MID 020 087128

FINAL REPORT

RCRA FACILITY INVESTIGATION WORK PLAN
Ferndale, Michigan

Reichhold Chemicals, Inc.
Research Triangle Park, North Carolina

JANUARY 1995

O'BRIEN & GERE
ENGINEERS, INC.

3208.076

Report

RCRA Facility Investigation Work Plan
Reichhold Chemicals, Inc.
Ferndale, Michigan

Reichhold Chemicals, Inc.
Research Triangle Park, North Carolina

Prepared by:

Richard P. Cawley, C.P.G.
Managing Hydrogeologist

Vernon C. Burrows
Senior Project Hydrogeologist

Andrew D. Crabb
Scientist

Submitted by:

Donald E. Stone, Jr., P.E.
Vice President

January 1995

O'BRIEN & GERE ENGINEERS, INC.

Raritan Plaza 1
Edison, New Jersey 08837

Contents

1. Introduction 1-1

1.1. Objectives and Scope 1-1

1.2. Site History and Background 1-3

1.3. Environmental Setting 1-4
- 1.3.1. Site Topography and Drainage 1-4
- 1.3.2. Regional Geology 1-5
- 1.3.3. Site Geology 1-5
- 1.3.4. Site Hydrogeology 1-6
- 1.3.5. Current and Potential Ground Water Usage 1-6
- 1.3.6. Definition of Impacted Ground Water 1-6
- 1.3.7. Climate 1-7

1.4. Site Closure Programs 1-7
- 1.4.1. General 1-7
- 1.4.2. RCRA Closure Plan Implementation 1-7
- 1.4.3. Facility Decommissioning Program 1-8

1.5. Summary of Phase I Investigation 1-8
- 1.5.1. General 1-8
- 1.5.2. Soil Gas Vapor Survey - East and West Areas . . . 1-8
- 1.5.3. Monitoring Well Installation Program 1-9
- 1.5.4. South Area Soil Sampling Program 1-9
- 1.5.5. Soil Gas Vapor Survey - South Area South Tank Farm 1-9

1.6. Summary of Phase II Investigation 1-9
- 1.6.1. General 1-9
- 1.6.2. Analytical Findings 1-10

2. Project Management Plan 2-1

2.1. Project Management 2-1

2.2. Technical Approach 2-1

2.3. Project Organization 2-2

2.4. Project Schedule 2-3

3. Field Investigations 3-1

3.1. Objectives and Scope 3-1

3.2. Building Foundation Integrity Evaluation 3-2

3.3. Building Foundation Soil Borings 3-2

3.4. Electronic Cone Penetration Testing 3-3

3.5. Soil Borings 3-4

3.6. Ground Water Monitoring Wells 3-5

3.7. Ground Water Sampling and Analyses 3-6

3.8. Sewer System 3-6

3.9. Phase II Sampling Program 3-7

4. Data Management Plan 4-1

4.1. Data Management 4-1

4.2. Data Presentation 4-2

5. Health and Safety Plan 5-1

5.1. Introduction 5-1

5.2. General 5-2

5.3. Personnel 5-2

5.4. Site Specific Health and Safety Concerns and Requirements 5-4

5.4.1. Employee Training 5-4

5.4.2. Air Monitoring 5-5

5.4.3. First Aid 5-6

5.4.4. Fire and Explosion 5-6

5.4.5. Personnel Protection 5-6

5.4.6. Confined Space Operations 5-7

5.4.7. Utility Markout 5-7

5.5. Task Specific Requirements 5-7

5.5.1. Electronic Cone Penetration Test 5-7

5.5.2. In-Field Gas Chromatograph Sampling 5-8

5.5.3. Subsurface Soil Borings 5-9

5.5.4. Monitoring Well Installation 5-10

5.5.5 Ground Water Monitoring . . . . . 5-1^

5.6. Medical Surveillance 5-13
5.7. Air Monitoring 5-14
5.8. Site Control 5-16
5.9. Emergency Response/Contingency Planning 5-19
5.10. Facility Resources 5-19

6. Community Relations Plan 6-1
6.1. General 6-1
6.2. Affected or Interested Public 6-1
6.3. Department Contacts 6-3
6.4. Document Repositories 6-4
6.5. Citizen Participation Activities 6-4
6.5.1. Project Plans 6-4
6.5.2. RFI Report 6-5
6.6. Glossary of Major Program Elements 6-5
6.7. References 6-7

Tables

1 Monitoring Well Specifications and Ground Water Elevations
2 Primary Contacts
3 SWMU Recommended Investigations - South Area
4 SWMU Recommended Investigations - West Area
5 SWMU Recommended Investigations - East Area
6 Location, Type and Number of Samples

Figures

1 Location Plan

2 East/West/South Area Locations

3 Ground Water Contour, May 13, 1992

4 East Area Plan & Analytical Results with Original MDNR SWMU Locations

5 West Area Plan & Analytical Results with Original MDNR SWMU Locations

6 South Area Plan & Analytical Results with Original MDNR SWMU Locations

7 Project Schedule

8 Proposed Sampling Locations - South Area

9 Proposed Sampling Locations - West Area

10 Proposed Sampling Locations - East Area

11 Off-Site Proposed Sampling Locations

12 Investigatory Logic Algorithm

13 Map and Directions to Oakland General Hospital

Appendices (Separately Bound)

A Description of Current Conditions - RCI Ferndale Facility

B Data Collection Quality Assurance Plan

SECTION 1

1. Introduction

1.1. Objectives and Scope

Reichhold Chemicals, Inc. (RCI) has developed this RCRA Facility Investigation (RFI) Work Plan to evaluate the environmental impact of manufacturing operations at the Ferndale, Michigan facility. The investigation and all subsequent activities at the site will be conducted in accordance with the Corrective Action Consent Order (CACO) entered with the MDNR on June 22, 1994. The RFI work plan provides the information required by Task III of Attachment I of the CACO.

The Corrective Action Program presented in the USEPA Guidance Document entitled "RCRA Corrective Action Plan - Interim Final," June 1988[1], is developed in three phases; the RFI; Corrective Measures Study, and Corrective Measures Implementation. At this time, RCI is proceeding with the initial phases of the RFI.

The scope of work for this portion of the RFI consists of three tasks outlined below:

Task 1 - Description of Current Conditions

A. Facility Background
B. Nature and Extent of Contamination
C. Implementation of Interim Measures

Task 2 - Pre-Investigation Evaluation of Corrective Measures Technologies

Task 3 - RFI Work Plan Requirements

A. Project Management Plan
B. Data Collection Quality Assurance Plan
C. Data Management Plan
D. Health and Safety Plan
E. Community Relations Plan

Tasks 1 and 2 for the RCI facility are addressed in a separate Description of Current Conditions document presented in Appendix A. The RFI Work Plan has been developed to identify the procedures, protocols, and methods to be used to gather necessary data to support a future CMS.

Section 1 of this work plan presents the history and background of the RCI-Ferndale facility, the regional soil and geologic setting, a description of the various production processes at the plant and a review of previous reports and investigations conducted at the site.

The RFI Work Plan includes the development of several plans prepared concurrently which apply to the RCI facility. A Project Management Plan (Section 2) presents the technical approach to the project, and qualifications of personnel performing the RFI. This plan documents the overall management approach to the RCRA Facility Investigation.

Section 3 describes the field investigation methodologies to be utilized to determine the nature and extent of hazardous constituents detected within the soils and ground water.

The scope of work identified in this plan is as follows:

1. Investigate the subsurface soils, where appropriate, in the vicinity of listed solid waste management units (SWMUs), former process areas, bulk storage and bulk transfer areas;

2. Investigate and monitor ground water hydraulics and ground water quality, upgradient, and downgradient of the suspected source areas;

3. Characterize the geology of the various flow systems and confining layers present at the site; and

4. Identify the corrective measures that could be used to remediate environmental contamination that is discovered.

A Data Management Plan (Section 4) is presented to track investigation data and results, and to provide a format to be used to present the raw data as well as the analytical methodology associated with the investigation.

A site-specific Health and Safety Plan (Section 5) includes the methodology for the identification of work site hazards, safety protocols, entry and exit procedures, decontamination procedures

and emergency response measures to be followed during performance of the RFI.

Section 6 presents a Community Relations Plan for the dissemination of information to the public regarding investigation activities and results.

Included as Appendix A is a separate document summarizing previous investigations and current conditions. This document serves to address the requirements of Task 1 (Description of Current Conditions) and Task 2 (Pre-Investigation Evaluation of Corrective Measure Technologies) of the RFI program. A data collection Quality Assurance Plan (Appendix B) sets forth quality control procedures to be performed, to ensure that information, data and decisions are technically sound, statistically valid and properly documented. Included in Appendix B are the specific sample analysis requirements to be performed to characterize the site as part of the data collection Quality Assurance Plan.

1.2. Site History and Background

The facility presently owned and operated until 1989 by RCI is located at 601 Woodward Heights Boulevard in Ferndale, Oakland County, Michigan. The facility coordinates are 42 degrees, 28 minutes, 0 seconds north latitude and 83 degrees, 8 minutes, 0 seconds west longitude. The facility is a closed manufacturing facility occupying approximately 602,000 square feet on 3 separate tracts totalling 14 acres in Ferndale, Michigan (Figure 1 - Site Location Map). The site is bisected by an active northwest-southeast trending railroad track network. This railroad track network, the Grand Trunk Western Railroad, splits the west and south sections of the facility from the east section. RCI also owns nearby off-site properties which were not used for industrial activities.

In 1927, synthetic resin and polymer production began in what is currently known as the West Area of the facility. At the on-set of World War II, the present East Area of the plant was developed by the Defense Plant Corporation and was used primarily to manufacture phthalic anhydride. The buildings within the East Area were constructed in their present numerical order. At the termination of the war, RCI assumed control of the East Area of the plant. In the early 1950's, a lumber business within what is now referred to as the South Area was destroyed by fire. RCI purchased and subsequently developed the South Area, utilizing the yard

primarily for the storage of finished goods. Figure 2 identifies the locations of each of the separate areas which comprise the facility. The plant manufactured synthetic resins and polymers including phenolic, alkyd and epoxy resins; coppal, styrene and polyester polymers; phthalic anhydride; and, distilled glycerin prior to operations termination in 1989. Section 2 of the attached August 1989 Environmental Assessment Work Plan contains more details.

On August 12, 1980, RCI filed a Notification of Hazardous Waste Activity form for the facility with USEPA pursuant to Section 3010 of RCRA. The notification served as identification that RCI was a generator of hazardous waste and/or an owner/operator of a treatment and storage facility. RCI filed a Part A hazardous waste permit application for the facility on November 11, 1980. Additional Part A applications were filed on May 11, 1983, July 11, 1983, and June 10, 1985. The Part A hazardous waste permit applications identified the following wastes were handled at the facility:

Waste Code	Description
D001	Ignitable
D002	Corrosive
D008	Lead
F002	Toxic spent halogenated solvents
F003	Spent non-halogenated solvents
F005	Spent non-halogenated ignitable and toxic solvents
U052	Cresols
U122	Methylene Oxide
U147	Maleic Anhydride
U162	Methyl Methacrylate
U188	Phenol
U190	Phthalic Anhydride
U223	Toluene Diisocyanate

1.3. Environmental Setting

1.3.1. Site Topography and Drainage

The RCI site is located in metropolitan Detroit, in the southeastern portion of Michigan. The immediate area surrounding the site is characterized by light industrial and residential properties. The site and the area surrounding the site show minimal topographic relief. Ground level elevations at the site do not differ more than

approximately two feet. The site is paved with storm water drains to the combined sewer.

The nearest surface water body is approximately one mile from the site. The Federal Emergency Management Agency (FEMA) publication entitled National Flood Insurance Community Status Book" identifies the status of Ferndale, Michigan as a "No Special Flood Hazard Area" (NSFHA) and further states that Ferndale is not a flood prone community. According to the Ferndale City Engineers Department, the site is not within a 100 year flood plain. A review of the USGS map for this area (Figure 1) indicates that there are no identified wetland areas within a one mile radius of the RCI properties.

1.3.2. Regional Geology

The surficial geology of the Ferndale area is dominated by an extensive, flat low-lying glacial lake plain deposited during the Port Huron time by glacial Lake Wittessey (Mozola, 1954). Sediments in the area, according to the MDNR Geologic Survey Map of Quaternary Geology of Southern Michigan (1984), consists of glaciolacustrine clay, with lessor amounts of sand and gravel. The predominantly clay overburden ranges in thickness from 100 to 250 feet and is underlain by a pre-glacial bedrock valley carved in the Antrim Formation of Upper Devonian age (Mozola, 1954).

1.3.3. Site Geology

Discussions of the site geology are limited to within 40 feet of ground surface, the maximum depth that has been reached during intrusive field investigations. The majority of the surface is covered by structures or is paved. As is discussed in Section 1.4.1, surface drainage is controlled by man made features consisting of roof drains and a complex storm drain network which directs surface water run off to a municipal storm sewer system.

Fill material, consisting of concrete, asphalt, and miscellaneous plant rubble, is present throughout the site from ground surface to approximately 1 to 3 feet below grade. Occurring below the fill material is a poorly sorted fine grained sand, fine to medium grained sand, or fine grained sandy silt. This material can vary from 4 to 7 feet in thickness. Underlying this silt-sand layer at approximately 4 to 10.5 feet below grade is a silty clay or clayey silt to clay deposit. This clay unit is identified in the literature (Mozola, 1954) as being 100 to 250 feet thick. This clay unit at the site is expected to retard

the vertical movement of water through the subsurface; this retardation effect causes perching of ground water above the clay.

1.3.4. Site Hydrogeology

The site is underlain by a clay aquiclude which is believed to be over 100 feet thick. Mantling this clay unit is a silty fine to medium grained sand overburden material which varies from 4 to 10.5 feet in thickness. Apparently, the topography of the underlying clay unit is the dominant control on the thickness of overburden material. Approximately 1 to 3 feet of fill material overlies the silty fine to medium sand throughout the site.

Ground water encountered at the site is a perched water table above the clay. Ground water flow rate at the site has been determined to range from 0.5 to 68 feet per year based on the range of hydraulic gradients observed at the site. Figure 3 depicts ground water flow at the site on May 13, 1993. Table 1 is the existing monitoring well specifications and the ground water elevations on May 13, 1993. The water bearing sediments at the site range from 1 to 7 feet in thickness. Estimated sustainable yields from wells screened within the water bearing sediments is below 0.5 gallons per minute.

1.3.5. Current and Potential Ground Water Usage

Ground water at the site is encountered as an incidental perched saturated zone approximately 1.5 to 4.0 feet below ground surface within a 4 to 10.5 foot thick silty sand layer which mantles a silty clay to clay aquiclude. Both the silty sand layer and the underlying silty clay are present throughout the entire site. The silty clay layer is believed to be over 100 feet thick. Ground water encountered at the site does not have potable usage potential; the very low anticipated yield of wells which draw water from within the silty sand layer indicates that there could be no economically feasible withdrawal of ground water for industrial or irrigation usage. The Oakland County Health Department indicates that current municipal and industrial water requirements are supplied by the City of Detroit water supply system.

1.3.6. Definition of Impacted Ground Water

With regulation R299.51019 (c) of P.A. 307, an aquifer is defined as "a geological formation, group of formations, or part of a formation capable of yielding a significant amount of ground water to wells or springs." Hydraulic properties of the unconfined saturated zone at the site do not indicate the ability to yield significant amounts of

ground water to wells or springs. This zone has no potable, industrial, or irrigation use potential. Since no "aquifer" exists at the facility, ground water will be addressed by the application of the Type B Soil Criteria as specified in Act 307 Rule 299.5709(4). As such, the term "impacted ground water" refers only to ground water that exhibits concentrations of regulated compounds above Type B Soil Criteria.

1.3.7. Climate

The climate of this area is characterized by moderate extremes of heat/cold and wetness/dryness. Normal average temperature over a calendar year is 49°F. Winters are moderately cold with an average temperature of about 29.3°F, with occasional subzero temperatures. Summers are warm with an average temperature of almost 70°F, but rarely exceed 100°F. The average temperatures of the spring and the fall are 57.3° and 41°F, respectively.

Annual precipitation for the region is 31.1 inches. May and June represent the wettest months, with an average rainfall of 3.2 inches each month. The lowest average monthly precipitation of 2 inches occurs in January.

1.4. Site Closure Programs

1.4.1. General

Following termination of the manufacturing operation in March 1989, RCI implemented two facility closure programs: 1) the closure of the hazardous waste drum and tank storage areas, and 2) a general facility decommissioning program. Each of these programs is discussed briefly in the following subsections:

1.4.2. RCRA Closure Plan Implementation

RCI implemented the approved closure plan and provide certification and documentation of the closure of the three hazardous waste storage areas at the Ferndale facility. This closure plan included the drum storage area, the tank storage area, and the Bermuda Avenue storage area.

The hazardous waste storage area decontamination and decommissioning activities were initiated on August 29, 1990, and

were completed on September 17, 1990. Closure activities were implemented in accordance with the closure plan dated January 10, 1989, as modified by the MDNR letter dated July 17, 1990, and the IT letter dated August 20, 1990. The final closure certification report was submitted to the MDNR on January 10, 1992.

1.4.3. Facility Decommissioning Program

After the termination of manufacturing operations, RCI personnel began an internal decommissioning of the process and storage vessels. This internal decommissioning program was completed by December 31, 1989. RCI then developed a decommissioning program designed to address the remaining process, storage, and transfer equipment at this facility using an outside contractor. This decommissioning program included the decontamination of process, storage, and transfer equipment. Additionally, this program consolidated, classified and disposed of all remaining raw and finished materials which were associated with the manufacturing operation. Also, Building 103, which was under construction at the time the facility operation was terminated, was dismantled during this program. The decommissioning program was completed by December 31, 1990.

1.5. Summary of Phase I Investigation

1.5.1. General

An Environmental Assessment Work Plan was prepared by RCI and submitted to the MDNR on August 2, 1989. This work plan presented the results of the initial site characterization and provided a soil and ground water program based upon the chemical manufacturing and storage practices historically conducted at the facility. The Phase I investigation consisted of a soil gas survey, a monitoring well installation program, and a soil boring program.

1.5.2. Soil Gas Vapor Survey - East and West Areas

A soil gas survey can provide a qualitative analysis of concentrations of volatile organic compounds within soils. In September 1989, a soil gas vapor survey was initiated within the East and West Areas of the facility. A 50-foot by 50-foot sampling grid was established across the East and West Areas and sampling activities were conducted at the grid intersections, where possible. Adjustments to the 50-foot grid spacing were noted and incorporated onto the sampling grid map. Additional sampling points were established as the sur

progressed where additional characterization was warranted. There were 219 readings collected from the East Area and 128 readings taken from the West Area. The results of the survey are presented on Figures 4 and 5, respectively.

1.5.3. Monitoring Well Installation Program

Five shallow ground water monitoring wells were installed during September 1989. The wells were strategically located throughout the facility to gain a preliminary understanding of the site geological conditions, ground water quality and ground water occurrence. The wells were constructed to monitor the first encountered water table. Ground water samples were submitted for total petroleum hydrocarbons (TPH), oil and grease, semi-volatile organic compound, and volatile organic compound analyses.

1.5.4. South Area Soil Sampling Program

Seven soil sample locations were selected in and around the South Tank Farm area. Five of the locations were outside and two of the locations were inside the tank farm area. Soil samples retrieved from the 0- to 1-foot and 3.5- to 4-foot depth intervals below grade were submitted for TPH, oil and grease, and volatile organic compound analyses. Fourteen soil samples were submitted for laboratory analyses.

1.5.5. Soil Gas Vapor Survey - South Area South Tank Farm

As a result of the soil analyses described within Section 1.6.4, a 5-foot by 5-foot sampling grid was established at the South Tank Farm within the South Area. There were 138 locations sampled during the soil gas vapor survey. Figure 6 provides the results of the survey.

1.6. Summary of Phase II Investigation

1.6.1. General

The Phase II program was designed to establish general site conditions. The soil boring and monitoring well locations were biased toward the site perimeter and to the areas of highest findings from the Phase I investigation. The following activities were conducted as part of the Phase II Investigation:

- the installation of 25 shallow borings;
- the installation of 3 deep borings;

- the collection and analysis of 63 discrete soil samples;
- completion of 16 soil borings as ground water monitoring wells;
- completion of a soil boring/monitoring well elevation survey;
- collection of ground water samples from on-site monitoring wells; and
- abandonment of ground water monitoring well MW-5.

A ground penetrating radar survey (GPR) report was received in March, 1992. The Current Conditions Report is Appendix A to this work plan and presents the results of the GPR program and the second ground water sampling event.

1.6.2. Analytical Findings

The compounds of concern at the facility are primarily volatile and semi-volatile organics. These compounds are found to impact soil and ground water quality at the site. Figures 4, 5 and 6 present a summary of the analytical findings, relative to the East, West and South areas of the site, respectively.

SECTION 2

2. Project Management Plan

2.1. Project Management

The investigative and remedial activities taking place at the RCI facility are managed by the Michigan Department of Natural Resources (MDNR) under contract to USEPA Region V in accordance with the Resource Conservation and Recovery Act (RCRA) Hazardous and Solid Waste Amendments (HSWA) with USEPA having control authority. Under the HSWA provisions, a facility regulated under RCRA upon site closure may be subject to a RCRA Facility Assessment (RFA). The RFA is designed to identify SWMUs which are, or are suspected to be, the source of a release to the environment. If units are identified, the owner or operator of the facility will be directed to perform an RFI to obtain information on the nature and extent of the release. The MDNR, in providing technical overview within the RFI program, presented the RFA to RCI as part of a draft Corrective Action Consent Order (CACO).

RCI as the facility owner and operator, has the responsibility for conducting the RFI as part of the CACO. RCI will act as lead group, assisted by O'Brien & Gere Engineers, Inc. (O'Brien & Gere) as RCI's consultant, to coordinate proper implementation of the RCRA Corrective Action Program at the site. Mr. John Knaub, as RCI's representative, will be responsible for overall project management and coordination. O'Brien & Gere will coordinate field activities, sampling protocols and analyses under RCI direction. Each will carry out their respective investigations concurrently in accordance with the plans and procedures identified herein. A detailed Project Management Plan is presented in Section 2.

2.2. Technical Approach

The objective of the RFI is to establish the nature and extent of contamination at the facility. Adherence to the procedures detailed below will allow consistency in gathering the necessary data required for future evaluation of corrective measures alternatives. Monthly and quarterly progress reports will provide transfer of project related information to the MDNR and USEPA.

The objective of the field investigations is to obtain sufficient accurate information on environmental conditions to allow identification, evaluation and selection of appropriate corrective measures. Field investigations will include building floor integrity evaluation, shallow soil sampling, an electronic cone penetration survey (ECP), on-site analysis utilizing a portable gas chromatograph (GC), soil borings and ground water monitoring. An ECP survey will be used to verify the lateral continuity and depth of the clay confining layer underlying the site. Quantitative soil and ground water quality data will be obtained via depth specific sample retrieval. The soil and ground water quality data obtained will assist to characterize the spatial distribution of concentrated volatile organics and volatile petroleum hydrocarbons in subsurface soils. The data obtained from the ECP survey will allow strategic selection of soil boring and monitoring well locations.

The information to be collected during the field investigation phase is presented in Section 3 of this report. Quality assurance procedures to be used for both field and laboratory evaluations are presented in the Quality Assurance Plan (QAP) (Appendix B).

Data collected from the field investigation program will be tabulated or graphed and reviewed by the Quality Assurance Officer. Following validation, the information will be supplied to the RCI Project Manager to allow site-wide assessment of environmental conditions. All analytical data and information regarding the environmental setting at the facility will be provided to the MDNR and USEPA Region V within the RFI Report.

2.3. Project Organization

RCI will act as the lead group in the RCRA Facility Investigation. Mr. John Knaub will be the RCI Project Manager and will maintain direct contact with the regulatory agencies. Investigation support will be provided to RCI by O'Brien & Gere Engineers. The O'Brien & Gere qualifications document submitted to the MDNR on August 15, 1994 contains a project specific description of project organization, and is hereby incorporated by reference. Table 2 contains a list of primary contacts for the project.

2.4. Project Schedule

Pursuant to Section X of the CACO and Task IIIA of Attachment A of the CACO, a schedule for implementation of the RFI and submission of information and cost estimates is provided as Figure 7.

SECTION 3

3. Field Investigations

3.1. Objectives and Scope

Sixty-eight solid waste management units (SWMUs) have been identified by the MDNR as potential sources or locations of soil and/or ground water contamination. The release potential of each SWMU was evaluated by the MDNR based upon a review of the SWMU design, waste type, waste management practices, and a review of documented or reported spills and releases. According to the RFA prepared by the MDNR and incorporated into the CACO, each of these areas has the potential for release of hazardous constituents. The objectives of the field investigations will be to evaluate the release potential of each SWMU identified.

Certain SWMUs may not require further investigation due to a low release potential and low probability of systematic and routine practices resulting in a release.

Tables 3, 4 and 5 are a summation of the recommended investigations at each SWMU identified within the RFA for the south, west, and east areas of the site, respectively. Figures 8, 9 and 10 provide a depiction of the sample locations associated with the investigative methodologies discussed below. Figure 11 depicts the off-site investigatory approach. Figure 12 is the investigatory logic depiction for the RFI.

Quantitative and qualitative field investigative sampling methods including required laboratory analyses pertaining to the RFI areas are outlined on Table 6 for the RCI Ferndale investigations. Investigative methodologies to be used are listed and described below:

1. Building Foundation Integrity Evaluations, with Biased Soil Borings through Foundations

2. Electronic Cone Penetration Testing with Field Prescreening Utilizing a Portable Gas Chromatograph

3. Subsurface Soil Borings

4. Monitoring Well Installation

5. Ground Water Sampling

Field investigation and laboratory analytical quality control protocols are presented in the data collection Quality Assurance Plan (Appendix B). Health and safety procedures to be employed during field investigations are described in the site Health and Safety Plan (HASP) (Section 5). The following sections provide a discussion of how each of the investigative methodologies are to be utilized at the facility and describes the desired investigatory objective to be achieved.

3.2. Building Foundation Integrity Evaluation

Building Foundation Integrity Evaluations will be used to initially characterize the potential for hazardous material manufactured, stored or transferred at any particular SWMU to have impacted soil and or ground water underlying the SWMU. This will be accomplished by visually evaluating breaches to porous flooring (cement, brick, or wood). Such breaches could consist of cracks, apertures or the physical absence of flooring.

3.3. Building Foundation Soil Borings

Soil borings will be installed to determine whether soil quality at a SWMU has been impacted due to past practices. Soil borings will be installed at a minimum of 1 soil boring per SWMU as per Table 6. Locations will be selected based upon the findings of the foundation integrity evaluation. Soil boring sampling protocols are detailed in Appendix B of this work plan.

The south area warehouses will have borings installed around their perimeters. Since the buildings are completely occupied, drilling from the inside would not be feasible.

Table 6 lists the estimated number of foundation borings per SWMU. Table 6A lists the foundation square footage for each SWMU which has a foundation. The numbers of borings will be treated with flexibility. For example - should one of the larger foundations need fewer than the number of borings listed in Table 6 to be delineated, borings might be assigned to a smaller foundation where more

borings are determined to be needed. Such adjustments will be based on the building foundation integrity evaluation and on field observations, in addition to records of known or suspected releases. There will be a minimum of one soil boring through a foundation for each SWMU which contains a building foundation.

Soil borings will be completed to first encountered water using conventional hollow-stem auger drilling methods. Soil samples will be collected continuously at two foot intervals. Each soil sample will be screened with a photoionization analyzer and assessed for visual indications of contaminants. The sample from each boring exhibiting the highest organic vapor levels as observed by the photoionization detector and from immediately above first encountered water will be submitted for laboratory analysis. Soil samples submitted to the contract laboratory will be analyzed at a minimum for volatile organic and semi-volatile organic compounds. Revised laboratory analyses for each of the areas of investigation are presented on Table 6.

3.4. Electronic Cone Penetration Testing

The use of an electronic cone penetration (ECP) survey will allow for the optimal number and placement of soil borings and monitoring wells. The ECP survey will be conducted at selected locations biased from results of previous investigations at the site. The primary objective of the ECP survey is to verify the lateral continuity and depth of the clay confining unit which underlies the site. The ECP will be used to optimize soil boring placement and rapidly assess soil and ground water quality through depth discrete sampling. At each location, ECP soundings will be advanced to five feet within the clay layer, estimated to occur from 15 to 20 feet below grade. A preliminary log of stratigraphy will be generated upon completion of each sounding. At the completion of the field activities, the logs will be finalized and a final report issued by the contractor for inclusion in the Draft RFI Report.

Based upon the intended project objective of using ECP testing to screen areas and allow for intelligent fixed sample point bias, the ECP equipment will be outfitted with an appropriate instrument package that will continuously delineate soil gases as the probe advances, detect ground water, measure hydrostatic pressure in the perched water bearing zone overlying clay at the site, and collect both soil and ground water samples for on-site analyses using a portable Gas Chromatograph (GC). The soil investigation will allow for quantitative data to be generated in the field. This in turn allows

for flexibility in the field, in that time and energy is not expended delineating areas that are not impacted. Also, the use of ECP allows for rapid source delineation. A percentage of soil samples collected (10%) would be submitted for laboratory analyses to confirm the concentrations of contaminants detected utilizing the portable GC. Preliminary screening will allow for the strategic placing of additional monitoring wells that may also serve to fulfill ground water remediation objectives. The following text describes the approach for site screening and the ground water investigation. A maximum of two samples per sounding is anticipated.

The ECP investigation will be used to collect samples for evaluation of DNAPL presence. Samples will be collected at the sand/clay interface. Sampling and analytical protocols to be utilized for ECP and in-field sampling are provided within the QAP to this Work Plan. Table 6 identifies the location, type and number of samples per SWMU. Figures 8, 9, 10 and 11 identify proposed ECP sounding locations.

3.5. Soil Borings

Based on results of the ECP testing, soil borings will be performed as appropriate in specific areas identified on Figures 8, 9, 10 and 11 to further define possible sources of residual materials. The results of metals sampling will be re-evaluated in light of recent MDNR revision to the Type A Criteria, MERA Operational Memo #15. The locations and numbers of anticipated subsurface soil samples are outlined on Table 6 and illustrated on Figures 8, 9, 10 and 11. Final locations of the test borings will be dependent upon site accessibility and the results of the ECP testing.

Soil borings will be completed to first encountered water using conventional hollow-stem auger drilling methods. Soil samples will be collected continuously at two foot intervals. Each soil sample will be screened with a photoionization analyzer and assessed for visual indications of contaminants. The sample from each boring exhibiting the highest organic vapor levels as observed by the photoionization detector and from immediately above first encountered water will be submitted for laboratory analysis. Soil samples submitted to the contract laboratory will be analyzed at a minimum for volatile organic and semi-volatile organic compounds. Revised laboratory analyses for each of the areas of investigation are presented on Table 6.

Subsequent to completion, boring locations will be marked via spray paint in the field for future reference. The protocol detailing the procedures for installation of these borings is included to in Appendix B of this work plan. Sampling equipment will be cleaned upon collection of each individual sample. Decontamination procedures for drilling and sampling equipment are described in the QAP.

The soil cuttings from the boreholes will be screened in the field with a photoionization detector to detect the presence of volatile organic compounds, if any. Soils and personal protective equipment will be segregated by borehole and placed in drums. Management of the waste materials will proceed as presented in the Waste Management Plan of Appendix B of this work plan.

3.6. Ground Water Monitoring Wells

To supplement the existing monitoring well system, additional monitoring wells may be installed to monitor the perched ground water above the clay confining layer at the site. Final locations will be determined based on preceding work efforts (e.g. ECP testing and soil borings) and accessibility.

The purpose of the proposed monitoring wells is to evaluate possible groundwater impacts in potential and/or identified source areas. Positioning of the proposed monitoring wells is selected to supplement the existing on-site monitoring well system and to provide additional horizontal and vertical ground water elevation and analytical data. The proposed shallow wells will be installed at the first encountered ground water table.

Shallow overburden ground water monitoring wells will be installed using hollow-stem auger drilling methods. Drilling and monitoring well installation protocols are presented in Appendix B of this work plan. During drilling, soil samples will be collected at two foot intervals from the shallow borings and five foot intervals from deep borings, in accordance with standard split-spoon sampling techniques (ASTM Method D-1586). Within the saturated zone, the wells will be constructed of 2-inch or 4-inch diameter flush-joint stainless steel casing and a 10 foot length of 0.010 slot stainless steel well screen, if possible (or five foot well screen if the perched water table column encountered is less that 5 feet). The completed wells will be positioned such that a portion of the well screen is above the water.

Subsequent to installation, the wells will be surveyed to record their locations and elevations. The survey data will be used to calculate ground water elevations and evaluate the on-site ground water flow directions. Ground water elevations will be collected in conjunction with ground water quality sampling events.

3.7. Ground Water Sampling and Analyses

To evaluate the ground water quality related to potential source areas, and to identify potential impacts resulting from upgradient flow on to the site or the potential migration of contaminants to on- or off-site downgradient areas, ground water samples will be collected from each of the newly installed wells and the existing wells. Each well will be checked for light and dense non-aqueous phase liquids (LNAPL, DNAPL). The ground water sampling will be completed in accordance with the protocols included in Attachment B of this work plan.

Samples to be submitted for metals analysis will be collected and analyzed for unfiltered and filtered metals. Analytical requirements are listed on Table 6. Purge water, well development water and decontamination materials will be managed in accordance with the Waste Management Plan discussed in Appendix B of this work plan.

This information will be used to evaluate the need for a Phase II sampling program as discussed in Section 3.1.1. and the implementation of interim measures. Interim measures are discussed under separate cover.

3.8. Sewer System

A video survey of the sewer system was conducted during the facility closure program in 1990. The system was also cleaned at that time. RCI will review the integrity of the system, and look for indications of impacts at the corridor exit using the ECP technology.

The results of this survey will be used to evaluate the need for further investigation during the Phase II sampling program, if appropriate or applicable.

3.9. Phase II Sampling Program

Pursuant to paragraph 36B of the CACO and the investigatory logic applied to the program (Figure 12), RCI will review the results of activities described in Sections 3.1. through 3.10. and meet with the MDNR to discuss a proposal for addressing possible off-site issues. It is anticipated that implementation of this "Phase II" investigation will begin upon concurrence of RCI and MDNR on the methods and goals for the Phase II program, as appropriate.

Pursuant to paragraph 36B of the CACO, ECI will delineate as required. In the event sampling activities described in Sections 3.1 through 3.10 do not achieve delineation, RCI will propose a supplemental sampling plan in accordance with the schedule already proposed.

SECTION 4

4. Data Management Plan

4.1. Data Management

Data management procedures will be established to effectively process the data generated from the RFI, such that relevant data descriptions (sample numbers, locations, methods, procedures, etc.) will be readily accessible and accurately maintained.

A grid system will be established using maps of the entire site with each area of the site given an identifier. Corresponding detailed blow-ups of each area, showing sample locations, will also be prepared. Sample identification will be tracked by area identifier, identifying location, media, type of sample and depth or sequence. These sample identifiers will be used throughout the data tracking and reporting process for displaying analytical results and sample location coordinates.

A database program will be used to manage the analytical data and sample characteristics (e.g. sample media, well depth, casing elevations, etc.). Each sample location will be related to a quadrant identifier through the database program. Database management allows for more sophisticated data manipulations than normal computer-based spreadsheet programs. Analytical data must be sortable by parameter, location, high/low concentrations of contaminants, media, etc. By relating samples to quadrants, analytical results can be examined more readily for specific source areas of the site.

Progress reports will be submitted to MDNR approximately bimonthly in accordance with project schedule as required by the CACO.

4.2. Data Presentation

The RFI data will be arranged and presented in a clear and logical format using tables, graphs, figures and isopleth maps (if appropriate), allowing effective evaluation of the data. Analytical data will be presented on custom spreadsheets generated by the database program.

The data record will include the following, if applicable:

- Unique sample or field measurement identification codes;
- Sampling or field measurement location (expressed in terms of a Facility coordinate system) and sample or measurement type;
- Sampling or field measurement raw data;
- Laboratory analysis ID number;
- Property or component measured; and
- Result of analysis (e.g., concentration).

The following data will be presented in tabular displays, if applicable:

- Data as reported by the laboratory;
- Laboratory results for each medium, or for each constituent monitored;
- Data reduction for and description of statistical analysis used;
- Sorting of data by potential stratification factors (e.g., location, soil layer, topography); and
- Summarized data. RCI will provide the MDNR summarized raw data tabulations from each sampling event within thirty (30) days of RCI's receipt of raw data from the analytical laboratory(ies), or as otherwise approved by the MDNR.

Statistical evaluation of laboratory or field measurement data will consist of comparisons to QA/QC samples:

Duplicate Samples Analytical measurement results of duplicate samples will be compared using relative percent difference (RPD), which will be calculated as follows:

$$RPD = \frac{A - B}{\frac{A+B}{2}} \times 100$$

No further statistical analysis is anticipated.

Data summaries will be submitted to MDNR and will consist of sample results which are greater than the laboratory reporting limits. Data reduction will consist initially of the removal of "non-detected" parameters, and ultimately of the removal of parameters detected below applicable regulatory limits.

Various data reports will include analytical results sorted by contaminant parameters, sample media, quadrant, or potential stratification factors. Corresponding detailed blow-ups of each quadrant, showing sample locations and results, will also be prepared. Other data tables will present ground water monitoring well data, including ground water depth, well depth, casing elevations, etc.

Graphical displays will present site layout and topography, sampling locations and grids, sample boundary areas, and water table elevations. Areal extent of contamination, vertical distribution of contaminants and contaminant values at sampling locations will also be displayed. Graphical displays will be prepared using computer-aided design/drafting (CADD) techniques. These displays will include sampling area boundaries where more information is required. The displays will attempt to convey changes in analyte concentrations in relation to distance from the source, time, depth, or other parameters, as appropriate.

If possible, features affecting intramedia transport and potential receptors will be displayed.

Data will be presented with comparisons to applicable regulatory criteria. Ground water and soil criteria will be compared to Michigan Type B Criteria. While data presented in Appendix A for ground water are compared to 1/20 of Type B Criteria, the water table at the site does not meet Michigan's definition of an aquifer. An aquifer is defined within R299.51019(c) of P.A.307 as follows:

> ...a geologic formation, group of formations or part of a formation capable of yielding a significant amount of ground water to wells or springs.

Section 2.2.2. of the November 1994 "Interim Measures Work Plan - Ground Water" presents a discussion of impacted ground water, and is incorporated by reference.

SECTION 5

5. Health and Safety Plan

5.1. Introduction

This Health and Safety Plan (HASP) has been developed to provide the requirements and general procedures to be met by supervisory or inspection personnel, while performing the RCRA Facility Investigation (RFI) of the Reichhold Chemicals, Inc. site at Ferndale, Michigan. This HASP describes the responsibilities, training requirements, protective equipment, and standard operating procedures necessary for protection of on-site workers, subcontractors and official visitors from exposure to contaminant levels which are unsafe or greater than established action levels. This plan specifies procedures and equipment to be utilized in order to prevent exposures to hazardous materials by site personnel as well as measures to be employed for decontamination of field equipment and for emergency response. This HASP incorporates by reference the applicable requirements of the Occupational Safety and Health Administration in 29 CFR 1910 and 29 CFR 1926. In addition, activities conducted under this HASP will be consistent with the following requirements, as applicable and appropriate, in addition to the requirements otherwise cited in this section:

a. The 1985 NIOSH Occupational Safety and Health Guidance Manual for Hazardous Waste Site Activities,

b. USEPA Order 1440.3

c. The facility contingency plan, and

d. The 1984 U.S.E.P.A. Standard Operating Safety Guide.

5.2. General

The requirements and guidelines in this HASP are based on a review of available information and an evaluation of potential on-site hazards. They have been developed to minimize the potential for exposures of supervisory inspection personnel. This HASP will be discussed with site personnel and will be available on-site while work is underway. On-site personnel will report to the Site Safety and Health Officer (SSHO) in matters of health and safety. Overall responsibility for HASP enforcement and implementation will be the responsibility of the project managers.In general, subcontractors are responsible for complying with all regulations and client policies applicable to the work that they are performing. Subcontractors must develop their own HASP's which must be at least as stringent as this one. With the project manager's permission, a subcontractor may adopt this HASP. Documentation of this adoption must be submitted to the SSHO and the MDNR WMD.

This HASP is specifically intended for those personnel who will be conducting activities within the defined scope of work in specified areas of the site. Future actions that may be conducted at this site may necessitate the modification of these requirements.

5.3. Personnel

Figure 9 illustrates key project personnel and organizational format. Table 2 contains the primary contacts for the project.

Site Safety and Health Officer The SSHO will establish operating standards and coordinate overall project safety and health activities for the site. The SSHO will review project plans and revisions to plans to assure proper safety and health procedures are maintained throughout the RFI. Specifically the SSHO is responsible for:

- Assuring that a complete copy of the HASP is at the site prior to the start of field activities and that workers are familiar with it.
- Conducting health and safety training and briefing sessions.
- Ensuring the availability, use, and proper maintenance of personal protective, decontamination and other safety or health equipment.

- Maintaining a high level of safety awareness among team members and communicating pertinent safety and health matters to them promptly.
- Assuring that field activities are performed in a manner consistent with this HASP.
- Monitoring for dangerous conditions during field activities.
- Coordinating with emergency response personnel and medical support facilities.
- Initiating immediate corrective actions in the event of an emergency or unsafe condition.
- Notifying the project manager promptly of an emergency, unsafe condition, problems encountered or exception to this HASP.
- Recommending improvements in safety and health measures to the project manager.
- Conducting safety and health performance and system audits. The SSHO has the authority to:
    - Suspend field activities or otherwise limit exposures if the health or safety of any person appears to be endangered.
    - Notify RCI or subcontractor personnel to alter work practices that he deems to not properly protect them or the Ferndale environment.
    - Suspend an individual from field activities for violation of the requirements of this HASP.

5.4. Site Specific Safety and Health Concerns and Requirements

Materials that have been detected in soil or water samples include:

- vinyl chloride
- trans-1,2-dichloroethene
- trichloroethane
- 1,1-dichloroethane
- benzene and
- traces of various petroleum hydrocarbons

No safety hazards have been identified other than those normally associated with on-site testing and are, therefore, well known to the personnel involved. Use of the existing Standard Operating Procedures and the specified engineering controls, work practices and personal protective equipment will minimize the risks of overexposure.If field measurements or observations indicate that a potential exposure is greater than the protection afforded by the equipment or procedures specified in this HASP, efforts will be made to reduce the exposure and/or increase the level of protection provided.

5.4.1. Employee Training

Site Workers: Employees responsible for on-site activities must have met one of the following requirements prior to the start of operations at the site:

1. An off-site training course of at least 40 hours meeting the requirements of 29 CFR 1910.120(e) on safety and health at hazardous waste operations.

2. An off-site refresher course of at least 8 hours meeting the requirements of 29 CFR 1910.120(e) on safety and health at hazardous waste operations within the last 12 months.

On-site Management and Supervisors An off-site training course of at least 8 hours meeting the requirements of 29 CFR 1910.120(e) on supervisor responsibilities for safety and health at hazardous waste operations within the last 12 months.

Emergency Response Personnel Employees who will respond to emergency situations involving hazardous materials shall be trained in how to respond to such emergencies.

Training Certification A written certificate of training shall be maintained on site for each employee, supervisor and emergency responder requiring training.

Site Specific Training Site specific training shall be provided each employee and shall be reviewed at daily safety briefings. Personnel will be briefed by the project manager or by the SSHO as to the potential hazards to be encountered. Topics will include:

- Availability of this HASP.
- General site hazards and specific hazards in the work areas including those attributable to the chemicals present.
- Selection, use, testing and care of the body, head, eye, hand, foot and respiratory protective equipment being worn, with the limitations of each.
- The demarcation system that will be used to identify the exclusion, contamination reduction and support zones.
- Regulations on eating, drinking, smoking and carrying of tobacco products, and having open fires in the work area.
- Decontamination procedures for personnel, their personal protective equipment and other equipment used on the site.
- Emergency response procedures and requirements.
- Emergency alarm systems and other forms of notification, and evacuation routes to be followed.
- Methods to obtain emergency assistance and medical attention.

5.4.2. Air Monitoring

No immediately dangerous to life or health exposures are expected to be encountered. Monitoring with a photoionization detector (HNU) for general hydrocarbon content will be performed to ensure adequacy of protective measures.

- If HNU analysis of breathing zone air indicates that more than 5 ppm of volatile organic compounds are present, respirators equipped with organic vapor cartridges will be worn.

- If HNU analysis of breathing zone air indicates that more than 50 ppm of volatile organic compounds are present, self contained breathing apparatus will be worn.

- The HNU will be calibrated according to the manufacturer's specifications.

5.4.3. First Aid

A first aid kit, portable eyewash and emergency transport vehicle will be kept in close proximity to the work site. A fire extinguisher rated 20A-B-C or higher will be kept in the immediate vicinity of drilling equipment.

5.4.4. Fire and Explosion

Upon determination of a fire beyond the incipient stage or of an explosion anywhere on the site, the fire department and personnel on the site will be notified and personnel moved to a location a safe distance from the fire or explosion.

5.4.5. Personnel Protection

1. General:

   a. Equipment Characteristics: Personal protective equipment will be used on the site only when operations can not be done safely in an other manner.

   b. Level of Protection Required: Based on the potential hazards identified in the reference documents and as discussed in the task analyses below, it appears that the maximum level of protection required will be Level C with a full face respirator.

2. Usage:

   a. Level of protection: Level C protection will be required when the action levels for the contaminants exceed the action levels or the operation requires the use of such protection without monitoring.

   b. Selection Criteria: Air purifying respirators will be provided that meet NIOSH/MSHA standards for protection against organic vapors, and dusts.

c. Contaminant Action Levels: See 5.04.2.

3. Respiratory Protection Program: A respiratory protection program meeting the requirements of 29 CFR 1910.134 must be established.

4. Required Personal Protective Equipment Program: Other personal protective equipment supplied must be purchased and maintained in accordance with the applicable provisions of Subpart G, 29 CFR 1910.

5. Protective Equipment Failure: If equipment fails and/or an employee experiences a failure or other alteration of protective equipment that may affect its protective ability, that person and his/her partner will immediately leave the work area. Re-entry will not be permitted until the equipment has been repaired or replaced and the cause of the failure identified. The Project Manager and the SSHO will be notified and, after reviewing the situation, determine the effect of the failure on the continuation of ongoing operations. If the failure affects the safety of personnel, the worksite or the surrounding environment, personnel will be evacuated until appropriate corrective actions have been taken.

5.4.6. Confined Space Operations

1. General: There is no potential for confined space operations.

5.4.7. Utility Markout

In accordance with Michigan Law Act 53, three working days before digging, a markout will be requested by calling 1-800-482-7171.

5.5. Task Specific Requirements

5.5.1. Electronic Cone Penetration Test

1. Operation and Tasks to be Performed: Semi-invasive ECP surveying will be performed to identify the locations of on-site anomalies.

2. Potential Health Hazards and Contaminants:

   a. Should exposed wastes be present in areas undergoing investigation, there is the potential for exposure to surface wastes, including the release of gases from the off-gassing of newly exposed soil.

   b. Benzene, vinyl chloride, trans-1,2-dichloroethene, trichloroethane, 1,1-dichloroethane and traces of various petroleum hydrocarbons were identified in monitoring wells at the site. The potential exists for their presence in soil at levels that may present an inhalation or skin contact hazard.

3. Contaminant Dispersion Pathways: The contaminants can exist in air, soil and water.

4. Contaminant Control: Clothing to resist soil contact and water splash are necessary. Direct reading instruments must be used for monitoring hydrocarbon and vinyl chloride levels during the drilling operations. The geologist on site during the drilling operations will use the air monitor prior to personally detecting the odor of the soil sample.

5.5.2. In-Field Gas Chromatograph Sampling

1. Operation and Tasks to be Performed: Use a portable gas chromatograph (GC) to collect soil and water vapor from a sampling probe. The GC will be calibrated with a mixture of benzene, toluene and xylene (BTX) (5 ppm, 25 ppm, 20 ppm and 0 ppm respectively). Decontamination of sampling equipment will be as defined in Section 5.05.4. Wash water from decontamination will be collected and stored until properly disposed.

2. Potential health hazards and contaminants:

   a. There is the potential for release of gases from the off-gassing of newly exposed surfaces. Once in operation, the possibility exists of splash of the well contents onto personnel.

   b. Benzene, vinyl chloride, trans-1,2-dichloroethene, trichloroethane, 1,1-dichloroethane and traces of various petroleum hydrocarbons were identified in the ground water

of the site. The potential exists for their release at levels that may present an inhalation or skin contact hazard. They may also generate a perceptible odor at concentrations below the PEL.

3. Contaminant Dispersion Pathways: The contaminants can be spread through the air.

4. Contaminant Control: The sampling system is closed and respiratory protection will not be required. Clothing to resist soil contact and water splash are necessary. Direct reading instruments must be used for monitoring hydrocarbon and vinyl chloride levels during the drilling operations.

5.5.3. Subsurface Soil Borings

1. Operation and Tasks to be Performed: A device will be used to extract deep core subsamples for field screening with PID for VOC. Soil gas will be scanned for the presence of photoionizable organic compounds.

2. Potential Health Hazards and Contaminants:

   a. There is the potential for release of gases from the off-gassing of newly exposed soil. Once in operation, the possibility exists of splash of the well contents onto personnel.

   b. Benzene, vinyl chloride, trans-1,2-dichloroethene, trichloroethane, 1,1-dichloroethane and traces of various petroleum hydrocarbons were identified in the ground water at the site. These constituents are also present in the soil and may release at levels that may present an inhalation or skin contact hazard. They may also generate a perceptible smell at concentrations below the PEL.

3. Contaminant Dispersion Pathways: The contaminants can be spread through the air, soil and water.

4. Contaminant Control: Clothing to resist soil contact and water splash are necessary. Direct reading instruments must be used for monitoring hydrocarbon and vinyl chloride levels during the drilling operations.

5.5.4. Monitoring Well Installation

1. Operation and Tasks to be Performed: Installation of monitoring wells in nested pairs. Monitoring wells will be developed or cleared of fine grained materials and sediments that have settled in or around the well screen during installation.

2. Potential health hazards and contaminants:

   a. During drilling, potential safety hazards common to drilling operations may result. Once in operation, the possibility exists of splash of the well contents onto personnel

   b. Work around heavy equipment has potential for trauma due to contact with overhead objects, cables, etc. Minimum protection from these hazards includes safety shoes, hard hats and safety glasses.

   c. Special precautions may be necessary to assure the drilling is performed in an area free of underground objects including power or gas lines. Precautionary measures include a through review of plans and careful sitting of the rig. Depending on the thoroughness of available information, non-destructive geotechnical testing for the presence of buried objects may be necessary.

   d. Care must be taken in the positioning of drilling and/or other heavy equipment such that it is not unstable and/or blocks emergency access/site evacuation routes.

      Equipment operators and field personnel must be familiar with the proper selection and operation of fire extinguishi ng equipment. Fully charged and recently inspected fire extinguishers will be immediately available at the drilling site. Contingency plans to ensure safe and timely evacuation and the provision of outside assistance will be adhered to.

   e. Hearing protection will be worn when predicted exposure to noise levels exceeding 90 dBA is to be for four hours or more.

   f. NIOSH has recently declared that some of the products of diesel combustion are potentially carcinogenic. Unnecessary exposure to these combustion products can be avoided by proper positioning of personnel and/or the use

of respiratory protection consisting of an organic vapor cartridge with a dust, mist and fume filter.

g. There is the potential for release of gases from the off-gassing of newly exposed material. Benzene, vinyl chloride, trans-1,2-dichloroethene,trichloroethane,1,1-dichloroethane and traces of various petroleum hydrocarbons were identified in the water effluent from the site. The potential exists for their release at levels that may present an inhalation or skin contact hazard. They may also generate a perceptible smell at concentrations below the PEL.

3. Contaminant Dispersion Pathways: The contaminants can be spread through the air.

4. Contaminant Control:

   a. Personnel: Air purifying respirators with organic vapor cartridges (if required by air monitoring) and clothing to resist soil contact and water splash are necessary. Direct reading instruments must be used for monitoring hydrocarbon and vinyl chloride levels during the drilling operations.

   b. Decontamination of Sampling and Drilling Equipment:

      1. The following decontamination procedures will be applicable to all drilling and sampling activities. Drilling and well construction equipment mobilized to the site will receive an initial decontamination consisting of steam cleaning of the entire rig and associated equipment to the satisfaction of the supervising geologist.

      2. The rear portion of the drill rig will be decontaminated by steam cleaning between test borings and/or monitoring well installations. In addition equipment entering a well boring but not used for sample collection, will be decontaminated using a high pressure steam cleaner followed by a control water rinse in order to remove soil and volatilize organics. Drilling equipment will be decontaminated prior to removing the equipment from the site.

3. The field sampling equipment cleaning and decontamination procedures will be as follows:

   1. Non-phosphate detergent wash
   2. Tap water rinse
   3. Distilled/deionized water rinse
   4.* 10% nitric acid rinse
   5.* Distilled/deionized water rinse
   6.** Acentone (pesticide grade) rinse
   7.** Total air dry or nitrogen blow out
   8.** Distilled/deionized water rinse

   * Only if sample is to be analyzed for metals
   ** Only if sample is to be analyzed for organics

Distilled/deionized water from commercial vendors may be used for decontamination of sampling equipment only if it has been verified by laboratory documentation that it has been distilled and deionized. Field decontamination wastes will be collected for disposal.

5.5.5. Ground Water Monitoring

1. Operation and Tasks to be Performed: Monitoring wells will be used as ground water elevation monitoring points. Water from the wells will be collected by field personnel and witnessed by others. Decontamination of the well evacuation equipment and limited water analyses are to be performed in the field.

2. Potential health hazards and contaminants: Benzene, vinyl chloride, trans-1,2-dichloroethene, trichloroethane, 1,1-dichloroethane and traces of various petroleum hydrocarbons were identified in the ground water at the site. The potential exists for their release at levels that may present an inhalation or skin contact hazard. They may also generate a perceptible smell at concentrations below the PEL. During sampling, the possibility exists for splash of the contents onto personnel.

3. Contaminant Dispersion Pathways: The contaminants can be spread through the air and through skin contact.

4. Contaminant Control: Adequate health protection during the sampling operations will be provided by use of water resistant coveralls, eye protection and water resistant gloves. Provide chemically resistant gloves as hand protection during sample collection. Wear splash goggles or face shield. Workers must be able to write with the gloves selected.

5.6. Medical Surveillance

1. Program Components: The medical surveillance program will consist of an examination prior to the start of work for factors related to exposure to benzene, vinyl chloride, trans-1,2-dichloroethene, trichloroethane, 1,1-dichloroethane and petroleum hydrocarbons. The examination will be repeated at the end of work or on the anniversary of the initial exam, if the work is still ongoing.

2. Medical Records: The medical record will be maintained in accordance with established procedures for maintenance of such records. A copy of the physician's report of medical fitness for each employee will be maintained on the site.

3. Fitness Certification and Certificates: The examining physician will provide each employer and each employee with a certificate (or equivalent medical report) of medical fitness to perform the work required.

4. Heat Stress / Cold Injury Prevention Program

   a. **Training:** Formal training in prevention of heat and/or cold injuries will be provided as part of the site specific training and repeated in October and April of each year. Informal review of these techniques will be made a part of daily pre-work briefings. Any person who experiences signs of heat related distress will be instructed to stop work immediately. Medical attention will be sought if there is doubt that prompt and full recovery will result without it. Symptoms of heat related distress include muscle cramps, pale and clammy or hot, dry and flushed skin, confusion, disorientation and incoherent speech, nausea and /or convulsions.

b. **Monitoring Logs:** Heat Stress Prevention: When the outdoor wet bulb globe temperature exceeds 86 degrees F, a log of oral temperatures will be established for each worker on the site. The work period of workers with oral temperatures in excess of 101 degrees F after the rest period will be reduced by 33% until the oral temperature returns below 101 degrees F.

Cold Injury Prevention: When the outdoor dry bulb temperature is less than 40 degrees F., a warming tent or other facility will be established for each work area that has personnel working outdoors on the site.

When the outdoor dry bulb temperature is less than 40 degrees F., a log of oral temperatures will be established for each worker working outdoors on the site. The outdoor period for workers with oral temperatures below 97 degrees F will be reduced by 33% until the oral temperature returns above 98 degrees F.

When the outdoor dry bulb temperature is less than 30 degrees F., the windspeed and air temperature will be recorded at least once during every four hour period.

5.7. Air Monitoring

1. General: Air monitoring for health and safety will be in accordance with the following plan. The contaminants of concern are benzene, vinyl chloride, trans-1,2-dichloroethene, trichloroethane, 1,1-dichloroethane and petroleum hydrocarbons. Concentrations of these contaminants are expected to be below the OSHA Permissible Exposure Limits.

2. Area and Personnel Air Sampling Program

   a. Initial Measurement Program: A detailed monitoring program will be developed prior to the start of work.

   b. Subsequent Measurement Program: To be developed as a result of the initial site findings.

3. Tasks to be Monitored: Air monitoring will be performed during the accomplishment of the following tasks.

    - Installation of the Groundwater Monitoring Wells
    - Electronic Cone Penetration Testing
    - Ground Water Monitoring
    - Evaluation of Subsurface soil borings

4. Monitoring Program

    a. Instruments to be used:

        - An Explosive Gas monitor calibrated for the detection of methane.
        - A direct reading instrument for total volatile organic hydrocarbons.

    b. Instrument Settings:

        - The Explosive Gas monitor will be set to read in percent of the Lower Explosive Limit (% LEL).

        - Readings of greater than 25% LEL will require evacuation of all except the monitoring personnel. The monitoring personnel will re-evaluate the environment after allowing the escaping gas to be diluted by the surrounding air.

        - Re-entry will not be allowed until the explosive gas concentration has been reduced below 20% LEL.

        - The volatile organic hydrocarbon instruments will be set to read in parts per million (ppm).

        - Readings greater than 5 ppm will require the use of air purifying respirators with appropriate chemical canisters.

        - Readings greater than 50 ppm will require evacuation of all except the monitoring personnel. The monitoring personnel will wear air supplying respirators when re-evaluating the environment after allowing the escaping gas to be diluted by the surrounding air.

    c. Instrument Calibration: The instruments will be calibrated according to manufacturer's instructions at the beginning of each workshift that they will be used.

d. Monitoring Frequency: Monitoring for explosive gases will be continuous during drilling operations unless results show that the level of materials being released is less than 5% of the LEL. Monitoring frequency can then be reduced to 30 minute intervals.

Monitoring for volatile hydrocarbons will be at 30 minute intervals during active work unless a continuous reading monitor is available or if results show that the level of materials being released is less than 1 ppm. Monitoring frequency can then be reduced to 60 minute intervals.

Monitoring Records: Records meeting the requirements of 29 CFR 1910.120 will be kept of all of the air monitoring done for health and safety protection.

5.8. Site Control

1. General: Site control procedures will be established to reduce the possibility of worker contact with any contaminants present, to protect the public in the area surrounding the site by preventing the movement of contaminated materials and contaminants from the site and to limit access to the site to those personnel required to be on it.

2. Work Zones

   a. General: Work zones that will accomplish the general objective stated above will be established by the project manager working with the SSHO. Three categories of work zones, an exclusion/ contaminated work zone, a contamination reduction/ buffer zone and a support/ clean zone, will be established.

   b. Map: A map depicting these work zones will be posted in a conspicuous location and reviewed during the daily safety briefings.

3. Communications

   a. Routine: The project manager and the SSHO will establish a system appropriate to the site, the work and the work zones that will provide communications within and off the site.

b. Emergency: The project manager and the SSHO will establish a system appropriate to the site, the work and the work zones that will provide an emergency communications system within the site and to emergency responders off the site. The numbers for the following emergency services will be provided and posted on site by the Project Manager.

In the event of an emergency, site personnel shall signal distress with three blasts from an appropriate horn (vehicle horn, air horn, etc.). Appropriate authorities will then be immediately notified of the nature and extent of the emergency.

The table below contains Emergency Response Telephone Numbers. This table shall be maintained at the work site by the SSHO. The location of the nearest telephone will be determined prior to initiation of on-site activities.

Should someone be transported to a hospital or doctor, a copy of this Health and Safety Plan must accompany them.

Emergency	911
Fire Department	911
Oakland General Hospital	(313) 967-7000
Ferndale Police	(313) 541-3650
Reichhold Chemicals, Inc.	(313) 542-1037
Poison Control Center	800-888-7655
Chemical Emergency Advice	800-424-9300
O'Brien & Gere Engineers	313-347-4350

A map showing the route of Oakland General Hospital, 27351 Dequindre Road, Madison Heights, Michigan 48071, is attached at the end of this section as Figure 13.

Hospital Directions

<u>From Reichhold Chemicals, Inc. in Ferndale</u>

- Take Woodward Heights Blvd. east to Dequindre Rd.
- Turn left (north) and proceed to Eleven Mile Rd.
- Turn left (west) and then right into Oakland General Hospital.

4. Daily Log Contents: The project manager and the SSHO will establish a system appropriate to the site, the work and the work zones that will record, as a minimum, the following information:

   a. Personnel on the site, their arrival and departure times and their destination on the site.

   b. Incidents and unusual activities that occur on the site such as, but not limited to, accidents, spills, breaches of security, injuries, equipment failures and weather related problems.

   c. Conversations that may affect the work such as:

      Media Visits
      Safety and Health Inspections, by the SSHO and external agencies.
      Owner/Agent Meetings
      Employee/Union meetings

   d. Changes to the Work Plan and the Health and Safety Plan.

   e. Daily Information generated such as:

      Changes to Work and Health and Safety Plans.
      Work accomplished and the current site status.
      Air monitoring results.

5. Decontamination

   a. General: Personnel and equipment exiting the exclusion zone shall be decontaminated prior to entering the support zone. The project manager and the SSHO will establish a decontamination system and decontamination procedures appropriate to the site and the work that will prevent potentially hazardous materials from leaving the site.

   b. Procedures: The decontamination procedures will be published as part of the site SOP's and be reviewed at each weekly safety briefing.

6. Personal hygiene facilities meeting at least the minimum requirements of 29 CFR 1910.120 will be provided.

7. The site will be secured in accordance with 40 CFR 265.14. The site will be surrounded by a combination of fences with locked gates and walls. Signs will be posted which say "Danger -

Unauthorized Personnel Keep Out", or other language with similar meaning.

5.9. Emergency Response/Contingency Planning

1. Emergency Response Plan:

   a. General: The project manager and the SSHO will establish an emergency response plan appropriate to the site, the work and the work zones that will handle anticipated on-site emergencies.

   b. Review Procedures: The plan will be reviewed daily to ensure its applicability for the planned day's operations.

2. Trained Personnel: Employees who will respond to emergency situations involving hazardous materials shall be trained in how to respond to such emergencies.

5.10. Facility Resources

Roads within and immediately surrounding the facility are depicted on Figure 2. Figure 1 depicts area roads beyond the immediate site vicinity.

Water will be brought on site as needed and generators will be used to meet power needs during site activities.

A cellular phone will be available for emergency communication.

SECTION 6

6. Community Relations Plan

6.1. General

The goal of the community relations plan is to establish effective public involvement within the corrective action program to enable interested parties to receive accurate and timely information regarding remedial plans, progress and to comment on proposed actions at significant decision points.

In addition, the plan provides an opportunity for both MDNR/USEPA and RCI to obtain information from the public which will enable development of a comprehensive remedial program which is protective of public health and the environment. This plan details the program which will be implemented as part of the Remedial Facility Investigation to involve the public in the project.

6.2. Affected or Interested Public

The following is a list of those individuals to be included in mailings of pertinent information.

Town Officials:

The Honorable Mayor of Ferndale
300 East Nine Mile Road
Ferndale, Michigan 48220
(810) 546-2360

City Manager of Ferndale
300 East Nine Mile Road
Ferndale, Michigan 48220
(810) 546-2360

Town Officials: (Cont'd)

The Honorable Mayor of Pleasant Ridge
23925 Woodward Avenue
Pleasant Ridge, Michigan 48069
(810) 541-2900

City Manager of Pleasant Ridge
23925 Woodward Avenue
Pleasant Ridge, Michigan 48069
(810) 541-2900

Ferndale/Ridgewood Environmental Coalition

Ms. Janet Narich (or designated representative)
c/o 706 Pinecrest Ave.
Ferndale, Michigan 48220
(810) 542-6739

State:

Mr. Dan Dailey
Michigan Department of Natural Resources
Waste Management Division
John A. Hannah Building
Lansing, Michigan 48909
(517) 335-6610

Federal:

Ms. Laura Lodisio
Chief, Michigan Enforcement Technical Section
USEPA Region V
77 West Jackson Boulevard
(HRE-8J)
Chicago, Illinois 60604
(312) 886-7090

A list of area property owners will be used to distribute a periodic newsletter describing activities at the site as well as listing ways of obtaining further information.

6.3. Department Contacts

The following is a list of the names, addresses and telephone numbers of contact individuals within the Michigan Department of Natural Resources (MDNR), United States Environmental Protection Agency (USEPA), and Reichhold Chemicals, Inc. (RCI).

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY

Project Manager: Ms. Laura Lodisio
Chief, Michigan Enforcement
Technical Section
USEPA, Region V
77 West Jackson Boulevard
(5HR-13)
Chicago, Illinois 60604
Phone No. (312) 886-7090

MICHIGAN DEPARTMENT OF NATURAL RESOURCES

Project Manager: Mr. Dan Dailey
Michigan Department of Natural Resources
Waste Management Division
John A. Hannah Building
P.O. Box 30241
Lansing, Michigan 48909
(517) 335-6610

REICHHOLD CHEMICALS, INC.

Project Manager: Mr. John Knaub
Reichhold Chemicals, Inc.
P.O. Box 13582
Research Triangle Park
Durham, North Carolina 27709
(919) 990-7655

6.4. Document Repositories

Citizens can review information pertinent to the project at the following location:

Ms. Darlah Munger
Ferndale Public Library
Reference Librarian
222 E. Nine Mile Road
Ferndale, Michigan 48220
(810) 546-2504

There is no public library in Pleasant Ridge, Michigan. Many Pleasant Ridge residents use the Ferndale library due to its proximity to Pleasant Ridge. In addition, Pleasant Ridge offers a subsidy to its residents which is equal to the non-resident fee at the Ferndale Public Library.

6.5. Citizen Participation Activities

The activities identified in this plan have been developed to address RCI and the MDNR/USEPA goals to keep the public informed and involved in RFI activities. The activities discussed below may be adjusted based upon the project scope, length, public interest or other factors.

6.5.1. Project Plans

A copy of the approved RFI Work Plan as well as quarterly progress reports will be available for public review at the document repository listed in Section 6.04. Information sheets may periodically be prepared by the USEPA to provide additional information to the public. Public meetings will be held at the facility once per quarter. Representatives of the MDNR and interested members of the community will be invited to attend. Meetings will be scheduled to inform the community about the initiation of new phases of the project.

RCI will develop a mailing list of local residents who will be sent a newsletter. The newsletter will be distributed to update local residents on progress of activities at the site, and to identify contacts for additional information and locations of reports.

A toll free number with a prerecorded message describing current activities will be followed by the ability to leave a message for subsequent attention.

6.5.2. RFI Report

The following activities will take place once the RFI Report is final:

- a copy of the RFI Report will be placed in the repository listed in Section 6.4 for public review.
- RCI will mail a summary of the RFI Report to individuals included on the contact list that briefly describes the Site, provides an overview of work completed, summarizes findings, and provides a brief analysis of the proposed Corrective Measures Study (CMS) program schedule for future work. The contact list will include those individuals listed in Section 6.02.

6.6. Glossary of Major Program Elements

NOTE: The following definitions represent major elements of the Resource Conservation and Recovery Act (RCRA) Corrective Action process. They are presented in the order in which they occur, rather than in alphabetical order, to provide a context to aid in their definition.

RCRA Facility Assessment (RFA) Every facility seeking RCRA permits is investigated under the authority of the USEPA. Results of the RFA are used as a basis for focusing on RCRA Corrective Action compliance.

RCRA Corrective Action Plan (CAP) The purpose of the CAP is to aid Regions and States in determining and directing the specific work the owner/operator or respondent must perform, as part of a complete corrective action program. The CAP is a document specifically intended to assist Regions and States in the development of Corrective Action Orders and corrective action requirements in permit application and permits. The three phases of a CAP are described below.

RCRA Facility Investigation (RFI) - The objective of the RFI is to evaluate thoroughly the nature and extent of the release of hazardous wastes or constituents from regulated units, solid waste management units (SWMUs), and other source areas at

the facility and to gather necessary data to support the Corrective Measure Study (CMS). However, during the course of the RFI, the regulatory agencies may require a response, prior to completion of sitewide corrective measures, to conditions at the facility that pose immediate threats to human health and the environment. Information gathered during the RFI is summarized in an RFI Report.

Corrective Measures Study (CMS) - The purpose of the CMS is to develop and evaluate the corrective action alternative or alternatives and to recommend the corrective action measure or measures to be implemented at the RCRA permitted facility.

Corrective Measures Implementation (CMI) - The purpose of the CMI program is to design, construct, operate, maintain, and monitor the performance of the corrective measure or measures selected to protect human health and the environment.

Remedial Design - Once a remedial action has been selected, technical drawings and specifications for remedial construction at a site are developed, as specified in the final CMS report. Design documents are used to bid and construct the chosen remedial actions. Remedial design is prepared by consulting engineers with experience in remedial actions.

Construction - RCI selects contractors and supervises construction work to carry out the designed remedial alternative. Construction may be as straightforward as excavation of contaminated soil with disposal at a permitted hazardous waste facility. On the other hand, it may involve complete encapsulation, leachate collection, storage and treatment, ground water management, or other technologies.

Monitoring/Maintenance - Denotes post-closure activities to demonstrate continued effectiveness of the remedial actions. Typical monitoring/maintenance activities include quarterly inspection by an engineering technician; measurement of level of water in monitoring wells; or collection of ground water and surface water samples and analysis for factors showing the condition of water, presence of toxic substances, or other indicators of possible pollution from the site. Monitoring/maintenance may be required indefinitely at many sites.

REFERENCES

6.7. References

1. RCRA Corrective Action Plan (Interim Final), USEPA Office of Solid Waste and Emergency Response, EPA 530-SW-88-028, June 1988.

2. RCRA Corrective Action for Solid Waste Management Units (SWMUs) at Hazardous Waste Management Facilities, USEPA Office of Solid Waste and Emergency Response, Draft Publication, July 1990.

3. Phase I Environmental Assessment, Reichhold Chemicals, Inc., Detroit, Michigan, IT Corporation, February 1989.

4. Environmental Assessment Work Plan, Reichhold Chemicals, Inc., Ferndale, Michigan, IT Corporation, August 1989.

5. Interim Report, Environmental Assessment, Reichhold Chemicals, Inc., Ferndale, Michigan, IT Corporation, November 1989.

6. Underground Gasoline Tank Closure, Reichhold Chemicals, Inc., Ferndale, Michigan, IT Corporation, March 1990.

7. Soil Gas Survey Report, South Tank Farm Area, Ferndale, Michigan, IT Corporation, August 1990.

8. Interim Phase II Investigation Report, Reichhold Chemicals, Inc., Ferndale, Michigan, O'Brien & Gere Engineers, Inc., January 1992.

9. Mazola, A.J., A Survey of the Ground Water Resources in Oakland County, Michigan, State of Michigan Department of Natural Resources, Geological Survey, 1953.

10. Guidelines and Specifications for Preparing Quality Assurance Program Plans (QAMS - 004/80)," EPA-600/8-83-024.

11. A Compendium of Superfund Field Operations Methods, USEPA 600/2-80-018.

12. Test Methods for Evaluating Solid Waste (SW846), USEPA September 1986.

13. Methods for Chemical Analysis of Water and Wastes, USEPA 600/4-79-020, Revised March 1983.

14. Data Quality Objectives for Remedial Response Activities, USEPA/540/G-87/003.

TABLES

Table 1
RCRA Facility Investigation Work Plan
RCI Ferndale, Michigan Facility

Monitoring Well Specifications and Ground Water Elevations

Well No.	Casing Elevation (ft.msl.)	Screened Interval (ft. bg.)	Depth to Clay (ft. bg.)	Clay Elevation (ft.msl.)	Ground Water Elevation (05/13/92) (ft.msl.)	Saturated Thickness (ft.)
1	644.08	3.61 - 5.61	6.2	637.20	640.86	3.66
2	644.95	3.49 - 7.49	8.0	636.30	642.21	5.91
3	643.68	4.10 - 6.10	4.8	638.20	641.28	3.08
4	644.25	4.82 - 7.37	6.5	637.20	642.67	5.47
6	643.24	1.50 - 6.50	9.0	634.68	641.32	6.64
7	644.55	1.0 - 6.0	7.5	637.30	643.29	5.99
8	644.50	2.0 - 7.0	10.5	634.49	642.90	8.41
9	644.86	2.0 - 9.0	9.0	636.39	641.38	4.99
10	643.85	2.0 - 7.0	7.0	637.27	640.47	3.20
11	644.68	2.5 - 7.5	7.5	637.53	642.12	4.59
12	646.38	1.5 - 6.5	6.5	639.50	644.46	4.96
13	646.48	1.0 - 6.0	9.0	637.02	644.58	7.56
14	645.26	4.0 - 9.0	7.0	637.71	640.20	2.49
15	644.73	2.0 - 6.0	6.0	639.07	639.99	0.92
16	646.42	2.0 - 6.0	9.0	637.88	642.60	4.72
17	644.06	2.0 - 7.0	7.0	637.38	641.36	3.98
18	646.39	1.0 - 6.0	8.0	637.80	643.79	5.99
19	644.92	1.5 - 6.5	6.5	638.70	644.67	5.97
20	645.09	1.5 - 6.5	6.5	638.92	643.79	4.87
21	644.48	1.5 - 6.5	7.5	637.17	643.14	5.97
22	644.94	3.5-8.5	8.0	636.94	640.86	4.08

Notes:
msl: Elevation relative to Mean Sea Level.
bg: Below Grade

Table 2
RCRA Facility Investigation Work Plan
RCI Ferndale, Michigan Facility

Primary Contacts

Name	Function	Address	Telephone No.
Mr. John Knaub	RCI Project Manager	Reichhold Chemicals, Inc. 2400 Ellis Road Durham, North Carolina 27709	919-990-7500
Mr. Donald E. Stone, Jr.	O'Brien & Gere Engineers, Inc. Project Officer	Raritan Plaza I Edison, New Jersey 08837	908-225-7380 ext.240
Mr. Vernon C. Burrows	O'Brien & Gere Engineers, Inc. RCRA Facility Investigation Manager	Raritan Plaza I Edison, New Jersey 08837	908-225-7380 ext.212
Mr. Neil R.L. Wilkinson	O'Brien & Gere Engineers, Inc. Quality Assurance Officer	Raritan Plaza I Edison, New Jersey 08837	908-225-7380 ext.213
Mr. Scott L. Cormier	O'Brien & Gere Engineers, Inc. Site Support	39500 Orchard Hill Place Suite 300 Novi, Michigan 48375	313-347-4350
Mr. S. Edward Wilson	O'Brien & Gere Engineers, Inc. Corporate Health & Safety Officer	5000 Brittonfield Parkway Syracuse, New York 13221	315-437-6100

Table 3
RCRA Facility Investigation Work Plan
RCI Ferndale, Michigan Facility

Solid Waste Management Units
South Area
Recommended Investigations

MDNR SWMU No	Name	Reason for Further Investigation	Reason for No Further Investigation	Proposed Method of Investigation
1.	South Tank Farm	-	Interim measure in place. In situ air stripping device in operation.	Incorporate into Corrective Measures.
2.	Building 204 - Product Storage Warehouse	Confirm low release potential	-	Bldg foundation integrity testing followed by biased soil boring installation through foundation
3.	Building 203 - Product Storage Warehouse	Confirm low release potential	-	Bldg foundation integrity testing followed by biased soil boring installation through foundation
4.	Pipe Bridge between Building 203 and 206	-	Low release potential. Overhead pipe bridge contained steam only.	No further investigation.
5.	Building 206 - Product Storage Area	Confirm low release potential	-	No further investigation.
6.	Pipe Tunnel beneath Woodward Heights Ave. Connecting South and West Areas	Unknown piping integrity.	-	Video survey or integrity testing to document leakage potential.
60.	Former Underground Storage Tank	-	Closure Plan submitted to MDNR: Analytical results below detectable levels.	No further investigation. Closure report submitted March, 1990.
61.	Driveway between Gainsboro Ave. and Buildings 204 and 205.	-	No documentation exists regarding storage or spills of hazardous materials. Previous investigations do not indicate environmental impact.	No further investigation.

Table 4
RCRA Facility Investigation Work Plan
RCI Ferndale, Michigan Facility

Solid Waste Management Units
West Area
Recommended Investigations

MDNR SWMU No	Name	Reason for Further Investigation	Reason for No Further Investigation	Proposed Method of Investigation
7.	Inflammable Solvents Tank Farm	Unknown release potential. Tank/containment integrity unknown	-	Bldg foundation integrity evaluation followed by biased soil borings through foundation.
8.	Solvent Pump Station	Unknown release potential.	-	Bldg foundation integrity evaluation followed by biased soil borings through foundation.
9.	Building "B" - Resin Production	Former production area	-	Bldg foundation integrity evaluation followed by biased soil borings through foundation.
10.	Building "C" - Resin Production	Former production area	-	Bldg foundation integrity evaluation followed by biased soil borings through foundation.
11.	Dock "C" - Storage and Processing	Bulk storage area, low release potential	-	Bldg foundation integrity evaluation followed by biased soil borings through foundation.
12.	Building "K" - Storage and Processing	Bulk storage area, low release potential	-	Bldg foundation integrity evaluation followed by biased soil borings through foundation.
13.	Dock "K" - Storage and Processing	Bulk storage area, low release potential	-	Bldg foundation integrity evaluation followed by biased soil borings through foundation.
14.	Inert Gas Generation Building	Phthalic Anhydride and Phenol/Formaldehyde	-	Bldg foundation integrity evaluation followed by biased soil borings through foundation.

Table 4
RCRA Facility Investigation Work Plan
RCI Ferndale, Michigan Facility

Solid Waste Management Units
West Area
Recommended Investigations

MDNR SWMU No	Name	Reason for Further Investigation	Reason for No Further Investigation	Proposed Method of Investigation
15.	Building "N"	Distillation of Glycerin resin and inflammable solvent production	-	Bldg foundation integrity evaluation followed by biased soil borings through foundation.
16.	Pump House	Unknown release potential.	-	Bldg foundation integrity evaluation followed by biased soil borings through foundation.
17.	Tank Farm	Unknown release potential.	-	Bldg foundation integrity evaluation followed by biased soil borings through foundation.
18.	Building "M" - Empty Drum Storage	Confirm low release potential	-	Bldg foundation integrity evaluation followed by biased soil borings through foundation.
19.	Building "L" - adjacent to Building "M"	Eight storage tanks, unknown spill potential.	-	Bldg foundation integrity evaluation followed by biased soil borings through foundation.
20.	Tank Truck Cleaning Building	Miscellaneous storage, Trichloroethene and Carbon Tetrachloride cleaning and storage. Unknown spill potential.	-	Bldg foundation integrity evaluation followed by biased soil borings through foundation.
21.	Storage Tanks adjacent to Tank Truck Cleaning Building	Unknown spill potential.	-	Bldg foundation integrity evaluation followed by biased soil borings through foundation.

Table 4
RCRA Facility Investigation Work Plan
RCI Ferndale, Michigan Facility

Solid Waste Management Units
West Area
Recommended Investigations

MDNR SWMU No	Name	Reason for Further Investigation	Reason for No Further Investigation	Proposed Method of Investigation
22.	Diked Area adjacent to Building "L"	Confirm low release potential	-	Bldg foundation integrity evaluation followed by biased soil borings through foundation.
23.	Garage Area of Building "L"	Miscellaneous storage, Tri-chloroethene storage. Low release potential.	-	Bldg foundation integrity evaluation followed by biased soil borings through foundation.
24.	Resin Drum Storage Shed	Unknown release potential.	-	Bldg foundation integrity evaluation followed by biased soil borings through foundation.
25.	Transformer Storage	-	Low release potential due to unit design. No documentation/reporting of spills. Previous investigations indicate no PCB present throughout facility at concentrations above action levels.	No further investigation.
26.	Diked Area Consisting of 7 Storage Tanks	Confirm low release potential	-	Bldg foundation integrity evaluation followed by biased soil borings through foundation.
27.	Building "D" Annex	Resin processing and filtering. Unknown release potential.	-	Bldg foundation integrity evaluation followed by biased soil borings through foundation.
28.	Building "D"	Resin processing and filtering. Unknown release potential.	-	Bldg foundation integrity evaluation followed by biased soil borings through foundation.
29.	Building "E" - 14 Process Tanks	Resin processing and filtering Unknown release potential.	-	Bldg foundation integrity evaluation followed by biased soil borings through foundation.

Table 5
RCRA Facility Investigation Work Plan
RCI Ferndale, Michigan Facility

Solid Waste Management Units
East Area
Recommended Investigations

MDNR SWMU No	Name	Reason for Further Investigation	Reason for No Further Investigation	Proposed Method of Investigation
34.	Building 102	Confirm low release potential	-	No further investigation.
35.	Hazardous Reagent Storage Area	Unknown release potential.	-	Bldg foundation integrity evalution followed by biased soil borings through foundation.
36.	Building 100 Maintenance Shop	Confirm low release potential	-	Bldg foundation integrity evalution followed by biased soil borings through foundation.
37.	Heated Storage Bldg. 101A Sample Resin Dispensing	Unknown release potential.	-	Bldg foundation integrity evalution followed by biased soil borings through foundation.
38.	Storage Shed	Confirm low release potential	-	No further investigation.
39.	Building 101B - Misc. Solvent Storage	Low release potential, but unknown containment/ integrity of storage areas.	-	Bldg foundation integrity evalution followed by biased soil borings through foundation.
40.	Hazardous Waste Tank Storage Area	Unknown release potential.	-	Bldg foundation integrity evalution followed by biased soil borings through foundation.

Table 5
RCRA Facility Investigation Work Plan
RCI Ferndale, Michigan Facility

Solid Waste Management Units
East Area
Recommended Investigations

MDNR SWMU No	Name	Reason for Further Investigation	Reason for No Further Investigation	Proposed Method of Investigation
41.	Boiler Room - Hazardous Waste Incineration	Unknown release potential - assumed low release potential due to unit design	-	Bldg foundation integrity evalution followed by biased soil borings through foundation.
42.	Hazardous Waste Container Area	Unknown release potential.	-	Bldg foundation integrity evalution followed by biased soil borings through foundation.
43.	Building 105A - Phthalic Anhydride Production	Unknown release potential.	-	Bldg foundation integrity evalution followed by biased soil borings through foundation.
44.	Hazardous Waste Container Storage Area	Unknown release potential.	-	Bldg foundation integrity evalution followed by biased soil borings through foundation.
45.	Building 103 - Resin and Inflammable Solvent Production	Unknown release potential.	-	ECP Screening with possible soil borings and subsurface soil samples followed by possible groundwater monitoring well.
46.	Building 104A - Phthalic Anhydride Production, Minerva Avenue, RCI owned property	Unknown release potential.	-	Bldg foundation integrity evalution followed by biased soil borings through foundation: ECP screening and possible soil borings on Minerva Avenue property.
47.	Building 104 - Tank Storage Area	-	Area incorporated into DNAPL interim measure.	Incorporate into corrective measures, conduct additional soil borings with subsurface soil samples, if warranted.

Table 5
RCRA Facility Investigation Work Plan
RCI Ferndale, Michigan Facility

Solid Waste Management Units
East Area
Recommended Investigations

MDNR SWMU No	Name	Reason for Further Investigation	Reason for No Further Investigation	Proposed Method of Investigation
48.	Building 104 - Resin Drum Storage	Unknown release potential.	-	Bldg foundation integrity evalution followed by biased soil borings through foundation.
49.	Building 104D - Resin Drum Storage	Unknown release potential.	-	ECP Screening with possible soil borings with subsurface soil sampling.
50.	Inflammable Solvent Tank Farm	Unknown release potential.	-	Bldg foundation integrity evalution followed by biased soil borings through foundation.
51.	Inflammable Solvent Tank Farm	Unknown release potential.	-	Bldg foundation integrity evalution followed by biased soil borings through foundation.
52.	Building 104 - Empty Drum Storage	Confirm low release potential	-	Bldg foundation integrity evalution followed by biased soil borings through foundation.
53.	Building 104E - Phthalic Anhydride Production	Unknown release potential.	-	Bldg foundation integrity evalution followed by biased soil borings through foundation.
54.	Building 105B - Phthalic Anhydride Production	Unknown release potential.	-	Bldg foundation integrity evalution followed by biased soil borings through foundation.
55.	Building 105 - Empty Drum Storage	Confirm low release potential	-	Bldg foundation integrity evalution followed by biased soil borings through foundation.

Table 5
RCRA Facility Investigation Work Plan
RCI Ferndale, Michigan Facility

Solid Waste Management Units
East Area
Recommended Investigations

MDNR SWMU No	Name	Reason for Further Investigation	Reason for No Further Investigation	Proposed Method of Investigation
56.	Building 101 - Phthalic Anhydride Production	Unknown release potential.	-	Bldg foundation integrity evalution followed by biased soil borings through foundation.
57.	Pipe Trench Between SWMU no. 36 and SWMU no. 34	-	No documentation exists regarding storage or spills of hazardous materials. Low release potential.	No further investigation.
58.	Pipe Bridge Between Bldg. 104 and Bldg 105	Unknown release potential.	-	Determination of former usage and release potential investigation.
59.	Pipe Tunnel From SWMU no. 41 to SWMU no. 13	Unknown Piping Integrity.	-	Video survey or integrity testing to document leakage potential
65.	Roadway Inside Wall along Bermuda Ave.	Unknown release potential.	-	ECP Screening with possible soil borings with subsurface soil samples.
66.	Truck Parking Lot	Unknown release potential.	-	ECP Screening with possible soil borings with subsurface soil samples.

Table 5
RCRA Facility Investigation Work Plan
RCI Ferndale, Michigan Facility

Solid Waste Management Units
East Area
Recommended Investigations

MDNR SWMU No	Name	Reason for Further Investigation	Reason for No Further Investigation	Proposed Method of Investigation
67.	Area Adjacent to Train Tracks - Entire Length of Property	Unknown release potential.	-	ECP Screening with possible soil borings with subsurface soil samples.
68.	Deep Well	-	Injection well abandoned over 20 years ago. Closure was overseen and approved by the MDNR. Well is reportedly 1500 feet deep and there is apparently no documentation supporting its use. Additionally, if the well had been used, the well is deep enough to have discharged into brine formations.	No further investigation. Eliminate as a SWMU.

Table 6
RCRA Facility Investigation Work Plan
RCI Ferndale, Michigan Facility

Location, Type and Number of Samples

MDNR SWMU Number	Name	Area	Building Foundation Integrity Evaluation	Foundation Soil Boring Samples	ECP Testing	Maximum Soil Borings	Monitoring Wells	Other	Required Analytical
1.	South Tank Farm	South	No	0	0	0	0	Incorporate into Corrective Measures	None
2.	Building 204 - Product Storage Warehouse	South	Yes	FD#	0	0	0		VOC Semi-VOC
3.	Building 203 - Product Storage Warehouse	South	Yes	FD#	0	0	0		VOC Semi-VOC
4.	Pipe Bridge between Building 203 and 206	South	No	0	0	0	0	Steam pipe only; No Further Investigation	None
5.	Building 206 - Product Storage Area	South	Yes	0	0	0	0		None
6.	Pipe Tunnel beneath Woodward Heights Ave. Connecting South and West Areas	South	No	0	0	0	0	Video survey or integrity testing to document leakage potential, Phase II investigation, if req'd.	None
60.	Former Underground Storage Tank	South	No	0	0	0	0	Closure report submitted March, 1990.	None
61.	Driveway between Gainsboro Ave. and Buildings 204 and 205.	South	No	0	0	0	0	Low release potential; No Further Investigation	None
7.	Inflammable Solvents Tank Farm	West	Yes	FD	0	0	0		VOC Semi-VOC
8.	Solvent Pump Station	West	Yes	FD	0	0	0		VOC Semi-VOC

NOTES:

: Foundation soil borings will be collected from around perimeter of building.

FD: Number of samples will be field determined.

* : Number of monitoring wells is dependent upon results from ECP testing and soil borings.

Table 6
RCRA Facility Investigation Work Plan
RCI Ferndale, Michigan Facility

Location, Type and Number of Samples

MDNR SWMU Number	Name	Area	Building Foundation Integrity Evaluation	Foundation Soil Boring Samples	ECP Testing	Maximum Soil Borings	Monitoring Wells	Other	Required Analytical
9.	Building "B" - Resin Production	West	Yes	FD	0	0	0		VOC Semi-VOC
10.	Building "C" - Resin Production	West	Yes	FD	0	0	0		VOC Semi-VOC
11.	Dock "C" - Storage and Processing	West	Yes	FD	0	0	0		VOC Semi-VOC
12.	Building "K" - Storage and Processing	West	Yes	FD	0	0	0		VOC Semi-VOC
13.	Dock "K" - Storage and Processing	West	Yes	FD	0	0	0		VOC Semi-VOC
14.	Inert Gas Generation Building	West	Yes	FD	0	0	0		VOC Semi-VOC
15.	Building "N"	West	Yes	FD	0	0	0		VOC Semi-VOC
16.	Pump House	West	Yes	FD	0	0	0		VOC Semi-VOC
17.	Tank Farm	West	Yes	FD	0	0	0		VOC Semi-VOC
18.	Building "M" - Empty Drum Storage	West	Yes	FD	0	0	0		VOC Semi-VOC
19.	Building "L" - adjacent to Building "M"	West	Yes	FD	0	0	0		VOC Semi-VOC

NOTES:

: Foundation soil borings will be collected from around perimeter of building.

FD: Number of samples will be field determined.

* : Number of monitoring wells is dependent upon results from ECP testing and soil borings.

Table 6
RCRA Facility Investigation Work Plan
RCI Ferndale, Michigan Facility

Location, Type and Number of Samples

MDNR SWMU Number	Name	Area	Building Foundation Integrity Evaluation	Foundation Soil Boring Samples	ECP Testing	Maximum Soil Borings	Monitoring Wells	Other	Required Analytical
20.	Tank Truck Cleaning Building	West	Yes	FD	0	0	0		VOC Semi-VOC
21.	Storage Tanks adjacent to Tank Truck Cleaning Building	West	Yes	FD	0	0	0		VOC Semi-VOC
22.	Diked Area adjacent to Building "L"	West	Yes	FD	0	0	0		VOC Semi-VOC
23.	Garage Area of Building "L"	West	Yes	FD	0	0	0		VOC Semi-VOC
24.	Resin Drum Storage Shed	West	Yes	FD	0	0	0		VOC Semi-VOC
25.	Transformer Storage	West	No	0	0	0	0	No Further Investigation	None
26.	Diked Area Consisting of 7 Storage Tanks	West	Yes	FD	0	0	0		VOC Semi-VOC
27.	Building "D" Annex	West	Yes	FD	0	0	0		VOC Semi-VOC
28.	Building "D"	West	Yes	FD	0	0	0		VOC Semi-VOC
29.	Building "E" - 14 Process Tanks	West	Yes	FD	0	0	0		VOC Semi-VOC
30.	Building "F"	West	Yes	FD	0	0	0		VOC Semi-VOC

NOTES:

: Foundation soil borings will be collected from around perimeter of building.

* : Number of monitoring wells is dependent upon results from ECP testing and soil borings.

FD: Number of samples will be field determined.

Table 6
RCRA Facility Investigation Work Plan
RCI Ferndale, Michigan Facility

Location, Type and Number of Samples

MDNR SWMU Number	Name	Area	Building Foundation Integrity Evaluation	Foundation Soil Boring Samples	ECP Testing	Maximum Soil Borings	Monitoring Wells	Other	Required Analytical
31.	Building "G"	West	Yes	FD	0	0	0		VOC Semi-VOC
32.	Four Storage Tanks	West	Yes	FD	0	0	0		VOC Semi-VOC
33.	Building "H"	West	Yes	FD	0	0	0		VOC Semi-VOC
59.	Pipe Tunnel from SWMU no. 41 to SWMU no. 13	West	No	0	0	0	0	Video survey or integrity testing, Phase II if req'd.	None
62.	Area between Railroad Spur on the Northern End of West Area	West	No	0	5	5	*		VOC Semi-VOC
63.	Driveway and Parking Area west side of West Area	West	No	0	16	16	*		VOC Semi-VOC
64.	Roadway between Two Sets of Buildings which Split the West Area	West	No	0	7	7	*		VOC Semi-VOC
34.	Building 102	East	Yes	FD	0	0	0		VOC Semi-VOC
35.	Hazardous Reagent Storage Area	East	Yes	FD	0	0	0		VOC Semi-VOC
36.	Building 100 Maintenance Shop	East	Yes	FD	0	0	0		VOC Semi-VOC

NOTES:

: Foundation soil borings will be collected from around perimeter of building.

