057 | BC_063 | DBC063 | BC_064 | BC_068 | DBC068 | BC_069 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| BCM Sample No.: | 010572 | 010573 | 010555 | 010556 | 0101582 | 010583 | 010581 | 010562 | 010563 | 010561 | 010575 | 010576 | 010574 | 010546 | 010547 | 010545 |
| Sample Date | 04/06/90 | | 04/05/90 | | 04/04/90 | | 04/04/90 | 04/05/90 | | 04/05/90 | 04/06/90 | | 04/06/90 | 04/09/90 | | 04/09/90 |
| Sample Name: | MWS-6-25 | | MWS-7-25 | | Field Blank | | Trip Blank | Field Blank | | Trip Blank | Field Blank | | Trip Blank | Field Blank | | Trip Blank |
| | Unfiltered | Filtered | Unfiltered | Filtered | Unfiltered | Filtered | | Unfiltered | Filtered | | Unfiltered | Filtered | | Unfiltered | Filtered | |
| Well Type: | Offsite DG | | Offsite DG | | | | | | | | | | | | | |
| Parameter (Units) | | | | | | | | | | | | | | | | |
| *Inorganic Compounds (mg/l)* | | | | | | | | | | | | | | | | |
| Aluminum | 7,560.0 | 71.9 U | 1,520.0 | 80.3 [] | 71.9 U | 71.9 U | 71.9 U | 71.9 U | 71.9 U | 71.9 U | 71.9 U | 71.9 U | 71.9 U | 71.9 U | 71.9 U | 71.9 U |
| Arsenic | 1.2 U | 1.2 U | 1.2 U | 1.2 U | 1.2 U | 1.2 U | 1.2 U | 1.2 U | 1.2 U | 1.2 U | 1.4 [] | 2.0 [] | 1.2 U | 1.2 U | 1.2 U | 1.2 U |
| Barium | 179.0 [] | 129.0 [] | 106.0 [] | 124.0 [] | 2.1 U | 2.1 U | 2.1 U | 2.1 U | 2.1 U | 2.1 U | 2.1 U | 2.1 U | 2.1 U | 10.9 [] | 13.0 [] | 2.1 U |
| Beryllium | 1.9 [] | 1.0 [] | 1.7 [] | 0.3 U | 1.6 [] | 0.3 U | 0.3 U | 0.3 U | 0.3 U | 0.3 U | 0.3 U | 0.3 U | 0.3 U | 0.3 U | 0.3 U | 0.3 U |
| Cadmium | 3.8 U | 3.8 U | 3.8 U | 3.8 U | 3.8 U | 3.8 U | 3.8 U | 3.8 U | 3.8 U | 3.8 U | 3.8 U | 3.8 U | 3.8 U | 3.8 U | 3.8 U | 3.8 U |
| Calcium | 10,500.0 | 9,310.0 | 7,210.0 | 8,020.0 | 22.9 [] | 24.0 [] | 28.5 [] | 10.6 [] | 25.2 [] | 29.2 [] | 9.8 U | 23.7 [] | 9.8 U | 25.4 [] | 22.2 [] | 10.5 [] |
| Chromium | 27.1 | 6.4 U | 6.4 U | 6.4 U | 6.4 U | 6.4 U | 6.4 U | 6.4 U | 6.4 U | 6.4 U | 6.4 U | 6.4 U | 6.4 U | 6.4 U | 6.4 U | 6.4 U |
| Cobalt | 12.6 U | 13.6 [] | 12.6 U | 12.6 U | 12.6 U | 15.2 [] | 12.6 U | 12.6 U | 15.3 [] | 12.6 U | 12.6 U | 16.1 [] | 12.6 U | 12.6 U | 12.6 U | 12.6 U |
| Copper | 6.8 U | 6.8 J | 13.8 [] | 6.8 U | 6.8 U | 6.8 U | 6.8 U | 6.8 U | 6.8 U | 6.8 U | 6.8 U | 6.8 U | 6.8 U | 6.8 U | 6.8 U | 6.8 U |
| Iron | 20,800.0 | 62.4 [] | 1,540.0 | 65.9 [] | 32.0 [] | 17.1 [] | 6.2 U | 74.9 [] | 6.2 U | 9.4 [] | 6.2 U | 6.2 U | 8.8 [] | 8.2 [] | 5.1 [] | 6.2 U |
| Lead | 4.6 | 1.0 U | 2.9 [] | 1.0 U | 1.0 U | 1.0 U | 1.0 U | 1.0 U | 1.0 U | 1.0 U | 4.9 | 1.0 U | 1.0 U | 1.0 U | 1.0 U | 1.0 U |
| Magnesium | 11,100.0 | 9,910.0 | 2,980.0 [] | 3,310.0 [] | 2.6 [] | 7.0 [] | 2.6 [] | 2.0 U | 9.2 [] | 3.7 [] | 2.0 U | 9.6 [] | 2.0 U | 13.0 [] | 11.0 [] | 3.7 [] |
| Manganese | 802.0 | 629.0 | 710.0 | 726.0 | 2.8 U | 2.8 U | 2.8 U | 2.8 U | 2.8 U | 2.8 U | 2.8 U | 2.8 U | 2.8 U | 2.8 U | 2.8 U | 2.8 U |
| Mercury | 0.3 | 0.2 | 6.9 | 5.1 | 0.2 U | 0.4 U | 0.4 U | 0.2 U | 0.2 U | 0.2 U | 0.2 U | 0.2 U | 0.2 U | 0.2 U | 0.2 U | 0.2 U |
| Potassium | 8,900.0 | 7,590.0 | 5,280.0 | 9,020.0 | 560.0 [] | 1,050.0 [] | 843.0 U | 843.0 U | 1,130.0 [] | 843.0 U | 843.0 U | 843.0 U | 843.0 U | 843.0 U | 843.0 U | 843.0 U |
| Selenium | 1.6 [] | 1.6 [] | 1.2 U | 1.2 U | 1.2 U | 1.2 U | 1.2 U | 1.2 U | 1.2 U | 1.2 U | 1.2 U | 1.2 U | 1.2 U | 1.2 U | 1.2 U | 1.2 U |
| Silver | 8.0 U | 8.0 U | 8.0 U | 8.0 U | 8.0 U | 8.0 U | 8.0 U | 8.0 U | 8.0 U | 8.0 U | 8.0 U | 8.0 U | 8.0 U | 8.0 U | 8.0 U | 8.0 U |
| Sodium | 34,800.0 | 29,500.0 | 30,100.0 | 30,900.0 | 689.0 [] | 755.0 [] | 777.0 [] | 53.2 U | 200.0 [] | 53.2 U | 53.2 U | 799.0 [] | 53.2 U | 924.0 [] | 967.0 [] | 53.2 U |
| Vanadium | 19.8 [] | 10.3 U | 10.3 U | 10.3 U | 10.3 U | 10.3 U | 10.3 U | 10.3 U | 10.3 U | 10.3 U | 10.3 U | 10.3 U | 10.3 U | 10.3 U | 10.3 U | 10.3 U |
| Zinc • | 100.0 | 63.3 | 35.2 | 25.8 | 5.7 [] | 6.5 [] | 11.5 [] | 5.0 U | 5.0 U | 11.8 [] | 5.0 U | 5.4 [] | 5.0 U | 14.3 [] | 10.3 [] | 5.0 U |

- * Duplicate samples
- Q Result questioned due to blank contamination.
- U Analyte undetected at the instrument detection limit (IDL); value reported is the contract required detection limit (CRDL).
- [] Analyte concentration < CRDL and > IDL.
- IEA Industrial and Environmental Analysts, Inc.

Source: BCM Engineers Inc. (BCM Project No. 00-6012-02)

# TABLE 4-8

## SUMMARY OF GROUNDWATER ANALYTICAL RESULTS
## INTERMEDIATE ZONE WELLS
## ORGANIC COMPOUNDS

## CHEM SOLV, INC SITE REMEDIAL INVESTIGATION
## CHESWOLD, DELAWARE

| IEA Organic Sample No.: | BC066 | BC046 | BC058 | BC059 | BC060 | BC054 | BC047 | BC048 | BC056 | BC057 | BC063 | BC064 | BC068 | BC069 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| BCM Sample No.: | 010541 | 010579 | 010564 | 010566 | 010568 | 010557 | 010583 | 010581 | 010562 | 010561 | 010575 | 010574 | 010546 | 010545 |
| Sample Date: | 04/09/90 | 04/04/90 | 04/06/90 | 04/06/90 | 04/06/90 | 04/05/90 | 04/04/90 | 04/04/90 | 04/05/90 | 04/05/90 | 04/06/90 | 04/06/90 | 04/09/90 | 04/09/90 |
| Sample Name: | MWI-1-43 | SB | SB* | SBD* | MWI-2-40 | MWI-4-40 | Field Blank | Trip Blank | Field Blank | Trip Blank | Field Blank | Trip Blank | Field Blank | Trip Blank |
| Well Type: | Offsite UG | Onsite DG | Onsite SG | Onsite SG | Offsite DG | Offsite DG | | | | | | | | |
| Parameter (Units) | | | | | | | | | | | | | | |
| Volatile Organics (ug/l) | | | | | | | | | | | | | | |
| Trichloroethene | 5.0 U | 5.0 J | 5.0 U | 5.0 U | 5.0 U | 5.0 U | 5.0 U | 5.0 U | 5.0 U | 5.0 U | 5.0 U | 5.0 U | 5.0 U | 5.0 U |
| Tentatively Identified Volatile Organic Compounds (ug/l) | | | | | | | | | | | | | | |
| 2-Propanol | ND | ND | ND | ND | ND | ND | 5.0 | ND | ND | ND | ND | ND | ND | ND |
| Semivolatile Organics (ug/l) | ND | ND | ND | ND | ND | ND | ND | NT | ND | NT | ND | NT | ND | NT |
| Tentatively Identified Semivolatile Organic Compounds (ug/l) | | | | | | | | | | | | | | |
| Ethanol, 2-(2-Butoxyethoxy)- | ND | 100.0 | ND | ND | ND | ND | ND | NT | ND | NT | ND | NT | ND | NT |
| Unknown ,Total) | 10.0 | 30.0 | 60.0 ** | 100.0 Q | ND | ND | ND | NT | ND | NT | 8.0 | NT | ND | NT |
| Substituted Phenol | ND | ND | ND | 8.0 Q | ND | ND | ND | NT | ND | NT | 8.0 | NT | ND | NT |
| Total Semivolatile TICs | 10.0 | 130.0 | 60.0 | ND | ND | ND | ND | NT | ND | NT | 16.0 | NT | ND | NT |
| Pestic[illegible]/PCBs (ug/l) | ND | ND | ND | ND | ND | ND | ND | NT | ND | NT | ND | NT | ND | NT |

* [illegible]duplicate samples
** [illegible]nown compound with an estimated concentration of 20 ug/l was questioned due to blank contamination
U Analyte undetected at the instrument detection limit (IDL); value reported is the contract required detection limit (CRDL)
B Analyte detected in associated laboratory blank
Q [illegible] questioned due to blank contamination
ND [illegible]etected
NT Not tested
DG Downgradient
SG Side gradient
UG Upgradient (background)
IEA Industrial and Environmental Analysts, Inc

Source: BCM Engineers Inc (BCM Project No 00-6012-02)

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TABLE 4-9

SUMMARY OF GROUNDWATER ANALYTICAL DATA
INTERMEDIATE ZONE WELLS
INORGANIC COMPOUNDS

CHEM-SOLV, INC. SITE RI/FS
CHESWOLD, DELAWARE

| IEA Inorganic Sample No.: | BC_066 | DBC066 | BC_046 | DBC046 | BC_058 | DBC058 | BC_059 | DBC059 | BC_060 | DBC060 | BC_054 | DBC054 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| BCM Sample No.: | 010541 | 010542 | 010579 | 010580 | 010564 | 010565 | 010566 | 010567 | 010568 | 010569 | 010557 | 010558 |
| Sample Date: | 04/09/90 | | 04/04/90 | | 04/06/90 | | 04/06/90 | | 04/06/90 | | 04/05/90 | |
| Sample Name: | MWI-1-43 | | 5B | | 9B | | 9BD | | MWI-2-40 | | MWI-4-40 | |
| | Unfiltered | Filtered | Unfiltered | Filtered | Unfiltered | Filtered | Unfiltered | Filtered | Unfiltered | Filtered | Unfiltered | Filtered |
| Well Type: | Offsite UG | | Onsite DG | | Onsite DG | | Onsite DG | | Offsite DG | | Offsite DG | |
| Parameter (Units) | | | | | | | | | | | | |
| Inorganic Compounds (mg/l) | | | | | | | | | | | | |
| Aluminum | 71.9 U | 71.9 U | 71.9 U | 71.9 U | 428.0 | 71.9 U | 398.0 | 71.9 U | 476.0 | 71.9 U | 1,430.0 | 260.0 |
| Arsenic | 1.2 [] | 1.2 U | 1.2 U | 1.2 U | 1.2 U | 1.2 U | 1.2 U | 1.2 U | 1.2 U | 1.2 U | 1.2 U | 1.6 [] |
| Barium | 135.0 [] | 126.0 [] | 86.2 [] | 102.0 [] | 97.6 [] | 99.3 [] | 86.8 [] | 78.0 [] | 115.0 [] | 125.0 [] | 171.0 [] | 132.0 [] |
| Beryllium | 0.3 U | 0.3 U | 0.8 [] | 0.3 U | 0.3 U | 0.3 U | 0.3 U | 0.3 U | 0.3 U | 0.4 [] | 0.7 [] | 0.3 U |
| Cadmium | 3.8 U | 3.8 U | 3.8 U | 3.8 U | 3.8 U | 3.8 U | 3.8 U | 3.8 U | 3.8 U | 3.8 U | 3.8 U | 3.8 U |
| Calcium | 8,450.0 | 8,070.0 | 6,060.0 | 6,400.0 | 17,300.0 | 16,700.0 | 15,600.0 | 17,200.0 | 11,300.0 | 12,500.0 | 57,900.0 | 31,400.0 |
| Chromium | 6.4 U | 6.4 U | 6.4 U | 6.4 U | 6.4 U | 6.4 U | 6.4 U | 6.4 U | 6.4 U | 6.4 U | 6.4 U | 6.4 U |
| Cobalt | 12.6 U | 12.6 U | 12.6 U | 12.6 U | 12.6 U | 14.2 [] | 12.6 U | 14.8 [] | 12.6 U | 12.7 [] | 12.6 U | 15.5 [] |
| Copper | 10.1 [] | 6.8 U | 6.8 U | 6.8 U | 6.8 U | 6.8 U | 6.8 U | 6.8 U | 6.8 U | 6.8 U | 6.8 U | 8.8 [] |
| Iron | 17.3 [] | 9.4 [] | 176.0 | 6.2 U | 724.0 | 6.2 U | 768.0 | 83.4 [] | 716.0 | 6.2 U | 1,060.0 | 6.2 U |
| Lead | 1.0 U | 1.0 U | 1.0 U | 1.0 U | 3.4 | 1.0 U | 2.3 [] | 1.5 [] | 1.0 U | 1.0 U | 1.2 [] | 1.0 U |
| Magnesium | 2,300.0 [] | 2,260.0 [] | 2,800.0 [] | 3,070.0 [] | 8,210.0 | 8,040.0 | 7,300.0 | 8,300.0 | 4,040.0 [] | 4,510.0 [] | 5,050.0 | 3,010.0 [] |
| Manganese | 11.3 [] | 9.6 [] | 15.9 | 10.4 [] | 49.6 | 46.5 | 46.4 | 42.4 | 30.3 | 33.9 | 96.5 | 27.8 |
| Mercury | 0.4 U | 0.4 U | 0.2 U | 0.2 U | 2.9 | 2.6 | 2.8 | 2.8 | 0.2 U | 0.2 U | 0.4 U | 0.2 U |
| Potassium | 6,970.0 | 6,290.0 | 4,970.0 [] | 5,610.0 | 16,000.0 | 16,600.0 | 15,400.0 | 15,900.0 | 3,390.0 [] | 3,750.0 [] | 19,100.0 | 23,100.0 |
| Selenium | 1.2 U | 1.4 [] | 1.2 U | 1.2 U | 1.5 [] | 2.4 [] | 1.2 U | 1.8 [] | 1.2 U | 1.2 U | 1.9 [] | 1.4 [] |
| Silver | 8.0 U | 8.0 U | 8.0 U | 8.0 U | 8.0 U | 8.0 U | 8.0 U | 8.0 U | 8.0 U | 8.0 U | 8.0 U | 8.0 U |
| Sodium | 16,900.0 | 18,000.0 | 5,600.0 | 5,120.0 | 17,800.0 | 16,500.0 | 16,000.0 | 15,600.0 | 13,100.0 | 13,400.0 | 37,900.0 | 37,700.0 |
| Vanadium | 10.3 U | 10.3 U | 10.3 U | 10.3 U | 10.3 U | 10.3 U | 10.3 U | 10.3 U | 10.3 U | 10.3 U | 10.3 U | 10.3 U |
| Zinc | 49.6 | 34.5 | 17.9 [] | 22.1 | 25.6 | 22.5 | 28.4 | 25.6 | 37.0 | 41.8 | 70.9 | 5.0 U |

Table 4-9 (Continued)

| IEA Inorganic Sample No.: | BC_047 | DBC047 | BC_048 | BC_056 | DBC056 | BC_057 | BC_063 | DBC063 | BC_064 | BC_068 | DBC068 | BC_[illegible] |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| BCM Sample No.: | 0101582 | 010583 | 010581 | 010562 | 010563 | 010561 | 010575 | 010576 | 010574 | 010546 | 010547 | 01[illegible]8 |
| Sample Date: | 04/04/90 | | 04/04/90 | 04/05/90 | | 04/05/90 | 04/06/90 | | 04/06/90 | 04/09/90 | | 04/[illegible]/90 |
| Sample Name: | Field Blank | | Trip Blank | Field Blank | | Trip Blank | Field Blank | | Trip Blank | Field Blank | | Trip Blank |
| Well Type: | Unfiltered | Filtered | | Unfiltered | Filtered | | Unfiltered | Filtered | | Unfiltered | Filtered | |
| Parameter (Units) | | | | | | | | | | | | |
| Inorganic Compounds (mg/l) | | | | | | | | | | | | |
| Aluminum | 71.9 U | 71.9 U | 71.9 U | 71.9 U | 71.9 U | 71.9 U | 71.9 U | 71.9 U | 71.9 U | 71.9 U | 71.9 U | 71.9 U |
| Arsenic | 1.2 U | 1.2 U | 1.2 U | 1.2 U | 1.2 U | 1.2 U | 1.4 [] | 2.0 [] | 1.2 U | 1.2 U | 1.2 U | 1.2 U |
| Barium | 2.1 U | 2.1 U | 2.1 U | 2.1 U | 2.1 U | 2.1 U | 2.1 U | 2.1 U | 2.1 U | 10.9 [] | 13.0 [] | 2.1 U |
| Beryllium | 1.6 [] | 0.3 U | 0.3 U | 0.3 U | 0.3 U | 0.3 U | 0.3 U | 0.3 U | 0.3 U | 0.3 U | 0.3 U | 0.3 U |
| Cadmium | 3.8 U | 3.8 U | 3.8 U | 3.8 U | 3.8 U | 3.8 U | 3.8 U | 3.8 U | 3.8 U | 3.8 U | 3.8 U | 3.8 U |
| Calcium | 22.9 [] | 24.0 [] | 28.5 [] | 10.6 [] | 25.2 [] | 29.2 [] | 9.8 U | 23.7 [] | 9.8 U | 25.4 [] | 22.2 [] | 10.5 [] |
| Chromium | 6.4 U | 6.4 U | 6.4 U | 6.4 U | 6.4 U | 6.4 U | 6.4 U | 6.4 U | 6.4 U | 6.4 U | 6.4 U | 6.4 U |
| Cobalt | 12.6 U | 15.2 [] | 12.6 U | 12.6 U | 15.3 [] | 12.6 U | 12.6 U | 16.1 [] | 12.6 U | 12.6 U | 12.6 U | 12.6 U |
| Copper | 6.8 U | 6.8 U | 6.8 U | 6.8 U | 6.8 U | 6.8 U | 6.8 U | 6.8 U | 6.8 U | 6.8 U | 6.8 U | 6.8 U |
| Iron | 32.0 [] | 17.1 [] | 6.2 U | 74.9 [] | 6.2 U | 9.4 [] | 6.2 U | 6.2 U | 8.8 [] | 8.2 [] | 25.1 [] | 6.2 U |
| Lead | 1.0 U | 1.0 U | 1.0 U | 1.0 U | 1.0 U | 1.0 U | 4.9 | 1.0 U | 1.0 U | 1.0 U | 1.0 U | 1.0 U |
| Magnesium | 2.6 [] | 7.0 [] | 2.6 [] | 2.0 U | 9.2 [] | 3.7 [] | 2.0 U | 9.6 [] | 2.0 U | 13.0 [] | 11.0 [] | 3.7 [] |
| Manganese | 2.8 U | 2.8 U | 2.8 U | 2.8 U | 2.8 U | 2.8 U | 2.8 U | 2.8 U | 2.8 U | 2.8 U | 2.8 U | 2.8 U |
| Mercury | 0.2 U | 0.4 U | 0.4 U | 0.2 U | 0.2 U | 0.2 U | 0.2 U | 0.2 U | 0.2 U | 0.2 U | 0.2 U | 0.2 U |
| Potassium | 960.0 [] | 1,050.0 [] | 843.0 U | 843.0 U | 1,130.0 [] | 843.0 U | 843.0 U | 843.0 U | 843.0 U | 843.0 U | 843.0 U | 843.0 U |
| Selenium | 1.2 U | 1.2 U | 1.2 U | 1.2 U | 1.2 U | 1.2 U | 1.2 U | 1.2 U | 1.2 U | 1.2 U | 1.2 U | 1.2 U |
| Silver | 8.0 U | 8.0 U | 8.0 U | 8.0 U | 8.0 U | 8.0 U | 8.0 U | 8.0 U | 8.0 U | 8.0 U | 8.0 U | 8.0 U |
| Sodium | 689.0 [] | 755.0 [] | 777.0 [] | 53.2 U | 200.0 [] | 53.2 U | 53.2 U | 799.0 [] | 53.2 U | 924.0 [] | 967.0 [] | 53.2 U |
| Vanadium | 10.3 U | 10.3 U | 10.3 U | 10.3 U | 10.3 U | 10.3 U | 10.3 U | 10.3 U | 10.3 U | 10.3 U | 10.3 U | 10.3 U |
| Zinc | 5.7 [] | 6.5 [] | 11.5 [] | 5.0 U | 5.0 U | 11.8 [] | 5.0 U | 5.4 [] | 5.0 U | 14.3 [] | 10.3 [] | 5.0 U |

Q Result questioned due to blank contamination
U Analyte undetected at the instrument detection limit (IDL); value reported is the contract required detection limit (CRDL).
[] Analyte concentration < CRDL and > IDL
DG Downgradient
UG Upgradient (background)
IEA Industrial and Environmental Analysts, Inc.

Source: BCM Engineers Inc. (BCM Project No. 00-6012-02)

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TABLE 4-10

SUMMARY OF GROUNDWATER ANALYTICAL RESULTS
ORGANIC COMPOUNDS
EPA SPLIT SAMPLES

CHEM-SOLV, INC SITE REMEDIAL INVESTIGATION
CHESWOLD, DELAWARE

| EPA Organic Sample No.: | CX699 | CX732 | CX697 | CX698 | CX696 |
|---|---|---|---|---|---|
| Sample Date: | 04/06/90 | 04/06/90 | 04/05/90 | 04/05/90 | 04/05/90 |
| Sample Name: | 9B* | 9BC* | 41A | MWS-5-18 | Trip Blank |
| Well Type: | Onsite Int. SG | Onsite Int. SG | Offsite Sh. DG | Offsite Sh. DG | |
| Parameter (Units) | | | | | |
| Volatile Organics (ug/l) | | | | | |
| 2-Butanone | 10.0 R | 10.0 R | 10.0 R | 10.0 R | 10.0 R |
| Chloroform | 5.0 U | 5.0 U | 5.0 U | 2.0 J | 5.0 U |
| Methylene Chloride | 3.0 B | 6.0 B | 5.0 B | 1.0 B | 6.0 B |
| Total Volatiles | ND | ND | ND | 2.0 | ND |
| Semivolatile Organics (ug/l) | ND | ND | ND | ND | NT |
| Semivolatile Organic Tentatively Identified Compounds (ug/l) | | | | | |
| 2-Cyclohexen-ol | ND | ND | 10 J | ND | NT |
| Unknown (Total) | ND | ND | 38 J | ND | NT |
| Pesticides/PCBs (ug/l) | ND | ND | ND | ND | NT |

| | |
|---|---|
| * | Duplicate samples |
| B | Not detected substantially above the level reported in laboratory or field blanks. |
| J | Analyte present. Reported value may not be accurate or precise. |
| R | Unreliable result. Analyte may or may not be present in the sample. Supporting data necessary to confirm result. |
| U | Not detected. The associated number indicates approximate sample concentration necessary to be detected. |
| ND | Not detected |
| NT | Not tested |
| DG | Downgradient |
| SG | Side gradient |

Source: U.S. EPA Region III
Compiled by: BCM Engineers Inc. (BCM Project No. 00-6012-02)

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### TABLE 4-11

### SUMMARY OF GROUNDWATER ANALYTICAL DATA
### INORGANIC COMPOUNDS
### EPA SPLIT SAMPLES

### CHEM-SOLV, INC. SITE REMEDIAL INVESTIGATION
### CHESWOLD, DELAWARE

| EPA Inorganic Sample No.: | MCCK06 | MCCK07 | MCCK08 | MCCK09 | MCCK00 | MCCK01 | MCCK02 | MCCK03 | MCCK04 | MCCK05 |
|---|---|---|---|---|---|---|---|---|---|---|
| Sample Date: | 04/06/90 | | 04/06/90 | | 04/05/90 | | 04/05/90 | | 04/06/90 | |
| Sample Name: | 9B* | | 9BC* | | 41A | | MWS-5-18 | | Field Blank | |
| | Unfiltered | Filtered | Unfiltered | Filtered | Unfiltered | Filtered | Unfiltered | Filtered | Unfiltered | Filtered |
| Well Type: | Onsite Intermediate SG | | Onsite Intermediate SG | | Offsite Shallow DG | | Offsite Shallow DG | | | |
| Parameter (Units) | | | | | | | | | | |
| Inorganic Compounds (mg/l) | | | | | | | | | | |
| Aluminum | 114.0 [] | 14.0 U | 227.0 | 14.0 U | 93.0 [] | 64.0 [] | 20,400.0 | 14.0 U | 14.0 U | 14.0 U |
| Antimony | 33.0 [] | 47.0 [] | 38.0 [] | 48.0 []B | 44.0 B | 32.0 [] | 53.0 [] | 49.0 []B | 44.0 [] | 26.0 [] |
| Barium | 88.0 [] | 86.0 [] | 86.0 [] | 93.0 [] | 42.0 [] | 45.0 [] | 171.0 [] | 280.0 | 9.0 U | 9.0 U |
| Calcium | 16,100.0 | 15,900.0 | 15,800.0 | 16,200.0 | 25,900.0 | 24,800.0 | 11,400.0 | 7,190.0 | 127.0 [] | 101.0 [] |
| Chromium | 4.0 U | 4.0 U | 4.0 U | 4.0 U | 4.0 U | 4.0 U | 63.0 | 4.0 U | 4.0 U | 4.0 U |
| Cobalt | 4.0 U | 4.0 U | 4.0 U | 4.0 U | 5.0 [] | 4.0 U | 14.0 [] | 4.0 U | 4.0 U | 4.0 U |
| Copper | 3.0 U | 3.0 U | 3.0 U | 3.0 U | 3.0 U | 3.0 U | 17.0 [] | 3.0 U | 3.0 U | 3.0 U |
| Iron | 260.0 | 60.0 [] | 464.0 | 35.0 U | 903.0 | 950.0 U | 61,300.0 | 49.0 []B | 35.0 U | 40.0 [] |
| Lead | 7.0 | 10.0 B | 7.0 K | 61.0 B | 2.0 U | 12.0 B | 29.0 | 5.0 B | 2.0 U | 15.0 K |
| Magnesium | 7,730.0 | 7,680.0 | 7,660.0 | 7,790.0 | 12,400.0 | 12,000.0 | 3,850.0 [] | 1,930.0 [] | 30.0 U | 30.0 U |
| Manganese | 47.0 | 45.0 | 47.0 | 45.0 | 1,920.0 | 1,840.0 | 702.0 | 151.0 | 3.0 U | 3.0 U |
| Mercury | 1.8 | 1.9 | 1.4 | 2.2 | 0.2 U | 0.2 U | 0.2 U | 0.2 U | 0.2 U | 0.2 U |
| Potassium | 16,500.0 | 16,500.0 | 16,600.0 | 16,800.0 | 4,710.0 | 4,570.0 [] | 5,920.0 | 4,350.0 [] | 90.0 U | 90.0 U |
| Selenium | 4.0 U | 4.0 U | 4.0 U | 4.0 U | 6.0 | 4.0 [] | 4.0 U | 4.0 U | 4.0 U | 4.0 U |
| Sodium | 16,700.0 | 16,600.0 | 16,600.0 | 16,900.0 | 83,100.0 | 80,200.0 | 86,100.0 | 80,700.0 | 303.0 [] | 200.0 [] |
| Vanadium | 4.0 U | 4.0 U | 4.0 U | 4.0 U | 4.0 U | 4.0 U | 60.0 | 4.0 U | 4.0 U | 4.0 U |
| Zinc | 21.0 B | 17.0 [] | 17.0 [] | 20.0 B | 7.0 [] | 7.0 [] | 65.0 | 58.0 | 11.0 [] | 11.0 [] |

---

* Duplicate samples

[]—Analyte present. As values approach the instrument detection limit (IDL) the quantitation may not be accurate.