FD: Number of samples will be field determined.

* : Number of monitoring wells is dependent upon results from ECP testing and soil borings.

Table 6
RCRA Facility Investigation Work Plan
RCI Ferndale, Michigan Facility

Location, Type and Number of Samples

MDNR SWMU Number	Name	Area	Building Foundation Integrity Evaluation	Foundation Soil Boring Samples	ECP Testing	Maximum Soil Borings	Monitoring Wells	Other	Required Analytical
37.	Heated Storage Bldg. 101A Sample Resin Dispensing	East	Yes	FD	0	0	0		VOC Semi-VOC
38.	Storage Shed	East	Yes	FD	1	1	*		VOC Semi-VOC
39.	Building 101B - Misc. Solvent Storage	East	Yes	FD	0	0	0		VOC Semi-VOC
40.	Hazardous Waste Tank Storage Area	East	Yes	FD	0	0	0		VOC Semi-VOC
41.	Boiler Room - Hazardous Waste Incineration	East	Yes	FD	0	0	0		VOC Semi-VOC
42.	Hazardous Waste Container Area	East	Yes	FD	0	0	0		VOC Semi-VOC
43.	Building 105A - Phthalic Anhydride Production	East	Yes	FD	0	0	0		VOC Semi-VOC
44.	Hazardous Waste Container Storage Area	East	Yes	FD	0	0	0		VOC Semi-VOC
45.	Building 103 - Resin and Inflammable Solvent Production	East	Yes	FD	4	4	*		VOC Semi-VOC
46.	Building 104A - Phthalic Anhydride Production	East	Yes	FD	0	0	0		VOC Semi-VOC
47.	Building 104 - Tank Storage Area	East	No	0	0	0	0	Incorporate into Corrective Measures	None

NOTES:

: Foundation soil borings will be collected from around perimeter of building.

FD: Number of samples will be field determined.

* : Number of monitoring wells is dependent upon results from ECP testing and soil borings.

Table 6
RCRA Facility Investigation Work Plan
RCI Ferndale, Michigan Facility

Location, Type and Number of Samples

MDNR SWMU Number	Name	Area	Building Foundation Integrity Evaluation	Foundation Soil Boring Samples	ECP Testing	Maximum Soil Borings	Monitoring Wells	Other	Required Analytical
48.	Building 104 - Resin Drum Storage	East	Yes	FD	0	0	0		VOC Semi-VOC
49.	Building 104D - Resin Drum Storage	East	Yes	FD	3	3	*		VOC Semi-VOC
50.	Inflammable Solvent Tank Farm	East	Yes	FD	0	0	0		VOC Semi-VOC
51.	Inflammable Solvent Tank Farm	East	Yes	FD	0	0	0		VOC Semi-VOC
52.	Building 104 - Empty Drum Storage	East	Yes	FD	0	0	0		VOC Semi-VOC
53.	Building 104E - Phthalic Anhydride Production	East	Yes	FD	0	0	0		VOC Semi-VOC
54.	Building 105B - Phthalic Anhydride Production	East	Yes	FD	0	0	0		VOC Semi-VOC
55.	Building 105 - Empty Drum Storage	East	Yes	FD	0	0	0		VOC Semi-VOC
56.	Building 101 - Phthalic Anhydride Production	East	Yes	FD	0	0	0		VOC Semi-VOC
57.	Pipe Trench Between SWMU no. 36 and SWMU no. 34	East	No	0	0	0	0	No Further Investigation	None

NOTES:

: Foundation soil borings will be collected from around perimeter of building.

* : Number of monitoring wells is dependent upon results from ECP testing and soil borings.

FD: Number of samples will be field determined.

Table 6
RCRA Facility Investigation Work Plan
RCI Ferndale, Michigan Facility

Location, Type and Number of Samples

MDNR SWMU Number	Name	Area	Building Foundation Integrity Evaluation	Foundation Soil Boring Samples	ECP Testing	Maximum Soil Borings	Monitoring Wells	Other	Required Analytical
58.	Pipe Bridge Between Bldg. 104 and Bldg 105	East	No	0	0	0	0	Determination of former usage	None
59.	Pipe Tunnel From SWMU no. 41 to SWMU no. 13	East	No	0	0	0	0	Video survey or integrity testing, Phase II if req'd.	None
65.	Roadway Inside Wall along Bermuda Ave.	East	No	0	7	7	*		VOC Semi-VOC
66.	Truck Parking Lot	East	No	0	6	6	*		VOC
67.	Area Adjacent to Train Tracks - Entire Length of Property	East	No	0	7	7	*		VOC Semi-VOC
68.	Deep Well	East	No	0	0	0	0	No Further Investigation	None

NOTES:

: Foundation soil borings will be collected from around perimeter of building.

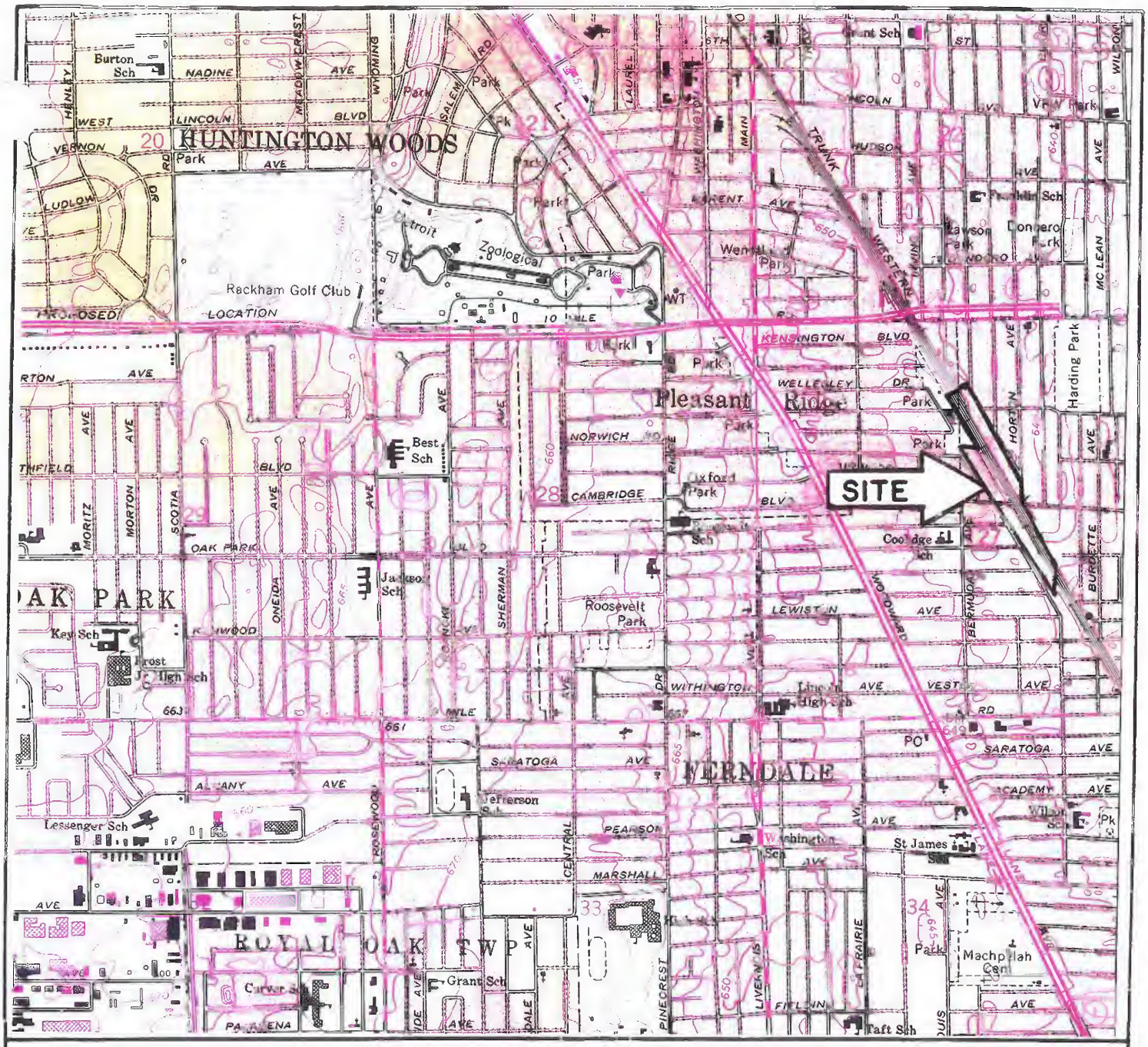
* : Number of monitoring wells is dependent upon results from ECP testing and soil borings.

FD: Number of samples will be field determined.

FIGURES

RCF-1

FIGURE 1



SITE LOCATION MAP

REICHHOLD CHEMICALS, INC.
FERNDALE, MICHIGAN

THIS MAP TAKEN FROM THE ROYAL OAK, MICHIGAN USGS QUADRANGLE

QUADRANGLE LOCATION

1 ½ 0 1 MILE

1000 0 1000 2000 3000 4000 5000 6000 7000 FEET

1 .5 0 1 KILOMETER

SCALE 1:24000

O'BRIEN & GERE ENGINEERS INC.
Edison, New Jersey

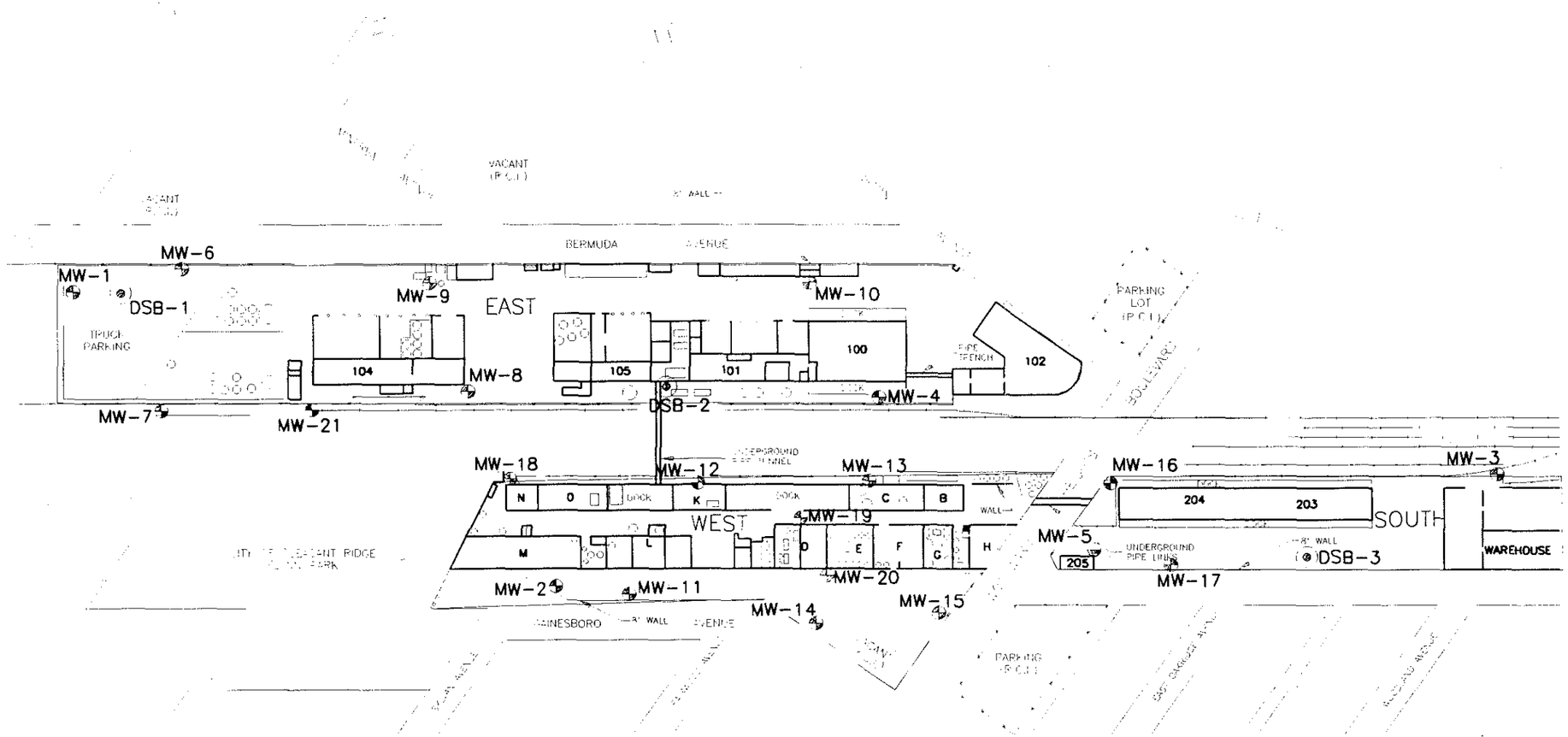


FIGURE 2

REICHHOLD CHEMICALS, INC
FERNDALE, MICHIGAN

LEGEND

- MONITORING WELL LOCATION
- MONITORING WELL WAS ABANDONED AND GROUTED
- DEEP SOIL BORING LOCATION

EAST\WEST\SOUTH AREA LOCATIONS

DECEMBER 1994

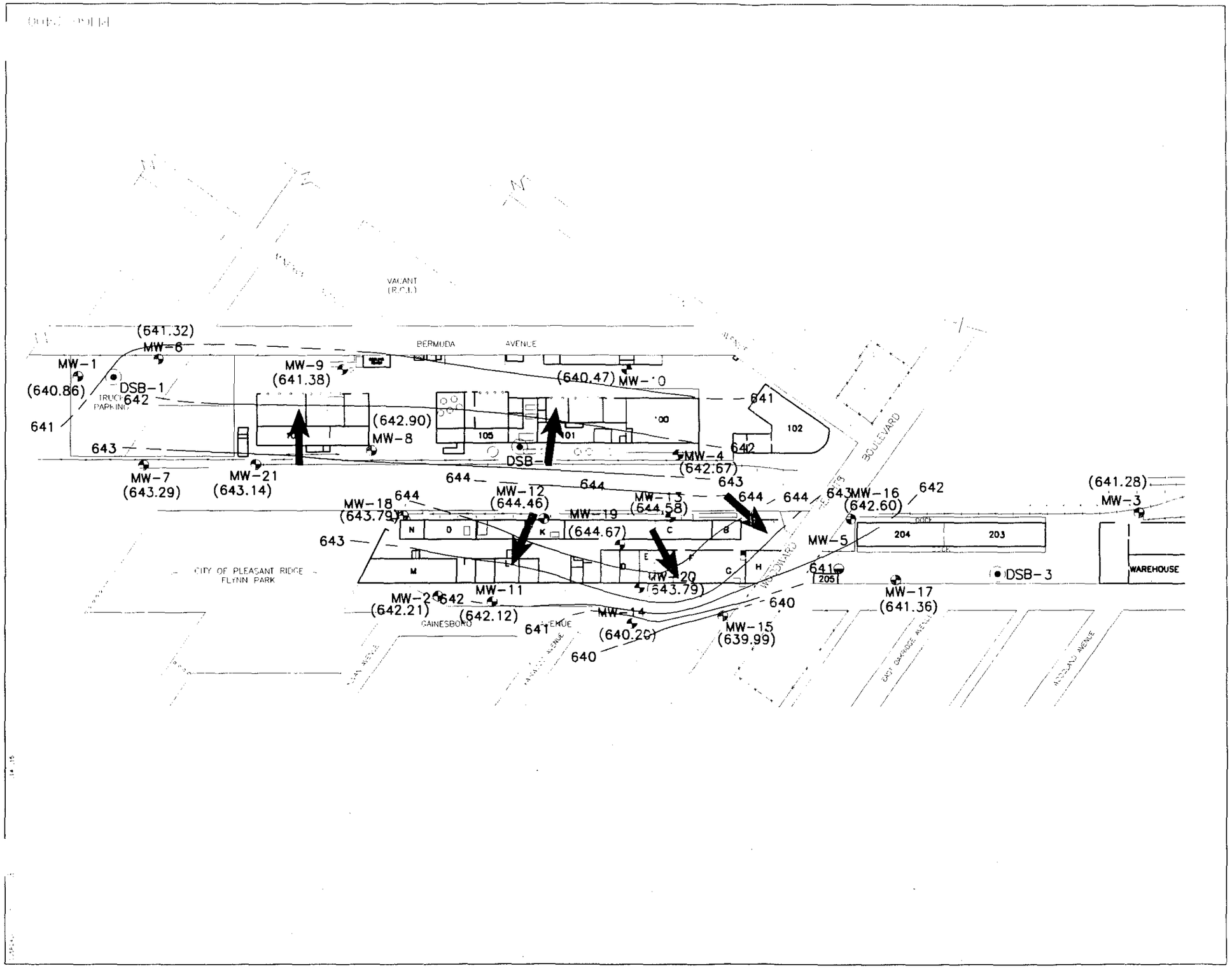
200 0 200

SCALE IN FEET

O'BRIEN & GERE

FIGURE 3

REICHHOLD CHEMICALS, INC
FERNDALE, MICHIGAN



LEGEND

- MONITORING WELL LOCATION
- MONITORING WELL WAS ABANDONED AND GROUTED
- DEEP SOIL BORING
- (639.54) GROUND WATER ELEVATION
- 641 GROUND WATER ELEVATION CONTOUR
- INFERRED GROUND WATER ELEVATION
- GROUND WATER FLOW DIRECTION

GROUND WATER CONTOUR
MAP 5/13/92

JULY 1993

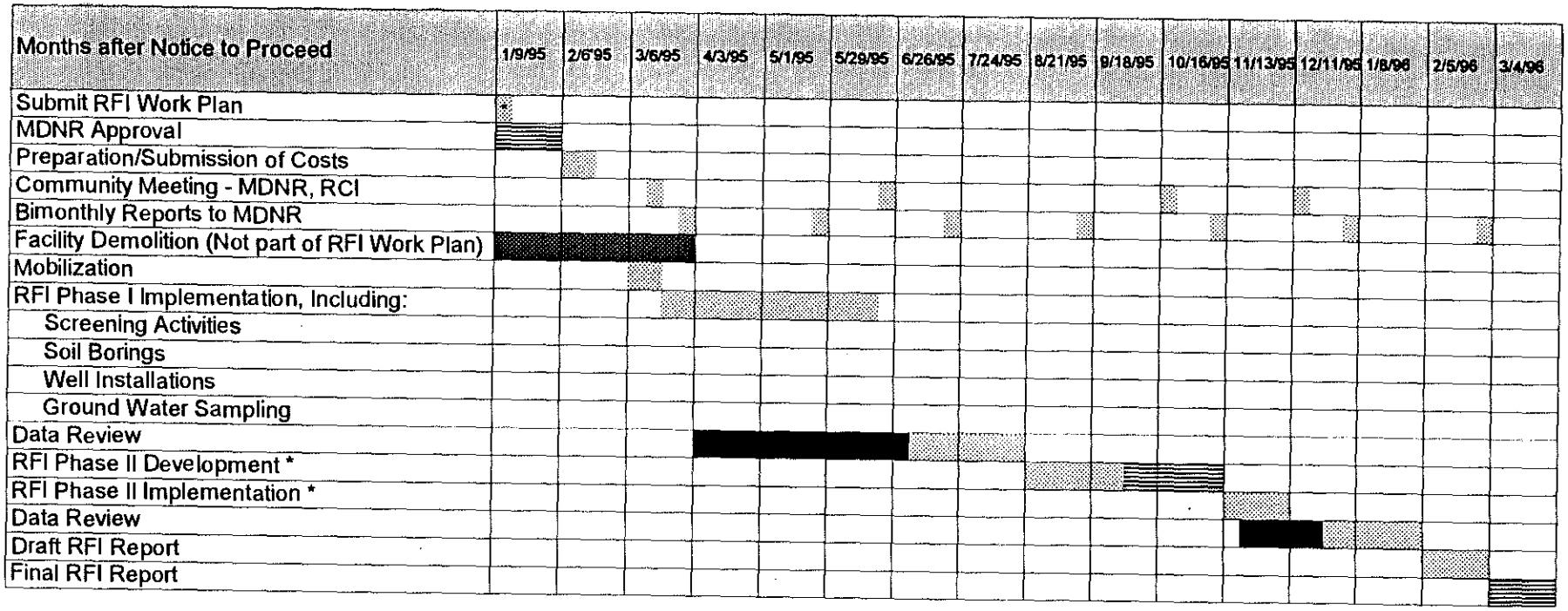
200 0 200

SCALE IN FEET

O'BRIEN & GERE
ENGINEERS, INC.

Reichhold Chemicals, Inc.
Ferndale, Michigan
RCRA Facility Investigation
Schedule

Figure 7



Required prior to start of field activities

Non-RFI Activities

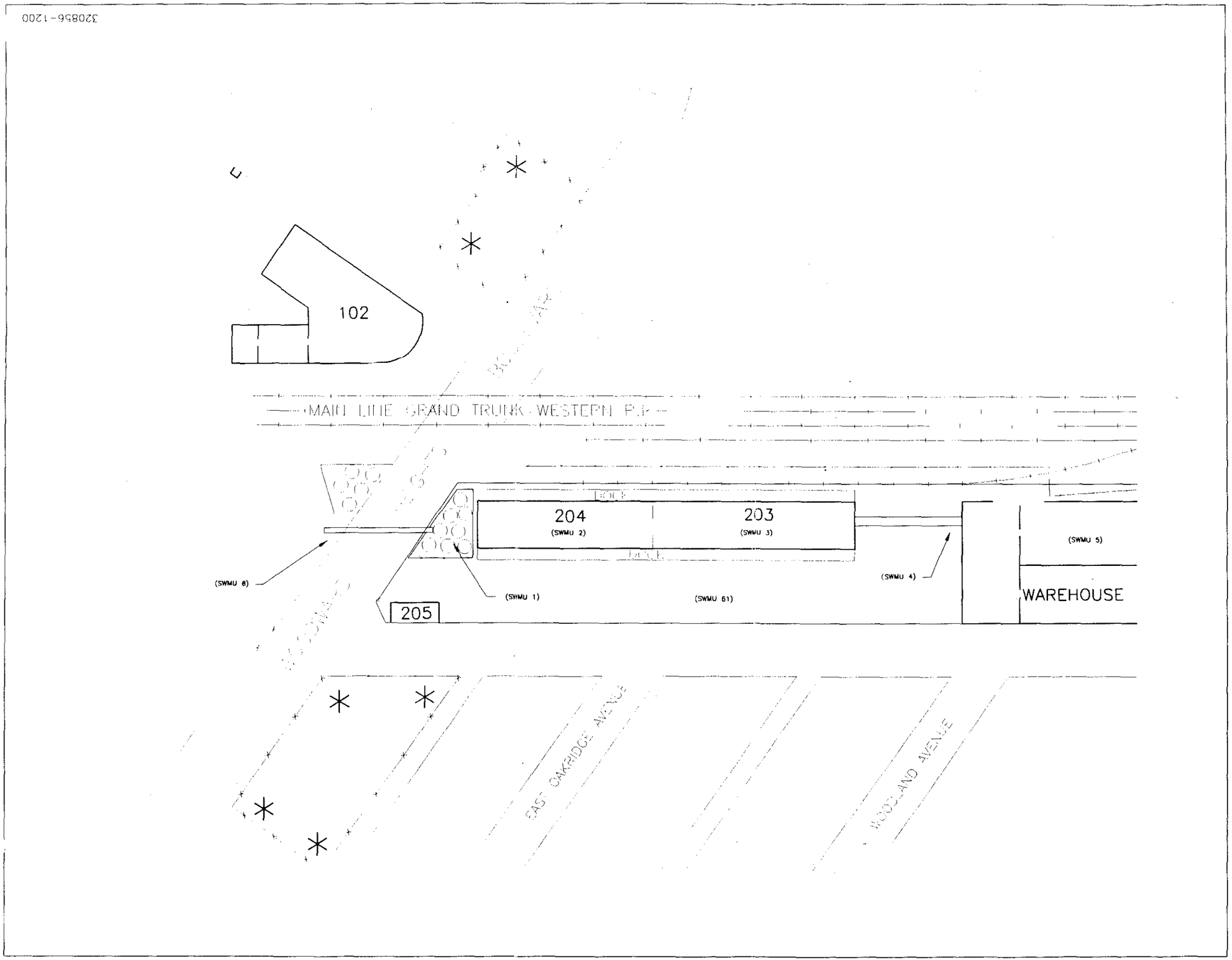
Reichhold Chemicals, Inc.

Michigan Department of Natural Resources - Review Time

Laboratory Analysis

* - Scope and final schedule for the Phase II program will be defined based on the results of the Phase I program. Phase II may not be required.

FIGURE 8



LEGEND

* ECP SCREENING/SOIL BORING LOCATION

REICHHOLD CHEMICALS, INC
FERNDALE, MICHIGAN

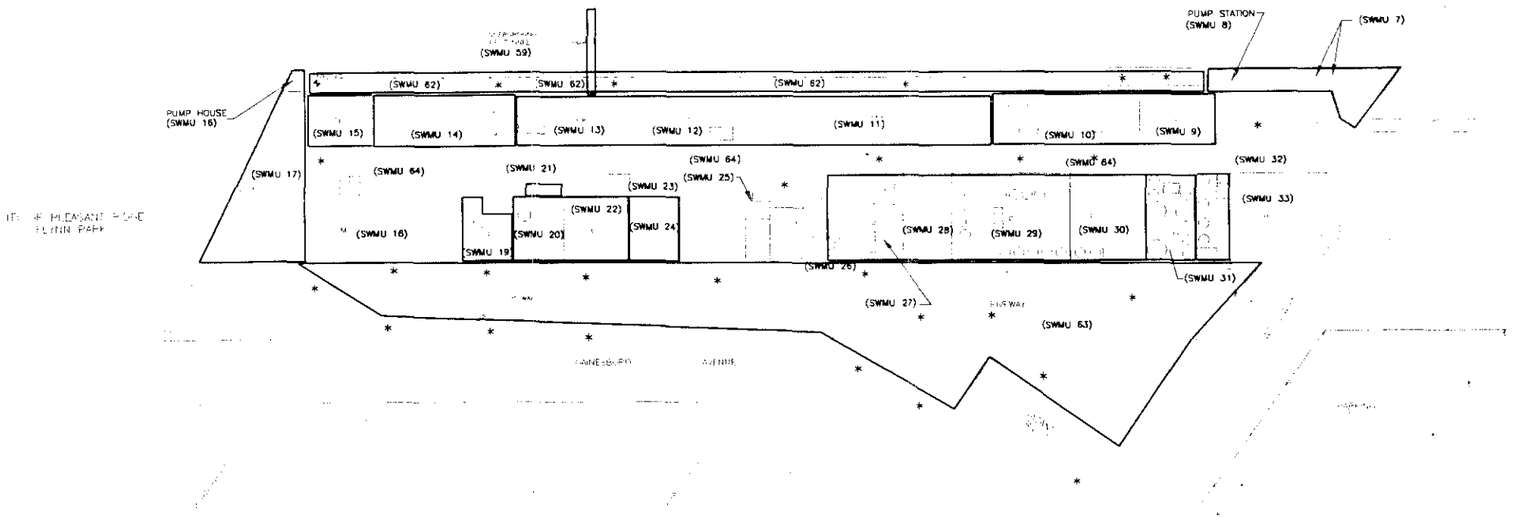
PROPOSED
SAMPLING LOCATIONS
SOUTH AREA

JULY 1993

100 0 100
SCALE IN FEET

O'BRIEN & GERE

FIGURE 9



LEGEND

* ECP SCREENING/SOIL BORING LOCATION

REICHHOLD CHEMICALS INC.
FERNDALE, MICHIGAN

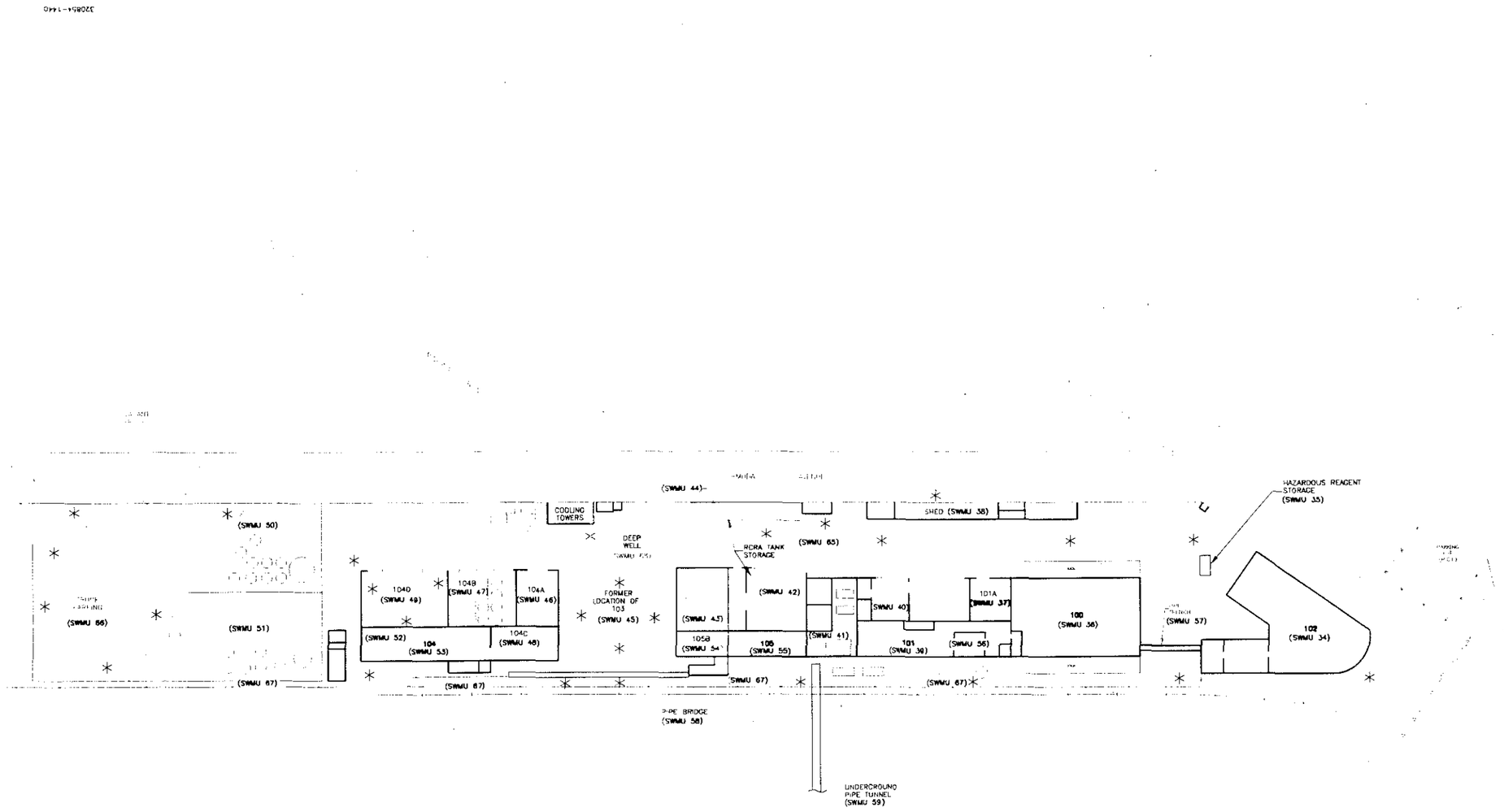
PROPOSED SAMPLING LOCATIONS WEST AREA

DECEMBER 1994

50 0 50 100

SCALE IN FEET

FIGURE 10



LEGEND

✳ ECP SCREENING/SOIL BORING LOCATION

REICHHOLD CHEMICALS INC.
FERNDALE, MICHIGAN

PROPOSED SAMPLING LOCATIONS EAST AREA

DECEMBER 1994

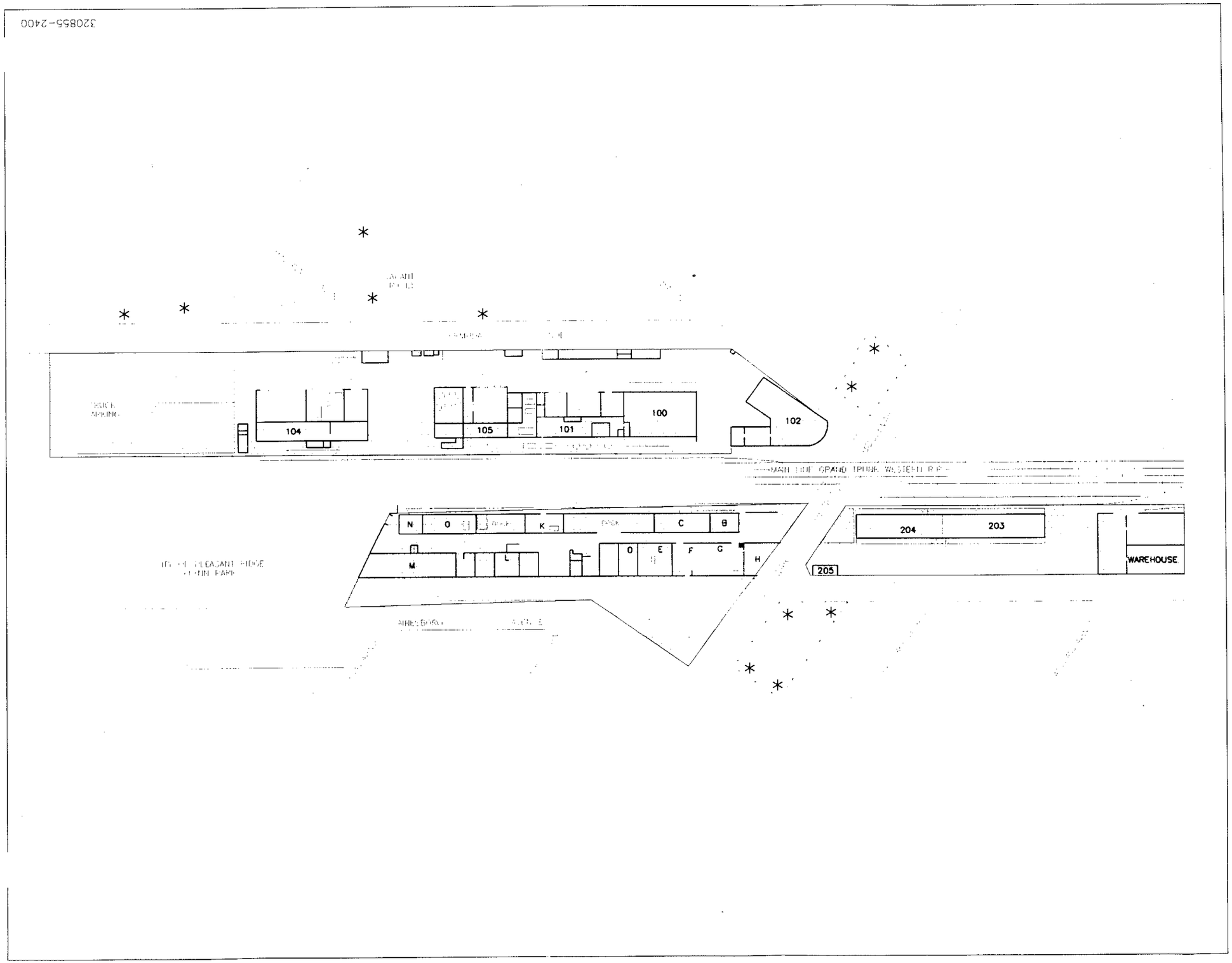
60 0 60 120

SCALE IN FEET

ENGINEERS INC.

320855-2400

FIGURE 11



LEGEND

* ECP SCREENING/SOIL BORING LOCATION

REICHHOLD CHEMICALS, INC
FERNDALE, MICHIGAN

OFF-SITE
PROPOSED SAMPLING
LOCATIONS

DECEMBER 1994

O'BRIEN & GERE

Figure 12
Investigatory Logic
Reichhold Chemicals, Inc.
Ferndale, Michigan

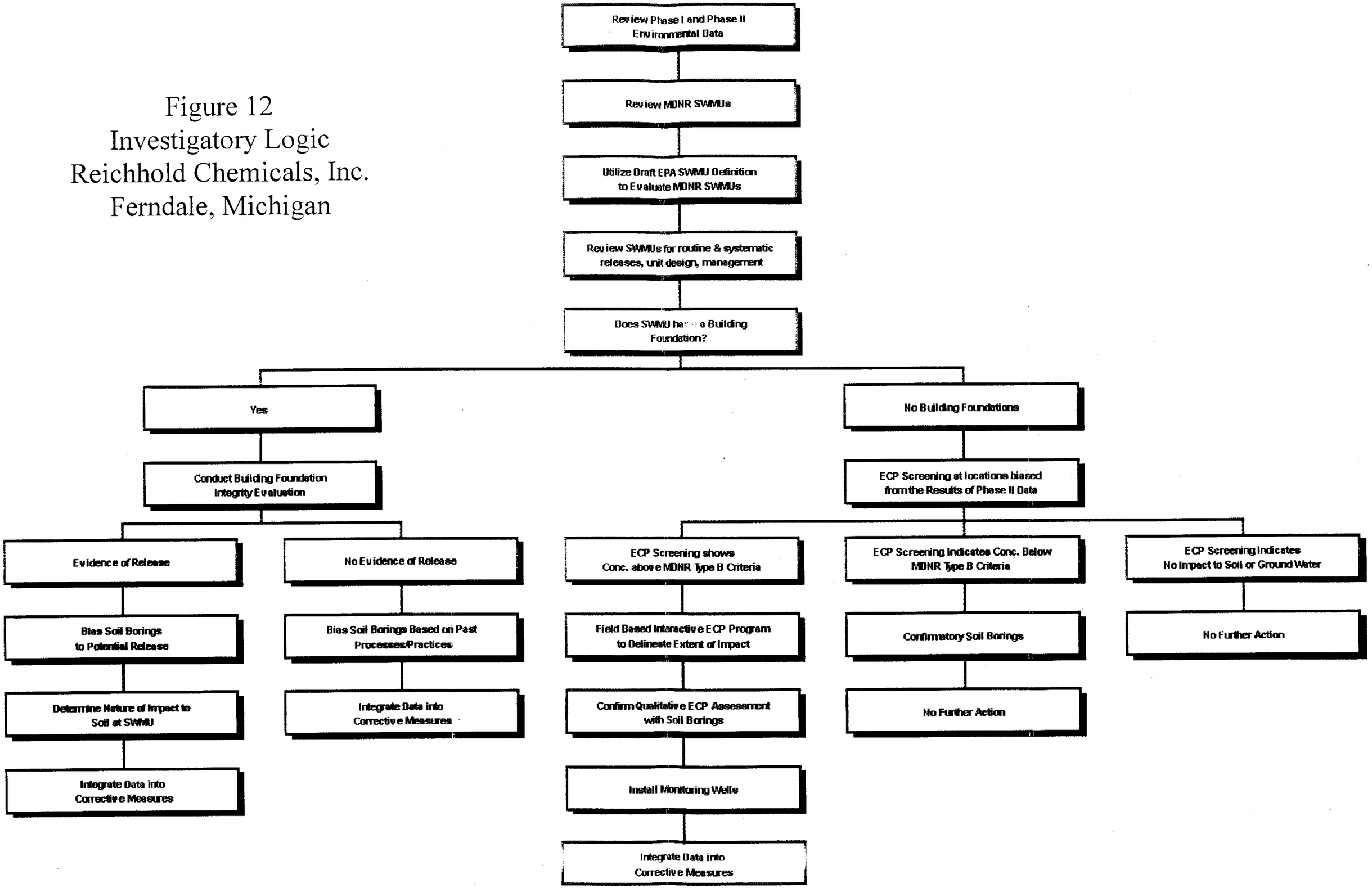
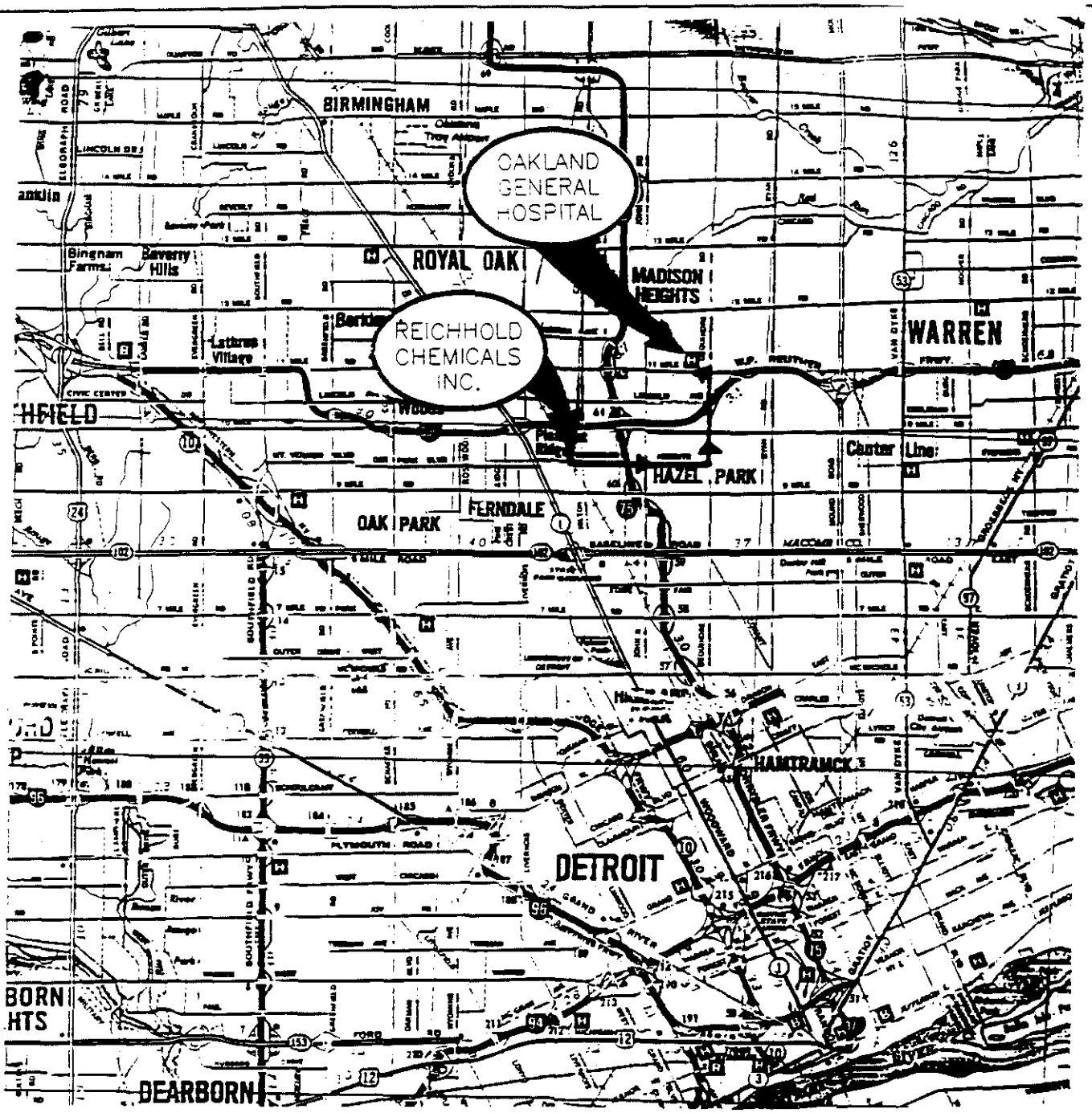


FIGURE 13



HOSPITAL LOCATION

REICHHOLD CHEMICALS, INC.
FERNDALE, MICHIGAN

DIRECTIONS TO OAKLAND GENERAL HOSPITAL

- FROM REICHHOLD CHEMICALS, INC. TAKE WOODWARD HEIGHTS BOULEVARD EAST TO DEQUINDRE ROAD
- TURN LEFT (NORTH) AND PROCEED TO ELEVEN MILE ROAD
- TURN LEFT (WEST) AND THEN RIGHT INTO HOSPITAL

3 0 3 6

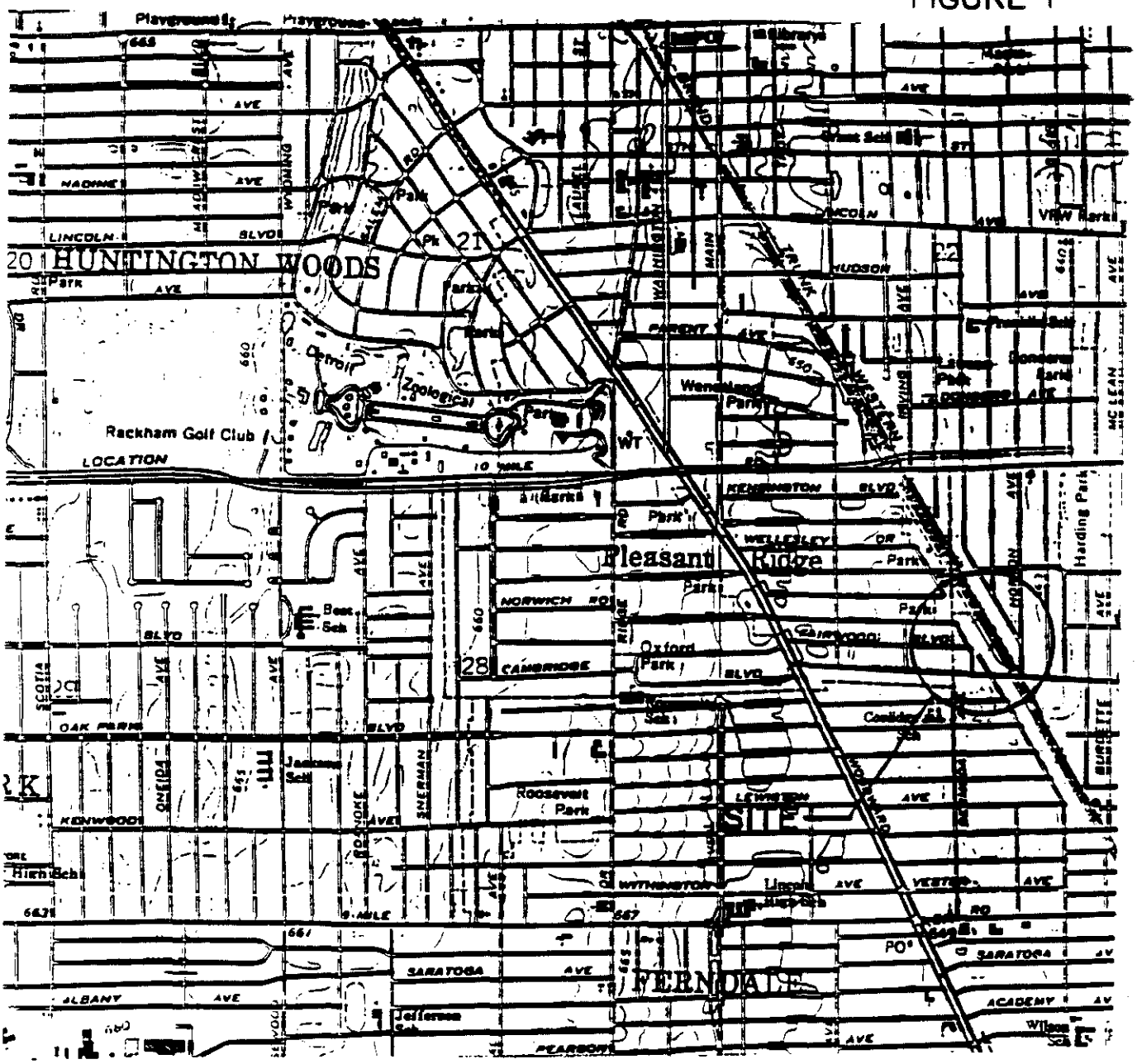
1" = APPROX. 3 MILES

FILE No. 3208-058-278

320865-1

DESC

FIGURE 1



SITE LOCATION MAP

REICHHOLD CHEMICALS, INC.
FERNDALE, MICHIGAN

THIS MAP TAKEN FROM THE
ROYAL OAKS, MICHIGAN
USGS QUADRANGLE

QUADRANGLE LOCATION

N

1 ½ 0 1 MILE

1000 0 1000 2000 3000 4000 5000 6000 7000 FEET

1 .5 0 1 KILOMETER

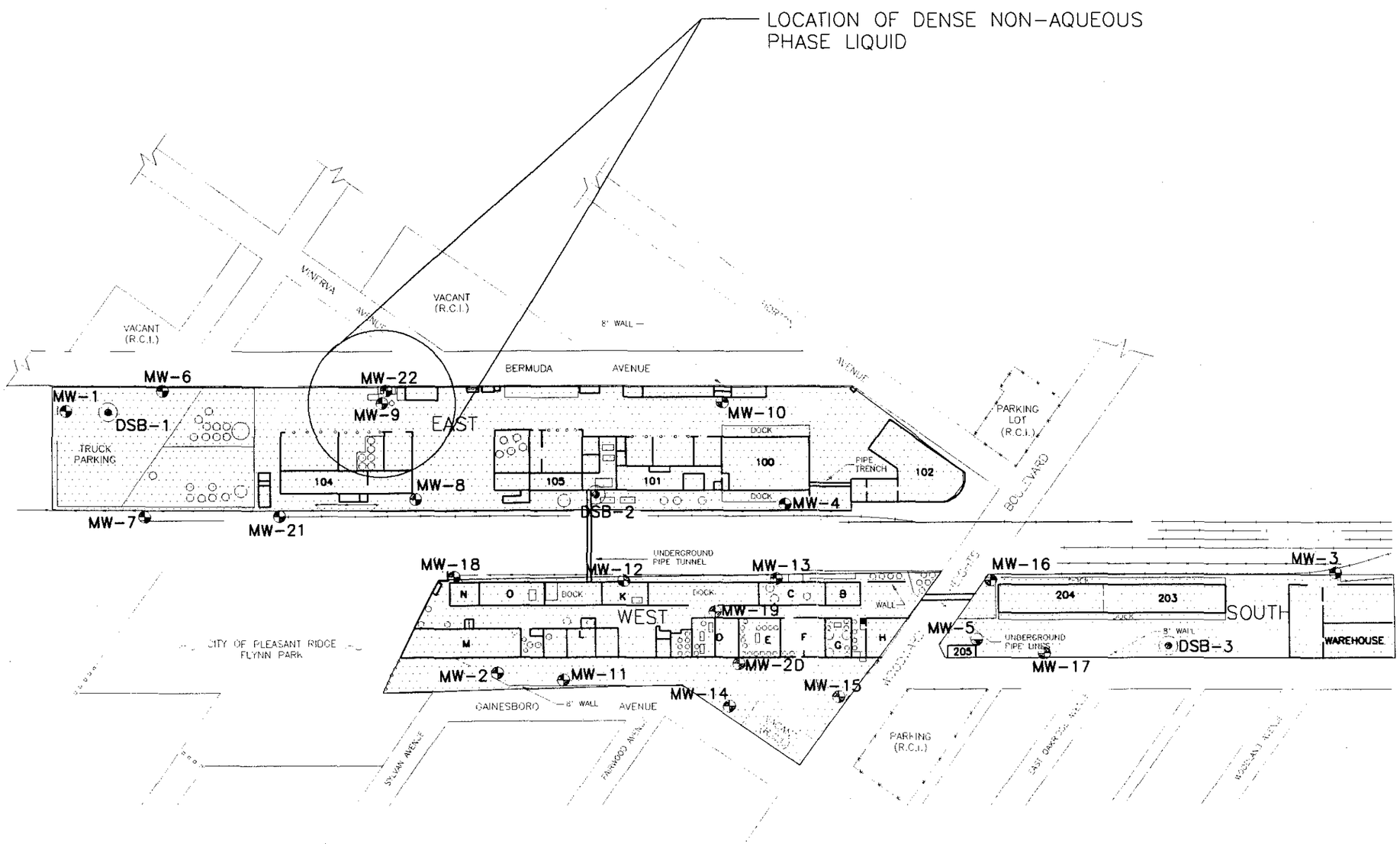
SCALE: 1:24000

FILE No.

O'BRIEN & GERE ENGINEERS, INC.

FIGURE 2

3208154-1200



LEGEND

- APPROX. MONITORING WELL LOCATION
- SOIL BORING LOCATION
- DEEP SOIL BORING LOCATION

REICHHOLD CHEMICALS, INC.
FERNDALE, MICHIGAN

EAST/WEST/SOUTH AREA LOCATIONS

NOVEMBER 1994

200 0 200 400

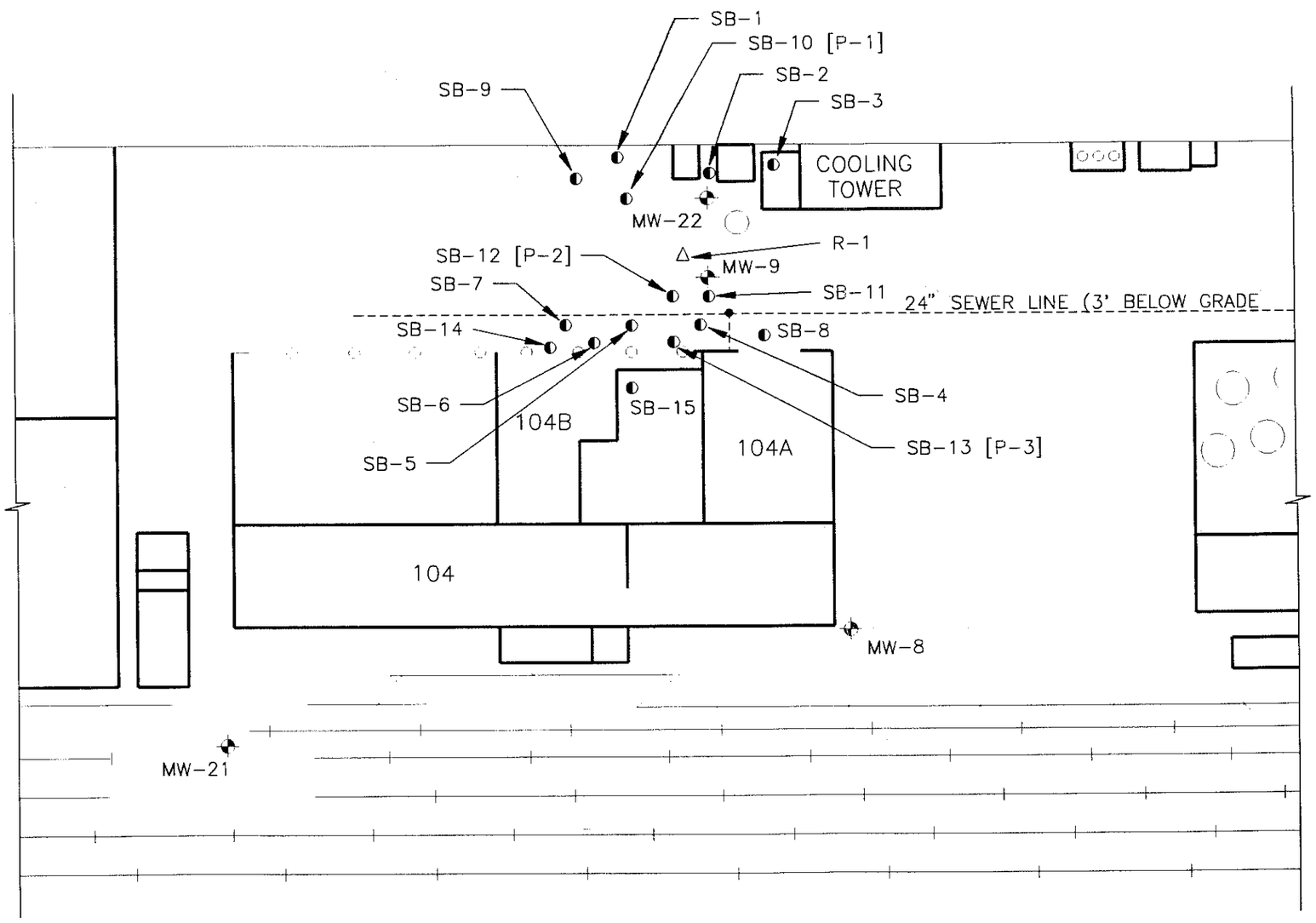
1" = 200'

FILE NO.

DESC

O'BRIEN & GERE ENGINEERS, INC.

FIGURE 3



LEGEND

- APPROX. MONITORING WELL LOCATION
- SOIL BORING LOCATION
- RECOVERY WELL LOCATION
- [P-2] PIEZOMETER
- CATCH BASIN

REICHHOLD CHEMICALS, INC.
FERNDALE, MICHIGAN

DNAPL RECOVERY
AREA PLAN

NOVEMBER 1994

50 0 50 100

1" = 50'

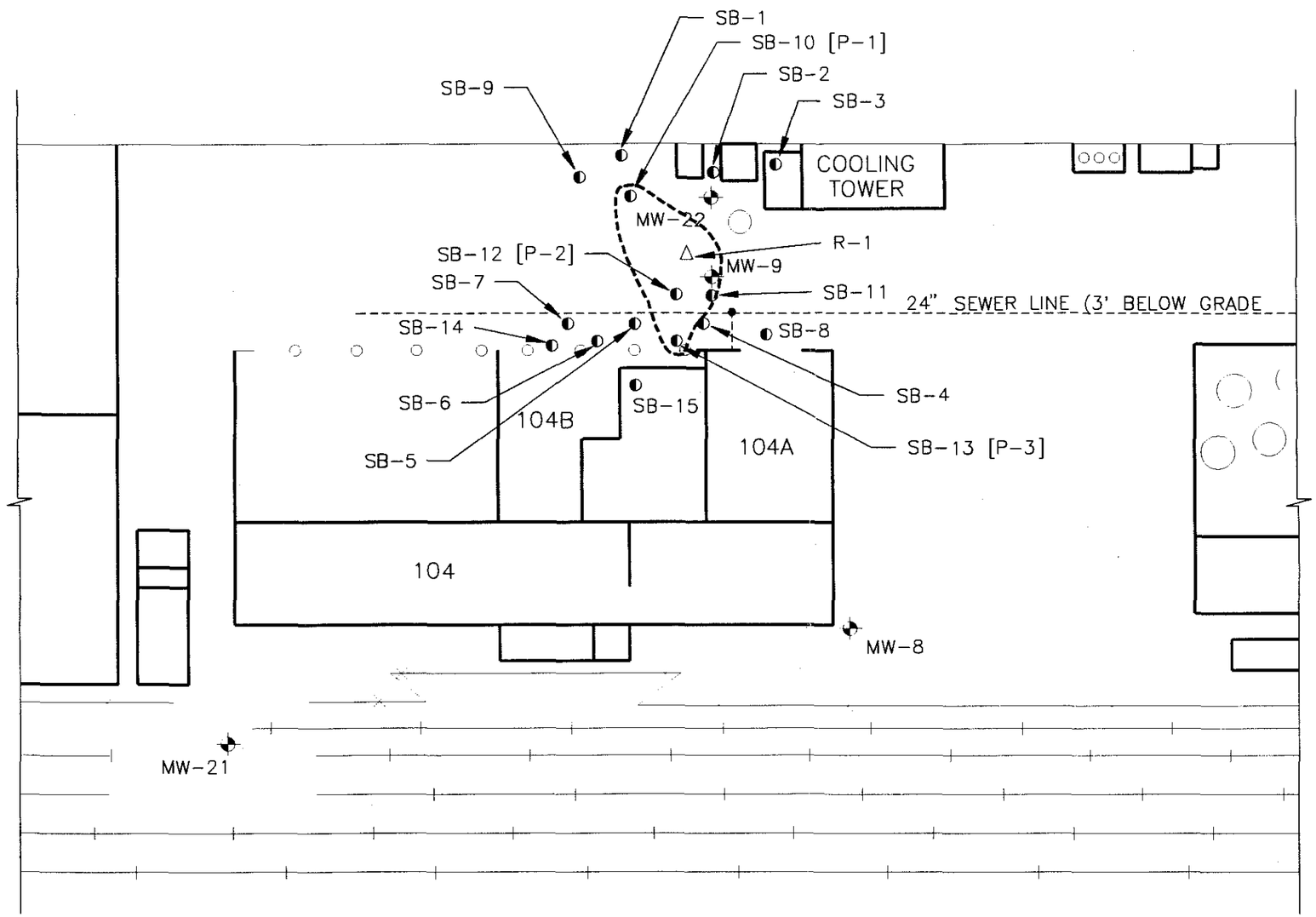
FILE NO.

DESC

O'BRIEN & GERE ENGINEERS, INC.

3208152-1200

FIGURE 4



LEGEND

- APPROX. MONITORING WELL LOCATION
- SOIL BORING LOCATION
- RECOVERY WELL LOCATION
- [P-2] PIEZOMETER
- CATCH BASIN
- APPROXIMATE EXTENT OF DNAPL OCCURENCE

REICHHOLD CHEMICALS, INC.
FERNDALE, MICHIGAN

DNAPL AREA
EXTENT

NOVEMBER 1994

50 0 50 100

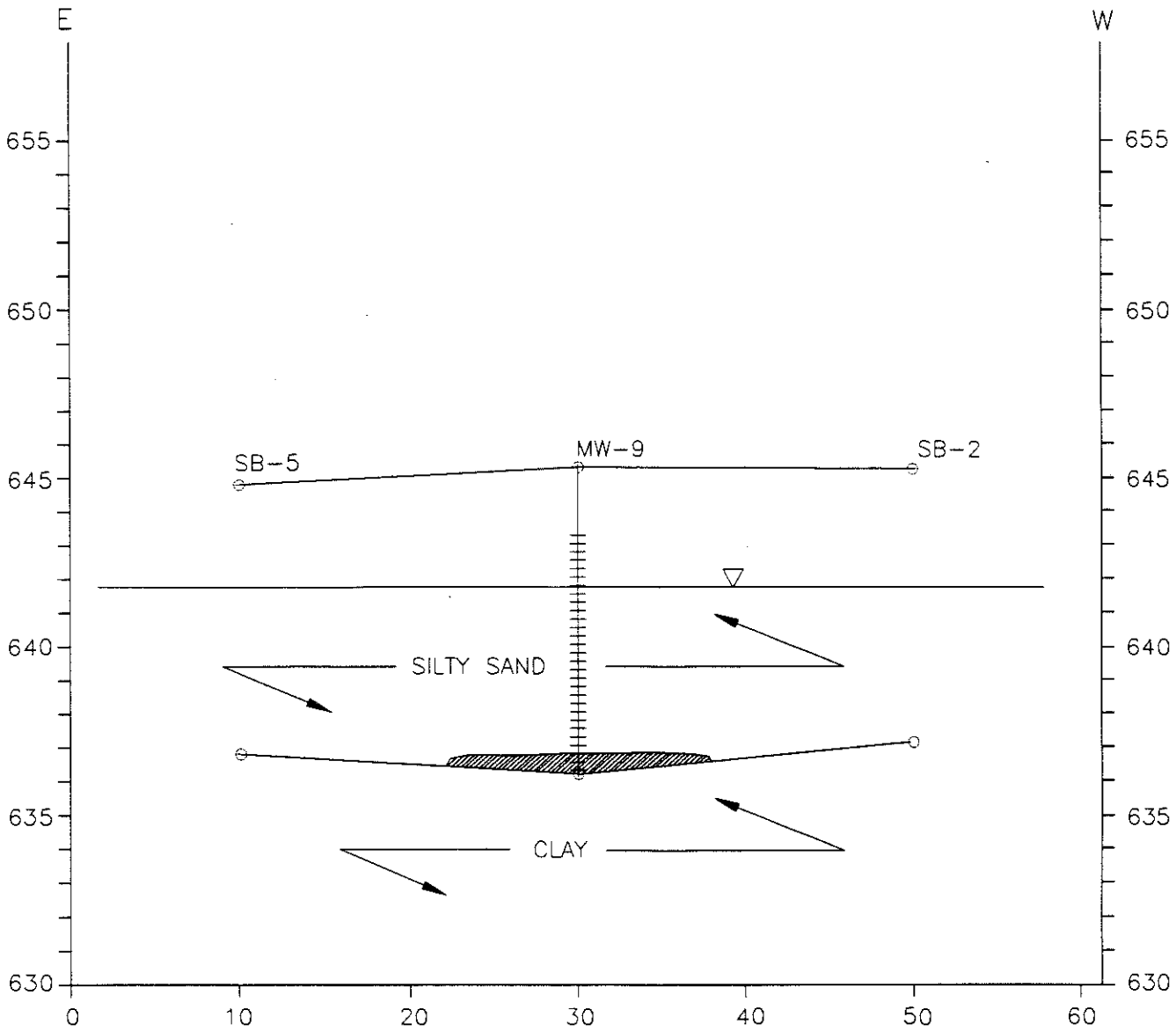
1" =50'

FILE NO.

O'BRIEN & GERE ENGINEERS, INC.

3208153-1200

DESC



LEGEND

SCREEN

DNAPL

PIEZOMETRIC SURFACE

VERTICAL SCALE = 1"=5'
HORIZONTAL SCALE = 1"=10'

O'BRIEN & GERE ENGINEERS, INC.

REICHHOLD CHEMICALS, INC.
FERNDALE, MICHIGAN

DNAPL OCCURRENCE

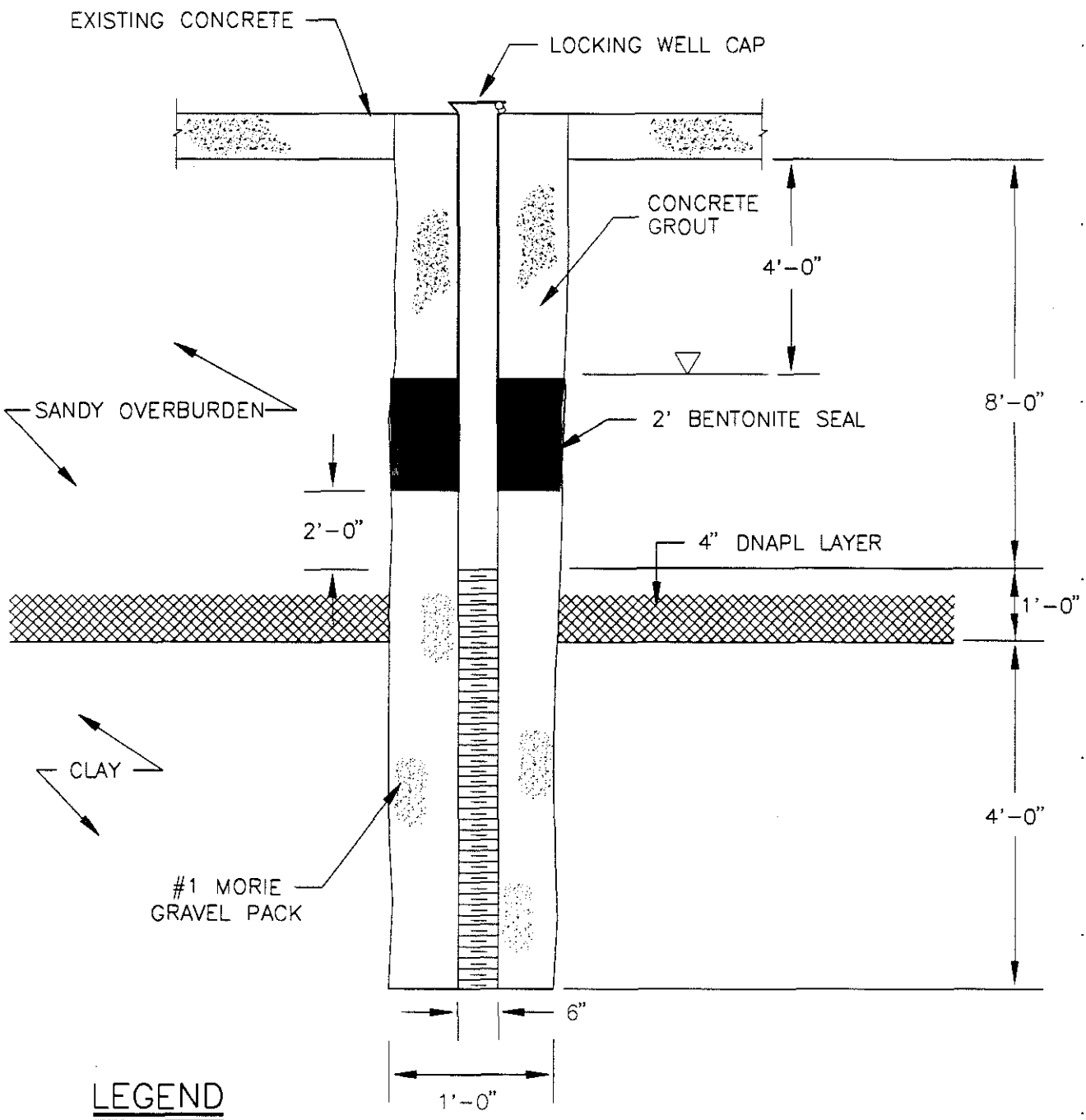
FILE NO. 3208.045

DATE NOV. 1994

DWG. NO. FIGURE 5

320855-480

DESC



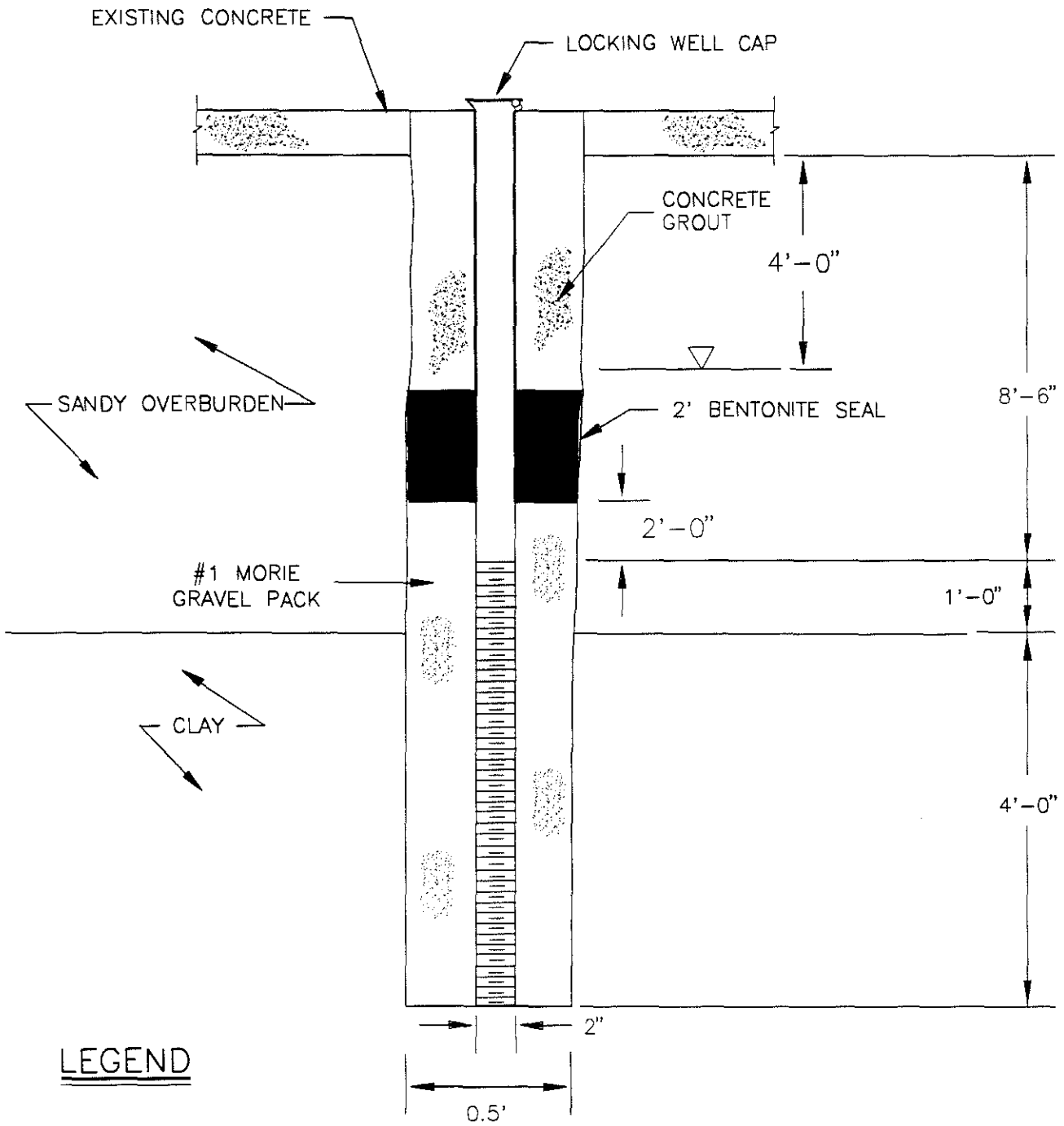
LEGEND

20 SLOT STAINLESS STEEL SCREEN

PIEZOMETRIC SURFACE

NOT TO SCALE

O'BRIEN & GERE ENGINEERS, INC.	REICHHOLD CHEMICALS, INC. FERNDALE, MICHIGAN TYPICAL RECOVERY WELL	FILE NO. 3208.045 DATE NOV. 1994 DWG. NO. FIGURE 6



LEGEND

20 SLOT STAINLESS STEEL SCREEN

PIEZOMETRIC SURFACE

NOT TO SCALE

O'BRIEN & GERE ENGINEERS, INC.	REICHHOLD CHEMICALS, INC. FERNDALE, MICHIGAN TEMPORARY PIEZOMETER	FILE NO. 3208.045 DATE NOV. 1994 DWG. NO. FIGURE 7

320857-1

DESC

APPENDICES

O'BRIEN & GERE ENGINEERS, INC.	SOIL BORING LOG	LOG NUMBER: SB-1 SHEET 1 OF 1

CLIENT RC Reichold Chemical PROJECT LOCATION RCI Ferndale, Michigan	GROUND WATER DATE DEPTH ELEVATION	FILE No.: 3208.035 DRILLING METHOD: Hollow Stem Auger SAMPLER TYPE: 2" Splitspoon HAMMER: 140 lbs FALL: 30"

O'BRIEN & GERE GEOLOGIST: Hugh G. Griffiths & Vernon C. Burrows
BORING CO.: Professional Services Ind.
FOREMAN: Mike Bond

BORING LOCATION:
GROUND ELEVATION: 645.54'
DATES: STARTED: 9/26/91 ENDED: 9/26/91

DEPTH	SAMPLE No.	SAMPLE DEPTH	BLOWS /6"	PENETRATION RECOVERY	"N" VALUE	SAMPLE DESCRIPTION	STRATUM CHANGE DEPTH	EQUIPMENT INSTALLED	FIELD TESTING SAL. 0/00	SP. COND	HNU	REMARKS
0	1	0'-2'	12-12-8	2'/1'2"		Concrete					0	
						Brown To Light Brown, Damp, SILT, Some Very Fine, Sand, Little Clay, Trace Of Gravel, Sample Is Of Low To Moderate Plasticity	7"					
	2	2'-4'	6-7-10-10	2'/6"		Same As Above, Appears to Be Fall In, Rock Fragment (Limestone) Jammed In Tip Of Spoon	2'				0	
	3	4'-6'	5-4-9-12	2'/1'4"		Light Brown, Damp To Moist, Fine Sand	4'				0	
5						SAND, Gray, Moist To Wet, Fine Sand, Trace OF Medium, Tip Of Spoon Wet	5'					
	4	6'-8'	8-16-17-9	2'-1'		Gray To Gray Black, Wet Alternating Bands Of Coarse, SAND, With Little Silt Within The Fine SAND, Band, Odor Is Present	6'				0	
	5	8'-10'	5-8-11-13			Light Gray, Moist, Silty CLAY Of Low To Medium Plasticity, Little Fine To Coarse Sand	8'					
10	6	10'-12'	5-8-13-16	2'/2'								
	7	12'-14'				E.O.B. @ 12 fbg						
	8	14'-16'										
15												
	9	16'-18'										
	10	18'-20'										

BNMRC

O'BRIEN & GERE ENGINEERS, INC.	SOIL BORING LOG	LOG NUMBER: SB-2
		SHEET 1 OF 1

CLIENT	GROUND WATER			
RC Reichold Chemical	DATE	DEPTH	ELEVATION	FILE No.: 3208.035
PROJECT LOCATION				DRILLING METHOD: Hollow Stem Auger
RCI Ferndale, Michigan				SAMPLER TYPE: 2" Splitspoon
				HAMMER: 140 lbs FALL: 30"

O'BRIEN & GERE GEOLOGIST: Hugh G. Griffiths & Vernon C. Burrows
BORING CO.: Professional Services Ind.
FOREMAN: Mike Bond

BORING LOCATION:
GROUND ELEVATION: 645.28'
DATES: STARTED: 9/26/91 ENDED: 9/26/91

DEPTH	SAMPLE No.	SAMPLE DEPTH	BLOWS /6"	PENETRATION RECOVERY	"N" VALUE	SAMPLE DESCRIPTION	STRATUM CHANGE DEPTH	EQUIPMENT INSTALLED	FIELD TESTING SAL. 0/00	SP. COND	HNU	REMARKS
0	1	0'-2'	4-4	2'/1'		Concrete					0	
						Brown To Light Brown, Dry, Silty, Very Fine SAND, Little Fine To Coarse Sand	1'					
						Tip Of Spoon Thick Organic Material						
	2	2'-4'	4-5-5-5	2'/1'		Yellow To Yellow Brown, Damp, Fine SAND Some Medium To Coarse Sand, Little Silt	2'				0	
						Yellow-Brown Damp, Fine To Coarse SAND Little Silt	2'6"					
	3	4'-6'	7-8-12-14	2'/1'1"		Same, Very Moist	4'				0	
5						Light Gray, Wet, Fine To Medium SAND, Trace Of Coarse Sand	4'7"					
	4	6'-8'	6-12-12-4	2'-1'2"		Black, Wet, Medium To Coarse SAND, Little Fine Sand, Trace Of Silt, Odor	6'				0	
	5	8'-10'	3-4-6-10	2'/2'		Light Gray, Moist, Silty CLAY Of Low Plasticity, Little Fine To Coarse Sand	8'					
10	6	10'-12'				E.O.B. @ 10 fbg						
	7	12'-14'										
	1	14'-16'										
15												
	9	16'-18'										
	10	18'-20'										

BNMRC

O'BRIEN & GERE ENGINEERS, INC.	SOIL BORING LOG	LOG NUMBER: SB-3 SHEET 1 OF 1

CLIENT Reichold Chemical PROJECT LOCATION Ferndale, Michigan	GROUND WATER DATE DEPTH ELEVATION	FILE No.: 3208.035 DRILLING METHOD: Hollow Stem Auger SAMPLER TYPE: 2" Splitspoon HAMMER: 140 lbs FALL: 30"

O'BRIEN & GERE GEOLOGIST: Hugh G. Griffiths & Vernon C. Burrows
BORING CO.: Professional Services Ind.
FOREMAN: Mike Bond

BORING LOCATION:
GROUND ELEVATION: 645.98'
DATES: STARTED: 9/26/91 ENDED: 9/26/91

DEPTH	SAMPLE No.	SAMPLE DEPTH	BLOWS /6"	PENETRATION RECOVERY	"N" VALUE	SAMPLE DESCRIPTION	STRATUM CHANGE DEPTH	EQUIPMENT INSTALLED	FIELD TESTING SAL. 0/00	SP. COND	HNU	REMARKS
0	1	0'-2'				Concrete					0	
	2	2'-4'	7-4-5-6	2'/1'1"		Black, Damp, Silty, Fine SAND, Little Medium To Coarse Sand	2'				0	
	3	4'-6'	4-5-5-10	2'/1'7"		Brown-Gray, Moist, Fine To Coarse SAND, Little Silt	4'				0	
5												
	4	6'-8'	7-14-18-18	2'-2'		Gray, Very Moist To Wet, Fine To Coarse SAND Little Silt, Trace Of Clay, Odor	6'				0	
	5	8'-10'	5-8-11-13	2'/1'6"		Light Gray, Moist, Silty CLAY Of Low Plasticity Trace Of Fine To Coarse Sand	8'				0	
10	6	10'-12'	18-11-10-12	2'/1'4"		Light Gray, Moist, Silty, Clay, Of, Low To Medium Plasticity, Trace Gf Sand						
	7	12'-14'				E.O.B. @ 12 fbg						
	8	14'-16'										
15												
	9	16'-18'										
	10	18'-20'										

BMNRC1

O'BRIEN & GERE ENGINEERS, INC.	SOIL BORING LOG	LOG NUMBER: SB-4 SHEET 1 OF 1

CLIENT Reichold Chemical PROJECT LOCATION Ferndale, Michigan	GROUND WATER DATE DEPTH ELEVATION	FILE No.: 3208.035 DRILLING METHOD: Hollow Stem Auger SAMPLER TYPE: 2" Splitspoon HAMMER: 140 lbs FALL: 30"

O'BRIEN & GERE GEOLOGIST: Hugh G. Griffiths & Vernon C. Burrows
BORING CO.: Professional Services Ind.
FOREMAN: Mike Bond

BORING LOCATION:
GROUND ELEVATION: 645.05'
DATES: STARTED: 9/26/91 ENDED: 9/26/91

DEPTH	SAMPLE No.	SAMPLE DEPTH	BLOWS /6"	PENETRATION RECOVERY	"N" VALUE	SAMPLE DESCRIPTION	STRATUM CHANGE DEPTH	EQUIPMENT INSTALLED	FIELD TESTING SAL. 0/00	SP. COND	HNU	REMARKS
0	1	0'-2'	6-6-6	2'/1'		Concrete					0	
						Yellow-Brown, Damp, Fine To Coarse SAND, Little Silt, Trace Of Clay	6"					
	2	2'-4'	3-4-3-3	2'/1'6"		Yellow-Brown, Dry To Damp, Fine To Coarse SAND, Some Fine To Medium Gravel, Little Silt Strong Odor	2'				0	
	3	4'-6'	2-2-3-3	2'/1'4"		Brown-Black, Very Moist To Wet, Silty Fine To Coarse, SAND, Trace Of Gravel, Odor	4'				0	
5												
	4	6'-8'	5-11-11-6	2'-1'1"		Brown-Black, Very Moist To Wet, Silty Fine To Coarse, SAND, Little Fine To Medium Gravel, Very Srong Odor	6'				0	
	5	8'-10'	6-9-8-6	2'/1'7"		Black, Wet, Grading To Gray, Fine SAND Some Silt	8'					
						Silty, CLAY, Light Gray Of Low To Medium Plasticity, Trace Of Fine To Coarse Sand	8'6"					
10	6	10'-12'	9-8-12-16	2'/1'6"		Light To Dark Gray, Moist, Silty CLAY Of Low To Medium Plasticity, trace Of Fine To Coarse Sand	10'					
	7	12'-14'				E.O.B. @ 12 fbg						
	8	14'-16'										
15												
	9	16'-18'										
	10	18'-20'										

BMNRCI4

O'BRIEN & GERE ENGINEERS, INC.	SOIL BORING LOG	LOG NUMBER: SB-5 SHEET 1 OF 1

CLIENT Reichold Chemical PROJECT LOCATION Ferndale, Michigan	GROUND WATER DATE DEPTH ELEVATION	FILE No.: 3208.035 DRILLING METHOD: Hollow Stem Auger SAMPLER TYPE: 2" Splitspoon HAMMER: 140 lbs PALL: 30"

O'BRIEN & GERE GEOLOGIST: Hugh G. Griffiths & Vernon C. Burrows
BORING CO.: Professional Services Ind.
FGREMAN: Mike Bond

BORING LOCATION:
GROUND ELEVATION: 644.78'
DATES: STARTED: 9/26/91 ENDED: 9/26/91

DEPTH	SAMPLE No.	SAMPLE DEPTH	BLOWS /6"	PENETRATION RECOVERY	"N" VALUE	SAMPLE DESCRIPTION	STRATUM CHANGE DEPTH	EQUIPMENT INSTALLED	FIELD TESTING SAL. 0/00	SP. COND	HNU	REMARKS
0	1	0'-2'	6-6-3	2'/1'4"		Concrete					0	
						Light Brown To Black, Very Moist To Wet, Silty Fine To Medium Sand, Trace Of Coarse Sand, Very Strong Odor	7"					
	2	2'-4'	3-4-4-5	2'/1'8"		Gray-Black, Very Moist To Wet Silty Fine SAND, Trace Of Medium To Coarse Sand, Very Strong Odor	2'				0	
	3	4'-6'	2-3-5-14	2'/1'4"		Gray-Black To Black, Very Moist To Wet, Silty Fine To Medium SAND, Trace Coarse Sand, Strong Odor	4'				0	
5												
	4	6'-8'	9-20-11-7	2'-1'3"		Black, Wet, Silty Fine SAND, Some Medium Grained Sand, Strong Odor	6'				0	
	5	8'-10'	5-9-14-16	2'/1'5"		Gray-Brown, Moist, Silty CLAY, Of Low To Medium Plasticity, Some Fine To Coarse Sand, Trace of Fine To Medium Gravel	8'				0	
10	6	10'-12'				E.G.B. @ 10 fbg						
	7	12'-14'										
	8	14'-16'										
15												
	9	16'-18'										
	10	18'-20'										

BMNRC15

O'BRIEN & GERE ENGINEERS, INC.	SOIL BORING LOG	LOG NUMBER: SB-6
		SHEET 1 OF 1

CLIENT	GROUND WATER			
Reichold Chemical	DATE	DEPTH	ELEVATION	FILE No.: 3208.035
PROJECT LOCATION				DRILLING METHOD: Hollow Stem Auger
Ferndale, Michigan				SAMPLER TYPE: 2" Splitspoon
				HAMMER: 140 lbs FALL: 30"

O'BRIEN & GERE GEOLOGIST: Hugh G. Griffiths & Vernon C. Burrows
BORING CO.: Professional Services Ind.
FOREMAN: Mike Bond

BORING LOCATION:
GROUND ELEVATION: 644.30'
DATES: STARTED: 9/28/91 ENDED: 9/28/91

DEPTH	SAMPLE No.	SAMPLE DEPTH	BLOWS /6"	PENETRATION RECOVERY	"N" VALUE	SAMPLE DESCRIPTION	STRATUM CHANGE DEPTH	EQUIPMENT INSTALLED	FIELD TESTING SAL. 0/00	SP. COND	HNU	REMARKS
0	1	0'-2'	3-5-5	2'/1'1"		Concrete					0	
						Black, Damp, Silty Fine SAND	6"					
	2	2'-4'	4-3-3-4			Same, Very Moist	2'				0	
	3	4'-6'	1-4-9-28			Black, Wet, Fine To Coarse SAND, Some Silt	4'				13	
5												
	4	6'-8'	8-14-13-10			Black, Wet, Silty, Fine SAND, Gray Silty CLAY Of High Plasticity	6'				0	
	5	8'-10'	1-3-6-8			Light Gray, Moist, Sitly CLAY Of Medium To High Plasticity, Trace Of Fine To Coarse Sand	8'				0	
10	6	10'-12'				E.O.B. @ 10 fbg						
	7	12'-14'										
	8	14'-16'										
15												
	9	16'-18'										
	10	18'-20'										

O'BRIEN & GERE ENGINEERS, INC.	SOIL BORING LOG	LOG NUMBER: SB-7 SHEET 1 OF 1

CLIENT Reichold Chemical PROJECT LOCATION Ferndale, Michigan	GROUND WATER DATE DEPTH ELEVATION	FILE No.: 3208.035 DRILLING METHOD: Hollow Stem Auger SAMPLER TYPE: 2" Splitspoon HAMMER: 140 lbs FALL: 30"

O'BRIEN & GERE GEOLOGIST: Hugh G. Griffiths & Vernon C. Burrows
BORING CO.: Professional Services Ind.
FOREMAN: Mike Bond

BORING LOCATION:
GROUND ELEVATION: 644.76'
DATES: STARTED: 9/28/91 ENDED: 9/28/91

DEPTH	SAMPLE No.	SAMPLE DEPTH	BLOWS /6"	PENETRATION RECOVERY	"N" VALUE	SAMPLE DESCRIPTION	STRATUM CHANGE DEPTH	EQUIPMENT INSTALLED	FIELD TESTING SAL. 0/00	SP. COND	HNU	REMARKS
0	1	0'-2'	4-3-4	2'/1'		Concrete					0	
						Yellow-Brown, Damp, Silt Fine SAND, Little Medium Grained Sand, Trace Of Clay	6"					
	2	2'-4'	2-3-4-2	2'/1'4"		Yellow-Brown To Gray-Balck, Silty Fine To Medium SAND, Trace Of Coarse Sand, Trace of Clay	2'				0	
	3	4'-6'	2-1-1-.5	2'/1'1"		Gray-Black, Wet Silty Fine To Medium SAND, Little Coarse Sand, Trace Of Clay	4'				0	
5												
	4	6'-8'	9-13-18-12			Black, Wet, Silty, Fine To Medium SAND, Little Coarse Sand, Trace Of Clay	6'				0	
	5	8'-10'	3-5-8-12			Light Gray, Moist, Sitly CLAY Of Low To Medium Flasticity, Trace Of Fine To Coarse Sand	8'				0	
10	6	10'-12'				E.O.B. @ 10 fbg						
	7	12'-14'										
	8	14'-16'										
15												
	9	16'-18'										
	10	18'-20'										

BMNRCI7

O'BRIEN & GERE ENGINEERS, INC.	SOIL BORING LOG	LOG NUMBER: SB-8 SHEET 1 OF 1

CLIENT Reichold Chemical PROJECT LOCATION Ferndale, Michigan	GROUND WATER DATE DEPTH ELEVATION	FILE No.: 3208.035 DRILLING METHOD: Hollow Stem Auger SAMPLER TYPE: 2" Splitspoon HAMMER: 140 lbs FALL: 30"

O'BRIEN & GERE GEOLOGIST: Hugh O. Griffiths & Vernon C. Burrows
BORING CO.: Professional Services Ind.
FOREMAN: Mike Bond

BORING LOCATION:
GROUND ELEVATION: 645.36'
DATES: STARTED: 9/28/91 ENDED: 9/28/91

DEPTH	SAMPLE No.	SAMPLE DEPTH	BLOWS /6"	PENETRATION RECOVERY	"N" VALUE	SAMPLE DESCRIPTION	STRATUM CHANGE DEPTH	EQUIPMENT INSTALLED	FIELD TESTING SAL. 0/00	SP. COND	HNU	RMKS
0	1	0'-2'	6-6-4	2'/1'2"		Concrete					0	
						Black, Damp, Silty Fine SAND, Little Medium Grained Sand, Faint Odor	6"					
	2	2'-4'	5-5-4-4	2'/1'3"		Brown To Brown-Black, Silty Fine To Medium SAND, Little Coarse Sand, Odor	2'				0	
	3	4'-6'	3-3-7-12	2'/1'4"		Gray, Wet, Silty, Fine To Medium SAND, Little Coarse Sand, Odor Like Sewer	4'				0	
5												
	4	6'-8'	8-16-22-20	2'/1'5"		Gray To Light Gray, Wet, Fine To Coarse SAND Little Silt, Trace Of Clay, Odor Like Sewer	6'				0	
	5	8'-10'	11-12-8-12	2'/1'4"		Same	8'				0	
						Light Gray, Moist, Silty Clay Of Low To Medium Plasticity, Little Fine To Medium Sand Very Strong Odor Like Sewer	9'					
10	6	10'-12'				E.O.B. @ 10 fbg						
	7	12'-14'										
	8	14'-16'										
15												
	9	16'-18'										
	10	18'-20'										

BMNRC18

O'BRIEN & GERE ENGINEERS, INC.

TEST BORING LOG

Report of Boring Number: SB-9
Sheet 1 of 1 Date Completed: 9/22/92

Project Location: Ferndale, Michigan
Client: Reichhold Chemicals, Inc.