B—Not detected substantially above the level reported in laboratory of field blanks.

K—Analyte present. Reported value may be biased high. Actual value is expected to be lower.

U—Not detected. The associated number indicates approximate sample concentration necessary to be detected.

UL—Not detected; quantitation limit is probably higher.

DG—Downgradient

SG—Side gradient

Source: U.S. EPA Region III

Compiled by: BCM Engineers Inc. (BCM Project No. 00-6012-02)

# 5.0 HUMAN HEALTH AND ENVIRONMENTAL RISK ASSESSMENT

## 5.1 INTRODUCTION

### 5.1.1 Overview

This human health and environmental risk assessment describes the potential for adverse health effects due to exposure to chemicals found in the soil and groundwater at the Chem-Solv, Inc. (Chem-Solv) site. Risk assessment combines the concentration of the chemicals with toxicological data to get a numerical estimate of the magnitude and severity of the potential health effects due to actual or possible future exposure to chemicals.

### 5.1.2 Site Description

This section presents a brief description of the site and a summary of the conditions pertinent to the risk assessment. For the risk assessment, the points of interest in the site description focus on opportunities for human and environmental exposure, now and in the future. The site description includes surrounding land use, evidence for current exposure, and site's proximity to surface waters. A more detailed presentation of this information is given in Sections 3.1 and 3.2 of this report.

The 1.5-acre Chem-Solv site is an open field adjacent to a four-lane highway. The surrounding land use is a medium-density mixture of agricultural, commercial, and residential land use. Although there is a residential unit adjacent to the site and others in the area, there is no evidence of consistent site use by area residents such as dirt bike paths or pathways to schools or playgrounds crossing the site.

The solvent recovery facility, operational from 1982 to 1984, was closed after an explosion and fire that may have released solvents into the surrounding soil, groundwater, and air. In April 1985, 1,300 cubic yards of soil were processed after the presence of solvents in the groundwater was identified. The soil material was processed onsite to remove the chemicals of concern and then replaced.

The nearest surface water and point of groundwater release is the Alston Branch of the Leipsic River, approximately 0.4 miles from the site. There are no wetlands adjacent to the site. The excavation, processing, and replacement of the soil resulted in an onsite depressed area that holds rainwater for extended periods. As a results, certain wetlands plants grow in this depressed area.

### 5.1.3 Scope of Risk Assessment

The risk assessment is a formal procedure with protocols established by the U.S. Environmental Protection Agency (EPA) (EPA 1989a, 1989b, 1986a-f, 1985). First, the risk assessment evaluates the chemicals found in the soil and groundwater at the site and determines which site-related chemicals are a potential concern to human health and the environment. Next, it considers the likelihood that humans or the environment are currently exposed to these chemicals or will be at some time in the future. In the final step, it uses the concentrations of the chemicals at the point of exposure to estimate the potential for an adverse effect on human health or the environment.

All chemicals, even beneficial ones, may produce some health effect if the concentration is sufficiently high. The factor differentiating safe from harmful is the amount of chemical entering into the body (dose). The risk assessment procedures estimate whether the concentration of a particular chemical is sufficiently high to cause concern for human health and the environment.

Risk assessment protocols are designed to be conservative to account for uncertainties such as the extent of contamination and the presence of highly sensitive individuals in the exposed population. The conservative approach is used to assure that the results of the risk assessment will be protective of human health and the environment.

The risk assessment evaluates a reasonable "worst-case" scenario so that regulators and the general public can compare this site with other measures of risk. This approach makes risk assessment a useful tool in assuring that all aspects of potential adverse health effects have been addressed.

Therefore, the risk assessment is structured to predict the "worst-case" effects that can happen rather than the most likely or probable potential or actual health impacts.

### 5.1.4 Organization of Risk Assessment

The risk assessment process consists of four steps: identification of chemicals of concern, exposure assessment, toxicological assessment, and risk characterization. The steps are briefly described below.

- Identification of Chemicals of Concern presents the data and describes the extent of contamination. The chemicals of concern are selected based on validity of the data, frequency of detection, range of concentrations, and comparison to background.

- Exposure Assessment determines the various ways humans are exposed to chemicals from the site (exposure pathways) and the concentrations actually taken into the body (dose). Exposure pathways are identified based on human and environmental populations in the vicinity of the site and within the pathways of chemical migration.

- Toxicological Assessment presents the toxicity values derived by EPA toxicologists for known health effects for each chemical. The toxicity values are calculated from studies which relate the level of a chemical taken into the body (dose) to an effect on human health (response).

- Risk Characterization estimates a numerical value for the risk by combining the dose from exposure with the toxicity value. It presents potential carcinogenic and non-carcinogenic health effects. It also presents uncertainty factors or an evaluation of how well these assumptions can be relied upon to give an accurate description of the potential risks.

## 5.2 IDENTIFICATION OF CHEMICALS OF POTENTIAL CONCERN

The analytical data for the site have been compiled and evaluated. Those site-related chemicals frequently detected at concentrations above background (chemicals of concern) have been selected for characterization of the risk.

### 5.2.1 Data Collection Considerations

### 5.2.1.1 Historical Data

The existing data on the site is discussed in detail in Sections 4.2.1 and 4.3.1 of the this report. In summary, volatile organic chemicals were detected in 16 shallow and 1 intermediate onsite wells, in 9 shallow offsite wells, and in a limited number of residential wells. Data is available from 1984 to 1990. There is evidence to suggest that there are sources for chemicals detected in these samples from other than the Chem-Solv site. Post-remediation soil analytical data show that the concentration of volatile chemicals has been reduced below levels of concern.

### 5.2.1.2 Rationale for Collection of Remedial Investigation Data

For the Remedial Investigation, 14 monitoring well locations were selected to characterize and delineate the offsite migration of chemicals in the groundwater further. Beneath the site, there is a clay layer which separates a shallow and deeper (intermediate zone) aquifer. Offsite, the clay layer is intermittent and the aquifers are likely to be connected. The 14 monitoring wells, both existing and new wells, were selected to characterize either the shallow zone or intermediate zone aquifer.

Samples were collected from unsaturated soils in locations surrounding the area remediated in 1985 to determine if the remediation was sufficient horizontally and vertically.

EPA risk assessment protocol recommends that samples from areas not impacted by the site be collected to provide background information of naturally-occuring chemicals. Chemicals which are found at concentrations similar to background levels are eliminated from further consideration in the risk assessment.

### Groundwater

Groundwater samples were collected from 14 monitoring wells. Two of these wells (22A and MWI-1-43) represent upgradient, background samples. These samples were analyzed for Target Compound List (TCL) organics and Target Analyte List (TAL) inorganics. The analytical results for groundwater are presented in Tables 4-6 through 4-11. Filtered and unfiltered samples were analyzed from all wells. Of the 16 groundwater samples (including duplicate samples), six samples were collected from intermediate zone wells, one of which is upgradient of the site. The remaining 10 samples were collected from the shallow aquifer, including one background (or upgradient) sample.

### Soil

Twenty-one soil samples were collected from seven onsite borings at depths from the upper 6 inches to 20 feet. Eleven samples were collected from the surface soil, defined in this risk assessment as the upper 6 inches to 4 feet. The remaining samples were collected at intervals to 20 feet. These samples were analyzed for TCL organics and TAL inorganics. The analytical results are presented in Tables 4-2 and 4-3.

Background soil samples were not collected due to difficulties in selecting a representative background area. There are multiple sources of offsite contamination due to the proximity of the highway and agricultural fields. Also, air-borne contaminants may have been associated with the explosion and fire. The area potentially exposed to any air-borne contaminants is unknown and, thus, selection of a representative background sample was not possible.

Literature values reported for soil from the State of Delaware, surrounding states, and the eastern coastal area were used to represent background concentrations.

### 5.2.2 Data Evaluation Considerations

The existing and RI analytical data on inorganic and organic chemicals in soil and groundwater were compiled and evaluated. The assessment included QA/QC information, location of samples, range of concentrations, and comparison to background.

#### 5.2.2.1 Historical Data

Data collected from previous site investigations and the ongoing residential well sampling program are presented in Sections 4.3.1 and 4.3.2 in this report. The data were not included in the risk assessment because there are insufficient quality assurance/quality control (QA/QC) samples and documentation. Also, the current RI data is more representative of existing conditions.

The decision to not include historical data does not indicate that the data is inaccurate, but only that there is insufficient information to support a review in accordance with EPA risk assessment protocols. The QA/QC information is used to determine the validity of the data. As discussed in more detail in this section, there is an inherent uncertainty in all analytical results that must be evaluated to determine if the reported concentration is accurate. The information necessary to perform a QA/QC review in accordance with EPA protocols was not available for the historical data.

The data collected during the RI is considered more representative of existing conditions. The soil and well locations sampled were designed to delineate the extent of contamination and the samples were collected in accordance with EPA protocols. The most recent historical data was collected in September 1988.

#### 5.2.2.2 Quality Assurance/Quality Control Evaluation of Data

The validity of analytical data is evaluated using a QA/QC protocol. QA/QC protocols are used to determine the level of confidence that the chemical concentration reported by the laboratory is the same as the concentration actually present in the sample. QA/QC protocols verify a series of requirements to support the validity of the data such as proper operation of the analytical equipment, consistent standard methods, correctness of calculations, and any uncertainty associated with the concentrations reported by the laboratory.

Prior to selection of chemicals of concern, the data was validated to identify cases where the reported concentration may be inaccurate (estimated concentrations) or the chemical may not have been present in the sample when it was collected (questionable data).

Data validation identifies chemical concentrations which could not be measured accurately. These data, called "estimated" or "trace" concentrations, occur when the concentration of the chemical is below a level (quantitation limit) that can be measured accurately, but above a level that can be detected (detection limit). In cases when the result is estimated, the chemical was present in the sample; however, it is not certain if the actual concentration is greater or less than the reported concentration.

During the collection and handling of samples and/or during laboratory procedures, chemical compounds can be inadvertently introduced. To account for these accidental additions of chemical contaminants, blank samples that are prepared in the field and/or laboratory are also analyzed. Chemicals detected in either the field or laboratory blank may not actually be present in the sample and may therefore be considered questionable.

Questionable data is defined as sample concentrations that are within a factor of 10 of the blank concentration for the common laboratory contaminants: methylene chloride, toluene, acetone, phthalate esters, and methanol. For any other compounds detected in a related blank, a factor of 5 is used to define questionable data.

### 5.2.3 Selection of Chemicals of Concern

The data were sorted into three groups for the selection of chemicals of concern: (1) all chemicals in soil, (2) inorganic chemicals in groundwater, and (3) organic chemicals in groundwater. The groups were based on the conclusions reached in this RI as well as previous investigations that organic chemicals, primarily volatiles, are the principle site-related chemicals. Nevertheless, data from all three groups received equal consideration in the assessment of chemicals of concern.

#### 5.2.3.1 Organic and Inorganic Chemicals in Soil

No organic or inorganic chemicals of concern were selected in soil because the concentrations detected were in the range of background concentrations, represented isolated events unrelated to previous site activities, or were infrequently detected at low concentrations (Table 5-1). A preliminary review of the data was presented to EPA Region III in an Interim Document dated June 1, 1990. EPA Region III agreed with the conclusion that there were no chemicals of concern in site soils (Appendix A-8).

For soil exposure, the upper 4 feet of soil was considered the depth of most likely human and environmental exposure. Chemicals found at greater depths were considered qualitatively to describe the extent of any contamination.

Volatile/Semivolatile Organic Compounds

Volatile and semivolatile organic chemicals were detected in a limited number of samples at low concentrations, and most of the data is questionable due to the presence of that chemical in a related blank.

In the 11 shallow soil samples, trichloroethene was detected twice with a maximum estimated concentration of 6 micrograms per kilogram (ug/kg). Methylene chloride was detected 5 times, but the data is questionable based on methylene chloride also being detected in the associated QA/QC samples, except for one sample with a detected value of 4 ug/kg. Acetone was detected 7 times, but all the values are questionable due to blank contamination.

Of the remaining soil samples from depths greater than two feet, chloroform was detected in 4 samples with a maximum concentration of 8 ug/kg. However, since chloroform was only detected in samples collected from the deeper soils (6 to 20 feet), human or environmental exposure to chloroform is considered unlikely.

Methylene chloride was detected in 7 samples; however, all of these are questionable due to blank contamination.

Acetone was detected in 9 soil samples taken from depths greater than two feet. All these results were questioned due to blank contamination.

Six soil samples from the 15 samples collected had detectable levels of semivolatile organic chemicals. Bis (2-ethylhexyl)phthalate (DEPH), a common laboratory contaminant, was detected in five samples with a maximum concentration of 510 ug/kg. Only one of these samples was obtained from surface soils; the remaining samples were collected from depths from 2 to 5.5 feet. Isophorone was detected twice in one boring with a maximum concentration of 3,100 ug/kg. Benzoic acid was detected in only one sample at 290 ug/kg.

Pesticides

The pesticides detected in onsite samples are attributable to farming activities in the adjacent fields. The use of DDT in the United States was banned in 1972, ten years prior to the time operations began at the site in 1982.

The pesticide DDT and its breakdown products, DDE and DDD, were found in 9 of the 15 samples collected throughout the site, at a maximum total concentration of 390 ug/kg (determined by averaging duplicate sample results for soil sample CSB-11 and summing the DDT, DDE and DDD results).

DDT is not considered site-related. The site is surrounded by agricultural fields and DDT and its breakdown products are very persistent in the environment; therefore, the presence of DDT in the soils is not unexpected. Literature values report DDT concentrations as high as 1,000 ug/kg in agricultural fields as late as 1983, 11 years after DDT use was banned (ATDSR, 1988).

Inorganic Compounds

Inspection of Table 5-1 shows that the concentrations of metals found in site soils are well within the background range for this area with the possible exception of lead. The maximum onsite lead concentration is 72.2 mg/kg, compared to the highest value for the area of 20 mg/kg. The average onsite lead concentration for all samples is 20.4 mg/kg and, therefore, typical of background.

The presence of slightly elevated levels of lead in isolated locations on the site is not unexpected. The impact of the highway and emissions from cars and trucks is highly probable.

In addition, metals and metallic compounds were not used as part of the re-processing activities that took place at Chem-Solv.

### 5.2.3.2 Organic Chemicals in Groundwater

To present a conservative estimate of the risk, all the volatile organic chemicals were included as chemicals of concern, even those chemicals detected infrequently (Tables 5-2 and 5-3). Ten volatile organic chemicals are included in this list. Seven of these chemicals, chloroform, 1,2-dichloroethane (1,2-DCA), methylene chloride, tetrachloroethene (PCE), toluene, 1,1,1-trichloroethane (1,1,1-TCA), and xylene were detected in only 1 of the 10 downgradient well samples. Two chemicals, acetone and benzene, were detected in 2 of the 10 wells. One chemical, trichloroethene (TCE), was detected in 3 downgradient wells.

Phenol was the only semivolatile compound or pesticide detected. Phenol was found in one downgradient, offsite shallow well at an estimated concentration of 9.0 micrograms per liter (ug/l). Phenol, a non-carcinogen, was not included in the chemicals of concern since this chemical was only detected in one sample at a location fairly distant from the site. Phenol is easily degraded by bacteria (Verschueren, 1983). Therefore, it is highly unlikely that this chemical would migrate in the groundwater at significant distances from the site.

The background wells, both shallow and deep, contained no volatile organic compounds. Blank samples did not contain any contamination. Therefore, none of the volatile organic data were questionable.

### 5.2.3.3 Inorganic Chemicals in Groundwater

No inorganic parameters were selected as chemicals of concern because, in general, the concentrations were within the range found in the background wells. The inorganic parameters found in excess of background can be explained as either isolated events at wells distant from the site or considered suspect. The assessment of suspect data was based on the atypical chemistry of groundwater in certain samples.

Inorganic parameters were analyzed on both filtered and unfiltered samples. The data are presented in Table 4-7 and 4-9. The unfiltered data includes inorganics absorbed on particulate soil material as well as inorganics dissolved in the water. The filtered results represent dissolved inorganic constituents only.

The evaluation of inorganic groundwater data was performed on the filtered samples. Previous evaluation, as discussed in Section 5.2.3, showed that onsite soils, regardless of depth, do not contain concentrations of inorganic parameters above background. Therefore, the soil particulate material measured in the unfiltered samples is considered to be the result of naturally-occuring soil material.

The data for filtered samples were compared to background. Any parameters found at concentrations greater than 50 percent above a quantified background concentration were considered in more detail. When both the background and downgradient concentrations were estimated, such as those detected below the quantitation limit, the concentrations were not considered different.

Shallow Wells

Aluminum was detected above background in only one well, MWS-3-17, and mercury was detected above background in only one well, MWS-7-25. It is unlikely these parameters are site-related since both wells are fairly distant from the site.

The remaining inorganics found above background (cobalt, iron, manganese and calcium), were found in the downgradient shallow wells installed by DNREC (26A, 41A, 39A and 33A). The chemistry of the water from these wells suggests that metals are being dissolved from soil material due to low oxygen conditions. The solubility of iron and manganese on soil is increased by low oxygen conditions in water (Wetzel, 1983). The high levels of these metals in these wells suggests that low oxygen conditions are present. The low oxygen conditions are generally caused by bacteria consuming organic matter in the water. It is not clear if this condition is related to site-activities or a result of the remedial activities. Elevated concentrations of zinc and selenium were also found, in one sample each, within this group of wells. Sodium is also elevated in all downgradient shallow wells.

Since known site activities involved use of organic chemicals, there is no evidence that any elevated levels of inorganics are site-related. An alternate possible explanation is that excavation and mixing of the soil during remediation resulted in increased exposure of the soil to infiltrating rainwater and a temporary increase in dissolved salts in the groundwater.

Regardless of the source, the data indicate that elevated levels of heavy toxic metals such as cobalt, zinc, selenium, aluminum, and mercury are isolated, single cases. Metals are to likely to be present due to site-related activities. Iron, manganese, sodium, and calcium do not represent the same level of concern for public health.

#### Intermediate Wells

The majority of inorganic parameters detected above background levels (aluminum, arsenic, calcium, potassium, and sodium) were found in MWI-4-40. This well is located on the Durham property. Mr. Durham has reported difficulties with a high mineral content in his drinking water well. It is likely that there is an area of high dissolved salts in the deep aquifer in this area. Mercury was elevated in one sample from well 9B. This well also had elevated levels of iron, magnesium, and potassium.

### 5.2.3.4 Tentatively Identified Compounds in Groundwater

Tentatively identified compounds (TICs) were found in samples from wells 26A and MWS-7-25. The list of chemicals is generally the same for both wells, although the concentrations are higher in 26A. The TICs found in Wells 26A and MWS-7-25, generally components of fuel oils, were not found in any other well on or offsite. This suggests that there may be another source of this material such as past leakage from offsite underground storage tanks.

These chemicals were not included as chemicals of concern because of the limited number of detections and indications that their presence may not be site-related.

### 5.2.4 Summary of Chemicals of Potential Concern

The chemicals of concern for this risk assessment include all volatile organic compounds detected in the groundwater. The selection of volatile organics is supported by the analytical data collected during previous investigations and the history of product use at the site.

In groundwater, the only semivolatile detected, phenol, is considered an isolated event unrelated to the site. The inorganic parameters are within the range of background, or isolated events unrelated to the site. The TICs were not included as chemicals of concern because of the limited number of detections and evidence that their presence may not be due to site-related activities.

No chemicals of concern were identified in soil samples. The majority of the volatile detections are questionable, the semivolatiles were found in isolated samples, and the inorganic parameters are within literature values for background.

## 5.3 EXPOSURE ASSESSMENT

Exposure assessment determines the pathways that may result in human exposure, the concentrations of chemicals at the point of exposure, and the concentration of each chemical absorbed by an exposed individual on a daily basis (chronic daily intake, CDI).

### 5.3.1 Characterization of Exposure Pathways

The only complete exposure pathway identified is residential use of the groundwater. Currently, there are two drinking water wells within the area defined by the near or far monitoring wells. There are other residential wells adjacent to the plume. DNREC has a quarterly monitoring program for potentially affected wells, most of which are at greater depths than the area of contamination.

### 5.3.2 Identification of Exposure Pathways and Assumptions

Exposure pathways include all the various ways in which humans come in contact with the chemicals of concern, either currently or at some time in the future. Exposure pathways are evaluated by considering direct contact to the media of concern (e.g., drinking water) and the potential for chemicals to migrate from one media to another (e.g., volatilization of chemicals from groundwater into the air).

At this site, the media of concern is groundwater and the chemicals of concern are several volatile organic chemicals. The exposure pathway identified is:

Residential Use of Groundwater

- Ingestion of groundwater
- Inhalation of indoor air
- Dermal absorption during showering and bathing

The potential for contamination of vegetables and fruits during watering and release of contaminants to surface water were also evaluated. Potential exposure via ingestion of home-grown fruits and vegetables that were watered with groundwater is considered negligible because the chemicals of concern are volatile organic chemicals. Since these chemicals will volatilize during the watering process, there is little or no potential for accumulation in home-grown foods.

The distance to the nearest point of surface water discharge is 0.4 miles, and low concentrations of volatile chemicals of concern indicate the potential for elevated concentrations in this creek is highly unlikely.

The objective of the exposure assumptions is to determine how much of the chemical is actually taken into the body (dose). The dose received on a daily basis is expressed as the milligrams of contaminant per kilogram of body weight per day (mg/kg/day).

In risk assessment, it is seldom possible to measure specific dosage for each identified exposure pathway. As a result, it is necessary to use an estimation of dose based upon a series of assumptions such as how much water the average person drinks. These assumptions were developed from EPA Region III guidance and the most current Superfund Risk Assessment guidance documents (EPA, 1989a, 1989b, and 1989c). The assumptions used in calculating the exposure for each pathway are presented in Table 5-4. The methods and calculations for exposure dose are presented in Appendix P.

The averaging time is the time period over which exposure is assessed. For carcinogens, the averaging time is a 70-year lifetime. For chemicals with non-carcinogenic effects, the averaging time is one day.

### 5.3.2.1 *Ingestion of Drinking Water*

The standard assumptions for drinking water are ingestion of 2 liters (a little over 2 quarts) of water a day by a 70-kilogram (154-pound) person (EPA, 1989a and 1989b). This assumption includes water that is consumed as coffee, juices, and other beverages containing tap water (EPA 1989b). In reality, people in the United States consume less than 2 liters a day of tap water. Sixty percent of the population consume less than 1.5 liters a day (EPA, 1989c).

### 5.3.2.2 Inhalation of Indoor Air

At this time, there is increasing awareness that inhalation of volatile chemicals that accumulate in indoor air can play a significant role in exposure. Chemicals enter the indoor air during everyday household usage such as washing clothes, showering, bathing, and flushing the toilet. However, there is still considerable controversy regarding the methods that can be used to estimate the dose from this exposure (EPA, 1989a and 1989b).

For inhalation, a draft whole house model from the Office of Drinking Water was used (Appendix Q). Briefly, the model assumes that a certain fraction of the chemical in the water entering the house volatilizes and accumulates in the indoor air in proportion to the air exchange or ventilation rate of the house. The exposed individual is assumed to remain indoors 24 hours a day.

There are two chemical-specific parameters in the model: 1) the fraction of chemical retained in the lungs, and 2) the fraction of chemical which volatilizes out of the water. The fraction retained by the lungs was assumed to be 100 percent for all chemicals. For the fraction volatilizing, a factor of 50 percent was used. This value is representative of volatile chemicals (Appendix Q).

A convenient way to express exposure via inhalation is in terms of drinking water equivalents (DWE). Use of DWE allows direct extrapolation from exposure via ingestion of water to exposure via inhalation for the same concentration of a chemical in the water. Exposure via inhalation is 0.95 times the DWE for the chemicals treated as volatile.

### 5.3.2.3 Dermal Exposure

Chemicals can enter the body via skin adsorption during showering and bathing activities. The dose received through dermal contact with water is calculated from assumptions on the length of time the person is in the shower or bath (exposure time), the amount of skin in contact with the water (skin surface area), the rate at which the chemicals penetrate the skin (dermal permeability), and the frequency of bathing or showering activities on a daily basis per year.

The amount of skin in contact with the water was estimated as 1.94 square meters. This value is suggested in the current EPA protocol and is considered to represent the fiftieth percentile total body surface area for adult males (EPA, 1989b).

There is very little information of dermal adsorption rates for individual chemicals (EPA, 1989a). For this risk assessment, the values were derived from data provided by EPA Region I and are presented in Appendix R.

### 5.3.3 Groundwater Exposure Concentrations

The data for the groundwater monitoring wells were evaluated to determine which wells were representative of the plume. The data from these wells were then combined to estimate water concentrations in a hypothetical drinking water well placed within the plume.

### 5.3.3.1 Data Evaluation

#### Shallow and Intermediate Aquifer Data

The data for groundwater from intermediate and shallow zone wells were combined to simulate groundwater use in this area. Area drinking water wells are generally installed at depths greater than 100 feet. However, the high porosity of the soil and absence of a confining aquifer in all areas suggests that water from shallow aquifers is likely to be included in the recharge for the intermediate wells. In this way, human exposure to water from the shallow aquifer may occur.

#### Plume Definition

The 12 downgradient wells were divided into three groups based on presence of chemicals, direction of groundwater flow, and probable location of the plume. The first group, the near wells, represent the five wells closest to the site and most likely to represent the plume. The data for the near wells, 5B, 9A, 26A, 33A, and 39A, is presented in Table 5-2.

The second group, the far wells, included all the near wells plus five additional wells, 41A, MWI-4-40, MWS-5-18, MWS-6-25, and MWS-7-25 (Table 5-3). All these wells had non-detectable or very low levels of chemicals except MWS-7-25. There is evidence to suggest that former underground storage tanks upgradient of MWS-7-25 may also be a source of chemicals. Also, groundwater quality for these wells is not as clearly associated with a plume from the site.

The third group, MWI-2-40 and MWS-3-17, were not included in the risk assessment. No chemicals were detected in groundwater from these wells and the pattern of groundwater flow supports the theory that these wells are not associated with a plume.

### 5.3.3.2 Exposure Concentration

The data from within the two well groups were combined to estimate a probable concentration of each chemical of concern for a hypothetical well drawing from the center of each plume. The data were combined into an arithmetic average from which a Reasonable Maximum Exposure (RME) concentration was calculated (Table 5-5). Methods used in handling of chemical data are in accordance with guidance received from EPA Region III (Appendix S) and Risk Assessment Guidance for Superfund (EPA, 1989).

#### Average Concentration

The arithmetic average was obtained using data from the near and far well groups. Data from duplicate samples were averaged into a single data point prior to calculating the group average.

The use of the arithmetic average requires statistical support and justification. The most quantitative form of statistical analysis, parametric statistics, requires that the arithmetic average only be calculated directly when the data are normally distributed. Normal distribution represents one of many patterns for data. A more typical pattern for environmental data is a log normal distribution. There are methods for adjusting log normal data to make it fit a normal distribution prior to calculating the average.

Statistical evaluation of the data for the Chem-Solv site indicated that neither a normal or log normal distribution described the pattern of the data nor did one fit better than the other.

Other techniques for adjusting data to a normal distribution were not evaluated. The arithmetic average was selected because this value represents an unbiased estimate of the mean (Gilbert, 1987). Since the data tend to be skewed to higher concentrations, it is highly likely that the arithmetic average calculation results in a higher, more conservative estimate of the concentration than any average calculated with adjusted data.

### Incorporation of Non-detected and Questionable Data

Two key issues in the calculation of the average are (1) the method used to incorporate questionable or non-detected data, and (2) the method used to calculate the upper bound 95 percent confidence interval for the arithmetic average concentrations.

When a chemical is not found in a sample, the laboratory reports the value as non-detected above a certain level. This means that if the chemical is present, the concentration is below the detection limit reported. However, it is also possible that the chemical was not present in the sample.

There are several approaches for use of data reported as non-detected. The data can be excluded from the data base, listed as zero, or listed as one-half the detection limit. For this risk assessment, arithmetic means were calculated using one half the detection limit for data which was reported as less than the detection limit. Method detection limits were obtained from the contract laboratory and are listed in Appendix W.

When a compound was detected (quantified or estimated) but the value is questionable because the chemical was also found in a related blank sample, one half the reported sample value was used.

### Calculation of Reasonable Maximum Exposure (RME)

Prior to 1989, EPA protocol required that the risk associated with the maximum concentration be evaluated. However, current protocol recognizes that the maximum concentration does not represent a reasonable exposure concentration. At this time, EPA recommends that the 95 percent upper-bound confidence interval for the arithmetic mean be used to represent a reasonable maximum exposure (RME).

In simpler terms, the average or means represents the central observation or most commonly observed concentration if a very large number of samples (e.g., greater than 100,000) were collected. If the data behave according to certain assumptions, in 50 percent of the samples the actual concentration is predicted to be lower than the average and in 50 percent of the samples the concentration may be higher than the average.

The RME is used to account for the fact that the actual number of samples is relatively small for accurately predicting the average. The RME is a statistical estimate of the highest average concentration predicted to occur in 95 out of 100 sets of samples.

The RME is a conservative estimate of the risk since it assumes that a concentration equal to the upperbound confidence interval of the average for every chemical of concern is present in one hypothetical residential well.

The methods and equations used to calculate the RME are presented in detail in Appendix T. The methods are those recommended by EPA risk assessment protocol and presented in Gilbert, 1987.