EQUIPMENT SPECIFICATIONS
Type: 2" Internal Diameter Split Barrel
Hammer: 140 Pounds Fall: 30"

GROUND WATER ELEVATION DATA (MSL)
Ground Water Elevation: Date:
Date:

Boring Co.: Industrial Waste Mgt., Inc.
Foreman:
OBG Geologist: Vernon C. Burrows

	Screen	Riser	Gravel Pack
Type			
Length			

Ground Surface Elevation:
Top of Casing Elevation:

Depth Below Grade	Sample No	Sample Depth (EL.)	Blows /6"	Penetr/ Recovry	"N" Value	Sample Description	Unified Soil Classif. System	Equipment Installed	Field Testing pH	Sp Cond	HNU ppm	Rmks*
0-2'	1		12	2'/1'	22	8" Concrete. Medium dense, light brown to brown-black, damp, silty fine SAND, grading at 1' into yellow silty fine sand - All fill material?					0	
			12									
			10									
			12									
2-4'	2		6	2'/15"	16	Medium dense, yellow-orange, damp to wet, silty fine to medium SAND.					0	
			8									
			8									
			10									
4-6'	3		8	2'/1'	22	Medium dense, yellow grading to light gray, wet, fine to medium SAND, little silt, trace coarse sand.					227	
			10									
			12									
			15									
6-8'	4		10	2'/8"	24	Medium dense, gray to black, wet, fine to coarse SAND, trace silt. Tip of spoon has light gray clay.					1257	
			12									
			12									
			15									
8-10'	5		10		24	Very stiff, light gray, silty CLAY of medium to high plasticity, little fine to medium sand					42	
			12									
			12									
			18									
						END OF BORING @ 10 FEET						

NOTE: HNU readings are headspace readings.

O'BRIEN & GERE ENGINEERS, INC.

TEST BORING LOG

Report of Boring Number: SB-10/P-1
Sheet 1 of 1 Date Completed: 9/22/92

ject Location: Ferndale, Michigan
ent: Reichhold Chemicals, Inc.

Boring Co.: Industrial Waste Mgt., Inc.
Foreman:
OBG Geologist: Vernon C. Burrows

EQUIPMENT SPECIFICATIONS
Type: 2" Internal Diameter Split Barrel
Hammer: 140 Pounds Fall: 30"

	Screen	Riser	Gravel Pack
Type 2" ID	Stainless	Stainless	Coarse Sand
Length	5 Feet	6.5 Feet	11.5 Feet

GROUND WATER ELEVATION DATA (MSL)

Ground Water Elevation: Date:
Date:

Ground Surface Elevation:
Top of Casing Elevation:

Depth Below Grade	Sample No	Sample Depth (EL.)	Blows /6"	Penetr/ Recovry	"N" Value	Sample Description	Unified Soil Classif. System	Equipment Installed	Field Testing pH	Sp Cond	HNU ppm	Rmks*
0-2'	1		8	2'/1'	20	8" Concrete. Medium dense, damp, light brown to gray-yellow, silty fine SAND, trace natural organics - All fill material?					41	
			10									
			10									
			15									
2-4'	2		6	2'/1'	16	Medium dense, wet, olive to yellow-green, silty fine to medium SAND.					0	
			8									
			8									
			10									
4-6'	3		6	2'/1.5'	14	Medium dense, wet, light gray to gray-black, medium SAND, little fine sand, trace coarse sand, trace silt.					19.6	
			6									
			8									
			8									
6-8'	4		6	2'/1'	16	Medium dense, wet, light gray to black, fine to coarse SAND, trace silt grading into a light gray clay. There is a black liquid layer above light gray CLAY of medium plasticity at approximately 7.5'.					403	
			8									
			8									
			10			Auger to depth.						
						SCREEN 11.5'-6.5' SAND 11.5'-4.5' PELLETS 4.5'-2.5' GROUT AND COMPLETE AS A FLUSH MOUNT END OF BORING AT 11.5 FEET						

NOTE: HNU readings are headspace readings.

O'BRIEN & GERE ENGINEERS, INC.

TEST BORING LOG

Report of Boring Number: SB-11
Sheet 1 of 1 Date Completed:9/22/92

ject Location: Ferndale, Michigan
ilient: Reichhold Chemicals, Inc.

EQUIPMENT SPECIFICATIONS
Type: 2" Internal Diameter Split Barrel
Hammer: 140 Pounds Fall: 30"

GROUND WATER ELEVATION DATA (MSL)
Ground Water Elevation: Date:
Date:

Boring Co.: Industrial Waste Mgt., Inc.
Foreman:
OBG Geologist: Vernon C. Burrows

	Screen	Riser	Gravel Pack
Type			
Length			

Ground Surface Elevation:
Top of Casing Elevation:

Depth Below Grade	Sample No	Sample Depth (EL.)	Blows /6"	Penetr/ Recovry	"N" Value	Sample Description	Unified Soil Classif. System	Equipment Installed	Field Testing pH	Sp Cond	HNU ppm	Rmks*
0-2'	1		6	2'/1.7'	16	6" Concrete. Medium dense, light brown to yellow brown with black mottling, damp, silty fine SAND, trace natural organics - All fill material?					0	
			8									
			8									
			10									
2-4'	2		2		6	Loose, yellow brown to brown, damp to wet, silty fine SAND, trace medium sand.					0	
			2									
			4									
			4									
4-6'	3		4		12	Medium dense, yellow brown grading to gray-black, wet, silty fine to coarse SAND.					0	
			6									
			6									
			8									
6-8'	4		6		16	Medium dense, dark gray to black, wet, silty fine to medium SAND, little coarse sand.					11.7	
			8									
			8									
			12									
8-10'	5		8		20	Very stiff, dark gray to black, wet, silty fine SAND grading at 8.2' into a light gray CLAY of high plasticity.					0	
			10									
			10									
			12									
						END OF BORING AT 10 FEET						

NOTE: HNU readings are headspace readings.

O'BRIEN & GERE ENGINEERS, INC.

TEST BORING LOG

Report of Boring Number: SB-12/P-2
Sheet 1 of 1 Date Completed: 9/22/92

ject Location: Ferndale, Michigan
..ient: Reichhold Chemicals, Inc.

Boring Co.: Industrial Waste Mgt., Inc.
Foreman:
OBG Geologist: Vernon C. Burrows

EQUIPMENT SPECIFICATIONS
Type: 2" Internal Diameter Split Barrel
Hammer: 140 Pounds Fall: 30"

	Screen	Riser	Gravel Pack
Type 2" ID	Stainless	Stainless	Coarse Sand
Length	5 Feet	6.5 Feet	11.5 Feet

GROUND WATER ELEVATION DATA (MSL)
Ground Water Elevation: Date:
Date:
Ground Surface Elevation:
Top of Casing Elevation:

Depth Below Grade	Sample No	Sample Depth (EL.)	Blows /6"	Penetr/ Recovry	"N" Value	Sample Description	Unified Soil Classif. System	Equipment Installed	Field Testing pH	Sp Cond	HNU ppm	Rmks*
0-2'	1		4		12	6" Concrete with rebar. Medium dense, light gray brown to yellow to black, damp, silty fine SAND - All fill material?		//			0	
			6					//				
			6					//				
			8					//				
2-4'	2		2		8	Loose, gray-black with black mottling damp to wet (?), silty fine to medium SAND, trace coarse sand, trace gravel.		oo			0	
			4					oo				
			4					oo				
			6					oo				
4-6'	3		2		6	Loose, SAME AS ABOVE.		oo			0	
			2					.				
			4					.				
			4					.				
6-8'	4		6		16	Medium dense, gray-black to black, wet, fine to medium SAND, little silt, trace coarse sand. At 7.5' light gray silty CLAY of high plasticity. There is an approx. 1" thick black liquid overlying the clay. Auger to depth.		.			172	
			8					.				
			8					.				
			10					.				
						SCREEN 11.5'-6.5' SAND 11.5'-4.5' PELLETS 4.5'-2.5' GROUT TO GRADE END OF BORING AT 8 FEET		.				

NOTE: HNU readings are headspace readings.

O'BRIEN & GERE ENGINEERS, INC.

TEST BORING LOG

Report of Boring Number: SB-13/P-3
Sheet 1 of 1 Date Completed:9/22/92

ject Location: Ferndale, Michigan
ient: Reichhold Chemicals, Inc.

Boring Co.: Industrial Waste Mgt., Inc.
Foreman:
OBG Geologist: Vernon C. Burrows

EQUIPMENT SPECIFICATIONS
Type: 2" Internal Diameter Split Barrel
Hammer: 140 Pounds Fall: 30"

	Screen	Riser	Gravel Pack
Type 2" ID	Stainless	Stainless	Coarse Sand
Length	5 Feet	6.5 Feet	11.5 Feet

GROUND WATER ELEVATION DATA (MSL)

Ground Water Elevation: Date:
Date:

Ground Surface Elevation:
Top of Casing Elevation:

Depth Below Grade	Sample No	Sample Depth (EL.)	Blows /6"	Penetr/ Recovry	"N" Value	Sample Description	Unified Soil Classif. System	Equipment Installed	Field Testing pH	Sp Cond	HNU ppm	Rmks*
0-2'	1		6	2'/1.5'	16	6" Concrete. Medium dense, black, moist to wet, silty fine SAND, little medium sand.					682	
			8									
			8									
			2									
2-4'	2		1	2'/0.5'	2	Very loose, black, wet, silty fine to medium SAND, trace coarse sand, trace fine gravel.					110D	
			1									
			1			LEVEL C CALLED						
			1									
4-6'	3		1	2'/2'	2	SAME AS ABOVE, very black liquid layer present from 4' to 4'-4".					2785	
			1									
			1									
			1									
6-8'	4		1	2'/	3	SAME AS ABOVE, grading into a light gray CLAY of high plasticity at 7.4' below grade.					834	
			1									
			2			Auger to depth.						
			12									
						SCREEN 11.5'-6.5'						
						SAND 11.5'-4.5'						
						PELLETS 4.5'-2.5'						
						GROUT AND COMPLETE AS FLUSH MOUNT						
						END OF BORING AT 11.5 FEET						

NOTE: HNU readings are headspace readings.

O'BRIEN & GERE ENGINEERS, INC.

TEST BORING LOG

Report of Boring Number: SB-14
Sheet 1 of 1 Date Completed: 9/22/92

Project Location: Ferndale, Michigan
Client: Reichhold Chemicals, Inc.

EQUIPMENT SPECIFICATIONS
Type: 2" Internal Diameter Split Barrel
Hammer: 140 Pounds Fall: 30"

GROUND WATER ELEVATION DATA (MSL)
Ground Water Elevation: Date:
Date:

Boring Co.: Industrial Waste Mgt., Inc.
Foreman:
OBG Geologist: Vernon C. Burrows

	Screen	Riser	Gravel Pack
Type			
Length			

Ground Surface Elevation:
Top of Casing Elevation:

Depth Below Grade	Sample No	Sample Depth (EL.)	Blows /6"	Penetr/ Recovry	"N" Value	Sample Description	Unified Soil Classif. System	Equipment Installed	Field Testing pH	Sp Cond	HNU ppm	Rmks*
D-2'	1		2	18"/24"	6	6" Concrete. Loose, brown olive green, dry medium SAND (Black staining 0-6").					117	
			2									
			4									
			2									
2-4'	2		2		6	Loose, black, wet, fine to medium SAND, little silt, green mottling throughout.					329	
			2									
			4									
			1									
4-6'	3		1		2	Very loose, black, wet, silty fine to medium SAND, grading at 5.6' into a gray, silty CLAY of high plasticity.					185	
			1									
			1									
			4									
						END OF BORING AT 6 FEET						

NOTE: HNU readings are headspace readings.

O'BRIEN & GERE ENGINEERS, INC.

TEST BORING LOG

Report of Boring Number: SB-15
Sheet 1 of 1 Date Completed: 9/23/92

Project Location: Ferndale, Michigan
Client: Reichhold Chemicals, Inc.

EQUIPMENT SPECIFICATIONS
Type: 2" Internal Diameter Split Barrel
Hammer: 140 Pounds Fall: 30"

GROUND WATER ELEVATION DATA (MSL)
Ground Water Elevation: Date:
Date:

Boring Co.: Industrial Waste Mgt., Inc.
Foreman:
OBG Geologist: Vernon C. Burrows

	Screen	Riser	Gravel Pack
Type			
Length			

Ground Surface Elevation:
Top of Casing Elevation:

Depth Below Grade	Sample No	Sample Depth (EL.)	Blows /6"	Penetr/ Recovry	"N" Value	Sample Description	Unified Soil Classif. System	Equipment Installed	Field Testing pH	Sp Cond	HNU ppm	Rmks*
0-2'	1		3	2'/1.7'	7	Loose, black grading into a dark yellow brown, very moist to wet, silty fine SAND, trace fine gravel.					5.7	
			3									
			4									
			4									
2-4'	2		4	2'/1.5'	12	Medium dense, yellow brown, wet, silty fine SAND, trace medium sand.					6.1	
			6									
			6									
			10									
4-6'	3		4	2'/0.9'	12	Medium dense, light to medium gray, silty fine to medium SAND, trace coarse sand.					53.7	
			6									
			6									
			8									
6-8'	4		6	2'/1.1'	16	Medium dense, light to medium gray, wet, silty fine to coarse SAND, trace fine gravel, grading at 7.2' into a light to dark gray silty CLAY of high plasticity.					26.7	
			8									
			8									
			12									
						END OF BORING AT 8 FEET						

NOTE: HNU readings are headspace readings.

O'BRIEN & GERE ENGINEERS, INC.

TEST BORING LOG

Report of Boring Number: Recovery Well #1
Sheet 1 of 1 Date Completed: 9/23/92

Project Location: Ferndale, Michigan
Client: Reichhold Chemicals, Inc.

Boring Co.: Industrial Waste Mgt., Inc.
Foreman:
OBG Geologist: Vernon C. Burrows

EQUIPMENT SPECIFICATIONS
Type: 2" Internal Diameter Split Barrel
Hammer: 140 Pounds Fall: 30"

	Screen	Riser	Gravel Pack
Type 6" ID	Stainless	Stainless	Coarse Sand
Length	5 Feet	7 Feet	12 Feet

GROUND WATER ELEVATION DATA (MSL)
Ground Water Elevation: Date:
Date:
Ground Surface Elevation:
Top of Casing Elevation:

Depth Below Grade	Sample No	Sample Depth (EL.)	Blows /6"	Penetr/ Recovry	"N" Value	Sample Description	Unified Soil Classif. System	Equipment Installed	Field Testing pH	Sp Cond	HNU ppm	Rmks*
0-2'	1		8	2'/1.7'	20	Medium dense, light gray to gray black, damp, silty fine SAND, trace medium sand, trace fine.					33.7	
			10									
			10									
			12									
2-4'	2		6	2'/1.6'	18	Medium dense, olive green to green gray, moist to wet, silty fine SAND, little medium sand.					39.5	
			8									
			10									
			10									
4-6'	3		3	2'/10'	13	Medium dense, olive green grading to gray to gray black, wet silty fine to medium SAND, trace coarse sand.					67.5	
			3									
			10									
			15									
6-8'	4		8	2'/0.9'	20	Medium dense, gray-black to black, wet, silty fine to medium SAND, trace coarse sand.					2206	
			10									
			10									
			15									
8-10'	5		8	2'/1.8'	25	Medium dense, SAME AS ABOVE, grading at 8.3' into a medium to dark gray, silty CLAY of high plasticity					2450	
			10									
			15									
			15									
10-12'	6		10	2'/1'	24	Very stiff, light to dark gray, moist, silty CLAY of medium to high plasticity.					948	
			12									
			12									
			15									
						SCREEN 12'-7' SAND 12'-5' PELLETS 5'-3' GROUT IN STICK-UP WELL TO +3' ABOVE GROUND SURFACE						

NOTE: HNU readings are headspace readings.

APPENDIX A

MID 020087128

RCRA Facility Investigation
Description of Current Conditions

Ferndale, Michigan

Reichhold Chemicals, Inc.
Research Triangle Park, North Carolina

January 1995

O'BRIEN & GERE
ENGINEERS, INC.

DESCRIPTION OF CURRENT CONDITIONS

3208.076

Final Report

RCRA Facility Investigation Description of Current Conditions Reichhold Chemicals, Inc. Ferndale, Michigan

Reichhold Chemicals, Inc.
Research Triangle Park, North Carolina

Prepared by:

Richard P. Cawley, C.P.G.
Managing Hydrogeologist

Vernon C. Burrows
Sr. Project Hydrogeologist

Christopher Rook
Design Hydrogeologist

Submitted by:

Donald E. Stone, Jr., P.E.
Vice President

January 1995

O'BRIEN & GERE ENGINEERS, INC.

Raritan Plaza 1
Edison, New Jersey 08837

Contents

1. Introduction 1-1

1.1 Objectives and Scope 1-1

1.2 Site History and Background 1-2

1.3. Hydrogeologic Setting 1-2
- 1.3.1. Site Topography and Drainage 1-2
- 1.3.2. Current and Potential Ground Water Use 1-3
- 1.3.3. Regional Geology and Hydrogeology 1-3
- 1.3.4. Site Hydrogeology 1-4

1.4. Environmental Setting 1-7
- 1.4.1. Meteorology 1-7
- 1.4.2. Definition of Impacted Ground Water 1-7

2. Nature and Extent of Contamination 2-1

2.1. Process Description 2-1

2.2. Summary of Previous Investigations 2-1
- 2.2.1. Introduction 2-1
- 2.2.2. Summary of Phase I Investigation 2-2
- 2.2.3. Summary of Phase II Investigation 2-5
- 2.2.4. Data Presentation 2-9

2.3. RCRA Facility Assessment 2-19

2.4. Recommended Investigations 2-19

3. Interim Corrective Measures 3-1

3.1. General 3-1

3.2. Current Interim Measures 3-1
- 3.2.1. Interim Measure No. 1. 3-1
- 3.2.2. Interim Measure No. 2 3-2
- 3.2.3. Interim Measure No. 3. 3-2

4. Pre-Investigation Evaluation of Corrective Measures Technologies 4-1

4.1. Introduction 4-1

4.2. Soils Technology Screening 4-1
4.2.1. Soil Remediation Technology Evaluation 4-1
4.2.2. Soil Treatment Evaluation Summary and Recommendations 4-6

4.3. Evaluation Strategies for Hydraulic Control of Ground Water 4-6
4.3.1. Ground Water Containment/Cutoff Wall 4-7
4.3.2. Ground Water Collection, Treatment, and Discharge 4-10
4.3.3. Evaluation Summary and Recommendations . 4-15

Tables

1 Hydrogeological Data
2 Soil Metals Analytical Results
3 Soil Volatile Organic Compounds (VOCs)
4 Soil Semi-Volatile Organic (SVOCs)
5 Soil Polychlorinated Biphenols (PCBs)
6 Ground Water - September 1991 Metals Analytical Results
7 Ground Water - December 1991 Metals Analytical Results
8 Ground Water - September 1991 VOCs Analytical Results
9 Ground Water - December 1991 VOCs Analytical Results
10 Ground Water - September 1991 SVOCs Analytical Results
11 Ground Water - December 1991 SVOCs Analytical Results
12 Ground Water - December 1991 PCBs Analytical Results
13 Ground Water Analytical Summary
14 Solid Waste Management Units
15 Summary Evaluation Matrix
16 Soil Data Requirements
17 Summary of Hydraulic Control Options

Figures

1	Site Location Map
2	Site Map
3	Utilities Map
4	North-South Geological Cross-Section
5	Ground Water Contour Map - July 26, 1991
6	Ground Water Contour Map - August 2, 1991
7	Ground Water Contour Map - October 29, 1991
8	Top of Clay Elevation Contour Map
8A	Wind Rose Diagram
9	South Section Soil Sample Locations
10	Phase I Monitoring Wells
11	North Half of East Section Contour of Soil Gas Vapor Results
12	South Half of East Section Contour of Soil Gas Vapor Results
13	North Half of West Section Contour of Soil Gas Vapor Results
14	South Half of West Section Contour of Soil Gas Vapor Results
15	South Section Contour Soil Gas Vapor Results
16	Location of 10,000 Underground Storage Tanks
17	Monitoring Well System Layout
18	East Area Plan Soil Analytical Results
19	East Area Plan Ground Water Analytical Results
20	West Area Plan Soil Analytical Results
21	West Area Plan Ground Water Analytical Results
22	South Area Plan Soil Analytical Results
23	South Area Plan Ground Water Analytical Results
24	South Area SWMUs with Proposed Sampling Locations
25	West Area SWMUs with Proposed Sampling Locations

26. East Area SWMUs with Proposed Sampling Locations

27 In-Situ Air Stripping System

References

1. A Compendium of Technologies Used in the treatment of Hazardous Wastes EPA/625/8-87/014, September 1987.
2. A Technology Assessment of Soil Vapor Extraction and Air Sparging EPA/600/R-92/1/3, September 1993.
3. Closure Plan and Closure Cost Estimate - Hazardous Waste Drum and Tank Storage Areas, Reichhold Chemicals, Inc., Ferndale, Michigan, IT Corporation, January 1989.
4. Environmental Assessment Work Plan, Reichhold Chemicals, Inc., Ferndale, Michigan, IT Corporation, August 1989.
5. Fetter, C.W., Applied Hydrogeology, New York: MacMillan Publishing Company, 1988, 592pp.
6. Handbook on In-Situ Treatment of Hazardous Waste-Contaminated Soils EPA/540/2-90/002, January 1990
7. Interim Report Environmental Assessment, Reichhold Chemicals, Inc., Ferndale, Michigan, IT Corporation, August 1990.
8. Mozola, A.J., A Survey of the Ground Water Resources in Oakland County, Michigan. State of Michigan Department of Natural Resources, Geological Survey, 1954.
11. Phase I Environmental Assessment, Reichhold Chemicals, Inc., Ferndale, Michigan, IT Corporation, February 1989.
12. Soil Gas Survey Report - South Tank Farm Area, Ferndale, Michigan Facility, IT Corporation, August 1990.
13. Technology Screening Guide for Treatment of CERCLA Soils and Sludges EPA/540/2-88/004, September 1988
14. The Superfund Innovative Technology Evaluation Program: Technology Profiles EPA/540/5-90/006, November 1990
15. Underground Gasoline Tank Closure, Reichhold Chemicals, Inc., Ferndale, Michigan, IT Corporation, March 1990.

Attachments

1 Environmental Assessment Work Plan

2 Monitoring Well Construction Diagrams

3 Ground Penetrating Radar (GPR) Report

1. Introduction

1.1. Objectives and Scope

Reichhold Chemicals, Inc. (RCI) is currently undertaking a Corrective Action Program at its former Ferndale, Michigan facility (see Figure 1) to evaluate the nature and extent of releases of hazardous waste constituents from solid waste management units (SWMUs), and to identify, develop and implement appropriate corrective measures to adequately protect human health and the environment.

The Corrective Action Program as indicated by the USEPA Guidance Document entitled "RCRA Corrective Action Plan - Interim Final," June 1988, is developed in three phases; the RCRA Facility Investigation (RFI); Corrective Measures Study (CMS); and Corrective Measures Implementation (CMI). At this time, RCI is proceeding with the initial phases of an RFI.

The scope for this portion of the RFI consists of three tasks:

Task 1 - Description of Current Conditions

A. Facility Background
B. Nature and Extent of Release
C. Implementation of Interim Measures

Task 2 - Pre-Investigation Evaluation of Corrective Measures Technologies

Task 3 - RFI Work Plan Requirements

A. Project Management Plan
B. Quality Assurance Plan
C. Data Management Plan
D. Health and Safety Plan
E. Community Relations Plan

This document, the Description of Current Conditions, has been developed to provide background information pertinent to the facility, nature and extent of releases and interim measures which were or are being undertaken at the facility. This document includes summaries of previous investigations and relevant data, descriptions of solid waste management units, assessment of documented or potential releases to the environment and recommendations for further investigations.

1.2. Site History and Background

In 1927 synthetic resin and polymer production began in the West Area of the facility. At the beginning of World War II, the present day East Area of the plant was developed by the Defense Plant Corporation and used primarily to manufacture phthalic anhydride. The buildings within the East Area were constructed in their present numerical order. At the termination of the war, RCI assumed control of the East Area of the plant. In the early 1950's, a lumber business within what is now referred to as the South Area was destroyed by fire. RCI purchased and subsequently developed the South Area, utilizing the yard primarily for the storage of finished goods. Figure 2 identifies the locations of each of the separate areas which comprise the facility. A utilities map is provided as Figure 3. The plant manufactured synthetic resins and polymers including phenolic, alkyd and epoxy resins, capped, styrene and polyester polymers; phthalic anhydride; and distilled glycerin prior to operations termination in 1989. A more detailed description of former site activities is provided in Section 2 of the August 1989 report provided as an Appendix to the RFI work plan. A U.S. Geological Survey site location map has been provided on Figure 1.

1.3. Hydrogeologic Setting

1.3.1. Site Topography and Drainage

The site and the area surrounding the site show minimal topographic relief. Ground level elevations throughout the site vary approximately two feet. No significant unpaved areas are present at the site, with the exception of the railroad track network. Drainage from the site does not contact surface water; the nearest surface water body is approximately one mile from the site. The Federal Emergency Management Agency (FEMA) has issued a publication entitled "National Flood Insurance Community Status Book" which identified the status of Ferndale, Michigan as a "No Special Flood Hazard Area (NSFHA)". The publication further states that Ferndale is not a flood prone community. According to the Ferndale City Engineers Department, the site is not within a 100-year flood plain. Wetland areas have not been identified within a one mile radius of the RCI properties.

1.3.2. Current and Potential Ground Water Usage

Ground water at the site is encountered as an incidental perched saturated zone approximately 1.5 to 4.0 feet below ground surface within a 4 to 10.5 foot thick silty sand layer which mantles a silty clay to clay aquiclude. Both the silty sand layer, and the underlying silty clay are present throughout the entire site. The silty clay is believed to be over 100 feet thick. Water derived from confined or partially confined aquifers have been used for municipal and commercial usage. The cities of Royal Oak and Berkeley are known to have derived municipal water supplies from confined aquifers of this region in that past, but are presently part of the City of Detroit water system. The Oakland County Health Department also indicates that current municipal and industrial water requirements are supplied by the City of Detroit water supply system.

1.3.3. Regional Geology and Hydrogeology

The Ferndale - Pleasant Ridge area is located within the glacial lake plain region of southeastern Michigan. The regional surface geology of the area consists of unconsolidated sediments of predominantly glaciolacustrine origin deposited during retreat of the glacial Great lakes at the end of the last period of continental glaciation (Wisconsinan). The unconsolidated deposits range in thickness from approximately 100 to 250 feet and can be characterized as a surface veneer of medium to fine sand of former beach, littoral, and deltaic deposits underlain by extensive lacustrine silt and clay. The clay unit is thick and is under the entire site. This confining layer serves as a barrier for the downward migration of surface water. A stratigraphic cross section is provided as Figure 4. Undifferentiated sediments of water-laid interlobate moraine deposit are also observed. Intercalated sand and gravel deposits have been observed regionally within the lacustrine silt and clay and are attributed to the complex history of glacial advances/retreats and lake level fluctuations. These unconsolidated sediments are underlain by shale of the Antrim Formation (Upper Devonian) which apparently occurred as a buried, preglacial valley cut into the bedrock surface (Mozola, 1954).

Ground water in the glacial lake plain area is observed within the unconsolidated deposits and underlying bedrock. Attempts to develop water supplies from the bedrock have been insignificant in comparison to that derived from the unconsolidated sediments.

A shallow unconfined (water table) saturated zone is typically observed in the veneer of sand and gravel perched above the lacustrine clay deposits. This zone varies widely in saturated thickness and is laterally discontinuous. Ground water under confined or partially confined conditions is encountered within seams, lenses, beds, and pockets of sand and gravel found buried in the lacustrine clay. These units are irregular in distribution and vary widely in dimension with the largest observed deposits occurring within buried valleys of the underlying bedrock. Recharge to the buried aquifers is principally achieved by a complex network of interconnections linked to the outwash and moraine deposits to the northwest. In the unconsolidated deposits, generally two water bearing zones are observed (Mozola, 1954).

Historically, water supplies have been derived from the water table and confined aquifers in the region. In general the supplies derived from the water table aquifers have been on a limited, domestic basis. In addition to individual domestic supplies, water derived from the confined and partially confined aquifers have been used for municipal and commercial usage. The cities of Royal Oak and Berkeley, cities adjacent to Ferndale, are known to have derived municipal water supplies from confined aquifers of this region in the past but are presently a part of the City of Detroit water system. The Oakland County Health Department had no record on file of water wells existing within a one mile radius of the RCI properties, with the exception of those wells present at the site.

1.3.4. Site Hydrogeology

Occurrence of Ground Water Ground water at the site occurs as a perched water table overlying the clay unit. The clay unit is over 100 feet in thickness and is present under the entire site. The thickness of the water bearing sediments above the clay unit will is subject to seasonal variations with saturated thickness having ranged from 0 to 6.94 feet. No ground water was encountered in the semipermeable clay zone into which deep borings were advanced for past site investigations.

Aquifer Characterization Subsequent to the completion of the monitoring well installation program described in Section 2.2.2., the hydraulic properties of the water bearing sediments were investigated. Aquifer characterization focused on evaluating the direction and the rate of ground water flow beneath the site. This was accomplished by collecting ground water elevation

data from each on-site monitoring well, and by calculating the hydraulic conductivity of the saturated soils.

Nine undisturbed samples were retrieved from the clay unit and submitted to a laboratory for falling head permeability testing to calculate the vertical permeability. The results of the laboratory analyses indicate a vertical permeability range of 1.4 x 10^{-9} ft/sec to 2.8 x 10^{-9} ft/sec. The low vertical permeability values support the inference that the clay layer retards the vertical migration of ground water, resulting in the perched ground water table presently observed above the clay unit.

Ground Water Flow Direction Ground water level data was collected from the on-site monitoring wells and elevations were calculated based upon USNGVD data. Ground water elevation data are summarized on Table 1. The ground water elevation maps generated are presented as Figures 5, 6 and 7. These contour maps illustrate the elevation and flow conditions observed on July 26, August 2 and October 3, 1991, respectively.

The three data sets illustrate that the overall direction of ground water flow at the site is to the east and west from the railroad tracks. The railroad network appears to be the major source of ground water recharge within the plant area. Most of the site is covered with either pavement or buildings with an efficient functioning surface water drainage network. This indicates that surface water would not infiltrate rapidly within the plant area. Therefore, preferential recharge would occur in the unpaved railroad track area. Ground water elevations within the central portion of the site are relatively high. The underlying clay unit is also topographically high within this area. A top of clay elevation contour map which supports this idea has been presented on Figure 8. The railroad network and the underlying topography of the clay unit appear to create a ground water divide, effectively separating the east and west areas of the plant.

In-Situ Hydraulic Conductivity Testing In-situ hydraulic conductivity testing was undertaken at each monitoring well to calculate the hydraulic conductivity of the saturated sediments overlying the clay unit. This was accomplished by evacuating a well to dryness, thus creating a potential head difference between the water in the well and the surrounding formation. The2009Xresponse to this hydraulic head differential was measured over time using

a water level indicator probe. This allowed hydraulic conductivity to be calculated. The evaluation of the hydraulic conductivity also allowed for the computation of the linear ground water flow velocity utilizing Darcy's law. For example, the calculated hydraulic conductivity of the silty-sand sediments for the site ranged from 1.9×10^{-8} ft/sec to 1.3×10^{-5} ft/sec. These sediments directly overlie the semipermeable lower clay unit.

Ground Water Flow Velocity The ground water flow velocity was calculated by the following equationwhich was derived from a combination of Darcy's Law and the standard continuity equation of hydraulics:

$$Vgw = KI/$$

where,

Vgw =	ground water flow velocity
K =	hydraulic conductivity
I =	hydraulic gradient
n =	porosity of saturated subsurface material

The above equation illustrates that the actual rate of ground water flow is proportional to the hydraulic gradient. In situ hydraulic conductivity testing indicates a range of hydraulic conductivity from 1.9×10^{-8} ft/sec to 1.3×10^{-5} ft/sec at the site; with an average conductivity of 1.7×10^{-6} ft/sec.

Calculations based on hydraulic conductivity and hydraulic gradients found at the Site indicate that water in the perched water table moves at different rates depending on location. An estimated porosity of 30% was utilized in the above equation, based on the grain size distribution of the water bearing sediments. A range of velocities was calculated and presented.

The maximum hydraulic gradient, calculated between wells MW-20 and MW-14, was .05 ft/ft. The highest hydraulic conductivity value was 1.3×10^{-5} ft/sec. The maximum ground water flow velocity was calculated to be 2.2×10^{-6} ft/sec, or 68 ft/yr.

The minimum ground water flow velocity was calculated using the average hydraulic conductivity of 1.7×10^{-6} ft/sec. The minimum hydraulic gradient, calculated from MW-6 to MW-21,

was .003 ft/ft. The minimum ground water flow velocity was calculated to be 1.7 x 10^{-7} ft/sec, or 0.5 ft/yr.

1.4. Environmental Setting

1.4.1. Meteorology

The RCI site is located in metropolitan Detroit, in the southeastern portion of Michigan. The climate of this area is characterized by moderate extremes of heat/cold and wetness/dryness. Normal average temperature over a calendar year is 49°F. Winters are moderately cold with an average temperature of about 29.3°F, with occasional subzero temperatures. Summers are warm with an average temperature of almost 70°F, but rarely exceed 100°F. The average temperatures of the spring and the fall are 57.3° and 41°F, respectively. A wind rose diagram is provided as Figure 8A.

Annual precipitation for the region is 31.1 inches. May and June represent the wettest months, with an average rainfall of 3.2 inches each month. The lowest average monthly precipitation of 2 inches occurs in January.

1.4.2. Definition of Impacted Ground Water

Within regulation R299.51019 (c) of P.A. 307, an aquifer is defined as "a geological formation, group of formations, or part of a formation capable of yielding a significant amount of ground water to wells or springs." Hydraulic properties of the unconfined saturated zone at the site do not indicate the ability to yield significant amounts of ground water to wells or springs. This zone has no potable, industrial, or irrigation use potential. Since no "aquifer" exists at the facility, ground water will be addressed by the application of the Type B Soil Criteria as specified in Act 307 Rule 299.5709(4). As such, the term "impacted ground water" refers only to ground water that exhibits concentrations of regulated compounds above Type B Soil Criteria.

2. Nature and Extent of Contamination

2.1. Process Description

During the period beginning in 1927 and ending in December, 1988, RCI used the Ferndale plant site for the production of synthetic resins and polymers. Specific classes of products manufactured at the site included:

- Alkyd resins;
- Epoxy ester resins;
- Polyester resins;
- Phenol-formaldehyde resins;
- Urea formaldehyde resins;
- Melamine formaldehyde resins;
- Styrenated alkyd resins; and
- Polyurethane resins.

Waste streams generated included over age or off-specification products, wastewater, and accidental spillage during transfer of raw materials and products.

2.2. Summary of Previous Investigations

2.2.1. Introduction

Following termination of the manufacturing operation in March 1989, RCI performed a series of investigations at the Ferndale site. These investigations were performed from September 1989 through September, 1992 to include two separate, comprehensive sampling programs. The Phase I investigation, performed in September, 1989, included soil boring and monitoring well installations, and a soil-gas vapor survey along the east/west area as well as the South Tank Farm Area. A decontamination and decommissioning program was conducted in 1990. The Phase II study which was conducted from June 1991 to December 1991, included the installation of additional shallow monitoring wells, a soil boring program, a Ground Penetrating Radar (GPR) survey, and two rounds of monitoring well sample collection. Delineation soil borings were installed around MW-9 in September, 1991 and September, 1992. The following summarizes the previous work which was performed including monitoring well depths and construction details, significant soil and monitoring well data, and the results of the October, 1991 GPR Survey.

2.2.2. Summary of Phase I Investigation

An Environmental Assessment Work Plan was prepared by RCI and submitted to the MDNR on August 2, 1989 (Attachment 1). This work plan presented the results of the initial site characterization and provided a soil and ground water program based upon the chemical manufacturing and storage practices historically conducted at the facility. The Phase I investigation consisted of a limited soil boring program, a monitoring well installation program, and a soil-gas vapor survey.

South Section Soil Sampling Program A total of seven soil sample locations were selected in and around the aboveground South Tank Farm area (Figure 9). Of these seven locations, five were outside and two were inside the aboveground tank farm area. Fourteen soil samples (2 per location) were collected from the 0-1' and 3.5-4.0' depth intervals below grade and were submitted for total petroleum hydrocarbons (TPH), oil and grease, and VOC analyses.

The soil samples collected from soil borings SSB-1, SSB-6, and SSB-7 within the aboveground tank farm showed concentrations of VOC's. Soil borings SSB-6 and SSB-7 were located within the tank farm. Soil boring SSB-1, which also showed significant VOC concentration was located approximately 15 feet from MW-5. Analytes identified included ethylbenzene, xylene, methylene chloride, and acetone. The remaining soil borings, SSB-2, SSB-3, SSB-4 and SSB-5 were located 10 to 60 feet south of the tank farm. Only trace concentrations of total xylenes were detected in soil borings SSB-4 and SSB-5. The distribution of the VOC's in the soil and the detection of VOC's in the monitoring wells supports the conclusion that the aboveground tank farm was the source of releases in this area. Oil and grease were detected at varying concentrations in the soil samples collected from the South Section, with the highest concentrations detected at soil borings SSB-1, SSB-6, and SSB-7. TPH detected in the soil samples from soil borings SSB-1, SSB-6 and SSB-7 ranged in concentration from 91 to 1100 mg/kg. The results of this analytical program indicated the occurrence of VOC's, TPH, and oil and grease in and immediately adjacent to the aboveground tank farm. A detailed presentation of this study was provided within the "Interim Report Environmental Assessment", November 1989.

Monitoring Well Installation Program Five shallow ground water monitoring wells were installed during September, 1989. The wells were strategically located throughout the facility to gain a preliminary understanding of the site geological conditions, ground water quality, and ground water occurrence (Figure 10). The wells were constructed to monitor the first encountered water table. Ground water samples were submitted for TPH, oil and grease, SVOCs, and VOCs. Of the Phase I monitoring wells, two wells were located in the East Section, designated MW-1 and MW-4. The ground water analytical data for MW-1 and MW-4 indicated the presence of VOC's. Oil and grease were also detected in samples from these two wells. The West Section contained one Phase I well MW-2. Analytical results indicated the presence of certain VOCs and SVOCs in MW-2, also contained measurable levels of oil and grease and TPH.

Two Phase I monitoring wells were located in the South Section of the site, designated as MW-3 and MW-5. The highest concentration of VOC's were detected at MW-5. The primary constituents detected at this location included acetone, ethylbenzene, and total xylenes. The concentrations detected at MW-5 were consistent with the compounds detected in the soil in this area, indicating that the aboveground tank farm was the source of these compounds. MW-3 was located adjacent to the warehouse in the southeast corner of the South Section of the site. VOCs and SVOCs were not detected above the method detection limits in the ground water sample from this location. Oil and grease and TPH were detected with concentrations of 1.6 mg/l and 0.3 mg/l, respectively. A detailed presentation of this study was provided within the "Interim Report Environmental Assessment", November 1989.

Soil Gas Vapor Survey A soil gas vapor survey was utilized to provide a qualitative estimate of VOC concentrations within soils. The survey was undertaken in the East and West areas of the site as well as within the South Section Tank Farm. VOC concentrations for these areas have been diagrammed on Figures 11, 12, 13, and 14. The results were used to bias the locations of soil borings and monitoring wells.

The soil gas vapor survey was initiated in September, 1989 in the East and West Sections of the site. Before conducting this survey, a 50 foot by 50 foot sampling grid was established. Sampling activities were conducted at the grid intersections,

where possible. Adjustments to the 50 foot grid spacing were noted and incorporated onto the sampling grid map. Additional sampling points were established as the survey progressed to refine the grid in areas where additional characterization was warranted. There were 219 readings collected from the East Section and 128 readings taken from the West Section for a total of 347 readings.

As a result of the soil sampling program described above, a soil gas vapor survey was conducted in July, 1990 in the tank farm portion of the South Section. A five foot by five foot sampling grid was established within this area with the intent of gaining an understanding of the distribution of VOC's. Sampling activities were conducted at the grid intersections, where possible. Adjustments to the five foot grid spacing were noted and incorporated onto the sampling grid map. Following the initiation of the soil-gas vapor survey, additional sampling points were established to refine the grid in areas where additional characterization was warranted. There were 138 locations sampled during the soil-gas vapor survey in this area.

East Section Soil-Gas Vapor Survey Results The soil-gas vapor survey in the East Section indicated that there were isolated areas where elevated concentrations of total VOC's were detected. The highest concentration of total VOC's were detected along the railroad siding adjacent to and west of the aboveground tank farm with concentrations of greater than 2000 ppm detected in this area. VOC's were detected within the aboveground tank farms in the northern end of the East Section, and in the truck parking area north of the aboveground tank farms.

West Section Soil-Gas Vapor Survey Results The soil-gas vapor survey in the West Section of the site has identified several areas where elevated concentrations of VOC's were detected. The major area of elevated total VOC concentrations was adjacent to the western side of the truck loading and cleaning area. Elevated concentrations were also detected northwest of Building D Annex and along the railroad tracks adjacent to Building N and extending south to C Dock. The highest readings were collected north of Building K, with VOC concentrations exceeding 2000 ppm. Total VOC's were also detected in other areas of the West Section in lower concentrations and in isolated areas.

South Section Soil-Gas Vapor Survey Results The soil-gas vapor survey in the South Section of the site indicated that the area in the northern portion of the South Section, which includes the south tank farm, demonstrated elevated concentrations of total VOC's. The highest concentrations of VOC's were detected to in the tank farm and to the southwest of the tank farm with concentrations exceeding 10,000 ppm in this area. Figure 15 provides isoconcentration contours for the south tank farm area based on the soil-gas vapor survey.

Underground Storage Tank Closure On September 5, 1989 one 10,000 gallon gasoline underground storage tank (UST) was excavated from the south section parking area (Figure 16). The UST was constructed of fiberglass and was 20 feet in length and ten feet in diameter. Tank closure regulations required collection of two post-excavation soil samples from the final excavation including one composite soil sample from the base of the excavation. The field observations and analytical results indicate that there has been no impact on the environment. The removal is therefore considered a clean closure with no further activities required.

2.2.3. Summary of Phase II Investigation

Soil Boring Program Overview The Phase II soil boring program consisted of the installation of twenty five shallow soil borings and three deep soil borings. The shallow soil borings were advanced to the top of the clay layer which was encountered throughout the site. The deep soil borings were advanced to a minimum of 30 feet into the clay layer. The soil boring program was undertaken in part to further investigate the geology of the site and to allow for the determination of soil quality at areas identified as having the highest potential for impacts to the environment.

The soil boring program consisted of drilling 16 shallow soil borings and 3 deep borings from June 10 through June 24, 1991. Each of the 16 shallow soil borings was subsequently converted into a monitoring well. A detailed description of the monitoring well program has been provided below. The 16 shallow soil borings are referred to as monitoring wells MW-6 through MW-21. The three deep soil borings drilled are referred to as soil borings DSB-1 through DSB-3. The location of each soil boring is indicated on Figure 17. The purpose of

these borings was to delineate an immiscible liquid identified in MW-9.

As part of the design of the In-Situ Air Stripping (ISAS) system, eight additional shallow soil borings were drilled from September 26 through September 27, 1991 in the vicinity of MW-9. These soil borings are referred to as supplemental borings SB-1 through SB-8. An observation well, MW-22, was installed approximately 2 feet from SB-2 (Figure 14).

Soil Boring Installation Soil borings were advanced utilizing the hollow stem auger drilling technique with continuous split barrel sampling of soils in accordance with ASTM D 1586-84. Upon retrieval of soil sample, the on-site hydrogeologist field screened the sample material for VOC's utilizing a Photovac Microtip model photoionization detector (PID). The on-site hydrogeologist then logged the sample using the modified Wentworth soil classification scheme. The PID was calibrated to manufacturer's specifications prior to usage.

The three deep soil borings were drilled primarily to confirm the presence of the underlying silty clay layer throughout the site and evaluate the thickness of the clay layer. The locations of the deep soil borings are presented on Figure 2. At each deep boring location, soil samples were initially collected from ground surface to 5 feet into the clay layer. To prevent potential cross contamination between the overlying silty sand material and the clay, a 12-inch internal diameter carbon steel casing was then grouted in place and allowed to set for a minimum of 24 hours. In 33 each case, the borings were advanced and continuously sampled a minimum of 30 feet into the clay unit.

On September 26 and September 27, 1991, eight additional shallow soil borings were drilled in the vicinity of MW-9. These soil borings are referred to as supplemental borings SB-1 through SB-8. During the drilling of MW-9, a 1500 ppm PID concentration was recorded from the 10-12 foot depth interval below grade. An odor was also noticed during the development of MW-9. When MW-9 was sampled, an immiscible liquid was collected. The eight soil borings were drilled at locations around MW-9 (Figure 17) to investigate the presence of the immiscible liquid in the East Section of the plant. An additional seven soil borings (SB-8 through SB-15) were

installed during September, 1992 as part of the Interim Measures program to recover DNAPL within the area.

Geotechnical Analyses The geotechnical analyses undertaken during Phase II activities involved characterizing the grain size distribution of the silty sand layer. Grain size analyses were conducted on select soil samples. The analyses were undertaken in accordance with ASTM D-422. The samples were selected by the on-site hydrogeologist to be representative of the predominant type of materials encountered above the clay unit. Only native soil material was submitted.

The results of the laboratory analyses closely correspond with the visual descriptions of grain size variations recorded by the on-site hydrogeologist in the field. The native sediments immediately overlying the clay unit at the site are fine to medium grained sand with varying amounts of silt.

Monitoring Well Installation Program Overview Sixteen soil borings were converted into monitoring wells during the Phase II Sampling Program. MW-1 through MW-5 were installed as part of the Phase I program. The monitoring wells installed during the Phase II Sampling Program are referred to as monitoring wells MW-6 through MW-21. In addition, an observation well, MW-22, was installed as part of the supplemental soil boring program.

The installation of additional monitoring wells was completed following installation of the borings in accordance with the recommendations of the Phase I Environmental Assessment Report (IT Corporation, November, 1989) and the revised Phase II Work Plan (January, 1992).

Monitoring Well Installation In accordance with the work plan amendments and the Phase I Environmental Assessment Report (IT Corporation, November, 1989), additional monitoring wells were installed within the silty sand material overlying the clay confining unit throughout the site. The locations of the monitoring wells are indicated on Figure 10. The monitoring wells were constructed to straddle the ground water table interface using a 5 foot length of 0.020 inch slot stainless steel screen. A portion of the screened interval of the well was above the water table and allowed for both the possible seasonal upward migration of the water table and the

monitoring of any potential presence of light non aqueous phase liquid. Two inch internal diameter monitoring wells were installed with the exception of monitoring wells MW-9 and MW-13. At these two locations, stained soil was observed during drilling. Therefore, four inch internal diameter wells were installed to serve as potential ground water recovery wells should ground water extraction or hydraulic control activities be warranted. Each monitoring well was installed and constructed in accordance with MDNR requirements and O'Brien & Gere Engineers protocols. The monitoring well installation program was biased to characterize environmental conditions throughout the facility.

Of the sixteen monitoring wells installed during Phase II, six wells (MW-6, MW-7, MW-8, MW-9, MW-10 and MW-21) were installed along the perimeter of the East Section of the site in order to assess ground water quality in this section of the facility and gain inferences on ground water flow characteristics. Monitoring wells MW-1 and MW-4 were installed during Phase I activities within the East Section of the plant (Figure 10). Observation well MW-22 was installed approximately two feet northeast of MW-9 adjacent to the property boundary (Figure 17). As is discussed above, the presence of an immiscible liquid during the drilling of MW-9 prompted a supplemental soil boring program and the installation of an observation well.

Eight of the monitoring wells installed as part of the Phase II activities were installed within the West Section of the plant (MW-11, MW-12, MW-13, MW-14, MW-15, MW-18, MW-19 and MW-20). Of these eight wells, two wells (MW-19 and MW-20) were installed to monitor ground water within the interior of the West Section. The remainder of the wells were installed to monitor ground water quality along the perimeter of the West Section. MW-2 was installed as part of the Phase I investigation at the site.

Two monitoring wells were installed along the perimeter within the South Section of the plant (MW-16 and MW-17) to assist the evaluation of the South Tank Farm Area.

Ground Penetrating Radar Survey During the period of October 7 through October 10, 1991, Detection Sciences, Inc. performed a ground-penetrating radar (GPR) survey at the Ferndale site. The purpose of this survey was to identify the lateral extent of

radar anomalies and the confining clay horizon. The ground-penetrating radar survey also determined the general trends of the depths of the semi-permeable clay horizon. The findings of the Phase II investigation are detailed in Section 2.2.4.

2.2.4. Data Presentation

This section presents the analytical results from the soil and ground water sampling conducted as part of the Phase II Investigation. The data are presented in Tables 2 through 12, organized by matrix (soil or water) and analysis.

Soil samples were submitted from soil borings MW-6 through MW-21 and DSB-1 through DSB-3. These samples were selected based on the highest PID concentration recorded within the vadose zone, the location of the ground water table, and at the interface between the silty sand and the underlying clay unit. Soil samples were submitted to the laboratory for the following analyses:

- Total metals including arsenic (USEPA Method 7060), barium, cadmium, chromium, copper, lead, silver, zinc (USEPA Method 6010), and mercury (USEPA Method 7471) (see Table 2 for results);
- VOC's (USEPA Method 8240) (see Table 3 for results);
- SVOCs (USEPA Method 8270) (see Table 4 for results); and

Four soil borings (MW-8, MW-10, MW-17 and MW-19) were drilled in the immediate vicinity of electrical transformers. In addition to the above analyses, soil samples submitted from these soil borings were also analyzed for polychlorinated biphenyls (USEPA Method 8080) (Table 5).

In September, 1991 and December, 1991, 19 of the 22 monitoring wells were sampled for total and dissolved metals, VOCs, SVOCs and PCBs, pesticides and herbicides. MW-9 and MW-22 were sampled in February, 1992. No results were reported for MW-5, which was damaged during the decommissioning program, or MW-15 (except VOC's) because there was an insufficient standing water column within the well to allow for sample collection. A minimum of three volumes were evacuated in order to obtain a representative ground water sample. Well samples were collected with dedicated polyethylene bottom filling bailers.

Ground water samples were collected and preserved in accordance with analytical requirements and submitted for the following laboratory analyses:

- Total and Dissolved Metals (USEPA Method 6010/7000) (Table 6 and 7);
- VOC's (USEPA Method 8240) (Table 8 and 9);
- SVOCs (USEPA Method 8270) (Table 10 and 11);
- Pesticides, herbicides, PCB's (USEPA Method 8080) (Table 12).

The USEPA Method 8080 analyses were not conducted during the September, 1991 groundwater analytical program. Reichhold subsequently re-sampled each of the 21 wells for the full Appendix IX parameter list.

Metals in Soil and Water Based on the review of historical plant operations, the only metal documented to have been stored on Site was lead. However, soil samples on Site have shown concentrations of arsenic, silver and zinc, in addition to lead, which exceed MDNR Act 307 Type A cleanup criteria based upon MERA operational memorandum #8. Also, certain soil samples have shown concentrations of barium, cadmium, chromium, and copper which exceed Type A criteria. Water collected during the first ground water sampling round from the perched water table at MW-2 and MW-12 exhibited concentrations of antimony that exceed the MDNR Act 307, Type B (20 X ground water) cleanup criteria. During the second ground water sampling round, only water collected from MW-2 was found to have a concentration of antimony in excess of the Type B criteria. Ground water collected from MW-12, MW-18 and MW-20 exhibited concentrations of lead that exceeded Type B criteria in the first sampling round, yet only MW-20, MW-9 (2/92) and MW-22 (2/92) had concentrations of lead which exceed the Type B criteria during the second round of sampling. Since only lead was identified as having been stored on Site by RCI, it is probable that the metals found in Site soil samples may be attributed to indigenous concentrations of metals. It is possible that lead concentrations observed in Site soils are not due to RCI operations at the Site, but are due to indigenous concentrations of lead in this area. The MDNR allows for the possibility of indigenous

concentrations of metals which exceed Type B criteria by allowing Type B criteria to be modified based on concentrations of metals observed in background samples collected at or near a Site. RCI will review MERA Operational Memo #5 and re-evaluate metals concentration in light of the default Type A soil values.

Organic Compounds in Soil and Water The analytical presentation herein discusses the VOC and SVOC data in terms of compounds which exceed Type B criteria. A brief, compound specific discussion is also included where the information is useful and relevant. Analytical results are discussed relative to Type B criteria. The discussion below is organized by referencing the three sections of the site (East, West and South). Furthermore, within each section discussion, data presentation is by matrix. Specifically, vadose zone soils, soil/water interface soils and sand-clay interface soil are discussed followed by an analysis of ground water quality via the two ground water sampling events.

East Section The East Section of the site is comprised of approximately six acres. Two monitoring wells, MW-1 and MW-4, were installed during the Phase I program. Six shallow soil borings installed during the Phase II investigation were converted into monitoring wells MW-6, MW-7, MW-8, MW-9, MW-10 and MW-21. Water samples were collected from these wells in September, 1991 and December, 1991. An additional monitoring well, MW-22, was later installed in the vicinity of MW-9 as part of the IM at this area. Both MW-9 and MW-22 were sampled in February, 1992. Two deep soil borings installed are referred to as DSB-1 and DSB-2. Figure 2 identifies the locations of these soil borings and monitoring wells.

East Section Soil Figure 18 presents the total VOC and SVOC concentrations for the vadose zone, ground water interface interval and sand/clay interface interval.

East Section Soil - Vadose Zone MW-6, MW-8 and MW-10 were not sampled within the vadose zone due to the high water table which was encountered.

VOCs: Analytical results for soil samples collected from the vadose zone indicated that DSB-1 and DSB-2 did not exceed Type B criteria for VOCs. Additionally, the soil sample from MW-21 indicated concentrations slightly above the Type B criteria for trichloroethene and styrene. Soil collected from MW-7 and MW-9 indicated concentrations of chlorinated solvents above Type B criteria. Soil from MW-7 was also found to have xylene and bromomethane (Table 3) above Type B criteria.

SVOCs: East Section vadose zone soil samples indicated that only soil from MW-7, MW-21, and DSB-2 had concentrations of SVOC's above Type B criteria. Typical compounds observed included phenanthrene and naphthalene (Table 4).

East Section Soil - Ground Water Interface

VOCs: The ground water interface interval soil samples indicated VOC concentrations at levels below the Type B criteria at MW-6, DSB-1 and DSB-2. Concentrations at MW-8, MW-10 and MW-21 marginally exceeded the Type B criteria for VOCs, while soil from MW-7 exceeded several Type B criteria substantially. VOCs at MW-7 included ethylbenzene, methylene chloride and xylene (Table 3).

SVOCs: Soil samples from MW-7, MW-10, and DSB-1 did not have concentrations which exceeded Type B criteria SVOCs. Soil sample from MW-6 showed a concentration of naphthalene above Type B criteria; soil from MW-21 had concentrations naphthalene, 2-methylnaphthalene and phenanthrene above the Type B criteria; and soil from DSB-2 had concentrations of the same compounds as MW-21 plus several polycyclic aromatic hydrocarbons (PAH's) which were above Type B criteria (Table 4).

East Section Soil - Sand/Clay Interface

VOCs: In the sand/clay interface, soil from MW-6, MW-10, DSB-1 and DSB-2 showed no concentrations of SVOCs above Type B criteria. Soil from MW-7, MW-8 and MW-21 showed concentrations slightly

above Type B criteria for trichloroethylene, while soil from MW-9 had concentrations of 12 compounds which were substantially above the Type B criteria (Table 3).

SVOCs: Soil from MW-6, MW-7, MW-8, MW-9, MW-10, MW-21, DSB-1 and DSB-2 showed no concentrations of SVOCs above Type B criteria in the sand/clay interface region (Table 4).

East Section Ground Water Figure 19 presents the total VOC and SVOC concentrations for the ground water samples during the September, 1991 and December, 1991 sampling events.

VOCs: Water collected from MW-1, MW-4, MW-8, MW-10 and MW-21 showed no concentrations of VOCs above Type B criteria during both the first and second rounds of sampling. Water collected from MW-6 and MW-7 showed no concentrations of VOCs in excess of the Type B criteria during the first round of sampling, but showed some VOCs in excess of the Type B criteria during the second round of sampling. For both wells, ethylbenzene and styrene showed up in the second round. Additionally, water collected from MW-7 showed concentrations of xylene and methylene chloride above Type B criteria. However, methylene chloride was found in a blank associated with MW-7, so its actual presence is unlikely. MW-9 was sampled for both rounds plus an extra sampling event when MW-22 was sampled. For each of the three sampling events, water collected from MW-9 showed several VOCs present in concentrations above Type B criteria. These VOCs included vinyl chloride, trichloroethene, styrene, ethylbenzene and other chlorinated VOCs. MW-22 was sampled only one time. Water collected from MW-22 was found to have concentrations of vinyl chloride and trichloroethene above Type B criteria. Tables 8 and 9 summarize the analytical results for the first and second rounds of ground water VOC sampling, respectively.

SVOCs: For both rounds of well sampling, water collected from MW-1, MW-4, MW-6, MW-7, MW-8, MW-9, MW-10 and MW-21 showed no SVOC concentrations above Type B criteria. In addition, the third water sample collection at MW-9 and concurrent initial water sample collection at MW-22 showed no SVOC concentrations above Type B criteria. Tables 10 and 11 summarize the analytical results for the first and second rounds of SVOC sampling, respectively.

Pesticides/
Herbicides/
PCBs: Table 12 details the analytical results of the second round of monitoring well pesticide/herbicide/PCB sampling. Water collected from MW-1, MW-4, MW-6, MW-8, MW-9, MW-10, MW-21 and MW-22 showed no concentrations of these compounds above the laboratory detection limits. Water collected from MW-7 had a concentration of gamma-chlordane which was slightly above Type B criteria, and concentrations of heptachlor and 4,4'-DDE which were not above Type B criteria.

West Section The West Section of the site is comprised of approximately four acres (Figure 20). One monitoring well, MW-2, was installed during the Phase I program. Eight shallow soil borings installed during the Phase II investigation were subsequently converted into monitoring wells MW-11, MW-12, MW-13, MW-14, MW-15, MW-18, MW-19 and MW-20. Two rounds of water samples were collected from these wells, September, 1991 and December, 1991. Figure 2 identifies the locations of these soil boring and monitoring wells.

West Section Soil The analytical results for soil samples collected from the West Section are presented in Tables 2, 3, 4 and 5. The sample locations with analyte concentrations are given. Figure 20 presents the total VOC and SVOC concentrations for the vadose zone, ground water interface interval, and clay interface interval.

West Section Soil - Vadose Zone MW-13, MW-15, MW-18, MW-20 were not sampled within the vadose zone due to the high water table which was encountered.

VOCs: Soil samples collected from MW-12 showed no VOC concentrations above Type B criteria. Soil collected from MW-11, MW-14 and MW-19 showed concentrations above Type B criteria, including chlorinated solvents, acetone and xylene (Table 3).

SVOCs: Soil samples collected from MW-11, MW-12 and MW-14 showed no SVOC concentrations above Type B criteria in the vadose zone. Soil from MW-19 showed a concentration of naphthalene above Type B criteria (Table 4).

West Section Soil - Ground Water Interface

VOCs: Soil from MW-12, MW-13, MW-15 and MW-19 showed no VOC concentrations above Type B criteria. Soil from MW-11, MW-14, MW-18, and MW-20 had concentrations of several VOCs which were above Type B criteria (Table 3).

SVOCs: Soil from MW-11, MW-12, MW-13, MW-14, MW-15, MW-18 and MW-19 showed no SVOC concentrations above Type B criteria in the ground water interface region. Soil from MW-20 was found to have concentrations above Type B criteria for naphthalene and 2-methylnaphthalene (Table 4).

West Section Soil - Sand/Clay Interface

VOCs: Soil from MW-15, MW-17, MW-18, MW-19 and MW-20 showed no VOC concentrations above Type B criteria. Soil from MW-11 and MW-13 showed some VOC concentrations which were slightly above Type B criteria, while soil from MW-14 showed concentrations which were above Type B criteria for trichloroethylene. Soil from MW-12 had VOC concentrations which were above Type B criteria for benzene, ethylbenzene, methylene chloride and xylene (Table 3).

SVOCs: Soil from MW-11, MW-13, MW-14, MW-15, MW-18, MW-19 and MW-20 showed no SVOC concentrations above Type B criteria. Soil from MW-12 had SVOC concentrations above Type B criteria for naphthalene, 2-methylnaphthalene, fluorene and phenanthrene (Table 4).

West Section Ground Water Figure 21 presents the total VOC and SVOC concentrations for the ground water samples during the September and December sampling events.

VOCs: Of the eight West Section monitoring wells, water samples from MW-12 and MW-13 showed substantial reductions in VOC concentrations from round 1 to round 2, to the extent that VOC concentrations above Type B criteria during the first round of sampling were found to be below laboratory detection limits during the second round. VOCs which were reduced in concentration in this manner were trichloroethene at MW-12 and trichloroethene and benzene at MW-13. The remaining six wells showed VOC concentrations in water samples above Type B criteria during both sampling rounds. VOCs detected at these wells typically included chlorinated VOCs as well as some aromatic compounds such as xylene and ethylbenzene. Tables 8 and 9 summarize the analytical results for the VOC analyses for round 1 and round 2, respectively.

SVOCs: Water samples from MW-2, MW-11, MW-12, MW-13, MW-14, MW-18 and MW-19 showed no SVOC concentrations above Type B criteria during either round of sampling. Water collected from MW-20 was found to have phenol concentrations above Type B criteria during both rounds of sampling. Tables 10 and 11 summarize the analytical results for SVOC analyses for round 1 and round 2, respectively.

Pesticides/
Herbicides/
PCBs: Table 12 details the analytical results of the second round of monitoring well pesticide/herbicide/PCB sampling. Water collected from MW-2, MW-12, MW-13, MW-14 and MW-19 showed no concentrations of these compounds above the laboratory detection limits. Water collected from MW-2, MW-18 and MW-20 showed concentrations above Type B criteria for dieldrin, heptachlor and aldrin, respectively.

South Section The South Section of the site is comprised of approximately three acres. Two monitoring wells, MW-3 and MW-5, were installed during the Phase I program. MW-5 was later abandoned and grouted due to damage caused during the decommissioning program. Two shallow soil borings were converted into monitoring wells MW-16 and MW-17. One deep soil boring installed was referred to as DSB-3. Two rounds of water samples were collected from the wells, September, 1991 and December, 1991. Figure 2 identifies the locations of these soil borings and monitoring wells.

South Section Soil Figure 22 presents the total VOC and SVOC concentrations for the vadose zone, ground water interface interval, and clay interface interval.

South Section Soil - Vadose Zone MW-17 was not sampled within the vadose zone due to the elevated water table encountered.

VOCs: Soil collected from DSB-3 showed no VOC concentrations above Type B criteria. Soil collected from MW-16 showed concentrations above Type B criteria for ethylbenzene, methylene chloride, trichloroethene and xylene (Table 3).

SVOCs: Soil samples from MW-16 and DSB-3 showed no concentrations of SVOCs in soil above Type B criteria (Table 4).

South Section Soil - Ground Water Interface

VOCs: Soil collected from MW-17 and DSB-3 showed no VOC concentrations above Type B criteria. Soil from MW-16 showed concentrations above Type B criteria for ethylbenzene, methylene chloride and xylene (Table 3).

SVOCs: Soil collected from MW-16, MW-17 and DSB-3 showed no SVOC concentrations above Type B criteria (Table 4).

South Section Soil - Sand/Clay Interface

VOCs: Soil collected from MW-16, MW-17 and DSB-3 showed no VOC concentrations above Type B criteria in the sand/clay interface region. However, DSB-3 had a slightly elevated concentration of trichloroethene at the 32'-34' interval (Table 3).

SVOCs: Soil collected from MW-16, MW-17 and DSB-3 showed no SVOC concentrations above Type B criteria (Table 4).

South Section Ground Water Figure 23 presents the total VOC and SVOC concentrations for the ground water samples during the first and second rounds of sampling.

VOCs: Tables 8 and 9 detail the analytical results of the first and second rounds of monitoring well VOC sampling, respectively. For both rounds of samples, water collected from MW-3, MW-16 and MW-17 showed no concentrations of VOCs above Type B criteria.

SVOCs: Tables 10 and 11 detail the analytical results of the first and second rounds of monitoring well SVOC sampling, respectively. For both rounds of samples, water collected from MW-3, MW-16 and MW-17 showed no concentrations of SVOC's above Type B criteria.

Pesticides/
Herbicides/
PCBs: Table 12 details the analytical results of the second round of monitoring well pesticide/herbicide/PCB sampling. Water collected from MW-3, MW-16 and MW-17 showed no concentrations of these compounds above the laboratory detection limits.

Table 13 summarizes the ground water results from the two sampling rounds.

Ground Penetrating Radar In general, the radar revealed patches of anomalies at various locations on the site. In addition, a relatively shallow water table approximately three feet below ground surface was observed. The radar survey was conducted in the West and East sections of the site. In the West Section,

a series of radar survey lines were run between building 104 and 105 to investigate the subsurface remnants of a previously demolished structure. The area did not appear to be a source of contamination. In addition, the lateral distribution of the topographical lows in the confining clays was observed in this section.

In the East Section, the lateral distribution of the underlying clay was observed. Radar readings taken in the vicinity of MW-9 indicated that this well was situated at the outer boundary of the anomalies in this area.

In general, the radar anomalies appear in patches. At various locations on the site. The site is underlain with shallow clays and there are topographical lows in the clays. The complete GPR report is provided as Attachment 3.

2.3. RCRA Facility Assessment

The Corrective Action Consent Order (CACO) dated July 1, 1994 contains the RFA for the Ferndale facility. The MDNR prepared the RFA on the basis of the investigations conducted by RCI and a file review of applicable permits and documented releases at the Ferndale site. The MDNR identified sixty-eight SWMUs at the facility. A listing and description of the SWMUs proposed by the MDNR at the Ferndale site is presented in Table 14. Locations of the SWMUs are identified on Figures 24, 25, and 26.

2.4. Recommended Investigations

Further investigations will be conducted at the site under the RCRA statutes identified within the CACO prepared by the MDNR. The CACO serves to identify that a RCRA Facility Investigation (RFI) is to be implemented at the facility followed in turn by a Corrective Measures Study (CMS) and Corrective Measures Implementation (CMI).

A RCRA Facility Investigation (RFI) Work Plan has been prepared which serves to provide a detailed description of the procedures and protocols to be utilized to evaluate the nature and extent of the

possible release of hazardous waste or constituents. The objective of the field investigations detailed within the RFI Work Plan is to obtain sufficient accurate information on environmental conditions to allow identification, evaluation and selection of appropriate corrective measures. The data presented within this Current Conditions Report is the basis for the RFI Work Plan.

The investigatory logic for the SWMUs, discussed in detail in the Work Plan, presents a phased investigation. The SWMUs will be screened using either a building foundation integrity evaluation or electronic cone penetration (ECP) testing. The foundation evaluation will be used to bias the selection of locations through the foundations. In other areas (without foundations), ECP in field analysis results will allow the strategic placement of soil borings and/or monitoring wells.

3. Interim Corrective Measures

3.1. General

Interim corrective measures are required to be undertaken where there is an imminent threat to human health or the environment or in non-emergency situations where a response or measure is appropriate prior to completion of the RFI. While no imminent threat to human health or the environment has been identified, RCI has undertaken small scale interim measures as pilot studies for possible corrective measures later in the program.

3.2. Interim Corrective Action Programs

Currently, there are two Interim Measures (IM) ongoing at the site: an In-Situ Air Stripping System (ISAS) within the former South Tank Farm area and a non-aqueous phase liquid (NAPL) recovery system within the East Area. A ground water interim measures work plan has also been proposed. The three interim measures are discussed in the following sections.

3.2.1. Interim Measure No. 1 - Non-Aqueous Phase Liquids

A total of eight soil borings, SB-1 through SB-8 were drilled in September 1991 in order to delineate the DNAPL encountered during ground water sampling at the MW-9 location. Additional field activities were initiated on September 22, 1992, including further delineation. Figure 12 depicts the location of the delineation borings, the piezometer, and the recovery well. Seven additional soil borings (SB-9 through SB-15) were drilled in order to delineate the DNAPL. Of these seven soil borings, three were converted into temporary piezometers. A 6-inch internal diameter recovery well was installed approximately 5 feet north of MW-9. A pneumatic displacement stainless steel pumping system was installed within the recovery well (RW-1). The system installed was a QED Environmental Systems, Inc., Alpha pulse pump which is designed especially for sinking hydrocarbons.

No DNAPL has been observed at RW-1 since November 1993. The work plan submitted in November 1994 describes the approach for the formal termination of this interim measure.

3.2.2. Interim Measure No. 2 - In-Situ Air Stripping

An ISAS system was operated within the former South Tank Farm area. The original design of the ISAS system included two extraction wells and six inlet wells. The maximum distance between an extraction well and an inlet well was 25 feet. Figure 27 depicts the ISAS layout. The system was designed to contact a passing air stream through the vadose zone via the inlet wells. VOC laced air was pulled through the vadose zone by the extraction wells into the ISAS system for capture by activated carbon. Beginning in May, 1993 and proceeding through September, 1994, VOCs were recovered. By the end of September, 1994, recovery rates had decreased to negligible levels. The November 1994 work plan describes the approach for formal termination of this interim measure.

3.2.3. Proposed Interim Measure No. 3 - Ground Water

A draft proposed IMWP has been developed which fulfills the following objectives:

- Develop the necessary technical basis for the implementation of an appropriate and applicable ground water interim measure; and

- Select an interim measure or measures consistent with site remediation objectives recognizing that east, west and south yard remedies may differ.

The draft proposed IMWP was submitted to the MDNR in November 1994.

Should data collected during RFI implementation support addressing ground water at the site, the November 1994 IMWP describes those activities that are to be conducted to select the appropriate response.

4. Pre-Investigation Evaluation of Corrective Measures Technologies

4.1. Introduction

Corrective measures at the Site will be organized according to the two contaminated matrices, soil and groundwater, which have been observed at the Site. This section provides a pre-investigation evaluation of several possible corrective measures technologies which might be implemented at the site. Beneficial and detrimental aspects of each technology are noted and recommendations are made based on the information currently available for the Site.

4.2. Soils Technology Screening

Environmental investigations at the site have indicated that Site soils contain levels of organic solvents and other compounds at levels which may require remediation by the MDNR. The principle soil contaminants are:

- Trichloroethene
- Tetrachloroethane
- Xylene
- Toluene
- Naphthalene
- Methyl Naphthalene
- Benzene
- Ethyl Benzene
- Vinyl Chloride

The purpose of this evaluation is to evaluate available remediation technologies for application to the Site and recommend for further study, those technologies that appear promising for implementation at the Site.

4.2.1. Soil Remediation Technology Evaluation

Technologies for remediating soils impacted with organic solvents include the following:

- Low Temp. Thermal Desorption
- Soil Washing
- Soil Flushing
- Biodegradation
- In-Situ Air Stripping
- In-Situ Air Sparging

These technologies will be evaluated with respect to cost, long term effectiveness, constructability/implementability, previous performance history of the technology on other similar sites, and regulatory acceptance/permitting issues.

Low Temperature Thermal Desorption Low temperature thermal desorption entails the application of heat to a soil matrix to volatilize (desorb) the organic compounds. Unlike incineration, which typically employs temperatures over 1500°F, low temperature thermal desorption typically employs temperatures less than 850°F and does not change the physical appearance of the soil. The volatilized organics are desorbed from the soil to the air stream where they are treated via air pollution control equipment (wet scrubbers, granular activated carbon (GAC), secondary combustion chamber, etc.). "Clean" air then exits a vent stack. This technology has been widely used in the past and is currently being employed on a number of CERCLA sites around the country. Typically, the remediation is performed on-site via mobile units. Several vendors have commercially available units. Typical costs for low temperature thermal desorption range from $75-$200 per cubic yard. This technology has a past history of proven effectiveness. However, treatability testing may be required to evaluate this method's ability to treat soils to the low cleanup levels likely required in program run according to Type B criteria. A low temperature thermal desorption system will likely require an air permit under RCRA and may also require a wastewater discharge related permit depending on the air pollution control equipment employed. Public acceptance of a low temperature thermal unit would likely be dependent on RCI being able to convey to the public that this technology is different from incineration. Given that past performance history of this technology indicates that it will successfully treat soils contaminated with organic solvents, this option will be retained for further consideration.

Soil Washing The soil washing process extracts contaminants from soil using a liquid medium composed of water and/or various chelating agents, surfactants, acids or bases depending on the contaminant to be removed. The soil is excavated and conveyed to a feeder where oversized soil material and debris are removed via a course screen. The soil then passes through a soil scrubber where it is sprayed with washing fluid.

Particles greater than 2mm in diameter are sorted and rinsed, leave the scrubber, are dewatered, and returned to the site. The remaining soil enters a countercurrent chemical extractor where additional washing fluid is applied. The treated soils are then dewatered and replaced on site. The washing fluid is then treated to remove contaminants and recycled. The residual sludge generated from wash water requires incineration or additional treatment for disposal in an approved landfill. Typically, one cubic yard of sludge is produced for every 20 cubic yards of soil processed. Costs for treatment via soil washing range from $80-150 per cubic yard. However, costs for disposal of residual sludge can add significantly to this cost. This technology will remove organic contaminants from the soil, however, it is unclear if "Type B" cleanup criteria can be achieved. Thus, a bench scale study or on-site pilot study will likely be required. Soil washing equipment is commercially available and can be performed on site. Previous experience has shown that soil washing is most effective on coarse particle soils. Fine sands, silts and clays do not lend themselves to particle separation and attempting to treat such soils via soil washing has resulted in material handling problems at other sites. Site soils at Ferndale are classified as fine sands/silty clay. This technology will likely not require an air permit, however, residual sludge management may require waste disposal permits. Given the potential cost involved with residual disposal and the performance history of soil washing on similar soils, this option will not be retained for further consideration.

Soil Flushing Soil flushing involves the injection of a solvent solution, which might consist of water, surfactants, acids, bases or some combination of these, into the soils to enhance the contaminant solubility which results in increased recovery of contaminants in site ground water. Ground water is reinjected upgradient of the extraction wells and leaches through soils. The leachate is then collected, treated and reinjected back into the ground creating a closed loop system. Non-toxic surfactant or chelating agents may be added to the ground water prior to reinjection. Soil flushing is typically employed at a cost of $40-80 per cubic yard (excluding ground water treatment costs) depending on soil type and contaminants. Soil flushing is best suited for sites contaminated with only a few specific chemicals. It is not

certain whether this technology can achieve "Type B" cleanup criteria. Bench scale studies and an on-site demonstration would likely be required to evaluate various flushing solutions and assess the effectiveness of soil flushing at this site. This technology is commercially available and can be implemented in conjunction with a ground water cleanup program on site. However, the washing agents employed in soil flushing may themselves be considered contaminants and, in most cases, must be completely recaptured to avoid further contaminating ground water. Given the wide range of contaminants present, it is likely that a multiple stage remediation (using multiple washing agents or soil flushing in conjunction with another technology) would be required for effective remediation. This technology will require permits associated with ground water reinjection and disposal of residual sludge. Due to the uncertain effectiveness, lack of proven past performance on sites with organic solvents, and potential regulatory and operational difficulties associated with multiple washing agents, this option will not be retained for further consideration.

In-Situ Biodegradation In-Situ biodegradation (biodegradation) involves the use of indigenous micro-organisms or introduced micro-organisms to accelerate the natural degradation of organic compounds in the soil. Nutrients are tilled into the soil at regular intervals to promote continued biological degradation of the organic compounds. Typical costs for biodegradation range from $20-50 per cubic yard. To date, biodegradation has not been shown to be effective on soils contaminated with organic solvents. In addition, the contamination of soil at the Ferndale site extends to depths up to six feet below grade. Biodegradation has been shown to be effective on surface soils. Typically, a ground water monitoring program is required by regulators to track the potential leaching of nutrients (phosphorus, nitrogen) to the ground water. Ex-situ biodegradation can also be performed; however, this process would be subject to the same limitations as the in-situ process with respect to effectiveness on organic solvents. This option will be retained for further consideration.

In-Situ Air Stripping ISAS is accomplished via a series of inlet wells extending radially from an air extraction well. Air is drawn through the inlet wells and the vadose zone to the extraction

well by a vacuum blower. Organic compounds are stripped from the soils to the passing air. Extracted air is then treated (usually with GAC) before being vented to the atmosphere. Typical costs for ISAS range from $10-35 per cubic yard of soil. ISAS would effectively remove volatile organic contaminants from the soil, however; previous experience has shown that removal of some organic solvents to "Type B" criteria may not be possible. Bench scale tests or on-site pilot tests may be required to assess the effectiveness of this option. An ISAS system and well network has been installed on the south portion of the site. This system could easily be adapted for use on the east or west portions of this site if it proves effective. An air permit would be required for operating this system. Securing an air permit would involve dispersion modelling for the site and could take up to 18 months to procure. Regulatory and public acceptance of this technology would be related to the results of the dispersion modelling and subsequent air pollution control requirements. Given that this technology is currently being implemented on the south portion of the site as a pilot study, it will be retained for further consideration.

In-Situ Air Sparging In-situ air sparging (air sparging) includes the injection of coarse bubble air into the ground water underlying the contaminated soil. The air bubbles diffuse through the ground water and into the vadose zone, sparging organic compounds from the ground water. The air and sparged VOCs are recovered from the vadose zone via an extraction well and a vacuum blower. The recovery of sparged air will cause additional organics to be stripped from the vadose zone soils. The recovered VOC laden sparged air is then treated (usually with GAC) and then either vented to the atmosphere or recycled (closed loop). Preliminary vendor information about air sparging systems indicates that a system suitable for treating this Site could be expected to have capital costs between $150,000-$300,000 and operating costs of $100,000-$150,000 per year. Air sparging has been proven effective on sites contaminated with petroleum hydrocarbons. As of this date, air sparging on organics has been demonstrated on a full scale, but has not been shown to achieve "Type B" cleanup standards. In addition, the effectiveness of the technology is dependent on site geology as well as contaminant makeup. Thus, on-Site pilot studies may be required to assess the effectiveness of this technology

with respect to achieving Type B criteria. This technology could be implemented on site with minimal disruption to the surrounding community and could serve as a ground water remediation as well as soil remediation. The equipment is typically skid mounted and moved as required within the site boundaries to remediate portions of the site as required. An air permit may be required if an open loop system is employed. A closed loop system will likely not require an air permit. Due to the potential cost effectiveness of in-situ air sparging, this technology will be retained for further evaluation.

4.2.2. Soil Treatment Evaluation Summary/Recommendations

Six remedial technologies were screened for potential application for soils remediation at the RCI, Ferndale, Michigan site. Of these six technologies, four were designated as potentially applicable including:

- Low Temperature Thermal Desorption
- Biodegradation
- In-Situ Air Stripping
- In-Situ Air Sparging

Costs for these options range from $150,000-$300,000 fixed cost for in-situ air sparging to $10-$35 per cubic yard for in-situ air stripping.

Table 15 provides a matrix summary of the evaluation. Table 16 presents a summary of the relevant soil data required to establish design parameters for each technology.

4.3. Evaluation of Strategies for Hydraulic Control of Ground Water

Environmental investigations at the Site have indicated that underlying ground water in the perched water table on site contain levels of organic solvents and other organic compounds at levels which may require remediation by the Michigan Department of Natural Resources (MDNR). The principle contaminants are:

- Trichloroethene
- Tetrachloroethane
- Xylene
- Toluene

- Naphthalene
- Methyl Naphthalene
- Benzene
- Ethyl Benzene
- Vinyl Chloride
- Non-Aqueous Phase Liquids (NAPLs)

The water table is recharged mainly through surface infiltration along the active railroad tracks which bisect the east and west portions of the site. Ground water flow is to the east and west of the railroad tracks.

The purpose of this evaluation is to evaluate commercially available options for controlling ground water at the site such that future off site migration of contaminated site ground water is prevented.

This section presents and discusses several options that may be used to effect hydraulic control in the perched water table at the Site. These options fall into two general categories: ground water containment/cutoff walls and ground water collection, treatment and discharge. The discussion focuses on the benefits and disadvantages of each remedial option. Each discussion provides a conclusion as to whether the remedial option is preferred or not preferred for possible further consideration for application at the Site.

4.3.1. Ground Water Containment/Cutoff Wall

The installation of a complete cutoff wall would effectively confine the site ground water and prevent off-site migration of contaminated ground water. A partial cutoff wall would impede the off-site migration of contaminated ground water, and in conjunction with a ground water pump and treat scheme, may be equally as effective as a complete cutoff wall.

Soil-Bentonite Slurry Wall Slurry walls are constructed in vertical trenches that are excavated under a slurry. The slurry, usually a mixture of bentonite and water, acts essentially like a soil porosity sealant and provides hydraulic shoring. It stabilizes the trench to prevent collapse and forms a low permeability filter cake on the trench walls to prevent water loss. Soil-bentonite slurry walls are installed by placing a mixture of soil and the bentonite slurry as backfill into the trench.

Initial Screening: The technology for installing soil-bentonite slurry walls is well-established. A low permeability clay layer is present throughout the site at a depth of approximately 12 to 15 feet, thus providing a means for near total encapsulation. A soil-bentonite slurry wall would provide a low permeability vertical barrier at low to medium cost. Sufficient space may not be available for construction of a slurry pond necessary to install a complete cutoff wall. This is a preferred remedial option for use on a partial cutoff wall.

Cement-Bentonite Slurry Wall Instead of a bentonite slurry, the cement-bentonite slurry wall uses a slurry composed of cement, bentonite and water, which is left in the trench to harden and form the containment wall.

Initial Screening: Like the soil-bentonite slurry wall, the cement-bentonite slurry wall is implementable and effective. The cement-bentonite slurry wall, however, is more costly than the soil-bentonite slurry wall and is more permeable. It is also more susceptible to chemical attacks by leachate. However, the cement-bentonite slurry wall has a higher strength, and can be more readily installed in areas with limited working space and steep topography. Although short term slope stability may be a concern during construction, long term slope stability is enhanced due to its higher strength. This option involves the disposal of contaminated soil which may be classified as hazardous. Disposal of this soil significantly increases the cost of this option. Therefore, this is not a preferred remedial option.

Steel Sheet Piling Steel sheet piling involves driving lengths of sheet steel into the ground. The steel sections are driven individually into the ground using a pile hammer. The interlocking sections form a relatively impermeable permanent barrier to flow.

Initial Screening: The top layer of soils at the site consists of asphalt and concrete, therefore driving steel sheet piling at the site would be accompanied by an initial removal/recycle of this top layer. Steel sheet piles provide structural stability to a cutoff wall. However, minor mismatching of the interlocks compromise the impermeability of the system, and the cost is relatively high. Additionally, the steel sheets are subject to corrosion from chemical attacks or electrolysis.

Often the corrosion is concentrated at the joints, which are the critical junctures of the wall. This can be partially offset by introducing anodes to reduce electrolysis or using special grade steel sheet. However, the use of special sheets increases the capital costs of this remedial option. This remedial option is preferred, but only for use in areas where other methods are not feasible.

Gundwall The installation of high density polyethylene (HDPE) walls involves either the driving of individual sheets into in-situ soils with a vibratory hammer or the placement of sheets by hand into an open trench. Rigid HDPE interlocking beams are separated by 80 to 120 mil thick HDPE sheets that form a relatively impermeable barrier. A groove in the locking beam allows for the insertion of an expansive material for sealing at the junction of the individual sheets.

Initial Screening: This is a relatively new containment technology. There are limited numbers of case studies existing to document its effectiveness. However, those case studies that do exist suggest that this technology is effective. The top layer of soils at the site consist of asphalt and concrete, therefore, installation of the sheets would be accompanied by an initial removal/recycle of this top layer. The interlocks incorporate an expansive seal designed to prevent leakage at panel locks. While HDPE is resistant to many chemicals, organic solvents and xylene degrade HDPE. An HDPE wall would provide a low permeability vertical barrier at a medium cost compared to other containment technologies. However, due to the potential degradation of HDPE in the presence of Site contaminants, this type of wall would require replacement after about five years. Currently, vendors are looking for plastic sheet material resistant to organic solvents, but such materials are not yet commercially available. This is a preferred remedial option only as a temporary hydraulic control measure.

4.3.2. Ground Water Collection, Treatment, and Discharge

Ground water collection may be implemented through the use of existing perimeter monitoring wells at the Site. Ground water collection would require perimeter wells on the east and west sides of the Site to be manifolded and collected water to be stored at a

central location for batch treatment. The following discussion will focus on ground water treatment and discharge options.

Ground Water Treatment Options Ground water contamination consists mainly of organic solvents, BTEX and NAPLs. The following treatment options are evaluated for treatment:

- Air Stripping
- Bioremediation
- Closed Loop Air Sparging
- Off-site Treatment and Disposal
- U.V. Oxidation, Peroxide Additive

These options are evaluated with respect to cost, long term effectiveness, constructability/implementability, previous performance history of the technology, and regulatory/public acceptance.

Air Stripping Prior to passing through this process, the ground water would pass through an oil/water separator to remove light NAPLs (LNAPL). Air stripping involves the mass transfer of VOCs from solution in a liquid (ground water) to the stripping gas (air). This is typically accomplished with a countercurrent packed tower, where water is introduced at the top of the tower and air is introduced at the bottom. VOC laden air is drawn off the top of the column and treated (usually with granular activated carbon, GAC) prior to being vented to the atmosphere. The stripped water is then discharged. Conventional air stripping requires a high energy input for air blowers for effective stripping to occur. The cost of constructing a conventional air stripping system is moderate to high. The operational costs (power, GAC replacement) are high.

The MDNR would likely require treatment of ground water to the low ppb range regardless of the method of discharge. Conventional air stripping may achieve such levels of treatment, however, it is possible that additional treatment (liquid phase GAC or ozonation) might be required.

Conventional air stripping systems do not require expansive areas for installation, and sufficient vertical clearance is available on site for the erection of a vent stack.

Conventional air stripping is a proven, widely used technology. As such, pilot testing would not be required. The use of a conventional air stripper would require an air permit for this site. Obtaining an air permit is a time consuming, and relatively costly endeavor. In addition, public resistance to a long term air discharge could be expected. Nonetheless, this is a preferred remedial option due to the proven effectiveness of this technology.

Closed Loop Air Sparging Prior to passing through this process, ground water will pass through an oil/water separator to remove LNAPLs. A closed loop air sparging system subjects VOC contaminated ground water to cross current coarse bubbled air which volatilizes VOCs. The system is typically maintained under a slight vacuum via the use of a vacuum blower. VOC laden air is pulled from the reactor tank and treated via vapor phase GAC. Treated air exiting the GAC is then recycled back to the air sparge header in the reactor tank. Treated (sparged) water is then pumped from the reactor tank to the disposal point or to additional treatment. Costs for construction of a closed loop air sparging system are slightly higher than for a conventional air stripper due to increases in process control; however, the operational costs associated with the closed loop system are considerably lower than for a conventional air stripper. Typically, air flow is much lower for sparging, resulting in lower energy costs. Closed loop air sparging systems are ideally suited for low flow (less then 20 gpm) or batch operations such as that anticipated at the site. These systems require minimal space and could easily be installed at the site, and, since there is no air discharge, no vent stack is required. These systems have been widely used throughout industry (although not as extensively as conventional air stripping). Past performance indicates that treatment efficiencies are slightly lower then for conventional air strippers, thus water polishing (liquid phase GAC or ozonation) may be required prior to discharge in order to meet discharge criteria. Bench scale testing would likely be required to establish system design parameters (air flow requirements, air contact time, etc.). This system is likely to be accepted by the public and regulatory communities since there is no air discharge to the environment. The perception of public risk will likely be that discharge of treated water to a closed environment such as a

sewer is desirable without an air discharge on site. This is a preferred remedial option.

U.V. Oxidation with Peroxide Addition Prior to passing through this process, ground water will pass through an oil/water separator to remove LNAPLs. This process involves the destruction of organic compounds via the use of ultra violet radiation. The absorption of ultra violet energy from the U.V. system causes chemical bonds in organic compounds to be broken. The addition of hydrogen peroxide serves to encourage the formation of hydroxide radicals which react with degraded organic compounds to form carbon dioxide and water. The result is the complete destruction of organic compounds to form water and carbon dioxide. The capital cost of a U.V. oxidation system is roughly equivalent to that of a closed loop air sparging system, but operational costs are considerably higher (roughly equivalent to operating costs of a conventional air stripper) due to the fact that U.V. oxidation is an energy intensive process. There is sufficient space and power available at the Ferndale site to construct a U.V. oxidation system, as spatial requirements are approximately the same for U.V. oxidation as for closed loop air sparging. U.V. oxidation is an effective process when operating properly.

U.V. oxidation is not a widely used technology because of the inability of U.V. light to penetrate and destroy pollutants in turbid or opaque water. In addition, U.V. lamps are subject to fouling by biological growth and/or silt build up. System influent may therefore require extensive pretreatment to prevent these situations, which can result in frequent shutdowns or poor performance. U.V. units are not generally accepted by regulatory agencies due to their performance history, but public acceptance would be likely since the process results in the complete destruction of VOCs. Due to the poor performance history of U.V. oxidation however, this is not a preferred remedial option.

Biodegradation Biodegradation involves the introduction of microbial activity into collected ground water to breakdown VOCs into less toxic compounds. The process is usually carried out in an aerobic reactor with phosphorus and nitrogen added as nutrients. A non-toxic organic compound (ethane or propane) is frequently added as a carbon and

energy source. The cost of constructing and operating a bioremediation system is approximately the same as for closed loop air sparging. This is a preferred remedial option.

Off-site Treatment and Disposal Removal of contaminated ground water from the site would be an effective means of cleaning up site ground water. This remedial option would involve collection of ground water from Site wells and subsequent transportation of the ground water off-site to a permitted facility for treatment and disposal. The costs for this option are high over time, but there are no construction or implementation issues associated with this option. Regulatory acceptance for this option may be low given the current regulatory philosophy favoring on-site treatment. Nonetheless, this is a preferred remedial option since there are many facilities that are capable of treating and disposing of contaminated water, and since this option has been implemented at other facilities.

Treated Water Discharge Options Once ground water has been collected and treated by one of the above remedial options, the treated ground water must be discharged. Discharge of treated water usually requires permits. Three options for discharge are presented below.

Discharge to the Local POTW: Treated water would be discharged to the sewer system owned by the Detroit Sewer and Water District (DSWD). To allow such a discharge, the DSWD would require a letter describing the discharge flow and duration and providing an analytical description. Approval of such a request to the DSWD would take approximately one month. Conversations with representatives of the DSWD indicated that a discharge limit of 20 ug/l of VOCs might be set for treated ground water from the Site. In addition to DSWD discharge authorization, written permission to discharge to the sewers would also have to be obtained from the City of Ferndale. This is a preferred remedial option which constitutes discharging treated ground water to a closed environment for eventual further treatment at the Publicly Owned Treatment Works (POTW).

Ground Water Reinjection: This option involves the reinjection of treated ground water to the site water table. Reinjection could be accomplished through a series of wells,

a reinjection trench or an infiltration pond. Prior to implementation, the MDNR requires the written approval of the ground water program section of the WMD, consistent with the requirements of Michigan's Water Resources Commission Act, 1929 PA245, as amended. Drinking water standards for organic solvents dictate treatment to levels approaching parts per trillion. Such extensive treatment would be costly, however this is a preferred remedial option.

Deep Well Injection: This remedial option involves the injection of treated ground water to the deep aquifer zone beneath the existing confining clay layer. Deep ground water, found at depths of approximately 5,000 to 15,000 feet, is typically characterized of high concentrations of brine and metals and generally has no commercial or residential applications. Injection would be accomplished through injection wells. A permit would be required for an injection program. Permits for such systems will apparently require substantial lead times for permit approval, and will be given poor chances for acceptance. While this remedial option might be preferred under other regulatory climates, it is not a promising option at the present time for this site.

4.3.3. Evaluation Summary and Recommendations

Four options were evaluated for a ground water containment cutoff wall, three were deemed preferred remedial options and will be considered further. Five ground water treatment options were evaluated, four were deemed preferred and will be considered further. Three treated water discharge options were evaluated, two were deemed preferred remedial options and will be considered further. Table 17 summarizes remedial options and current status with respect to consideration for implementation at the site.

These technologies will be evaluated with respect to cost, long term effectiveness, constructability/implementability, previous performance history of the technology on other similar sites, and regulatory acceptance/permitting issues.