### 5.3.4 Identification of Uncertainties

Exposure assessment assumptions are selected to estimate an upper concentration limit and the amount of each chemical that individuals take into their bodies.

Exposure assumptions tend to estimate the risk for a large percentage of the population and, therefore, be protective of human health. Each of the assumptions and its basis were discussed in detail in Section 5.3.2. The assumptions tend to be conservative. For example, the carcinogenic risk assumes that exposure occurs daily for 70 years.

The estimated exposure concentrations tend to be conservative for two reasons. First, the average assumes that all the chemicals are present at one half the detection limit for samples with non-detect results. It is likely that for many of the wells, the chemicals are not present at all. Also, the RME represents an upperbound confidence interval concentration. The rational behind the use of the RME is that an area of higher concentrations may not have been detected. The sufficiency of the number of wells and appropriateness of their locations improves the confidence level in the data base.

There is some uncertainty in the exposure assessment associated with the lack of chemical specific dermal permeation constants for several potential chemicals of concern. Constants selected for these compounds were based on similarities in chemical composition since literature values for many compounds are not available. The absence of chemical specific permeation constants may have either overstated or underestimated the risk.

### 5.3.5 Summary of Exposure Assessment

The only media of concern identified was the groundwater. The exposure pathways identified was the residential use of groundwater. This pathway includes ingestion of water, inhalation of airborne contaminants, and dermal absorption of contaminantion through water usage. Future usage of the site is considered to be the same or the current usage.

## 5.4 TOXICITY ASSESSMENT

The toxicity profiles provided in Appendix U summarize chemical and toxicological information on the chemicals of concern. A more technical presentation of toxicological data for the chemicals is given in Appendix V. Unless otherwise noted, the technical toxicological profiles were obtained from the Integrated Risk Information System (IRIS).

EPA toxicologists derived toxicity values after an extensive review of the available data for each chemical. Although data from epidemiological studies on human exposure is the most valuable, generally the only data available are laboratory studies with animals. There is some uncertainty in results from using laboratory studies with animals since the animals are usually exposed to high doses of chemicals for short periods of time. Dose-response evaluations utilize this data to assess the potential for health effects in humans exposed to low doses for long periods.

Toxicity values for each parameter can differ depending on the way humans are exposed to the chemical. Chemicals can be taken into the body through the gastrointestinal tract after ingestion of soil, sediment, or water (oral); into the lungs after inhalation of vapors or particulates in the air (inhalation); and into the body through the skin after contact with chemicals in soil, sediment, or water (dermal).

Some chemicals are not as potent via one exposure route versus another. Thus, different health effect factors have been established for each route of exposure. For example, certain metals, such as hexavalent chromium, have been shown to have carcinogenic effects via inhalation but not via ingestion.

Chemicals can also have both carcinogenic and noncarcinogenic effects. Therefore, it is possible that a chemical can have both a carcinogenic health effect factor for oral and inhalation exposure and a noncarcinogenic health factor for oral and inhalation exposure.

The toxicity values used for this risk assessment to assess human health effects are presented in Tables 5-6 and 5-7. The following sources were used to identify toxicity values and are listed in order of preferential selection.

Integrated Risk Information System (IRIS)

IRIS is an on-line computer data base that presents toxicological assessments of chemicals and the status of EPA-approved toxicity values. The toxicity values obtained through IRIS are current as of January 1990.

Health Effects Assessment Summary Tables (HEAST)

The EPA Office of Emergency and Remedial Response publishes a quarterly summary of toxicity values from a variety of recognized sources in addition to IRIS. The toxicity values obtained through HEAST were taken from the Fourth Quarter, 1989.

### 5.4.1 Toxicity Information for Noncarcinogenic Effects

The potential for adverse noncarcinogenic health effects is estimated with a toxicity value known as a reference dose (RfD). RfDs are associated with an adverse health effects which are also referred to as toxicity endpoints. The RfDs and toxicity endpoints for the chemicals of concern are listed in Table 5-7.

Reference Dose

The model to determine RfDs from the dose-response assessment assumes that there is a concentration for noncarcinogens below which there is little potential for adverse health effects over a lifetime of exposure. The RfD is designed to represent this threshold level.

The RfD is calculated from the highest chronic (long-term) exposure level that did not cause adverse effects (the no-observed-adverse-effect-level or NOAEL) in animals. The NOAEL is divided by a factor to account for any uncertainty such as using data on animals to predict effects on humans and an allowance for sensitive individuals. Uncertainty factors range from 1 to 10,000, based on the confidence level associated with the data. The resulting RfD (mg/kg of body weight per day) is used to quantify the risk.

### Toxicity Endpoint

The determination of adverse impact for noncarcinogens is based on a wide variety of responses ranging from increases in organ weight, changes in blood chemistry, to death. Noncarcinogenic effects are also defined by the toxicity endpoint in laboratory animals used to identify the RfD.

## 5.4.2 Toxicity Information for Carcinogenic Effects

The EPA approach for evaluations of carcinogens assumes that exposure to any level of a carcinogen, no matter how low, has a certain probability of causing cancer. The toxicity value calculated for carcinogens is known as the potency factor (PF). The weight-of-evidence is a qualitative descriptor that is important to the interpretation of carcinogenic risk. The PFs and weight-of-evidence for the chemicals of concern are listed in Table 5-6.

### Potency Factors

The PF is calculated with a mathematical model that draws a line based on data from laboratory animals exposed to high doses and extends it to predict potential increases in cancer rates for humans who are exposed to low doses. Then confidence intervals are calculated for the line. The slope of the line which represents the 95 percent confidence interval is known as the potency factor or slope factor. The use of the upperbound confidence interval means that there is a 95 percent probability that the actual risk will be less than that predicted by the model. The units for the PF are (mg/kg of body weight per day)$^{-1}$.

### Weight-of-Evidence

The weight-of-evidence reflects the degree of confidence in the data used to determine that the chemical is a human carcinogen. EPA toxicologists recognize that the risks associated with a known human carcinogen, based on epidemiological studies, should be evaluated differently than a chemical which causes tumor production in a limited number of laboratory animals. Each carcinogen is assigned to a group depending on the quality and quantity of evidence for carcinogenicity in humans and animals. The definitions for the groups are presented in Table 5-8.

## 5.4.3 Chemicals Without Available EPA Toxicity Values

Uncertainty is low with regards to omission from the risk calculations of chemicals without EPA toxicity values. All the identified chemicals of concern have EPA toxicity values. Therefore, the only chemicals not included in the risk assessment are the TICs. In the majority of the samples, the TICs are listed as unknown. In the two wells with names assigned to the chemicals, 26A and MSW-7-25, the TICs are generally associated with petroleum hydrocarbons. The adverse health effects associated with long-term exposure to petroleum hydrocarbons have been attributed only to the carcinogenic components such as benzene and polyaromatic hydrocarbons (PAHs) (Bingham et al., 1980). Benzene is included in the risk assessment; no PAHs were detected in the groundwater.

### 5.4.4 Uncertainties Related to Toxicity Information

In the general profiles, much of the information on human health effects from chemicals is based on occupational exposure. Adverse effects observed in the workplace are a valuable source of toxicological information. Some of the health effects studies discussed in the toxicological profiles presented in Appendices U and V may have been used by EPA toxicologists to help determine health effects at much lower concentrations. However, the reader should keep in mind that many of the health effects observed for the workplace are acute or short-term, high level effects. Workplace exposure levels are generally much higher than the potential exposures encountered at the Chem-Solv site. The adverse effects presented in the general profiles (Appendix U) are not necessarily comparable to the potential effects related to exposure concentrations predicted by the Chem-Solv risk assessment.

The dose-response assessment for the majority of chemicals relies on an extrapolation of known effects on animals to humans. The use of data based on animal studies to predict impacts on humans is an area of uncertainty, particularly because different species of animals respond with different sensitivities to chemicals. Also, there are many models available which extrapolate animal data to humans and the toxicity values generated from the same data by different models can very substantially. The models used by the EPA tend to be conservative and are unlikely to underestimate the risk. The method used by the EPA for PFs uses a 95 percent upperbound confidence interval, which means that while the actual risk is unlikely to be higher, it could be much lower.

## 5.5 RISK CHARACTERIZATION

The risk characterization combines the exposure dose with the toxicity value to estimate a numerical value for the risk. There are several differences between the numerical value used to describe risk for carcinogens (cancer risk) and the value used for noncarcinogens (hazard index, HI). The methods and results for this risk assessment are presented separately for carcinogens and noncarcinogens.

### 5.5.1 Carcinogenic Risk Characterization

#### 5.5.1.1 Methods

Carcinogenic risk is calculated by multiplying the exposure dose (chronic daily intake [CDI]) times the slope factor. The resulting value is the probability of an increase in the incidence in cancer and should not be directly interpreted in terms of the number of cases of cancer in the exposed population. The risk level of 1 x $10^{-6}$ can also be viewed as a one in one million probability that there will be one additional case of cancer.

Cancer risk estimates for the same chemical in different exposure pathways are added together. Also, cancer risks for different chemicals are added together to determine the risk associated with exposure to all the chemicals.

#### 5.5.1.2 EPA Guidance on Cancer Risk

EPA has not established an acceptable level of risk. A range of cancer risks of 1 x $10^{-4}$ to 1 x $10^{-8}$ has been identified for Superfund sites. This means that target risk levels should be between an upper limit of a 1 in 10,000 probability of cancer incidence to a lower limit of 1 in 10,000,000. A total cancer risk of 1 x $10^{-6}$ is often used as a benchmark by state and federal regulatory agencies.

#### 5.5.1.3 Discussion and Interpretation of Cancer Risk Results

The results of the cancer risk calculations for each exposure pathway are presented in Appendix P. Tables 5-9 and 5-10 present the risk associated with each chemical and pathway for the near and far wells, respectively.

The average cancer risk associated with the near wells for all pathways was within the EPA target risk range with a value of 1 x $10^{-4}$. The risk associated with the RME, however, exceeded this range. Trichloroethene was greater than 50 percent of the total cancer risk within the near well group.

For the far wells, the cancer risk associated with the average exposure for all pathways was slightly over the EPA target risk range with a value of 1 x $10^{-4}$. RME cancer risks exceeded the target range, 5 x $10^{-4}$. For the far wells, benzene was the highest contributor to the cancer risk (greater than 60 percent), followed by trichloroethene.

Ingestion of Groundwater

The average and RME cancer risk associated with the near wells was 6 x $10^{-5}$ and 2 x $10^{-4}$, respectively. Approximately 50 percent of the risk can be attributed to trichloroethene, and 33 percent to benzene.

For the far wells, the cancer risk associated with the average and RME was 1 x $10^{-4}$ and 3 x $10^{-4}$, respectively. Again, benzene and trichloroethene contributed to the majority of the risk. However, approximately 70 to 80 percent of the risk can be attributed to benzene, and 20 percent to trichloroethene. 1,2-Dichloroethane contributed approximately 5 percent of the risk for the far wells.

Inhalation of Indoor Air

The average and the reasonable maximum cancer risk associated with inhalation of airborne contaminants from the groundwater for the near wells was 7 x $10^{-5}$ and 3 x $10^{-4}$, respectively. The majority of the risk (approximately 70 percent) was attributed to trichloroethene, while benzene represented the remainder of the risk. For the far wells, the cancer risk associated with the average and RME was 1 x $10^{-4}$ and 3 x $10^{-4}$, respectively. Benzene contributed of approximately 70 to 80 percent of the risk and trichloroethene contributed 20 percent. 1,2-Dichloroethane contributed less than 5 percent of the risk for the far wells.

Dermal Absorption of Groundwater During Use

For the near wells, the average and the reasonable maximum cancer risk associated with dermal absorption of contaminants was 1 x $10^{-5}$ and 3 x $10^{-5}$, respectively. Benzene and trichloroethene equally contributed 50 percent of the risk. The cancer risk associated with the average and RME for the far wells was 4 x $10^{-5}$ and 1 x $10^{-4}$, respectively. The majority of the risk (approximately 75 to 90 percent) was attributed to benzene. Trichloroethene contributed only 10 percent of the cancer risk.

A General Discussion of Cancer Risks

The interpretation of cancer risk is complicated by the absence of guidance from the federal government on acceptable risk. Instead, the decision to remediate a site and the determination of a clean-up levels is made on a case-by-case basis within the Superfund target range.

The target risk range (1 x $10^{-4}$ to 1 x $10^{-6}$) identified for Superfund is consistent with that for other federal agencies that make risk-based decisions. A review of criteria for foods, pesticide use, and occupational safety shows that other agencies such as the Food and Drug Administration (FDA) and Occupational Safety and Health Organization (OSHA) frequently make risk-based decisions within this range. Sometimes risk-based decisions have used cancer risks as high as 1 x $10^{-3}$ (Rodericks, et al., 1987).

It is also helpful to consider the risks associated with this site in a context of normal, everyday risks. The cancer risk associated with natural background radiation is greater than 1 x $10^{-4}$ and the risk from smoking is greater than 8 x $10^{-2}$, or 8 in 100. Strictly speaking, unavoidable risks such as natural radiation and voluntary risks such as smoking can not be compared to those risks associated with chemicals contamination due to human activities. This information on risk is included just to help the reader's perspective on various levels of cancer risk.

### 5.5.2 Noncarcinogenic Risk Characterization

#### 5.5.2.1 Methods

The numerical value for noncarcinogenic risk is the Hazard Index (HI). The HI is the ratio of the exposure dose to the RfD and is calculated by dividing dose (chronic daily intake or CDI) by the RfD. The HI is not strictly an estimate of the risk, but a number which compares CDI to a level considered to have limited potential for lifetime health effects. Hence, HI values greater than 1 indicate that exposure exceeded the acceptable daily level while HI values less than 1 show that exposure is lower.

Similar to cancer risks, the HI values for each chemical are summed together to assess the overall potential for noncarcinogenic effects. This approach was developed by EPA based on the the assumption that simultaneous subthreshold exposures to numerous chemical compounds can result in an adverse health effect (EPA, 1986).

#### 5.5.2.2 EPA Guidance on Hazard Indices

EPA has not established specific guidance for acceptable HI values. However, since an HI value of 1 indicates that lifetime exposure has limited potential for causing an adverse effect in sensitive populations, values that are less than one can generally be considered acceptable. Values greater than one are usually given closer attention. For values greater than one, the magnitude of the uncertainty factor and toxicity endpoint are included in the evaluation.

#### 5.5.2.3 Discussion and Interpretation of Hazard Indices

The results of the HI calculations for each exposure pathway are presented in Appendix P. Tables 5-11 and 5-12 present the hazard index associated with each chemical and pathway for the near and far wells.

The HI values for individual chemicals and the total HI for each pathway did not exceed unity (the value of one). Therefore, for the exposure pathways examined, potential noncarcinogenic health effects are not expected.

Ingestion of Groundwater

The average and the reasonable maximum HI values associated with the rear wells were 0.009 and 0.03, and 0.01 and 0.02 for the far wells, respectively. For the near wells, the HI associated with acetone (0.004) consists of approximately 50 percent of the total HI value. Tetrachloroethene and 1,1,1-trichloroethane each represent approximately 25 percent of the total HI. For the far wells, acetone, tetrachloroethene, and 1,1,1-trichloroethane represent the majority of the HI (approximately 80 percent).

Inhalation of Groundwater During Use

The average and the reasonable maximum HI values associated with inhalation of airborne contaminants from the groundwater for the near wells were 0.007 and 0.02, respectively. The majority of the risk (approximately 75 percent) was attributed to acetone and tetrachloroethene. The HI for the far wells was 0.009 and 0.02 for the average and RME, respectively. Acetone, tetrachloroethene, and chloroform contributed of approximately 70 to 80 percent of the total HI value.

Dermal Absorption of Groundwater During Use

For the near wells, the average and the reasonable maximum HI values associated with the dermal absorption of contaminants were 0.002 and 0.005, respectively. The majority of the HI value was almost exclusively the result of tetrachloroethene. The HI values associated with the average and RME for the far wells were 0.002 and 0.004, respectively. The majority of the risk (approximately 50 to 70 percent) was attributed to tetrachloroethene.

### 5.5.3 Uncertainties in Risk Characterization

Areas that represent some uncertainty in the risk assessment include the toxicological effects of chemical mixtures and the presence of any unknown chemicals.

There is very little information on the toxicological effects of mixtures. In some cases, the presence of several chemicals together may result in an enhancement of the overall toxicity (synergistic) effects. Other chemicals mixed together may result in fewer toxic effects (antagonism). There is uncertainty associated with having many chemicals together.

Lastly, the chemical analyses were for specific parameters. The chemicals evaluated are those that have been identified as the most important chemicals in air, soil, and water. The possibility exists that other chemicals are present that were not detected.

The information included in the general toxicity profiles (Appendix U) represents a broad spectrum of studies that are available on health effects. The conclusions may or may not have undergone extensive review to determine their significance or validity. The technical profiles discuss the adequacy of the studies presented and define those which EPA considers adequate to support an assessment of the adverse health effects of the chemical.

## 5.6 ENVIRONMENTAL ASSESSMENT

The environmental assessment determines the potential for adverse health effects to the environment using essentially the same approach as the risk assessment used for human health, with the addition of a site biological survey. The steps include a description of relevant aspects of the site, identification of chemicals of concern, exposure pathways, toxicity assessment, and risk characterization. The final step is a survey of the site conducted by a trained field biologist to determine any observable impacts.

### 5.6.1 Site Description

The aspects of the site description relevant to the environmental assessment are site's the proximity to surface water, points of discharge for groundwater, and terrestrial community. Surface water at the Chem-Solv site infiltrates to the soil or runs onto the adjacent highway so that there are no surface drainage bodies of concern. The point of groundwater discharge is sufficiently far from the site that these surface waters are unlikely to be impacted.

The terrestrial plant and animal community on the site is the environmental receptor of concern. Therefore, soil is the medium of concern as this represents the only completed exposure pathway.

### 5.6.2 Identification of Chemicals of Concern

There are no chemicals in the soils at significant concentrations above background at the Chem-Solv site (see Section 5.2.3.1).

In principle, the environmental assessment process would end after the determination that the soil is the only environmental media of concern and that there are no chemicals of concern in it. However, a site biological survey was conducted in order to present a complete description of the site and make a final determination that all aspects of the risk assessment process had been addressed.

### 5.6.3 Biological Site Assessment

On June 15, 1990, a qualitative analysis of the plant communities was conducted at the Chem-Solv site. The purpose of the analysis was to describe the terrestrial community and make a qualitative determination of plant distribution patterns.

The area of investigation was confined to the area within the chainlink fence. The study area included well 3A and the remains of a concrete pad in the north central portion of the area (Figure 5-1). The entire study area is characteristic of an early successional stage meadow. Within this meadow, three microcommunities were defined based on patterns in the distribution of species. Each of the three communities separately inhabits approximately one-third of the site. A presence/absence matrix of the predominant taxa observed on the Chem-Solv site is provided in Table 5-14. Four photographs of the site are presented in Figure 5-2.

In Area 1, the western one-third of the site, has more perennial toxa than Area 2 and the dominant vegetation is several species of clover, Cow vetch, fleabane, plantain, ironweed, and several perennial grasses (Table 5-14; Figure 5-2, Photograph 1). In Area 2, the middle one-third of the site which includes well 3A, the dominant vegetation is similar to Area 1 and likewise includes several species of clover, cow vetch, fleabane, plantain, ironweed and perennial grasses. Photographs 2 and 3 depict representative portions of this area.

Area 3, the eastern one-third of the site, is the area where remediation has occurred. Although this area supports many of the same plant taxa as Areas 1 and 2, several of the more common taxa in the other areas are absence from Area 3. The most conspicuous absences include cow vetch, fleabane, planatain and, most of the perennial grasses. Area 3 is the only one of the three areas to contain taxa (e.g., rush) with an affinity for wet conditions. Photograph 4 depicts Area 3.

All three communities are characteristic of early successional stages. The high proportion of legumes (e.g., clover and cow vetch) suggests poor nutrient conditions in the soil. In succession, nitrogen fixers (plants that can take atmospheric nitrogen and convert it to form usable by most other plants) are typically the first plants to colonize a recently disturbed area. As succession proceeds, annual taxa are next to invade and these annual plants are then typically outcompeted and displaced by perennial taxa.

The most likely explanation for the differences in the plant communities on the Chem-Solv site is based on the history of the site. The three plant communities appear to have different histories of disturbance. Area 3 is the most recently disturbed. The date of disturbance can be traced to the remediation of the soils. Thus, this area supports the fewest number of perennial taxa compared to Areas 1 and 2. Area 1 supports the greatest number of perennial taxa and is likely the oldest of the communities. Area 2 is intermediate in occurrence of perennials and was likely disturbed during the installation of Well 3A. Therefore, the differences in the communities can best be explained by the age of the communities. The occurrence of hydrophytes (i.e., moisture tolerant) plants in Area 3 can be explained by topography. Area 3 contains a low lying area where water accumulates following precipitation events. Many of the predominant taxa in Areas 1 and 2 cannot tolerate such wet conditions.

## 5.7 CONCLUSIONS OF THE RISK ASSESSMENT

The following paragraphs summarize the Chem-Solv assessment conclusions (Table 5-13).

- Risk assessment protocols are designed to be conservative to account for uncertainties such as the extent of contamination and the presence of highly sensitive individuals in the exposed population. The conservative approach is used to assure that the results of the risk assessment will be protective of human health and the environment.

- The chemicals of concern at the Chem-Solv site are the 10 volatile organic chemicals detected in the groundwater: acetone, chloroform, methylene chloride, tetrachloroethene, toluene, 1,1,1-trichloroethane, xylene, 1,2-dichloroethane, benzene, and trichloroethene.

- The inorganic chemicals in the soil and groundwater and the organic chemicals in the soil are either within the range of natural background, or detected infrequently and at low concentrations so that their presence as site-contaminants is unlikely.

- In the near well group, those most likely to contain chemicals from site-related activities, the maximum or RME cancer risk is 5 x $10^{-4}$. The cancer risk associated with the average concentration is 1 x $10^{-4}$. The majority of the risk (greater than 50 percent) is due to trichloroethene.

- In the far well group, the maximum or RME cancer risk is 7 x $10^{-4}$. The cancer risk associated with the average concentration is 2 x $10^{-4}$. The majority of the risk (greater than 60 percent) is due to benzene found in Well MWS 7-25.

- The level of potential exposure to all chemicals with noncarcinogenic effects is over 10 times lower than the level considered unlikely to produce an adverse impact for a lifetime of exposure.

- There is no evidence of widespread distribution of the site-related chemicals, i.e., chlorinated solvents. Trichloroethene was detected in 3 of 12 downgradient wells and tetrachloroethene was detected in 2 of the 12 wells.

- There is evidence to suggest that some or all of the contaminants in Wells 26A and MWS-7-25 may be due to leakage of gasoline or other fuel from former offsite underground storage tanks. The chemicals without positive identification, TICs, in these wells are components of combustion fuels. This information is discussed in more detail in Section 4.3.1.1.

- There are drinking water wells in the vicinity of the site, although these wells are deeper than the area of contamination. The state has an ongoing monitoring program for contamination of the residential drinking water supplies.

- There is no environmental risk associated with the Chem-Solv site. There are no completed exposure pathways due to the absence of soil contamination, surface waters on or adjacent to the site, and a point of groundwater discharge at a sufficient distance to reduce the levels of the chemicals of concern. A site-survey confirmed that the minor differences in the terrestrial community across site can be attributed to soil disturbance during remedial activities.

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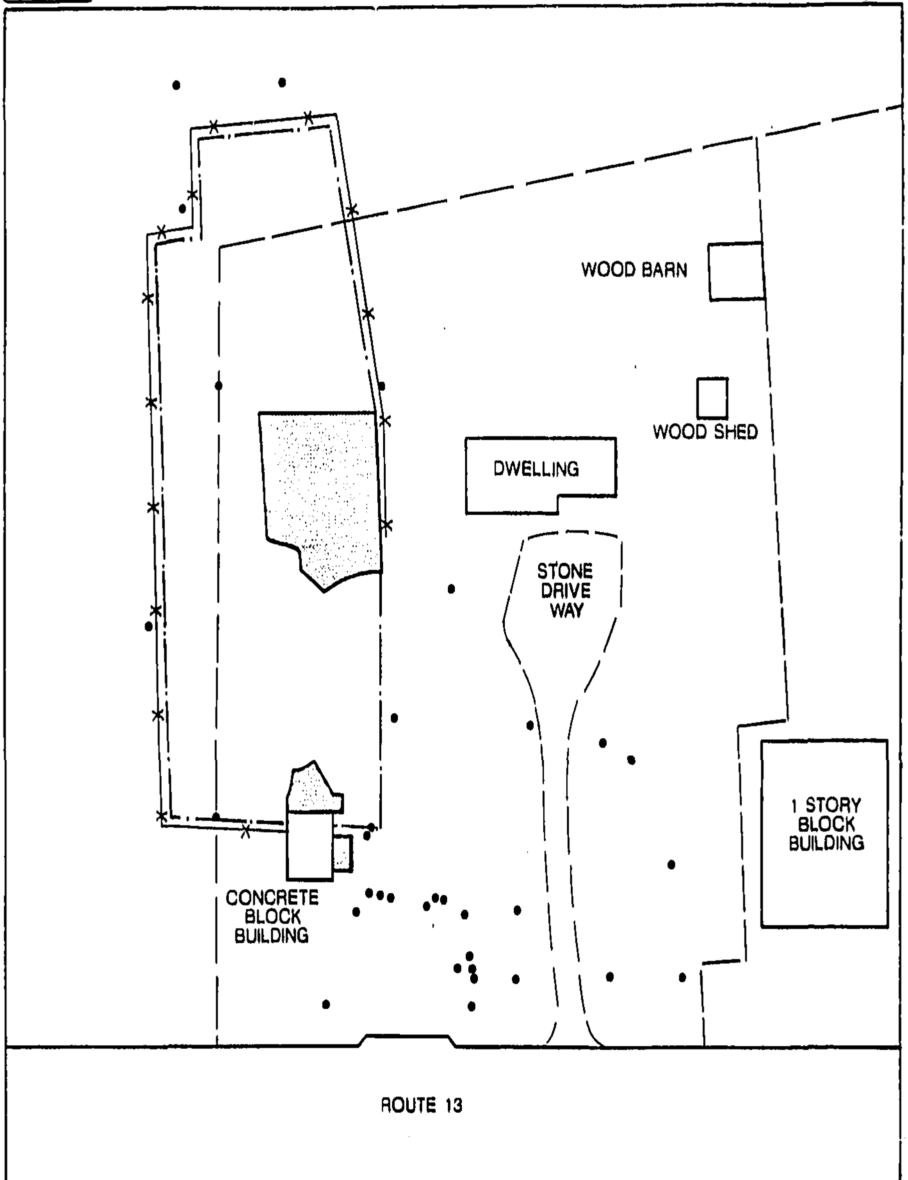
## SECTION 5.0

## FIGURES



SOURCE: March 11, 1986 Survey (Robert L. Larimore, Wyoming, Delaware);
June 4 and 5, 1990 Survey (J. G. Park Associates, Inc.,
Washington Crossing, Pennsylvania).

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0 50 Feet

NORTH

LEGEND
- ● Monitoring Well
- — — Property Line
- ▨ Concrete
- —·— Biological Assessment Study Area Boundary

Figure 5-1
Biological Assessment Boundary

PHOTOGRAPH 1

[illegible] northwest corner of site from well 3A. Area 1 is in the background. Area [illegible] in the foreground.

PHOTOGRAPH 2

Looking east from well 3A. Area 2 is in the foreground. Area 3 is in the background.

PHOTOGRAPH 3

[illegible] from remains of concrete pad. This photograph is characteristic of Area 2.

PHOTOGRAPH 4

Looking southeast from remains of concrete pad. Area 2 is in the foreground. Area 3 is in the background.