Low Temperature Thermal Desorption Low temperature thermal desorption entails the application of heat to a soil matrix to volatilize (desorb) the organic compounds. Unlike incineration, which typically employs temperatures over 1500°F, low temperature thermal desorption typically employs temperatures less than 850°F and does not change the physical appearance of the soil. The volatilized organics are desorbed from the soil to the air stream where they are treated via air pollution control equipment (wet scrubbers, granular activated carbon (GAC), secondary combustion chamber, etc.). "Clean" air then exits a vent stack. This technology has been widely used in the past and is currently being employed on a number of CERCLA sites around the country. Typically, the remediation is performed on-site via mobile units. Several vendors have commercially available units. Typical costs for low temperature thermal desorption range from $75-$200 per cubic yard. This technology has a past history of proven effectiveness. However, treatability testing may be required to evaluate this method's ability to treat soils to the low cleanup levels likely required in program run according to Type B criteria. A low temperature thermal desorption system will likely require an air permit under RCRA and may also require a wastewater discharge related permit depending on the air pollution control equipment employed. Public acceptance of a low temperature thermal unit would likely be dependent on RCI being able to convey to the public that this technology is different from incineration. Given that past performance history of this technology indicates that it will successfully treat soils contaminated with organic solvents, this option will be retained for further consideration.

Soil Washing The soil washing process extracts contaminants from soil using a liquid medium composed of water and/or various chelating agents, surfactants, acids or bases depending on the contaminant to be removed. The soil is excavated and conveyed to a feeder where oversized soil material and debris are removed via a course screen. The soil then passes through a soil scrubber where it is sprayed with washing fluid.

Particles greater than 2mm in diameter are sorted and rinsed, leave the scrubber, are dewatered, and returned to the site. The remaining soil enters a countercurrent chemical extractor where additional washing fluid is applied. The treated soils are then dewatered and replaced on site. The washing fluid is then treated to remove contaminants and recycled. The residual sludge generated from wash water requires incineration or additional treatment for disposal in an approved landfill. Typically, one cubic yard of sludge is produced for every 20 cubic yards of soil processed. Costs for treatment via soil washing range from $80-150 per cubic yard. However, costs for disposal of residual sludge can add significantly to this cost. This technology will remove organic contaminants from the soil, however, it is unclear if "Type B" cleanup criteria can be achieved. Thus, a bench scale study or on-site pilot study will likely be required. Soil washing equipment is commercially available and can be performed on site. Previous experience has shown that soil washing is most effective on coarse particle soils. Fine sands, silts and clays do not lend themselves to particle separation and attempting to treat such soils via soil washing has resulted in material handling problems at other sites. Site soils at Ferndale are classified as fine sands/silty clay. This technology will likely not require an air permit, however, residual sludge management may require waste disposal permits. Given the potential cost involved with residual disposal and the performance history of soil washing on similar soils, this option will not be retained for further consideration.

Soil Flushing Soil flushing involves the injection of a solvent solution, which might consist of water, surfactants, acids, bases or some combination of these, into the soils to enhance the contaminant solubility which results in increased recovery of contaminants in site ground water. Ground water is reinjected upgradient of the extraction wells and leaches through soils. The leachate is then collected, treated and reinjected back into the ground creating a closed loop system. Non-toxic surfactant or chelating agents may be added to the ground water prior to reinjection. Soil flushing is typically employed at a cost of $40-80 per cubic yard (excluding ground water treatment costs) depending on soil type and contaminants. Soil flushing is best suited for sites contaminated with only a few specific chemicals. It is not

certain whether this technology can achieve "Type B" cleanup criteria. Bench scale studies and an on-site demonstration would likely be required to evaluate various flushing solutions and assess the effectiveness of soil flushing at this site. This technology is commercially available and can be implemented in conjunction with a ground water cleanup program on site. However, the washing agents employed in soil flushing may themselves be considered contaminants and, in most cases, must be completely recaptured to avoid further contaminating ground water. Given the wide range of contaminants present, it is likely that a multiple stage remediation (using multiple washing agents or soil flushing in conjunction with another technology) would be required for effective remediation. This technology will require permits associated with ground water reinjection and disposal of residual sludge. Due to the uncertain effectiveness, lack of proven past performance on sites with organic solvents, and potential regulatory and operational difficulties associated with multiple washing agents, this option will not be retained for further consideration.

In-Situ Biodegradation In-Situ biodegradation (biodegradation) involves the use of indigenous micro-organisms or introduced micro-organisms to accelerate the natural degradation of organic compounds in the soil. Nutrients are tilled into the soil at regular intervals to promote continued biological degradation of the organic compounds. Typical costs for biodegradation range from $20-50 per cubic yard. To date, biodegradation has not been shown to be effective on soils contaminated with organic solvents. In addition, the contamination of soil at the Ferndale site extends to depths up to six feet below grade. Biodegradation has been shown to be effective on surface soils. Typically, a ground water monitoring program is required by regulators to track the potential leaching of nutrients (phosphorus, nitrogen) to the ground water. Ex-situ biodegradation can also be performed; however, this process would be subject to the same limitations as the in-situ process with respect to effectiveness on organic solvents. This option will be retained for further consideration.

In-Situ Air Stripping ISAS is accomplished via a series of inlet wells extending radially from an air extraction well. Air is drawn through the inlet wells and the vadose zone to the extraction

well by a vacuum blower. Organic compounds are stripped from the soils to the passing air. Extracted air is then treated (usually with GAC) before being vented to the atmosphere. Typical costs for ISAS range from $10-35 per cubic yard of soil. ISAS would effectively remove volatile organic contaminants from the soil, however; previous experience has shown that removal of some organic solvents to "Type B" criteria may not be possible. Bench scale tests or on-site pilot tests may be required to assess the effectiveness of this option. An ISAS system and well network has been installed on the south portion of the site. This system could easily be adapted for use on the east or west portions of this site if it proves effective. An air permit would be required for operating this system. Securing an air permit would involve dispersion modelling for the site and could take up to 18 months to procure. Regulatory and public acceptance of this technology would be related to the results of the dispersion modelling and subsequent air pollution control requirements. Given that this technology is currently being implemented on the south portion of the site as a pilot study, it will be retained for further consideration.

In-Situ Air Sparging In-situ air sparging (air sparging) includes the injection of coarse bubble air into the ground water underlying the contaminated soil. The air bubbles diffuse through the ground water and into the vadose zone, sparging organic compounds from the ground water. The air and sparged VOCs are recovered from the vadose zone via an extraction well and a vacuum blower. The recovery of sparged air will cause additional organics to be stripped from the vadose zone soils. The recovered VOC laden sparged air is then treated (usually with GAC) and then either vented to the atmosphere or recycled (closed loop). Preliminary vendor information about air sparging systems indicates that a system suitable for treating this Site could be expected to have capital costs between $150,000-$300,000 and operating costs of $100,000-$150,000 per year. Air sparging has been proven effective on sites contaminated with petroleum hydrocarbons. As of this date, air sparging on organics has been demonstrated on a full scale, but has not been shown to achieve "Type B" cleanup standards. In addition, the effectiveness of the technology is dependent on site geology as well as contaminant makeup. Thus, on-Site pilot studies may be required to assess the effectiveness of this technology

with respect to achieving Type B criteria. This technology could be implemented on site with minimal disruption to the surrounding community and could serve as a ground water remediation as well as soil remediation. The equipment is typically skid mounted and moved as required within the site boundaries to remediate portions of the site as required. An air permit may be required if an open loop system is employed. A closed loop system will likely not require an air permit. Due to the potential cost effectiveness of in-situ air sparging, this technology will be retained for further evaluation.

4.2.2. Soil Treatment Evaluation Summary/Recommendations

Six remedial technologies were screened for potential application for soils remediation at the RCI, Ferndale, Michigan site. Of these six technologies, four were designated as potentially applicable including:

- Low Temperature Thermal Desorption
- Biodegradation
- In-Situ Air Stripping
- In-Situ Air Sparging

Costs for these options range from $150,000-$300,000 fixed cost for in-situ air sparging to $10-$35 per cubic yard for in-situ air stripping.

Table 15 provides a matrix summary of the evaluation. Table 16 presents a summary of the relevant soil data required to establish design parameters for each technology.

4.3. Evaluation of Strategies for Hydraulic Control of Ground Water

Environmental investigations at the Site have indicated that underlying ground water in the perched water table on site contain levels of organic solvents and other organic compounds at levels which may require remediation by the Michigan Department of Natural Resources (MDNR). The principle contaminants are:

- Trichloroethene
- Tetrachloroethane
- Xylene
- Toluene

- Naphthalene
- Methyl Naphthalene
- Benzene
- Ethyl Benzene
- Vinyl Chloride
- Non-Aqueous Phase Liquids (NAPLs)

The water table is recharged mainly through surface infiltration along the active railroad tracks which bisect the east and west portions of the site. Ground water flow is to the east and west of the railroad tracks.

The purpose of this evaluation is to evaluate commercially available options for controlling ground water at the site such that future off site migration of contaminated site ground water is prevented.

This section presents and discusses several options that may be used to effect hydraulic control in the perched water table at the Site. These options fall into two general categories: ground water containment/cutoff walls and ground water collection, treatment and discharge. The discussion focuses on the benefits and disadvantages of each remedial option. Each discussion provides a conclusion as to whether the remedial option is preferred or not preferred for possible further consideration for application at the Site.

4.3.1. Ground Water Containment/Cutoff Wall

The installation of a complete cutoff wall would effectively confine the site ground water and prevent off-site migration of contaminated ground water. A partial cutoff wall would impede the off-site migration of contaminated ground water, and in conjunction with a ground water pump and treat scheme, may be equally as effective as a complete cutoff wall.

Soil-Bentonite Slurry Wall Slurry walls are constructed in vertical trenches that are excavated under a slurry. The slurry, usually a mixture of bentonite and water, acts essentially like a soil porosity sealant and provides hydraulic shoring. It stabilizes the trench to prevent collapse and forms a low permeability filter cake on the trench walls to prevent water loss. Soil-bentonite slurry walls are installed by placing a mixture of soil and the bentonite slurry as backfill into the trench.

Initial Screening: The technology for installing soil-bentonite slurry walls is well-established. A low permeability clay layer is present throughout the site at a depth of approximately 12 to 15 feet, thus providing a means for near total encapsulation. A soil-bentonite slurry wall would provide a low permeability vertical barrier at low to medium cost. Sufficient space may not be available for construction of a slurry pond necessary to install a complete cutoff wall. This is a preferred remedial option for use on a partial cutoff wall.

Cement-Bentonite Slurry Wall Instead of a bentonite slurry, the cement-bentonite slurry wall uses a slurry composed of cement, bentonite and water, which is left in the trench to harden and form the containment wall.

Initial Screening: Like the soil-bentonite slurry wall, the cement-bentonite slurry wall is implementable and effective. The cement-bentonite slurry wall, however, is more costly than the soil-bentonite slurry wall and is more permeable. It is also more susceptible to chemical attacks by leachate. However, the cement-bentonite slurry wall has a higher strength, and can be more readily installed in areas with limited working space and steep topography. Although short term slope stability may be a concern during construction, long term slope stability is enhanced due to its higher strength. This option involves the disposal of contaminated soil which may be classified as hazardous. Disposal of this soil significantly increases the cost of this option. Therefore, this is not a preferred remedial option.

Steel Sheet Piling Steel sheet piling involves driving lengths of sheet steel into the ground. The steel sections are driven individually into the ground using a pile hammer. The interlocking sections form a relatively impermeable permanent barrier to flow.

Initial Screening: The top layer of soils at the site consists of asphalt and concrete, therefore driving steel sheet piling at the site would be accompanied by an initial removal/recycle of this top layer. Steel sheet piles provide structural stability to a cutoff wall. However, minor mismatching of the interlocks compromise the impermeability of the system, and the cost is relatively high. Additionally, the steel sheets are subject to corrosion from chemical attacks or electrolysis.

Often the corrosion is concentrated at the joints, which are the critical junctures of the wall. This can be partially offset by introducing anodes to reduce electrolysis or using special grade steel sheet. However, the use of special sheets increases the capital costs of this remedial option. This remedial option is preferred, but only for use in areas where other methods are not feasible.

Gundwall The installation of high density polyethylene (HDPE) walls involves either the driving of individual sheets into in-situ soils with a vibratory hammer or the placement of sheets by hand into an open trench. Rigid HDPE interlocking beams are separated by 80 to 120 mil thick HDPE sheets that form a relatively impermeable barrier. A groove in the locking beam allows for the insertion of an expansive material for sealing at the junction of the individual sheets.

Initial Screening: This is a relatively new containment technology. There are limited numbers of case studies existing to document its effectiveness. However, those case studies that do exist suggest that this technology is effective. The top layer of soils at the site consist of asphalt and concrete, therefore, installation of the sheets would be accompanied by an initial removal/recycle of this top layer. The interlocks incorporate an expansive seal designed to prevent leakage at panel locks. While HDPE is resistant to many chemicals, organic solvents and xylene degrade HDPE. An HDPE wall would provide a low permeability vertical barrier at a medium cost compared to other containment technologies. However, due to the potential degradation of HDPE in the presence of Site contaminants, this type of wall would require replacement after about five years. Currently, vendors are looking for plastic sheet material resistant to organic solvents, but such materials are not yet commercially available. This is a preferred remedial option only as a temporary hydraulic control measure.

4.3.2. Ground Water Collection, Treatment, and Discharge

Ground water collection may be implemented through the use of existing perimeter monitoring wells at the Site. Ground water collection would require perimeter wells on the east and west sides of the Site to be manifolded and collected water to be stored at a

central location for batch treatment. The following discussion will focus on ground water treatment and discharge options.

Ground Water Treatment Options Ground water contamination consists mainly of organic solvents, BTEX and NAPLs. The following treatment options are evaluated for treatment:

- Air Stripping
- Bioremediation
- Closed Loop Air Sparging
- Off-site Treatment and Disposal
- U.V. Oxidation, Peroxide Additive

These options are evaluated with respect to cost, long term effectiveness, constructability/implementability, previous performance history of the technology, and regulatory/public acceptance.

Air Stripping Prior to passing through this process, the ground water would pass through an oil/water separator to remove light NAPLs (LNAPL). Air stripping involves the mass transfer of VOCs from solution in a liquid (ground water) to the stripping gas (air). This is typically accomplished with a countercurrent packed tower, where water is introduced at the top of the tower and air is introduced at the bottom. VOC laden air is drawn off the top of the column and treated (usually with granular activated carbon, GAC) prior to being vented to the atmosphere. The stripped water is then discharged. Conventional air stripping requires a high energy input for air blowers for effective stripping to occur. The cost of constructing a conventional air stripping system is moderate to high. The operational costs (power, GAC replacement) are high.

The MDNR would likely require treatment of ground water to the low ppb range regardless of the method of discharge. Conventional air stripping may achieve such levels of treatment, however, it is possible that additional treatment (liquid phase GAC or ozonation) might be required.

Conventional air stripping systems do not require expansive areas for installation, and sufficient vertical clearance is available on site for the erection of a vent stack.

Conventional air stripping is a proven, widely used technology. As such, pilot testing would not be required. The use of a conventional air stripper would require an air permit for this site. Obtaining an air permit is a time consuming, and relatively costly endeavor. In addition, public resistance to a long term air discharge could be expected. Nonetheless, this is a preferred remedial option due to the proven effectiveness of this technology.

Closed Loop Air Sparging Prior to passing through this process, ground water will pass through an oil/water separator to remove LNAPLs. A closed loop air sparging system subjects VOC contaminated ground water to cross current coarse bubbled air which volatilizes VOCs. The system is typically maintained under a slight vacuum via the use of a vacuum blower. VOC laden air is pulled from the reactor tank and treated via vapor phase GAC. Treated air exiting the GAC is then recycled back to the air sparge header in the reactor tank. Treated (sparged) water is then pumped from the reactor tank to the disposal point or to additional treatment. Costs for construction of a closed loop air sparging system are slightly higher than for a conventional air stripper due to increases in process control; however, the operational costs associated with the closed loop system are considerably lower than for a conventional air stripper. Typically, air flow is much lower for sparging, resulting in lower energy costs. Closed loop air sparging systems are ideally suited for low flow (less then 20 gpm) or batch operations such as that anticipated at the site. These systems require minimal space and could easily be installed at the site, and, since there is no air discharge, no vent stack is required. These systems have been widely used throughout industry (although not as extensively as conventional air stripping). Past performance indicates that treatment efficiencies are slightly lower then for conventional air strippers, thus water polishing (liquid phase GAC or ozonation) may be required prior to discharge in order to meet discharge criteria. Bench scale testing would likely be required to establish system design parameters (air flow requirements, air contact time, etc.). This system is likely to be accepted by the public and regulatory communities since there is no air discharge to the environment. The perception of public risk will likely be that discharge of treated water to a closed environment such as a

sewer is desirable without an air discharge on site. This is a preferred remedial option.

U.V. Oxidation with Peroxide Addition Prior to passing through this process, ground water will pass through an oil/water separator to remove LNAPLs. This process involves the destruction of organic compounds via the use of ultra violet radiation. The absorption of ultra violet energy from the U.V. system causes chemical bonds in organic compounds to be broken. The addition of hydrogen peroxide serves to encourage the formation of hydroxide radicals which react with degraded organic compounds to form carbon dioxide and water. The result is the complete destruction of organic compounds to form water and carbon dioxide. The capital cost of a U.V. oxidation system is roughly equivalent to that of a closed loop air sparging system, but operational costs are considerably higher (roughly equivalent to operating costs of a conventional air stripper) due to the fact that U.V. oxidation is an energy intensive process. There is sufficient space and power available at the Ferndale site to construct a U.V. oxidation system, as spatial requirements are approximately the same for U.V. oxidation as for closed loop air sparging. U.V. oxidation is an effective process when operating properly.

U.V. oxidation is not a widely used technology because of the inability of U.V. light to penetrate and destroy pollutants in turbid or opaque water. In addition, U.V. lamps are subject to fouling by biological growth and/or silt build up. System influent may therefore require extensive pretreatment to prevent these situations, which can result in frequent shutdowns or poor performance. U.V. units are not generally accepted by regulatory agencies due to their performance history, but public acceptance would be likely since the process results in the complete destruction of VOCs. Due to the poor performance history of U.V. oxidation however, this is not a preferred remedial option.

Biodegradation Biodegradation involves the introduction of microbial activity into collected ground water to breakdown VOCs into less toxic compounds. The process is usually carried out in an aerobic reactor with phosphorus and nitrogen added as nutrients. A non-toxic organic compound (ethane or propane) is frequently added as a carbon and

energy source. The cost of constructing and operating a bioremediation system is approximately the same as for closed loop air sparging. This is a preferred remedial option.

Off-site Treatment and Disposal Removal of contaminated ground water from the site would be an effective means of cleaning up site ground water. This remedial option would involve collection of ground water from Site wells and subsequent transportation of the ground water off-site to a permitted facility for treatment and disposal. The costs for this option are high over time, but there are no construction or implementation issues associated with this option. Regulatory acceptance for this option may be low given the current regulatory philosophy favoring on-site treatment. Nonetheless, this is a preferred remedial option since there are many facilities that are capable of treating and disposing of contaminated water, and since this option has been implemented at other facilities.

Treated Water Discharge Options Once ground water has been collected and treated by one of the above remedial options, the treated ground water must be discharged. Discharge of treated water usually requires permits. Three options for discharge are presented below.

Discharge to the Local POTW: Treated water would be discharged to the sewer system owned by the Detroit Sewer and Water District (DSWD). To allow such a discharge, the DSWD would require a letter describing the discharge flow and duration and providing an analytical description. Approval of such a request to the DSWD would take approximately one month. Conversations with representatives of the DSWD indicated that a discharge limit of 20 ug/l of VOCs might be set for treated ground water from the Site. In addition to DSWD discharge authorization, written permission to discharge to the sewers would also have to be obtained from the City of Ferndale. This is a preferred remedial option which constitutes discharging treated ground water to a closed environment for eventual further treatment at the Publicly Owned Treatment Works (POTW).

Ground Water Reinjection: This option involves the reinjection of treated ground water to the site water table. Reinjection could be accomplished through a series of wells,

a reinjection trench or an infiltration pond. Prior to implementation, the MDNR requires the written approval of the ground water program section of the WMD, consistent with the requirements of Michigan's Water Resources Commission Act, 1929 PA245, as amended. Drinking water standards for organic solvents dictate treatment to levels approaching parts per trillion. Such extensive treatment would be costly, however this is a preferred remedial option.

Deep Well Injection: This remedial option involves the injection of treated ground water to the deep aquifer zone beneath the existing confining clay layer. Deep ground water, found at depths of approximately 5,000 to 15,000 feet, is typically characterized of high concentrations of brine and metals and generally has no commercial or residential applications. Injection would be accomplished through injection wells. A permit would be required for an injection program. Permits for such systems will apparently require substantial lead times for permit approval, and will be given poor chances for acceptance. While this remedial option might be preferred under other regulatory climates, it is not a promising option at the present time for this site.

4.3.3. Evaluation Summary and Recommendations

Four options were evaluated for a ground water containment cutoff wall, three were deemed preferred remedial options and will be considered further. Five ground water treatment options were evaluated, four were deemed preferred and will be considered further. Three treated water discharge options were evaluated, two were deemed preferred remedial options and will be considered further. Table 17 summarizes remedial options and current status with respect to consideration for implementation at the site.

TABLES

Table 1
Reichhold Chemicals, Inc.
Ferndale, Michigan
Hydrogeological Data
(Measurements in feet)

WELL NO.	SCREENED INTERVAL	DEPTH TO CLAY	CLAY ELEV.	GROUND WATER ELEVATION [07/26/91]	Saturated Thickness	GROUND WATER ELEVATION [08/2/91]	Saturated Thickness	GROUND WATER ELEVATION [9/4/91]	Saturated Thickness
MW - 1	3.61 - 5.61	6.2	637.20	639.25	2.05	639.14	1.94	638.98	1.78
MW - 2	3.49 - 7.49	8.0	636.30	640.58	4.28	640.45	4.15	640.30	4.00
MW - 3	4.10 - 6.10	4.8	638.20	639.74	1.54	639.54	1.34	640.47	2.27
MW - 4	4.82 - 7.37	6.5	637.20	642.23	5.03	642.09	4.89	642.42	5.22
MW - 5	5.76 - 7.40	7.5	636.80	NA	NA	NA	NA	NA	NA
MW - 6	1.50 - 6.50	9.0	634.68	640.05	5.37	639.95	5.27	639.86	5.18
MW - 7	1.00 - 6.00	7.5	637.30	640.89	3.59	640.62	3.32	640.25	2.95
MW - 8	2.00 - 7.00	10.5	634.49	641.43	6.94	641.23	6.74	641.00	6.51
MW - 9	2.00 - 9.00	9.0	636.39	639.96	3.56	639.77	3.38	639.46	3.07
MW - 10	2.00 - 7.00	7.0	637.27	639.81	2.54	639.68	2.41	639.52	2.25
MW - 11	2.50 - 7.50	7.5	637.53	641.07	3.54	641.02	3.49	641.08	3.55
MW - 12	1.50 - 6.50	6.5	639.50	643.58	4.08	643.35	3.85	643.94	4.44
MW - 13	1.00 - 6.00	9.0	637.02	643.52	6.50	643.46	6.44	643.78	6.76
MW - 14	4.00 - 9.00	7.0	637.71	639.06	1.35	638.94	1.23	638.71	1.00
MW - 15	2.00 - 6.00	6.0	639.07	639.99	0.92	638.96	-0.11	639.23	0.16
MW - 16	2.00 - 6.00	9.0	637.88	641.50	3.62	641.30	3.42	641.24	3.36
MW - 17	2.00 - 7.00	7.0	637.38	640.54	3.16	637.45	0.07	640.57	3.19
MW - 18	1.00 - 6.00	8.0	637.80	642.46	4.66	642.30	4.50	642.36	4.56
MW - 19	1.50 - 6.50	6.5	638.70	643.82	5.12	643.84	5.14	644.10	5.40
MW - 20	1.50 - 6.50	6.5	638.92	643.26	4.34	643.33	4.41	643.44	4.52
MW - 21	1.50 - 6.50	7.5	637.17	640.97	3.80	640.73	3.56	640.32	3.15

Table 2
Reichhold Chemicals, Inc.
Ferndale, Michigen
Soil Boring Analytical Results – September, 1991
Metals (Method 6010 and 7000 series)

PARAMETER	METHOD	Type A Criteria	MW-6 2'-4'	MW-6 8'-10'	MW-6 12'-14'	MW-7 6"-2'	MW-7 2'-4'	MW-7 6'-7.5'	MW-7 12'-14'	MW-8 4'-6'	MW-8 10'-12'	MW-8 14'-16'	MW-9 6"-2'	MW-9 8'-10'	MW-10 2'-4'	MW-10 10'-12'	MW-11 6"-2'	MW-11 6'-8'	MW-11 10'-12'
ARSENIC	7060	5.8	0.67	1.4	5.4	1.5	0.24	2.7	7.8	4.3	8.5	5	3.1	2.7	0.23	4.9	3.1	2.8	279
BARIUM	6010	75	7.4	7.7	32.5	17.2	14.1	9.4	70.9	11.8	106	57	32.7	28.7	7.7	44.6	41.7	22.7	66
CADMIUM	6010	1.2*	0.36	ND	ND	ND	ND	ND	ND	ND	ND	0.33	ND	ND	ND	ND	ND	ND	ND
CHROMIUM	6010	18	4	5	12.9	3.7	5.2	ND	22.3	5.3	31.8	19.3	8.5	6.7	4	15.5	10.6	8.9	22
COPPER	6010	32	3	3.8	11.9	3.3	2.3	ND	16.6	14.2	27.8	16	11.7	8.2	ND	13.3	11.6	10.1	16.5
LEAD	6010	21	2.9	ND	12.6	6	ND	ND	15.4	10	25.2	15	20	8.9	ND	14	16.2	11	12.3
MERCURY	7471	0.13	0.12	ND	ND	ND	ND	ND	0.12	ND	0.12	ND	ND	ND	ND	ND	ND	ND	ND
SILVER	6010	1.0	1.2	1.1	1.1	1.1	2.1	1.2	1.2	2.2	2.7	1.6	1.6	2.2	1.2	2	1.6	1.2	1.2
ZINC	6010	47	20	14.6	38.7	11.1	17.8	ND	55	14.6	73.5	50.1	36.5	28.1	15.8	38.7	58.7	30.5	53.1

NOTES:
(1): Concentrations in mg/kg.
(2): "ND" indicates the analyte was reported below the laboratory detection limit. Refer to the laboratory report for detection limits.
(3): NL = Not Listed
(4):MDNR Type A Soil Cleanup Criteria based upon MERA Operational Memo #15

Table 2
Raichhold Chemicals, Inc.
Ferndale, Michigan
Soil Boring Analytical Results – September, 1991
Metals (Method 6010 and 7000 series)

PARAMETER	METHOD	Type A Criteria	MW-12 1.5'-3'	MW-12 5'-7'	MW-12 9'-11'	MW-13 2'-4'	MW-13 10'-12'	MW-14 6'-2'	MW-14 6'-8'	MW-14 10'-12'	MW-15 4'-6'	MW-15 6'-8'	MW-15 10'-12'	MW-16 2'-4'	MW-16 8'-10'	MW-16 12'-14'	MW-17 4'-6'	MW-17 6'-7'	MW-17 9'-12'
ARSENIC	7060	5.8	1.9	6.6	0.32	5.5	4.6	2.2	5.9	7.9	1.1	4.3	7	9.2	3.4	5.3	2.9	1.9	7.9
BARIUM	6010	75	5.8	36.7	14.1	58.2	39.6	31.5	92	74.7	8.5	43.6	54.5	129	47	51.6	28.3	7.4	78.6
CADMIUM	6010	1.2	ND	ND	ND	ND	ND	ND	ND	ND	ND	0.36	ND	1.9	ND	ND	ND	ND	ND
CHROMIUM	6010	18	4.2	13.6	3	17.3	13.6	8.6	22.1	25.6	2.9	14.5	17.5	10.6	15	15.6	11.4	3.5	21.3
COPPER	6010	32	3.9	12.6	ND	15	12.8	15.5	19.8	18.1	5.1	13.1	14.2	141	17.3	13	3.3	5.3	18.6
LEAD	6010	21	ND	10.3	ND	10.6	7.5	ND	20.8	18.2	12	10.5	12.1	228	11.9	12.1	5.9	6.8	14.8
MERCURY	7471	0.13	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
SILVER	6010	1.0	1.2	1.1	1.3	1.2	1.1	1.1	1.3	1.3	1.2	1.2	1.4	1.2	1.2	1.3	1.2	1.2	1.2
ZINC	6010	47	21.3	42.2	13.6	51.2	44.9	44.7	68	60.2	15.3	42.7	49.7	197	55.5	45.2	18.1	21.2	61.6

NOTES:
(1): Concentretions in mg/kg.
(2): "ND" indicates the analyte was reported below the laboratory detection limit. Refer to the laboratory report for detaction limits.
(3): NL = Not Listed
(4):MDNR Type A Soil Cleanup Criteria based upon MERA Operational Memo #15

Table 2
Reichhold Chemicals, Inc.
Ferndale, Michigan
Soil Boring Analytical Results – September, 1991
Metals (Method 6010 and 7000 series)

PARAMETER	METHOD	Type A Criteria	MW-18 4'-6'	MW-18 8'-10'	MW-18 12'-14'	MW-19 6"-2'	MW-19 4'-6'	MW-19 10'-12'	MW-20 2'-4'	MW-20 8'-8'	MW-20 10'-12'	MW-21 1'-3'	MW-21 3'-4'	MW-21 12'-14'	DSB-1 6"-2'	DSB-1 4'-6'	DSB-1 10'-12'	DSB-1 22'-24'	DSB-1 38'-40'
ARSENIC	7060	5.8	0.39	5.5	3.2	4.3	0.83	6.6	1.8	2.9	6.2	3	4.8	6.8	3.3	3.5	3.9	4.3	4.8
BARIUM	6010	75	8.6	86.9	67.5	35.5	5.7	94	18.7	58.7	75.8	10.8	7.2	39	54.1	33.9	23.8	58.5	50.7
CADMIUM	6010	1.2	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	0.86	ND	ND	ND	ND	ND	11.5
CHROMIUM	6010	18	4	22.5	16.1	8.1	3.7	23.7	6.9	16.8	23.3	12.1	10.1	10.9	14.3	8.1	8.6	16.6	14.3
COPPER	6010	32	2.6	22	18.8	9.1	2.5	21.3	5	12.5	17.7	30.2	5.3	12.6	12.8	11.6	9.6	15.1	12.8
LEAD	6010	21	2.7	16.3	12.6	37	3.6	18.1	10.1	12.4	15.7	23.6	5.8	7.8	21.2	17.4	8.7	12.5	9.5
MERCURY	7471	0.13	ND	ND	ND	ND	ND	ND	ND	ND	ND	5.2	ND	ND	ND	ND	ND	ND	ND
SILVER	6010	1.0	1.2	1.3	1.2	1.2	1.2	1.2	1.2	1.2	1.1	1.2	2.1	1.1	1.2	1.3	1.1	1.1	1.1
ZINC	6010	47	26	68.7	59.5	53.9	13.5	66.8	35.7	46.6	60.1	26.5	26	35.6	69.5	46.7	34.2	48.5	43.2

NOTES:
(1): Concentrations in mg/kg.
(2): "ND" indicates the analyte was reported below the laboratory detection limit. Refer to the laboratory report for detection limits.
(3): NL = Not Listed
(4): MDNR Type A Soil Cleanup Criteria based upon MERA Operational Memo #15

Table 2
Reichhold Chemicals, Inc.
Ferndale, Michigan
Soil Boring Analytical Results – September, 1991
Metals (Method 6010 and 7000 series)

PARAMETER	METHOD	Type A Criteria	DSB-2 1.5'-3'	DSB-2 7'-9'	DSB-2 11'-13'	DSB-2 23'-25'	DSB-2 33'-35'	DSB-3 4'-6'	DSB-3 6'-12'	DSB-3 10'-12'	DSB-3 22'-24'	DSB-3 32'-34'
ARSENIC	7060	5.8	5.2	0.7	5.1	4.1	4.7	6.4	4.7	6.7	5.5	4.5
BARIUM	6010	75	20.1	8.8	66	60.4	62.1	13	30.8	52.7	57.7	56
CADMIUM	6010	1.2	6.5	ND	ND	ND	ND	ND	ND	ND	ND	ND
CHROMIUM	6010	18	6.5	4.4	19.6	16.3	18.2	6.3	7.2	16.6	16.7	16.6
COPPER	6010	32	31.2	4.5	16.2	21.7	12.9	3.2	9.8	17.3	17.5	13.8
LEAD	6010	21	38.1	3.5	12	10.1	6	2.9	20.8	11.4	14.3	10
MERCURY	7471	0.13	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
SILVER	6010	1.0	1.4	1.2	1.2	1.1	1.1	ND	ND	ND	ND	ND
ZINC	6010	47	140	19.8	53.6	44.6	44.5	16.1	55.4	47	53.1	44.1

NOTES:
(1): Concentrations in mg/kg.
(2): "ND" indicates the analyte was reported below the laboratory detection limit. Refer to the laboratory report for detection limits.
(3): NL = Not Listed
(4):MDNR Type A Soil Cleanup Criteria based upon MERA Operational Memo #15

Table 3
Reichhold Chemicals, Inc.
Ferndale, Michigan
Soil Boring Analytical Results – September, 1991
Volatile Organic Compounds (Method 8240)

PARAMETER	METHOD	Cleanup Criteria *	MW-6 2'-4'	MW-6 8'-10'	MW-6 12'-14'	MW-7 6"-2'	MW-7 2'-4'	MW-7 6'-7.5'	MW-7 12'-14'	MW-8 4'-6'	MW-8 18'-12'	MW-8 14'-16'	MW-9 6"-2'
1,1,1-TRICHLOROETHANE	8240	4000	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
1,1-DICHLOROETHANE	8240	17000	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
1,1-DICHLOROETHENE	8240	140	ND	ND	ND	220 J	ND	ND	ND	ND	ND	ND	ND
1,2-DICHLOROETHENE (TOTAL)	8240	1500	ND	ND	ND	360 J	ND	ND	8	2 J	36	19	150 J
2-BUTANONE	8240	6400	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
2-HEXANONE	8240	20000	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
4-METHYL-2-PENTANONE	8240	7000	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
ACETONE	8240	14000	140 B	15 B	54 B	1,200 J B	5,600 J B	ND	14 B	7 J B	280 B	29 B	250 J B
BENZENE	8240	24	ND	ND	ND	ND	ND	ND	ND	ND	28	ND	ND
BROMOMETHANE	8240	200	ND	ND	ND	260 J	ND	ND	ND	ND	ND	ND	ND
CARBON DISULFIDE	8240	15000	ND	1 J	ND	ND	ND	ND	ND	ND	2 J	ND	ND
CARBON TETRACHLORIDE	8240	5.4	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
ETHYLBENZENE	8240	1500	120	130	3 J	240,000 D	10,000	13	29	ND	4 J	ND	14,000
METHYLENE CHLORIDE	8240	92	35 DB	6 J B	10 B	94,000 J B	1,900 J B	4 J B	5 J B	4 J B	26 B	7 B	540 J B
STYRENE	8240	24	ND	ND	ND	ND	ND	ND	ND	ND	ND	2 J	ND
TRICHLOROETHENE	8240	44	24	6	11	600 J	ND	17	110	64	340	210	5,000
VINYL CHLORIDE	8240	0.32	ND	ND	ND	420 J	ND	ND	ND	ND	5 J	ND	ND
XYLENE (TOTAL)	8240	5600	44 D	23	10	3,300,000 D	14,000 D	510	310	ND	20	13	620 J
TOLUENE	8240	16000	2 J	ND	ND	1,000	ND	ND	ND	ND	ND	ND	ND
TETRACHLOROETHENE	8240	14	1 J	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND

NOTES:
All concentrations are in ug/kg.
ND: indicates the analyte was reported at below the laboratory detection limit. Refer to the laboratory reports for datection limits.
NL: Not Listed
*: MDNR Act 307 Type B (20 X Ground Water) Cleanup Criteria. (MERA Operational Memorandum #8, Revision 3)
D: compound found in diluted run.
J: indicates an estimated value.
B: Analyte was found in blank as well as sample.
E: exceeded calibration range.

Table 3
Reichhold Chemicals, Inc.
Ferndale, Michigan
Soil Boring Analytical Results – September, 1991
Volatile Organic Compounds (Method 8240)

PARAMETER	METHOD	Cleanup Criteria *	MW-9 8'-10'	MW-10 2'-4'	MW-10 6'-8'	MW-10 10-12'	MW-11 6"-2'	MW-11 6'-8'	MW-11 10'-12'	MW-12 1.5'-3'	MW-12 5'-7'	MW-12 9'-11'	MW-13 2'-4'	MW-13 10'-12'
1,1,1-TRICHLOROETHANE	8240	4000	4900	ND	ND	ND	79	ND	ND	ND	ND	ND	ND	ND
1,1-DICHLOROETHANE	8240	17000	180 J	ND	ND	ND	3 J	ND	ND	ND	ND	ND	ND	ND
1,1-DICHLOROETHENE	8240	140	170 J	ND	ND	ND	2 J	3 J	ND	ND	ND	ND	ND	ND
1,2-DICHLOROETHENE (TOTAL)	8240	1500	98,000 E	1 J	28	14	4,700 D	3,800 JD	68	ND	ND	ND	ND	ND
2-BUTANONE	8240	6400	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
2-HEXANONE	8240	20000	ND	ND	ND	ND	ND	10 J	ND	ND	ND	ND	ND	ND
4-METHYL-2-PENTANONE	8240	7000	3400	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
ACETONE	8240	14000	1,400,000 B	14 B	175 B	110 B	22,000 B	58,000 B	75 B	17 B	60 B	ND	110 B	140 B
BENZENE	8240	24	ND	ND	ND	ND	ND	ND	ND	ND	ND	39,000 B	ND	ND
BROMOMETHANE	8240	200	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
CARBON DISULFIDE	8240	15000	ND	ND	2 J	ND	ND	1 J	ND	ND	ND	ND	ND	ND
CARBON TETRACHLORIDE	8240	5.4	700 J	ND	ND	ND	10	ND	ND	ND	ND	ND	ND	ND
ETHYLBENZENE	8240	1500	30,000 E	ND	8	ND	1,800 J	5,900 JD	1 J	3 J	ND	280,000	21	32
METHYLENE CHLORIDE	8240	92	150,000 J B	8 B	30 B	35 B	3,400 B	9,200 J B	ND	10 B	17 B	190,000 J B	11 B	140 B
STYRENE	8240	24	1,000,000 D	ND	ND	ND	ND	340 E	ND	ND	ND	ND	ND	ND
TRICHLOROETHENE	8240	44	4,700,000 D	16	72 D	26 JD	50,000 D	ND	200	ND	ND	ND	ND	ND
VINYL CHLORIDE	8240	0.32	890 J	ND	ND	ND	15	21	5 J	ND	ND	ND	ND	ND
XYLENE (TOTAL)	8240	5600	19,000	ND	ND	ND	140 D	24,000 D	4 J	38	13	740,000 D	290	460
TOLUENE	8240	16000	2,100	ND	2 J	ND	76	180	ND	4 J	ND	ND	23	49
TETRACHLOROETHENE	8240	14	5,200	ND	ND	ND	190	450 E	ND	ND	ND	ND	ND	ND

NOTES:
All concentrations are in ug/kg.
ND: indicates the analyte was reported at below the laboratory detection limit. Refer to the laboratory reports for detection limits.
NL: Not Listed
*: MDNR Act 307 Type B (20 X Ground Water) Cleanup Criteria. (MERA Operational Memorandum #8, Revision 3)
D: compound found in diluted run.
J: indicates an estimated value.
B: Analyte was found in blank as well as sample.
E: exceeded calibration range.

Table 3
Reichhold Chemicals, Inc.
Ferndale, Michigan
Soil Boring Analytical Results - September, 1991
Volatile Organic Compounds (Method 8240)

PARAMETER	METHOD	Cleanup Criteria *	MW-14 6"-2'	MW-14 6'-8'	MW-14 10'-12'	MW-15 4'-6'	MW-15 6'-8'	MW-15 10'-12'	MW-16 2'-4'	MW-16 8'-10'	MW-16 12'-14'	MW-17 4'-6'	MW-17 6'-7'	MW-17 9'-12'
1,1,1-TRICHLOROETHANE	8240	4000	ND	ND	ND	ND	ND	ND	260 J	ND	ND	ND	ND	ND
1,1-DICHLOROETHANE	8240	17000	ND	9	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
1,1-DICHLOROETHENE	8240	140	ND	57	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
1,2-DICHLOROETHENE (TOTAL)	8240	1500	280 J	250	1,000 D	ND	ND	ND	ND	ND	ND	ND	ND	ND
2-BUTANONE	8240	6400	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
2-HEXANONE	8240	20000	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
4-METHYL-2-PENTANONE	8240	7000	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
ACETONE	8240	14000	23,000 B	55 B	4,200 B	ND	110 B	86	ND	ND	76 B	51 B	43 B	49 B
BENZENE	8240	24	ND	4 J	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
BROMOMETHANE	8240	200	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
CARBON DISULFIDE	8240	15000	ND	4 J	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
CARBON TETRACHLORIDE	8240	5.4	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
ETHYLBENZENE	8240	1500	9,000	24 J	360 J	ND	2 J	3	220,000 D	3,800	15	ND	3 J	ND
METHYLENE CHLORIDE	8240	92	4,300 B	9 J B	480 J B	9 B	18 B	14 B	110,000 J B	3,200 B	15 B	7 B	8 B	7 B
STYRENE	8240	24	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
TRICHLOROETHENE	8240	44	88,000 D	23 JD	5,100	36	16	5	2,400	2 J	15	2 J	2 J	ND
VINYL CHLORIDE	8240	0.32	ND	740 E	4 J	ND	ND	ND	ND	ND	ND	ND	ND	ND
XYLENE (TOTAL)	8240	5600	66,000	120	140	3 J	12	28	1,400,000 D	60,000 D	62	35	420	16
TOLUENE	8240	16000	1,600 J	15 J	12	ND	ND	ND	1,400	ND	2 J	ND	ND	ND
TETRACHLOROETHENE	8240	14	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND

NOTES:
All concentrations are in ug/kg.
ND: indicates tha analyte was reported at below the laboratory detection limit. Refer to the laboratory reports for detection limits.
NL: Not Listed
*: MDNR Act 307 Type B (20 X Ground Water) Cleanup Criteria. (MERA Operational Memorandum #8, Revision 3)
D: compound found in diluted run.
J: indicates an estimated value.
B: Analyte was found in blank as well as sample.
E: exceeded calibration range.

Table 3
Reichhold Chemicals, Inc.
Ferndale, Michigan
Soil Boring Analytical Results – September, 1991
Volatile Organic Compounds (Method 8240)

PARAMETER	METHOD	Cleanup Criteria *	MW-18 4'-6'	MW-18 8'-10'	MW-18 12'-14'	MW-19 6"-2'	MW-19 4'-6'	MW-19 10-12'	MW-20 2'-4'	MW-20 6'-8'	MW-20 10'-12'	MW-21 1'-3'	MW-21 3'-4'	MW-21 12'-14'
1,1,1-TRICHLOROETHANE	8240	4000	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
1,1-DICHLOROETHANE	8240	17000	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
1,1-DICHLOROETHENE	8240	140	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
1,2-DICHLOROETHENE (TOTAL)	8240	1500	47	230 J	ND	ND	ND	9 J	2,600	ND	6	4 J	ND	13
2-BUTANONE	8240	6400	ND	ND	ND	ND	ND	ND	ND	ND	27	ND	ND	ND
2-HEXANONE	8240	20000	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
4-METHYL-2-PENTANONE	8240	7000	ND	ND	ND	ND	ND	ND	ND	ND	28	ND	ND	ND
ACETONE	8240	14000	4,300 B	2,100 B	41 B	58,000 B	ND	40 B	1,200,000 B	17,000 B	150 B	200 B	370 B	110 B
BENZENE	8240	24	ND	ND	ND	ND	ND	ND	870 J	ND	ND	ND	ND	ND
BROMOMETHANE	8240	200	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
CARBON DISULFIDE	8240	15000	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
CARBON TETRACHLORIDE	8240	5.4	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
ETHYLBENZENE	8240	1500	1,900 D	23,000 D	15	210,000 D	270	200	930,000 D	48,000	18	130	63	ND
METHYLENE CHLORIDE	8240	92	480 J B	1,200 B	49 B	25,000 B	10 J B	23 J B	170,000 J B	1,400 J B	4 J B	10 B	23 J B	21 B
STYRENE	8240	24	ND	ND	ND	ND	ND	ND	ND	ND	ND	76	54	ND
TRICHLOROETHENE	8240	44	36	540	2 J	360 J	24 J	18	15,000	ND	31	150	27 J	99
VINYL CHLORIDE	8240	0.32	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
XYLENE (TOTAL)	8240	5600	6,800 D	73,000 D	77	1,000,000 D	1,300	2,000 D	5,600,000 D	18,000	120	700	460	18
TOLUENE	8240	16000	17 J	100	ND	22,000	49	52	150,000 J	ND	28	ND	ND	ND
TETRACHLOROETHENE	8240	14	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND

NOTES:
All concentrations are in ug/kg.
ND: indicates the analyte was reported at below the laboratory detection limit. Refer to the laboratory reports for detection limits.
NL: Not Listed
*: MDNR Act 307 Type B (20 X Ground Water) Cleanup Criteria. (MERA Operational Memorandum #8, Revision 3)
D: compound found in diluted run.
J: indicates an estimated value.
B: Analyte was found in blank as well as sample.
E: exceeded calibration range.

Table 3
Reichhold Chemicals, Inc.
Ferndale, Michigan
Soil Boring Analytical Results - September, 1991
Volatile Organic Compounds (Method 8240)

PARAMETER	METHOD	Cleanup Criteria *	DSB-1 22'-24'	DSB-1 38'-40'	DS-1 6"-2'	DS-1 4'-6'	DS-1 10'-12'	DS-2 1.5'-3'	DS-2 7'-9'	DS-2 11'-13'	DS-2 23'-25'	DS-2 33'-35'	DS-3 6"-2'	DS-3 4'-6'
1,1,1-TRICHLOROETHANE	8240	4000	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
1,1-DICHLOROETHANE	8240	17000	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
1,1-DICHLOROETHENE	8240	140	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
1,2-DICHLOROETHENE (TOTAL)	8240	1500	ND	ND	3 J	520 B	37 B	ND	ND	ND	2 J	ND	ND	ND
2-BUTANONE	8240	6400	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
2-HEXANONE	8240	20000	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
4-METHYL-2-PENTANONE	8240	7000	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
ACETONE	8240	14000	21 B	33 B	150 B	ND	2 J B	80 B	47 B	45 B	37 B	ND	ND	13 B
BENZENE	8240	24	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
BROMOMETHANE	8240	200	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
CARBON DISULFIDE	8240	15000	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
CARBON TETRACHLORIDE	8240	5.4	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
ETHYLBENZENE	8240	1500	ND	ND	3 J	ND	ND	ND	ND	ND	2 J	ND	ND	ND
METHYLENE CHLORIDE	8240	92	14 B	11 B	5 J B	19 J B	6 B	24 B	11 B	14 B	12 B	3 J B	22 B	19 B
STYRENE	8240	24	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
TRICHLOROETHENE	8240	44	ND	ND	40	11 J	9	ND	ND	ND	26	3 J	ND	ND
VINYL CHLORIDE	8240	0.32	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
XYLENE (TOTAL)	8240	5600	ND	6 B	18	1,900	9	25 B	16	ND	21 B	ND	8	11
TOLUENE	8240	16000	ND	ND	2 J	ND	ND	ND	ND	ND	ND	ND	ND	1 J
TETRACHLOROETHENE	8240	14	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND

NOTES:
All concentrations are in ug/kg.
ND: indicates the analyte was reported at below the laboratory detection limit. Refer to the laboratory reports for detection limits.
NL: Not Listed
*: MDNR Act 307 Type B (20 X Ground Water) Cleanup Criteria. (MERA Operational Memorandum #8, Revision 3)
D: compound found in diluted run.
J: indicates an estimated value.
B: Analyte was found in blank as well as sample.
E: exceeded calibration range.

Table 3
Reichhold Chemicals, Inc.
Ferndale, Michigan
Soil Boring Analytical Results – September, 1991
Volatile Organic Compounds (Method 8240)

PARAMETER	METHOD	Cleanup Criteria *	DS-3 10'-12'	DS-3 22'-24'	DS-3 32'-34'
1,1,1-TRICHLOROETHANE	8240	4000	ND	ND	ND
1,1-DICHLOROETHANE	8240	17000	ND	ND	ND
1,1-DICHLOROETHENE	8240	140	ND	ND	ND
1,2-DICHLOROETHENE (TOTAL)	8240	1500	ND	ND	4 J
2-BUTANONE	8240	6400	ND	ND	ND
2-HEXANONE	8240	20000	ND	ND	ND
4-METHYL-2-PENTANONE	8240	7000	ND	ND	ND
ACETONE	8240	14000	50 B	120 B	54 B
BENZENE	8240	24	ND	ND	ND
BROMOMETHANE	8240	200	ND	ND	ND
CARBON DISULFIDE	8240	15000	ND	ND	ND
CARBON TETRACHLORIDE	8240	5.4	ND	ND	ND
ETHYLBENZENE	8240	1500	ND	ND	5 J
METHYLENE CHLORIDE	8240	92	2 J B	7 B	8 B
STYRENE	8240	24	ND	ND	ND
TRICHLOROETHENE	8240	44	ND	29	74
VINYL CHLORIDE	8240	0.32	ND	ND	ND
XYLENE (TOTAL)	8240	5600	ND	8	21
TOLUENE	8240	16000	ND	ND	ND
TETRACHLOROETHENE	8240	14	ND	ND	ND

NOTES:
All concentrations are in ug/kg.
ND: indicates the analyte was reported at below the laboratory detection limit. Refer to the laboratory reports for detection limits.
NL: Not Listed
*: MDNR Act 307 Type B (20 X Ground Water) Cleanup Criteria. (MERA Operational Memorandum #8, Revision 3)
D: compound found in diluted run.
J: indicates an estimated value.
B: Analyte was found in blank as well as sample.
E: exceeded calibration range.

Table 4
Reichhold Chemicals, Inc.
Ferndale, Michigan
Soil Boring Analytical Results – September, 1991
Semi-Volatile Organic Compounds (Method 8270)

PARAMETER	METHOD	Type B Criteria *	MW-6 2'-4'	MW-6 8'-10'	MW-6 12'-14'	MW-7 6"-2'	MW-7 2'-4'	MW-7 6'-7.5'	MW-7 12'-14'	MW-8 4'-6'	MW-8 10'-12'	MW-8 14'-16'	MW-9 6"-2'	MW-9 8'-10'
PHENOL	8270	64000	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
NAPHTHALENE	8270	5000	3,200	7,700	ND	920	ND	200 J	ND	ND	ND	ND	4,800	ND
2-METHYLNAPHTHALENE	8270	220	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	160 J	ND
DIMETHYL PHTHALATE	8270	NL	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
ACENAPHTHYLENE	8270	500	ND	ND	ND	190 J	ND	ND	ND	ND	ND	ND	ND	ND
ACENAPHTHENE	8270	24000	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
DIBENZOFURAN	8270	330	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
FLUORENE	8270	17000	ND	ND	ND	140 J	ND	ND	ND	ND	ND	ND	81 J	ND
PHENANTRHRENE	8270	500	ND	ND	ND	1,000	ND	ND	ND	ND	ND	ND	230 J	ND
ANTHRACENE	8270	14000	ND	ND	ND	160 J	ND	ND	ND	ND	ND	ND	ND	ND
DI-N-BUTYLPHTHALATE	8270	17000	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
FLUORANTHENE	8270	17000	ND	ND	ND	840	96 J	ND	ND	ND	ND	ND	150 J	ND
PYRENE	8270	10000	ND	ND	ND	670 J	86 J	ND	ND	ND	ND	ND	250 J	ND
BUTYLBENZYLPHTHALATE	8270	22000	ND	ND	ND	200 J	ND	ND	ND	ND	ND	ND	ND	ND
BENZO(A)ANTHRACENE	8270	330	ND	ND	ND	110 J	ND	ND	ND	ND	ND	ND	ND	ND
BIS(2-ETHYLHEXYL)PHTHALATE	8270	330	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
CHRYSENE	8270	330	ND	ND	ND	230 J	ND	ND	ND	ND	ND	ND	150 J	ND
DI-N-OCTYL PHTHALATE	8270	2600	ND	ND	ND	88 J	ND	ND	ND	ND	ND	ND	ND	ND
BENZO(B)FLUORANTHENE	8270	330	ND	ND	ND	110 J	ND	ND	ND	ND	ND	ND	170 J	ND
BENZO(K)FLUORANTHENE	8270	330	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	150 J	ND
INDENO(1,2,3-CD)PYRENE	8270	330	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
BENZO(G,H,I)PERYLENE	8270	330	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND

NOTES:
All concentrations are in ug/kg.
ND: indicates the analyte was reported at below laboratory detection limit. Refer to the laboratory reports for detection limits.
NL: Not Listed
*: MDNR Act 307 Type B (20 X Ground Water) Cleanup Criteria (MERA Operational Memorandum #8, Revision 3)
D: compound found in diluted run.
J: indicates an estimated value.
B: analyte was found in blank as well as sample.

Table 4
Reichhold Chemicals, Inc.
Ferndale, Michigan
Soil Boring Analytical Results – September, 1991
Semi-Volatile Organic Compounds (Method 8270)

PARAMETER	METHOD	Type B Criteria *	MW-10 2'-4'	MW-10 6'-8'	MW-10 10'-12'	MW-11 6"-2'	MW-11 6'-8'	MW-11 10'-12'	MW-12 1.5'-3'	MW-12 5'-7'	MW-12 9'-11'	MW-13 2'-4'	MW-13 10'-12'	MW-14 6"-2'
PHENOL	8270	64000	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
NAPHTHALENE	8270	5000	ND	ND	ND	ND	ND	ND	ND	ND	30,000	ND	ND	80 J
2-METHYLNAPHTHALENE	8270	220	ND	ND	ND	ND	ND	ND	ND	ND	44,000	ND	ND	ND
DIMETHYL PHTHALATE	8270	NL	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
ACENAPHTHYLENE	8270	500	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
ACENAPHTHENE	8270	24000	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
DIBENZOFURAN	8270	330	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
FLUORENE	8270	17000	ND	ND	ND	ND	ND	ND	ND	ND	8,700	ND	ND	ND
PHENANTRHRENE	8270	500	ND	ND	ND	ND	ND	ND	ND	ND	23,000	ND	ND	ND
ANTHRACENE	8270	14000	ND	ND	ND	ND	ND	ND	ND	ND	2,800	ND	ND	ND
DI-N-BUTYLPHTHALATE	8270	17000	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
FLUORANTHENE	8270	17000	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	100 J
PYRENE	8270	10000	ND	ND	ND	ND	ND	ND	ND	ND	3,700	ND	ND	140 J
BUTYLBENZYLPHTHALATE	8270	22000	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
BENZO(A)ANTHRACENE	8270	330	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
BIS(2-ETHYLHEXYL)PHTHALATE	8270	330	ND	ND	ND	170 J	ND	ND	ND	ND	ND	380 J	830	ND
CHRYSENE	8270	330	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	78 J
DI-N-OCTYL PHTHALATE	8270	2600	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
BENZO(B)FLUORANTHENE	8270	330	ND	ND	ND	130 J	ND	ND	ND	ND	ND	ND	ND	110 J
BENZO(K)FLUORANTHENE	8270	330	ND	ND	ND	140 J	ND	ND	ND	ND	ND	ND	ND	87 J
INDENO(1,2,3-CD)PYRENE	8270	330	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
BENZO(G,H,I)PERYLENE	8270	330	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND

NOTES:
All concentrations are in ug/kg.
ND: indicates the analyte was reported at below laboratory detection limit. Refer to tha laboratory reports for detection limits.
NL: Not Listed
*: MDNR Act 307 Type B (20 X Ground Water) Cleanup Criteria (MERA Operational Memorandum #8, Revision 3)
D: compound found in dilluted run.
J: indicates an estimated value.
B: analyte was found in blank as well as sample.

Table 4
Reichhold Chemicals, Inc.
Ferndale, Michigan
Soil Boring Analytical Results – September, 1991
Semi-Volatile Organic Compounds (Method 8270)

PARAMETER	METHOD	Type B Criteria *	MW-14 6'-8'	MW-14 10'-12'	MW-15 4'-6'	MW-15 6'-8'	MW-15 10'-12'	MW-16 2'-4'	MW-16 8'-10'	MW-16 12'-14'	MW-17 4'-6'	MW-17 6'-7'	MW-17 9'-12'	MW-18 4'-6'
PHENOL	8270	64000	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
NAPHTHALENE	8270	5000	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	680 J
2-METHYLNAPHTHALENE	8270	220	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
DIMETHYL PHTHALATE	8270	NL	490 J	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
ACENAPHTHYLENE	8270	500	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
ACENAPHTHENE	8270	24000	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
DIBENZOFURAN	8270	330	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
FLUORENE	8270	17000	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
PHENANTRHRENE	8270	500	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
ANTHRACENE	8270	14000	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
DI-N-BUTYLPHTHALATE	8270	17000	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
FLUORANTHENE	8270	17000	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
PYRENE	8270	10000	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
BUTYLBENZYLPHTHALATE	8270	22000	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
BENZO(A)ANTHRACENE	8270	330	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
BIS(2-ETHYLHEXYL)PHTHALATE	8270	330	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
CHRYSENE	8270	330	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
DI-N-OCTYL PHTHALATE	8270	2600	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
BENZO(B)FLUORANTHENE	8270	330	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
BENZO(K)FLUORANTHENE	8270	330	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
INDENO(1,2,3-CD)PYRENE	8270	330	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
BENZO(G,H,I)PERYLENE	8270	330	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND

NOTES:
All concentrations are in ug/kg.
ND: indicates the analyte was reported at below laboratory detection limit. Refer to the laboratory reports for detection limits.
NL: Not Listed
*: MDNR Act 307 Type B (20 X Ground Water) Cleanup Criteria (MERA Operational Memorandum #8, Revision 3)
D: compound found in diluted run.
J: indicates an estimated value.
B: analyte was found in blank as well as sample.

Table 4
Reichhold Chemicals, Inc.
Ferndale, Michigan
Soil Boring Analytical Results – September, 1991
Semi-Volatile Organic Compounds (Method 8270)

PARAMETER	METHOD	Type B Criteria *	MW-18 8'-10'	MW-18 12'-14'	MW-19 6"-2'	MW-19 4'-6'	MW-19 10'-12'	MW-20 2'-4'	MW-20 6'-8'	MW-20 10'-12'	MW-21 1'-3'	MW-21 3'-4'	MW-21 12'-14'	DSB-1 22'-24'
PHENOL	8270	64000	ND	ND	ND	ND	ND	14001 J B	ND	ND	ND	ND	ND	ND
NAPHTHALENE	8270	5000	2,100	ND	15,000 J	150 J	ND	21,000 J	ND	ND	730,000	1,000,000	330 J	ND
2-METHYLNAPHTHALENE	8270	220	ND	ND	ND	ND	ND	4,700 J	ND	ND	24,000	9,100 J	ND	ND
DIMETHYL PHTHALATE	8270	NL	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
ACENAPHTHYLENE	8270	500	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
ACENAPHTHENE	8270	24000	ND	ND	ND	ND	ND	ND	ND	ND	4,700	ND	ND	ND
DIBENZOFURAN	8270	330	ND	ND	ND	ND	ND	ND	ND	ND	6,200 J	ND	ND	ND
FLUORENE	8270	17000	ND	ND	ND	ND	ND	ND	ND	ND	4,500 J	3,000 J	ND	ND
PHENANTRHRENE	8270	500	ND	ND	ND	ND	ND	ND	ND	ND	13,000 J	3,400 J	ND	ND
ANTHRACENE	8270	14000	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
DI-N-BUTYLPHTHALATE	8270	17000	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
FLUORANTHENE	8270	17000	ND	ND	ND	ND	ND	ND	ND	ND	6,800 J	ND	ND	ND
PYRENE	8270	10000	ND	ND	ND	ND	ND	ND	ND	ND	5,700 J	ND	ND	ND
BUTYLBENZYLPHTHALATE	8270	22000	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
BENZO(A)ANTHRACENE	8270	330	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
BIS(2-ETHYLHEXYL)PHTHALATE	8270	330	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
CHRYSENE	8270	330	ND	ND	ND	ND	ND	ND	ND	ND	3,000 J	ND	ND	ND
DI-N-OCTYL PHTHALATE	8270	2600	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
BENZO(B)FLUORANTHENE	8270	330	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
BENZO(K)FLUORANTHENE	8270	330	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
INDENO(1,2,3-CD)PYRENE	8270	330	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
BENZO(G,H,I)PERYLENE	8270	330	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND

NOTES:
All concentrations are in ug/kg.
ND: indicates the analyte was reported at below laboratory detection limit. Refer to the laboratory reports for detection limits.
NL: Not Listed
*: MDNR Act 307 Type B (20 X Ground Water) Cleanup Criteria (MERA Operational Memorandum #8, Revision 3)
D: compound found in dilluted run.
J: indicates an estimated value.
B: analyte was found in blank as well as sample.

Table 4
Raichhold Chemicals, Inc.
Ferndale, Michigan
Soil Boring Analytical Results – September, 1991
Semi-Volatile Organic Compounds (Method 8270)

PARAMETER	METHOD	Type B Criteria *	DSB-1 38'-40'	DSB-1 6"-2'	DSB-1 4'-6'	DSB-1 10'-12'	DSB-2 1.5'-3'	DSB-2 7'-9'	DSB-2 11'-13'	DSB-2 23'-25'	DSB-2 33'-35'	DSB-3 6"-2'	DSB-3 4'-6'	DSB-3 10'-12'
PHENOL	8270	64000	ND	ND	ND	ND	660 J	ND	ND	ND	ND	ND	ND	ND
NAPHTHALENE	8270	5000	ND	ND	ND	ND	6,700	5,500	ND	ND	ND	ND	ND	ND
2-METHYLNAPHTHALENE	8270	220	ND	ND	ND	ND	740 J	130 J	ND	ND	ND	ND	ND	ND
DIMETHYL PHTHALATE	8270	NL	ND	ND	ND	ND	140 J	ND	ND	ND	ND	ND	ND	ND
ACENAPHTHYLENE	8270	500	ND	ND	ND	ND	120 J	ND	ND	ND	ND	ND	ND	ND
ACENAPHTHENE	8270	24000	ND	ND	ND	ND	180 J	ND	ND	ND	ND	ND	ND	ND
DIBENZOFURAN	8270	330	ND	ND	ND	ND	390 J	ND	ND	ND	ND	ND	ND	ND
FLUORENE	8270	17000	ND	ND	ND	ND	280 J	ND	ND	ND	ND	ND	ND	ND
PHENANTRHRENE	8270	500	ND	ND	ND	ND	1,800	250 J	ND	ND	ND	ND	ND	ND
ANTHRACENE	8270	14000	ND	ND	ND	ND	410 J	88 J	ND	ND	ND	ND	ND	ND
DI-N-BUTYLPHTHALATE	8270	17000	ND	ND	ND	ND	720 J	150 J	ND	ND	ND	ND	ND	ND
FLUORANTHENE	8270	17000	ND	ND	88 J	ND	1,400	190 J	ND	ND	ND	ND	ND	ND
PYRENE	8270	10000	ND	ND	100 J	ND	1,600	200 J	ND	ND	ND	ND	ND	ND
BUTYLBENZYLPHTHALATE	8270	22000	ND	ND	ND	ND	ND	450 J	ND	ND	ND	ND	ND	ND
BENZO(A)ANTHRACENE	8270	330	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
BIS(2-ETHYLHEXYL)PHTHALATE	8270	330	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
CHRYSENE	8270	330	ND	ND	ND	ND	550 J	ND	ND	ND	ND	ND	ND	ND
DI-N-OCTYL PHTHALATE	8270	2600	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
BENZO(B)FLUORANTHENE	8270	330	ND	ND	ND	ND	590 J	ND	ND	ND	ND	ND	ND	ND
BENZO(K)FLUORANTHENE	8270	330	ND	ND	ND	ND	570 J	ND	ND	ND	ND	ND	ND	ND
INDENO(1,2,3-CD)PYRENE	8270	330	ND	ND	ND	ND	400 J	ND	ND	ND	ND	ND	ND	ND
BENZO(G,H,I)PERYLENE	8270	330	ND	ND	ND	ND	460 J	ND	ND	ND	ND	ND	ND	ND

NOTES:
All concentrations are in ug/kg.
ND: indicates the analyte was reported at below laboratory detection limit. Refer to the laboratory reports for detection limits.
NL: Not Listed
*: MDNR Act 307 Type B (20 X Ground Water) Cleanup Criteria (MERA Operational Memorandum #8, Revision 3)
D: compound found in diluted run.
J: indicates an estimated value.
B: analyte was found in blank as well as sample.

Table 4
Reichhold Chemicals, Inc.
Ferndale, Michigan
Soil Boring Analytical Results - September, 1991
Semi-Volatile Organic Compounds (Method 8270)

PARAMETER	METHOD	Type B Criteria *	DSB-3 22'-24'	DSB-3 32'-34'
PHENOL	8270	64000	ND	ND
NAPHTHALENE	8270	5000	ND	ND
2-METHYLNAPHTHALENE	8270	220	ND	ND
DIMETHYL PHTHALATE	8270	NL	ND	ND
ACENAPHTHYLENE	8270	500	ND	ND
ACENAPHTHENE	8270	24000	ND	ND
DIBENZOFURAN	8270	330	ND	ND
FLUORENE	8270	17000	ND	ND
PHENANTRHRENE	8270	500	ND	ND
ANTHRACENE	8270	14000	ND	ND
DI-N-BUTYLPHTHALATE	8270	17000	ND	ND
FLUORANTHENE	8270	17000	ND	ND
PYRENE	8270	10000	ND	ND
BUTYLBENZYLPHTHALATE	8270	22000	ND	ND
BENZO(A)ANTHRACENE	8270	330	ND	ND
BIS(2-ETHYLHEXYL)PHTHALATE	8270	330	ND	ND
CHRYSENE	8270	330	ND	ND
DI-N-OCTYL PHTHALATE	8270	2600	ND	ND
BENZO(B)FLUORANTHENE	8270	330	ND	ND
BENZO(K)FLUORANTHENE	8270	330	ND	ND
INDENO(1,2,3-CD)PYRENE	8270	330	ND	ND
BENZO(G,H,I)PERYLENE	8270	330	ND	ND

NOTES:
All concentrations are in ug/kg.
ND: indicates the analyte was reported at below laboratory detection limit. Refer to the laboratory reports for detection limits.
NL: Not Listed
*: MDNR Act 307 Type B (20 X Ground Water) Cleanup Criteria (MERA Operational Memorandum #8, Revision 3)
D: compound found in diluted run.
J: indicates an estimated value.
B: analyte was found in blank as well as sample.

Table 5
Reichhold Chemicals, Inc.
Ferndale, Michigan
Soil Boring Analytical Results – September, 1991
PCBs (Method 8080)

PARAMETER	METHOD	Type B Criteria *	MW-8 4'-6'	MW-8 10'-12'	MW-8 14'-16'	MW-10 2'-4'	MW-10 6'-8'	MW-10 10'-12'	MW-17 4'-6'	MW-17 6'-7'	MW-17 9'-12'	MW-19 6"-2'	MW-19 4'-6'	MW-19 10'-12'
AROCLOR-1016	8080	1000	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
AROCLOR-1221	8080	1000	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
AROCLOR-1232	8080	1000	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
AROCLOR-1242	8080	1000	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
AROCLOR-1248	8080	1000	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
AROCLOR-1254	8080	1000	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
AROCLOR-1260	8080	1000	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND

NOTES:
All concentrations are in ug/kg.
ND: Indicates the analyte was reported at below the laboratory detection limit. Refer to the laboratory reports for detection limits.
NL: Not Listed
*: MDNR Act 307 Type B (20 X Ground Water) Cleanup Criteria (MERA Operational Memorandum #8, Revision 3)

Table 6
Raichhold Chamicals, Inc.
Ferndale, Michigan
Ground Water Analytical Results – September, 1991
Metals (Method 6010, 7000 series)

PARAMETER	METHOD	Type B Criteria *	MW-1T	MW-2T	MW-3T	MW-4T	MW-4D	MW-6D	MW-6T	MW-7D	MW-7T	MW-8D
ANTIMONY	6010/7000	48	ND	156	ND	ND	ND	ND	ND	ND	ND	ND
ARSENIC	6010/7000	0.4	51.6	9.5	13.1	ND	ND	37.2	54.4	11.4	10.5	12.6
BARIUM	6010/7000	48000	260	257	199	61.2	60	123	180	120	130	55.6
CADMIUM	6010/7000	70	3.3	ND	ND	ND	ND	ND	ND	ND	ND	ND
CHROMIUM	6010/7000	2400	ND	41.1	14.5	ND	ND	ND	16.7	10	8.9	ND
COPPER	6010/7000	20000	ND	2.3	ND	ND	ND	ND	20	4.5	ND	ND
LEAD	6010/7000	80	2.9	ND	10.6	2.1	1.3	1.5	11.3	ND	5.8	8.7
MERCURY	6010/7000	42	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
NICKEL	6010/7000	11000	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
SELENIUM	6010/7000	700	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
VANADIUM	6010/7000	1200	ND	95.6	ND	ND	ND	ND	28.9	ND	ND	ND
ZINC	6010/7000	46000	110	416	252	153	74.5	141	110	163	110	120

NOTES:
All concentrations are in ug/l.
ND: Indicates tha analyte was reportad at below the laboratory detection limit. Refer to tha laboratory reports for detection limits.
NL: Not Listed
*: MDNR Act 307 Type B Soit (20 X Ground Water) Cleanup Criteria (MERA Operational Memorandum #8, Revision 3)
[Ground Water at the site does not meet the definition of an aquifer; as such, soil cleanup criteria defines impacted ground water. See text for further inf ormation]
B: Analyte was found in blank as well as sample.

Table 6
Reichhold Chemicals, Inc.
Ferndale, Michigan
Ground Water Analytical Results - September, 1991
Metals (Method 6010, 7000 series)

PARAMETER	METHOD	Type B Criteria *	MW-8T	MW-9D	MW-9T	MW-10D	MW-10T	MW-11D	MW-11T	MW-12D	MW-12T	MW-13D
ANTIMONY	6010/7000	48	ND	ND	ND	ND	ND	ND	ND	111	ND	ND
ARSENIC	6010/7000	0.4	14.6	ND	26.6	64.4	3.4	9	4.6	20.2	13.7	9.2
BARIUM	6010/7000	48000	46.7	155	164	ND	80	57.8	71.1	ND	ND	94.5
CADMIUM	6010/7000	70	ND	ND	ND	ND	ND	ND	ND	18	16	ND
CHROMIUM	6010/7000	2400	ND	ND	10	74.4	918	ND	ND	18	22	ND
COPPER	6010/7000	20000	ND	ND	ND	ND	36.7	ND	ND	4680	4300	ND
LEAD	6010/7000	80	8.9	ND	18.7	3	7.4	1.9	2.1	470	408	1.3
MERCURY	8010/7000	42	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
NICKEL	6010/7000	11000	ND	ND	57.8	269	409	ND	ND	ND	ND	97.8
SELENIUM	6010/7000	700	ND	ND	ND	ND	ND	ND	ND	4.1	4.3	ND
VANADIUM	6010/7000	1200	ND	ND	ND	ND	ND	ND	ND	730	436	ND
ZINC	6010/7000	46000	77.8	77.8	80	109	229	66.7	68.9	887	626	156

NOTES:
All concentrations are in ug/l.
ND: Indicates the analyte was reported at below the laboratory detection limit. Refer to the laboratory reports for detection limits.
NL: Not Listed
*: MDNR Act 307 Type B Soil (20 X Ground Water) Cleanup Criteria (MERA Operational Memorandum #8, Revision 3)
[Ground Water at the site does not meet the definition of an aquifer; as such soil cleanup criteria defines impacted ground water. See text for further inf
B: Analyte was found in blank as well as sample.

Table 6
Reichhold Chemicals, Inc.
Ferndale, Michigan
Ground Water Analytical Results – September, 1991
Metals (Method 6010, 7000 series)

PARAMETER	METHOD	Type B Criteria *	MW-13T	MW-14D	MW-16D	MW-16T	MW-17D	MW-17T	MW-18D	MW-18T	MW-19T	MW-20D
ANTIMONY	6010/7000	48	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
ARSENIC	6010/7000	0.4	5.2	ND	16.2	40.1	26.6	49.2	53.2	65	21.6	274
BARIUM	6010/7000	48000	134	459	285	312	150	154	70	95.6	660	ND
CADMIUM	6010/7000	70	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
CHROMIUM	6010/7000	2400	ND	ND	ND	ND	23.3	37.8	11.1	27.8	100	300
COPPER	6010/7000	20000	31.1	ND	ND	ND	ND	ND	118	181	ND	380
LEAD	6010/7000	80	15.2	ND	2.8	1.2	ND	31.7	78.2	184	37.8	295
MERCURY	6010/7000	42	ND	0.28	0.57	ND	ND	ND	ND	ND	ND	ND
NICKEL	6010/7000	11000	87.8	ND	42.2	ND	ND	52.2	48.8	55.6	ND	ND
SELENIUM	6010/7000	700	ND	ND	ND	ND	ND	ND	62.3	ND	8.6	ND
VANADIUM	6010/7000	1200	ND	ND	ND	ND	81.1	71.1	52.2	52.2	240	1020
ZINC	6010/7000	46000	123	100	90	73.3	100	318	255	434	ND	ND

NOTES:
All concentrations are in ug/l.
ND: indicates the analyte was reported at below the laboratory detection limit. Refer to the laboratory reports for detection limits.
NL: Not Listed
*: MDNR Act 307 Type B Soil (20 X Ground Water) Cleanup Criteria (MERA Operational Memorandum #8, Revision 3)
[Ground Water at the site does not meet the definition of an aquifer; as such soil cleanup criteria defines impacted ground water. See text for further inf
B: Analyte was found in blank as well as sample.

Table 6
Reichhold Chemicals, Inc.
Ferndale, Michigan
Ground Water Analytical Results - September, 1991
Metals (Method 6010, 7000 series)

PARAMETER	METHOD	Type B Criteria *	MW-20T	MW-21D	MW-21T
ANTIMONY	6010/7000	48	ND	ND	ND
ARSENIC	6010/7000	0.4	129	4.7	9
BARIUM	6010/7000	48000	ND	118	151
CADMIUM	6010/7000	70	ND	ND	ND
CHROMIUM	6010/7000	2400	340	ND	13.3
COPPER	6010/7000	20000	ND	ND	ND
LEAD	6010/7000	80	880	2.9	13.4
MERCURY	6010/7000	42	ND	ND	ND
NICKEL	6010/7000	11000	ND	ND	ND
SELENIUM	6010/7000	700	ND	ND	ND
VANADIUM	6010/7000	1200	880	ND	47.8
ZINC	6010/7000	46000	ND	77.8	101

NOTES:
All concentrations are in ug/l.
ND: Indicates the analyte was reported at below the laboratory detection limit. Refer to the laboratory reports for detection limits.
NL: Not Listed
*: MDNR Act 307 Type B Soil (20 X Ground Water) Cleanup Criteria (MERA Operational Memorandum #8, Revision 3)
[Ground Water at the site does not meet the definition of an aquifer; as such soil cleanup criteria defines impacted ground water. See text for further inf
B: Analyte was found in blank as well as sample.

Table 7
Reichhold Chemicals, Inc.
Ferndale, Michigan
Ground Water Analytical Results – December, 1991 *
Metals (Method 6010, 7000 series)

PARAMETER	METHOD	Type B Criteria *	MW-1T	MW-1D	MW-2T	MW-2D	MW-4T	MW-4D	MW-6T	MW-6D	MW-7T
ANTIMONY	6010/7000	48	ND	ND	76.0	ND	ND	ND	ND	ND	ND
ARSENIC	6010/7000	0.4	5.7 B	7.2 B	6.5 B	3.3 B	ND	ND	31.0	42.0 B	9.9 B
BARIUM	6010/7000	48000	171 B	207	158 B	73.0 B	72.0 B	82.0 B	148 B	234	148 B
BERYLLIUM	6010/7000	NL	ND	ND	ND	ND	ND	ND	ND	ND	ND
CADMIUM	6010/7000	70	ND	ND	7.0	3.0 B	ND	ND	ND	ND	ND
CHROMIUM	6010/7000	2400	ND	ND	14.0	ND	ND	ND	18.0	ND	13.0
COBALT	6010/7000	NL	ND	ND	ND	ND	ND	ND	ND	ND	ND
COPPER	6010/7000	20000	ND	ND	ND	ND	ND	ND	ND	ND	ND
LEAD	6010/7000	80	3.0	ND	9.9	ND	3.0 B	ND	3.5	2.4 B	3.8
MERCURY	6010/7000	42	ND	ND	ND	ND	ND	ND	ND	ND	ND
NICKEL	6010/7000	11000	ND	ND	ND	ND	ND	ND	ND	ND	ND
SELENIUM	6010/7000	700	ND	ND	ND	ND	ND	ND	ND	ND	ND
SILVER	6010/7000	660	ND	12.0	ND	ND	ND	12.0	ND	12.0	ND
THALLIUM	6010/7000	12	ND	ND	ND	ND	ND	ND	ND	ND	ND
TIN	6010/7000	NL	ND	ND	ND	ND	ND	ND	ND	ND	ND
VANADIUM	6010/7000	1200	ND	23.0 B	23.0 B	ND	ND	ND	ND	26.0 B	ND
ZINC	6010/7000	46000	ND	ND	55.0	ND	69.0	88.0	ND	53.0	ND

NOTES:
All concentrations are in ug/l.
ND: indicates the analyte was reported at below the laboratory detection limit. Refer to the laboratory reports for detection limits.
B: analyte was found in blank as well as sample.
NL: Not Listed
*: MDNR Act 307 Type B Soil (20 X Ground Water) Cleanup Criteria.
(MERA Operational Memorandum #8, Revision 3)
[Ground Water at the site does not meat the definition of an aquiler; as such, soil cleanup criteria defines impacted ground water. See text for further information.]
MW-9 and MW-22 samplee were collected on February 7, 1992
all other samples were collected on December 11, 1991.
MW-1T identifies total metal concentration, while MW-1D identifies the dissolved metal concentration.

Table 7
Reichhold Chemicals, Inc.
Ferndale, Michigan
Ground Water Analytical Results – December, 1991*
Metals (Method 6010, 7000 series)

PARAMETER	METHOD	Type B Criteria *	MW-7D	MW-8T	MW-8D	MW-8QT	MW-8QD	MW-9T	MW-9D	MW-10T	MW-10D
ANTIMONY	6010/7000	48	ND	ND	ND	ND	ND	ND	ND	ND	ND
ARSENIC	6010/7000	0.4	6.6 B	ND	ND	3.6 B	3.4 B	11.7	6.9 B	4.0 B	ND
BARIUM	6010/7000	48000	162 B	103 B	98.0 B	101 B	102 B	173 B	183 B	85.0 B	103 B
BERYLLIUM	6010/7000	NL	ND	ND	ND	ND	ND	ND	ND	ND	ND
CADMIUM	6010/7000	70	ND	ND	ND	ND	ND	ND	ND	ND	ND
CHROMIUM	6010/7000	2400	8.0 B	ND	ND	ND	ND	11.0	ND	655	ND
COBALT	6010/7000	NL	ND	ND	ND	ND	ND	ND	ND	ND	ND
COPPER	6010/7000	20000	ND	ND	ND	ND	ND	ND	ND	22.0 B	ND
LEAD	6010/7000	80	ND	2.5 B	2.4 B	3.7	ND	8.7	ND	6.9	ND
MERCURY	6010/7000	42	ND	ND	ND	ND	ND	ND	ND	ND	5.0
NICKEL	6010/7000	11000	ND	ND	ND	ND	ND	ND	ND	227	132
SELENIUM	6010/7000	700	ND	ND	ND	ND	ND	ND	ND	ND	ND
SILVER	6010/7000	660	10.0	ND	10.0	ND	13.0	ND	ND	ND	ND
THALLIUM	6010/7000	12	ND	ND	ND	ND	ND	ND	ND	ND	ND
TIN	6010/7000	NL	ND	ND	ND	ND	ND	ND	ND	ND	ND
VANADIUM	6010/7000	1200	22.0 B	ND	ND	ND	ND	20.0 B	ND	ND	ND
ZINC	6010/7000	46000	ND	ND	73.0	ND	144	189	131	ND	ND

NOTES:
All concentrations are in ug/l.
ND: indicates the analyte was reported at below the laboratory detection limit. Refer to the laboratory reports for detection limits.
B: analyte was found in blank as well as sample.
NL: Not Listed
*: MDNR Act 307 Type B Soil (20 X Ground Water) Cleanup Criteria.
(MERA Operational Memorandum #8, Revision 3)
[Ground Water at the site does not meet the definition of an aquifer; as such, soil cleanup criteria defines impacted ground water. See text for further information.
MW-9 and MW-22 samples were collected on February 7, 1992
all other samples were collected on December 11, 1991.
MW-1T identifies total metal concentration, while MW-1D identifies the dissolved metal concentration.

Table 7
Reichhold Chemicals, Inc.
Ferndale, Michigan
Ground Water Analytical Results – December, 1991*
Metals (Method 6010, 7000 series)

PARAMETER	METHOD	Type B Criteria *	MW-11T	MW-11D	MW-12T	MW-12D	MW-13T	MW-13D	MW-14T	MW-14D	MW-16T
ANTIMONY	6010/7000	48	ND	ND	ND	ND	ND	ND	ND	ND	ND
ARSENIC	6010/7000	0.4	5.5 B	3.2 B	ND	ND	ND	9.1 B	ND	8.3 B	58.1 B
BARIUM	6010/7000	48000	123 B	118 B	ND	ND	52.0 B	47.0 B	596	545	290
BERYLLIUM	6010/7000	NL	ND	ND	ND	ND	ND	ND	ND	ND	2.0 B
CADMIUM	6010/7000	70	ND	ND	ND	ND	ND	ND	ND	ND	ND
CHROMIUM	6010/7000	2400	ND	ND	7.0 B	ND	ND	ND	ND	8.0 B	ND
COBALT	6010/7000	NL	ND	ND	ND	ND	ND	ND	ND	ND	ND
COPPER	6010/7000	20000	ND	ND	52.0	23.0 B	ND	ND	ND	25.0	ND
LEAD	6010/7000	80	2.7 B	ND	15.2	4.3	7.2	2.3 B	6.1	ND	4.4
MERCURY	6010/7000	42	ND	ND	ND	ND	ND	ND	ND	ND	ND
NICKEL	6010/7000	11000	ND	ND	ND	ND	59.0	60.0	ND	ND	ND
SELENIUM	6010/7000	700	ND	ND	ND	ND	ND	ND	ND	ND	ND
SILVER	6010/7000	660	ND	13.0	ND	ND	ND	11.0	ND	ND	ND
THALLIUM	6010/7000	12	ND	ND	ND	ND	ND	ND	ND	ND	ND
TIN	6010/7000	NL	ND	ND	ND	ND	ND	ND	ND	ND	ND
VANADIUM	6010/7000	1200	ND	ND	34.0 B	27.0 B	ND	ND	ND	ND	ND
ZINC	6010/7000	46000	ND	ND	77.0	ND	81.0	ND	68.0	64.0	ND

NOTES:
All concentrations ere in ug/l.
ND: indicates the analyte was reported at below the laboratory detection limit. Refer to the laboratory reports for detection limits.
B: analyte was found in blank as well as sample.
NL: Not Listed
*: MDNR Act 307 Type B Soil (20 X Ground Water) Cleanup Criteria. (MERA Operational Memorandum #8, Revision 3)
[Ground Water at the site does not meet the definition of an aquifer; as such, soil cleanup critaria defines impacted ground water. See text for further information.
MW-9 and MW-22 samples were collectsd on February 7, 1992
all other samples were collected on December 11, 1991.
MW-1T identifies total metal concentration, while MW-1D identifies the dissolved metal concentration.

Table 7
Reichhold Chemicals, Inc.
Ferndale, Michigan
Ground Water Analytical Results - December, 1991*
Metals (Method 6010, 7000 series)

PARAMETER	METHOD	Type B Criteria *	MW-16D	MW-17T	MW-17D	MW-18T	MW-18D	MW-19T	MW-19D	MW-20T	MW-20D	MW-21T
ANTIMONY	6010/7000	48	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
ARSENIC	6010/7000	0.4	54.8 B	ND	11.6	7.2 B	ND	53.0 B	ND	154	13.1	4.7 B
BARIUM	6010/7000	48000	273	201	197 B	ND	ND	624	216	885 B	182 B	106 B
BERYLLIUM	6010/7000	NL	2.0 B	ND	ND	ND	ND	4.0 B	ND	15.0 B	4.0 B	ND
CADMIUM	6010/7000	70	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
CHROMIUM	6010/7000	2400	ND	42.0	36.0	ND	ND	116	41.0	395	86.0	ND
COBALT	6010/7000	NL	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
COPPER	6010/7000	20000	ND	ND	18.0 B	41.0	ND	96.0	25.0	500	54.0	ND
LEAD	6010/7000	60	2.0 B	7.2	7.9	18.4	ND	53.2	2.2 B	237	55.5	3.9
MERCURY	6010/7000	42	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
NICKEL	6010/7000	11000	ND	ND	ND	ND	ND	ND	ND	500	168	ND
SELENIUM	6010/7000	700	ND	ND	ND	ND	6.3	4.1 B	ND	ND	ND	ND
SILVER	6010/7000	660	11.0	ND	10.0	ND	10.0	ND	12.0	ND	20.0	ND
THALLIUM	6010/7000	12	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
TIN	6010/7000	NL	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
VANADIUM	6010/7000	1200	22.0 B	166	182	ND	ND	284	124	1760	460	ND
ZINC	6010/7000	46000	ND	62.0	ND	83.0	ND	342	50.0	490	ND	ND

NOTES:
All concentrations are in ug/l.
ND: indicates the analyte was reported at below the laboratory detection limit. Refer to the laboratory reports for detection limits.
B: analyte was found in blank as well as sample.
NL: Not Listed
*: MDNR Act 307 Type B Soil (20 X Ground Water) Cleanup Criteria. (MERA Operational Memorandum #8, Revision 3)
[Ground Water at the site does not meet the definition of an aquifer; as such, soil cleanup criteria defines impacted ground water. See text for further information.
MW-9 and MW-22 samples were collected on February 7, 1992
all other samples were collected on December 11, 1991.
MW-1T identifies total metal concentration, while MW-1D identifies the dissolved metal concentration.

Table 7
Reichhold Chemicals, Inc.
Ferndale, Michigan
Ground Water Analytical Results – December, 1991 *
Metals (Method 6010, 7000 series)

PARAMETER	METHOD	Type B Criteria *	MW-21D	MW-9T	MW-9D	MW-22T	MW-22D
ANTIMONY	6010/7000	48	ND	40	40	40	40
ARSENIC	6010/7000	0.4	4.4 B	100	100	100	100
BARIUM	6010/7000	48000	139 B	107	107	474	389
BERYLLIUM	6010/7000	NL	ND	2.0	2.0	2.0	2
CADMIUM	6010/7000	70	ND	5.0	5.0	5.0	5.0
CHROMIUM	6010/7000	2400	ND	6.3	5.0	23.1	5.0
COBALT	6010/7000	NL	ND	5.0	5.0	5.9	5.0
COPPER	6010/7000	20000	ND	8.4	8.1	16.2	5.0
LEAD	6010/7000	80	ND	100	100	100	100
MERCURY	6010/7000	42	ND	0.20	0.20	0.20	0.20
NICKEL	6010/7000	11000	ND	9.60	6.7	22.3	6.00
SELENIUM	6010/7000	700	ND	100	100	100	100
SILVER	6010/7000	660	13.0	5.0	5.0	5.0	5.0
THALLIUM	6010/7000	12	ND	200	200	200	200
TIN	6010/7000	NL	ND	100	100	100	100
VANADIUM	6010/7000	1200	ND	8.60	5.00	13.9	5.0
ZINC	6010/7000	46000	ND	44.5		64.7	29.8

NOTES:
All concentrations are in ug/l.
ND: indicates the analyte was reported at below the laboratory detection limit. Refer to the laboratory reports for detection limits.
B: analyte was found in blank as well as sample.
NL: Not Listed
*: MDNR Act 307 Type B Soil (20 X Ground Water) Cleanup Criteria. (MERA Operational Memorandum #8, Revision 3)
[Ground Water at the site does not meet the definition of an aquifer; as such, soil cleanup criteria defines impacted ground water. See text for further information.
MW-9 and MW-22 samples were collected on February 7, 1992 all other samples were collected on December 11, 1991.
MW-1T identifies total metal concentration, while MW-1D identifies the dissolved metal concentration.

Table 8
Reichhold Chemicals, Inc.
Ferndale, Michigan
Ground Water Analytical Results - September, 1991
Volatile Organic Compounds (Method 8240)

PARAMETER	METHOD	Type B Criteria *	MW-1	MW-2	MW-3	MW-4	MW-6	MW-7	MW-8	MW-9	MW-10RE	MW-11
VINYL CHLORIDE	8240	0.32	ND	310 E	ND	ND	ND	ND	ND	ND	ND	1,900 E
METHYLENE CHLORIDE	8240	92	ND	ND	ND	ND	ND	ND	ND	ND	ND	20
ACETONE	8240	14000	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
1,1-DICHLOROETHENE	8240	140	ND	11	ND	ND	ND	ND	ND	ND	ND	150
1,1-DICHLOROETHANE	8240	17000	ND	13	ND	ND	ND	ND	ND	ND	ND	ND
trans-1,2-DICHLOROETHENE	8240	2400	ND	7,700	ND	ND	ND	ND	ND	29,000	ND	24,000
1,1,1-TRICHLOROETHANE	8240	4000	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
cis-1,2-DICHLOROETHENE	8240	1500	ND	22	ND	ND	ND	ND	ND	ND	ND	64
TRICHLOROETHENE	8240	44	15	2,500	ND	ND	ND	ND	ND	220,000	78	400,000
1,1,2-TRICHLORDETHANE	8240	13	ND	ND	ND	ND	ND	ND	ND	ND	ND	190
BENZENE	8240	24	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
METHYL ISOBUTYL KETONE	8240	4600	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
TETRACHLOROETHENE	8240	14	ND	ND	ND	ND	ND	ND	ND	ND	ND	830 E
TOLUENE	8240	16000	ND	99	ND	ND	ND	30	ND	ND	ND	ND
CHLOROBENZENE	8240	2600	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
ETHYLBENZENE	8240	1500	ND	1,300	ND	ND	510	1,000	110	1,400	ND	990 E
STYRENE	8240	24	ND	ND	ND	ND	ND	ND	ND	9,400	ND	510 E
XYLENE (total)	8240	5600	ND	8,000	ND	ND	95	2,500	710	ND	ND	2,500 E

NOTES:
All concentrations are in ug/l.
ND: Indicates the analyte was reported at below the laboratory detection limit. Refer to the laboratory reports for detection limits.
D: compound found in diluted run.
J: indicates an estimated run.
B: analyte was found in blank as well as sample.
E: exceeded calibration range.
NL: Not Listed
*: MDNR Act 307 Type B Soil (20 X Ground Water) Cleanup Criteria.
(MERA Operational Memorandum #8, Revision 3)
[Ground water at the site does not meet the definition of an aquifer; as such, soil cleanup criteria defines impacted ground water. See text for further information.]

Table 8
Reichhold Chemicals, Inc.
Ferndale, Michigan
Ground Water Analytical Results – September, 1991
Volatile Organic Compounds (Method 8240)

PARAMETER	METHOD	Type B Criteria *	MW-12	MW-13	MW-14	MW-16	MW-17	MW-18	MW-19	MW-20	MW-21
VINYL CHLORIDE	8240	0.32	ND	ND	ND	ND	ND	ND	ND	ND	ND
METHYLENE CHLORIDE	8240	82	ND	ND	ND	ND	5	110	ND	ND	ND
ACETONE	8240	14000	ND	22	ND	ND	ND	ND	ND	ND	ND
1,1-DICHLOROETHENE	8240	140	ND	ND	ND	ND	ND	ND	ND	ND	ND
1,1-DICHLOROETHANE	8240	17000	ND	ND	ND	ND	ND	ND	ND	ND	ND
trans-1,2-DICHLOROETHENE	8240	2400	ND	ND	121,000	ND	ND	610	ND	3,800	ND
1,1,1-TRICHLOROETHANE	8240	4000	36	ND	ND	ND	ND	ND	ND	ND	ND
cis-1,2-DICHLOROETHENE	8240	1500	ND	ND	ND	ND	ND	ND	ND	ND	ND
TRICHLOROETHENE	8240	44	660	430 E	120,000	ND	ND	350	ND	9,300	ND
1,1,2-TRICHLOROETHANE	8240	13	ND	ND	ND	ND	ND	ND	ND	ND	ND
BENZENE	8240	24	ND	41	ND	ND	ND	ND	ND	ND	ND
METHYL ISOBUTYL KETONE	8240	4600	170	410 E	ND	ND	ND	ND	ND	3,900	ND
TETRACHLOROETHENE	8240	14	ND	14	ND	ND	ND	ND	ND	ND	ND
TOLUENE	8240	16000	23	160	ND	ND	ND	ND	ND	14,000	ND
CHLOROBENZENE	8240	2600	ND	ND	ND	ND	ND	290	ND	ND	ND
ETHYLBENZENE	8240	1500	47	33	ND	29	ND	ND	ND	4,200	4
STYRENE	8240	24	ND	ND	ND	ND	ND	ND	ND	ND	ND
XYLENE (total)	8240	5600	240	430	ND	680	37	1,300	7,100	38,000	5

NOTES:
All concentrations are in ug/l.
ND: indicates the analyte was reported at below the laboratory detection limit. Refer te the laboratory reports for detection limits.
D: compound found in diluted run.
J: indicates an estimated run.
B: analyte was found in blank es well as sample.
E: exceeded calibration range.
NL: Not Listed
*: MDNR Act 307 Type B Soil (20 X Ground Water) Cleanup Criteria.
(MERA Operational Memorandum #8, Revision 3)
[Ground water at the site does not meet the definition of an aquifer; as such, soil cleanup criteria defines impacted ground water. See text for further information.]

Table 9
Reichhold Chemicals, Inc.
Ferndale, Michigan
Ground Water Analytical Results – December, 1991*
Volatile Organic Compounds (Method 8240)

PARAMETER	METHOD	Type B Criteria *	MW-1	MW-2	MW-3	MW-4	MW-6	MW-7	MW-7DL	MW-8	MW-8Q	MW-9
VINYL CHLORIDE	8240	0.32	ND	ND	ND	ND	ND	ND	ND	ND	ND	25000
METHYLENE CHLORIDE	8240	92	6 B	13 J B	6 B	4 J B	81 J B	150 B	ND	ND	ND	ND
1,1-DICHLOROETHENE	8240	140	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
1,1-DICHLOROETHANE	8240	17000	1 J	ND	ND	ND	ND	ND	ND	ND	ND	ND
trans-1,2-DICHLOROETHENE	8240	2400	10	610	ND	ND	ND	ND	ND	ND	ND	97000
2-BUTANONE	8240	6400	ND	ND	ND	ND	ND	200 B	ND	19	ND	ND
ACETONITRILE	8240	2800	ND	40 J	ND	ND	ND	ND	ND	ND	ND	ND
ACRYLONITRILE	8240	1.3	ND	31 J	ND	ND	ND	ND	ND	ND	ND	ND
cis-1,2-DICHLOROETHENE	8240	1500	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
TRICHLOROETHENE	8240	44	54	740	ND	ND	ND	15 J	ND	ND	ND	1000000 E
BENZENE	8240	24	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
METHYL ISOBUTYL KETONE	8240	4600	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
2-HEXANONE	8240	20000	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
TETRACHLOROETHENE	8240	14	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
TOLUENE	8240	16000	ND	ND	ND	ND	ND	47 J	ND	ND	ND	ND
ETHYLBENZENE	8240	1500	ND	14 J	ND	ND	3500	2500 E	1900 J D	6	8	1900 J
STYRENE	8240	24	ND	ND	ND	ND	44 J	430	ND	ND	ND	62000
XYLENE (total)	8240	5600	ND	53	ND	ND	76 J	22000 E	51000 D	11	10	ND

NOTES:
All concentrations are in ug/l.
ND: indicates the analyte was reported at below the laboratory detection limit. Refer to the laboratory reports for detection limits.
D: compound analyzed at secondary dilution and found in diluted run.
J: indicates the presence of a compound that meets the identified criteria but the result is less than the specified detection limit but greater than zero.
B: analyte was found in blank as well as sample.
E: Exceed the Calibration Range.
MW-9C and MW-22C sample were collected on February 7, 1992, all other samples were collected on December 11, 1991.
*: MDNR Act 307 Type B Soil (20 X Ground Water) Cleanup Criteria (MERA Operational Memorandum #8, Revision 3)
[Ground water at the site does not meet the definition of an aquifer; as such, soil cleanup criteria defines impacted ground water. See text for further information.]

Table 9
Reichhold Chemicals, Inc.
Ferndale, Michigan
Ground Water Analytical Results – December, 1991*
Volatile Organic Compounds (Method 8240)

PARAMETER	METHOD	Type B Criteria *	MW-9DL	MW-10	MW-11	MW-11DL	MW-12	MW-13	MW-14	MW-14DL	MW-15	MW-16
VINYL CHLORIDE	8240	0.32	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
METHYLENE CHLORIDE	8240	92	35000 JDB	ND	ND	ND	ND	ND	2700 J B	ND	ND	73 B
1,1-DICHLOROETHENE	8240	140	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
1,1-DICHLOROETHANE	8240	17000	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
trans-1,2-DICHLOROETHENE	8240	2400	ND	4 J	74000 E	68000 D	ND	ND	400000 E	340000 D	2 J	ND
2-BUTANONE	8240	6400	ND	ND	ND	ND	ND	ND	ND	ND	ND	67 J B
ACETONITRILE	8240	2600	ND	ND	ND	ND	ND	ND	ND	ND	2 J	ND
ACRYLONITRILE	8240	1.3	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
cis-1,2-DICHLOROETHENE	8240	1500	ND	ND	ND	ND	ND	ND	1800 J	ND	ND	ND
TRICHLOROETHENE	8240	44	1600000	18	450000 E	870000 D	2 J	ND	87000	70000 D	270	ND
BENZENE	8240	24	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
METHYL ISOBUTYL KETONE	8240	4600	ND	ND	2000	ND	ND	ND	ND	ND	ND	ND
2-HEXANONE	8240	20000	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
TETRACHLOROETHENE	8240	14	ND	ND	1300	ND	ND	ND	ND	ND	ND	ND
TOLUENE	8240	16000	ND	ND	1300	ND	ND	800	2000 J	ND	ND	110
ETHYLBENZENE	8240	1500	ND	ND	2900	ND	ND	110 J	ND	ND	ND	27 J
STYRENE	8240	24	38000 JD	ND	1700	ND	ND	ND	ND	ND	ND	ND
XYLENE (total)	8240	5600	ND	ND	18000	ND	ND	4300	3900 J	ND	ND	3100

NOTES:
All concentrations are in ug/l.
ND: indicates the analyte was reported at below the laboratory detection limit. Refer to the laboratory reports for detection limits.
D: compound analyzed at secondary dilution and found in diluted run.
J: indicates the presence of a compound that meets the identified criteria but the result is less than the specified detection limit but greater than zero.
B: analyte was found in blank as well as sample.
E: Exceed the Calibration Range.
MW-9C and MW-22C sample were collected on February 7, 1992, all other samples were collected on December 11, 1991.
*: MDNR Act 307 Type B Soil (20 X Ground Water) Cleanup Criteria (MERA Operational Memorandum #8, Revision 3)
[Ground water at the site does not meet the definition of an aquifer; as such, soil cleanup criteria defines impacted ground water. See text for further information.]

Table 9
Reichhold Chemicals, Inc.
Ferndale, Michigan
Ground Water Analytical Results – December, 1991*
Volatile Organic Compounds (Method 8240)

PARAMETER	METHOD	Type B Criteria *	MW-17	MW-18	MW-19	MW-20	MW-21	MW-9C	MW-22C
VINYL CHLORIDE	8240	0.32	ND	ND	ND	ND	ND	26000	10500
METHYLENE CHLORIDE	8240	82	ND	160 J	ND	ND	1 J	ND	ND
1,1-DICHLOROETHENE	8240	140	ND	ND	5 J	ND	ND	ND	ND
1,1-DICHLOROETHANE	8240	17000	1 J	ND	ND	ND	ND	ND	ND
trans-1,2-DICHLOROETHENE	8240	2400	ND	510	10 J	1800	1 J	ND	ND
2-BUTANONE	8240	6400	5 J	ND	ND	ND	ND	ND	ND
ACETONITRILE	8240	2600	ND	ND	ND	300 J	ND	ND	ND
ACRYLONITRILE	8240	1.3	ND	ND	ND	ND	ND	ND	ND
cis-1,2-DICHLOROETHENE	8240	1500	1 J	ND	ND	ND	ND	ND	ND
TRICHLOROETHENE	8240	44	7	560	120	3500	2 J	681000	23900
BENZENE	8240	24	2 J	ND	15 J	ND	ND	ND	ND
METHYL ISOBUTYL KETONE	8240	4600	ND	ND	ND	1300	ND	ND	ND
2-HEXANONE	8240	20000	ND	ND	180	ND	ND	ND	ND
TETRACHLOROETHENE	8240	14	ND	ND	ND	ND	ND	ND	ND
TOLUENE	8240	16000	ND	ND	ND	9200	ND	ND	ND
ETHYLBENZENE	8240	1500	ND	1900	ND	6000	26	ND	1060
STYRENE	8240	24	ND	2400	ND	ND	ND	32000	ND
XYLENE (total)	8240	5600	140	7900	600	42000	52	ND	ND

NOTES:
All concentrations are in ug/l.
ND: indicates the analyte was reported at below the laboratory detection limit. Refer to the laboratory reports for detection limits.
D: compound analyzed at secondary dilution and found in diluted run.
J: indicates the presence of a compound that meets the identified criteria but the result is less than the specified detection limit but greater than zero.
B: analyte was found in blank as well as sample.
E: Exceed the Calibration Range.
MW-9C and MW-22C sample were collected on February 7, 1992, all other samples were collected on December 11, 1991.
*: MDNR Act 307 Type B Soil (20 X Ground Water) Cleanup Criteria (MERA Operational Memorandum #8, Revision 3)
[Ground water at the site does not meet the definition of an aquifer; as such, soil cleanup criteria defines impacted ground water. See text for further information.]

Table 10
Reichhold Chemicals, Inc.
Ferndale, Michigan
Ground Water Analytical Results – September, 1991
Semi-Volatile Organic Compounds (Method 8270)

PARAMETER	METHOD	Type B Criteria *	MW-1	MW-2	MW-3	MW-4	MW-6	MW-7	MW-8	MW-9	MW-10	MW-11
PHENOL	8270	84000	ND	260	ND	ND	ND	78	ND	17	ND	16
BENZYL ALCOHOL	8270	200000	ND	ND	ND	ND	ND	ND	ND	ND	ND	23
2-METHYLPHENOL	8270	7000	ND	8	ND	ND	ND	ND	ND	5	ND	5
4-METHYLPHENOL	8270	700	ND	34	ND	ND	ND	12	ND	14	ND	8
2,4-DIMETHYLPHENOL	8270	7000	ND	70	ND	ND	ND	160	ND	ND	ND	4
NAPHTHALENE	8270	5000	200	240	ND	ND	300	38	ND	76	ND	27
2-METHYLNAPHTHALENE	8270	220	ND	ND	ND	ND	ND	ND	ND	ND	ND	2
ACENAPHTHENE	8270	24000	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
DIBENZOFURAN	8270	330	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
FLUORENE	8270	17000	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
DI-N-BUTYLPHTHALATE	8270	17000	ND	4	3	ND	ND	ND	ND	ND	ND	ND
3-METHYLPHENOL	8270	7000	ND	34	ND	ND	ND	12	ND	14	ND	8
ACETOPHENONE	8270	NL	5	15	ND	ND	6	ND	ND	17	ND	71

NOTES:
All concentrations are in ug/l.
ND: indicates the analyte was reported at below the laboratory detection limit. Refer to the laboratory reports for detection limits.
D: compound found in diluted run.
J: indicates compound was detected at a concentration less than the specified detection limit. The concentration given is estimated.
NL: Not Listed
*: MDNR Act 307 Type B Soil (20 X Ground Water) Cleanup Criteria. (MERA Operational Memorandum #8, Revision 3)
[Ground water at the site does not meet the definition of an aquifer; as such, soil cleanup criteria defines impacted ground water. See text for further infor mation.]

Table 10
Reichhold Chemicals, Inc.
Ferndale, Michigan
Ground Water Analytical Results – September, 1991
Semi-Volatile Organic Compounds (Method 8270)

PARAMETER	METHOD	Type B Criteria *	MW-12	MW-13	MW-14	MW-16	MW-17	MW-18	MW-19	MW-20	MW-21
PHENOL	8270	84000	ND	21	10	ND	ND	360	11	170000	6
BENZYL ALCOHOL	8270	200000	ND	ND	ND	ND	ND	10	ND	ND	ND
2-METHYLPHENOL	8270	7000	ND	68	7	ND	ND	8	ND	570	ND
4-METHYLPHENOL	8270	700	ND	43	12	ND	ND	31	23	3700	ND
2,4-DIMETHYLPHENOL	8270	7000	ND	690	19	44	ND	110	180	2400	ND
NAPHTHALENE	8270	5000	ND	21	ND	ND	ND	340	ND	140	20000
2-METHYLNAPHTHALENE	8270	220	ND	23	ND	ND	ND	ND	ND	ND	22
ACENAPHTHENE	8270	24000	ND	ND	ND	ND	ND	ND	ND	ND	9
DIBENZOFURAN	8270	330	ND	ND	ND	ND	ND	ND	ND	ND	5
FLUORENE	8270	17000	ND	ND	ND	ND	ND	ND	ND	ND	2
DI-N-BUTYLPHTHALATE	8270	17000	ND	ND	ND	ND	ND	ND	ND	ND	ND
3-METHYLPHENOL	8270	7000	ND	43	12	ND	ND	31	ND	3700	ND
ACETOPHENONE	8270	NL	ND	ND	13	ND	ND	32	ND	ND	ND

NOTES:
All concentrations are in ug/l.
ND: indicates the analyte was reported at below the laboratory detection limit. Refer to the laboratory reports for detection limits.
D: compound found in diluted run.
J: indicates compound was detected at a concentration less than the specified detection limit. The concentration given is estimated.
NL: Not Listed
*: MDNR Act 307 Type B Soil (20 X Ground Water) Cleanup Criteria. (MERA Operational Memorandum #8, Revision 3)
[Ground water at the site does not meet the definition of an aquifer; as such, soil cleanup criteria defines impacted ground water. See text for further infor

Table 11
Reichhold Chamicals, Inc.
Farndale, Michigan
Ground Water Analytical Results - December, 1991*
Semi-Volatile Organic Compounds (Method 8270)

PARAMETER	METHOD	Type B Criteria *	MW-1	MW-2	MW-3	MW-4	MW-6	MW-7	MW-7DL	MW-8	MW-8Q	MW-8RE
PHENOL	8270	84000	ND	37	ND	ND	ND	35	ND	ND	ND	ND
BENZYL ALCOHOL	8270	200000	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
2-METHYLPHENOL	8270	7000	ND	ND	ND	ND	ND	18	ND	ND	ND	ND
4-METHYLPHENOL	8270	700	ND	23	ND	ND	ND	37	ND	ND	ND	ND
2,4-DIMETHYLPHENOL	8270	7000	ND	6 J	ND	ND	11	890 E	790 D	ND	ND	ND
BENZOIC ACID	8270	620000	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
NAPHTHALENE	8270	5000	ND	52	ND	ND	100	ND	ND	ND	ND	ND
2-METHYLNAPHTHALENE	8270	220	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
ACENAPHTHENE	8270	24000	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
BIS(2-ETHYLHEXYL)PHTHALATE	8270	330	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
3-METHYLPHENOL	8270	7000	ND	23	ND	ND	ND	37	ND	ND	ND	ND
ACETOPHENONE	8270	NL	ND	40	ND	ND	17	48	ND	ND	ND	ND

NOTES:
All concentrations are in ug/l.
<: indicates the compound was analyzed for but not detected.
The minimum detection limit is reported.
D: compound analyzed at secondary and found in diluted run.
J: indicates the presence of a compound that meets the identified criteria but the result is less than the specified detection limit, but greater than zero.
E: exceed the Calibration Range.
B: analyte was found in blank as well as sample.
NL: Not Listed
*: MDNR Act 307 Type B Soil (20 X Ground Water) Cleanup Criteria.
(MERA Operational Memorandum #8, Revision 3)
[Ground water at the site does not meet the definition of an aquifer; as such, soil cleanup criteria defines impacted ground water. See text for further infor mation.]
MW-9C and MW-22C samples were collected on February 7, 1992.
All other samples were collected on December 11, 1991.

Table 11
Reichhold Chemicals, Inc.
Ferndale, Michigan
Ground Water Analytical Results - December, 1991*
Semi-Volatile Organic Compounds (Method 8270)

PARAMETER	METHOD	Type B Criteria *	MW-9	MW-10	MW-11	MW-11DL	MW-12	MW-13	MW-13DL	MW-14	MW-16	MW-17
PHENOL	8270	84000	ND	ND	24	ND	ND	21	ND	21	ND	ND
BENZYL ALCOHOL	8270	200000	ND	ND	50	ND	ND	ND	ND	ND	ND	ND
2-METHYLPHENOL	8270	7000	ND	ND	5 J	ND	ND	71	ND	10	ND	ND
4-METHYLPHENOL	8270	700	ND	ND	13	ND	ND	23	ND	68	ND	ND
2,4-DIMETHYLPHENOL	8270	7000	ND	ND	13	ND	ND	58	ND	19	24	ND
BENZOIC ACID	8270	620000	100	ND	3100 E	820 D	ND	3000 E	1100 D	ND	ND	ND
NAPHTHALENE	8270	5000	63	ND	23	ND	ND	28	ND	ND	ND	ND
2-METHYLNAPHTHALENE	8270	220	ND	ND	ND	ND	ND	6 J	ND	ND	ND	ND
ACENAPHTHENE	8270	24000	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
BIS(2-ETHYLHEXYL)PHTHALATE	8270	330	ND	ND	ND	ND	36	ND	ND	ND	ND	ND
3-METHYLPHENOL	8270	7000	ND	ND	13	ND	ND	23	ND	68	21	ND
ACETOPHENONE	8270	NL	ND	ND	85	ND	ND	8 J	ND	35	ND	ND

NOTES:
All concentrations are in ug/l.
<: indicates the compound was analyzed for but not detected.
The minimum detection limit is reported.
D: compound analyzed at secondary and found in diluted run.
J: indicates the presence of a compound that meets the identified criteria but the result is less than the specified detection limit, but greater than zero.
E: exceed the Calibration Range.
B: analyte was found in blank as well as sample.
NL: Not Listed
*: MDNR Act 307 Type B Soil (20 X Ground Water) Cleanup Criteria.
(MERA Operational Memorandum #8, Revisinn 3)
[Ground water at the site does not meet the definition of an aquifer; as such, soil cleanup criteria defines impacted ground water. See text for further infor
MW-9C and MW-22C samplas were collected on February 7, 1992.
All other samples were collected on December 11, 1991.

Table 11
Reichhold Chemicals, Inc.
Ferndale, Michigan
Ground Water Analytical Results – December, 1991*
Semi-Volatile Organic Compounds (Method 8270)

PARAMETER	METHOD	Type B Criteria *	MW-18	MW-19	MW-20	MW-20DL	MW-21	MW-21DL	MW-9C	MW-22C
PHENOL	8270	84000	130	12	ND	580000D	ND	ND	ND	112
BENZYL ALCOHOL	8270	200000	ND	ND	ND	ND	ND	ND	ND	ND
2-METHYLPHENOL	8270	7000	ND	ND	ND	ND	ND	ND	ND	ND
4-METHYLPHENOL	8270	700	ND	24	2600 E	ND	ND	ND	ND	ND
2,4-DIMETHYLPHENOL	8270	7000	21	110	1800 E	ND	ND	ND	ND	ND
BENZOIC ACID	8270	620000	ND	ND	19000 E	ND	ND	ND	102	47
NAPHTHALENE	8270	5000	61	3 J	110	ND	1200 E	1400 D	103	ND
2-METHYLNAPHTHALENE	8270	220	ND	ND	ND	ND	16	ND	ND	ND
ACENAPHTHENE	8270	24000	ND	ND	ND	ND	8 J	ND	ND	ND
BIS(2-ETHYLHEXYL)PHTHALATE	8270	330	ND	ND	ND	ND	ND	ND	ND	ND
3-METHYLPHENOL	8270	7000	ND	24	2600 E	ND	ND	ND	ND	ND
ACETOPHENONE	8270	NL	11	ND	ND	ND	ND	ND	ND	ND

NOTES:
All concentrations are in ug/l.
<: indicates the compound was analyzed for but not detected.
The minimum detection limit is reported.
D: compound analyzed at secondary and found in diluted run.
J: indicates the presence of a compound that meets tha identified criteria but the result is less than the specified detection limit, but greater than zero.
E: exceed the Calibration Range.
B: analyte was found in blank as well as sample.
NL: Not Listed
*: MDNR Act 307 Type B Soil (20 X Ground Water) Cleanup Criteria.
(MERA Operational Memorandum #8, Revision 3)
[Ground water at the site does not meet tha definition of an aquifer; as such, soil cleanup criteria defines impacted ground water. See text for further infor
MW-9C and MW-22C samples were collected on February 7, 1992.
All other samples were collected on December 11, 1991.

Table 12
Reichhold Chemicals, Inc.
Ferndale, Michigan
Ground Water Analytical Results - December, 1991*
Pesticides/Herbicides/PCBs (Method 8080)

PARAMETER	METHOD	Type B Criteria *	MW-1	MW-2	MW-3	MW-4	MW-6	MW-7	MW-8	MW-8Q	MW-9
alpha-BHC	8080	NL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL
delta-BHC	8080	NL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL
Heptachlor	8080	1.7	BDL	BDL	BDL	BDL	BDL	0.07	BDL	BDL	BDL
Aldrin	8080	1.7	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL
Dieldrin	8080	3.3	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL
4,4'-DDE	8080	3.3	BDL	BDL	BDL	BDL	BDL	0.61	BDL	BDL	BDL
Endrin	8080	3.3	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL
Endosulfan II	8080	3.3	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL
gamma-Chlordane	8080	0.54	BDL	BDL	BDL	BDL	BDL	1.6	BDL	BDL	BDL

NOTES:
All concentrations are in ug/l.
BDL: vindicates the compound was analyzed for but was not detected.
NA: Not Analyzed
NL: Not Listed
*: MDNR Act 307 Type B Soil (20 X Ground Water) Cleanup Criteria.
(MERA Operational Memorandum #8, Revision 3)
[Ground water at the site does not meet the definition of an aquifer; as such, soil cleanup criteria defines impacted ground water. See text for further information.]
MW-9C and MW-22C samples were collected on February 7, 1992 and all other samples were collected on December 11, 1991.

Table 12
Reichhold Chemicals, Inc.
Ferndale, Michigan
Ground Water Analytical Results - December, 1991*
Pesticides/Herbicides/PCBs (Method 8080)

PARAMETER	METHOD	Type B Criteria *	MW-10	MW-11	MW-12	MW-13	MW-14	MW-16	MW-17	MW-18	MW-19
alpha-BHC	8080	NL	BDL	BDL	BDL	BDL	0.16	BDL	BDL	BDL	BDL
delta-BHC	8080	NL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	0.12	BDL
Heptachlor	8080	1.7	BDL	BDL	BDL	BDL	BDL	BDL	BDL	0.33	0.08
Aldrin	8080	1.7	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL
Dieldrin	8080	3.3	BDL	0.48	BDL	BDL	BDL	BDL	BDL	BDL	BDL
4,4'-DDE	8080	3.3	BDL	BDL	BDL	BDL	BDL	BDL	BDL	0.48	BDL
Endrin	8080	3.3	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL
Endosulfan II	8080	3.3	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL
gamma-Chlordane	8080	0.54	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL

NOTES:
All concentrations are in ug/l.
BDL: vindicates the compound was analyzed for but was not detected.
NA: Not Analyzed
NL: Not Listed
*: MDNR Act 307 Type B Soil (20 X Ground Water) Cleanup Criteria.
(MERA Operational Memorandum #8, Revision 3)
[Ground water at the site does not meet the definition of an aquifer; as such, soil cleanup criteria defines impacted ground water. See text for further information.
MW-9C and MW-22C samples were collected on February 7, 1992
and all other samples were collected on December 11, 1991.

Table 12
Reichhold Chemicals, Inc.
Ferndale, Michigan
Ground Water Analytical Results - December, 1991*
Pesticides/Herbicides/PCBs (Method 8080)

PARAMETER	METHOD	Type B Criteria *	MW-20	MW-21	MW-9C	MW-22C
alpha-BHC	8080	NL	0.12	BDL	BDL	BDL
delta-BHC	8080	NL	BDL	BDL	BDL	BDL
Heptachlor	8080	1.7	0.06	BDL	BDL	BDL
Aldrin	8080	1.7	0.07	BDL	BDL	BDL
Dieldrin	8080	3.3	BDL	BDL	BDL	BDL
4,4'-DDE	8080	3.3	BDL	BDL	BDL	BDL
Endrin	8080	3.3	0.13	BDL	BDL	BDL
Endosulfan II	8080	3.3	0.25	BDL	BDL	BDL
gamma-Chlordane	8080	0.54	BDL	BDL	BDL	BDL

NOTES:
All concentrations are in ug/l.
BDL: vindicates the compound was analyzed for but was not detected.
NA: Not Analyzed
NL: Not Listed
*: MDNR Act 307 Type B Soil (20 X Ground Water) Cleanup Criteria.
(MERA Operational Memorandum #8, Revision 3)
[Ground water at the site does not meet the definition of an aquifer; as such, soil cleanup criteria defines impacted ground water. See text for further information.
MW-9C and MW-22C samples were collected on February 7, 1992 and all other samples were collected on December 11, 1991.

Table 13
Reichhold Chemicals, Inc.
Ferndale, Michigan
Two Rounds of Ground Water Sampling

Well ID Area	MW-1 East	MW-2 West	MW-3 South	MW-4 East	MW-5 South	MW-6 East	MW-7 East	MW-8 East	MW-9 East	MW-10 East	MW-11 West	MW-12 West
VOC rnd1	15	19955	0	0	na	605	3530	820	259800	78	431154	1176
rnd2	71	1501	6	4	na	3681	52900	36	1673000	22	938000	2
SVOC rnd1	205	665	3	0	na	306	298	0	143	0	164	0
rnd2	0	181	0	0	na	128	866	0	163	0	3336	36
P/H/PCB rnd1*	0	0	0	0	na	0	0	0	0	0	0	0
rnd2	0	0	0	0	na	0	2.28	0	0	0	0.46	0

Well ID Area	MW-13 West	MW-14 West	MW-15 West	MW-16 South	MW-17 South	MW-18 West	MW-19 West	MW-20 West	MW-21 East	MW-9C East	W-22C East
VOC rnd1	1540	341000	na	709	42	2660	7100	73200	9	na	na
rnd2	5210	497400	274	3377	156	13430	930	64100	82	739000	35460
SVOC rnd1	909	73	na	44	0	922	214	180510	2044	na	na
rnd2	3239	221	na	45	0	223	173	580000	1400	205	159
P/H/PCB rnd1*	0	0	na	0	0	0	0	0	0	na	na
rnd2	0	0.16	na	0	0	0.94	0.06	0.63	0	0	0

Round 1 sampling occurred during September, 1991.
Round 2 sampling occurred during December, 1991, except MW-9C and MW-22C, which were sampled in February, 1992.
na – well was not sampled for a given parameter.
0 – no analytes detected above detection limits provided by the laboratory.
Results in ug/L (parts per billion or ppb).
* – only PCB analysis was conducted for round 1.

Table 14
Reichhold Chemicals, Inc.
Ferndale, Michigan
Solid Waste Management Units

MDNR SMNU No.	Name	Area	Description
1.	South Tank Farm	South	Consisted of 8 resin storage tanks which were decommissioned and removed. The area has been paved. ISAS is planned for August 1993.
2.	Building 204	South	Warehouse used for storing product and raw materials upon receipt or prior to shipment via rail cars.
3.	Building 203	South	Warehouse used for storing product and raw materials upon receipt or prior to shipment via rail cars.
4.	Pipe Bridge	South	Pipe bridge running between building 203 and building 206.
5.	Building 206	South	Warehouse used for storing drummed final products.
6.	Pipe Tunnel Under Woodward Hts Ave Connecting S.&W. Areas	South	Tunnel between south and west areas containing pipes used to transfer final product. Tunnel is approximately two feet below grade.
7.	Tank Farm	West	Tank farm located in the southeast corner of the west section, used for storage of inflammable solvents.
8.	Solvent Pump Station	West	Used to pump solvents from storage tanks to trains, and from trains to storage tanks.
9.	Building "B"	West	Processing plant and chemical laboratories. Phenols were used in some processes, wastewater discharges may have occurred.
10.	Building "C"	West	Boiler house until 1941, alkyd, epoxy and phenol resin production thereafter.
11.	Dock "C" - Storage and Processing	West	Loading/unloading along railroad spur
12.	Building "K" - Storage and Processing	West	Processing of coppal, a natural gum in the early days of plant operation, also used as covered storage.
13.	Dock "K" - Storage and Processing	West	Loading/unloading along railroad spur Transfer station for product traveling through the pipe tunnel under the train tracks (SWMU 59).

Table 14
Reichhold Chemicals, Inc.
Ferndale, Michigan
Solid Waste Management Units

MDNR SMNU No.	Name	Area	Description
14.	Inert Gas Generation Building	West	Pilot operation for production of phthalic anhydride in '30s and '40s.
15.	Building "N"	West	Building was demolished, was used for production of resins and inflammable solvents.
16.	Pump House	West	Pump house used to pump product into and out of the tank farm identified as SWMU 17.
17.	Tank Farm	West	Tank farm located at the north end of the west area.
18.	Building "M"	West	Storage of empty drums. Built over old drum storage area. Tank cars cleaned on west side of building with TCE and caustic solutions.
19.	Building "L" - adjacent to Building "M"	West	Portion of "L" building adjacent to "M" building. Contains 8 storage tanks.
20.	Tank Truck Cleaning Building	West	Portion of "L" building used for cleaning trucks. TCE and carbon tetrachloride used for cleaning. TCE stored inside and outside building.
21.	3 storage tanks	West	Storage tanks adjacent to tank truck cleaning building.
22.	Diked Area adjacent to Building "L"	West	Diked area containing two storage tanks.
23.	Garage Area of Building "L"	West	Portion of "L" building used as a garage. TCE was stored inside and outside of the building.
24.	Shed	West	Shed used for storage of resin drums.
25.	Transformer Storage	West	Building in center of west area across from "C" dock, used for storage of transformers.
26.	Diked Area	West	SW portion of west area, diked area containing 7 tanks used to store resins.

Table 14
Reichhold Chemicals, Inc.
Ferndale, Michigan
Solid Waste Management Units

MDNR SMNU No.	Name	Area	Description
27.	Building "D" Annex	West	Building used for resin processing and filtration, primarily phenolic resins.
28.	Building "D"	West	Building used for resin processing and filtration, primarily phenolic resins.
29.	Building "E"	West	Primary resin processing, filtration and storage. 14 process tanks.
30.	Building "F"	West	Primary resin processing, filtration and storage.
31.	Building "G"	West	Primary resin processing, filtration and storage. Phenol production equipment contained here.
32.	Building South of Building "G"	West	Contains four storage tanks used for resin processing and filtration operations.
33.	Building "H"	West	Administrative offices and laboratory usage.
34.	Building 102	East	Administrative offices, chemical laboratories.
35.	Hazardous Reagent Storage Area	East	Located in parking lot for building 102. Small containers of inflammable solvents including methyl ethyl ketone and powders were stored here.
36.	Building 100	East	Maintenance shop. Loading dock next to rail spur used for loading/unloading of maintenance materials. Temporary dimethyl phthalate storage during WWII.
37.	Heated Storage Bldg. 101A	East	Heated portion of building 101. Used for dispensing of sample resin.
38.	Storage Shed	East	Equipment storage and possibly storage of product and wastes.
39.	Building 101B	East	Miscellaneous solvent storage area.

Table 14
Reichhold Chemicals, Inc.
Ferndale, Michigan
Solid Waste Management Units

MDNR SMNU No.	Name	Area	Description
40.	Hazardous Waste Tank Storage Area	East	Decommissioned storage tanks, three removed (450 gal, 150 gal, 150 gal) one remains (5,000 gal)
41.	Boiler Room	East	Incineration of hazardous waste generated at the facility.
42.	Hazardous Waste Container Area	East	Hazardous waste container storage pad, 1000 container capacity - 65 feet by 60 feet.
43.	Building 105A	East	Contains five storage tanks. Production of phthalic anhydride took place in this area.
44.	Hazardous Waste Container Storage Area	East	Storage of hazardous waste containers prior to disposal. Located along the Bermuda Avenue wall across the driveway from the hazardous waste container storage pad.
45.	Building 103	East	Building demolished during facility decommisioning. Production of dimethyl phthalate, resin, phthalic anhydride, inflammable solvents.
46.	Building 104A	East	Portion of building 104 used to produce phthalic anhydride.
47.	Building 104B	East	Portion of building 104 used as tank storage - six tanks were stored in this area.
48.	Building 104C	East	Portion of building 104 used for storage of drums containing resins.
49.	Building 104D	East	Portion of building 104 used for storage of drums containing resins.
50.	Inflammable Solvent Tank Farm	East	Ten storage tanks located in the northeast corner of the east area of the facility used for storage of of inflammable solvents.
51.	Inflammable Solvent Tank Farm	East	Ten storage tanks located in the northwest corner of the east area of the facility used for storage of of inflammable solvents.
52.	Building 104	East	Consists of building 104 used for empty drum storage.

Table 14
Reichhold Chemicals, Inc.
Ferndale, Michigan
Solid Waste Management Units

MDNR SMNU No.	Name	Area	Description
53.	Building 104E	East	Portion of building 104 used for production of phthalic anhydride.
54.	Building 105B	East	West of and adjacent to SWMU 43. Area contained four tanks used in production of phthalic anhydride.
55.	Building 105	East	Storage of empty drums.
56.	Building 101	East	Pilot plant for production of phthalic anhydride - plant had four kettles utilized for production. Adjacent to SWMU 36
57.	Pipe Trench	East	Pipe trench between SWMU 36 and SWMU 34.
58.	Pipe Bridge	East	Pipe bridge running from building 104 to the edge of building 105 along the railroad spur.
59.	Pipe Tunnel	East/West	Pipe tunnel connecting east area (SWMU 41) to west area (SWMU 13). Approximately 20 feet below grade, made of concrete. Waste and product pumped through pipes.
60.	Former Underground Storage Tank	South	UST for gasoline - located on the western edge of the Reichhold parking lot on the south side of Woodward Hts. Blvd. - Closure performed by IT. Inc.
61.	Driveway between Gainsboro Ave. and Bldgs. 204 and 205	South	Designated an SWMU due to truck traffic generated by the warehouses.
62.	Area between Railroad Spur on the Northern End of West Area	West	Designated an SWMU due to loading, unloading, and storage that occurred at the railroad spur.
63.	Driveway and Parking Area west side of West Area	West	Designated an SWMU due to traffic on the driveway and because of a 30 inch city sewer line located near the production areas of the facilty.
64.	Roadway between Two Sets of Buildings which Split the West Area	West	Roadway.
65.	Roadway Inside Wall along Bermuda Ave.	East	Designated an SWMU due to truck traffic passing through the area, including hazardous waste shipments. Waste solvents were stored against the wall.

Table 14
Reichhold Chemicals, Inc.
Ferndale, Michigan
Solid Waste Management Units

MDNR SMNU No.	Name	Area	Description
66.	Truck Parking Lot	East	Parking lot.
67.	Area Adjacent to Train Tracks - Entire Length of Property	East	Designated an SWMU due to intense manufacturing operations that took place in the area. 3 formaldehyde tanks located by pilot plant, drums stored by pilot plant.
68.	Deep Well	East	Well used by Reichhold for disposal of phenolic wastes in the 1950's.
69.	Minerva Avenue. Reichhold Chemicals, Inc. owned property	East	Designated an SWMU due to a complaint filed with the MDNR on September 24, 1984.

TABLE 15

REICHHOLD CHEMICALS INC.
SOIL REMEDIATION TECHNOLOGY
SUMMARY EVALUATION MATRIX

	EVALUATION CRITERIA					
TECHNOLOGY	COST	LONG TERM EFFECTIVENESS	CONSTRUCTABILITY IMPLEMENTABILITY	PREVIOUS PERFORMANCE HISTORY	REGULATORY/ PUBLIC ACCEPTANCE	OPTION RETAINED FOR FURTHER EVALUATION
LOW TEMP. THERMAL DESORP.	0	0	+	+	0	YES
SOIL WASHING	0	–	0	–	+	NO
SOIL FLUSHING	+	–	+	–	0	NO
BIODEGRADATION	+	0	0	0	0	Yes
IN-SITU AIR STRIPPING	+	0	+	0	0	YES
IN-SITU AIR SPARGING	+	0	+	0	0	YES

NOTES: +=PERCEIVED ADVANTAGE, 0=NEUTRAL, –=PERCEIVED DISADVANTAGE.

TABLE 16
REICHHOLD CHEMICALS, INC.
FERNDALE, MICHIGAN

SOIL DATA REQUIREMENTS

Technology	Design Parameters or Relevant Soils Data
Low Temperature Thermal Desorption	Soils Percent Moisture, Soil Particle Size Distribution, Depth, Profile and Areal Distribution of Contamination Across the Site Soils, pH of Soil, Metals Concentration in Soil.
In-Situ Air Stripping	Soil Permeability, Vacuum Radius of Influence, Depth, Profile and Areal Distribution of Contamination Across Site Soils, Groundwater Level History Across Site, Soil Moisture Content, Soil Porosity, Particle Size Distribution, and Soil Organic Carbon Content.
In-Situ Air Sparging/Air Stripping	Soil Permeability, Vacuum Radius of Influence, Depth, Profile and Areal Distribution of Contamination Across Site Soils, Groundwater Level History Across Site, Soil Moisture Content, Soil Porosity, Particle Size Distribution, and Soil Organic Carbon Content, Depth of Top of Perched Aquifer to Confining Clay Layer, and Dissolved Oxygen Content in Aquifer.

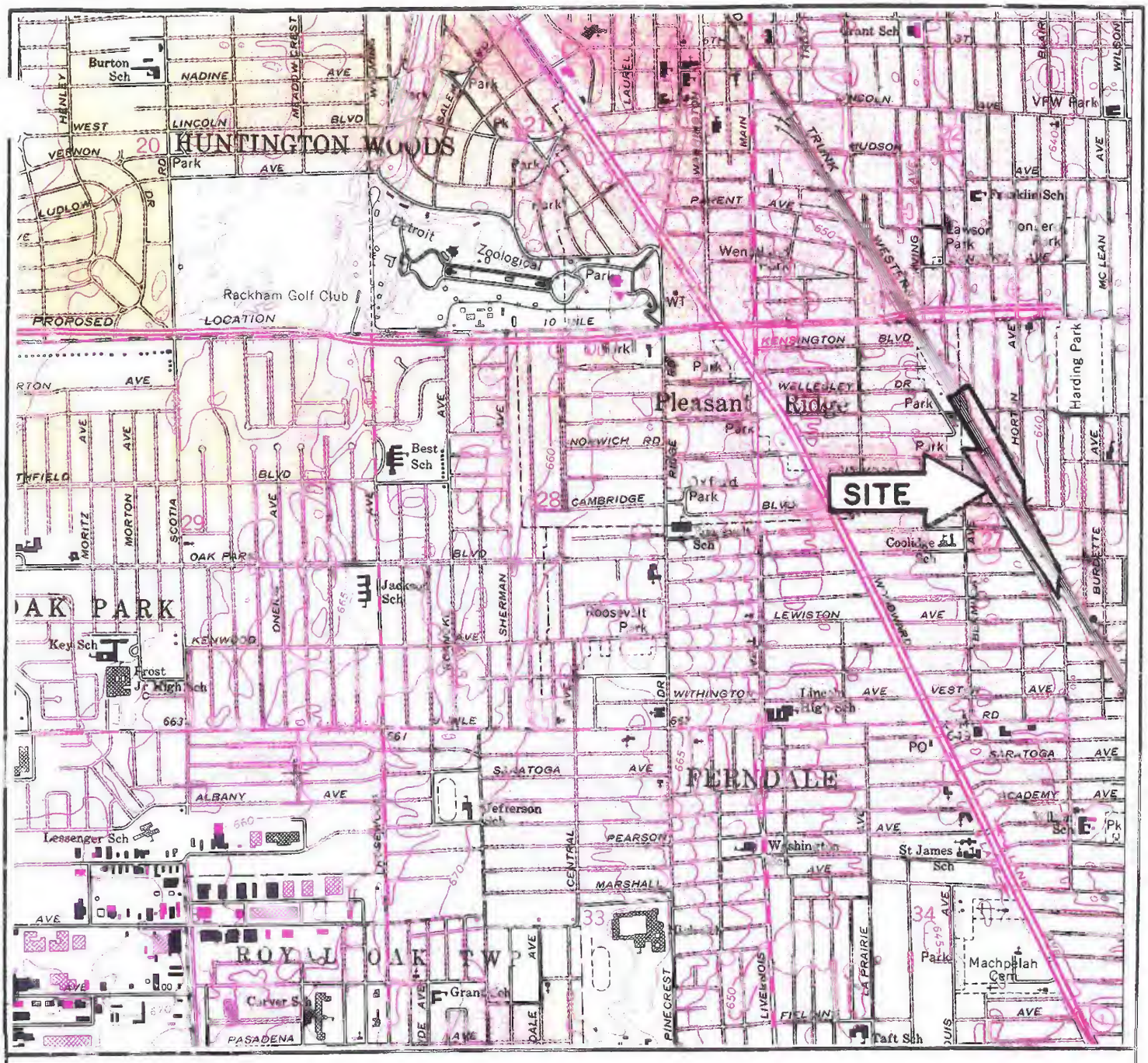
TABLE 17
REICHHOLD CHEMICALS, INC.
FERNDALE, MICHIGAN

SUMMARY OF HYDRAULIC CONTROL OPTIONS

Option	Preferred Remedial Option	Comments
Ground Water Containment/Cutoff Wall		
Soil/Bentonite Slurry Wall	Yes	Partial Cutoff Wall Only
Cement/Bentonite Slurry Wall	No	Cost Prohibitive
Steel Sheet Piling	Yes	
Gundwall	Yes	Temporary Control Only (up to 5 years)
Ground Water Treatment		
Air Stripping	Yes	
Closed Loop Air Sparging	Yes	Further Treatment May Be Required
U.V. Oxidation with Peroxide Additive	No	Poor Performance History
Bioremediation	Yes	
Off-Site Treatment and Disposal	Yes	
Ground Water Discharge		
Discharge to POTW	Yes	
Discharge to Shallow Aquifer	Yes	Treatment to drinking water stds required.
Deep Well Reinjection	No	Generally Unacceptable to MDNR

FIGURES

FIGURE 1



SITE LOCATION MAP

REICHHOLD CHEMICALS, INC.
FERNDALE, MICHIGAN

THIS MAP TAKEN FROM THE ROYAL OAK, MICHIGAN USGS QUADRANGLE

QUADRANGLE LOCATION

1 ½ 0 1 MILE

1000 0 1000 2000 3000 4000 5000 6000 7000 FEET

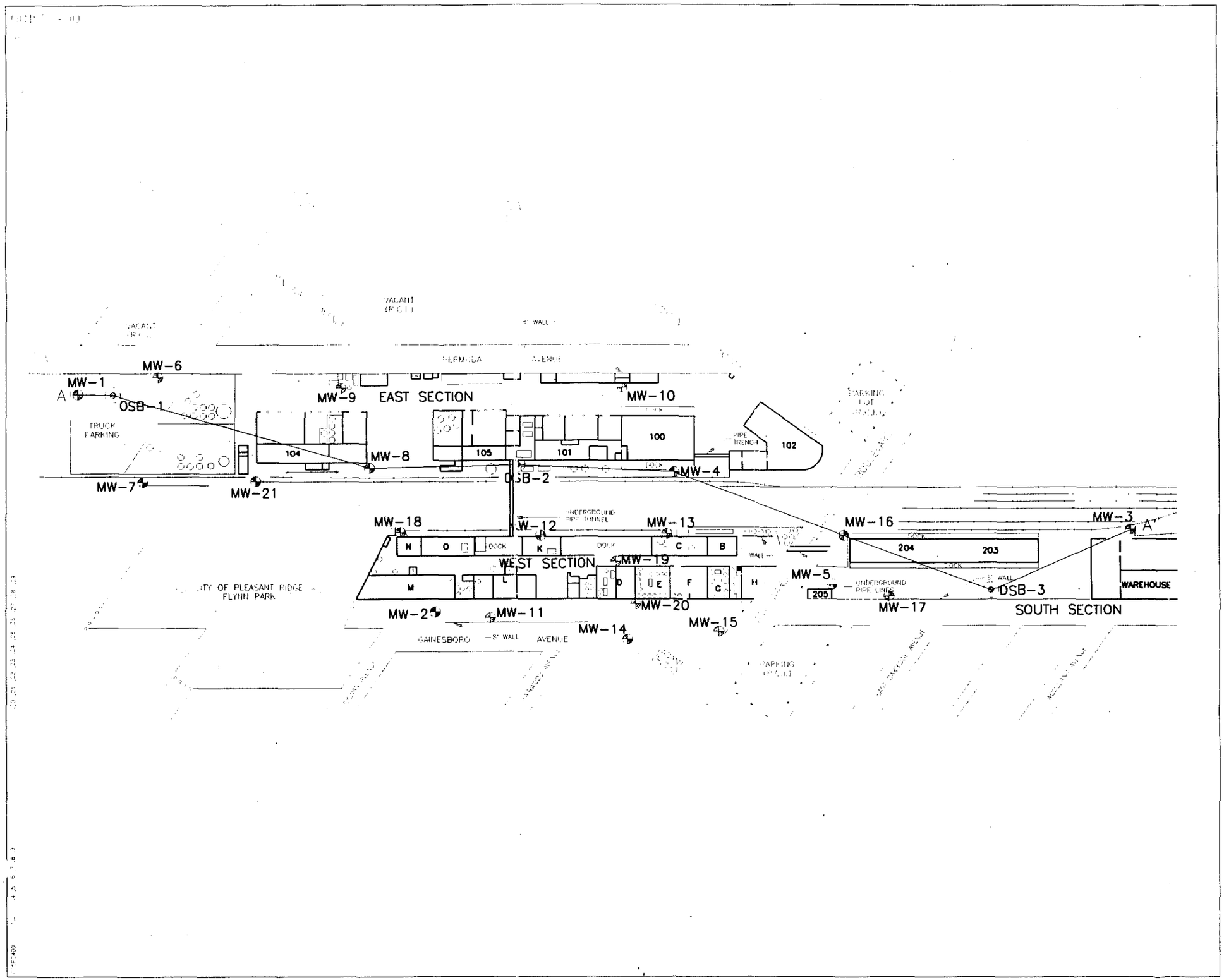
1 .5 0 1 KILOMETER

SCALE 1:24000

O'BRIEN & GERE ENGINEERS INC.
Edison, New Jersey

FIGURE 2

REICHHOLD CHEMICALS, INC
FERNDALE, MICHIGAN



LEGEND

- MONITORING WELL LOCATION
- MONITORING WELL WAS ABANDONED AND GROUTED
- DEEP SOIL BORING LOCATION
- A — A' HYDROGEOLOGIC CROSS SECTION

SITE PLAN

DECEMBER 1994

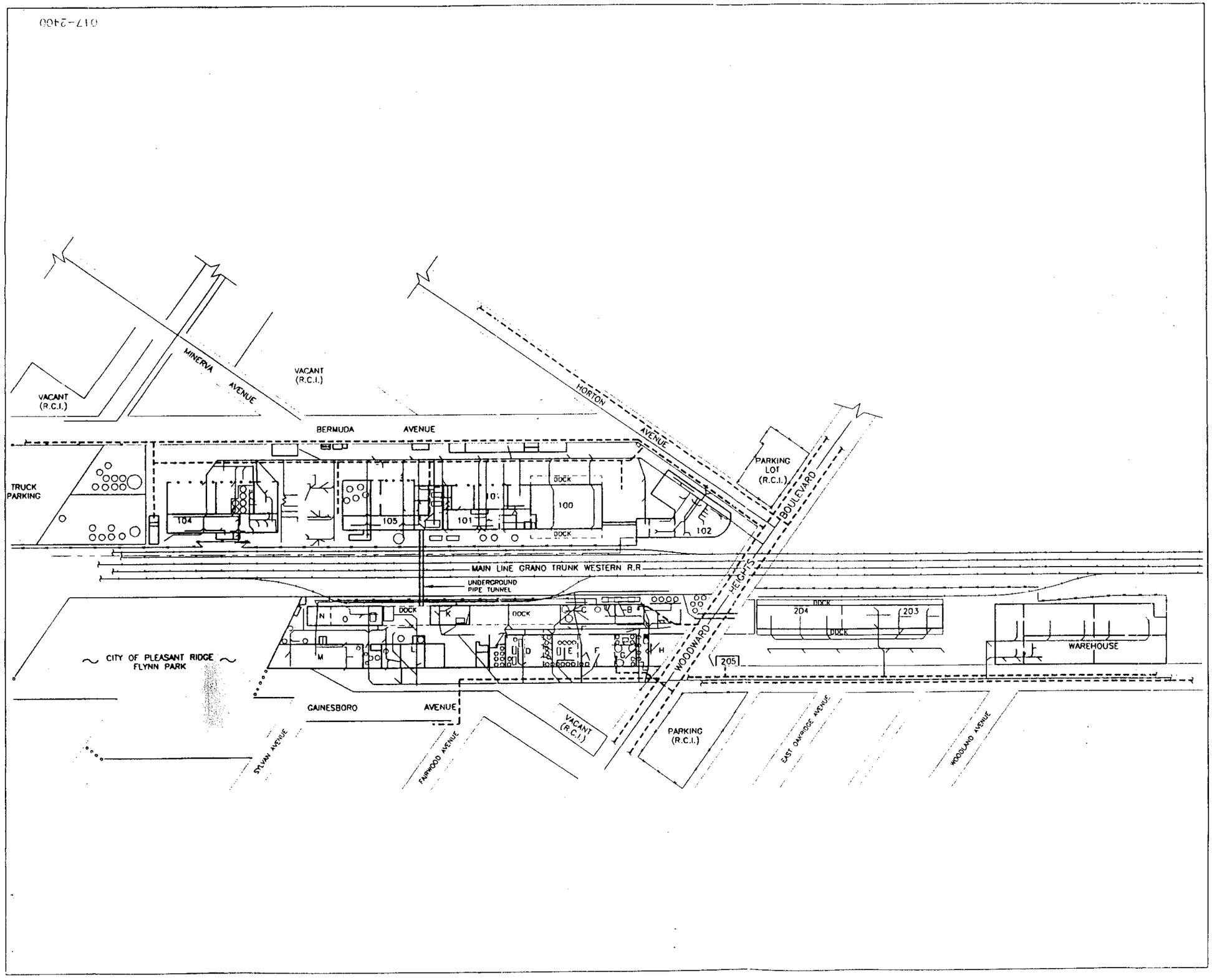
200 0 200

SCALE IN FEET

O'BRIEN & GERE ENGINEERS, INC

FIGURE 3

REICHHOLD CHEMICALS, INC
FERNDALE, MICHIGAN



LEGEND

WATERLINE

SEWERLINE

UTILITIES MAP

JULY 1993

200 0 200

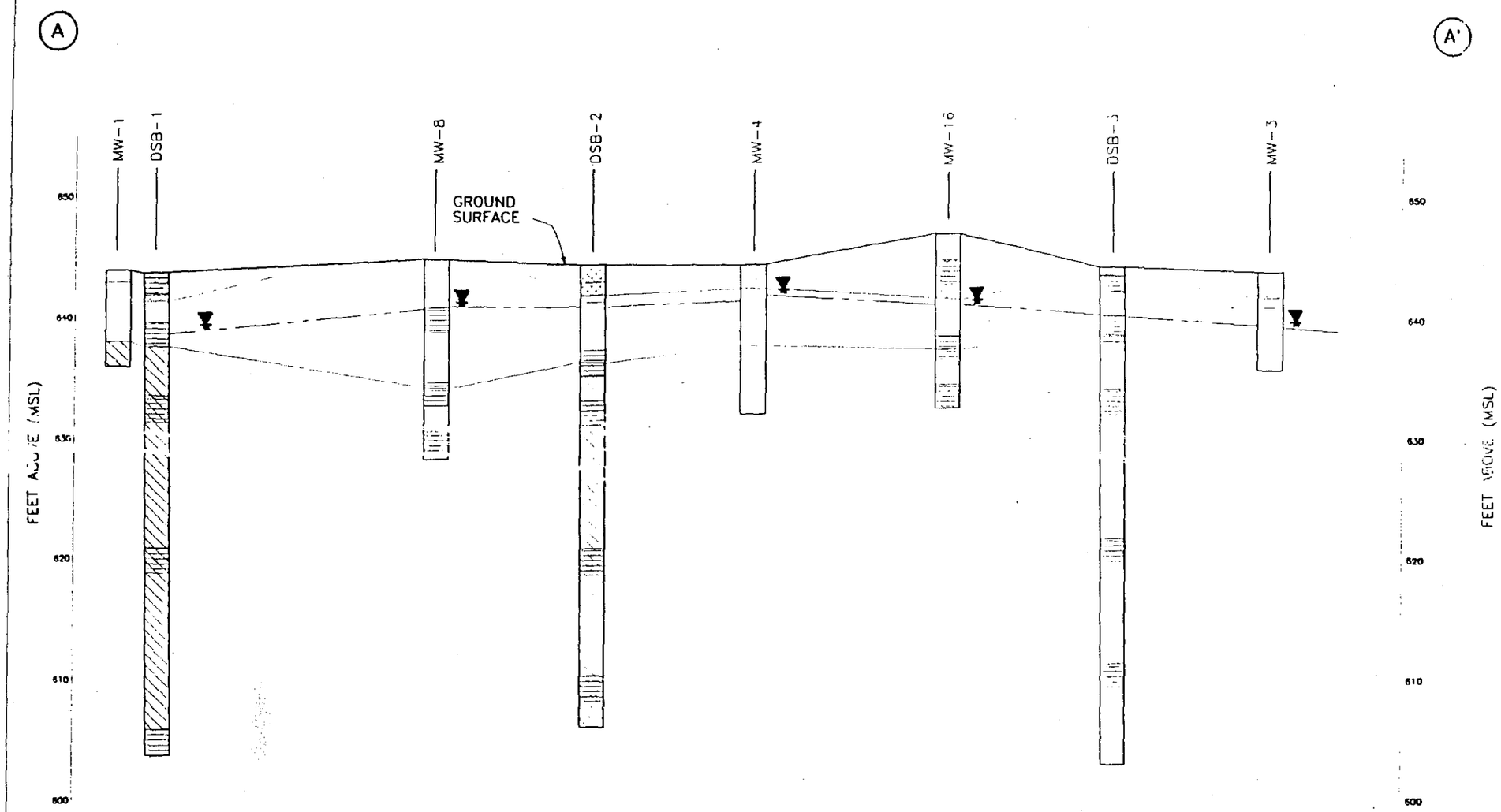
SCALE IN FEET

O'BRIEN & GERE

010-120

FIGURE 4

REICHHOLD CHEMICALS, INC
FERNDALE, MICHIGAN



LEGEND

F-C SAND, SILTY SAND

CONCRETE, ASPHALT, RUBBLE,FILL

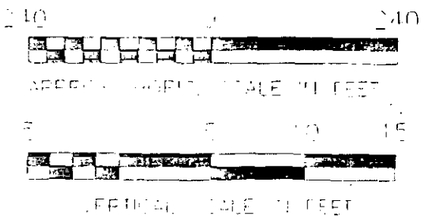
GRAY CLAY

DISCRETE SOIL SAMPLE INTERVAL

GROUND WATER ELEVATION

NORTH - SOUTH GEOLOGICAL CROSS SECTION

JULY 1993



O'BRIEN & GERE

012-2400

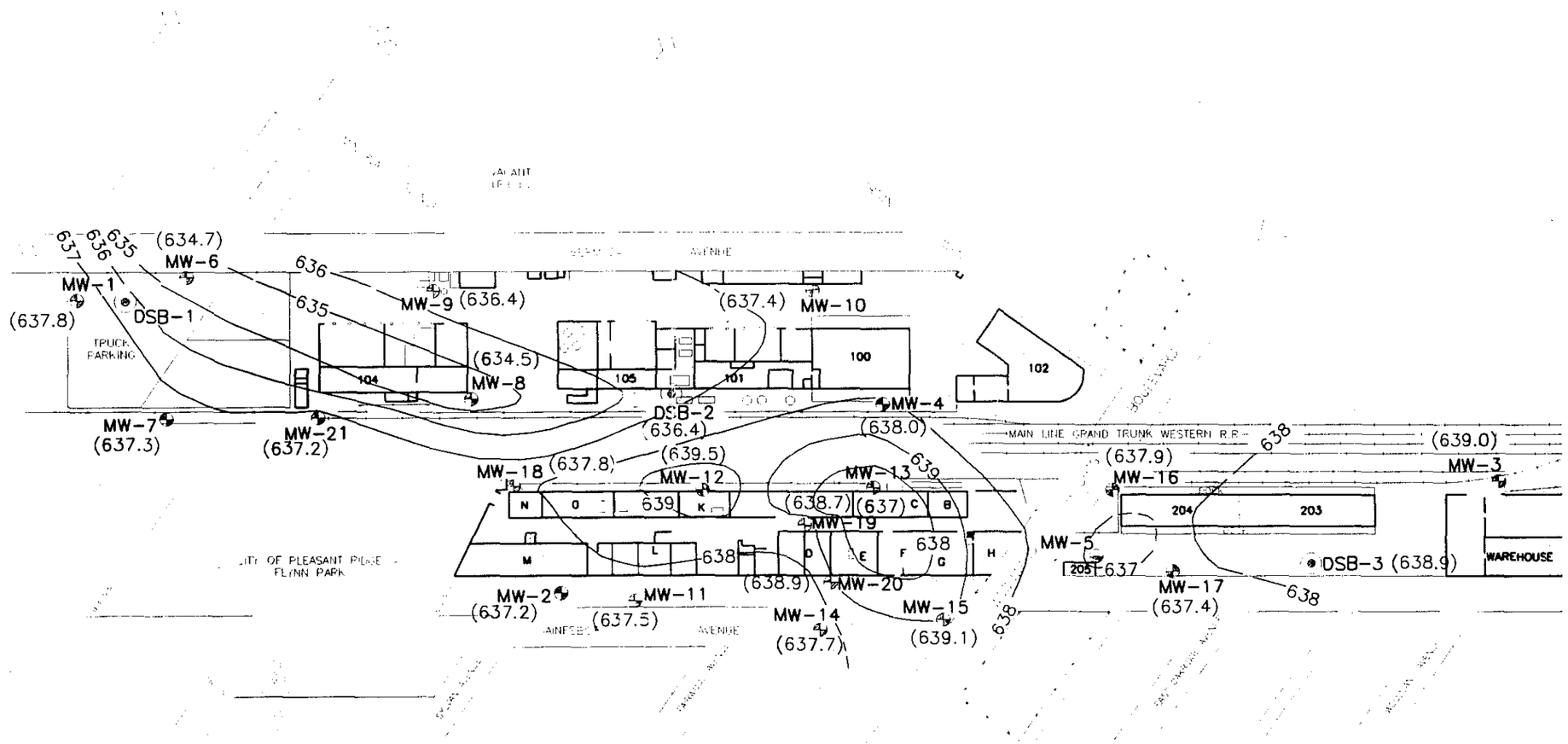


FIGURE 8

REICHHOLD CHEMICALS, INC
FERNDALE, MICHIGAN

LEGEND

- MONITORING WELL LOCATION
- MONITORING WELL WAS ABANDONED AND GROUTED
- DEEP SOIL BORING
- (639.0) TOP OF CLAY ELEVATION
- 641 TOP OF CLAY ELEVATION CONTOUR (DASHED WHERE INFERRED)

TOP OF CLAY ELEVATION CONTOUR MAP

DECEMBER 1994

200 0 200

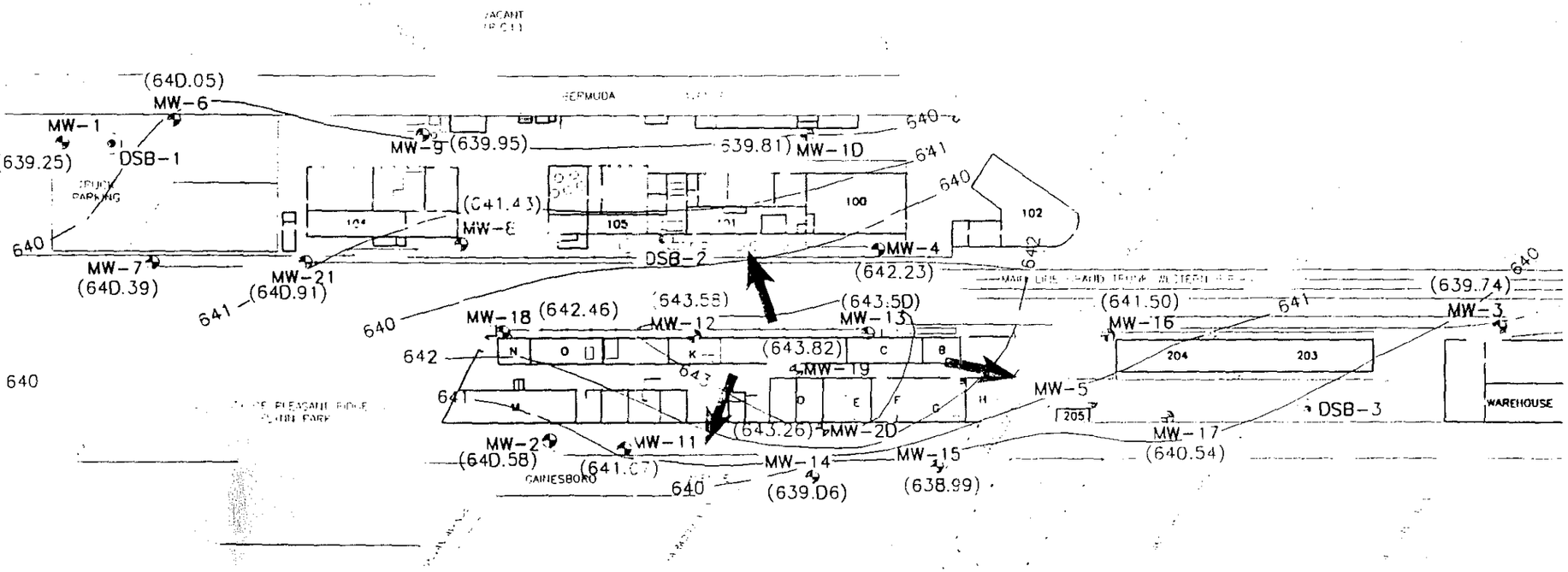
SCALE IN FEET

O'BRIEN & GERE ENGINEERS, INC.

013-2400

FIGURE 5

REICHHOLD CHEMICALS, INC
FERNDALE, MICHIGAN



LEGEND

- MONITORING WELL LOCATION
- MONITORING WELL WAS ABANDONED AND GROUTED
- DEEP SOIL BORING
- (639.74) GROUND WATER ELEVATION
- 641 GROUND WATER ELEVATION CONTOUR
- GROUND WATER FLOW DIRECTION

GROUND WATER CONTOUR MAP 7/26/91

JULY 1993

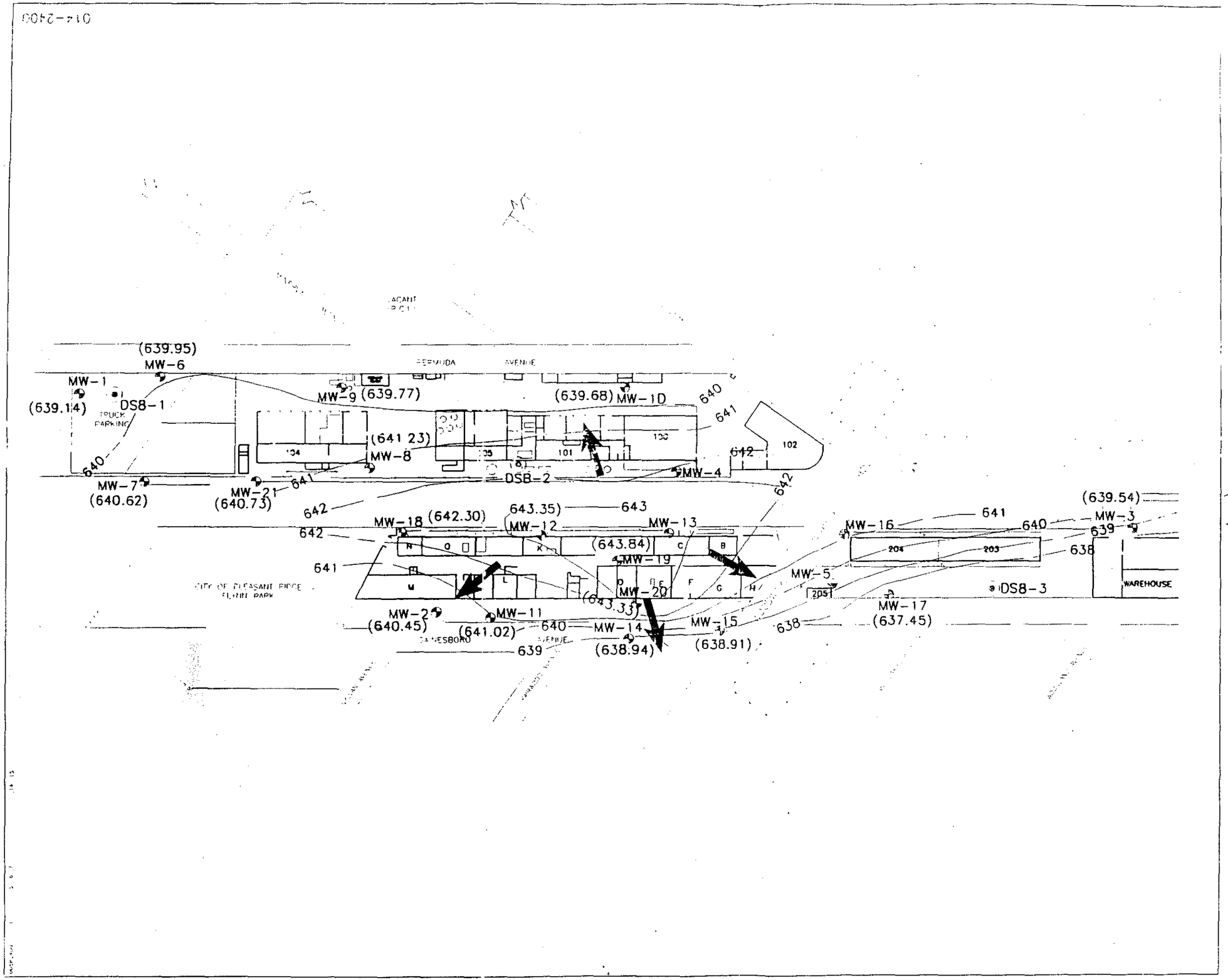
100 200

SCALE IN FEET

O'BRIEN & GERE ENGINEERS

FIGURE 6

REICHHOLD CHEMICALS, INC
FERNDALE, MICHIGAN



LEGEND

- MONITORING WELL LOCATION
- MONITORING WELL WAS ABANDONED AND GROUTED
- DEEP SOIL BORING
- (639.54) GROUND WATER ELEVATION
- 641 GROUND WATER ELEVATION CONTOUR
- GROUND WATER ELEVATION CONTOUR

GROUND WATER CONTOUR MAP 8/2/91

JULY 1993

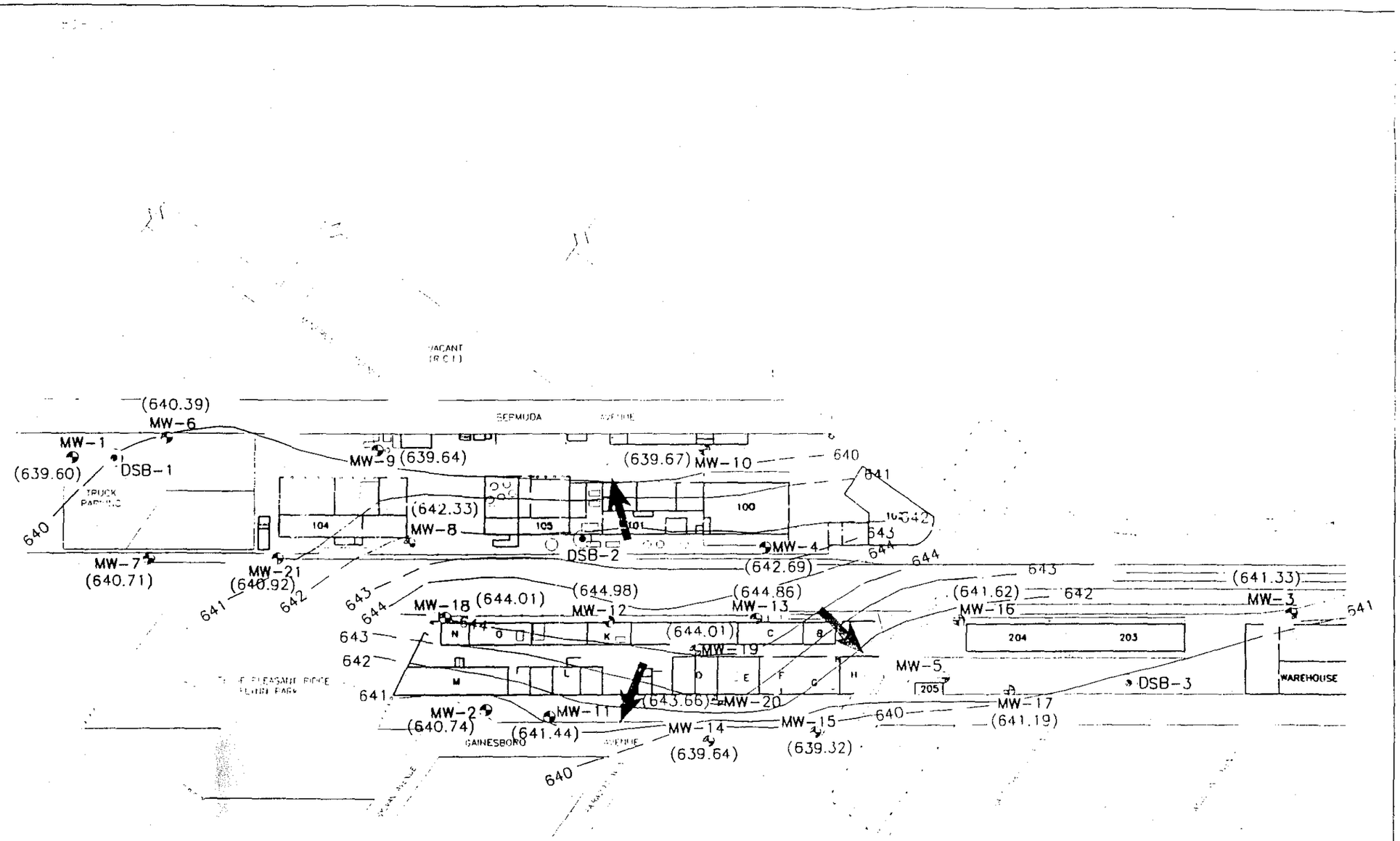
200 0 200

SCALE IN FEET

O'BRIEN & GERE ENGINEERS INC

FIGURE 7

REICHHOLD CHEMICALS, INC
FERNDALE, MICHIGAN



LEGEND

- MONITORING WELL LOCATION
- MONITORING WELL WAS ABANDONED AND GROUTED
- DEEP SOIL BORING
- (641.33) GROUND WATER ELEVATION
- 641 GROUND WATER ELEVATION CONTOUR
- GROUND WATER FLOW DIRECTION

GROUND WATER CONTOUR
MAP 10/29/91

200 0 200

SCALE IN FEET

O'BRIEN & GERE
ENGINEERS, INC

012-2400

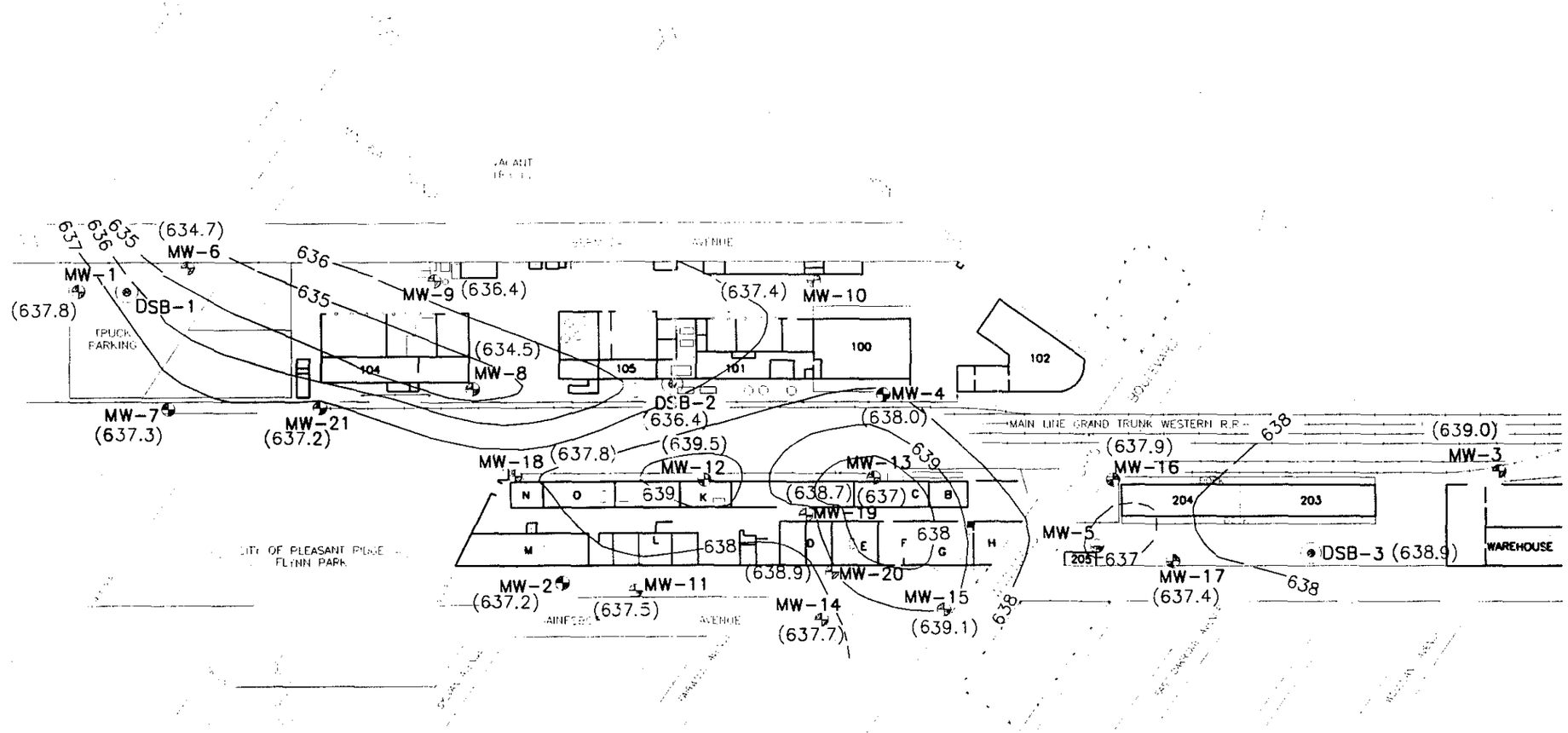


FIGURE 8

REICHHOLD CHEMICALS, INC
FERNDALE, MICHIGAN

LEGEND

- MONITORING WELL LOCATION
- MONITORING WELL WAS ABANDONED AND GROUTED
- DEEP SOIL BORING
- (639.0) TOP OF CLAY ELEVATION
- 641 TOP OF CLAY ELEVATION CONTOUR (DASHED WHERE INFERRED)

TOP OF CLAY ELEVATION CONTOUR MAP

DECEMBER 1994

200 0 200

SCALE IN FEET

O'BRIEN & GERE

REICHHOLD CHEMICALS, INC.
FERNDALE, MI FACILITY

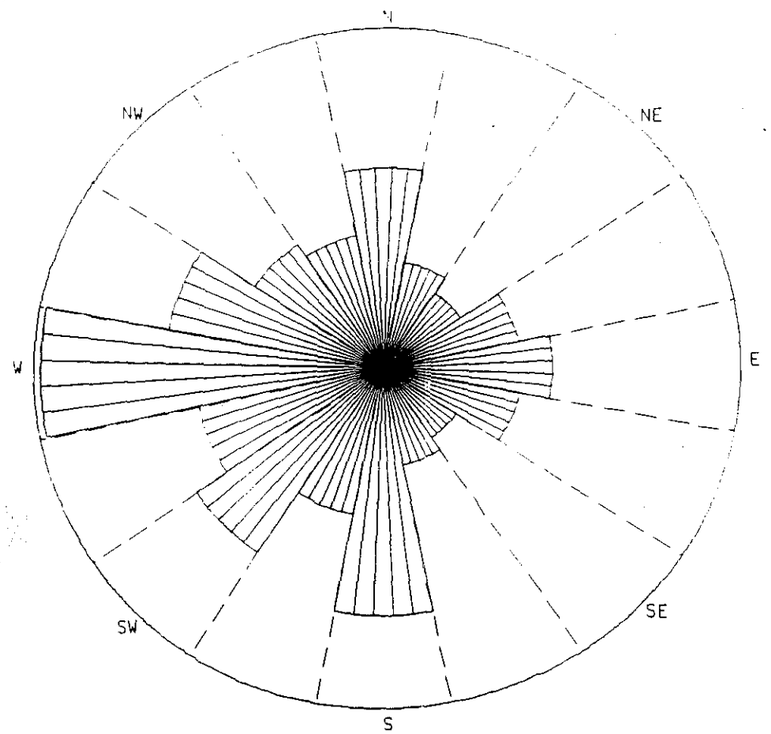
FIGURE 8a

WIND ROSE DIAGRAMS

WBAN NUMBER 14822 DETROIT CITY 14853 M 1969-1973

PLOT TYPE = WIND DIRECTION,

SECTOR	FREQUENCY
N	7.582E-02
NNE	4.067E-02
NE	3.402E-02
ENE	4.995E-02
E	6.126E-02
ESE	5.045E-02
SE	3.191E-02
SSE	3.742E-02
S	9.361E-02
SSW	5.644E-02
SW	8.313E-02
WSW	6.952E-02
W	1.267E-01
WNW	8.103E-02
NW	5.686E-02
NNW	5.133E-02



WBAN NUMBER 14822 DETROIT CITY 14853 M 1969-1973

PLOT TYPE = AVERAGE WIND SPEED

SECTOR	METERS/SEC
N	4.050E+00
NNE	3.940E+00
NE	4.050E+00
ENE	3.940E+00
E	4.030E+00
ESE	4.010E+00
SE	3.680E+00
SSE	3.770E+00
S	4.360E+00
SSW	4.900E+00
SW	5.540E+00
WSW	5.560E+00
W	5.100E+00
WNW	4.670E+00
NW	4.660E+00
NNW	4.520E+00

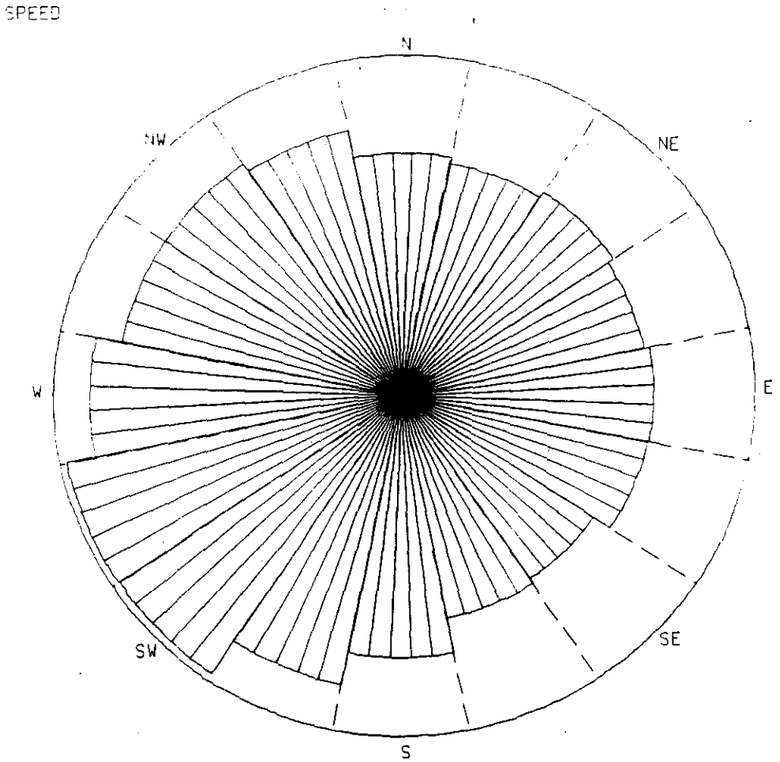
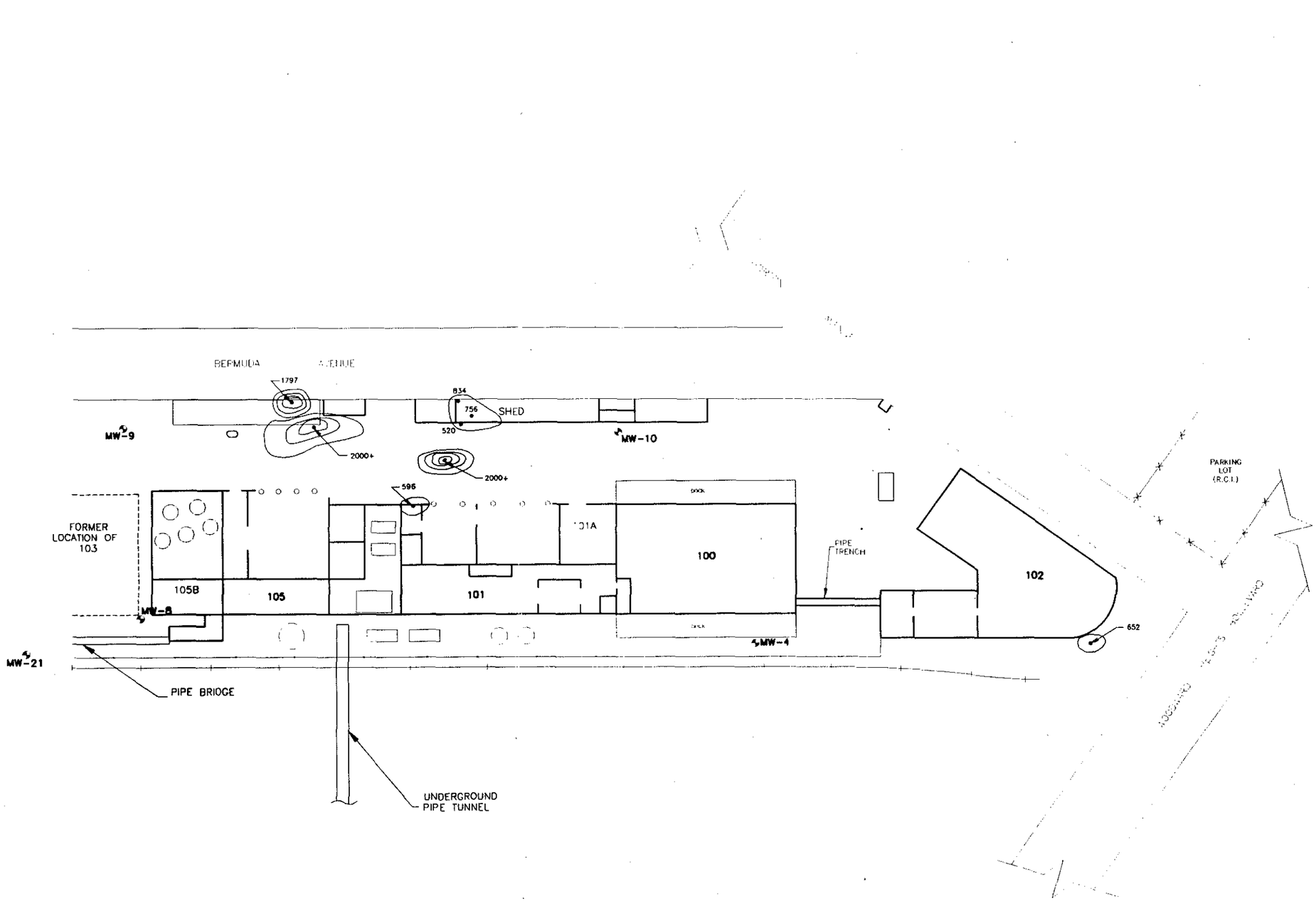


FIGURE 12



LEGEND

- SOIL-GAS VAPOR COLLECTION POINT AND CORRESPONDING READING OF TOTAL VOC'S IN PARTS PER MILLION (ppm)
- 500 — CONTOUR OF TOTAL VOC'S UNITS ARE IN PARTS PER MILLION, CONTOUR INTERVAL IS 500 ppm
- MONITORING WELL LOCATION

REICHHOLD CHEMICALS INC.
FERNDALE, MICHIGAN

SOUTH HALF OF THE EAST SECTION CONTOUR OF SOIL-GAS VAPOR RESULTS

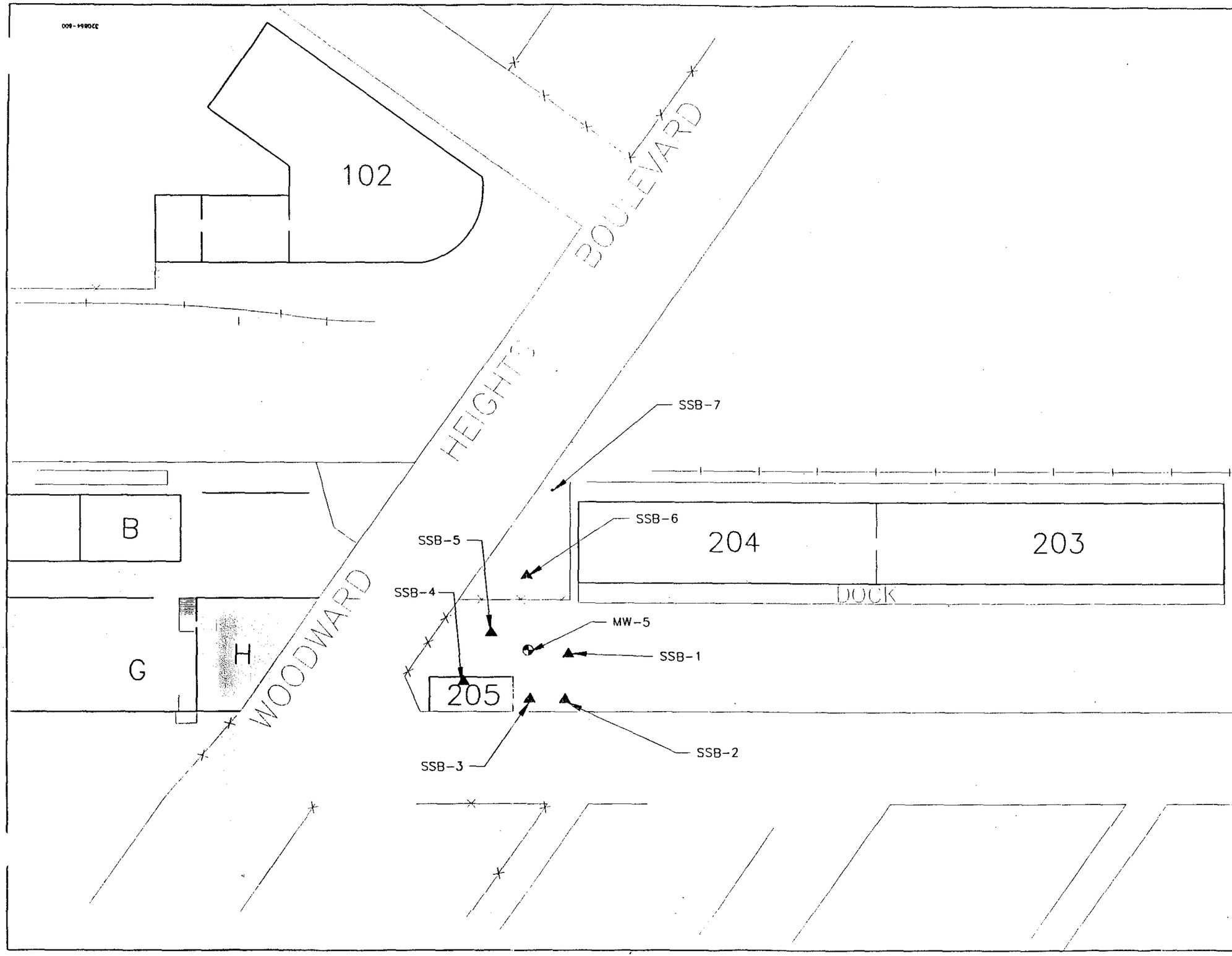
DECEMBER 1994

90 0 90 180

SCALE IN FEET

320660-1080

FIGURE 9



LEGEND

- MONITORING WELL LOCATION
- SOIL BORING LOCATION

REICHHOLD CHEMICALS INC.
FERNDALE, MICHIGAN

SOUTH SECTION SOIL SAMPLE LOCATIONS

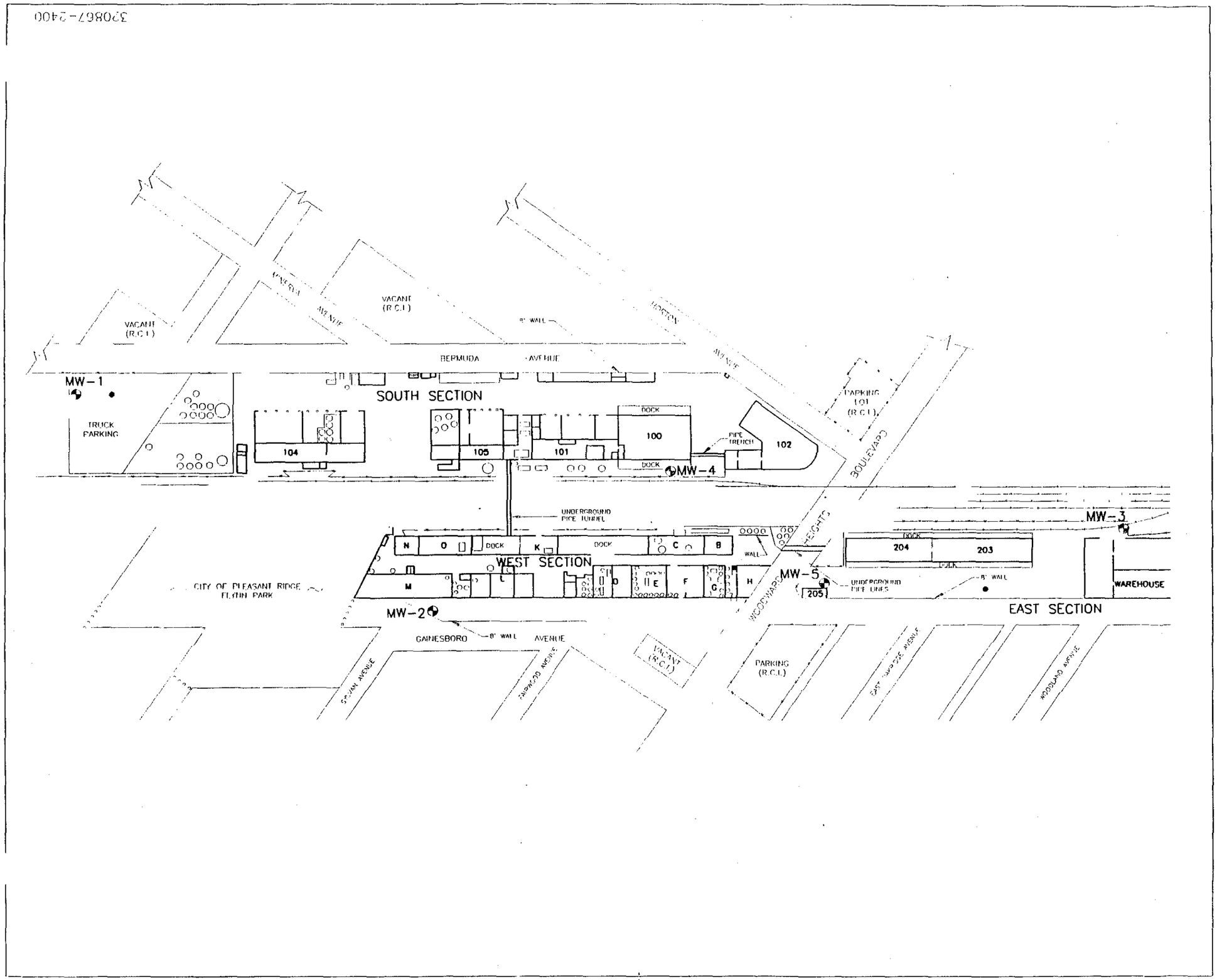
JULY 1993

50 0 50 100

SCALE IN FEET

FIGURE 10

REICHHOLD CHEMICALS, INC
FERNDALE, MICHIGAN



LEGEND

MONITORING WELL LOCATION

PHASE I
MONITORING WELLS

JULY 1993

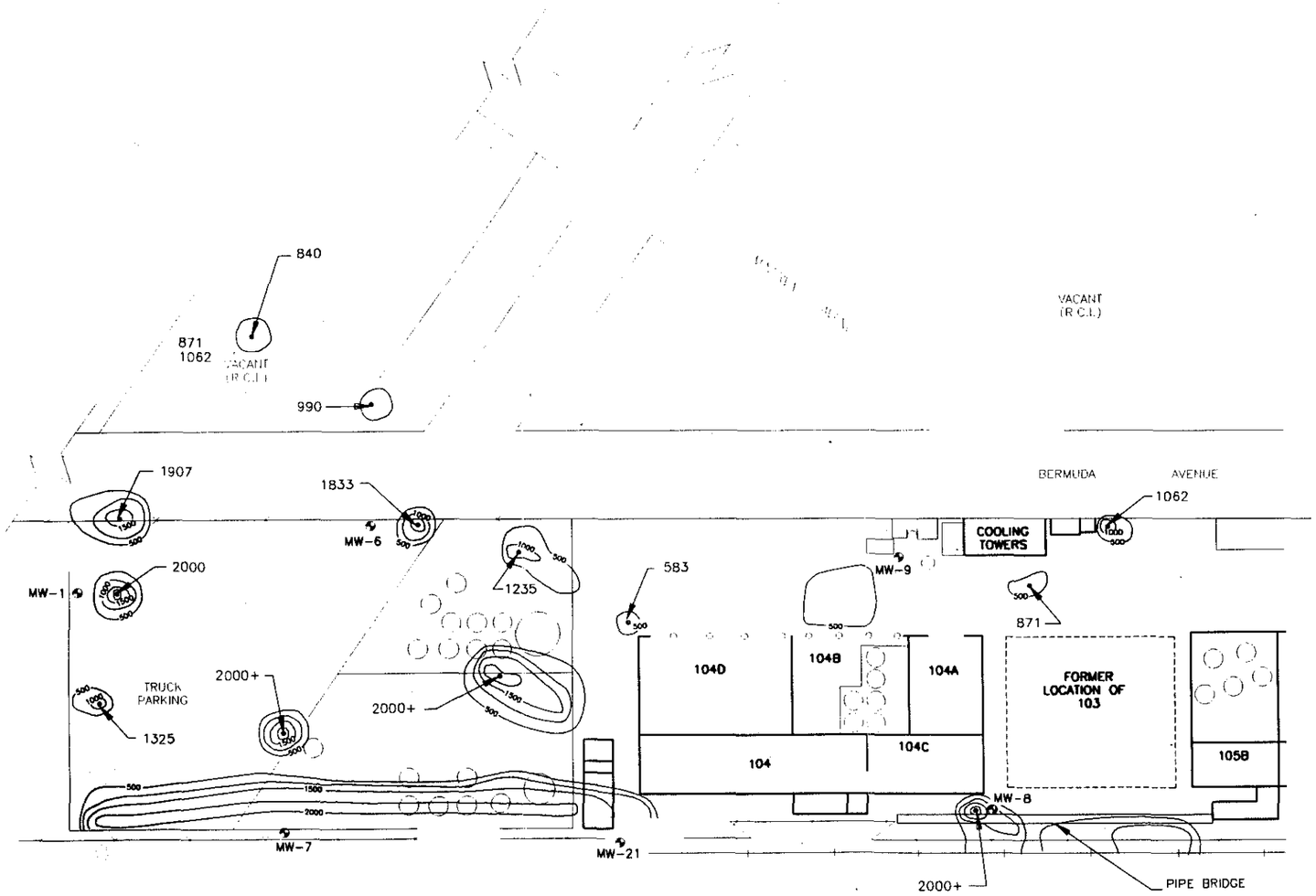
200 0 200

SCALE IN FEET

O'BRIEN & GERE ENGINEERS, INC.