Figure 5-2
**Plant Communities**

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# SECTION 5.0

# TABLES

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## TABLE 5-1

## SUMMARY OF SOIL SAMPLES AND COMPARISION TO BACKGROUND CONCENTRATIONS

CHEM-SOLV, INC. SITE REMEDIAL INVESTIGATION
CHESWOLD, DELAWARE

| Data Summary | Frequency of Detection | | Quantitation Limit * | Sampling | | Concentrations in Soils | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | No. of Analyses | No. of Detects (valid) | | Maximum | Arithmetic Average ** | Northern Delaware a | Delaware b Mean | Delaware b SD | Southern NJ MD - Delaware a | Eastern U.S. Geometric Mean d |
| **Volatile Organics, ug/kg** | | | | | | | | | | |
| Methylene Chloride | 21 | 11 (1) | 5 | 15 (4.0) | NA | - | - | - | - | - |
| Acetone | 21 | 18 (0) | 10 | 400 (--) | 38.2 | - | - | - | - | - |
| Chloroform | 21 | 4 (4) | 5 | 8.0 (8.0) | 3.8 | - | - | - | - | - |
| Trichloroethene | 21 | 2 (2) | 5 | 6.0 (6.0) | 3.1 | - | - | - | - | - |
| **Semi-Volatile Organics, ug/kg** | | | | | | | | | | |
| Benzoic Acid | 15 | 1 | 2,000 | 290 | NA | - | - | - | - | - |
| bis(2-ethylhexyl) phthalate | 15 | 5 | 390 | 510 | 198.8 | - | - | - | - | - |
| Isophorone | 15 | 2 | 390 | 3,100 | 497.1 | - | - | - | - | - |
| **Metals, mg/kg** | | | | | | | | | | |
| Aluminum | 14 | 14 | 71 | 17,900 | 12,563 | 30,000 | - | - | 700-30,000 | - |
| Arsenic | 14 | 14 | 1.0 | 10.7 | 3.7 | <0.1-2.8 | - | - | 18-41 e | - |
| Barium | 14 | 14 | 1.7 | 103.1 | 53.7 | 500 | - | - | 10-300 | 300 |
| Beryllium | 14 | 8 | 0.7 | 0.89 | 0.3 | <1 | - | - | <1 | - |
| Cadmium | 14 | 11 | 0.61 | 1.7 | 0.6 | - | 0.17 | 0.08 | - | 1.8 e |
| Calcium | 14 | 14 | 8.2 | 1,880 | 655.8 | 130-2,300 | - | - | 130-6,200 | - |
| Chromium | 14 | 14 | 4.1 | 15.8 | 10.2 | 50 | - | - | 1-30 | 36 |
| Cobalt | 14 | 13 | 2.4 | 9.0 | 4.3 | 3-8 | - | - | <3 | 7 |
| Copper | 14 | 14 | 3.9 | 14.0 | 6.0 | <1-10 | 5 | 2.2 | <1-20 | 14 |
| Iron | 14 | 14 | 5.1 | 115,800 | 9,914 | <7,000 | - | - | 100-10,000 | 15,000 |
| Lead | 14 | 14 | 1 | 80.0 | 22.0 | 20 | 10 | 2 | <10-20 | 14 |
| Magnesium | 14 | 14 | 4.4 | 1,030 | 591.6 | 0-1,500 | - | - | 50-3,000 | - |
| Manganese | 14 | 14 | 4.0 | 255 | 134.7 | 150 | - | - | <2-300 | 285 |
| Nickel | 14 | 12 (9) | 3.7 | 8.8 | 5.7 | 7-10 | 6.6 | 4.4 | <5-10 | 13 |
| Potassium | 14 | 14 (10) | 674 | 831 | 517.8 | 16,000 | - | - | 2,200-11,000 | - |
| Selenium | 14 | 1 | 0.21 | 0.27 | 0.2 | 0.5 | - | - | <0.1-0.3 | - |
| Sodium | 14 | 13 (6) | 16.2 | 141.0 | 59.1 | ,000-8,000 | - | - | <500-8,000 | - |
| Vanadium | 14 | 14 | 8.1 | 25.1 | 16.1 | 30-50 | - | - | <7-50 | 46 |
| Zinc | 14 | 14 (13) | 4 | 96.6 | 39.6 | 82 c | 25 | 9 | <5-198 c | 36 |
| **Pesticides, ug/kg** | | | | | | | | | | |
| 4,4'-DDE | 14 | 10 | 0.1 | 275 | 59.7 | - | - | - | - | - |
| 4,4'-DDT | 14 | 9 | 0.1 | 92.5 | 24.8 | - | - | - | - | - |
| 4,4'-DDD | 14 | 2 | 0.1 | 23 | 3.1 | - | - | - | - | - |

---

* Quantitation limit varies between samples

** One half of the quantitation limit was used when the chemical concentration was not detected. Duplicate samples were averaged.

SD Standard deviation

\- Data not available

NA Not applicable - Average concentration exceeds the maximum concentration.

Valid - value not questionable due to related blanks

a Shacklette & Boerngen, 1984. Element Concentrations in Soils and other Surficial Materials of the Conterminous United States.

b Logan, T.G. and Ryan, J.A., 1987. Land Application of Sludge. Lewis Publishers, Chelsea, MI.

c Pennsylvania State University, 1985. Criteria and Recommendations for Land Application of Sludges in the Northeast. Bulletin 851, March 1985.

d USEPA. 1985. Water Quality Assessment: A Screening Procedure for Toxic and Conventional Pollutants in Surface and Ground Water - Part 1. EPA/600/6-85/002a. September 1985 Revised.

e USEPA. 1984. Health Assessment Document for Inorganic Arsenic. EPA-600/8-83-021F. March 1984.

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## TABLE 5-2

## CHEMICALS DETECTED IN GROUNDWATER - NEAR WELLS

## CHEM-SOLV, INC. SITE REMEDIAL INVESTIGATION
## CHESWOLD, DELAWARE

| Chemical | Frequency of Detection * | Range of Sample Quantitation Limits (ug/l) | Range of Detected Concentrations (ug/l) | Background Levels (ug/l) |
|---|---|---|---|---|
| Acetone | 1/5 | 10 - 50 | 110 | < 10 |
| Benzene | 1/5 | 5 - 25 | 53 - 200 # | < 5 |
| Tetrachloroethene | 1/5 | 5 - 25 | 6 | < 5 |
| Toluene | 1/5 | 5 - 25 | 3 | < 5 |
| 1,1,1- Trichloroethane | 1/5 | 5 - 25 | 23 | < 5 |
| Trichloroethene | 3/5 | 5 - 25 | 5 - 540 | < 5 |

---

* Number of samples in which the chemical was positively detected over the number of samples available.
\# Duplicate samples were analyzed for this sample

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## TABLE 5-3

## CHEMICALS DETECTED IN GROUNDWATER - FAR WELLS

## CHEM-SOLV, INC. SITE REMEDIAL INVESTIGATION
## CHESWOLD, DELAWARE

| Chemical | Frequency of Detection * | Range of Sample Quantitation Limits (ug/l) | Range of Detected Concentrations (ug/l) | Background Levels (ug/l) |
|---|---|---|---|---|
| Acetone | 2/10 | 10 - 50 | 51 - 110 | < 10 |
| Benzene | 2/10 | 5 - 25 | 53 - 830 | < 5 |
| Chloroform | 1/10# | 5 - 25 | 2 | < 5 |
| 1,2-Dichloroethane | 1/10 | 5 - 25 | 16 | < 5 |
| Methylene chloride | 1/10 | 5 - 25 | 5 | < 5 |
| Tetrachloroethene | 1/10 | 5 - 25 | 6 | < 5 |
| Toluene | 1/10 | 5 - 25 | 3 | < 5 |
| 1,1,1- Trichloroethane | 1/10 | 5 - 25 | 23 | < 5 |
| Trichloroethene | 3/10 | 5 - 25 | 5 - 540 | < 5 |
| Xylene | 1/10 | 5 - 25 | 24 | < 5 |

---

* Number of samples in which the chemical was positively detected over the number of samples available.

\# Concentration was detected in an USEPA split sample

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## TABLE 5-4

## ASSUMPTIONS USED IN CALCULATING EXPOSURE

## CHEM-SOLV, INC. SITE REMEDIAL INVESTIGATION
## CHESWOLD, DELAWARE

| | | Reference |
|---|---|---|
| Ingestion of Groundwater | | |
| Ingestion Rate (liters/day) | 2 | EPA, 1989a |
| Body Weight (kg) - adult | 70 | EPA, 1989a |
| Lifetime Exposure (years) | 70 | EPA, 1989a |
| Dermal Absorption from Groundwater Use | | |
| Skin surface area - Adult | 19400 | EPA, 1989 |
| Exposure time (hours/event) | 0.25 | EPA, 1988 |
| Exposure frequency (events/year) | 365 | Site Specific |
| Exposure duration (years) | 70 | Site Specific |
| Body weight (kg) - Adult | 70 | EPA, 1989c |
| Lifetime Exposure (years) | 70 | EPA, 1989a |
| Inhalation from Groundwater Use | | |
| Assumptions used to calculate inhalation exposure are listed in Appendix | | EPA, 1986 |

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## TABLE 5-5

## CONCENTRATIONS USED IN RISK ASSESSMENT CALCULATIONS IN PPB

## CHEM-SOLV, INC. SITE REMEDIAL INVESTIGATION
## CHESWOLD, DELAWARE

| Chemical | Far Wells |  | Near Wells |  |
|---|---|---|---|---|
|  | Average | RME | Average | RME |
| Acetone | 12.64 | 28.11 | 13.16 | 43.03 |
| Benzene | 95.88 | 282.56 | 25.53 | 95.6 |
| Chloroform | 0.59 | 0.94 | ... | ... |
| 1,2-Dichloroethane | 1.77 | 5.35 | ... | ... |
| Methylene chloride | 2.57 | 3.18 | ... | ... |
| Tetrachloroethene | 0.89 | 1.5 | 1.16 | 2.65 |
| Toluene | 0.41 | 0.71 | 0.54 | 1.3 |
| 1,1,1-Trichloroethane | 2.85 | 7.91 | 5.09 | 17.52 |
| Trichloroethene | 55.35 | 177.17 | 110.34 | 408.54 |
| Xylene | 2.71 | 8.06 | ... | ... |

---

... Compound not detected in the onsite wells

RME - Reasonable maximum exposure is defined as the upper bound 95 percent confidence interval of the arithmetic average.

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## TABLE 5-6

## TOXICITY VALUES: POTENTIAL CARCINOGENIC EFFECTS

CHEM-SOLV, INC. SITE REMEDIAL INVESTIGATION
CHESWOLD, DELAWARE

| Chemical | | Slope Factor (mg/kg-day)-1 | Weight -of-Evidence Classification | Tumor Site | Source of Slope Factor |
|---|---|---|---|---|---|
| Benzene | Oral | 0.029 | A | Leukemia | IRIS |
| | Inhalation | 0.029 | A | Leukemia | IRIS |
| Chloroform | Oral | 0.0061 | B2 | Kidney | IRIS |
| | Inhalation | 0.081 | B2 | Kidney, Liver | IRIS |
| 1,2-Dichloroethane | Oral | 0.091 | B2 | Circulatory System | IRIS |
| | Inhalation | 0.091 | B2 | Circulatory System | IRIS |
| Methylene Chloride | Oral | 0.0075 | B2 | Liver | IRIS |
| | Inhalation | 0.0075* | C | Liver, Lung | IRIS |
| Tetrachloroethene | Oral | 0.051 | B2 | Liver | IRIS |
| | Inhalation | 0.0033 | B2 | Leukemia, Liver | HEAST |
| Trichloroethene | Oral | 0.011 | B2 | Liver | HEAST |
| | Inhalation | 0.017 | B2 | Lung | HEAST |

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* Inhalation slope factor not determined for Methylene Chloride; oral slope factor used for exposure calculations.

IRIS - Integrated Risk Information System
HEAST - Health Effects Assessment Summary Tables

Compiled by : BCM Engineers Inc. (BCM Project No. 00-6012-02)

## TABLE 5-7

## TOXICITY VALUES: POTENTIAL NONCARCINOGENIC EFFECTS

## CHEM-SOLV, INC. SITE REMEDIAL INVESTIGATION
## CHESWOLD, DELAWARE

| Chemical | Oral * Chronic RfD (mg/kg-day) | Confidence Level | Critical Effect | RfD Source | Uncertainty and Modifying Factors UF | MF |
|---|---|---|---|---|---|---|
| Acetone | 0.1 | Low | Kidney, Liver | IRIS | 1000 | 1 |
| Chloroform | 0.01 | Medium | Liver | IRIS | 1000 | 1 |
| Methylene Chloride | 0.06 | Medium | Liver | IRIS | 100 | 1 |
| Tetrachloroethene | 0.01 | Medium | Liver | IRIS | 1000 | 1 |
| Toluene | 0.3 | Medium | Blood | IRIS | 100 | 1 |
| 1,1,1-Trichloroethane | 0.09 | Medium | Liver | IRIS | 1000 | 1 |
| Xylene | 2 | Medium | Mortality | IRIS | 100 | 1 |

---

IRIS - Integrated Risk Information System

* Inhalation RfD have not been determined; oral RfD values were used in the exposure calculations, except for 1,1,1-trichloroethane. HEAST lists an inhalation RfD of 0.3 mg/kg-day for 1,1,1-trichloroethane. Critical effect is the central nervous system and uncertainty factor of 100.

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## TABLE 5-8

## EPA CATEGROIES FOR POTENTIAL CARCINOGENS

## CHEM-SOLV, INC. SITE REMEDIAL INVESTIGATION
## CHESWOLD, DELAWARE

| EPA Category | Group Description | Evidence |
|---|---|---|
| Group A | Human Carcinogen | Sufficient evidence from epidemiologic studies to support a causal association between exposure and cancer in humans |
| Group B1 | Probable Human Carcinogen | Limited evidence in humans from epidemiologic studies |
| Group B2 | Possible Human Carcinogen | Sufficient evidence in animals, inadequate evidence in humans |
| Group C | Possible Human Carcinogen | Limited evidence in animals and/or carinogenic properties in short-term studies |
| Group D | Not Classified | Inadequate evidence in animals |
| Group E | No Evidence | No evidence in at least two adequate animal tests or in both epidemiologic and animal studies |

---

Source: EPA, 1986

# TABLE 5-9

## CANCER RISK ESTIMATES - NEAR WELLS

## CHEM-SOLV, INC. SITE REMEDIAL INVESTIGATION
## CHESWOLD, DELAWARE

| | CDI (mg/kg-day) | | Slope | Weight of | Chemical Specific Risk | | Total Exposure Pathway | |
|---|---|---|---|---|---|---|---|---|
| Chemical | Average | RME | Factor | Evidence | Average | RME | Average | RME |
| **Exposure Pathway: Ingestion of Contaminated Groundwater** | | | | | | | | |
| Benzene | 7.30E-04 | 2.70E-03 | 0.029 | A | 2E-05 | 8E-05 | | |
| Tetrachloroethene | 3.30E-05 | 7.60E-05 | 0.051 | B2 | 2E-06 | 4E-06 | | |
| Trichloroethene | 3.20E-03 | 1.20E-02 | 0.011 | B2 | 3E-05 | 1E-04 | | |
| | | | | | | | 6E-05 | 2E-04 |
| **Exposure Pathway: Inhalation of Contaminants in Groundwater During Use** | | | | | | | | |
| Benzene | 6.90E-04 | 2.60E-03 | 0.029 | A | 2E-05 | 8E-05 | | |
| Tetrachloroethene | 3.10E-05 | 7.20E-05 | 0.0033 | B2 | 1E-07 | 2E-07 | | |
| Trichloroethene | 3.00E-03 | 1.10E-02 | 0.017 | B2 | 5E-05 | 2E-04 | | |
| | | | | | | | 7E-05 | 3E-04 |
| **Exposure Pathway: Dermal Absorption of Contaminants in Groundwater During Use** | | | | | | | | |
| Benzene | 2.83E-04 | 1.06E-03 | 0.029 | A | 8E-06 | 3E-05 | | |
| Tetrachloroethene | 1.61E-05 | 3.67E-05 | 0.051 | B2 | 8E-07 | 2E-06 | | |
| Trichloroethene | 4.59E-05 | 1.70E-04 | 0.011 | B2 | 5E-07 | 2E-06 | | |
| | | | | | | | 1E-05 | 3E-05 |
| | | | | | TOTAL EXPOSURE | | 1E-04 | 5E-04 |

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RME - Reasonable maximum exposure is defined as the upper bound 95 percent confidence interval of the arithmetic average

Compiled by: BCM Engineers Inc. (BCM Project No. 00-6012-02)