32086-2400

FIGURE 11



LEGEND

- SOIL-GAS VAPOR COLLECTION POINT AND CORRESPONDING READING OF TOTAL VOC'S IN PARTS PER MILLION (ppm)
- CONTOUR OF TOTAL VOC'S UNITS ARE IN PARTS PER MILLION, CONTOUR INTERVAL IS 500 ppm
- MONITORING WELL LOCATION

REICHHOLD CHEMICALS
INC.
FERNDALE, MICHIGAN

NORTH HALF OF THE
EAST SECTION CONTOUR
OF SOIL-GAS VAPOR
RESULTS

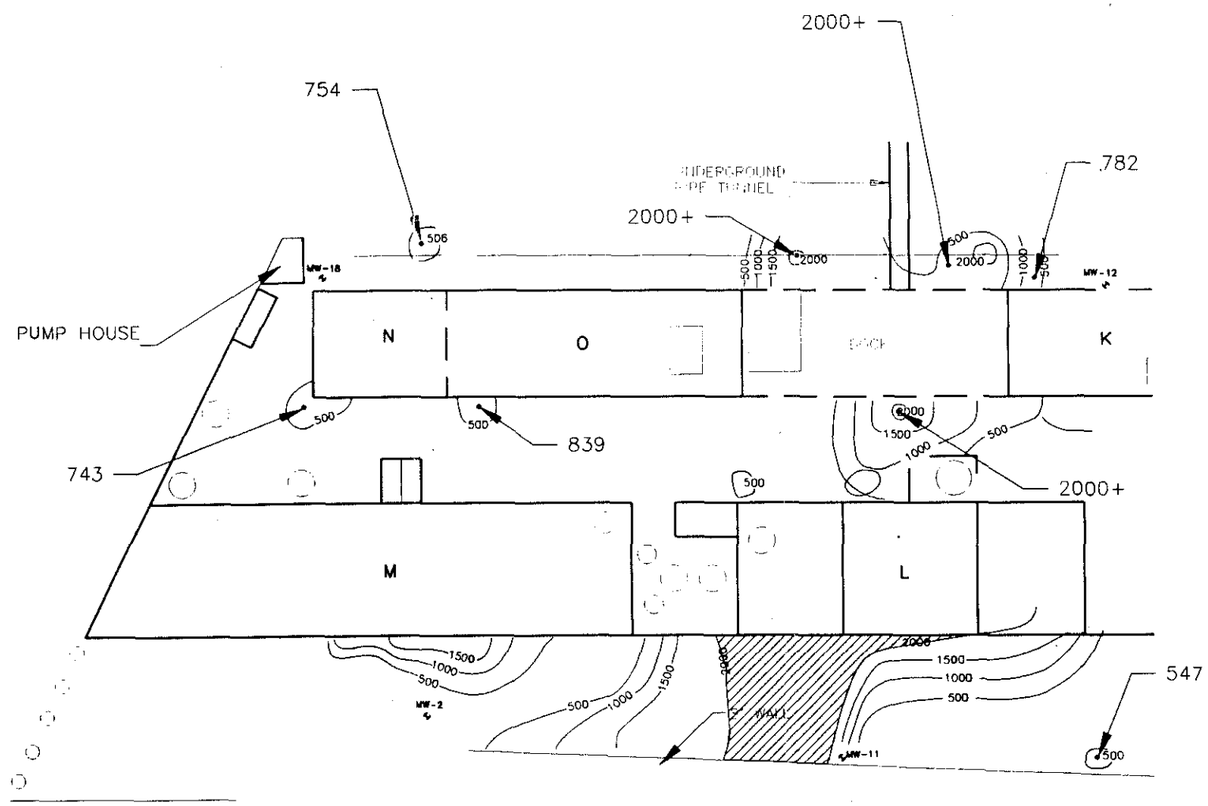
DECEMBER 1994

90 0 90 180

SCALE IN FEET

320662-1060

FIGURE 13



LEGEND

- SOIL-GAS VAPOR COLLECTION POINT AND CORRESPONDING READING OF TOTAL VOC'S IN PARTS PER MILLION (ppm)
- CONTOUR OF TOTAL VOC'S UNITS ARE IN PARTS PER MILLION, CONTOUR INTERVAL IS 500 ppm
- > 2000 ppm
- MONITORING WELL LOCATION

REICHHOLD CHEMICALS INC.
FERNDALE, MICHIGAN

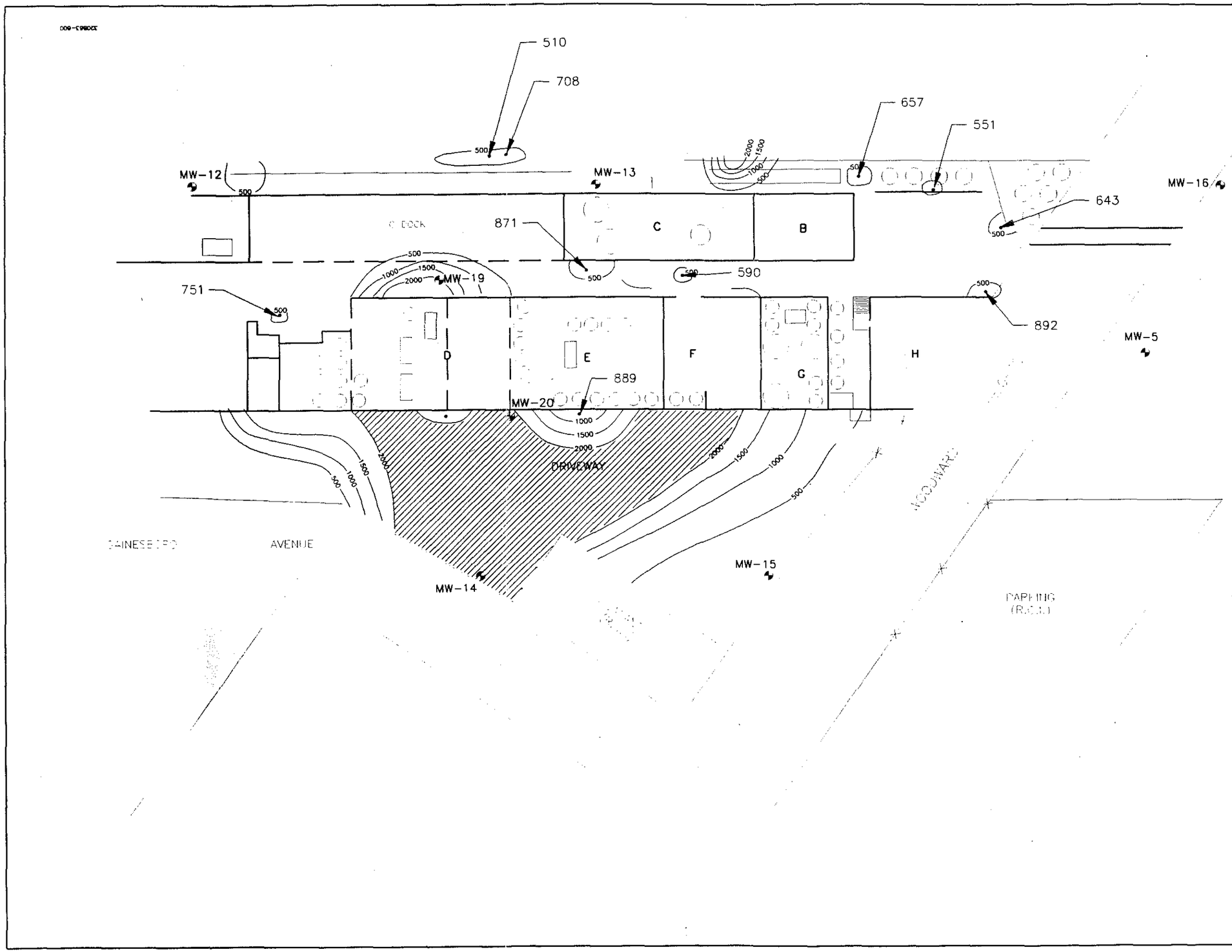
NORTH HALF OF THE WEST SECTION CONTOUR SOIL GAS VAPOR RESULTS

DECEMBER 1994

50 0 50 100

SCALE IN FEET

FIGURE 14



LEGEND

- SOIL-GAS VAPOR COLLECTION POINT AND CORRESPONDING READING OF TOTAL VOC'S IN PARTS PER MILLION (ppm)
- CONTOUR OF TOTAL VOC'S UNITS ARE IN PARTS PER MILLION. CONTOUR INTERVAL IS 500 ppm
- > 2000 ppm
- MONITORING WELL LOCATION

REICHHOLD CHEMICALS INC.
FERNDALE, MICHIGAN

SOUTH HALF OF THE WEST SECTION CONTOUR SOIL GAS VAPOR RESULTS

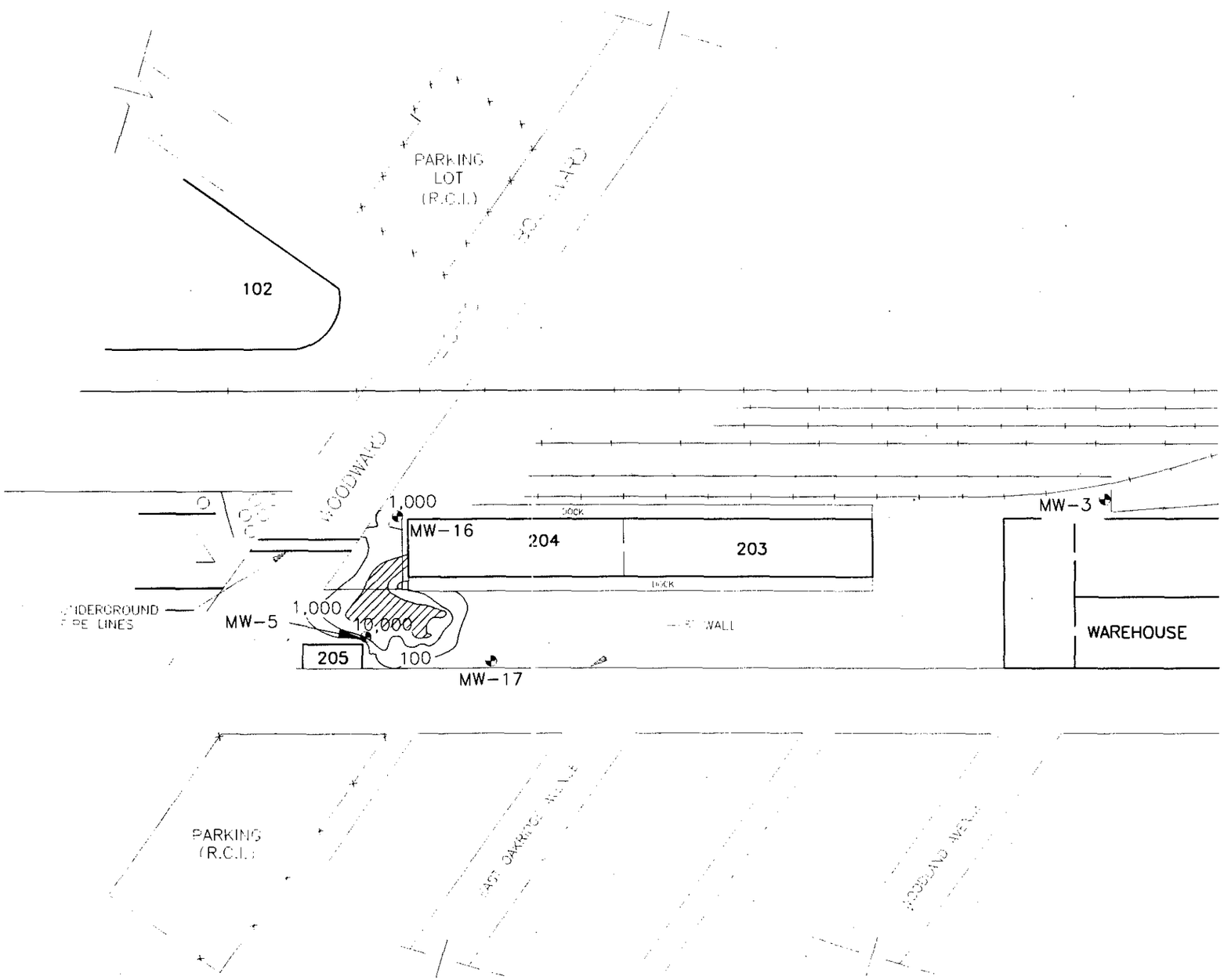
DECEMBER 1994

50 0 50 100

SCALE IN FEET

FIGURE 15

REICHHOLD CHEMICALS, INC
FERNDALE, MICHIGAN



LEGEND

100 CONTOUR OF TOTAL VOC'S UNITS ARE IN PARTS PER MILLION.

> 10,000

MONITORING WELL LOCATION

SOUTH SECTION
CONTOUR SOIL
GAS VAPOR RESULTS

DECEMBER 1994

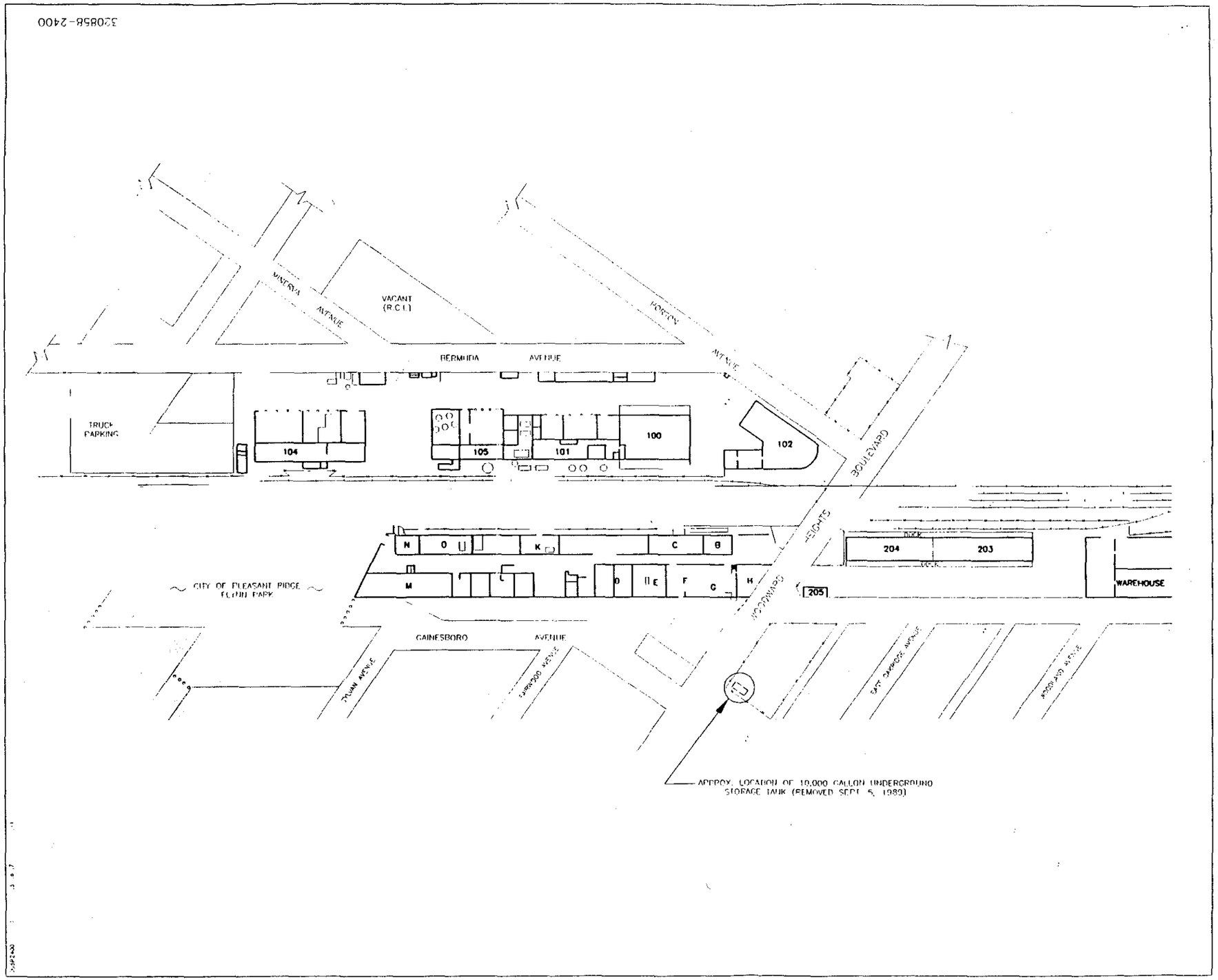
100 0 100

SCALE IN FEET

O'BRIEN & GERE
ENGINEERS, INC.

FIGURE 16

REICHHOLD CHEMICALS, INC
FERNDALE, MICHIGAN



LOCATION OF 10,000 GALLON
UNDERGROUND STORAGE TANK

JULY 1993

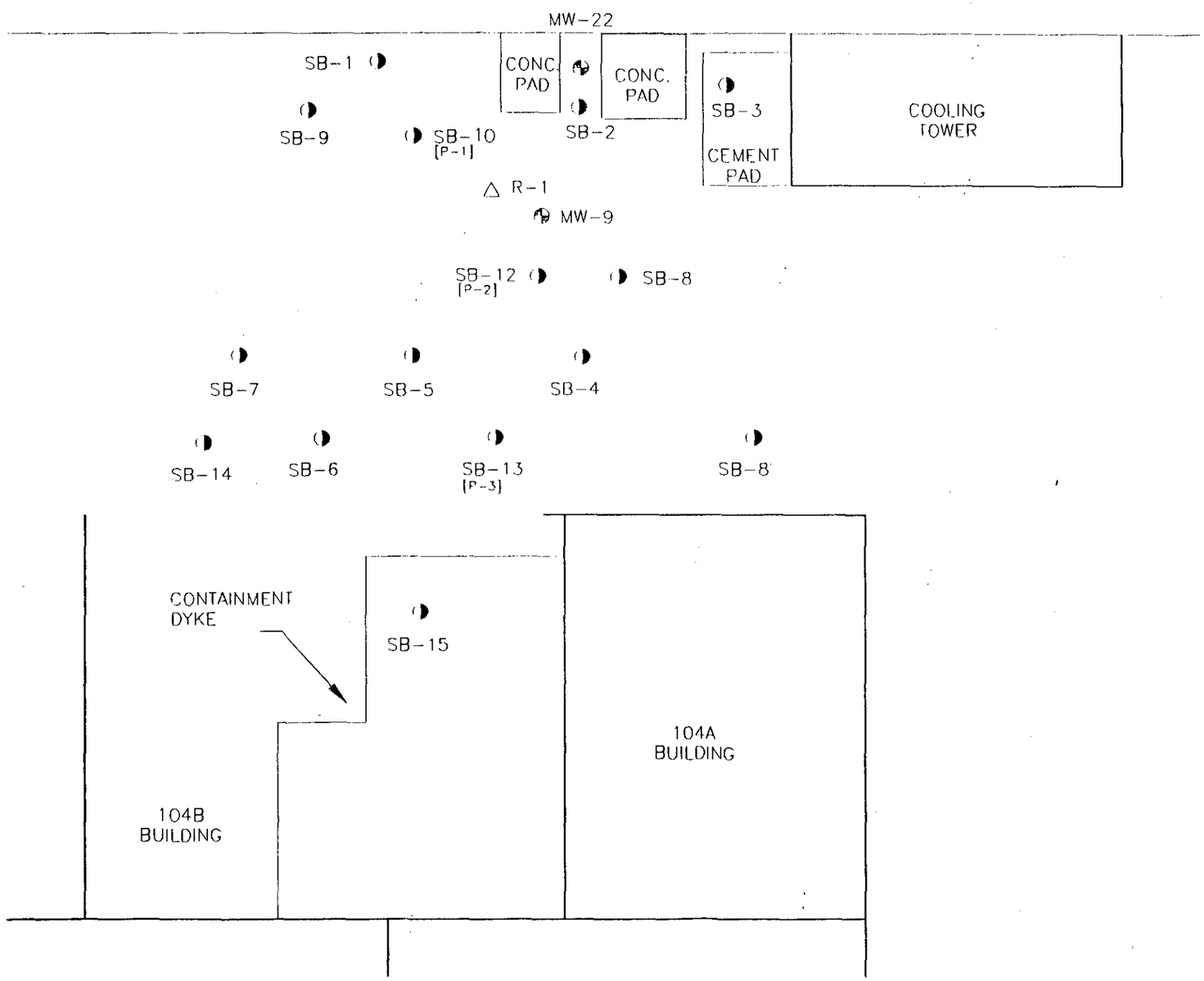
200 0 200

SCALE IN FEET

O'BRIEN & GERE
ENGINEERS, INC

320858-2400

FIGURE 17



LEGEND

- MONITORING WELL LOCATION
- SOIL BORING LOCATION
- △ RECOVERY WELL LOCATION
- [P-2] PIEZOMETER

REICHHOLD CHEMICALS, INC.
FERNDALE, MICHIGAN

MONITORING WEL L
SYSTEM LAYOUT

JULY 1993

FILE NO.

O'BRIEN & GERE ENGINEERS, INC.

320849-240

DESC

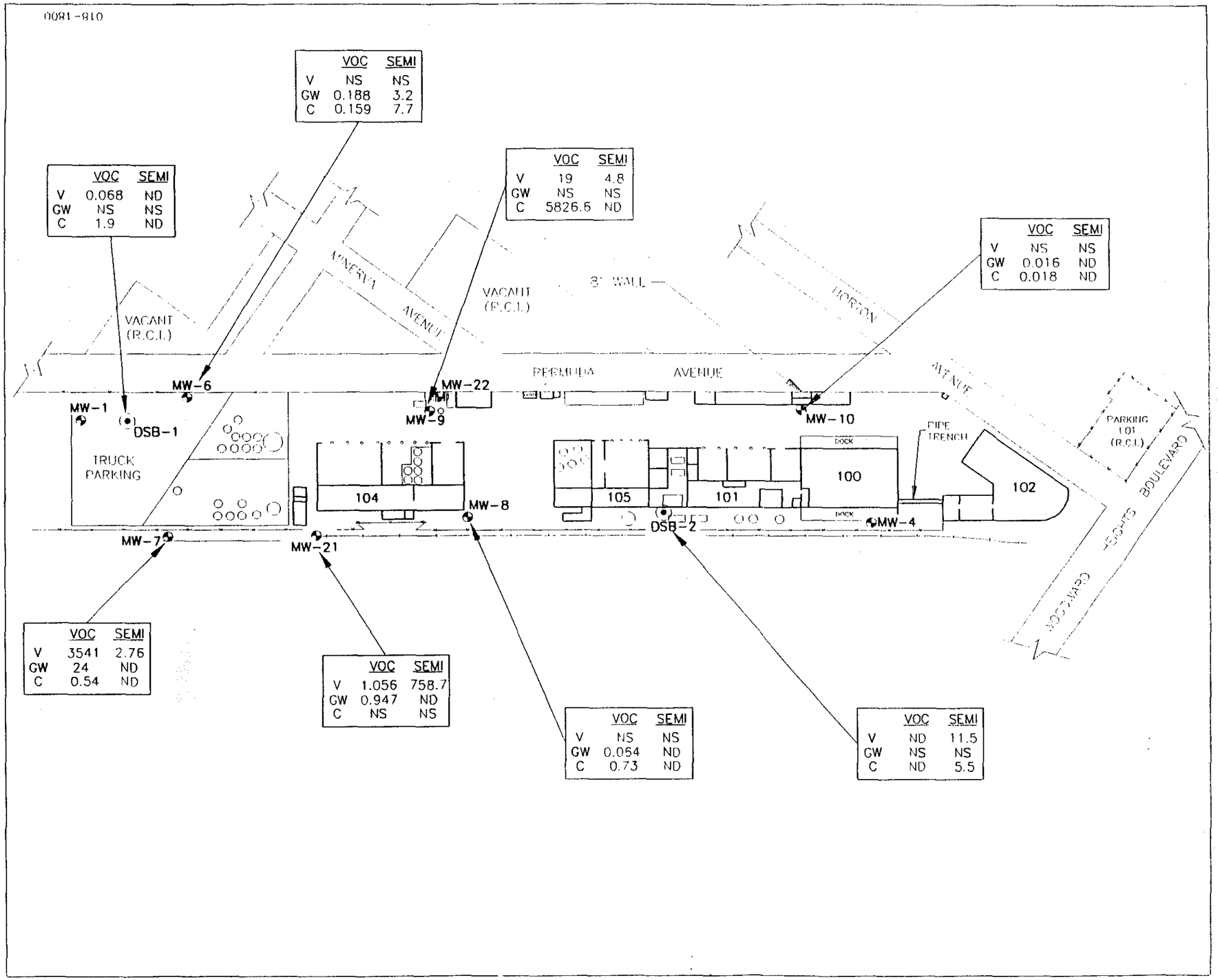


FIGURE 18

REICHHOLD CHEMICALS, INC
FERNDALE, MICHIGAN

LEGEND

	MONITORING WELL LOCATION
(•)	DEEP SOIL BORING LOCATION
VOC	VOLATILE ORGANIC CARBONS (ppM)
SEMI	SEMI VOLATILE ORGANICS (ppM)
ND	NOT DETECTED
NS	NO SAMPLE– UNABLE TO COLLECT SAMPLE
V	VADOSE ZONE INTERVAL
GW	GROUND WATER INTERFACE INTERVAL
C	CLAY INTERFACE INTERVAL

EAST AREA PLAN
SOIL ANALYTICAL RESULTS

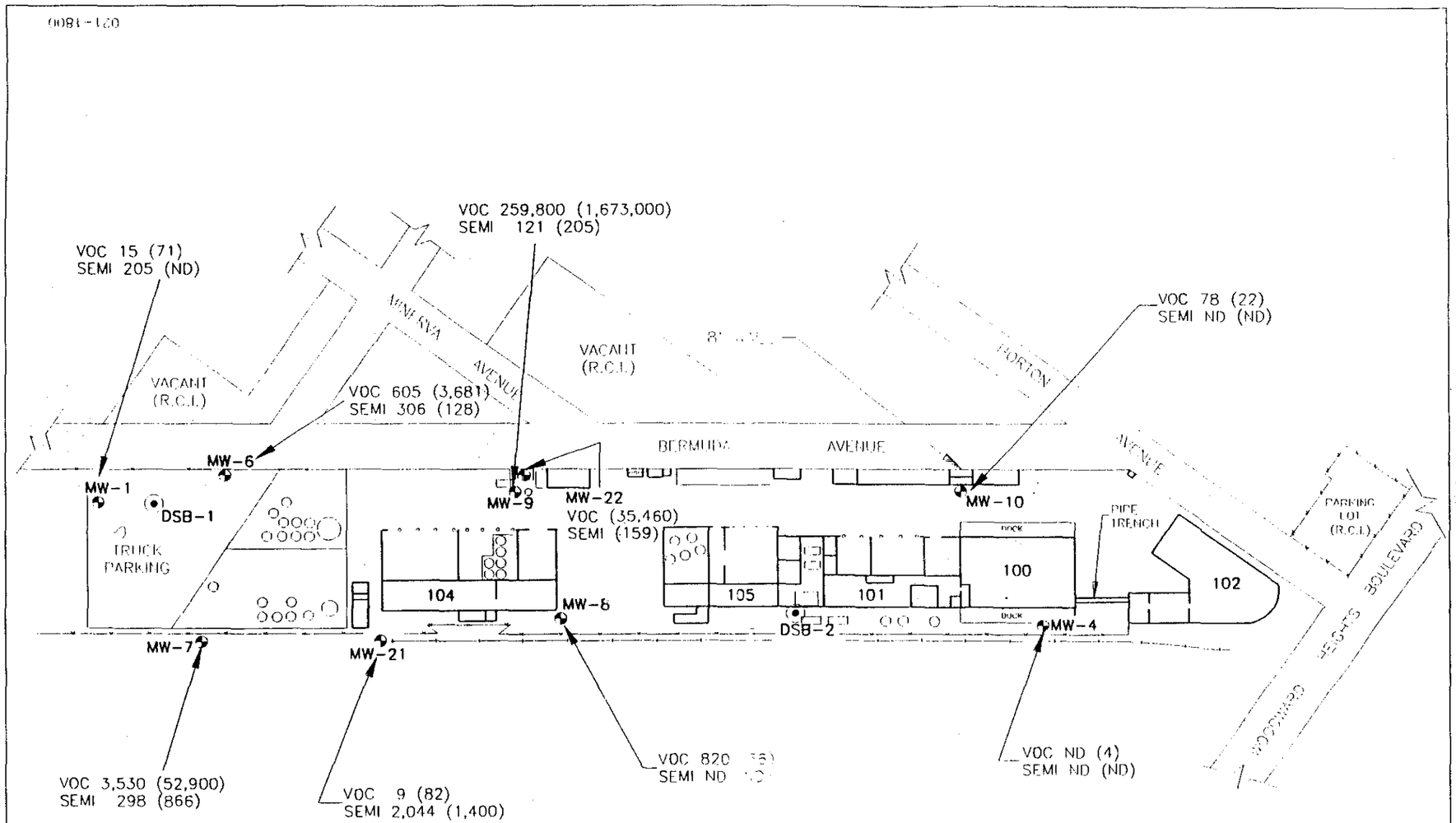
JULY 1993

150 0 150
SCALE IN FEET

O'BRIEN & GERE
ENGINEERS, INC

FIGURE 19

REICHHOLD CHEMICALS, INC
FERNDALE, MICHIGAN



LEGEND

- MONITORING WELL LOCATION
- DEEP SOIL BORING LOCATION
- VOC — VOLATILE ORGANIC CARBONS (ppB)
- SEMI — SEMI VOLATILE ORGANICS (ppB)
- ND — NOT DETECTED
- (430) — DECEMBER 1991 RESULTS

EAST AREA PLAN
GROUND WATER
ANALYTICAL RESULTS
(SEPTEMBER AND DECEMBER 1991)

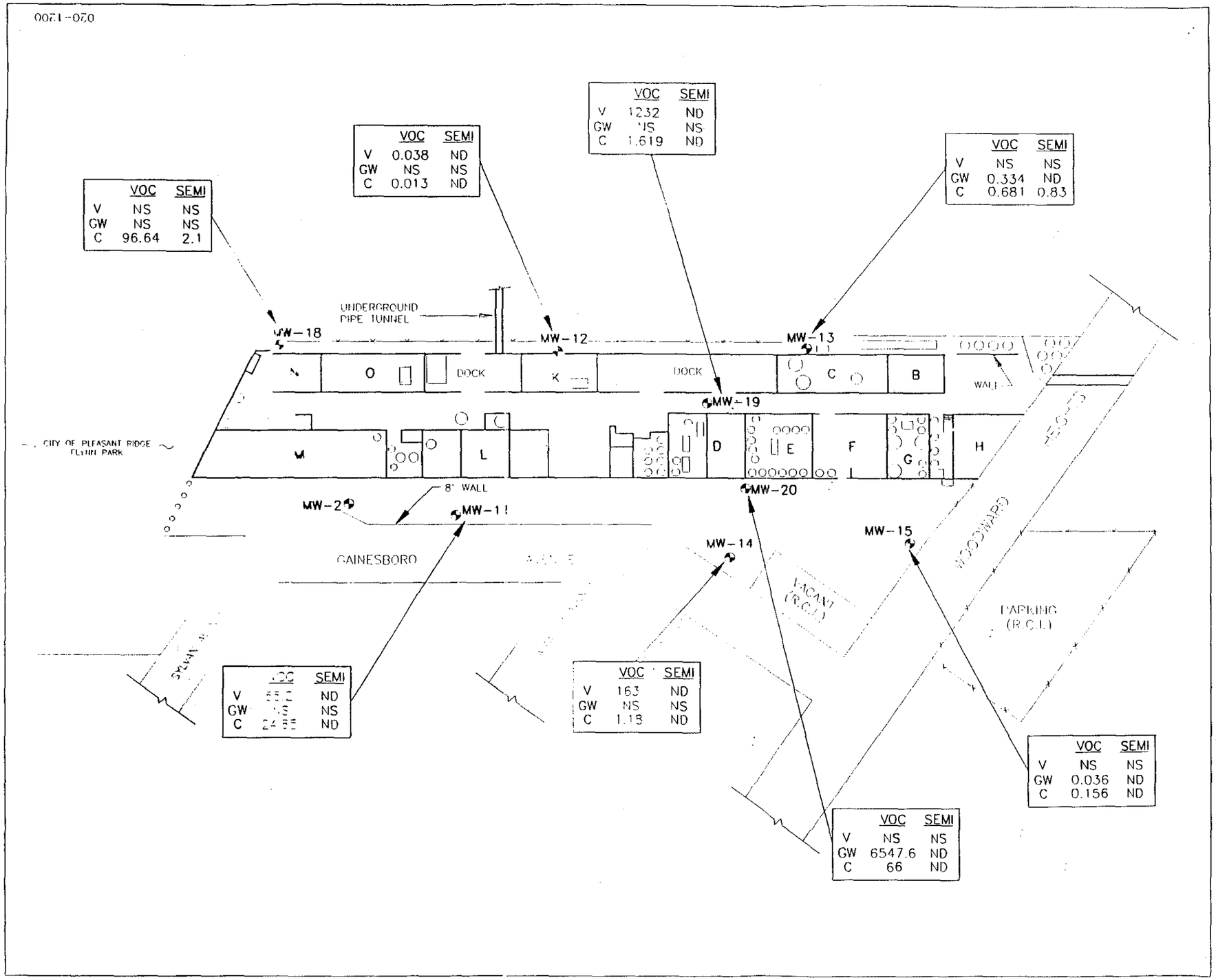
JULY 1993

150 0 150
SCALE IN FEET

O'BRIEN & GERE ENGINEERS, INC

FIGURE 20

REICHHOLD CHEMICALS, INC
FERNDALE, MICHIGAN



LEGEND

	MONITORING WELL LOCATION
	DEEP SOIL BORING LOCATION
VOC	VOLATILE ORGANIC CARBONS (ppM)
SEMI	SEMI VOLATILE ORGANICS (ppM)
ND	NOT DETECTED
NS	NO SAMPLE- UNABLE TO COLLECT SAMPLE
V	VADOSE ZONE INTERVAL
GW	GROUND WATER INTERFACE INTERVAL
C	CLAY INTERFACE INTERVAL

WEST AREA PLAN
SOIL ANALYTICAL RESULTS

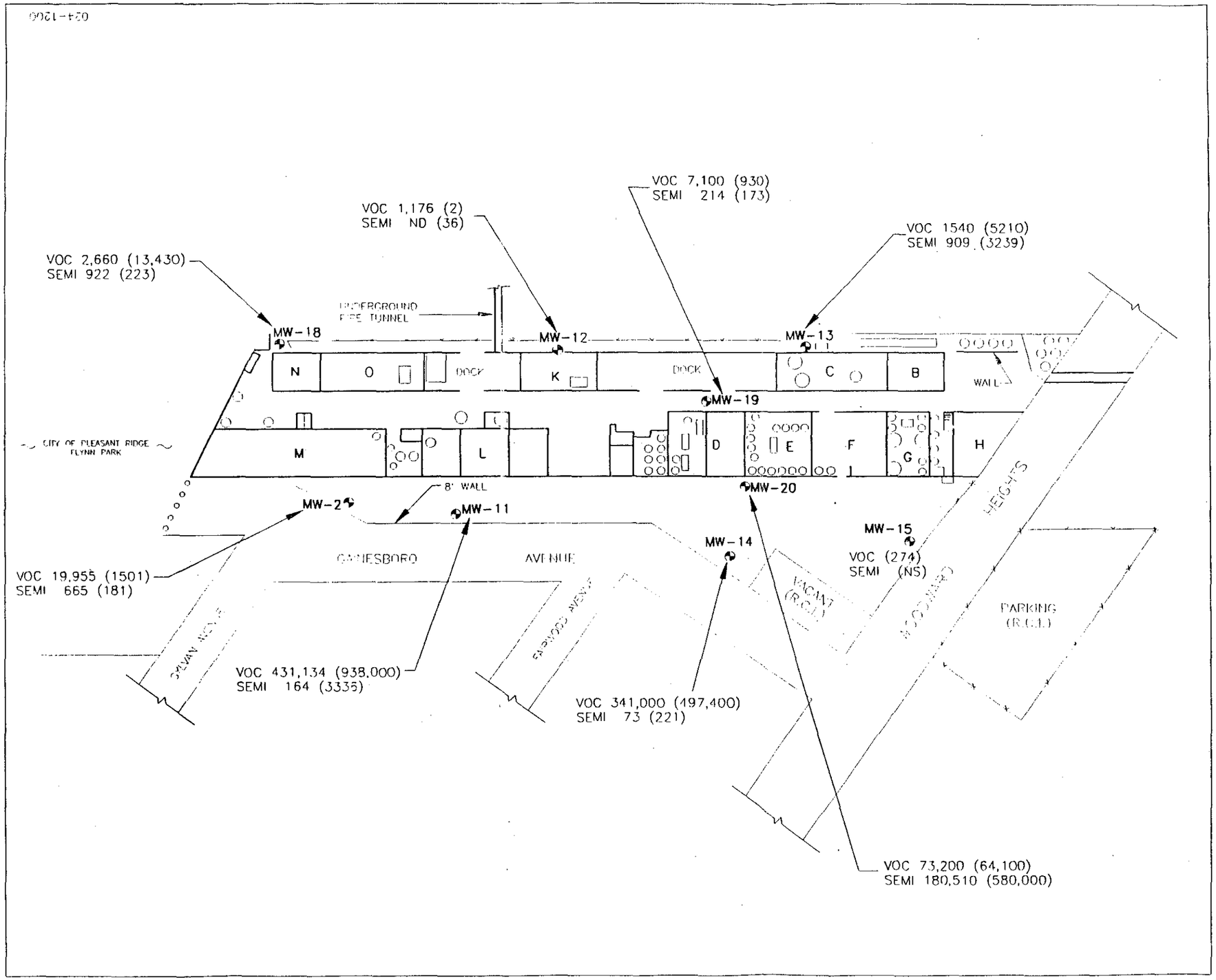
JULY 1993

100 0 100
SCALE IN FEET

O'BRIEN & GERE
ENGINEERS, INC

FIGURE 21

REICHHOLD CHEMICALS, INC
FERNDALE, MICHIGAN



LEGEND

●	MONITORING WELL LOCATION
(●)	DEEP SOIL BORING LOCATION
VOC	VOLATILE ORGANIC CARBONS (ppB)
SEMI	SEMI VOLATILE ORGANICS (ppB)
NS	NOT SAMPLED
ND	NOT DETECTED
(430)	DECEMBER 1991 RESULTS

WEST SECTION PLAN
GROUND WATER
ANALYTICAL RESULTS

(SEPTEMBER AND DECEMBER 1991)

JULY 1993

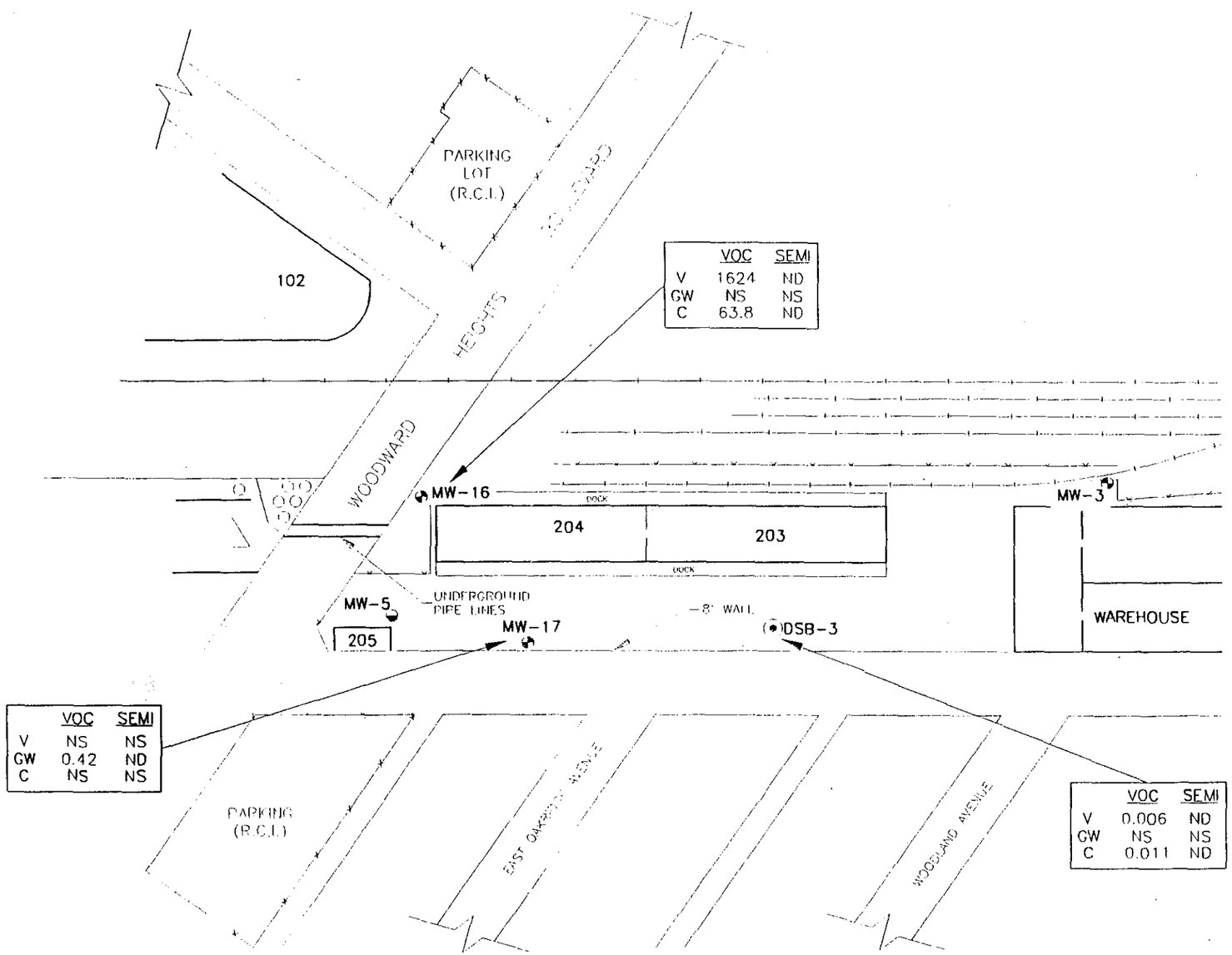
100 0 100

SCALE IN FEET

O'BRIEN & GERE ENGINEERS, INC.

FIGURE 22

REICHHOLD CHEMICALS, INC
FERNDALE, MICHIGAN



LEGEND

- MONITORING WELL LOCATION
- MONITORING WELL WAS ABANDONED AND GROUTED
- DEEP SOIL BORING LOCATION
- VOC — VOLATILE ORGANIC CARBONS (ppM)
- SEMI — SEMI VOLATILE ORGANICS (ppM)
- ND — NOT DETECTED
- NS — NO SAMPLE- UNABLE TO COLLECT SAMPLE
- V — VADOSE ZONE INTERVAL
- GW — GROUND WATER INTERFACE INTERVAL
- C — CLAY INTERFACE INTERVAL

SOUTH AREA PLAN
SOIL ANALYTICAL RESULTS

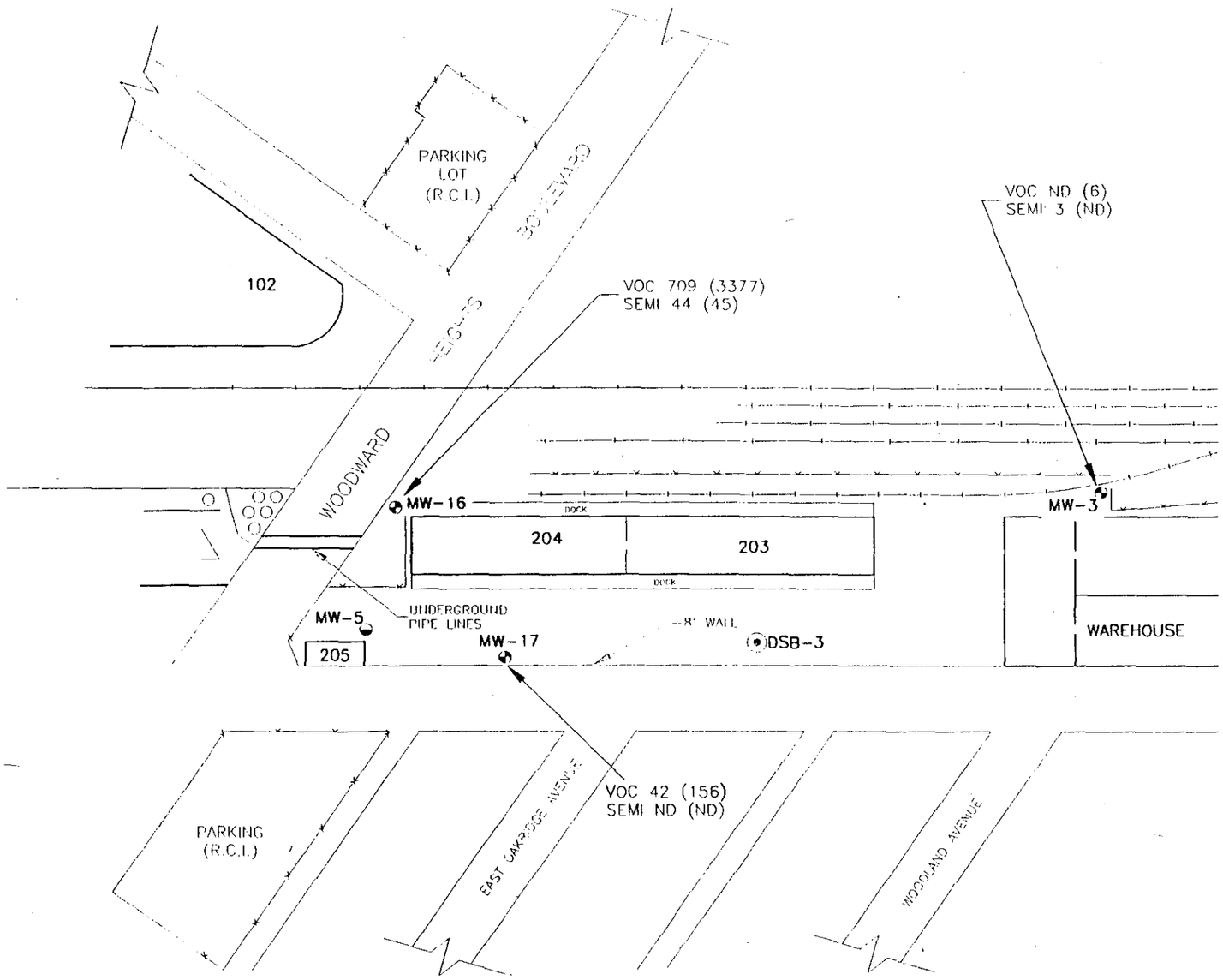
JULY 1993

100 0 100
SCALE IN FEET

O'BRIEN & GERE
ENGINEERS, INC

FIGURE 23

REICHHOLD CHEMICALS, INC
FERNDALE, MICHIGAN



LEGEND

- MONITORING WELL LOCATION
- MONITORING WELL WAS ABANDONED AND GROUTED
- DEEP SOIL BORING LOCATION
- VOC — VOLATILE ORGANIC CARBONS (ppB)
- SEMI — SEMI VOLATILE ORGANICS (ppB)
- ND — NOT DETECTED
- (430) — DECEMBER 1991 RESULTS

SOUTH AREA PLAN
GROUND WATER
ANALYTICAL RESULTS

(SEPTEMBER AND DECEMBER 1991)

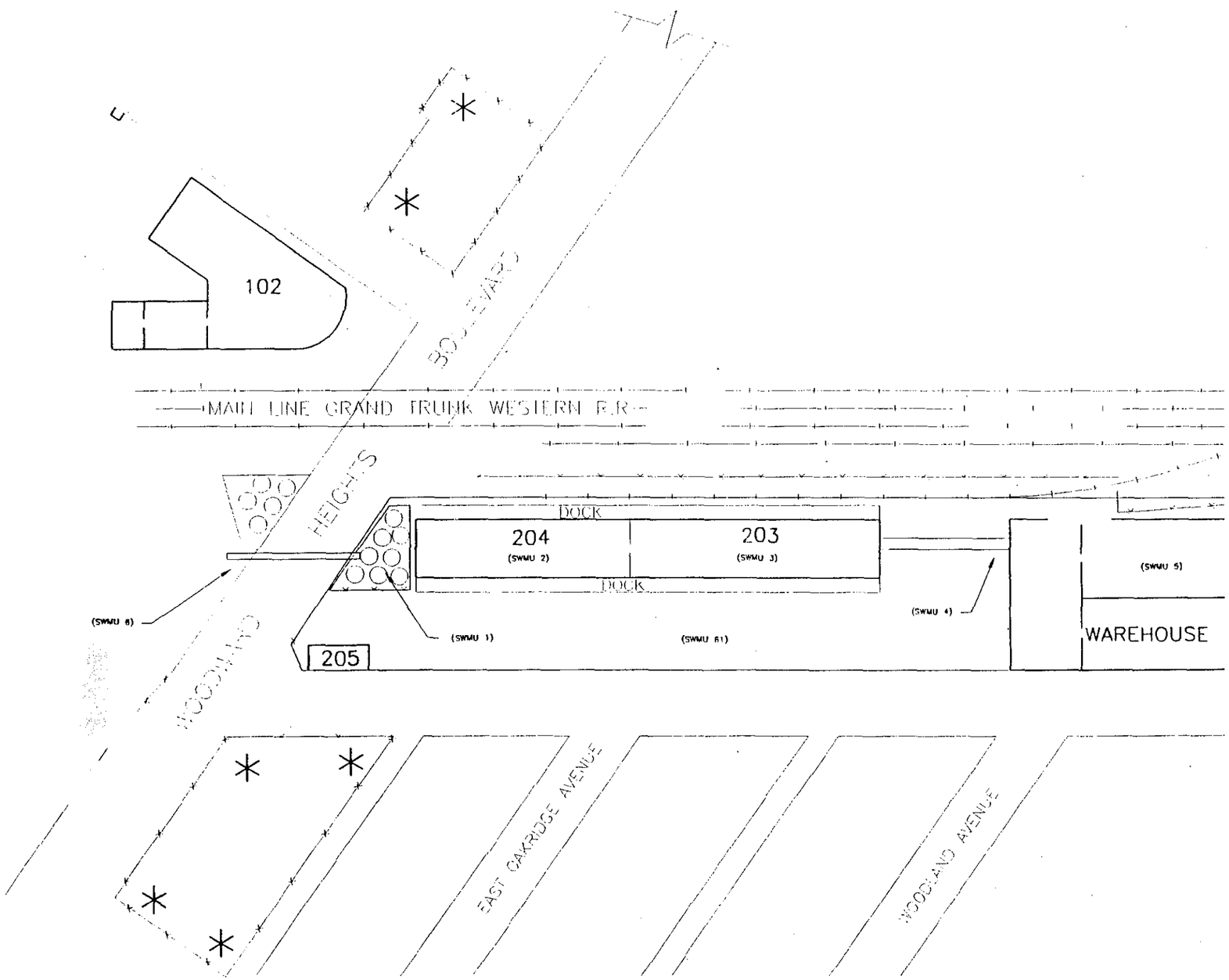
JULY 1993

100 0 100

SCALE IN FEET

O'BRIEN & GERE ENGINEERS, INC.

FIGURE 24



LEGEND

* ECP SCREENING/SOIL BORING LOCATION

REICHHOLD CHEMICALS, INC
FERNDALE, MICHIGAN

PROPOSED
SAMPLING LOCATIONS
SOUTH AREA

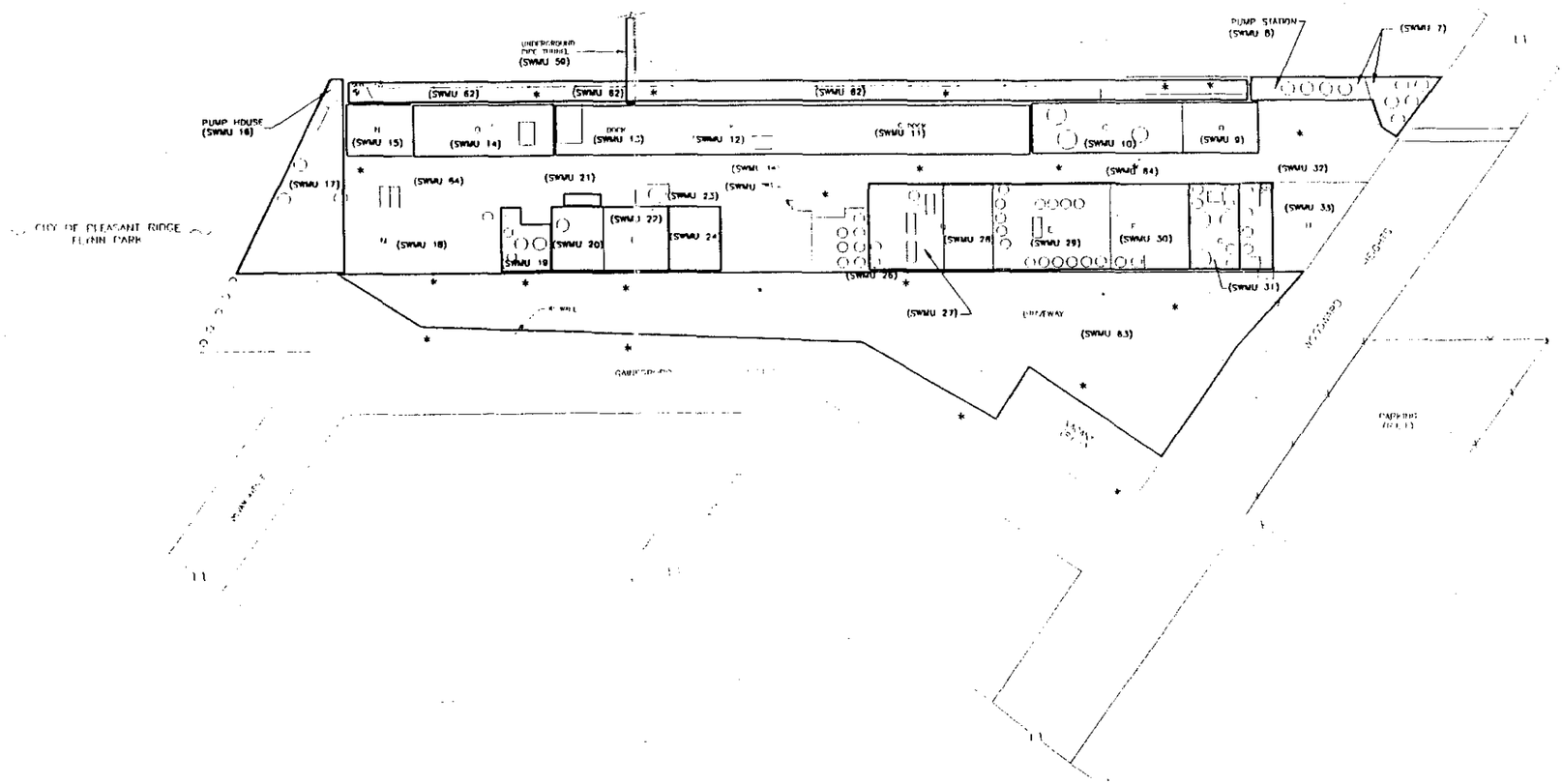
JULY 1993

100 0 100
SCALE IN FEET

O'BRIEN & GERE
ENGINEERS, INC.

320856-1200

FIGURE 25



LEGEND

* ECP SCREENING/SOIL BORING LOCATION

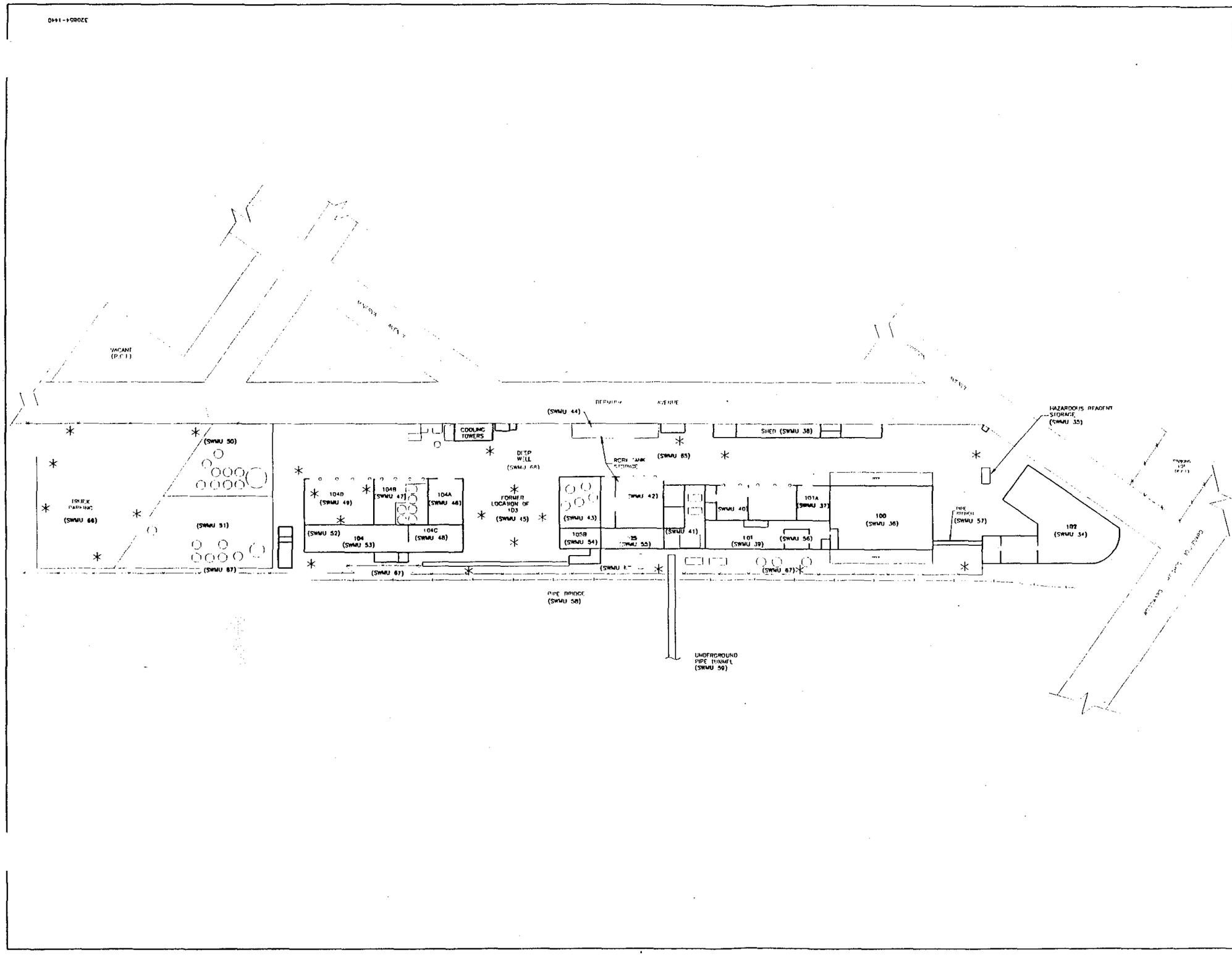
REICHHOLD CHEMICALS
INC.
FERNDALE, MICHIGAN

PROPOSED
SAMPLING LOCATIONS
WEST AREA

50 0 50 100

SCALE IN FEET

FIGURE 26



LEGEND

✳ ECP SCREENING/SOIL BORING LOCATION

REICHHOLD CHEMICALS INC.
FERNDALE, MICHIGAN

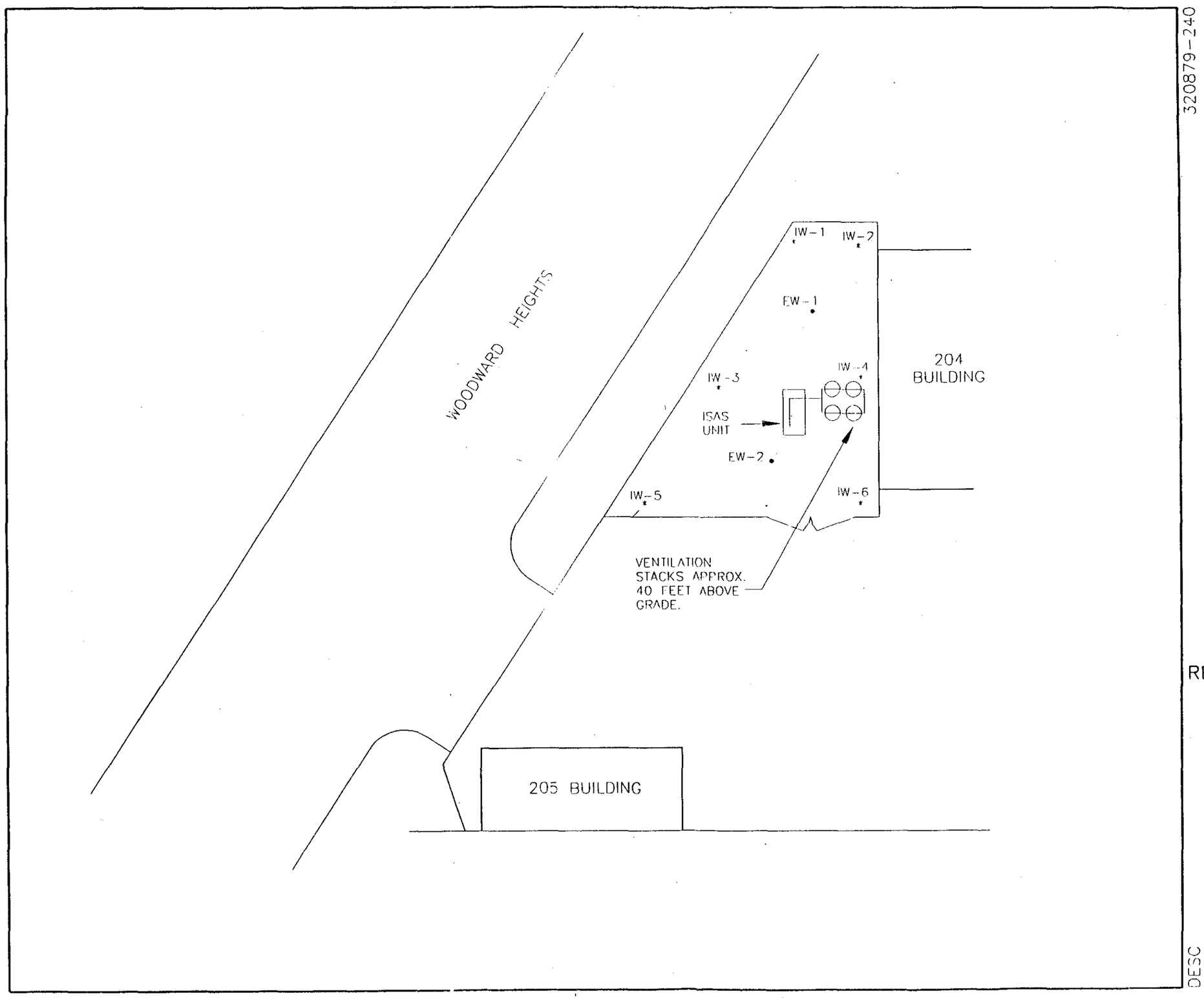
PROPOSED SAMPLING LOCATIONS EAST AREA

JULY 1993

60 0 60 120

SCALE IN FEET

FIGURE 27



320879-240

LEGEND

IW-1	INJECTION WELL
EW-1	EXTRACTION WELL
○	CARBON CANISTERS

REICHHOLD CHEMICALS, INC.
FERNDALE, MICHIGAN

IN-SITU AIR STRIPPING SYSTEM (ISAS) LAYOUT

JULY 1993

20 0 20

FILE NO.

DESC

OMMEN & DERE ENGINEERS, INC.

ATTACHMENT 1

INTERNATIONAL TECHNOLOGY CORPORATION

Project No. 303702
August 1989

Work Plan

Environmental Assessment Work Plan
Reichhold Chemicals, Inc.
Ferndale, Michigan

Prepared For:

Reichhold Chemicals, Inc.
White Plains, New York

Prepared By:

IT Corporation
Monroeville, Pennsylvania

RESPONSIVE TO THE NEEDS OF ENVIRONMENTAL MANAGEMENT

INTERNATIONAL TECHNOLOGY CORPORATION

September 28, 1989

Project No. 303702

Mr. Michael J. Kowalski
Reichhold Chemicals, Inc.
525 North Broadway
White Plains, NY 10603

Transmittal
Project Status Report
Environmental Assessment
Reichhold Chemicals, Inc.
Ferndale, Michigan

Dear Mr. Kowalski:

This letter transmits the first Project Status Report for the Environmental Assessment at the Reichhold Chemicals, Inc., facility located in Ferndale, Michigan. The enclosed Project Status Report summarizes the progress of the field activities which have been initiated by IT Corporation (IT). A schedule for future activities to be performed as part of the Environmental Assessment has also been included.

If you have any questions, please feel free to call.

Very truly yours,

Susan Tituskin

Susan Tituskin
Project Manager

Lawra Dodge

Lawra Dodge
Project Director

ST:LD:isw
Enclosure

cc: Mr. Stephen Blayer, MDNR (w/encl.)
Mayor Albert Gertley, City of Ferndale (w/encl.)
Ms. Janet Narich, Fern/Ridge Environmental Coalition (w/encl.)
Mayor Jeffery Sherbow, City of Pleasant Ridge (w/encl.)

Regional Office
William Penn Plaza • 2790 Mosside Boulevard • Monroeville, Pennsylvania 15146-2792 • 412-372-7701

Project Status Report
Environmental Assessment
Reichhold Chemicals, Inc.
Ferndale, Michigan

Reporting Period

September 11, 1989 through September 22, 1989

Progress This Report Period

- The Phase I monitoring well installation was completed on September 22, 1989, one week ahead of schedule. Monitoring wells MW-1 through MW-4 were installed at the locations originally proposed in the Environmental Assessment Work Plan (Work Plan) dated August 1989. An additional well, designated Monitoring Well MW-5, was installed immediately west of the above ground tank farm located in the South Section of the site. This monitoring well was installed during the Phase I program since the field activities were ahead of schedule. This additional monitoring well will aid in defining the scope of the Phase II ground water investigation for the South Section of the site.

- Two hundred and thirty-two soil-gas vapor readings have been taken on a 50 X 50-foot grid within the East and West Sections of the site. The soil-gas vapor survey has been completed in the East Section. The West Section soil-gas vapor survey is approximately 80 percent complete.

- A site visit was conducted by the Michigan Department of Natural Resources (MDNR) on September 18, 1989. The MDNR observed soil-gas vapor sampling techniques performed by IT. The MDNR also discussed additional areas of potential environmental concern with Reichhold and IT representatives during the site visit. IT has thoroughly evaluated the nature and location of these areas for incorporation into the soil-gas vapor survey and/or the soil sampling program in the East, West and South Sections, as appropriate.

Project Schedule

- The remainder of the West Section soil-gas vapor survey will be completed by September 29, 1989. These data will be thoroughly evaluated for purposes of designing the discrete soil sampling program for the East and West Sections.

- Ground water samples from the five newly installed Phase I monitoring wells will be collected by IT during the week of October 9, 1989. The South Section soil sampling program will also be conducted the week of October 9, 1989.

- The ground water and the South Section soil sample analytical results will be received by November 3, 1989.

- A report summarizing the Phase I monitoring well installation, ground water sampling and the results of the East and West Section soil-gas vapor survey will be submitted to the MDNR by November 22, 1989. This report will include proposed locations for additional monitoring wells and discrete soil sample collection locations for the East and West Sections.

INTERNATIONAL TECHNOLOGY CORPORATION

August 2, 1989

Project No. 303702

Mr. Steven Blayer
Waste Management Division
Michigan Department of Natural Resources
Box 30241
Lansing, MI 48909

Environmental Assessment Work Plan
Reichhold Chemicals, Inc.
Ferndale, Michigan

Dear Mr. Blayer:

Enclosed are four copies of the Environmental Assessment Work Plan for your review. If you have any questions or comments, please contact Ms. Lawra Dodge (513-782-4700) or me (412-372-7701).

Sincerely,

Susan Tituskin

Susan Tituskin

ST:isw
Enclosures

cc: Ms. Lawra Dodge, IT Corporation
Mr. Michael Kowalski, Reichhold
Mr. John Yonke, Reichhold

INTERNATIONAL TECHNOLOGY CORPORATION

Environmental Assessment Work Plan
Reichhold Chemicals, Inc.
Ferndale, Michigan

TABLE OF CONTENTS

	PAGE
LIST OF TABLES/LIST OF FIGURES	iv
EXECUTIVE SUMMARY	ES-1
1.0 INTRODUCTION	1-1
2.0 SITE DESCRIPTION	2-1
3.0 INITIAL SITE CHARACTERIZATION	3-1
3.1 SOIL SAMPLING LOCATIONS	3-1
3.2 SOIL SAMPLING METHODOLOGY	3-2
3.3 EQUIPMENT DECONTAMINATION PROCEDURES	3-2
3.4 SOIL ANALYTICAL PROGRAM	3-3
4.0 RESULTS OF INITIAL SITE CHARACTERIZATION	4-1
4.1 SUBSURFACE CONDITIONS	4-1
4.2 ANALYTICAL TEST RESULTS	4-2
4.2.1 Summary of Analytical Results: West Section	4-2
4.2.2 Summary of Analytical Results: East Section	4-4
4.2.3 Summary of Analytical Results: South Section	4-6
4.2.4 Evaluation of Soil Sample Results	4-8
5.0 ENVIRONMENTAL ASSESSMENT WORK PLAN	5-1
5.1 GROUND WATER MONITORING PROGRAM	5-2
5.1.1 Phase I	5-2
5.1.2 Phase II	5-3
5.2 SUBSURFACE SOIL INVESTIGATION	5-4
5.2.1 Soil Investigation: East and West Sections	5-4
5.2.2 Soil Investigation: South Section	5-6
5.3 FIELD METHODS	5-7
5.3.1 Ground Water Monitoring Well Installation	5-7
5.3.2 Ground Water Sampling	5-9
5.3.3 Monitoring Well Survey	5-11
5.3.4 Soil-Gas Vapor Survey	5-11
5.3.5 Soil Sample Collection	5-13
6.0 PROJECT SCHEDULE AND REPORT SUBMITTAL	6-1

TABLE OF CONTENTS
(Continued)

PAGE

7.0 QUALITY ASSURANCE PROGRAM 7-1
7.1 INTRODUCTION 7-1
7.2 IMPLEMENTATION 7-1
7.3 PROJECT QUALITY ASSURANCE 7-1
7.4 QUALITY ASSURANCE DATA OBJECTIVES 7-1
7.5 PROCUREMENT AND CONTROL OF SUBCONTRACTORS 7-3
7.6 FIELD DOCUMENTATION 7-4
7.7 FIELD DATA MANAGEMENT 7-5
7.8 FIELD CUSTODY PROCEDURES 7-5
7.9 TRANSFER OF CUSTODY AND SHIPMENT 7-6
7.10 CALIBRATION PROCEDURES 7-7
7.10.1 Calibration Failures 7-7
7.10.2 Calibration Records 7-8
7.11 PROJECT RECORDS 7-8
7.12 FIELD AUDITS 7-9
7.12.1 Audit-Planning and Conduct 7-9
7.12.2 Audit Reporting 7-9
8.0 HEALTH AND SAFETY PROGRAM 8-1
8.1 INTRODUCTION 8-1
8.2 SITE CHARACTERIZATION AND HAZARD ASSESSMENT 8-1
8.2.1 Chemical Hazards 8-2
8.2.2 Health Standards 8-2
8.2.3 Air Monitoring 8-2
8.3 GENERAL WORK PRACTICES 8-3
8.3.1 Site Drilling 8-5
8.3.2 Heavy Equipment Operation and Heavy Materials Handling Safety 8-5
8.3.3 Regulated Areas 8-6

TABLE OF CONTENTS
(Continued)

PAGE

8.4 PERSONNEL PROTECTION PROGRAM 8-7
8.4.1 Levels of Protection 8-7
8.4.2 Respiratory Protective Program 8-9
8.5 HEAT AND COLD STRESS 8-11
8.5.1 Heat Stress 8-11
8.5.2 Cold Stress 8-13
8.6 DECONTAMINATION PROCEDURES 8-14
8.6.1 Personnel Decontamination 8-14
8.6.2 Equipment Decontamination 8-15
8.6.3 Site Security 8-15
8.7 MEDICAL SURVEILLANCE 8-16
8.8 TRAINING 8-17
8.9 EMERGENCY RESPONSE PLAN 8-18
8.9.1 Project Team Responsibilities 8-18
8.9.2 Public Response Agencies 8-19
8.10 WORKER INJURY AND RECORD KEEPING 8-19
9.0 REFERENCES 9-1
TABLES
FIGURES
APPENDIX A - ANALYTICAL DATA
APPENDIX B - ANALYTICAL QUALITY ASSURANCE/QUALITY CONTROL PROTOCOL

LIST OF TABLES

TABLE NO.	TITLE
1	Summary Table - Field Sampling Data
2	Summary Table - Chemical Analysis, Soil Samples
3	Environmental Assessment, Analytical Parameters

LIST OF FIGURES

FIGURE NO.	TITLE
1	Plant Layout
2	Plant Operation Areas
3	Sampling Locations - West Section
4	Sampling Locations - East Section
5	Sampling Locations - South Section
6	Proposed Monitoring Well Locations
7	Monitoring Well Installation Diagram
8	Project Schedule

EXECUTIVE SUMMARY

This Work Plan has been prepared to present the scope of work for the Environmental Assessment to be conducted at the Reichhold Chemical, Inc. (Reichhold), facility located in Ferndale, Michigan. The area surrounding the site is generally flat, and characterized by residential tracts and small industry. The plant was built in 1927 to produce synthetic resins and polymers.

The site has been divided into three sections based on the sequence of construction and geographic location. These sections are referred to as the East, West, and South Sections. The West Section is the oldest section of the site, acquired by Reichhold in 1927. This section is used primarily to process synthetic resins. In addition to processing facilities, storage areas, office space, and laboratories are also located in this section of the plant. The East Section of the plant was constructed in the 1940s by the Defense Plant Corporation to produce phthalic anhydride. Reichhold purchased the property at the end of World War II. The primary activity in the East Section was the production of phthalic anhydride. In addition to processing, a maintenance shop, aboveground tank farm, offices, and laboratories are also located in this section. The South Section of the site is a low activity area. This section was purchased by Reichhold in the 1950s. A bulk storage aboveground tank farm, warehouses, offices, and parking areas are located in the South Section.

IT Corporation (IT) performed an initial site characterization of surface and shallow subsurface soils at the site to assess the potential environmental impact of site operations. Composite soil samples were collected from 15 operational areas, defined for the purpose of sampling, to evaluate areas of potential environmental concern and to guide the scope of the sitewide Environmental Assessment.

The initial site characterization identified specific volatile and semivolatile organic compounds in soils in the East and West Sections of the site and lower concentrations of volatile and semivolatile organics in the South Section in varying concentrations across the site. The detection and distribution of these constituents indicates that additional investigation of the site is warranted and that each section of the site should be addressed with a program of sampling appropriate to the potential environmental concern. The focus of these activities will be to define the nature and extent of constituents identified in subsurface soils and to determine if ground water has been impacted. To achieve these goals, the Environmental Assessment will include the following:

- Ground water monitoring program
- Soil quality investigation

A sitewide ground water monitoring program will be implemented in order to characterize the subsurface soil strata, determine direction of ground water flow across the site, and to evaluate ground water quality. This program will be implemented in two phases. During the first phase, ground water monitoring wells will be installed to determine flow direction and to obtain preliminary ground water quality data. A second phase of monitoring well installation will be initiated after completion of a soil-gas vapor survey so that additional monitoring wells can be located within areas of potential concern. The ground water analytical program will include volatile and semivolatile organic compounds oil and grease and total petroleum hydrocarbons (TPH). TPH will be added to the analytical program to determine if oil and grease concentrations previously reported in the soils represent a potential environmental concern.

For performance of the subsurface soil investigation, the West, East, and South Sections of the site will each be treated separately. A scope of work has been developed for each section which considers the age of

each section, previous land use, future land use options, and the results of the initial site characterization.

With these factors in mind, the soil investigation for each of the three sections of the site has been designed to include either a soil-gas vapor survey followed by a program of discrete soil sampling program or a discrete soil sampling program to be initiated without any preliminary screening. This will enable the soil investigations for each section of the site to proceed on individual schedules. This approach will also result in a scope of work which effectively addresses the potential environmental concerns within each section.

Prior to initiation of a program of discrete soil sampling, a soil-gas vapor survey will be conducted in both the East and West Sections to identify potential areas of volatile organic and/or total petroleum hydrocarbon contamination. The soil-gas vapor survey is a semiqualitative screening technique for the detection of VOCs and TPHs in soil and/or ground water. The technique is based on the theory that if VOCs are present in ground water or subsurface soil, they will occupy the interstices or void spaces in the soil. These vapors can then be sampled using a photoionization detector (PID). Data obtained from the soil-gas vapor survey will then be utilized to identify the most appropriate locations for collection of discrete soil samples in the East and West Sections.

Following completion of the soil-gas vapor survey, a soil sampling plan will be submitted to the MDNR for the East and West Sections. Sampling locations will be focused on defining the nature and extent of areas of concern identified during the soil-gas vapor survey. Parameters for soil sample analysis will include volatile organic compounds (VOCs), oil and grease, and TPH for discrete soil sampling locations in the East and West Sections. Base/neutral compounds will be added to the analytical program for samples collected adjacent to the railroad track. These

parameters were selected based on the soil analytical data collected in the initial site characterization.

Based on the results of the initial site characterization, VOC concentrations in the South Section soil do not warrant performance of a soil-gas survey. Instead, a discrete soil sample collection program will be initiated for characterization of soil quality in those areas where potential environmental concern is indicated.

The soil sampling and analysis performed during the initial site investigation indicates that the aboveground storage tank farm is the only area of the South Section which warrants additional investigation. The pavement and warehouse structures are in excellent structural condition, and the soil analytical data from these areas does not indicate that soils underlying these structures are of environmental concern. In addition, the Phase I ground water monitoring program includes installation of a monitoring well in the South Section in order to confirm that historical drum storage areas have not adversely impacted ground water quality.

In order to evaluate the soils in the aboveground storage tank farm, discrete soil samples will be collected and submitted for analysis. Soil samples will be collected at the nodes of a 50-by-50-foot sampling grid. Soil samples will be collected continuously to the top of the saturated zone, an estimated three to four feet below grade. Soil samples representing the six-inch increment below the pavement and the six-inch increment above the saturated zone will be submitted for analysis. Soil samples will be analyzed for the VOCs, oil and grease, and base neutral organics as identified in the initial site characterization. TPH will also be included in the soil analytical program in addition to the oil and grease to evaluate the potential environmental concern of these materials.

The results of the Environmental Assessment will be presented in a comprehensive report summarizing site soils stratigraphy, ground water occurrence, ground water flow direction, and an evaluation of the nature, concentrations, and distribution of any soil and/or ground water contaminants. The report will also provide conclusions and recommendations for the next course of action for each section of the site.

1.0 INTRODUCTION

This work plan has been prepared by IT Corporation (IT) on behalf of Reichhold Chemicals, Inc. (Reichhold) for performance of a sitewide Environmental Assessment at the Reichhold plant in Ferndale, Michigan. Manufacturing operations at the Ferndale site have ceased and Reichhold will proceed with a plant shutdown. Reichhold is performing the site Environmental Assessment on their own initiative in order to determine if plant operations have adversely impacted the environment. Reichhold's objectives are to work closely with the Michigan Department of Natural Resources (MDNR) to coordinate all environmental activities and to proceed with a parallel schedule of execution for the sitewide Environmental Assessment, the Resource Conservation and Recovery Act (RCRA) closure of the two regulated storage areas (closure plan previously submitted to the MDNR), and the overall demolition/plant shutdown activities.

The objectives of the Environmental Assessment are as follows:

- To expand upon the soil's quality data generated during the initial site characterization
- To identify the nature and extent of areas of potential environmental concern
- To evaluate potential routes of migration through characterization of ground water
- To determine the need for additional site investigation and/or remediation

The Environmental Assessment Work Plan has been prepared based on a detailed review of the site operational history, site inspections, and on the results of the initial site characterization conducted by IT. The site history is summarized in Chapter 2.0 of this report. Chapters 3.0 and 4.0 discuss the field screening and sampling techniques used during the initial site characterization and the results of the

initial soil quality evaluation, respectively. The proposed scope of work for the sitewide Environmental Assessment is presented in Chapter 5.0, along with the field procedures to be used. The project schedule and reporting are summarized in Chapter 6.0 and the project-specific Quality Assurance (QA) and Health and Safety Programs (H&S) are given in Chapters 7.0 and 8.0, respectively.

2.0 SITE DESCRIPTION

The Reichhold site is located on Woodward Heights Boulevard in the city of Ferndale, Oakland County, Michigan. The site is bordered on the north by the city of Pleasant Ridge. The area surrounding the site is generally flat and characterized by residential tracts and small industry.

The plant was built in 1927 to produce synthetic resins and polymers. As shown in Figure 1, the site has been divided into three sections based on sequence of construction and geographic location. These sections are referred to as the East, West, and South Sections. To aid in discussing the results of our investigation, we will continue to refer to the site using these section delineations.

The West Section is the oldest section of the site. It was acquired by Reichhold in 1927 and has been in continuous operation since that time until plant shutdown in March 1989. This section of the site was used primarily to process synthetic resins. In addition to processing facilities, storage areas, office space, and laboratories are also located in this section of the plant.

The primary operations located in the West Section were as follows:

- Buildings B, D, D Annex, E, F, and G which have been used to process phenolic, alkyd, and epoxy resins. Several laboratories were also located in Building B.

- Resins were produced in Building C. The boiler house and the loading docks to serve the railroad spur are also at this location.

- Coppal, a natural gum, was processed in Building K. Loading docks to serve the railroad spur are also at this location.

- Glycerin was distilled in Building N, which has since been demolished. Styrene and polyester polymers were also produced at this location.

- Office facilities were located in Building H.
- Building O was used as a pilot operation for the production of phthalic anhydride. Another pilot plant building was located adjacent to Building B but was destroyed by fire in the 1960s.
- A bulk storage area containing seven aboveground solvent storage tanks is located at the south end of the western section. Natural oils (i.e., linseed, safflower, soy) used in processing were also stored adjacent to this storage area.
- Buildings L and M were used for storage of finished product and solvents. These structures were constructed over an old drum storage area.

Three parking areas are located within the western part of this section. A 10,000-gallon gasoline underground tank is located in the parking lot. Reichhold has scheduled to remove this tank as part of a separate tank closure plan.

The East Section of the plant was constructed in the 1940s by the Defense Plant Corporation and used for the production of phthalic anhydride. Pesticides were also produced in Building 103 for a short period of time. Reichhold purchased the property at the end of World War II. The primary activities conducted in this section of the site were as follows:

- Phthalic anhydride was distilled or produced in Buildings 101, 103, 104, and 105. A variety of resins have also been produced in Building 103. The boiler room is located in Building 105. Two aboveground storage tanks are located adjacent to the boiler room. Building 101 was also used for storage of drummed raw materials and finished product.
- Building 100 was primarily used as a maintenance shop for the site facilities and equipment. A loading dock serving the railroad spur is also at this location.

- Offices and laboratories are located in Building 102.

- An aboveground tank farm is located at the northern end of the eastern section. Currently, storage tanks from other areas of the site are being stored here. These tanks have been drained, washed, and rinsed. One sodium hydroxide and two phenol storage tanks are also located adjacent to Building 101.

The South Section is a low activity area purchased by Reichhold in the 1950s. Buildings 203, 204, and 206 were warehouses for the storage of raw materials and finished products. Building 205 was used for office space and locker rooms. A bulk storage aboveground tank farm for finished product is located at the northern end of this section. The remainder of the area was used for parking.

3.0 INITIAL SITE CHARACTERIZATION

IT performed an initial site characterization of surface and shallow subsurface soils at the Ferndale site in order to assess overall soil quality and to evaluate the potential environmental impact of site operations. This initial site characterization is described in the following sections, including the selection of sampling locations, drilling methodology, equipment decontamination procedures, soil sampling methods, and soil sample selection for laboratory analysis.

3.1 SOIL SAMPLING LOCATIONS

The objective of the initial site characterization was to evaluate overall site soil quality. The three sections of the site were divided into smaller plant operational areas, as shown in Figure 2, for purposes of identifying composite sample locations only. Composite soil samples were then collected from each of the operational areas to evaluate the potential for environmental concern and to guide the scope of the sitewide Environmental Assessment.

IT collected a total of 15 composite soil samples, one from each of the plant operational areas. The West Section was divided into four operational areas, and a composite soil sample was collected from each area. In addition, one composite soil sample was also collected from along the western railroad spur and one composite soil sample collected from the western parking areas. The East Section was divided into four operational areas, and composite soil samples were collected from each area. An additional composite soil sample was collected from the eastern railroad spur. The South Section was also divided into four operational areas, and a composite sample was collected from each area.

As an additional measure, a qualitative screening of VOCs was conducted at each soil sampling location. The field screening was performed using an HNu photoionization detector (PID). Data obtained from each sample

location were used to determine relative values of VOCs in the shallow subsurface soil as a supplemental evaluation of general soil quality.

3.2 SOIL SAMPLING METHODOLOGY

Prior to collection of soil samples, concrete overlying the soil surface was drilled using a diamond drill bit. Soil borings were then advanced using a hand-held power auger. Each boring was advanced to a depth of approximately four feet or to refusal, whichever came first. An HNu was used to measure VOCs at each boring location. The HNu probe was placed approximately six inches into each borehole immediately after drilling was completed. HNu readings are summarized in Table 1. Discrete soil samples were then collected using a hand auger from each sampling location within each of the operational areas. The discrete samples were then composited in the field at the sampling location. The composite sample was then placed into appropriate sample jars, cooled to approximately 4 degrees Celsius, and packaged for shipment to the IT analytical laboratory in Knoxville, Tennessee. With the exception of Area 5 (West Section, railroad spur), the soil samples from each area were composited into one sample using a composite ratio of two or three discrete samples to one. Because of the physical characteristics and high HNu readings from Sampling Point 2 in Area 5, a discrete soil sample (Soil Sample SS5) was submitted to the laboratory from this location.

Chain-of-Custody and Request for Analysis forms were completed and accompanied samples to ITAS in Knoxville, Tennessee. The soil sample analytical program is discussed in Section 3.4.

3.3 EQUIPMENT DECONTAMINATION PROCEDURES

Sampling equipment was decontaminated to minimize the potential of cross contamination from one sampling area to another area. The following steps were followed to decontaminate drilling and sampling equipment between sampling areas:

- Tap water rinse
- Distilled water and trisodium phosphate wash
- Distilled water rinse
- Isopropyl alcohol rinse
- Distilled water rinse

Decontamination wash waters were collected and subsequently disposed of in the sewer system.

3.4 SOIL ANALYTICAL PROGRAM

The soil analytical program was designed based on historical site operations, including raw materials used and manufacturing processes. The soil samples collected during the initial site characterization were analyzed for the target compound list VOC (Method 8240) and semivolatile organic compounds (Method 8270). In addition, the following site-specific parameters were analyzed:

- Oil and Grease (Method 413.1)
- Total Phenols (Method 420.1)
- Formaldehyde (Colorimetric Method)
- Methanol (Method GC/FID)
- pH (Method 9045)

In addition, three Soil Samples SS1 (West Section), SS11 (East Section), and SS14 (South Section) were selected to be analyzed for the following parameters:

- Mercury (Method 7471)
- Lead (Method 7421)
- PCBs (Method 8080)

These soil sample locations were selected because they are representative of high activity areas within each of the three sections of the site. The results of soil sample analyses are discussed in the following chapter of this report.

4.0 RESULTS OF INITIAL SITE CHARACTERIZATION

The initial site characterization was performed as a semiqualitative assessment of soil quality and for the identification of the relative potential environmental concern represented by the East, West, and South Sections of the site. These data have been collected in order to focus the sitewide Environmental Assessment of the Ferndale site. The data collected during the initial site characterization include the following:

- HNu readings from soil sample boreholes
- Lithologic descriptions of soil samples and visual observations of soil quality
- Depth to ground water
- Analytical results for composite soil samples from 15 operational areas across the three sections of the site

A description of the depths of each soil sample, the subsurface conditions encountered, and the HNu readings are presented in Table 1. A summary of analytical results are presented in Table 2. Analytical data sheets are presented in Appendix A. Approximate soil sampling locations are shown in Figures 3, 4, and 5. The following sections discuss the results of the initial site characterization.

4.1 SUBSURFACE CONDITIONS

Subsurface soils encountered during the shallow soil sampling program generally consisted of brown sands to silty sands. The depth to ground water varied from three to four feet below the ground surface. Ground water encountered at depths shallower than this saturated zone may represent a localized perched water zone or poor drainage at these locations. The site soils and hydrogeology will be characterized based on the drilling and well installation program to be performed as part of the Environmental Assessment.

4.2 ANALYTICAL TEST RESULTS

A summary of the soil analytical results from the initial site characterization is presented in Table 2. Only those compounds detected in any soil sample are summarized. Concentrations reported below detection limits ("J" designation) or concentrations which can be attributed to laboratory contamination ("B" designation) are summarized in Table 2, but are not considered as representative of actual soil quality unless otherwise indicated in the following summary of analytical results.

4.2.1 Summary of Analytical Results: West Section

Six soil samples were collected from the West Section of the site as shown in Figure 3. Each of the samples are composite soil samples representing two to three discrete sample locations, with the exception of the sample from Area 5 which is adjacent to the rail siding. A discrete soil sample was submitted to the laboratory from Area 5 (designated sample SS5/2) since visual contamination, high HNu readings (200 ppm), and a strong odor were observed. Other Area 5 boring locations shown in Figure 3 were only screened using an HNu. The data are summarized in Tables 1 and 2.

The soil analytical results indicate that total xylenes were detected in the West Section at 3,600 mg/kg at the Area 5 rail siding, but in lower concentrations in the remaining areas. Specifically, total xylenes concentrations were 17.0, 3.8, 8.8, 0.016, and 40 mg/kg in Areas 1, 2, 3, 4, and 6, respectively. Other volatile organic compounds detected in the West Section include:

- Trichloroethene was detected at concentrations of 1.0, 0.015, and 33.0 mg/kg in soil samples from Areas 2, 4, and 6, respectively. The higher reported value was obtained from Area 6, a finished product truck loading area. Trichloroethene was not detected in the soil samples from Areas 1, 3, and 5.

- Ethylbenzene was detected in soil samples from Areas 1, 3, 4, and 6 in concentrations of 1.6,

1.6, 0.005, and 7.5 mg/kg, respectively. The highest concentration was detected in the soil sample from the truck loading area in Area 6.

- Toluene was detected in the soil sample from Area 5 only at 1.6 mg/kg. Area 5 is the rail siding which services the Area 2 manufacturing and storage operations.

Methylene chloride and acetone were detected in most soil samples; however, these compounds are common laboratory contaminants. A comparison of concentrations detected in the soil samples to values found in the laboratory method blanks indicates that these compounds are either below quantifiable levels or they can be attributed to laboratory contamination.

HNu readings measured at the sampling locations in each area generally correspond to levels of VOCs detected in the soil sample. The HNu readings are summarized in Table 1. The highest readings were detected from the soil sample in Area 5 (250 ppm) which may correspond to the elevated total xylenes concentrations at this location. Similarly, moderate HNu readings were measured at the discrete soil sample locations in Areas 1 (1 to 60 ppm) and Area 6 (20 to 200 ppm), corresponding to total VOC concentrations of 18.6 mg/kg in Area 1 and 80.5 mg/kg in Area 6. HNu readings in Areas 2, 3, and 4 were low (less than 20 ppm). Similarly, soil analytical results indicate low concentrations of total VOCs (less than 10 mg/kg).

Semivolatile organic compounds were only detected in the soil sample from Area 5 collected adjacent to the railroad spur. Compounds detected include 4-methylphenol (1.9 mg/kg), and isophorone (0.89 mg/kg), as well as polycyclic aromatic hyorocarbons (PAHs), including naphthalene (1.9 mg/kg), phenanthrene (1.6 mg/kg), fluoranthene (2.1 mg/kg), and pyrene (1.2 mg/kg). These PAHs detected at low concentrations are incomplete combustion products of fossil fuels commonly associated with railroad activities (Santodanto, et al., 1978).

Other parameters detected in soils from the West Section in varying concentrations include oil and grease, total phenols, formaldehyde, and lead. Oil and grease were detected in each of the composite soil samples from the West Section ranging in concentration from 190 to 2,100 mg/kg. The highest concentrations were found in the soil samples from the Area 5 rail siding (1,700 mg/kg) and the Area 6 truck loading area (2,100 mg/kg). The data may reflect interferences of the vegetable oils (i.e., linseed, safflower, and soy) used in manufacturing processes at the site, and therefore, may not be a threat to human health and the environment. The presence of regulated compounds will be addressed in subsequent sampling and analysis for total petroleum hydrocarbons (TPH) in addition to oil and grease.

Formaldehyde was detected in Areas 2, 3, and 5 ranging in concentration from 3 to 8 mg/kg. Lead was detected at 16 mg/kg in the soil sample from Area 1, well within the expected range of naturally occurring lead in soils (Schacklette, et al., 1971)

4.2.2 Summary of Analytical Results: East Section

Five composite soil samples were collected in the East Section of the site from Areas 7 through 11 as shown in Figure 4. VOCs were the primary constituents detected. The results of VOC analysis are summarized as follows:

- Total xylenes were detected in the soil samples from Areas 7, 8, 10, and 11 at concentrations of 0.26, 0.013, 5,400, and 150 mg/kg, respectively. The highest concentration was in the composite soil sample from Area 10, which is an aboveground storage tank farm. Total xylenes were not detected in the soil sample from Area 9.

- Ethylbenzene was detected in the soil samples from Areas 7, 9, 10, and 11 at concentrations of 0.25, 3.9, 700, and 130 mg/kg, respectively. The highest concentration was found in the soil sample from Area 10, the aboveground storage tank farm.

- Low concentrations of toluene were detected in the soil samples from adjacent to Building 101 in Area 7 (1.5 mg/kg) and adjacent to Building 105 in Area 8 (0.006 mg/kg, just slightly above the 0.005 mg/kg practical quantification limit (PQL).

- 4-Methyl-2-pentanone was detected in the composite soil sample from adjacent to Building 101 in Area 7 at 0.2 mg/kg.

- Styrene was detected in the soil sample from the railroad spur in Area 11 at 390 mg/kg.

The highest concentrations of total VOCs detected in soil samples in the East Section are in the aboveground storage tank farm located in Area 10 (6,100 mg/kg) and the Area 11 railroad spur (670 mg/kg). HNu readings in these areas were of a similar magnitude and ranged from 8 to 400 ppm in Area 10 and 0 to 350 ppm in Area 11. HNu readings in Areas 7, 8, and 9 were less than 20 ppm, which correspond to the low levels of total VOCs detected in soil samples from these areas (less than 4 mg/kg).

Methylene chloride and acetone were also detected in soil samples from Areas 7 and B. Each of these compounds are common laboratory contaminants. Acetone was detected in the laboratory method blank associated with these samples at comparable concentrations, indicating that the concentrations of acetone reflect laboratory contamination. Methylene chloride was not detected in the laboratory method blank; however, the low concentrations detected in soil samples (0.009 and 0.005 mg/kg) are equal to or just slightly above the PQL of 0.005 mg/kg.

Semivolatile organic compounds were only detected above quantifiable limits in the soil sample collected adjacent to the railroad track in Area 11. This soil sample contained 2-methylnaphthalene (6.1 mg/kg), naphthalene (43 mg/kg), phenanthrene (15 mg/kg), fluoranthene (7 mg/kg), and pyrene (7 mg/kg). As previously noted, these base neutral compounds are PAHs commonly associated with railroad activities (Santodanto, et al., 197B).

Oil and grease were detected in all soil samples, varying in concentration from 850 to 11,000 mg/kg. The highest concentration detected was in the soil sample from the Area 11 rail spur, with lower concentrations detected in the manufacturing and storage areas of Areas 7, 8, 9, and 10. The reported concentrations of oil and grease detected may reflect interference from the natural vegetable oils used in manufacturing at the site and may not be an appropriate indicator of hazardous substance contamination. The interpretation of oil and grease concentrations will be addressed through the addition of TPH to subsequent soil analyses.

Low concentrations of phenols were detected in the Area 10 aboveground storage tank area (4.4 mg/kg) and the Area 11 rail siding (2.9 mg/kg). Lead and mercury were detected in Area 11 at 17 mg/kg and 3 mg/kg, respectively. Both of these values are well within the expected range of these metals in natural soils (Schacklette, et al., 1971). PCBs were also detected in the soil sample from Area 10 at 0.06 mg/kg, which is equal to the 0.06 mg/kg PQL. In addition, the concentration of PCBs detected is significantly below the Toxic Substances Control Act (TSCA) cleanup level for PCBs of 10 to 25 mg/kg for industrial facilities (40 CFR, 52FR10688, April 2, 1987).

4.2.3 Summary of Analytical Results: South Section

Four composite soil samples were collected from Areas 12, 13, 14, and 15 in the South Section of the Ferndale site as shown in Figure 5. Relatively low concentrations of VOCs were detected in this section of the site. The VOC results are summarized as follows:

- Trichloroethene was detected in the composite soil samples from adjacent to the aboveground storage tank farm in Area 12 and adjacent to the rail spur in Area 15 at 9.3 mg/kg and 0.009 mg/kg, respectively

- Total xylenes were also detected in Area 12 at 430 mg/kg and at a concentration of 0.034 mg/kg adjacent to the former drum storage area in Area 14

- Ethylbenzene was detected at concentrations of 9.5, 0.008, and 0.02 mg/kg in Areas 12, 13, and 14; the highest concentration was detected in Area 12, adjacent to the southern aboveground tank farm

- Toluene was detected in the composite soil sample from Area 12 (5.2 mg/kg) and below the PQL level in the paved driveway of Area 13 (0.001 mg/kg)

- 1,2-Dichloroethene was detected in the soil sample from Area 12 at a concentration of only 0.2 mg/kg

Methylene chloride and acetone, common laboratory contaminants, were detected in all of the samples from the South Section. Concentrations detected were compared to the concentration reported in the laboratory method blank. Only the the soil sample from adjacent to the aboveground tank farm (Area 12) contained acetone at 8.2 mg/kg, which is above the value detected in the method blank. The remainder of the values detected are comparable to concentrations in the method blank and are attributed to laboratory contamination.

The highest concentrations of total VOCs detected in soil samples from the South Area was in Area 12 (454.2 mg/kg), corresponding to HNu readings in the range of 200 to 300 ppm. VOCs detected in the soil samples from the remaining areas are low, ranging in concentration from 0.001 mg/kg to 0.034 mg/kg. Similarly, HNu readings collected from borings in these locations were less than 10 ppm.

Naphthalene was the only semivolatile organic compound detected above quantitation limits in the South Section. This compound was found in the sample from the paved driveway (Area 13) at a concentration of 2 mg/kg and from adjacent to the Area 14 warehouse at 380 mg/kg.

Other parameters detected in the South Area include oil and grease, total phenols, formaldehyde, methanol, lead, and mercury. Oil and grease concentrations ranged from 420 mg/kg in Area 13 to 1,000 mg/kg in Area 14. The concentrations detected may reflect the use of non-hazardous oils at the site, and therefore, may not be solely an indication of an adverse impact of site operations.

The composite sample from Area 12 contained methanol at a concentration of 5 mg/kg. Formaldehyde was detected in the soil samples from Area 13 (3 mg/kg) and Area 15 (2 mg/kg). Total phenols (1.8 mg/kg), lead (27 mg/kg), and mercury (0.1 mg/kg) were detected in the sample from Area 14. Both lead and mercury concentrations are within the range found in natural soils.

4.2.4 Evaluation of Soil Sample Results

Concentrations of compounds detected in soil samples from each of the areas were compared to corrective action levels (CALs) which have been proposed in the draft RCRA Facility Investigation (RFI) Guidance document (U.S. EPA, 1987), the proposed rule for RCRA Corrective Action for Solid Waste Management Units and Hazardous Waste Management Facilities, Subpart S (U.S. EPA, 1987). Where CALs were not available, health risk based concentrations have been used. CALs are included in Table 2 for comparison to the soil analytical data.

Concentrations of compounds detected in the soil from the West Section were compared to RCRA CALs. Trichloroethene was detected in the soil sample from the Area 6 truck loading dock at a concentration of 33 mg/kg, just slightly over the CAL of 32 mg/kg. All other volatile, semivolatile, and inorganic compounds detected in the West Section were below the CAL.

Constituents detected in the East Section were all below the CAL, with the exception of PCBs which were detected in the Area 10 abovegrpund

storage tank farm at a concentration of 0.06 mg/kg, just slightly above the 0.05 mg/kg CAL but equal to the 0.06 mg/kg PQL. This concentration is significantly below the TSCA cleanup level of 10 to 25 mg/kg for industrial areas (40 CFR 761, 52 FR10688, April 2, 1987).

Concentrations of constituents detected in the composite soil samples from the South Section were compared against the CALs. None of the VOCs, semivolatile organic compounds, inorganics, or PCBs exceeded the CALs for any of the soil samples collected in the South Section of the site.

5.0 ENVIRONMENTAL ASSESSMENT WORK PLAN

The initial site characterization identified both volatile and semi-volatile organic compounds in soils in varying concentrations across the site. The occurrence of these constituents indicates that additional investigation of the site is warranted. The focus of these activities will be to identify the distribution of constituents identified in subsurface soils and to determine if ground water has been impacted. To achieve these goals, the Environmental Assessment will include the following:

- Ground water monitoring program
- Soil quality investigation

A sitewide ground water monitoring program will be implemented in order to characterize the subsurface soil strata, determine direction of ground water flow across the site, and to evaluate ground water quality. This program will be implemented in two phases. During the first phase, ground water monitoring wells will be installed to determine flow direction and to obtain preliminary ground water quality data. A second phase of monitoring well installation will be initiated after completion of a soil-gas vapor survey so that additional monitoring wells can be located within areas of potential concern.

For performance of the subsurface soil investigation, the West, East, and South Sections of the site will each be treated separately. A scope of work has been developed for each section which considers the age of each section, previous land use, future land use options, and the results of the initial site characterization.

With these factors in mind, the soil investigation for each of the three sections of the site has been designed to include either a soil-gas vapor survey followed by a program of discrete soil sampling program or a discrete soil sampling program to be initiated without any preliminary

screening. This will enable the soil investigations for each section of the site to proceed on individual schedules. This approach will also result in a scope of work which effectively addresses the potential environmental concerns within each section.

The following is a discussion of the sitewide ground water monitoring program and the section-specific subsurface soil investigations in detail.

5.1 GROUND WATER MONITORING PROGRAM

The ground water monitoring program has been designed to characterize soil stratigraphy, to evaluate site hydrogeology, and to evaluate ground water quality. An estimated six to eight monitoring wells will be installed in two phases of well installation in order to achieve the goals of this program.

5.1.1 Phase I

A total of four monitoring wells will be installed during the first phase of the monitoring program. Three ground water monitoring wells will be installed around the perimeter of the site to determine the direction of ground water flow (Figure 6). The placement of these monitoring wells in the three corners of the site should provide both upgradient and downgradient ground water quality data. A fourth monitoring well will be installed adjacent to the railroad tracks which dissect the site. The area along the railroad track is the only major portion of the site which has not been sealed with concrete. Consequently, this area may be the primary zone of recharge at the site. A monitoring well at this location will provide the necessary data to determine shallow ground water flow patterns across this potential recharge area as well as evaluate whether or not site operations have impacted ground water quality. Following installation of the four monitoring wells, each monitoring well will be surveyed by a licensed surveyor for elevation and location. Ground water elevations will be

measured, and the ground water flow direction and gradient will be determined.

Soil samples will be collected during the drilling program to provide stratigraphic data on the subsurface soil. It is estimated that a clay layer is located between 15 and 20 feet below grade (MDNR, personnel communication). Monitoring wells will be installed to the first confining clay layer. If a confining clay layer is not encountered in the first 25 feet, monitoring wells will be completed to a maximum depth of 25 feet. The well screen will intercept a minimum of ten feet into the water table at each well location.

Ground water samples will be collected following the methods summarized in Section 5.3.2. The ground water analytical program will include volatile and semivolatile organic compounds, oil and grease, and TPH as discussed in Section 5.3.2. TPH will be added to the analytical program for comparison to oil and grease data and to determine if oil and grease concentrations previously reported in the soils represent a potential environmental concern. Additional parameters measured during the initial site characterization (including total phenols, formaldehyde, methanol, PCBs, and lead) will not be included since these constituents were not found to be prevalent in the soils at the site.

5.1.2 Phase II

An estimated two to four additional monitoring wells will be installed to further characterize ground water quality at the Ferndale site. These monitoring wells will be located after determination of shallow ground water flow patterns and the initial evaluation of ground water quality. The results of the soil-gas vapor survey in the East and West Sections and the soil sampling program in the South Section will also be used to select appropriate locations for ground water monitoring. The Phase II well installation program will be submitted to the MDNR for review and approval as part of the work plan for the soil sampling

program for the East and West Sections of the site. Upon completion of the Phase II well installation, each new well will be surveyed and the elevation data evaluated for further definition of shallow ground water flow patterns. All of the site monitoring wells will then be sampled to evaluate ground water quality at the new locations and to identify potential routes of contaminant migration, if any.

5.2 SUBSURFACE SOIL INVESTIGATION

Following completion of the Phase I monitoring well installation, a soil investigation will be initiated. Each of the sections of the site have been treated separately in the development of the soil sampling program. Factors which have been considered in the design of the soil investigations include age of the section, previous land use, potential future land use options, and the results of the initial site characterization. A discussion of the proposed scope of work for each of the sections is presented below.

5.2.1 Soil Investigation: East and West Sections

The East and West Sections are the oldest areas of the site and are the highest activity areas. Production has varied throughout each of these sections over the history of the operation. Historical site operations included processing, material transfer, and material storage. The initial site characterization identified certain VOCs at varying concentrations in the soil in the East and West Sections. PAHs were also identified along the railroad track in both the East and West Sections. Oil and grease was also detected at varying concentrations.

Prior to initiation of a program of discrete soil sampling, a soil-gas vapor survey will be conducted in both the East and West Sections to identify potential areas of volatile organic and total petroleum hydrocarbon contamination. The soil-gas vapor survey is a semiqualitative screening technique for the detection of VOCs and TPHs in soil and/or ground water. The technique is based on the theory that if VOCs are

present in ground water or subsurface soil, they will occupy the interstices or void spaces in the soil. These vapors can then be sampled using a photoionization detector (PID). Data obtained from the soil-gas vapor survey will then be utilized to identify the most appropriate locations for collection of discrete soil samples in the East and West Sections.

A 50-by-50-foot grid will be established across the East and West Sections of the soil for performance of the soil-gas survey. When PID readings greater than 100 ppm are collected, the spacing of the sampling grid will be reduced, and additional samples will be collected to further define the extent of VOCs. The collection of additional soil-gas samples will be a field determination based on actual site conditions. The soil-gas survey field procedures are detailed in Section 5.3.3.

Following completion of the soil-gas vapor survey, a soil sampling plan will be submitted to the MDNR for the East and West Sections. Sampling locations will be focused on defining the nature and extent of areas of concern identified during the soil-gas vapor survey. This approach will result in a focused soil sampling program aimed at characterizing the areas of greatest potential environmental concern. Parameters for soil sample analysis will include VOCs, oil and grease, and TPH for discrete soil sampling locations in the East and West Sections. Base/neutral compounds will be added to the analytical program for samples collected adjacent to the railroad track. These parameters were selected based on the soil analytical data collected in the initial site characterization. The analytical methods for soil analysis are provided in Appendix B.

Actual soil sampling locations and sample collection intervals for the East and West Sections will be detailed in a soil sampling work plan which will be submitted to the MDNR for approval following completion of the soil-gas vapor survey.

5.2.2 Soil Investigation: South Section

The South Section is the newest section of the site. It has been used by Reichhold primarily for warehouse and aboveground tank storage of finished product and raw materials. A drum storage area was historically located in the southernmost portion at the current location of Building 206. The current buildings and aboveground tank storage areas are in good condition and will require minimal alteration during plant shutdown.

During the initial site characterization, low concentrations of VOCs and oil and grease at varying concentrations were reported in soil samples from the South Section. PAHs were detected adjacent to Building 206. The remaining constituents analyzed were below detection.

Based on the results of the initial site characterization, VOC concentrations in soil do not warrant performance of a soil-gas survey. Instead, a discrete soil sample collection program will be initiated for characterization of soil quality in those areas where potential environmental concern is indicated.

As summarized in Chapter 4.0, the soil sampling and analysis performed during the initial site investigation indicate that the aboveground storage tank farm in Area 12 is the only area of the South Section which warrants additional investigation. The pavement and warehouse structures in Areas 13 and 14 are in excellent structural condition, and the soil analytical data from these areas do not indicate that soils underlying these structures are of environmental concern. In addition, the Phase I ground water monitoring program includes installation of a monitoring well in the South Section in order to confirm that historical drum storage areas have not adversely impacted ground water quality.

In order to evaluate the soils in Area 12, discrete soil samples will be collected and submitted for analysis. As shown in Figure 5, soil

samples will be collected at the nodes of a 50-by-50-foot sampling grid in Area 12. Soil samples will be collected to the top of the saturated zone, an estimated three to four feet below grade. Soil samples will be collected continuously. Soil samples representing the six-inch increment below the pavement and the six-inch increment above the saturated zone (30 to 36 inches or 42 to 48 inches, depending on the depth to water) will be submitted for analysis. Soil samples will be analyzed for the VOCs, base neutral organics, and oil and grease as identified in the initial site characterization. TPH will also be included in the soil analytical program in addition to oil and grease to evaluate the potential environmental concern of these materials. The soil sampling program is summarized in Table 3. All soil sampling procedures are summarized in Section 5.3.1 and quality assurance practices are detailed in Chapter 7.0 of this work plan.

5.3 FIELD METHODS

5.3.1 Ground Water Monitoring Well Installation

The ground water monitoring wells will be installed in the shallow water table which is encountered three to four feet below ground surface. The monitoring wells will be installed to the top of the first clay layer encountered or to a maximum depth of 25 feet.

At each of the monitoring well locations, a soil boring will be advanced using 6-1/4-inch hollow-stem augers. Soil samples will be collected in accordance with American Society for Testing and Materials (ASTM) methodology using a split-spoon sampler. The split-spoon sample will be visually described by the IT field geologist using the Unified Soil Classification System (USCS). A geologic boring log will be prepared for inclusion in the final report.

Drill cuttings and any excess soil samples will be drummed and staged at an on-site location designated by Reichhold. After completion of each

boring, the augers and any other downhole equipment will be steam cleaned prior to reuse. Cleaning will be performed only in areas designated by Reichhold within the plant boundary, and all wash waters will be containerized and disposed of properly. Disposal of all wash waters will be approved by the MDNR and fully documented.

Upon completion of the boring for each well, a four-inch-diameter monitoring well will be constructed of Schedule 40 PVC screens and riser pipes. Each monitoring well will be constructed in accordance with U.S. EPA specifications as detailed in Figure 7. Well construction will consist of the following:

- Installing the well casing, including a 10-foot section of 0.010-inch slot well screen
- Backfilling the annulus around the well screen with coarse sand to a depth approximately two feet above the top of the well screen to form the well sensing zone
- Sealing the well sensing zone with bentonite pellets
- Grouting the remainder of the well annulus with a cement bentonite grout to the ground surface
- Protective casings will be flush-mounted at each well location

Once the installation of the wells is complete, each well will be developed by pumping for one hour or until the discharge runs sediment free. Development will be conducted by either pumping or airlifting. All well development water will be contained on site, and disposal options will be evaluated. Disposal of all wastewaters will be fully approved and documented.

5.3.2 Ground Water Sampling

Ground water samples will be collected approximately two weeks after installation of each of the four Phase I monitoring wells proposed for the site. In addition, two quality assurance (QA) samples will be collected including a duplicate sample and equipment rinsate blank. A second round of ground water sampling will be conducted following installation of the additional Phase II monitoring wells. Ground water samples will be analyzed for the following parameters:

- Volatile organics
- Semivolatile organics
- TPH
- Oil and grease

TPH will be substituted for the oil and grease analysis conducted in the initial site characterization to evaluate if the oil detected is of potential environmental concern. TPH will be analyzed using Method 418.1. Volatile and semivolatile organic samples will be analyzed using U.S. EPA SW 846, Third Edition methods. Analytical methods are described in the Quality Assurance Plan summarized in Chapter 7.0.

Prior to ground water sampling, the static water level and the depth to the bottom of the well will be measured to the nearest one-hundredth of a foot. Water levels will be measured with an M-scope water level meter rinsed with distilled water between each well location. The height of standing water within the well will then be determined and the volume of water to be purged from the well calculated.

A minimum of three well volumes of water will be removed from the monitoring wells prior to sample collection. In the event that a well goes dry before three well volumes of water are removed, the well will be considered adequately purged. Ground water which eventually recharges the monitoring well will be considered fresh formation water suitable for sample collection.

The monitoring wells will be purged with teflon bailers which are decontaminated between sampling locations. Decontamination of the bailers will consist of a distilled water wash, hexane rinse, and a final wash with distilled water. New nylon rope will be used at each well location. Water generated during the well purging process will be contained in 55-gallon drums which will be appropriately labeled and staged for evaluation of disposal options. Disposal of all purge water will be approved and fully documented.

Ground water samples will be collected with a stainless steel or teflon bailer. Samples for volatile organic analysis will be collected first. Samples will be collected in 40-milliliter (ml) vials with teflon-lined silicone rubber septa. The collection of samples to be submitted for volatile organic analysis will be followed by the collection of an aliquot of sample to be utilized for time sensitive, physical measurements including temperature, pH, and conductivity. Physical parameters will be measured in the field using a conductivity meter, thermometer, and pH meter. The conductivity and pH meter will be calibrated at the beginning of each day.

Ground water sampling will continue at each well location with the collection of samples for TPH. A field blank will be prepared at a frequency of 1 for every 15 samples by filling a decontaminated bailer with distilled water and collecting the reinstate from the bailer.

Ground water and field blank samples will be properly labeled at the time of collection and placed in an ice chest. The samples will then be cooled to 4 degrees Celsius and properly packaged to avoid breakage during delivery to the laboratory. Chain-of-Custody and Request for Analysis forms will be completed for each sample and accompany each daily sample shipment to the IT laboratory in Export, Pennsylvania.

5.3.3 Monitoring Well Survey

After the well installation is completed, a licensed surveyor will survey the monitoring wells for location and elevation. The wells will be surveyed to a vertical accuracy of 0.01 foot. All well casing and ground surface elevations will be provided to the MDNR in tabular form, and a base map will be developed indicating all monitoring well locations.

5.3.4 Soil-Gas Vapor Survey

Soil-gas surveys are currently being used by the MDNR as a state-of-the-art technique for remedial investigations at a variety of sites. Field application and collection of related data have shown a direct correlation between the soil-gas vapor concentration and subsurface contaminant concentrations. The technique has shown a wide range of successful applications, including:

- Tracing of subsurface plumes due to leaks and spills
- Determination of subsurface migration routes of contaminants
- Delineation of ground water contamination
- Preparation of isoconcentration plots to locate point source(s)

Prior to the initiation of a discrete sampling program, a 50-by-50-foot grid will be established across the East and West Sections of the site. It is estimated that approximately 230 points will be collected in the East and West Sections at this spacing. The actual sampling locations may deviate from the surveyed stations based on the accessibility and/or physical location of each section of the site (i.e., tanks, dike, etc.). In this event, the actual sampling location with respect to the grid station will be measured and recorded.

The soil-gas sampling technique will involve drilling through concrete or asphalt at each of the sampling locations using a diamond-bit drill and then driving a solid steel rod (approximately five feet long and three-eighths inch in diameter) into the soil to a depth of approximately three feet. The sample depth is based on an estimated depth to ground water of three to four feet. The solid rod is withdrawn and replaced with a 1/4-inch-diameter stainless steel tube. A stainless steel cable is placed within the stainless steel tube prior to installation of the tube into the borehole to prevent soil from entering the sample tube. The steel cable is then removed, and a soil-gas vapor sample is collected through a teflon tube connected in series with the probe of a portable organic vapor detector (i.e., Photovac TIP). A maximum stabilized TIP reading is then obtained. Each reading will be documented in the field log. Sample collection logs will be completed by the field technician at each location of soil-gas sampling.

The steel probes will be decontaminated prior to use by flushing the probes with bottled air or nitrogen to eliminate the possibility of cross contamination between samples. An adequate supply of probes will be maintained to complete each day's measurements without reusing a probe. If a probe requires reuse in the same day, it will be decontaminated by flushing with bottled air or nitrogen prior to use.

Isoconcentration maps of the soil-gas vapor data will be prepared for the East and West Sections. The isoconcentrations will be used to identify the location of point sources or plumes of subsurface volatile organic contamination. Together with the results of the Phase I ground water analysis, the potential impact of site operations on soil and ground water will be determined. Discrete soil sample locations and additional monitoring wells will then be selected to evaluate the nature and extent of the contamination.

5.3.5 Soil Sample Collection

At each of the new soil sample locations, a soil boring will be advanced using a minimum of 4-1/4-inch-diameter hollow-stem augers, and samples will be collected in accordance with ASTM methodology using a split-spoon sampler. The split-spoon sample will be visually described by the IT field geologist using the Unified Soil Classification System (USCS). A geologic boring log will be prepared for inclusion in the final report.

Soil samples will be collected using a split-spoon sampler and will be removed from the sampler using a clean tongue depressor which will be discarded after each use. Each sample will be placed into a glass sample container and labeled. Soil samples will be submitted for analysis from the six-inch-interval below the pavement and the six-inch-interval above the saturated zone (30 to 36 inches or 42 to 48 inches, depending on the depth to water).

To prevent cross contamination between soil samples, sampling devices (split spoons) will be decontaminated between samples by brushing off excess soil and washing the device with a nonphosphate detergent wash and a deionized water rinse. Finally, they will be wiped down with methanol and air dried.

All soil samples will be placed into a sealed sample bottle and identified at the field location. The sample bottles will be labeled with the following information: project name and number, boring hole number, sample number, interval depth, date of sample, and name of person taking the sample. The samples will be placed on ice to maintain a temperature of 4 degrees Celsius.

Samples will be logged into field collection reports and will then be shipped with the Chain-of-Custody and Request for Analysis forms to the IT laboratory in Export, Pennsylvania.

6.0 PROJECT SCHEDULE AND REPORT SUBMITTAL

Upon approval of this plan by the MDNR, IT will initiate the Environmental Assessment according to the schedule presented in Figure 8. The schedule of execution is as follows:

- Phase I monitoring well installation to allow characterization of the soil stratigraphy, to determine the depth to the water table, and to evaluate direction of ground water flow
- Performance of the soil-gas survey in the East and West Sections of the site to provide guidance for selection of discrete soil sample locations and additional ground water monitoring wells
- Performance of the South Section discrete soil sampling program to evaluate the nature and extent of potential soil contamination in Area 12
- Phase I ground water sampling and analysis to evaluate ground water quality prior to installation of additional monitoring wells
- Preparation of an East and West Sections soil sampling and Phase II monitoring well installation plan; the plan will identify the discrete soil sampling locations and sample intervals for evaluation of soil quality and the Phase II monitoring well locations based on the results of the soil-gas survey and Phase I ground water quality data
- Performance of the East and West Sections soil sampling and analysis program to determine the nature and extent of areas of potential soil contamination
- Installation of the Phase II ground water monitoring wells to further evaluate the potential impact of soils contamination on ground water quality
- Phase II ground water sampling and analysis of all site wells to characterize ground water quality and evaluate potential routes of migration

- Preparation of an Environmental Assessment report to summarize the results of the soil and ground water investigation and to determine the next course of action for each section of the site

A letter report will be prepared for the East and West Sections after evaluation of the soil-gas vapor survey results, determination of ground water flow direction, and assessment of Phase I ground water quality results. This letter report will include discrete soil sample locations, sample intervals, and sampling collection and analytical procedures for the East and West Sections. The locations for the Phase II monitoring wells will also be proposed at this time. These locations will be selected based on the results of the soil-gas survey, the direction of shallow ground water flow, and the results of the Phase I ground water sampling. After approval from the MDNR, the field program for these activities will be initiated.

The results of the Environmental Assessment will be presented in a comprehensive report summarizing site soils stratigraphy, ground water occurrence, ground water flow direction, and an evaluation of the nature, concentrations, and distribution of any soil and/or ground water contaminants. The report will also provide conclusions and recommendations for the next course of action for each section of the site. The report will be supplemented by the data and analysis documentation and will include:

- Introduction, purpose, and scope of the project
- Field methods
- Soil-gas survey discussion and results
- Well logs, field logs, and well sampling location maps
- Hydrogeological setting

- Characterization of soil and/or ground water chemical constituents and their distribution
- Conclusions and recommendations

A draft report will be submitted for Reichhold's review and comments. A final report will be submitted to the MDNR after receiving and incorporating Reichhold's comments.

The project schedule presented in Figure 8 is based on the following assumptions:

- Five weeks of field work for completion of the installation of four monitoring wells, performance of the soil-gas vapor survey, and the Phase I ground water sampling
- Four weeks for analysis of soil and ground water samples
- One week to complete discrete soil sampling in the South Section
- Two weeks to complete discrete soil sampling in the East and West Sections
- Six weeks to complete the Environmental Assessment report
- One-week period of review by Reichhold for all submittals
- Four-week period of review by MDNR for all submittals

As shown in Figure 8, the project will progress based on site-specific soil and ground water data generated during the preliminary work tasks in order to fill data gaps and properly focus the site assessment. Some field tasks may be executed on a parallel schedule if data analysis and MDNR approvals allow.

7.0 QUALITY ASSURANCE PROGRAM

7.1 INTRODUCTION

This chapter describes objectives of the QA program and QA procedures to be implemented in the field. Laboratory QA procedures are presented in Appendix B.

7.2 IMPLEMENTATION

The investigation and evaluation of the Detroit, Michigan site will be completed in accordance with applicable elements of the IT Corporate QA/QC Program.

7.3 PROJECT QUALITY ASSURANCE

The project will be implemented based on the following IT documents as appropriate: Quality Assurance Manual, Analytical Services, IT, February 1, 1988, Revision No. 1; and Quality Assurance Manual, Engineering Services, IT, July 1, 1987, Revision No. 1.

7.4 QUALITY ASSURANCE DATA OBJECTIVES

The purposes of this plan are to verify that the requirements of the Work Plan and applicable regulatory requirements have been met and to provide internal means for control and review so that the environmentally related measurements and data collected by IT and its subcontractors are scientifically sound, defensible, and of known acceptable document quality.

Project objectives are:

- To generate quality, scientific data that will withstand scientific and legal scrutiny.
- To gather and develop data in accordance with procedures appropriate for the intended use of the data.

- To generate data which are precise, accurate, representative, complete, and comparable. Detection limits will meet U.S. EPA and MDNR requirements specified in the selected method.

To assure that these objectives are met, the following elements are to be used for assessing the quality of the measurement data:

- Completeness - Completeness is a measure of the reported values that meet the precision and accuracy criteria. For the project, a goal of 90 percent completeness of data will be established.

- Representativeness - Measurements must be made so that results are representative of the media (soil, ground water, and sediment) and conditions being measured.

- Accuracy - Accuracy is an indication of the agreement between a measurement and the true value.

- Precision - Precision is the measure of mutual agreement among individual measurements of the same property.

- Comparability - Comparability is accomplished by obtaining data using standard procedures and by reporting data using standard units to allow comparison with similar data collected by other organizations.

- Traceability - Traceability indicates the extent to which data can be substantiated by hard copy documentation. Traceability documentation exists in two essential forms: one that links quantification to accepted standards; a second describes the history of each sample from collection to analysis.

- Detection Limit - This represents the minimum concentration of an analyte that can be identified, measured, and reported with 99 percent confidence that the analyte concentration is greater than zero in a given sample which contains the analyte.

The fundamental mechanisms that will be employed to achieve these quality objectives can be categorized as prevention, assessment, and correction. Modus operandi of these mechanisms is given below:

- Prevention of defects in quality is enhanced through planning and design, documented instructions and procedures, and careful selection, training, and use of skilled, qualified personnel
- Quality assessment is made through a program of regular audits, surveillance, or inspections to supplement continual informal review
- Permanent correction of conditions adverse to quality is achieved through a nonconformance and corrective action reporting system

This QA/QC Program has been prepared in direct response to these objectives and describes the quality assurance plan to be implemented and the quality control site procedures to be followed by IT and its subcontractors.

7.5 PROCUREMENT AND CONTROL OF SUBCONTRACTORS

Prequalification and review of procurement documents will be performed to assess that items and services provided conform to project requirements. The day-to-day responsibility for compliance with the IT Corporate QA/QC Program will be delegated in the procurement documents to subcontractors who have an acceptable internal QA program equivalent to the IT program. Overall responsibility for compliance will be retained by IT. In the case of subcontractors who do not have such a program, IT shall use the procurement documents to specify the performance of specific quality requirements to each subcontractor, including certification requirements. The specific requirements allow for all appropriate QA requirements to be met without requiring each subcontractor to have their own individual QA program.

Collection, identification, preservation, packaging, shipping, storage, and holding times will be based on all applicable U.S. EPA requirements

with IT QA requirements. The analytical QA Program will be in accordance with IT Analytical Services QA protocol and will include the use of field blanks and one duplicate for each 10 to 15 samples submitted for analysis.

7.6 FIELD DOCUMENTATION

An integral part of the Field QA/QC Plan for the field activities will be maintaining a Field Activity Daily Log. Information identified on the Field Activity Daily Log will be obtained from site exploration and sampling activities and will be documented by the field supervisor or supervising geologist. Each sample collected will be recorded on a sample collection log. Information included will be date and time of sample collection, sample method, bottle requirements, and analytical parameters.

Procedures cannot be prepared which properly address all specific conditions encountered during a field program. Variances from approved operating procedures in the Work Plan, the QA/QC Program, or the Health and Safety Program will be documented on a Variance Log. The field supervisor will initiate and chronologically maintain the Variance Log. The Quality Assurance Coordinator is to concur with (and indicate by signing) a variance that may impact any activity affecting quality. A variance from the Health and Safety Program must be signed by the Health and Safety Coordinator, rather than the Quality Assurance Coordinator. Approval by the project manager can be initiated on a verbal basis via telephone with follow-up signature. If a variance is proposed by the client, it will be so recorded. In no case will an IT subcontractor initiate a variance. The Variance Log will be kept on site until the field work is complete and will then be sent to the project files.

7.7 FIELD DATA MANAGEMENT

The intended use of field data is to assess the nature of the site and the extent of potential problems resulting from past activities at the site and to identify, evaluate, and recommend appropriate actions.

Numerical analyses, instrument readings and recordings, measurements and tests will be documented and subjected to internal review. Field records will be legible and sufficiently complete to permit a qualified individual other than the originator to reconstruct the data gathering activities during the process of data reduction. The method of reduction of data will be identified and recorded. Field generated data sheets will be collected and reviewed for accuracy and completeness by the field supervisor. The forms will be assembled by the field supervisor into packages that represent each borehole, sampling well, etc. These data sheet record packages will be delivered to the IT Project Management Office in Pittsburgh, Pennsylvania for review, examination, analysis of data, and for the technical staff to use in preparing the required reports.

7.8 FIELD CUSTODY PROCEDURES

Field custody procedures include the following items:

- The field supervisor or supervising geologist will instruct site personnel in the chain-of-custody procedures, as necessary, before sampling begins.
- The field supervisor or supervising geologist determines whether proper custody procedures and report forms were used during the field work and documents results in the Field Activity Daily Log.
- The field supervisor or supervising geologist has overall responsibility for the care and custody of the samples collected until they are transferred or dispatched properly to the laboratory. Each individual who collects a sample is responsible for sample custody until transferred to someone else via the Chain-of-Custody Record.

- Shipment information is recorded for shipment of samples at the end of the shift, day, or collection period in the Field Activity Daily Log.

7.9 TRANSFER OF CUSTODY AND SHIPMENT

Transfer of custody and shipping procedures are listed below.

- A Chain-of-Custody Record which will be initiated in the field for each sample. A copy of this record will accompany each sample.

- In the event that the laboratory sample custodian judges sample custody to be invalid (i.e., samples arrive damaged), a Nonconformance Report Form will be initiated. The project manager will then be notified. The project manager will make a decision as to the fate of the sample(s) in question. The sample(s) will be either processed "as is" with custody failure noted, along with the analytical data; or rejected with sampling rescheduled, if necessary. The project manager will sign off the Nonconformance Report, noting the reason for disposition.

- Each time responsibility for custody of the sample changes, the new custodian will sign the record and note the date.

- The custody of individual sample containers will be documented by recording each container's identification on an appropriate Chain-of-Custody Record.

- The analyses to be performed for each sample will be recorded on an IT Analytical Services (ITAS) Request for Analysis Form.

- Upon sample destruction or disposal, the custodian responsible for the disposal will complete the Chain-of-Custody Record, file a copy, and send a copy to the project manager or to his designated representative for record keeping.

7.10 CALIBRATION PROCEDURES

Field measuring and testing equipment will be calibrated in accordance with the requirements of IT's Engineering Services field equipment calibration procedures. Measuring equipment, test equipment and reference standards will be calibrated at prescribed intervals and/or before use. Calibration frequency will be based on the type of equipment, inherent stability, manufacturer's recommendations, values given in national standards, intended use, and experience.

In some cases, particularly for field equipment, scheduled periodic calibration will not be performed because the equipment is not continuously in use. Such equipment will be calibrated on an "as needed" basis prior to use, and then at the required frequencies for as long as its use continues.

Calibrated equipment will be uniquely identified by using the manufacturer's serial number. A label will be attached to the equipment and will indicate the identification number and the date when the next calibration is due. A copy of the IT Equipment Calibration Record will be completed with each calibration activity for the Project Record. It is the responsibility of each individual equipment user to verify calibration status from the due date labels or records prior to using the equipment.

7.10.1 Calibration Failures

Scheduled periodic calibration of testing equipment will not relieve field personnel of the responsibility for employing properly functioning equipment. If an equipment malfunction is suspected, field personnel will remove the device from service, tag it so it is not inadvertently used, and notify the project manager so that recalibration can be performed or substitute equipment obtained.

Equipment that cannot be calibrated or that becomes inoperable during use will be removed from service and either segregated to prevent inadvertent use, or tagged to indicate it is out of calibration. Such equipment will be repaired and recalibrated or replaced as appropriate. Any such action should be reported in the Field Activity Daily Log and on the instrument calibration record.

7.10.2 Calibration Records

Records will be prepared and maintained for each piece of calibrated measuring and test equipment and each piece of reference equipment to indicate that established calibration procedures have been followed. Records for equipment used will be kept in the project files.

7.11 PROJECT RECORDS

The IT records system provides for central control and retention of project-related information. Records are tracked from receipt of external sources (site, laboratory, etc.) and during transfer to storage.

Records will be prepared during the performance of this project to furnish documentary evidence of the conduct and quality of the work. Field records will be collected and maintained by the field supervisor or supervising geologist. Upon completion of the field activities, the original field records will be submitted to the project manager.

Quality records document activities performed during the project to check that the quality assurance program is maintained. These records will be maintained by the project manager on a routine basis during performance of work activities, according to the IT Quality Assurance Program procedures. The project manager or his designee may periodically review field/quality records for accuracy and completeness prior to incorporation in the project central files.

7.12 FIELD AUDITS

An audit of field activity will be scheduled to verify compliance with IT and specific Field QA/QC Program requirements. An audit will consist of an evaluation of project and Work Plan requirements, implementation of these requirements and effectiveness of project implementation, and a review of project documentation.

7.12.1 Audit Planning and Conduct

Audits will cover both field activities as well as other project activities and will be conducted by one or more of the following personnel:

- Greg Shamitko, Corporate Quality Assurance Officer (Pittsburgh Office)
- N. Foster Allen, Quality Assurance Officer (Pittsburgh Office)

Records of field operations would be reviewed to verify that field-related activities were performed in accordance with approved project procedures. Items reviewed may include, but would not be limited to, calibration records of field equipment; Field Activity Daily Logs; photographs; and data, logs, and field drawings resulting from the field operations.

Audits would also examine the documentation and verification of field and laboratory data and results; performance, documentation, and verification of analyses; preparation and verification of drawings and logs; contents, consistency, and conclusions of the final report; compliance with IT and project requirements; and maintenance and filing of project records.

7.12.2 Audit Reporting

Audit results will be reported to the appropriate IT management. Requests for any required corrective actions will be made in the audit report. The corrective actions will be implemented by the project

manager and reported in writing to the quality assurance officer. All corrective actions will be implemented within the time specified by the audit report.

8.0 HEALTH AND SAFETY PROGRAM

8.1 INTRODUCTION

This Health and Safety program describes the policies and procedures that will be implemented and followed by IT personnel and subcontractors during the soil-gas survey, monitoring well installation, and subsurface exploration activities at the Reichhold site located in Ferndale, Michigan.

The health and safety guidelines for this project are based on the history of the site as well as the information previously gained from the Phases I and II investigations.

Activities conducted during this operation shall be performed to protect the health and safety of project personnel and the public. The following health and safety program includes general safe work practices, personnel protection program, respiratory protection program, health and safety training, medical surveillance, air quality monitoring, and decontamination procedures. The health and safety program also covers considerations for fire, explosion, and oxygen deficiency. Furthermore, details of emergency response procedures, first-aid/CPR capabilities, and fire control are included.

The specifications of this site-specific health and safety program shall meet the requirements of the Occupational Safety and Health Administration (OSHA), the U.S. EPA, and the health and safety policies and procedures of IT Corporation.

8.2 SITE CHARACTERIZATION AND HAZARD ASSESSMENT

A complete characterization and analysis have been performed at the site. The results of the site characterization are described below.

8.2.1 Chemical Hazards

Analytical data from the Phases I and II investigations indicate possibility of exposure to volatile organics. Those of concern are the following:

VOCs

Toluene
Ethylbenzene
Xylene
Trichloroethene

The Material Safety Data Sheets (MSDS) on any of the potential contaminants will be made available upon request.

8.2.2 Health Standards

Permissible Exposure Limits (PELs) and Threshold Limit Values (TLVs) refer to the airborne concentration of substances which represent conditions that nearly all employees may be repeatedly exposed to day after day without adverse effect. The TLVs are recommended guidelines prescribed by the American Conference of Governmental Industrial Hygienists (ACGIH) and the PELs are the standards enforced by OSHA. They are based upon the best available information from industrial experience, animal, and human studies. Because of the wide variation in individual susceptibility, a small percentage of workers may experience discomfort from some substances at concentrations below the recommended values. For good hygienic practices, the strictest guidelines shall be used for determining worker protection levels since this operation will involve exposure to a variety of chemicals.

8.2.3 Air Monitoring

Measurements of airborne contaminants will be conducted all over the work area and in the breathing zone. A combustible gas/oxygen indicator will be used to monitor for flammability. Exposure to VOCs shall be monitored with a photoionization detector such as an HNu meter. Chemical exposure monitoring shall be supplemented by use of Draeger colorimetric detector tubes.

Background reading shall be taken upwind of the work area. The monitoring shall be conducted at the beginning of every shift, at every change in work procedure, and continually throughout the job as often as is necessary. Flammability monitoring should always be the first step in the sequence of monitoring steps.

Action levels for area air monitoring are as follow:

- VOC - >5 ppm (based on benzene calibration)
- Oxygen - <20 percent
- Flammable Atmospheres - >10 percent of the lower explosion limit (based on propane calibration)

If action levels are equaled or exceeded, work will stop immediately and personnel will move upwind of the work area. The area will be allowed to vent for a minimum of five minutes. At the end of the five-minute waiting period, air quality measurements will be taken.

If the measured concentrations continue to exceed the action levels, the level of protection necessary for personnel will be reevaluated. Air purifying respirators or Level C protection will be required if VOC levels above 5 ppm are measured in the workers' breathing zone. In extreme cases, a particular operation may be delayed and restarted under new working health and safety guidelines or may be abandoned totally. Work will not be allowed at any time when oxygen and flammability conditions are above the action levels.

8.3 GENERAL WORK PRACTICES

Protective clothing and respiratory protective equipment will be used for various stages of the entire operation. The levels of protection are specified depending upon the degree of hazard as outlined in Section 8.4. All information regarding work to be performed, emergency procedures, and health and safety hazards will be reviewed before the work begins during a daily tailgate safety meeting. No work will be performed without completing these procedures.

Operators of trucks and heavy equipment used on site will be properly trained in the inspection and operation of such equipment. The site supervisor will be responsible to check the proficiency of the operator. One standby person will provide guidance to the equipment operator, using either two-way radios or universal hand signals. Perimeter barricades will be placed around equipment used in a fixed location. Audio and/or visual backup alarms will be utilized on all heavy equipment on site.

Only authorized personnel will be permitted in the work area. These authorized individuals must have successfully completed a medical examination and been properly trained in the use of respiratory protective equipment and specific health and safety hazards.

Several fire extinguishers will be on site. In the event of an emergency, these extinguishers will be ready for the workers' safety and protection. Smoking will not be permitted on the premises except in the support areas or other specified locations. Any employee not willing to comply with this procedure will be dismissed from the project immediately.

No unapproved electrical equipment for hazardous atmospheres will be permitted in areas where there exists a flammable atmosphere. All static ignition sources will be identified and eliminated by the use of bonding and grounding techniques.

At least one qualified person competent in both American Red Cross first-aid techniques and cardiopulmonary resuscitation (CPR) will be part of the team performing a specified task. A complete first-aid box will be readily available on site. If a serious injury occurs, the local hospital and ambulance will be summoned to evacuate the injured person.

MSDS will be obtained for every commercial chemical product used on site. This information will be made readily available to all employees upon request and stored in a central location. MSDS or applicable information will be available with regard to materials used in the soil collection, drilling, and decontamination process. All secondary containers of any commercial chemical products will be properly labeled to comply with the Federal OSHA Hazard Communication Standard (29CFR1910.1200).

8.3.1 Site Drilling

Site drilling will comply with the following rules:

- Before drilling, the existence and location of underground pipe, electrical equipment, and gas lines will be determined. This will be done, if possible, by contacting the appropriate utility company to mark the location of their lines. If the utility company cannot be utilized, an appropriate device, such as a flux-gate magnetometer, will be used to locate ferrometallic underground lines.

- Operations must be suspended and corrective action taken if the airborne flammable concentration reaches 10 percent of LEL in the immediate area (a one-foot radius) of the point of drilling.

8.3.2 Heavy Equipment Operation and Heavy Materials Handling Safety

The following procedures will be established for work around heavy equipment (drilling rigs, front and/backhoe loaders, etc.) and heavy materials:

- Hard hats are to be worn at all times on site. Other protective gear as specified in the health and safety plan is also applicable.

- Establish hand signal communication when verbal communication is difficult. Determine one person per work group to give hand signals to equipment operators.

- Be aware of footing at all times when transporting materials.
- All heavy equipment will have backup alarms of some type.
- Only qualified people are to operate heavy equipment.
- Use chains, hoists, straps, and any other equipment to safely aid in moving heavy materials. A minimum of a four-point suspension will be used to move these items.
- Use proper personal lifting techniques. Use your legs, not your back.
- Some of the materials to be utilized during this project may be extremely heavy. Make sure all precautions have been taken prior to moving. Let the equipment do the moving and not your body.
- Get help whenever you are in doubt about a material's weight. Always use the buddy system.
- Never walk directly in back of or to the side of heavy equipment without the operator's knowledge.
- Never use any equipment unless you are familiar with its operation.
- Be sure that no underground or overhead power lines, sewer lines, gas lines or telephone lines will present a hazard in the work area.

8.3.3 Regulated Areas

The work area will include three separate zones: an exclusion ("hot") zone, a contamination reduction zone, and a support zone.

The exclusion zone will include areas of suspected contamination. All employees will use proper personnel protective equipment when working in contaminated areas. The location of the exclusion zone will be demarcated by warning signs.

Decontamination will be performed in the contamination reduction zone which shall be contiguous to the exclusion zone. The decontamination zone will be established at the perimeter of the regulated area. Personnel entering or leaving the exclusion zone will pass through this area in order to prevent any cross contamination and for the purpose of accountability. Tools and any equipment or machinery will be decontaminated in a specified location. Personnel decontamination includes removal of protective outer garments and respiratory protection will be performed in the contamination reduction zone.

The support zone will consist of an area outside the contamination reduction zone. The support zone will be located to prevent employees from being exposed to any organic vapors or dust above environmental levels.

8.4 PERSONNEL PROTECTION PROGRAM

Equipment for personnel protection will be referenced to the potential contaminant, as stipulated by the health and safety representative. Guidelines will be adhered to pending evaluation of the site conditions. It will be the responsibility of the health and safety representative to specify the level of protection required for site work.

8.4.1 Levels of Protection

Three levels of protection may be required for this project. The final determination will be made by the health and safety representative for required level of protection based upon the hazards and conditions of the work site. The requirements for specific levels of protection are described below.

LEVEL B PROTECTION

This level of personal protection will be utilized by individuals when (1) the toxic nature of the material or anticipated airborne concentration of suspected contaminants may be greater than two times the OSHA

PELs, (2) when the HNu reading sustains a reading greater than 50 ppm above background, or (3) when the O_2 level on the MSA combustible gas indicator sustains a reading of less than 19.5 percent.

The following equipment will be used for Level B protection:

- Full-face, self-contained breathing apparatus or supplied air respirator which is NIOSH/MSHA approved
- Hooded, chemical resistant Saranex coated Tyvek® (outer)
- Unhooded, chemical resistant white Tyvek® (inner)
- Gloves (outer) - Chemical resistant Nitrile or PVC
- Gloves (inner) - Surgical latex
- Boots (outer) - Chemical resistant Neoprene with steel toes and shank; steel-sole inserts will be used where materials could puncture boots; disposable booties over steel-toed shoes for equipment operators
- Hard hat
- Hearing protection (if necessary)

LEVEL C PROTECTION

Level C protection will be required when the nature of the material and airborne concentration of suspected contaminants are known to be at or above the OSHA PEL or when the HNu readings are greater than 5 ppm.

The following equipment will be used for Level C protection:

- Full-face, air purifying respirators with organic vapor and acid gas cartridge in combination with high efficiency particulate filter (HEPA) which are NIOSH/MSHA approved; half-face respirators will be utilized if accompanied by chemical splash goggles and specified by the health and safety representative

- Hooded, chemical resistant Saranex coated Tyvek® (outer)
- Unhooded, chemical resistant white Tyvek® (inner)
- Gloves (outer) - Chemical resistant Nitrile or PVC
- Gloves (inner) - Latex surgical or PVC
- Boots (outer) - Chemical resistant Neoprene boots with steel toes
- Hard hat
- Emergency egress respiratory protection
- Hearing protection (if necessary)

LEVEL D PROTECTION

The minimal level of protection which will be required of project personnel at the site will be Level D. This level of protection shall be used for drilling of monitoring wells, geophysical surveys, and soil-gas surveys.

The following equipment will be used for Level D protection:

- Coveralls - Tyvek® or Saranex
- Boots/shoes - Steel-toed boots with chemical protection (latex booties), where necessary
- Safety glasses or goggles
- Hard hat
- Chemical resistant Nitrile or PVC protective gloves with surgical latex undergloves

B.4.2 Respiratory Protective Program

A comprehensive respiratory protection program has been established by IT. This program will be followed in all locations where use of such equipment could lessen the potential for adverse health effects to any

employee. The type of respiratory equipment will be continuously reevaluated based upon the current level of exposure.

As part of the respiratory training program, each employee will have been instructed in the following elements:

- Nature of the respiratory hazard on the work site
- Use and proper fitting of the respirator
- Cleaning, disinfecting, inspection, maintenance, and storage of the respirator
- Proper selection, capabilities, and their limitations

The respiratory protection training program will be conducted, documented, and recorded by the health and safety representative.

Respiratory equipment will be inspected, cleaned, and disinfected daily. An inspection of the respirator equipment will include the following:

- Examination of the head straps for breaks, loss of elasticity, broken or malfunctioning buckles, and other attachments.
- Examination of the facepiece for excessive dirt, cracks, tears, distortion, holes, or inflexibility.
- Examination of the exhalation and inhalation valves for any foreign material, cracks, tears, distortion in the valve. Additional checks will be made to inspect for proper insertion, defective valve covers, or improper installation.
- Examination of air purifying elements for incorrect cartridge, expired shelf-life of the cartridge, cracks or dents in the cartridge or cartridge holder.
- Examination of proper insertion of the cartridges into the facepiece and a check of the gaskets inside the cartridge holder.

- Examination of air cylinders for adequate air volume. Only Grade D air will be utilized for breathing air.

When Level C protection is required, respirator cartridges will be changed daily. This requirement may be modified by the health and safety representative, depending upon the ambient exposure to the air contaminants.

The safety custodian will maintain the respiratory equipment and perform the cleaning and disinfection process. If broken or malfunctioning parts are found during the cleaning process, these parts will be replaced or new respiratory equipment will be issued to the user. The respiratory equipment will be stored in an area protected from any mechanical damage, dust, heat, excessive moisture, or damage by chemical contact. The storage area for the respirators will be in a readily accessible location.

8.5 HEAT AND COLD STRESS

8.5.1 Heat Stress

One or more of the following control measures will be used to help control heat stress:

- Provision for adequate liquids to replace lost body fluids will be made. Replacement fluids can be a 0.1 percent salt water solution, commercial mixes such as Gatorade® or Quick Kick®, or a combination of these with fresh water.
- Establishment of a work regimen that will provide adequate rest periods for cooling down.
- Cooling devices such as vortex tubes or cooling vests can be worn beneath protective garments.
- All breaks are to be taken in a cool area.
- Emoloyees shall be informed of the importance of adequate rest, acclimation, and proper diet in the prevention of heat stress.

During periods of intense activity, the site health and safety representative will observe the workers for symptoms of heat stress, especially in areas where protective clothing is being worn. Symptoms may include fatigue; irritability; headache; faintness; weak, rapid pulse; shallow breathing; cold, clammy skin; profuse perspiration. Heat related problems are presented below:

- Heat Rash - This is caused by continual exposure to heat and humid air, and aggravated by chaffing clothes. Heat rash decreases a person's ability to tolerate heat as well as becoming an irritating nuisance.

- Heat Cramps - This is caused by profuse perspiration with inadequate water intake and chemical electrolyte imbalance. This results in muscle spasm and pain in the extremities and abdomen.

- Heat Exhaustion - Increased stress on various organs to meet increasing demands to cool the body will result in signs and symptoms including shallow breathing; pale, cool, moist skin; profuse sweating; dizziness and lassitude.

- Heat Stroke - This is the most severe form of heat stress which must be treated immediately by cooling the body, or death may result. Signs and symptoms include red, hot, dry skin; no perspiration; nausea; dizziness and confusion; strong, rapid pulse; and coma.

If symptoms of heat stress are observed, the following procedures will be implemented:

- Instruct victim to lie down in a cool, shaded area or air-conditioned room. Elevate feet.

- Massage legs toward heart.

- Give cold salt water (1/2 teaspoon to 1/2 glass of water) or cool, sweetened drink, especially iced tea and coffee, every 15 minutes until victim recovers.

- DO NOT let victim sit up, even after feeling recovered. Victim should rest for a while longer.

8.5.2 Cold Stress

Workers should be protected from exposure to extreme cold temperatures so that the body temperature does not fall below 36 degrees Celsius (98.6 degrees Fahrenheit). Lower body temperature may result in reduced mental alertness, in irrational decision making, or loss of consciousness.

When the air temperature is below 40 to 45 degrees Fahrenheit, workers shall have warm clothing, gloves and heavy socks, such as whole-body thermal underwear, wool socks, or insulated gloves and knit caps. If the clothing of the worker becomes wet on job site, an outer impermeable layer will be worn. When the worker's underclothing becomes wet, the worker will change into dry clothing. The following provisions will also be made:

- Hot liquids shall be provided in the break area, but the intake of coffee shall be limited because of the diuretic and circulatory effects.
- Workers observed shivering shall leave the cold area immediately.
- Workers shall wear multiple layers of clothing, with the thinner clothing next to the body and the heavier clothing on the outside.
- Overdressing that could lead to heat stress will be avoided.
- Work shall be arranged to avoid long periods of sitting still or standing.

Symptoms of cold stress may include shivering, numbness, low body temperature, drowsiness, and weakness.

Treatment for Cold Stress Includes the Following:

- Move victim into warm room as soon as possible
- Be alert for breathing difficulties; start rescue breathing techniques, if necessary

- Remove wet or frozen clothing; immediately rewarm victim by wrapping in blankets
- Give victim hot liquids to drink, only if conscious
- Follow treatment for frostbite
- Consult professional medical help, if required

8.6 DECONTAMINATION PROCEDURES

8.6.1 Personnel Decontamination

A decontamination zone will be established at the perimeter of the work area. At the end of each work period (before eating, drinking, smoking, or leaving the site), each person who has entered the work area will decontaminate by passing through the contamination reduction line. Soiled boots, hard hats, respirators, and other equipment will be inspected daily, and washed and scrubbed in a detergent/water solution. After cleaning, equipment will be rinsed thoroughly in water and allowed to dry on a clean surface. Each of the following stations will be entered and used as appropriate:

- Equipment/Tool Drop Station
- Boot Wash - Soiled boots will be washed in a tub containing a detergent solution
- Boot Rinse - Personnel will step into a tub containing rinse water after washing boots
- Glove Wash - Intact gloves will be wiped clean over a glove wash bucket containing detergent and water
- Glove Rinse - Washed gloves will be rinsed with water or wiped with a water-wet towel
- Used coveralls will be dropped into a bag-lined garbage can for disposal at an approved facility
- Spent disposable respirator cartridges will be dropped into a bag-lined garbage can

- Personnel may then exit the site through the access control point

If there is a rip or tear in the employee's protective clothing, the worker will remove the torn garment in the decontamination area and new protective clothing will be issued in order for the employee to return back to work. The same procedure will apply to defective respiratory equipment.

8.6.2 Equipment Decontamination

Any equipment used inside the work area will be considered contaminated and will be cleaned before leaving the work site. Decontamination of all large equipment will be performed on site (prior to personnel decontamination). Verification that all equipment has been properly decontaminated will be the responsibility of the site manager. All contaminated solvents generated from the cleaning operation will be collected and containerized for disposal.

8.6.3 Site Security

A controlled access to the regulated area will be established. Only authorized personnel shall be permitted to enter the regulated area. No one will enter the exclusion or the contamination reduction zones without appropriate authorization. Operations will be suspended until unauthorized individuals have left the site. The following procedure will be followed for individuals entering the work area:

- All persons entering the regulated area will be equipped with appropriate personnel protective devices.
- All persons entering the regulated area must be familiar with and abide by the health and safety program.
- All persons must have completed the necessary 40 hours of training for uncontrolled hazardous waste site operations and emergency response.

- All employees will sign in and out daily while performing duties on site. The record of all site entry personnel shall be monitored by the site manager.

8.7 MEDICAL SURVEILLANCE

All personnel on site will have completed a preplacement or periodic (annual) physical examination. The physical will comply with ITC PRO 9410.1. This examination has been designed to comply with all regulatory requirements.

Tests that are performed for employment physicals include the following:

- Medical and occupational history and past gastrointestinal, hematologic, renal cardio-vascular, reproductive, immunological and neurological problems, along with a history of respiratory disease and personal smoking habits
- Blood pressure measurements
- Complete blood count and differential to include hemoglobin and hemotocrit determinations, red cell indices, and smear of peripheral morphology
- Blood urea nitrogen and serum creatinine
- Urinalysis (dipstick and microscopic examination)
- Audiometric examination
- Pulmonary function test ($FEV_{1.0}$ and FVC)
- SMA-25 or equivalent liver function test
- EKG for employees over 45 years old or when other complications indicate the necessity
- Drug and alcohol screen

The IT Health and Safety Department maintains employee medical records in the Torrance, California office. These records are continually reviewed and updated. IT will maintain all medical records for a period of 30 years, and a copy of these records will be made available to any

employee for either review or copying upon request. In order to obtain a copy of the medical record, a written release order must be completed by the employee and submitted to the health and safety representative.

The medical surveillance provided to employees includes a judgment by the medical examiner of the ability of the employee to use either positive or negative pressure respiratory equipment. Any employee found to have a medical condition which could directly or indirectly be aggravated by exposure to chemical substances or by the use of respiratory equipment will not be employed for the project.

All part-time employees and all nonproject personnel visiting the site will be restricted unless evidence is presented that a medical examination covering all the above-mentioned tests have been conducted with satisfactory results.

8.8 TRAINING

The following training programs will be required for on-site personnel.

- Health and Safety Training - A 40-hour course that covers all topics required, in accordance with 29CFR1910.120.
- First Aid and CPR - At least one person shall have completed both the first aid and the cardiopulmonary resuscitation training.
- Site-Specific Safety Training - Instruction will be given in a tailgate safety meeting at the beginning of the project to acquaint personnel with project-specific health and safety requirements. This covers the specifics of this health and safety program.

Employees will have completed all of the training described, except the site-specific training, prior to entering the site.

Tailgate safety meetings will be conducted at the beginning of each work shift, or whenever new employees arrive on the job site. This meeting will discuss the health and safety considerations for that particular day's activities, and outline the protective equipment and other materials necessary to perform the work.

8.9 EMERGENCY RESPONSE PLAN

Emergencies must be dealt with in a manner to minimize the health and safety risk to all site personnel. Work activities will be conducted in groups of at least two workers (buddy system) to provide continuous monitoring in the event of an emergency. Emergency hand signals shall be covered in the tailgate safety meeting. A standby person will be dressed appropriately and ready to assist in the event of an emergency.

8.9.1 Project Team Responsibilities

In the event of an emergency, the chain of command will be the on-site health and safety representative, the site manager, and team members, in that order. Of those present on site at the time of emergency the person highest in the chain of command shall have the responsibility for directing the response activity in the event of an emergency. These responsibilities are described below:

- Assess the emergency situation and notify site security personnel
- Determine the required response measures by informing the site supervisor
- Notify the appropriate response teams of the specific action that will be taken upon request
- Determine and coordinate the on-site personnel actions for the particular emergency situation
- Contact and coordinate with any governmental or regulatory agency
- Contact the appropriate public response agency

- Contact contractor representative and Reichhold representative
- Complete the Supervisor Injury Report Form upon occurrence of the accident or incident and list on the OSHA Occupational Injury/Illness Form 200

8.9.2 Public Response Agencies

Before the start of the project, the health and safety representative will develop a list of public response agencies which may be contacted, depending on the nature of the emergency.

In the event of an emergency, an agency may assume authority for the emergency response. Personnel will be instructed to assist the agency in charge.

The list of contacts shall be posted at several prominent locations and local authorities shall be notified of our on-site activity and schedule prior to start of work.

8.10 WORKER INJURY AND RECORD KEEPING

If a person working in an area is physically injured, first-aid procedures will be followed. Depending upon the severity of the injury or illness, emergency medical response may be obtained accordingly. If the person can be moved, that individual will be taken to a location away from the work area where emergency first-aid treatment can be administered. The local emergency medical facility will be contacted along with an ambulance, if necessary.

The site manager will prepare a written report detailing the particular accident, its causes, and consequences within three days from the time of the accident.

If the injury to the worker is of a chemical nature, the following first-aid procedures will be instituted as soon as possible:

- Eye Exposure - If contaminated material gets into the eyes, the eyes will be flushed immediately at the eyewash station using copious amounts of water while lifting up the lower and upper eyelids.

- Skin Exposure - If contaminated material gets on the skin, the affected area will be washed with soap or mild detergent.

- Inhalation - If an individual inhales a volume of toxic or corrosive vapors, the employee will be removed to a breath space at once. If breathing has stopped, artificial respiration will be performed on the affected individual until medical attention can arrive on scene and transport the patient to the nearest medical facility.

- Ingestion - In the event a person ingests a toxic liquid or solid material, medical attention shall be obtained at once.

All exposure monitoring conducted during the project will be recorded with a description of the field activities. The recorded results and the methodologies will be kept for a period of at least 30 years. All logs and reports required by either local, state, and federal regulations will be kept and submitted accordingly.

9.0 REFERENCES

Santodanto, J., et al., 1978, Health Assessment Document for Polycyclic Organic Matter, Syracuse Research Center, Inc., Under Contract to U.S. EPA.

Shacklette, et al., 1971, "Elemental Composition of Surface Materials in the Conterminous United States," U.S. Geological Survey Professional Paper 574-D, U.S. Government Printing Office, Washington, D.C.

U.S. EPA, 1987, "Polychlorinated Biphenyls Spill Cleanup Policy; Final Rule," 40 CFR Part 761, 52 FR 10688, April 2, 1987.

Tables

O'BRIEN & GERE

TABLES

TABLE 1

SUMMARY TABLE
FIELD SAMPLING DATA
REICHHOLD CHEMICALS, INC.
DETROIT, MICHIGAN

AREA[a]	SAMPLE NO.[b]	SAMPLING POINT	LOCATION	HNU READING (ppm)	SAMPLE DEPTH (feet)	WATER TABLE (feet)[c]	SOIL DESCRIPTION	THICKNESS OF CONCRETE (inches)
1	SS1	1	Six feet north of "C" Building boiler room	60	0-0.5	0	Saturated/soupy fine black sands and silt	12 (in two layers)
		2	Three feet east of S.E. corner of old pilot building pad	0	2.0-2.5	0	Saturated/mucky black clay and silts (quicksand)	5
2	SS2	1	Five feet north of N.W. corner of "N" Building	5	4.0-4.5	4	Moist dark brown sand	6
		2	Middle of drive between "K" and "L" Buildings	1	4.0-4.5	4-5	Brown with black sand	8
		3	Two feet from N. edge of bay in "C" Dock	3.5	3.0-3.5	0	Soupy black silts and sands - oily odor	10 (in two layers)
3	SS3	1	Twenty feet N. of N.E. corner D Annex, eight feet E. of containment dike	15	4.0-4.5	1	Wet, light to dark brown sand	8
		2	Two feet S. of acid tank on S. side of "G" Building	0	4.0-4.5	>4	Moist, light brown sand	5

See footnotes at end of table.

INTERNATIONAL TECHNOLOGY CORPORATION

TABLE 1
(Continued)

AREA[a]	SAMPLE NO.[b]	SAMPLING POINT	LOCATION	HNU READING (ppm)	SAMPLE DEPTH (feet)	WATER TABLE (feet)[c]	SOIL DESCRIPTION	THICKNESS OF CONCRETE (inches)
4	SS4	1	Six feet W. of S.W. corner of "M" Building	3-4	7.0-7.5	4	Black and brown, coarse to fine sand with areas of gray	8.5
		2	Six feet from S.W. corner "L" Building	5-6	4.0-4.5	>4	Wet/soupy fine sands and silts	7
		3	Six feet E. of inert gas tank, three feet S. of "M" Building	0	4.0-4.5	>4	Moist dark sandy soil with lighter sands at four foot level	8
5	SS5	1	E. of N.E. corner "O" Building in middle of R/R track	0	N/A	>3	Wet black sand and gravel (no sample taken)	0
		2	Centered on "K" Dock between dock and R/R tracks	250	3.0-3.5	0.5	Wet dark sand with strong solvent odor	0
		3	By stairs at "C" Dock between dock and R/R tracks	60	N/A	3	Wet black sand and gravel slight odor (no sample taken)	0
6	SS6	1	Thirty feet W. of S.W. corner of "O" Building	20	3.0-3.5	>3	Moist dark sand	6
		2	Thirty feet S.W. of Sampling Point No. 1	200	3.0-3.5	>3	Muddy silt and sand light brown sand at three feet	6
7	SS7	1	Fifteen feet E. of Building "101", and twenty feet N. of N. end truck ramp	0	4.0-4.5	>4	Moist dark sandy soil	7
		2	In S.E. bay of "101" Building fifteen feet W. of S.W. corner of truck ramp	15	4.0-4.5	>4	Moist brown sand	6

See footnotes at end of table.

TABLE 1
(Continued)

AREA[a]	SAMPLE NO.[b]	SAMPLING POINT	LOCATION	HNU READING (ppm)	SAMPLE DEPTH (feet)	WATER TABLE (feet)[c]	SOIL DESCRIPTION	THICKNESS OF CONCRETE (inches)
8	SS8	1	Ten feet E. and centered on bulk fuel containment dike Building "105"	0	4.0-4.5	>4	Moist brown and gray sand	6.5
		2	Ten feet E. of containment dike in S.E. bay of "105" Building, fifteen feet W. of E. edge of Building	0	4.0-4.5	>4	Moist brown to black sand	8 (3" of asphalt)
9	SS9	1	N.E. bay of "104" Building, centered ten feet from E. side	0	4.0-4.5	>4	Wet black sand	10
		2	Five feet W. of E. side Building "104" S.E. bay in containment area	5	4.0-4.5	>4	Moist gray sand	8
		3	Three feet S.E. of end of N.E. wall Building "103"	0-1	6.0-6.5	4	Watery brown silt and sand quicksand below four feet	0
10	SS10	1	N. tank farm fifteen feet N. of S. wall, ten feet E. of S.E. tank	8	1.0-1.5	0-1	Wet black sand, diesel smell, oily sheen	6
		2	N. tank farm between tank and pump pads in N.W. corner	+400	3.0-3.5	3	Wet black sand, strong solvent odor	6
11	SS11	1	Centered on N. edge tank farm between R/R tracks	350	4.0-4.5	4	Wet gray sand	0
		2	Between R/R tracks and concrete W. of single blue tank by Building "105"	50	4.0-4.5	>4	Moist black sand	0
		3	Between R/R and old blue phenol tanks W. of Building "101"	0	4.0-4.5	>4	Moist black sand	0

See footnotes at end of table.

TABLE 1
(Continued)

AREA[a]	SAMPLE NO.[b]	SAMPLING POINT	LOCATION	HNU READING (ppm)	SAMPLE DEPTH (feet)	WATER TABLE (feet)[c]	SOIL DESCRIPTION	THICKNESS OF CONCRETE (inches)
12	SS12	1	Center truck loading area S. tank farm	300	4.0-4.5	>4	Oily moist black sand and silts	7
		2	Ten feet E. of stairs in S. tank farm containment area	200	2.0-2.5	2	Oily wet black sand and silts	0
13	SS13	1	Twenty feet E. of W. fence, one hundred feet N. of Building "206"	0	3.0-3.5	>3	Moist brown sand	5.5
		2	Fifty feet N. of sample point No. 1	0	3.0-3.5	>3	Moist stained brown sand	5.5
		3	Twenty five feet N. of sample point No. 2	1-2	3.0-3.5	>3	Moist dark stained brown sand	5.5
14	SS14	1	Twenty feet S. of R/R spur S. gate, two feet E. of Building "206"	0	N/A	>4	Clean/moist light brown sand (no sample taken)	0
		2	Twenty feet N. of Building "206", fifteen feet W. of ramp	5	2.0-2.5	1	Wet dark sands and silts, mothball smell	8
		3	Twenty feet N. of Building "106", five feet E. of personnel door	2-3	2.0-2.5	2	Wet dark sands and silts, mothball smell	8
15	SS15	1	East and centered on Building "203"/"204" dock, between dock and R/R tracks	0	2.0-2.5	>2	Moist black gravel and sand	0
		2	Twenty feet N. of S. end Building "203"/"204", between docks and R/R tracks	10	4.0-4.5	>4	Moist dark sand and gravel	0
		3	Two feet E. of Building "206", centered on N.E. loading bay door	0	4.0-4.5	>4	Moist brown gravel and sand	0

[a]For location of area, refer to Figure 2

[b]For location of soil sample, refer to Figures 3, 4, and 5

[c]Feet below g surface

TABLE 2

SUMMARY TABLE
CHEMICAL ANALYSIS
SOIL SAMPLES
REICHHOLD CHEMICALS, INC.
DETROIT, MICHIGAN
(mg/kg [ppm])

PARAMETER	CAL[a]	SS1[b]	SS2	SS3	SS4	SS5	SS6	SS7	SS8	SS9	SS10	SS11	SS12	SS13	SS14	SS15
								SAMPLE NO.								
Volatile Organics																
Methylene Chloride	47	0.20J	0.35J	0.41J	0.011B	0.77J	0.780J	0.009	0.005	0.26J	-	6J	0.578J	0.0058J	0.008B	0.008B
Acetone	1,700	0.360J	1.4B	-	0.017B	-	0.46BJ	0.068B	0.024B	0.38BJ	-	-	8.2B	0.023B	0.053B	0.052B
Trichloroethene	32	-	1	-	0.01B	-	33	-	-	-	-	-	9.3	0.002J	0.002J	0.009
Total Xylenes	34,000	17	3.8	8.8	0.016	3,600D	40	0.26	0.013	-	5,400B	150	430B	0.003J	0.034	0.004J
2-Butanone	850	0.2J	0.3J	0.17J	0.002J	-	-	0.004J	0.003J	-	-	-	1.3B	-	0.003JB	0.001JB
Ethylbenzene	1,700	1.6	-	1.6	0.005	-	7.5	0.25	-	3.9	70D	13D	9.50	0.008	0.02	-
Toluene	5,100	-	-	-	-	1.6	0.46J	1.5D	0.006	-	12J	-	5.2	0.001	0.05J	0.005J
4-Methyl-2-Pentanone	850	-	-	-	-	-	-	0.2	-	-	-	-	0.54BJ	-	0.005B	-
Styrene	3,400	-	-	-	-	-	-	-	-	-	-	390	-	0.001J	0.004J	-
1,2-Dichloroethene	3.8	-	-	-	-	-	-	-	-	-	-	-	0.2	-	-	-
Semivolatile Organics																
Fluorene	6,800	-	-	-	-	0.41J	-	-	-	-	-	3.9J	-	-	-	
Bis(2-Chloroethyl)Ether	0.32	-	-	-	-	-	-	-	-	-	-	0.89J	-	-	-	-
2-Methylnaphthalene	6,800	0.42J	-	-	-	-	-	-	-	-	-	6.1	-	-	2J	-
Di-N-Butylphthalate	1,700	3.5B	2.4B	1.5B	5.7B	0.62J	3B	4.8B	0.630J	0.38BJ	1.2BJ	4.90J	0.4BJ	-	0.338J	0.29BJ
Bis(2-Ethylhexyl)Phthalate	340	1.7B	0.089J	0.087J	1.3B	0.23J	0.99BJ	1.2BJ	1.1B	0.98BJ	1.5BJ	1.7BJ	1.6B	2B	3B	0.42BJ
4-Methylphenol	85B	-	-	-	-	1.9	-	-	-	-	-	-	-	-	-	-
Isophorone	85.37	-	-	-	-	0.89	-	-	-	-	-	-	-	-	-	-
Naphthalene	6,800	0.43J	-	-	-	1.9	-	-	0.12J	-	-	43	-	2	380D	0.62J
Acenaphthylene	6,800	-	-	-	-	0.19	-	-	-	-	-	-	-	-	-	-
Phenanthrene	6,800	0.13	-	-	-	1.6	-	-	-	-	-	15	-	-	0.33J	-
Fluoranthene	6,800	-	-	-	-	2.1	-	-	-	-	-	7	-	-	0.42J	-
Pyrene	6,800	-	-	-	-	1.2	-	-	-	-	-	17	-	-	0.37J	-
Benzo(a)Anthracene	7.06	-	-	-	-	0.45J	-	-	-	-	-	3.4J	-	-	0.25J	-
Chrysene	6,800	-	-	-	-	0.65J	-	-	-	-	-	3.3J	-	-	0.25J	-
Benzo(b)Fluoranthene	0.85	-	-	-	-	0.85J	-	-	-	-	-	1.5J	-	-	0.28J	-
Benzo(k)Fluoranthene	0.40	-	-	-	-	0.81J	-	-	-	-	-	-	-	-	-	0.23J
Benzo(a)Pyrene	0.03	-	-	-	-	-	-	-	-	-	-	1.2J	-	-	-	-
Dibenzofuran	7.08	-	-	-	-	0.30J	-	-	-	-	-	2.2J	-	-	-	-
Phenol	680	-	-	-	-	0.38J	-	-	-	-	-	-	-	-	-	-
N-Nitroso-di-n-propylamine	-	-	-	-	-	0.71J	-	-	-	-	-	-	-	-	-	-
Acenaphthene	6,800	-	-	-	-	0.30J	-	-	-			2.3J	-	-	-	-

See footnotes at end of table.

INTERNATIONAL TECHNOLOGY CORPORATION

TABLE 2
(Continued)

PARAMETER	CAL[a]	SS1[b]	SS2	SS3	SS4	SS5	SS6	SS7	SS8	SS9	SS10	SS11	SS12	SS13	SS14	SS15
								SAMPLE NO.								
Miscellaneous																
Oil and Grease	N/A[d]	710	190	670	610	1,700	2,100	960	1,100	850	2,600	11,000	670	420	1,000	540
Total Phenols	1,700	-	-	-	-	8	-	-	-	-	4.4	2.9	-	-	1.8	-
pH	N/A	7.52	8.45	8	7.52	7.62	8.48	7.29	7.75	8.03	8.77	7.29	11.14	8.6	8.58	8.07
Formaldehyde	N/A	-	7	8	-	3	-	-	-	-	-	-	-	3	-	2
Methanol	N/A	-	-	-	-	-	-	-	-	-	-	-	5	-	-	-
Lead	23.80	16	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	17	N/A	N/A	27	N/A
Mercury	3.4	-	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	0.3	N/A	N/A	0.1	N/A
PCBs	0.05	-	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	0.06	N/A	N/A	-	N/A

[a]Corrective Action Levels (CALs) from proposed rule for RCRA Corrective Action for Solid Waste Management Units at Hazardous Waste Management Facilities, Subpart S (U.S. EPA, 1987) and Draft RCRA Facility Investigation (RFI) Guidance Document (U.S. EPA, 1987), where data not available, health-based criteria are used.

[b]Sample locations are shown in Figures 3, 4, and 5.

[c]"-" indicates below detectable limits.

[d]N/A = Not applicable.

"J" indicates an estimated value less than the detection limit.

"B" indicates compound was found in the blank as well as the sample.

"D" indicates concentration based on a dilution.

TABLE 3

ENVIRONMENTAL ASSESSMENT
ANALYTICAL PARAMETERS
REICHHOLD CHEMICALS, INC.
FERNDALE, MICHIGAN

SAMPLE MATRIX	ANALYTICAL PARAMETERS	NUMBER OF SAMPLES	ANALYTICAL METHODS
Ground Water	Volatile organic compounds Semivolatile organic compounds Total Petroleum Hydrocarbons Oil and grease	Phase I: 4 Phase II: 6 to 8 (depending on results of soil-gas survey)	8240[a] 8270[a] 418.1[b] 413.1[b]
Soil:			
West Section	Volatile organic compounds Base/neutral compounds[b] Total Petroleum Hydrocarbons Oil and grease	To be determined based on results of soil-gas survey	8240 8270 418.1 413.1
East Section	Volatile organic compounds Base/neutral compounds[c] Total Petroleum Hydrocarbons Oil and grease	To be determined based on results of soil-gas survey	8240 8270 418.1 413.1
South Section	Volatile organic compounds Total Petroleum Hydrocarbons Oil and grease	7	8240 418.1 413.1

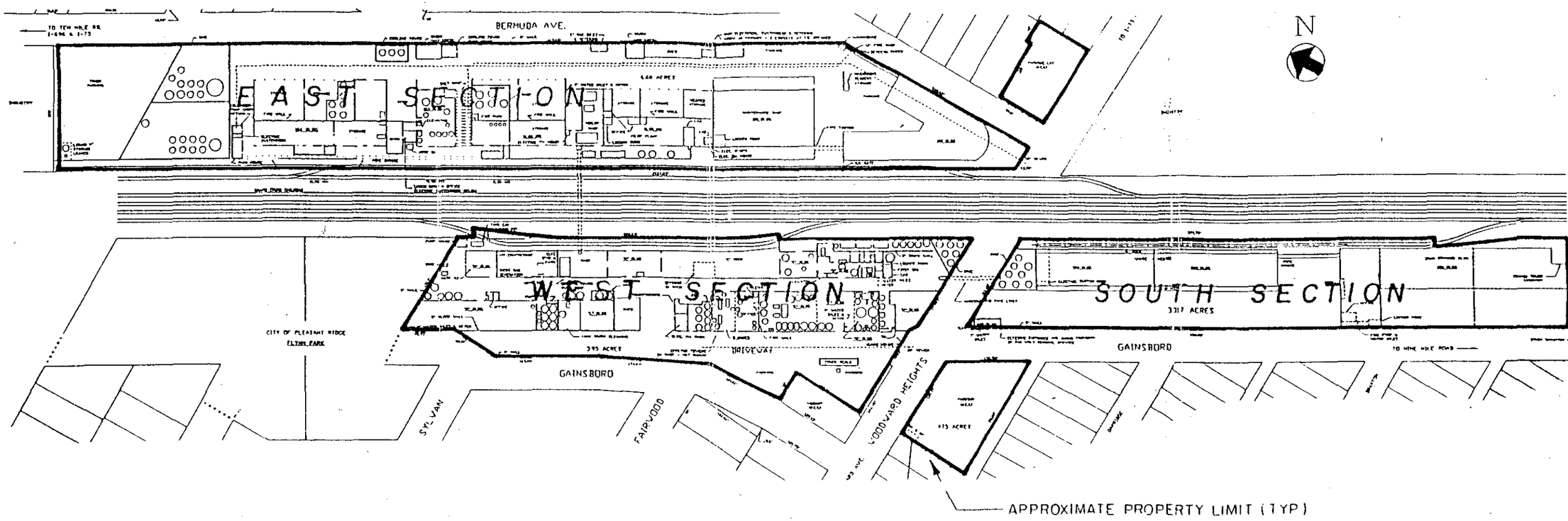
[a]U.S. EPA, 1986, "Test Methods for Evaluating Solid Waste, Physical Chemical Methods," U.S. EPA SW-846, 3rd revised ed.

[b]U.S.EPA, 1983, "Methods for Chemical Analysis of Water and Waste," EPA-600/4-79-20.

Figures

O'BRIEN & GERE

FIGURES



PLAN

APPROXIMATE SCALE

0 150 300 FEET

FIGURE 1

PLANT LAYOUT
REICHHOLD CHEMICAL, INC.
FERNDALE, MICHIGAN

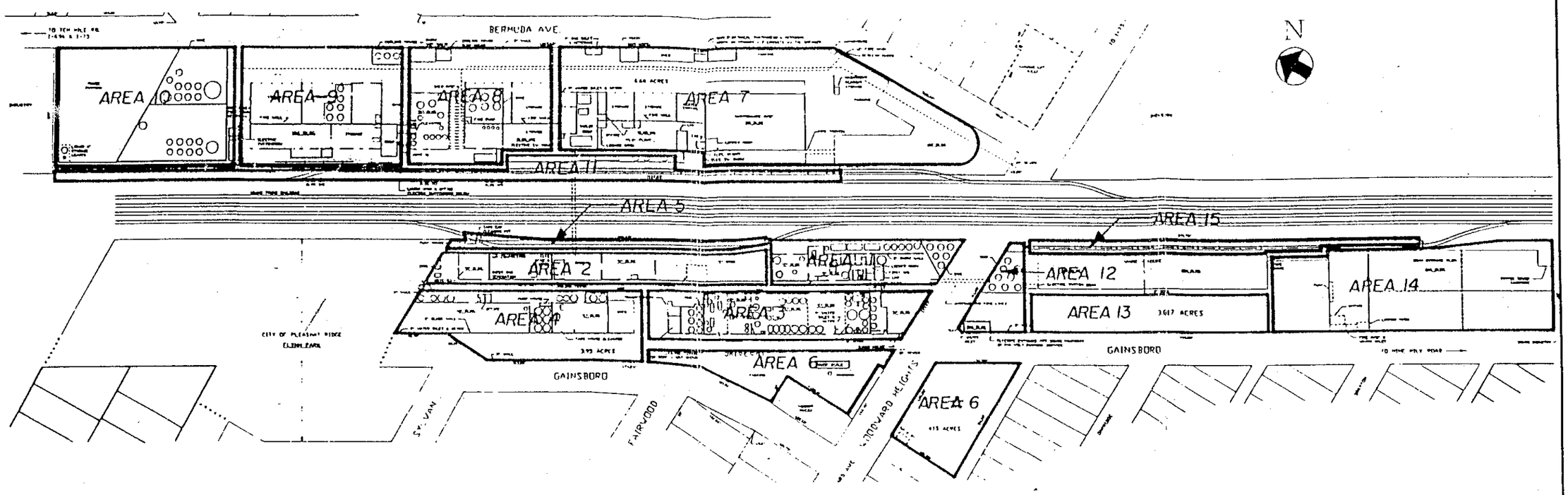
PREPARED FOR

REICHHOLD CHEMICAL, INC.
WHITE PLAINS, NEW YORK

INTERNATIONAL TECHNOLOGY CORPORATION

REFERENCE:
PLOT PLAN DETROIT PLANT DWG NO TP-1
FERNDALE, MICHIGAN
SCALE 1" = 75', DATED JUNE 7, 1988.

DES	2-23-88	
SET	7/28/89	303702-B4
LAD	9/2/89	



AREA NO.	DESCRIPTION
1	OLD PILOT BUILDING; B & C BUILDINGS, STORAGE TANK AREAS
2	H, G, F, E, D BUILDINGS, D ANNEX & STORAGE TANK AREAS
3	C & K DOCK; K, O, & N BUILDINGS
4	L & M BUILDINGS
5	WEST RAILROAD SPUR
6	WEST PARKING AREAS
7	100, 101, 102 BUILDINGS & BOILER ROOM
8	105 & 103 BUILDINGS
9	104 BUILDING
10	NORTH TANK FARM AND PARKING AREA
11	EASTERN RAILROAD SPUR
12	SOUTHERN AREA TANK FARM
13	PAVED DRIVE AREA
14	SOUTHERN STORAGE AREA
15	SOUTHERN RAILROAD SPUR

REFERENCE:
PLOT PLAN DETROIT PLANT DWG. NO. TP-1, FERNDALE, MICHIGAN.
SCALE: 1" = 75', DATED JUNE 7, 1988.