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## TABLE 5-10

## CANCER RISK ESTIMATES - FAR WELLS

CHEM-SOLV, INC. SITE REMEDIAL INVESTIGATION
CHESWOLD, DELAWARE

| Chemical | CDI (mg/kg-day) Average | CDI (mg/kg-day) RME | Slope Factor | Weight of Evidence | Chemical Specific Risk Average | Chemical Specific Risk RME | Total Exposure Pathway Average | Total Exposure Pathway RME |
|---|---|---|---|---|---|---|---|---|
| **Exposure Pathway: Ingestion of Contaminated Groundwater** | | | | | | | | |
| Benzene | 2.70E-03 | 8.10E-03 | 0.029 | A | 8E-05 | 2E-04 | | |
| Chloroform | 1.70E-05 | 2.70E-05 | 0.0061 | B2 | 1E-07 | 2E-07 | | |
| 1,2-Dichloroethane | 5.10E-05 | 1.50E-04 | 0.091 | B2 | 5E-06 | 1E-05 | | |
| Methylene chloride | 7.30E-05 | 9.10E-05 | 0.0075 | B2 | 6E-07 | 7E-07 | | |
| Tetrachloroethene | 2.50E-05 | 4.30E-05 | 0.051 | B2 | 1E-06 | 2E-06 | | |
| Trichloroethene | 1.60E-03 | 5.10E-03 | 0.011 | B2 | 2E-05 | 6E-05 | | |
| | | | | | | | 1E-04 | 3E-04 |
| **Exposure Pathway: Inhalation of Contaminants in Groundwater During Use** | | | | | | | | |
| Benzene | 2.60E-03 | 7.70E-03 | 0.029 | A | 8E-05 | 2E-04 | | |
| Chloroform | 1.60E-05 | 2.60E-05 | 0.081 | B2 | 1E-06 | 2E-06 | | |
| 1,2-Dichloroethane | 4.80E-05 | 1.50E-04 | 0.091 | B2 | 4E-06 | 1E-05 | | |
| Methylene chloride | 7.00E-05 | 8.60E-05 | 0.0075 | B2 | 5E-07 | 6E-07 | | |
| Tetrachloroethene | 2.40E-05 | 4.10E-05 | 0.0033 | B2 | 8E-08 | 1E-07 | | |
| Trichloroethene | 1.50E-03 | 4.80E-03 | 0.017 | B2 | 3E-05 | 8E-05 | | |
| | | | | | | | 1E-04 | 3E-04 |
| **Exposure Pathway: Dermal Absorption of Contaminants in Groundwater During Use** | | | | | | | | |
| Benzene | 1.06E-03 | 3.13E-03 | 0.029 | A | 3E-05 | 9E-05 | | |
| Chloroform | 4.09E-06 | 6.51E-06 | 0.0061 | B2 | 2E-08 | 4E-08 | | |
| 1,2-Dichloroethane | 1.23E-05 | 3.71E-05 | 0.091 | B2 | 1E-06 | 3E-06 | | |
| Methylene chloride | 1.78E-05 | 2.20E-05 | 0.0075 | B2 | 1E-07 | 2E-07 | | |
| Tetrachloroethene | 1.23E-05 | 2.08E-05 | 0.051 | B2 | 6E-07 | 1E-06 | | |
| Trichloroethene | 2.30E-05 | 7.37E-05 | 0.011 | B2 | 3E-07 | 8E-07 | | |
| | | | | | | | 4E-05 | 1E-04 |
| | | | | | TOTAL EXPOSURE | | 2E-04 | 7E-04 |

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RME - Reasonable maximum exposure is defined as the upper bound 95 percent confidence interval of the arithmetic average

Compiled by: BCM Engineers Inc. (BCM Project No. 00-6012-02)

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## TABLE 5-11

## CHRONIC HAZARD INDEX ESTIMATES - NEAR WELLS

CHEM-SOLV, INC. SITE REMEDIAL INVESTIGATION
CHESWOLD, DELAWARE

| Chemical | CDI (mg/kg-day) Average | CDI (mg/kg-day) RME | RfD (mg/kg-day) | Hazard Index Average | Hazard Index RME | Pathway Hazard Index Average | Pathway Hazard Index RME |
|---|---|---|---|---|---|---|---|
| **Exposure Pathway: Ingestion of Contaminated Groundwater** | | | | | | | |
| Acetone | 3.80E-04 | 1.20E-03 | 0.1 | 0.004 | 0.01 | | |
| Tetrachloroethene | 3.30E-05 | 7.60E-05 | 0.01 | 0.003 | 0.008 | | |
| Toluene | 1.50E-05 | 3.70E-05 | 0.3 | 0.00001 | 0.0001 | | |
| 1,1,1-Trichloroethane | 1.50E-04 | 5.00E-04 | 0.09 | 0.002 | 0.006 | | |
| | | | | | | 0.009 | 0.03 |
| **Exposure Pathway: Inhalation of Contaminant Groundwater during use** | | | | | | | |
| Acetone | 3.60E-04 | 1.20E-03 | 0.1 | 0.004 | 0.01 | | |
| Tetrachloroethene | 3.10E-05 | 7.20E-05 | 0.01 | 0.003 | 0.007 | | |
| Toluene | 1.50E-05 | 3.50E-05 | 0.3 | 0.00005 | 0.0001 | | |
| 1,1,1-Trichloroethane | 1.40E-04 | 4.80E-04 | 0.3 | 0.0005 | 0.002 | | |
| | | | | | | 0.007 | 0.02 |
| **Exposure Pathway: Dermal Absorption of Contaminant Groundwater during use** | | | | | | | |
| Acetone | 4.56E-06 | 1.49E-05 | 0.1 | 0.00005 | 0.0001 | | |
| Tetrachloroethene | 1.61E-05 | 3.67E-05 | 0.01 | 0.001 | 0.004 | | |
| Toluene | 1.87E-06 | 4.50E-06 | 0.3 | 0.0000006 | 0.00002 | | |
| 1,1,1-Trichloroethane | 3.53E-05 | 1.21E-04 | 0.09 | 0.0004 | 0.001 | | |
| | | | | | | 0.002 | 0.005 |
| | | | | | TOTAL EXPOSURE | 0.02 | 0.06 |

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RME - Reasonable maximum exposure is defined as the upper bound 95 percent confidence interval of the arithmetic average

Compiled by: BCM Engineers Inc. (BCM Project No. 00-6012-02)

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TABLE 5-12

## CHRONIC HAZARD INDEX ESTIMATES - FAR WELLS

CHEM-SOLV, INC. SITE REMEDIAL INVESTIGATION
CHESWOLD, DELAWARE

| Chemical | CDI (mg/kg-day) Average | CDI (mg/kg-day) RME | RfD (mg/kg-day) | Hazard Index Average | Hazard Index RME | Pathway Hazard Index Average | Pathway Hazard Index RME |
|---|---|---|---|---|---|---|---|
| **Exposure Pathway: Ingestion of Contaminated Groundwater** | | | | | | | |
| Acetone | 3.60E-04 | 8.00E-04 | 0.1 | 0.004 | 0.008 | | |
| Chloroform | 1.70E-05 | 2.70E-05 | 0.01 | 0.002 | 0.003 | | |
| Methylene Chloride | 7.30E-05 | 9.10E-05 | 0.06 | 0.001 | 0.002 | | |
| Tetrachloroethene | 2.50E-05 | 4.30E-05 | 0.01 | 0.003 | 0.004 | | |
| Toluene | 1.20E-05 | 2.00E-05 | 0.3 | 0.00004 | 0.00007 | | |
| 1,1,1-Trichloroethane | 8.10E-05 | 2.30E-04 | 0.09 | 0.001 | 0.003 | | |
| Xylene | 7.80E-05 | 2.30E-04 | 2 | 0.00004 | 0.0001 | | |
| | | | | | | 0.01 | 0.02 |
| **Exposure Pathway: Inhalation of Contaminants in Groundwater During Use** | | | | | | | |
| Acetone | 3.42E-04 | 7.60E-04 | 0.1 | 0.003 | 0.008 | | |
| Chloroform | 1.62E-05 | 2.57E-05 | 0.01 | 0.002 | 0.003 | | |
| Methylene Chloride | 6.94E-05 | 8.65E-05 | 0.06 | 0.001 | 0.001 | | |
| Tetrachloroethene | 2.38E-05 | 4.09E-05 | 0.01 | 0.002 | 0.004 | | |
| Toluene | 1.14E-05 | 1.90E-05 | 0.3 | 0.00004 | 0.00006 | | |
| 1,1,1-Trichloroethane | 7.70E-05 | 2.19E-04 | 0.3 | 0.0003 | 0.001 | | |
| Xylene | 7.41E-05 | 2.19E-04 | 2 | 0.00004 | 0.0001 | | |
| | | | | | | 0.009 | 0.02 |
| **Exposure Pathway: Dermal Absorption of Contaminants in Groundwater During Use** | | | | | | | |
| Acetone | 4.38E-06 | 9.74E-06 | 0.1 | 0.00004 | 0.0001 | | |
| Chloroform | 4.09E-06 | 6.51E-06 | 0.01 | 0.0004 | 0.0007 | | |
| Methylene Chloride | 1.78E-05 | 2.20E-05 | 0.06 | 0.0003 | 0.0004 | | |
| Tetrachloroethene | 1.23E-05 | 2.08E-05 | 0.01 | 0.001 | 0.002 | | |
| Toluene | 1.42E-06 | 2.46E-06 | 0.3 | 0.000005 | 0.00001 | | |
| 1,1,1-Trichloroethane | 1.97E-05 | 5.48E-05 | 0.09 | 0.0002 | 0.0006 | | |
| Xylene | 1.51E-05 | 4.47E-05 | 2 | 0.00001 | 0.00002 | | |
| | | | | | | 0.002 | 0.004 |
| | | | | TOTAL EXPOSURE | | 0.02 | 0.04 |

RME - Reasonable maximum exposure is defined as the upper bound 95 percent confidence interval of the arithmetic average

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## TABLE 5-13

## SUMMARY OF RISK

## CHEM-SOLV, INC. REMEDIAL INVESTIGATION
## CHESWOLD, DELAWARE

| | | CANCER RISK | | HAZARD INDEX | |
|---|---|---|---|---|---|
| | Pathway | Average | RME | Average | RME |
| Far wells | Ingestion | 1E-04 | 3E-04 | 0.01 | 0.02 |
| | Inhalation | 1E-04 | 3E-04 | 0.009 | 0.02 |
| | Dermal | 3E-05 | 1E-04 | 0.002 | 0.004 |
| | Total | 2E-04 | 7E-04 | 0.02 | 0.04 |
| Near wells | Ingestion | 6E-05 | 2E-04 | 0.009 | 0.03 |
| | Inhalation | 7E-05 | 3E-04 | 0.007 | 0.02 |
| | Dermal | 1E-05 | 3E-05 | 0.002 | 0.005 |
| | Total | 1E-04 | 5E-04 | 0.02 | 0.06 |

RME - Reasonable maximum exposure is defined as the upper bound 95 percent confidence interval of the arithmetic average.

Compiled by: BCM Engineers Inc. (BCM Project No. 00-6012-02)

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## TABLE 5-1.4
## CHEM-SOLV INC. SITE REMEDIAL INVESTIGATION

## PRESENCE-ABSENCE MATRIX OF PREDOMINANT PLANT TAXA WITHIN THE THREE PLANT COMMUNITIES

| | | Community | | |
|---|---|---|---|---|
| Common Name | Scientific Namne | I | II | III |
| White clover | Trifolium repens | + | + | + |
| Low hop clover | Trifolium procumbens | + | + | + |
| Rabbit-foot clover | Trifolium arvense | + | - | - |
| Cow vetch | Vicia cracca | + | + | - |
| Yellow sweet clover | Meliotus officinalis | + | + | - |
| Plantain | Plantago sp. | + | + | - |
| Fleabane | Erigeron sp. | + | + | + |
| Aster | Aster sp. | + | + | + |
| Ragweed | Ambrosia sp. | - | + | + |
| Hungarian brome | Bromus inermis | + | - | - |
| Little bluestem | Andropogon sp. | + | + | - |
| Japanese brome | Bromus japanicus | + | + | + |
| Ironweed | Veronica sp. | + | + | + |
| Dock | Rume+ sp. | + | + | + |
| Wild onion | Alium cernuum | + | + | + |
| Mustard | Brassica sp. | - | + | + |
| Rush | Juncus sp. | - | - | + |
| Wild berry | Rubus sp. | - | - | + |
| Japanese honeysuckle | Lonicera japonica | - | - | + |

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+ denotes presence of taxa

- denotes absence of taxa

Compiled by: BCM Engineers Inc. (BCM Project No. 00-6012-02)

# 6.0 CONCLUSIONS AND RECOMMENDATIONS

## 6.1 CONCLUSIONS

Evaluation of data obtained for the Chem-Solv, Inc. site supports the following conclusions:

- The inorganic chemicals in the soil and groundwater and the organic chemicals in the soil are either within the range of natural background, or are detected infrequently and at concentrations so low that their presence as site-contaminants is unlikely or not of concern. EPA has agreed with this conclusion for soils (Appendix A-8). EPA has not yet reviewed BCM's evaluation of the groundwater data.

- Groundwater quality information obtained during this and previous investigations indicates that groundwater from the shallow aquifer has been impacted with organic compounds, primarily TCE and related compounds. A groundwater plume extends in the shallow groundwater from the area below the former distillation building to the eastern edge of Route 13. Impact to the deeper zones of the aquifer have been limited by the presence of a silt layer approximately 20 feet below the ground surface in the vicinity of the site. However, some VOC contamination of the intermediate zone has occurred, as indicated by low levels of VOCs in the intermediate zone monitoring wells and nearby domestic wells.

- In addition, a second plume has been identified just north of the intersection of Routes 13 and 42. Groundwater quality data and hydrogeologic information indicate that source(s) other than the Chem-Solv site are involved.

- There is now no environmental risk associated with the Chem-Solv site. There are no completed exposure pathways due to the absence of soil contamination and absence of surface waters on or adjacent to the site. The point of groundwater discharge is at a sufficient distance to reduce the levels of the chemicals of concern. A site-survey confirmed that the minor differences in the terrestrial community across site can be attributed to soil disturbance during remedial activities.

## 6.2 RECOMMENDATIONS

Based on the conclusions presented in this Remedial Investigation, there is no environmental risk associated with the Chem-Solv site. However, to obtain information needed to reduce uncertainties associated with the Chem-Solv data base, BCM recommends the following additional work:

- One additional round of groundwater sampling for selected wells in the shallow aquifer zone (26A, 33A, 41A, MWS-6-25, MWS-7-25) for volatile and semivolatile compounds. This information would provide two rounds of analytical data that had been collected and analyzed in accordance with EPA QA/QC protocol, and would provide confirmation of the data obtained by DNREC.
- Two additional rounds of water level measurements should be obtained to confirm the shallow aquifer zone groundwater flow pattern delineated during this RI and to define any seasonal fluctuations in the flow pattern. These measurements should be scheduled 1 week following a significant precipitation event (0.5 inch) and 2 weeks following a major precipitation event (greater than 2 inches) in the late summer.

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