APPROXIMATE SCALE
0 150 300 FEET

FIGURE 2

PLANT OPERATION AREAS
REICHHOLD CHEMICAL, INC.
FERNDALE, MICHIGAN

PREPARED FOR

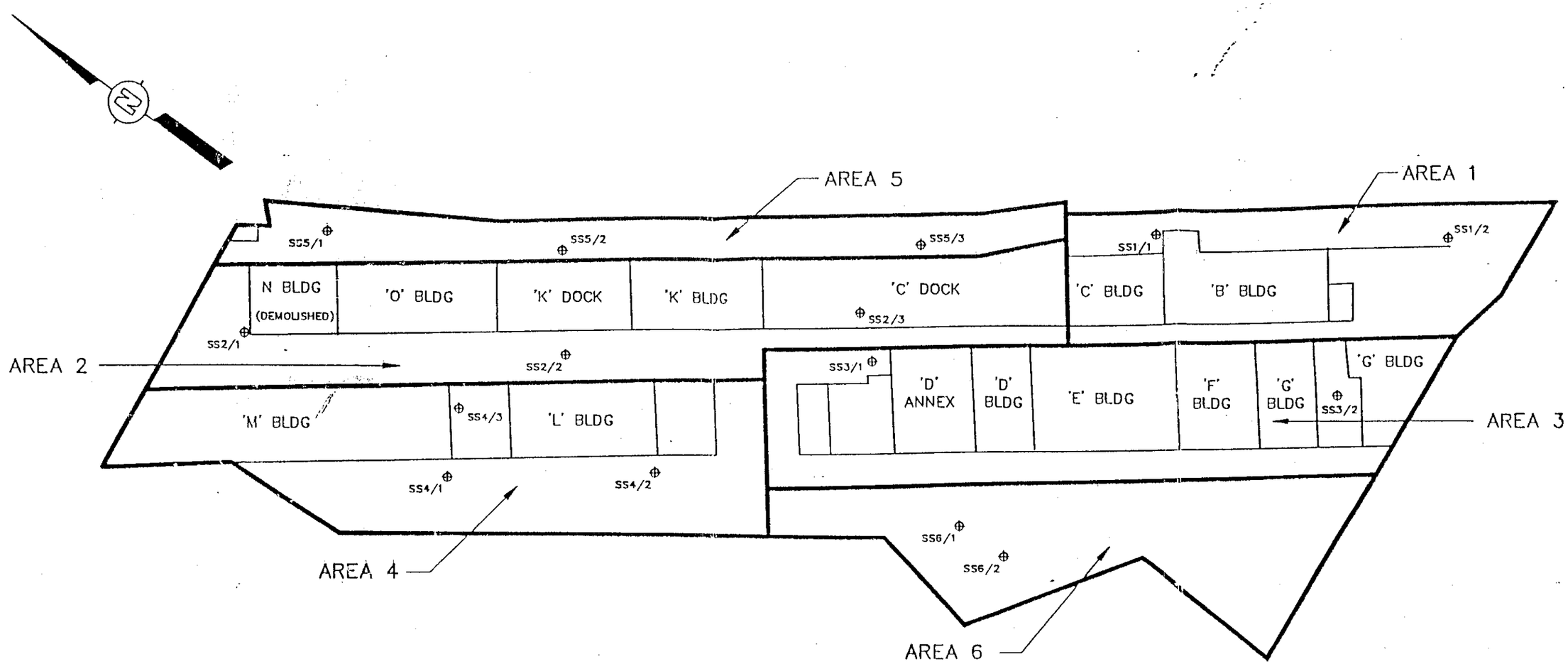
REICHHOLD CHEMICAL, INC.
WHITE PLANS, NEW YORK

INTERNATIONAL TECHNOLOGY CORPORATION

© 1984 IT CORPORATION
ALL COPYRIGHTS RESERVED

Do Not Scale This Drawing

DRAWN BY D.E.S 2-24-88
CHECKED BY SET 9-23-89
APPROVED BY CJA 9-28-89
DRAWING NUMBER 303702-B5



LEGEND:

⊕ SAMPLING LOCATION

SS1/3 SAMPLE NUMBER/SAMPLING LOCATION NUMBER

FIGURE 3

SAMPLING LOCATIONS
WEST SECTION
REICHHOLD CHEMICAL, INC.
FERNDALE, MICHIGAN

PREPARED FOR

REICHHOLD CHEMICAL, INC.
WHITE PLAINS, NEW YORK

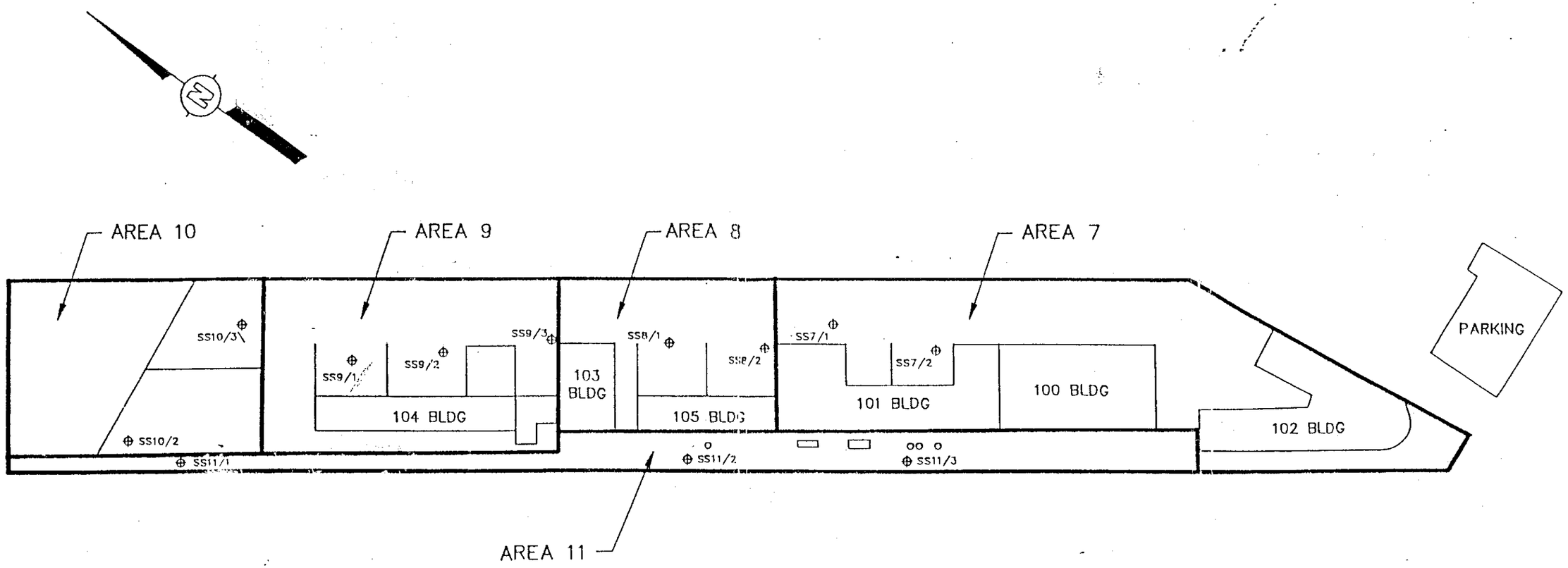
INTERNATIONAL TECHNOLOGY CORPORATION

DRAWN BY	KME 6-30-89	CHECKED BY	APPROVED BY	DRAWING NUMBER 303702-B1

132298

© 1984 IT CORPORATION
ALL COPYRIGHTS RESERVED
"Do Not Scale This Drawing"

DRAWN BY	KME	CHECKED BY		DRAWING NUMBER
	6-30-89	APPROVED BY		303702-B2



PLAN

APPROXIMATE SCALE

0 100 200 FEET

LEGEND:

⊕ SAMPLING LOCATION

SS1/3 SAMPLE NUMBER/SAMPLING LOCATION NUMBER

FIGURE 4

SAMPLING LOCATIONS
EAST SECTION
REICHHOLD CHEMICAL, INC.
FERNDALE, MICHIGAN

PREPARED FOR

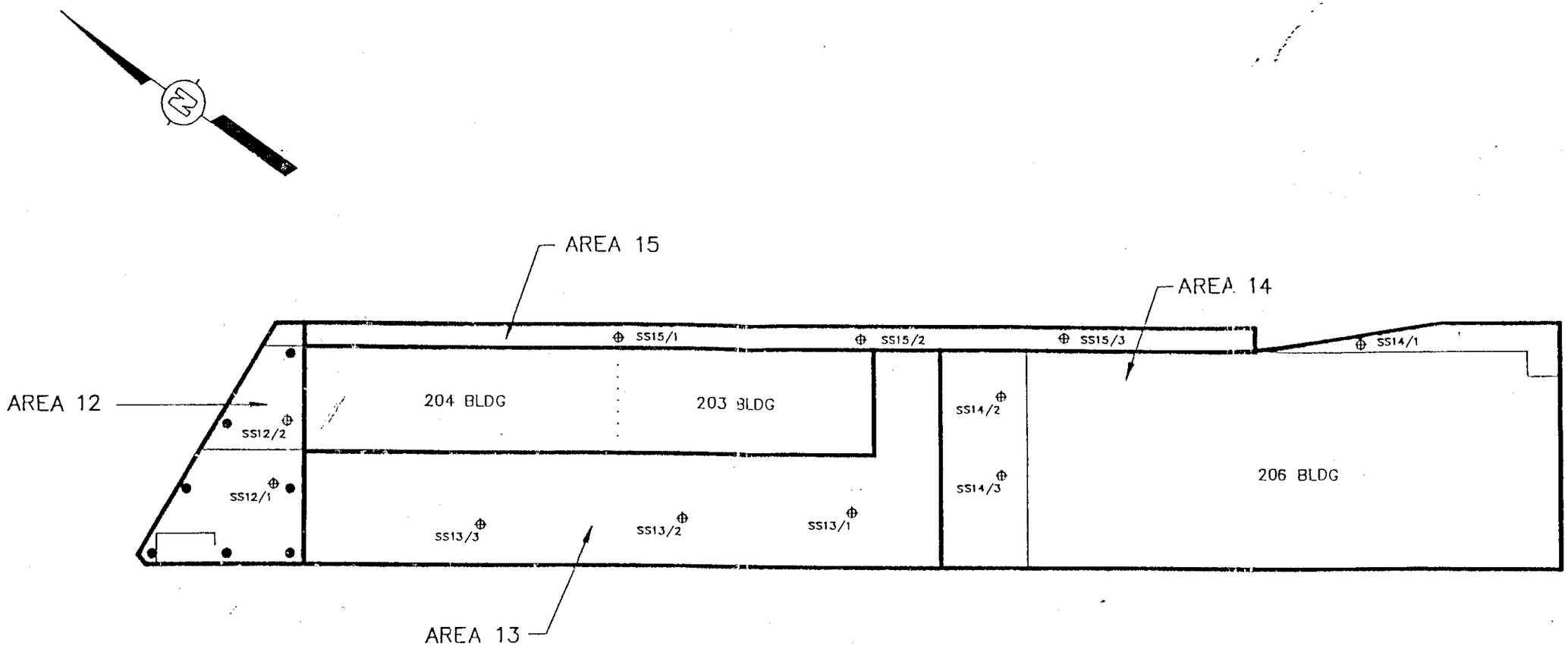
REICHHOLD CHEMICAL, INC.
WHITE PLAINS, NEW YORK

INTERNATIONAL TECHNOLOGY CORPORATION

132298

© 1984 IT CORPORATION
ALL COPYRIGHTS RESERVED

"Do Not Scale This Drawing"



APPROXIATE SCALE

0 100 200 FEET

LEGEND:

⊕ INITIAL SITE CHARACTERIZATION SOIL SAMPLING LOCATION

SS1/3 SAMPLE NUMBER/SAMPLING LOCATION NUMBER

● PROPOSED SOIL SAMPLING LOCATION

FIGURE 5

SAMPLING LOCATIONS
SOUTH SECTION
REICHHOLD CHEMICAL, INC.
FERNDALE, MICHIGAN

PREPARED FOR

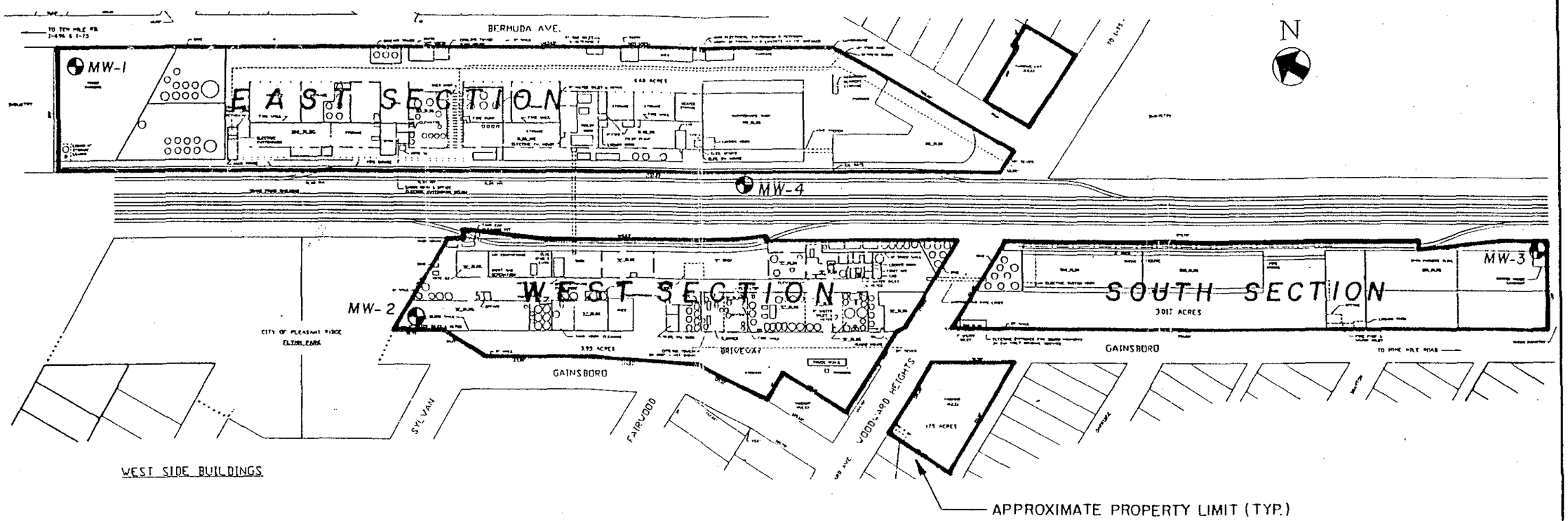
REICHHOLD CHEMICAL, INC.
WHITE PLAINS, NEW YORK

INTERNATIONAL TECHNOLOGY CORPORATION

DRAWN BY KME 6-30-89 | CHECKED BY SET 8/2/89 | APPROVED BY [illegible] | DRAWING NUMBER 303702-B3

132298

© 1984 IT CORPORATION
ALL COPYRIGHTS RESERVED
"Do Not Scale This Drawing"



LEGEND:

PROPOSED MONITORING WELL LOCATION

PLAN

APPROXIMATE SCALE

0 150 300 FEET

FIGURE 6

PROPOSED MONITORING WELL LOCATIONS
REICHHOLD CHEMICAL, INC.
FERNDALE, MICHIGAN

PREPARED FOR

REICHHOLD CHEMICAL, INC.
WHITE PLAINS, NEW YORK

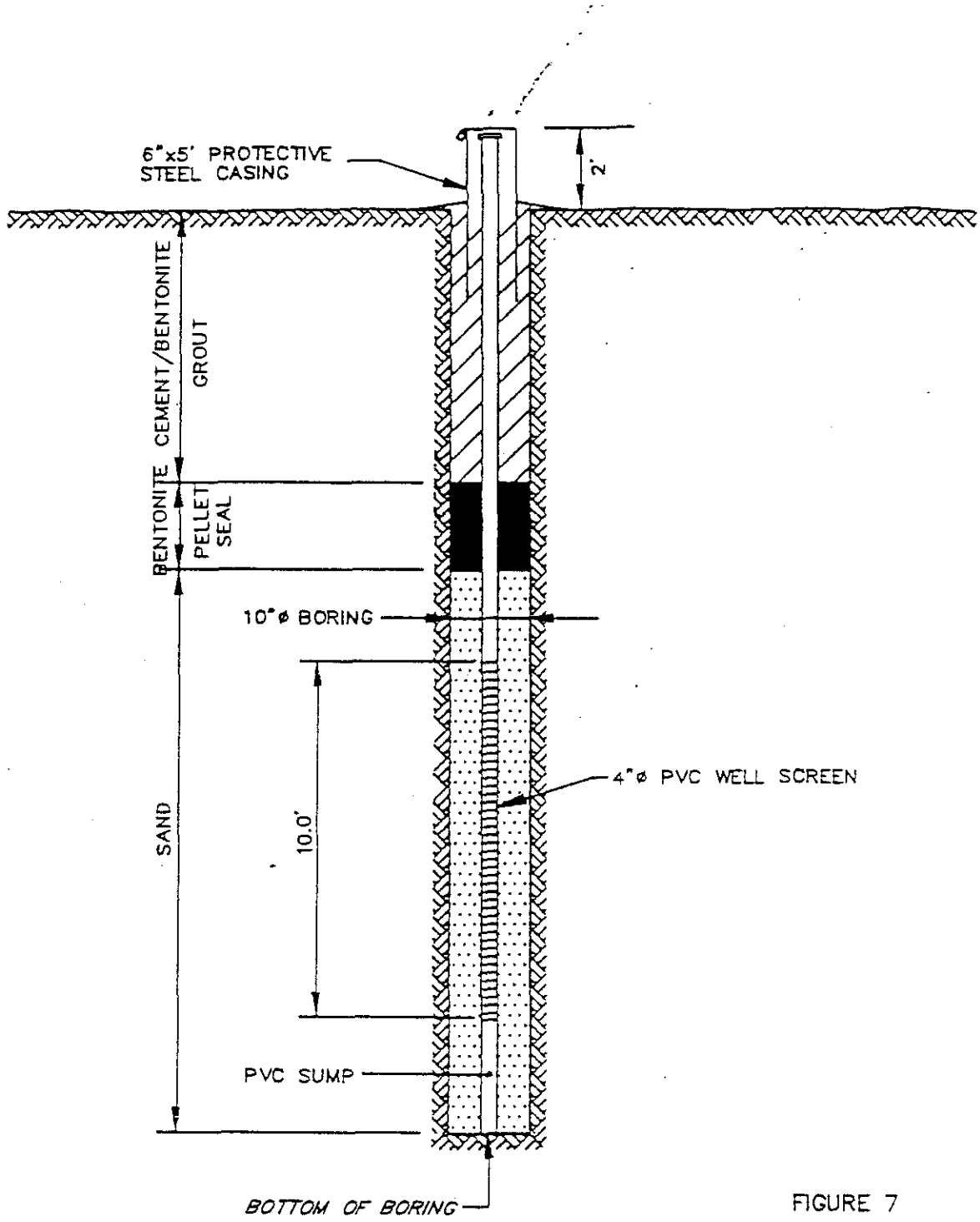
INTERNATIONAL TECHNOLOGY CORPORATION

REFERENCE:
PLOT PLAN DETROIT PLANT DWG. NO. TP-1
FERNDALE, MICHIGAN.
SCALE: 1" = 75', DATED JUNE 7, 1988.

© 1984 IT CORPORATION
ALL COPYRIGHTS RESERVED

Do Not Scale This Drawing

DRAWN BY D.E.S. 2-23-88 | CHECKED BY 7/28/89 | APPROVED BY 9/7/89 | DRAWING NUMBER 303702-B6



NOTES:

1. RISER PIPE IS 4 IN. I.D. SCHEDULE 40 PVC PIPE, THREADED, FLUSH-JOINTED.
2. SCREEN IS 4 IN I.D. PVC PIPE CONTINUOUS SLOT SCREEN (0.010 IN. SLOT SIZE).
3. LOWER END OF SCREEN IS CAPPED.

FIGURE 7

MONITORING WELL INSTALLATION DIAGRAM

REICHHOLD CHEMICAL, INC.
FERNDALE, MICHIGAN

PREPARED FOR

REICHHOLD CHEMICALS, INC.
WHITE PLAINS, NEW YORK

INTERNATIONAL TECHNOLOGY CORPORATION

"NOT TO SCALE"

© 1984 IT CORPORATION
ALL COPYRIGHTS RESERVED

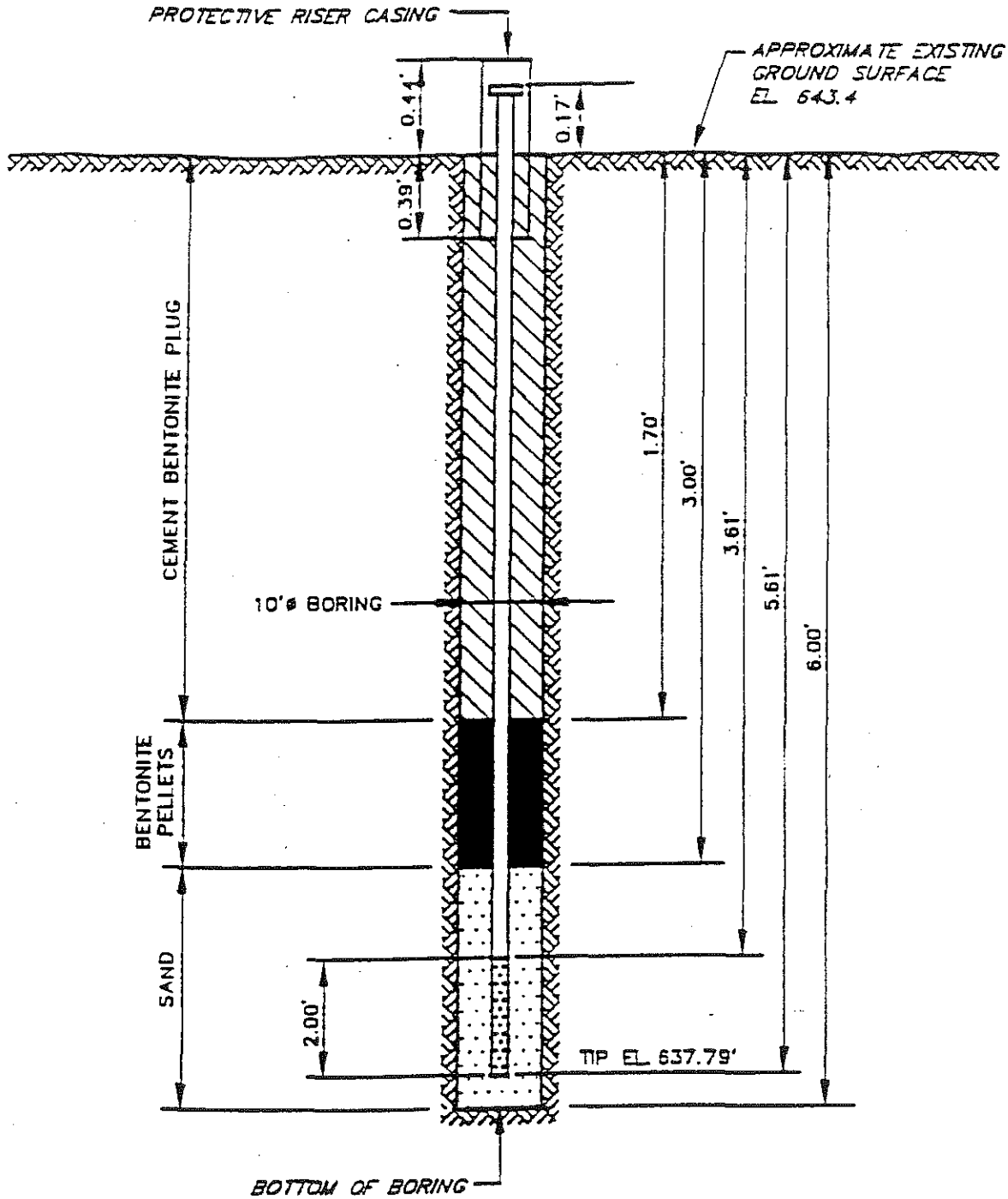
"Do Not Scale This Drawing"

DRAWN BY B. KUMPF 21APR89
CHECKED BY SGT 7/29/89
APPROVED BY LJD 9/2/89
DRAWING NUMBER 303. -A1

65380

ATTACHMENT 2

DRAWN BY	R. Walble	CHECKED BY		DRAWING NUMBER	303702-A2
	11-7-89	APPROVED BY			



NOTES:

1. RISER PIPE IS 4 IN. I.D. SCHEDULE 40 PVC PIPE, THREADED, FLUSH-JOINTED.
2. SCREEN IS 4 IN I.D. PVC PIPE CONTINUOUS SLOT SCREEN (0.010 IN. SLOT SIZE).
3. LOWER END OF SCREEN IS CAPPED.
4. ELEVATION OF WATER LEVEL 639.0'.
5. WATER LEVEL READING ON 10-9-89.

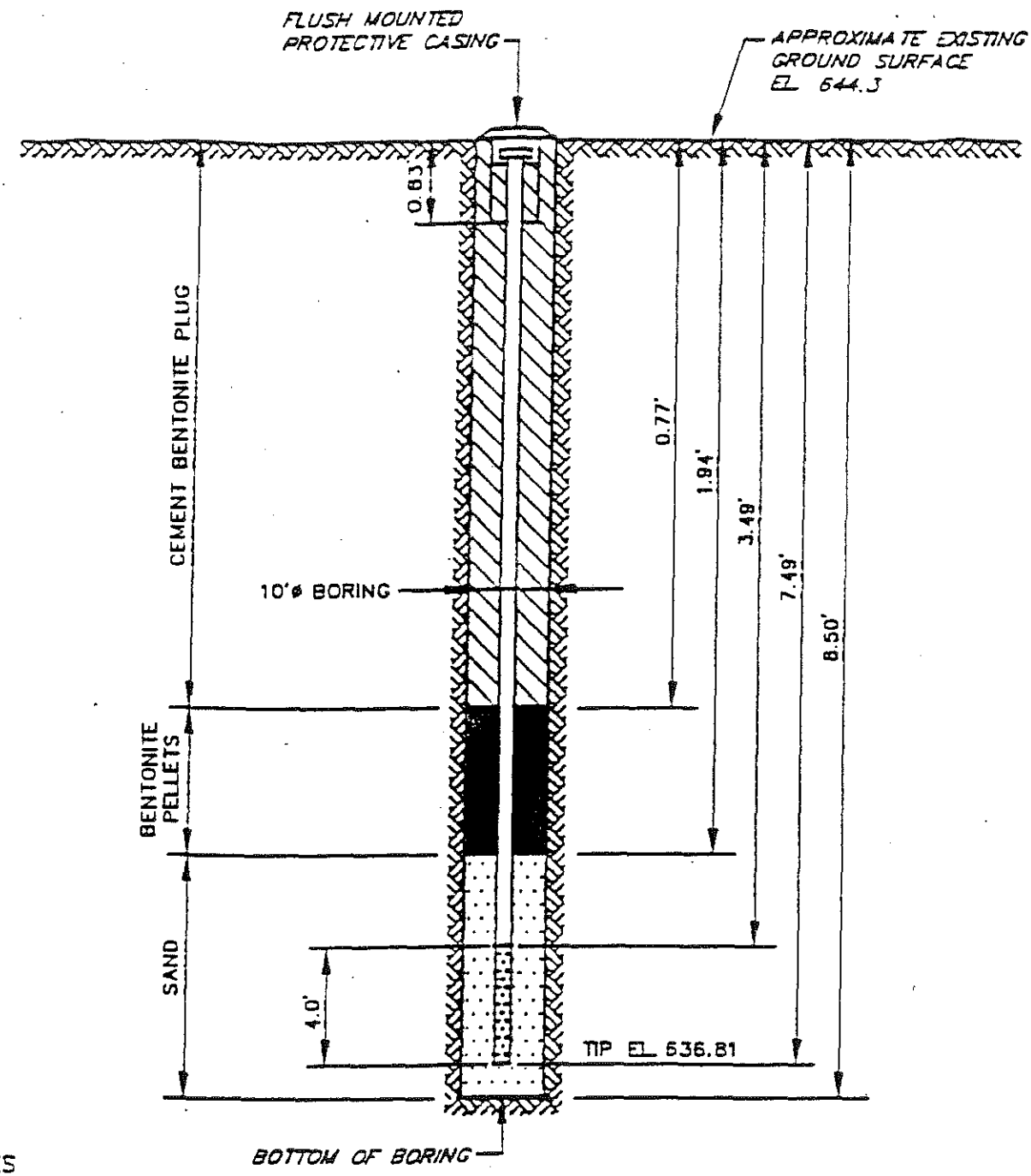
INSTALLATION DETAILS
MONITORING WELL MW-1

PREPARED FOR

REICHHOLD CHEMICALS INC.
WHITE PLAINS, NEW YORK

INTERNATIONAL TECHNOLOGY

DRAWN BY	CHECKED BY	DRAWING NUMBER
R. Kelly 11-7-89	APPROVED BY	303702-A3



NOTES

1. RISER PIPE IS 4 IN. I.D. SCHEDULE 40 PVC PIPE. THREADED, FLUSH-JOINTED.
2. SCREEN IS 4 IN I.D. PVC PIPE CONTINUOUS SLOT SCREEN (0.010 IN. SLOT SIZE).
3. LOWER END OF SCREEN IS CAPPED.
4. TOP OF RISER PIPE IS 0.44 FEET BELOW THE GROUND SURFACE.
5. ELEVATION OF WATER LEVEL 640.2.
6. WATER LEVEL READING ON 10-9-89.

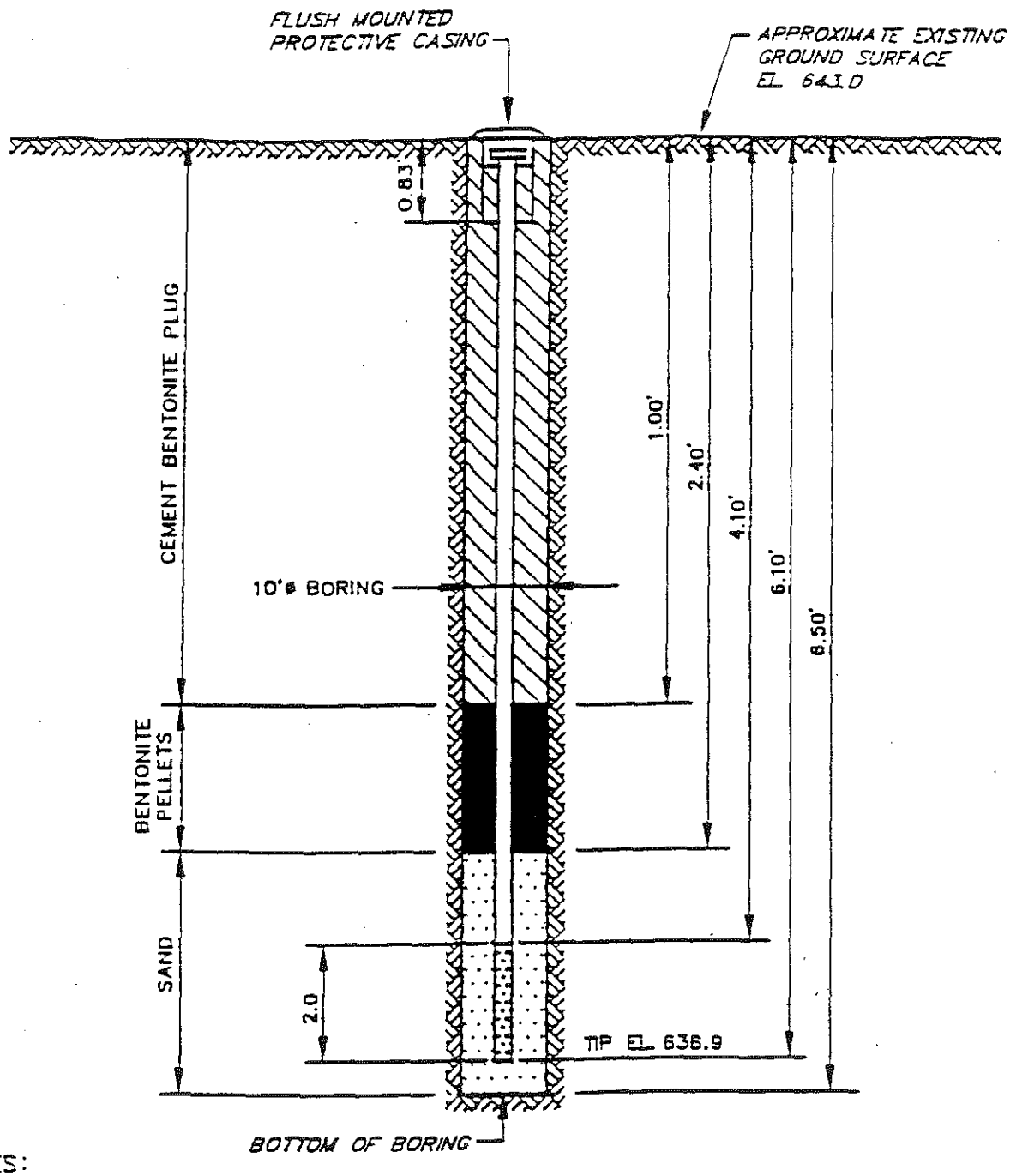
INSTALLATION DETAILS
MONITORING WELL MW-2

PREPARED FOR

REICHHOLD CHEMICALS INC.
WHITE PLAINS, NEW YORK

INTERNATIONAL TECHNOLOGY CORPORATION

© 1984 IT CORPORATION



NOTES:

1. RISER PIPE IS 4 IN. I.D. SCHEDULE 40 PVC PIPE, THREADED, FLUSH-JOINTED.
2. SCREEN IS 4 IN I.D. PVC PIPE CONTINUOUS SLOT SCREEN (0.010 IN. SLOT SIZE).
3. LOWER END OF SCREEN IS CAPPED.
4. TOP OF RISER PIPE IS 0.30' BELOW THE GROUND SURFACE.
5. ELEVATION OF WATER LEVEL 640.2.
6. WATER LEVEL READING ON 10-9-89.

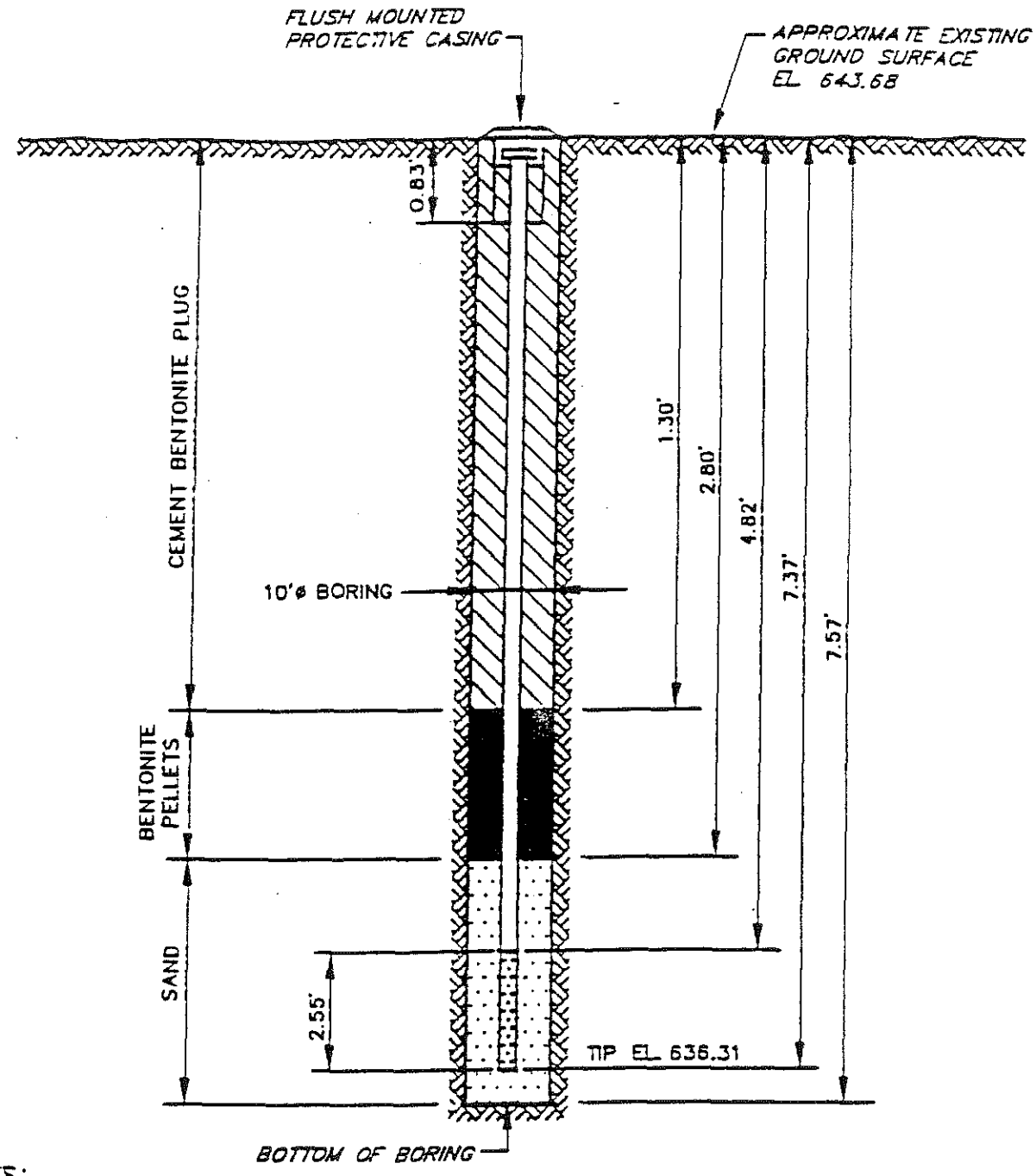
INSTALLATION DETAILS
MONITORING WELL MW-3

PREPARED FOR

REICHHOLD CHEMICALS INC.
WHITE PLAINS, NEW YORK

INTERNATIONAL TECHNOLOGY

DRAWN BY	R. Weible	CHECKED BY		DRAWING NUMBER	303702-A4
	11-7-89	APPROVED BY			



NOTES:

1. RISER PIPE IS 4 IN. I.D. SCHEDULE 40 PVC PIPE, THREADED, FLUSH-JOINTED.
2. SCREEN IS 4 IN I.D. PVC PIPE CONTINUOUS SLOT SCREEN (0.010 IN. SLOT SIZE).
3. LOWER END OF SCREEN IS CAPPED.
4. TOP OF RISER PIPE IS 0.38' BELOW THE GROUND SURFACE.
5. ELEVATION OF WATER LEVEL 641.8.
6. WATER LEVEL READING ON 10-9-89.

INSTALLATION DETAILS
MONITORING WELL MW-4

PREPARED FOR

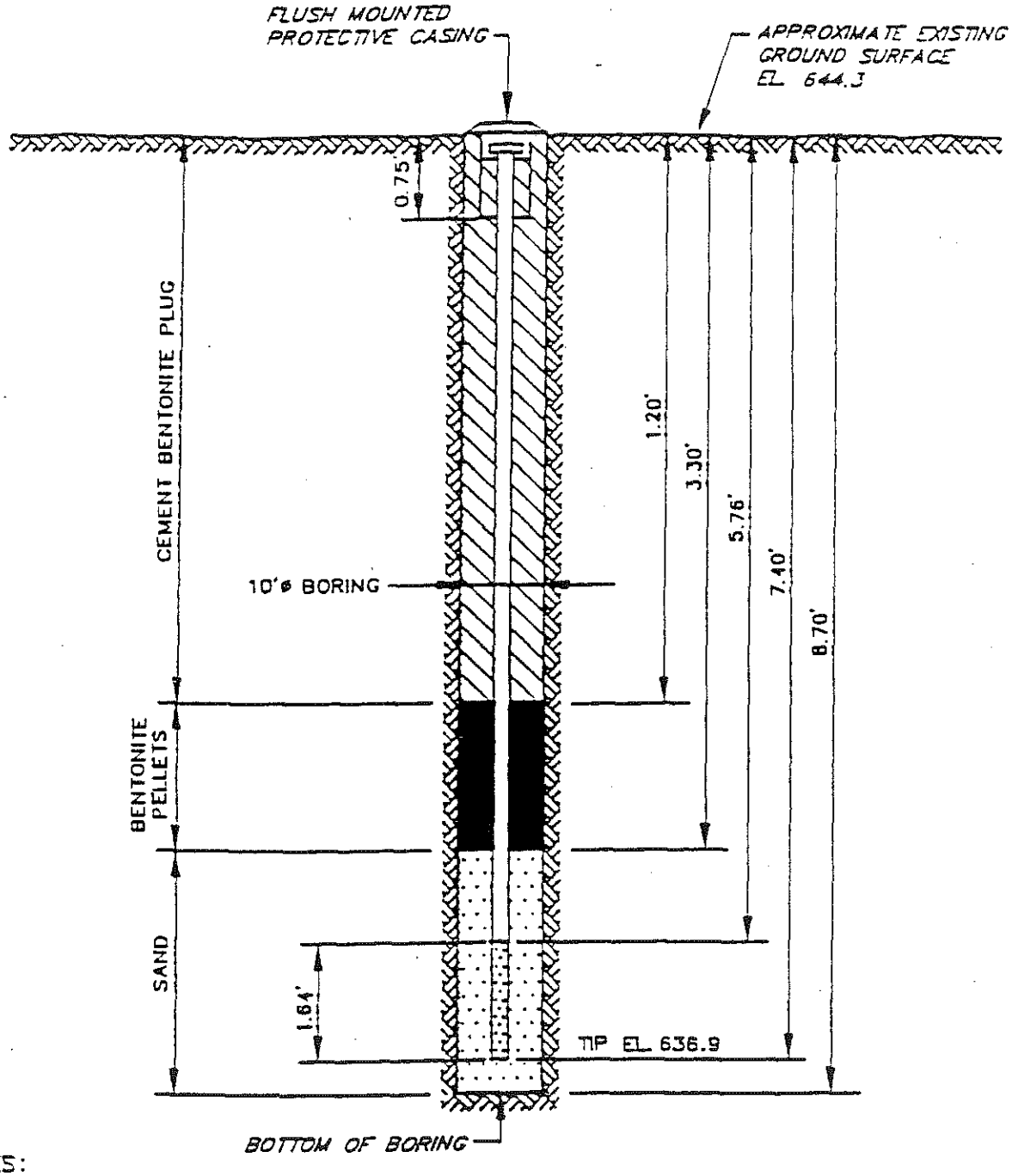
REICHHOLD CHEMICALS INC.
WHITE PLAINS, NEW YORK

INTERNATIONAL TECHNOLOGY CORPORATION

DRAWN BY R. Walble 11-7-89
CHECKED BY
APPROVED BY
DRAWING NUMBER 303702-A5

© 1984 IT CORPORATION

DRAWN BY	R. Weible 11-7-89	CHECKED BY	[illegible]	11-20-89	DRAWING NUMBER	303702-A6
		APPROVED BY	[illegible]	11-20-89		



NOTES:

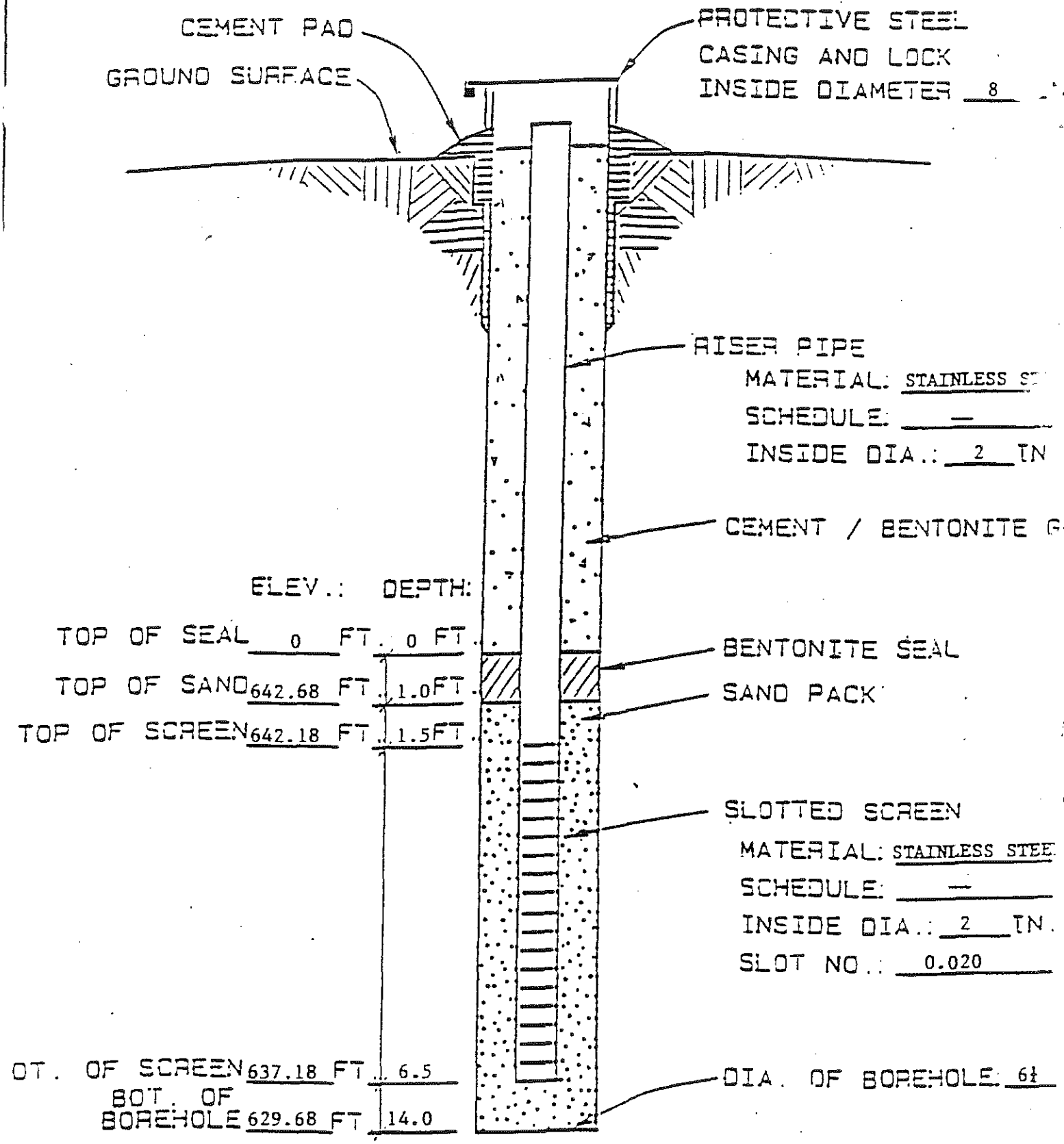
1. RISER PIPE IS 4 IN. I.D. SCHEDULE 40 PVC PIPE, THREADED, FLUSH-JOINTED.
2. SCREEN IS 4 IN I.D. PVC PIPE CONTINUOUS SLOT SCREEN (0.010 IN. SLOT SIZE).
3. LOWER END OF SCREEN IS CAPPED.
4. TOP OF RISER PIPE IS 0.16' BELOW THE GROUND SURFACE.
5. ELEVATION OF WATER LEVEL 640.5.
6. WATER LEVEL READING ON 10-9-89.

INSTALLATION DETAILS
MONITORING WELL MW-5

PREPARED FOR

REICHHOLD CHEMICALS INC.
WHITE PLAINS, NEW YORK

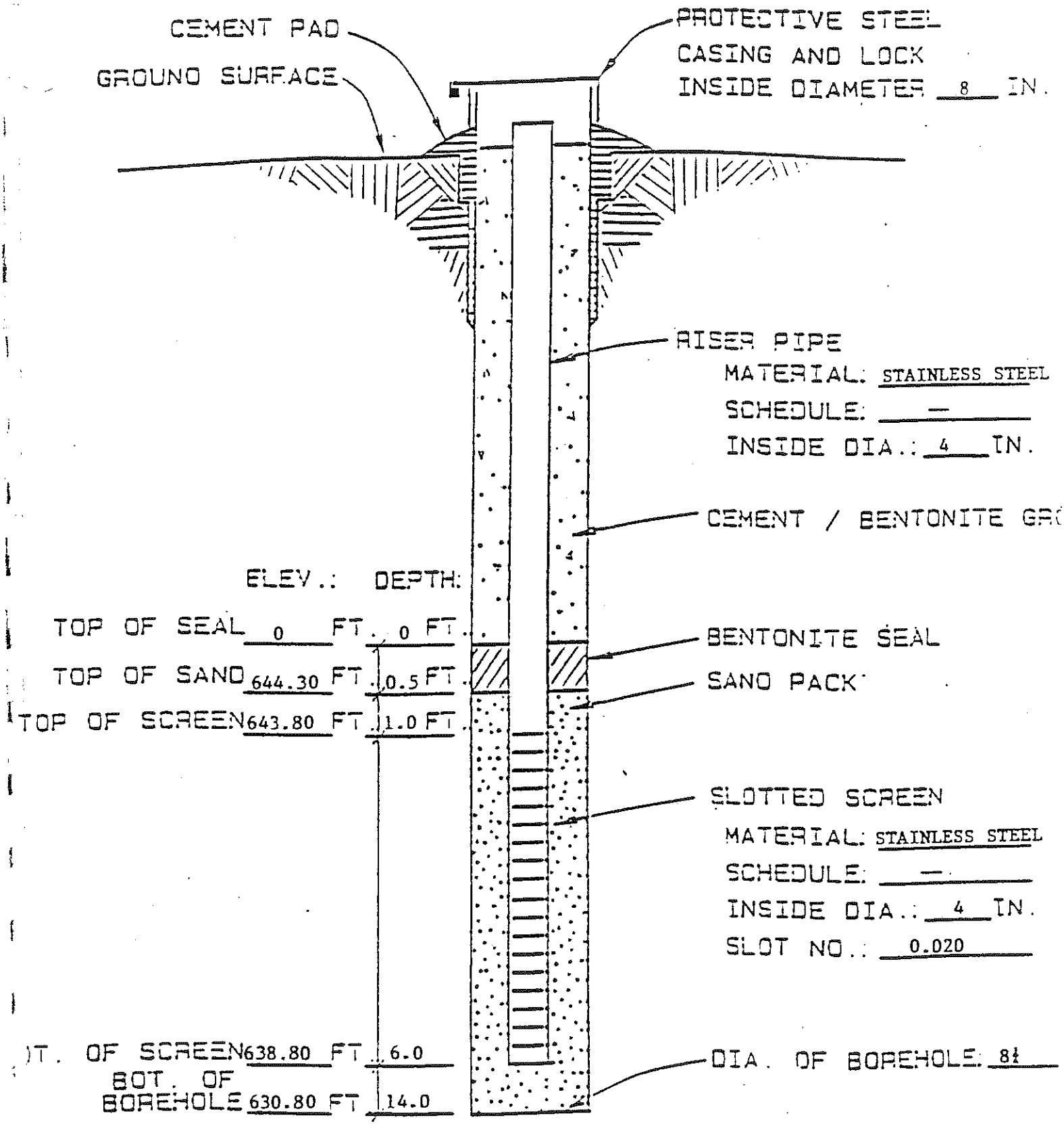
INTERNATIONAL TECHNOLOGY



Reichhold Chemicals, Inc.
Ferndale, MI

TYPICAL OVERBURDEN MONITORING WELL

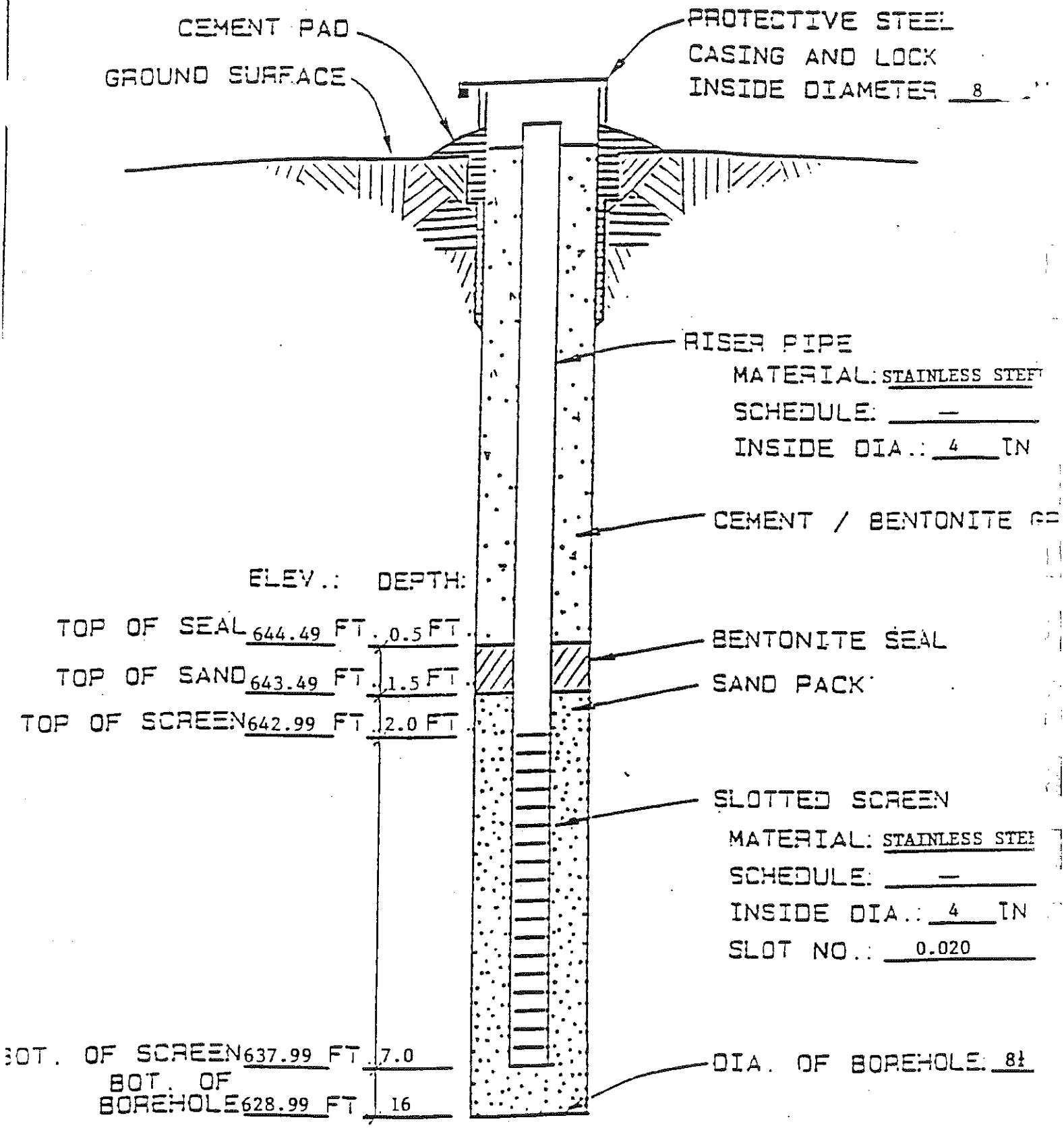
N.T.S.



Reichhold Chemicals, Inc.
Ferndale, MI

TYPICAL OVERBURDEN MONITORING WELL

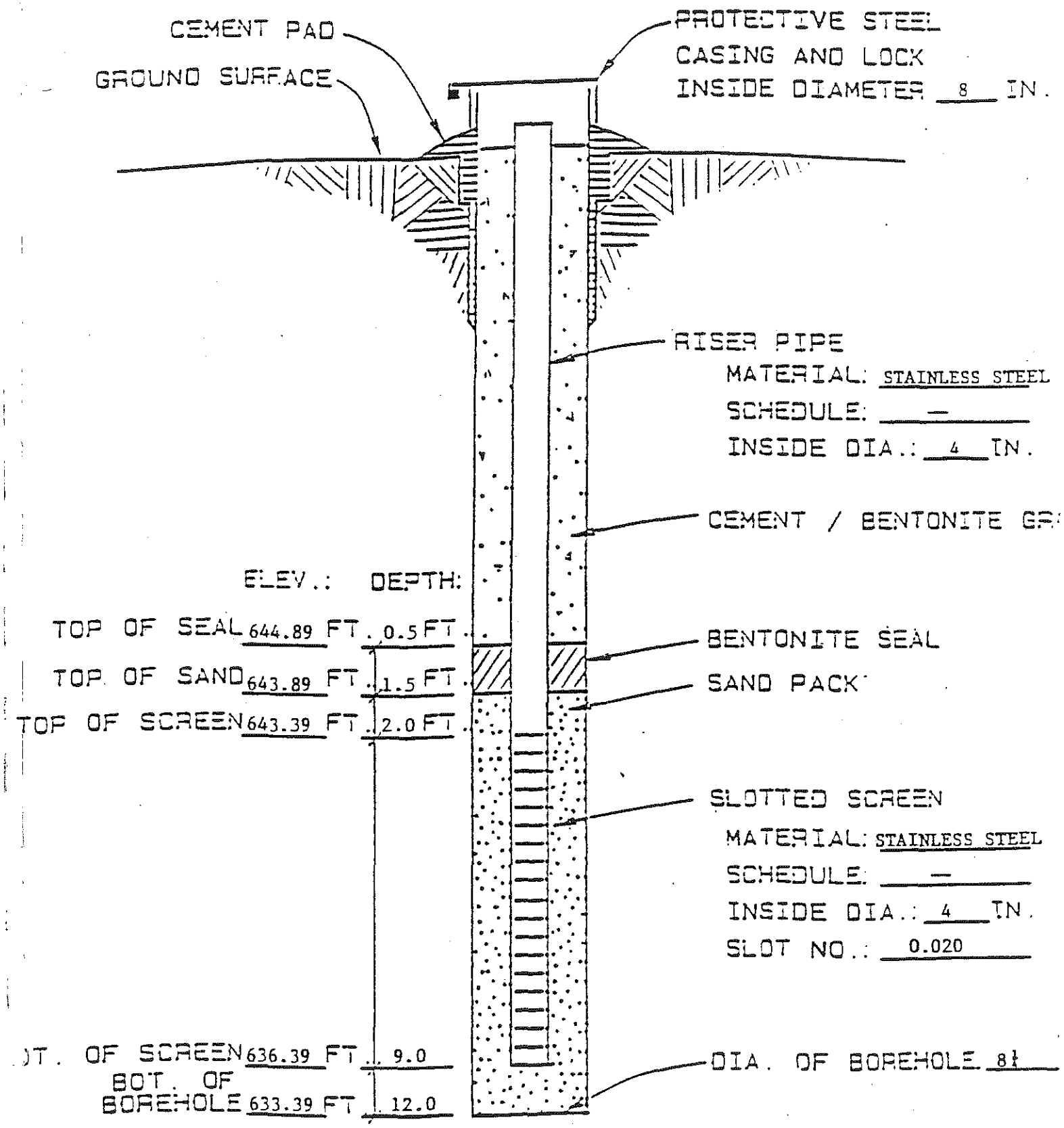
N.T.S.



Reichhold Chemicals, Inc.
Ferndale, MI

TYPICAL OVERBURDEN MONITORING WELL

N.T.S.

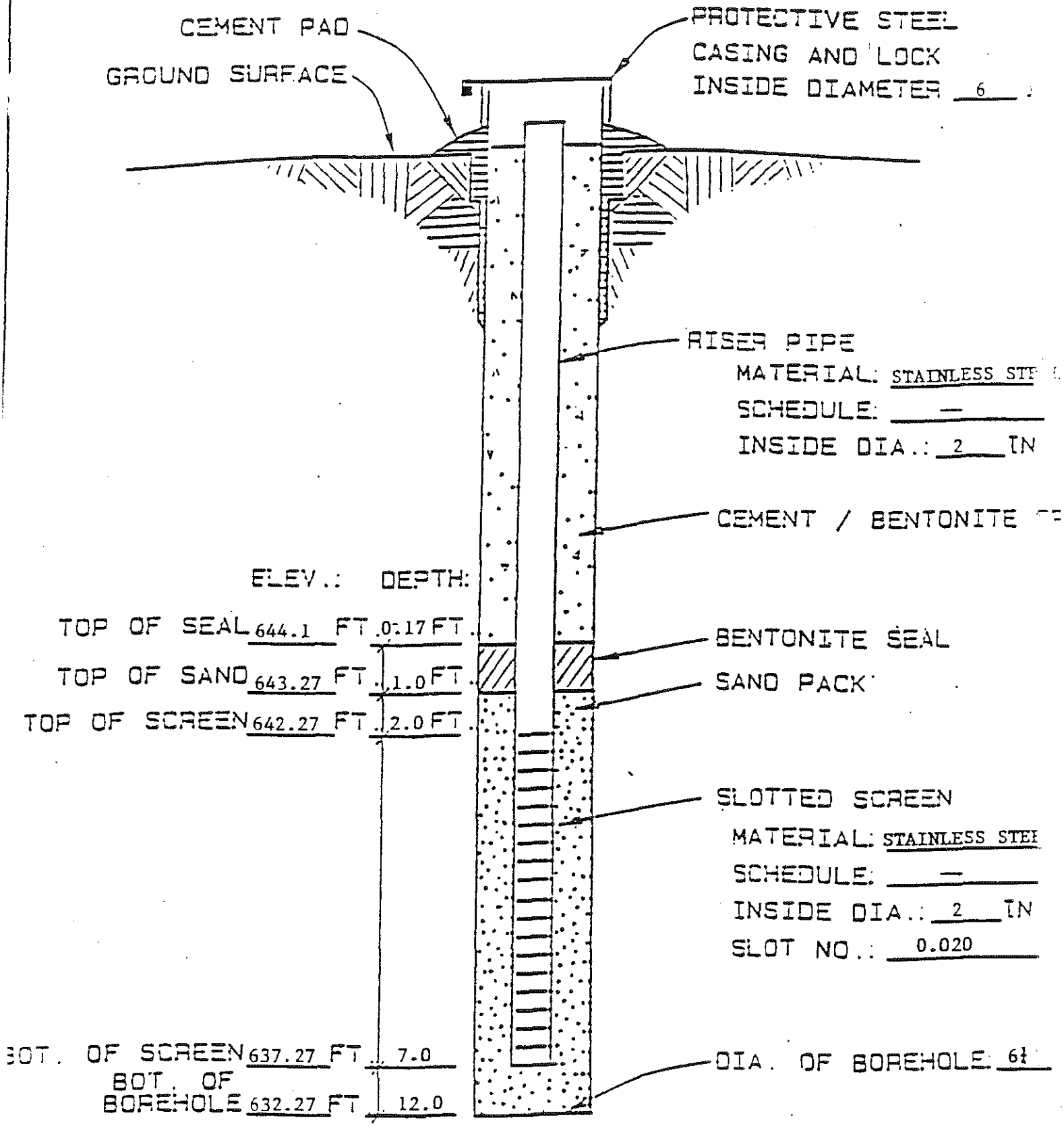


Reichhold Chemical, Inc.
Ferndale, MI

TYPICAL OVERBURDEN MONITORING WELL

N.T.S.

MW-10

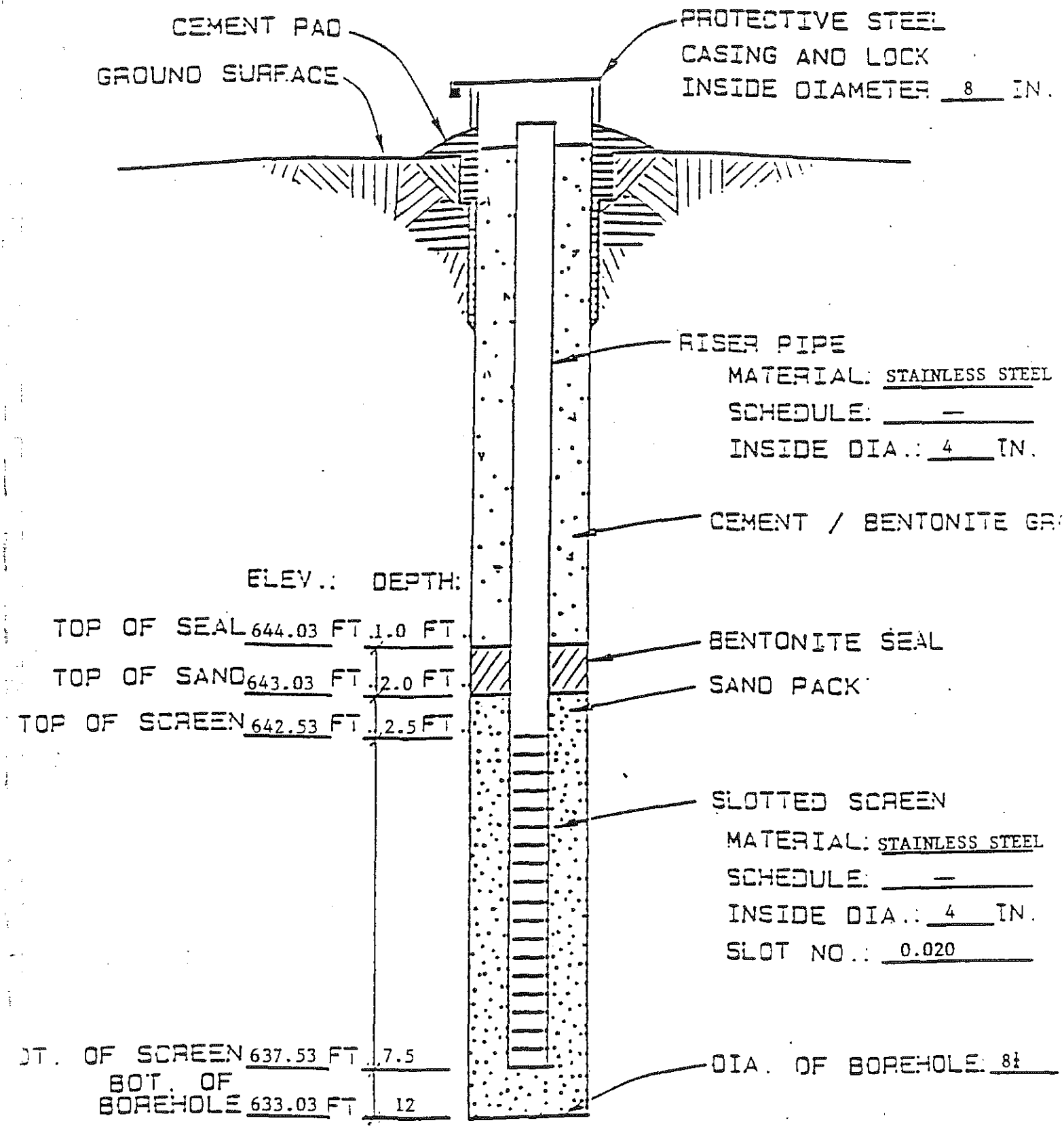


Reichhold Chemicals, Inc.
Ferndale, MI

TYPICAL OVERBURDEN MONITORING WELL

N.T.S.

MW-11

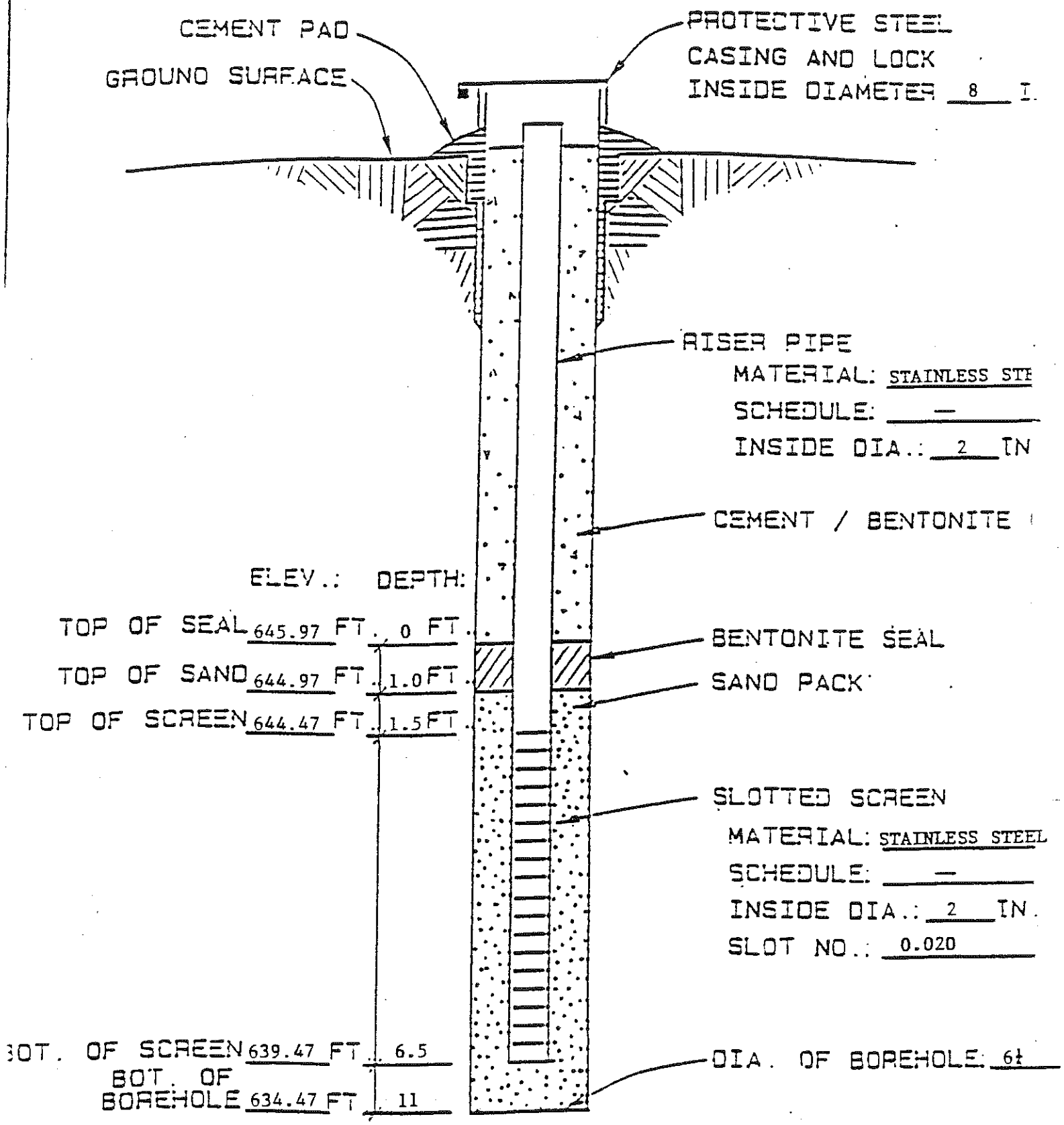


Reichhold Chemicals, Inc.
Ferndale, MI

TYPICAL OVERBURDEN MONITORING WELL

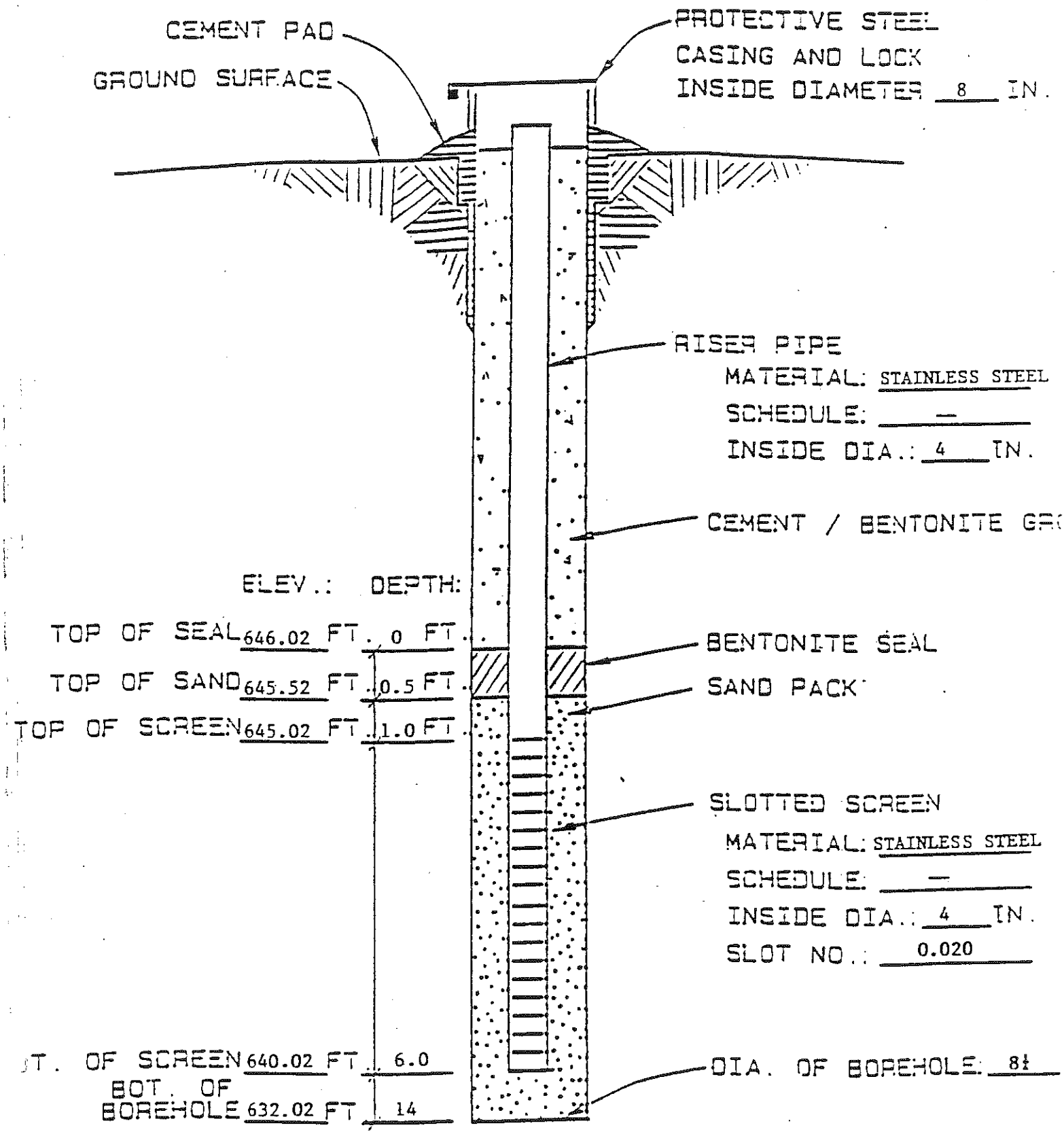
N T S

MW-12



Reichhold Chemicals, Inc.
Ferndale, MI

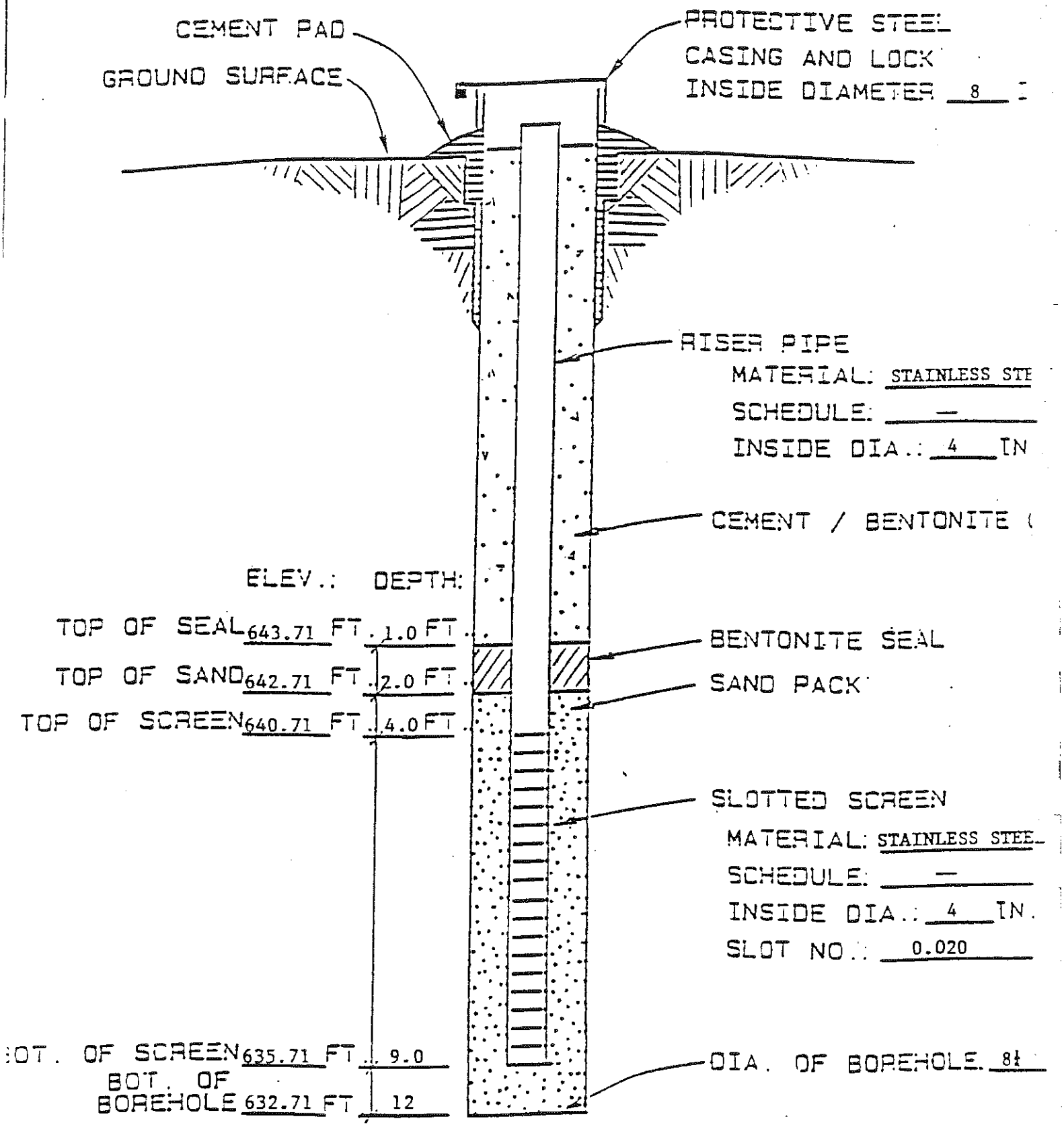
TYPICAL OVERBURDEN MONITORING WELL



Reichhold Chemicals, Inc.
Ferndale, MI

TYPICAL OVERBURDEN MONITORING WELL

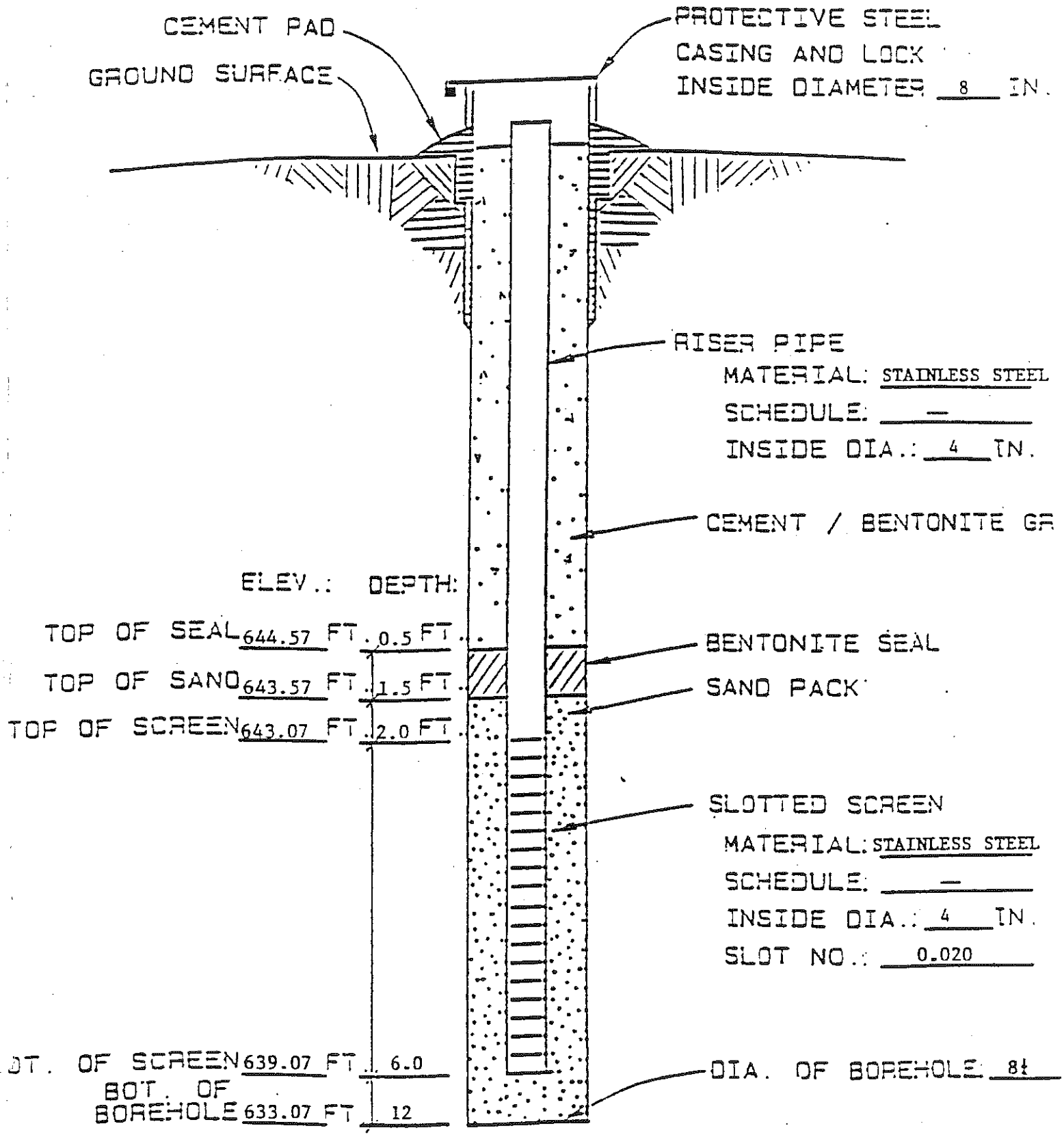
N T S



Reichhold Chemicals, Inc.
Ferndale, MI

TYPICAL OVERBURDEN MONITORING WELL

MW-15

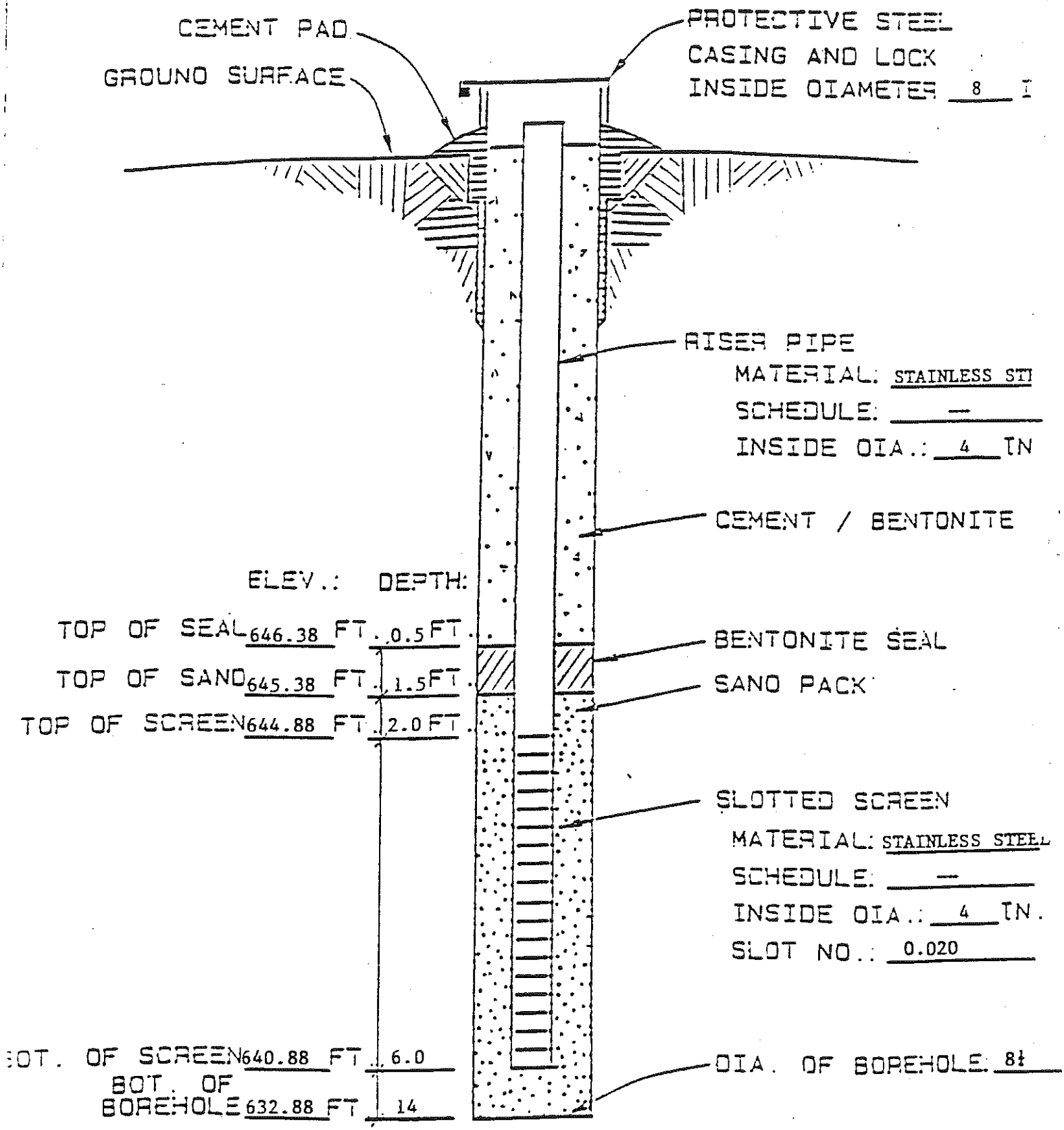


Reichhold Chemicals, Inc.
Ferndale, MI

TYPICAL OVERBURDEN MONITORING WELL

N T S

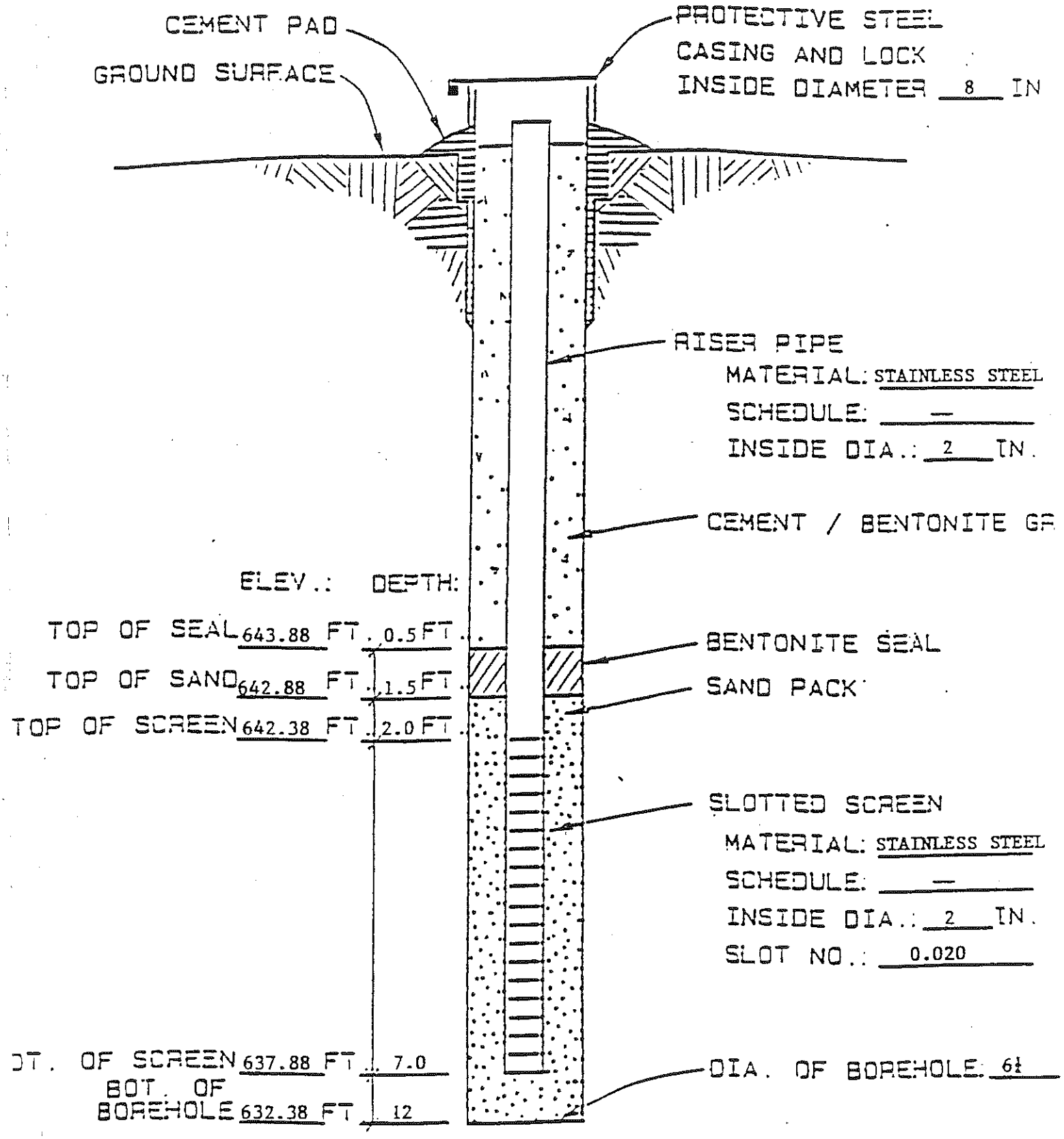
MW-16



Reichhold Chemicals, Inc.
Ferndale, MI

TYPICAL OVERBURDEN MONITORING WELL

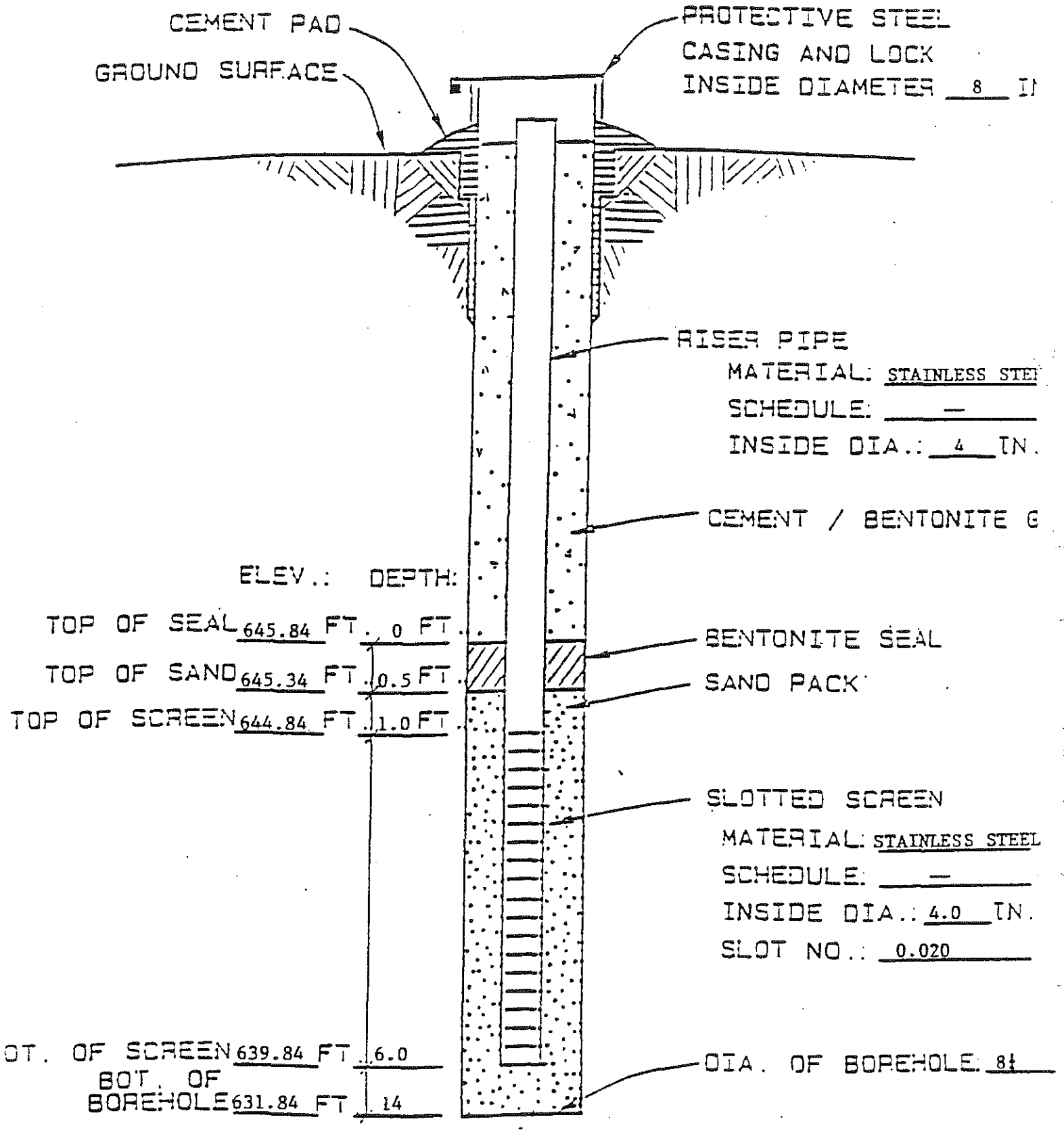
MW-17



Reichhold Chemicals, Inc.
Ferndale, MI

TYPICAL OVERBURDEN MONITORING WELL

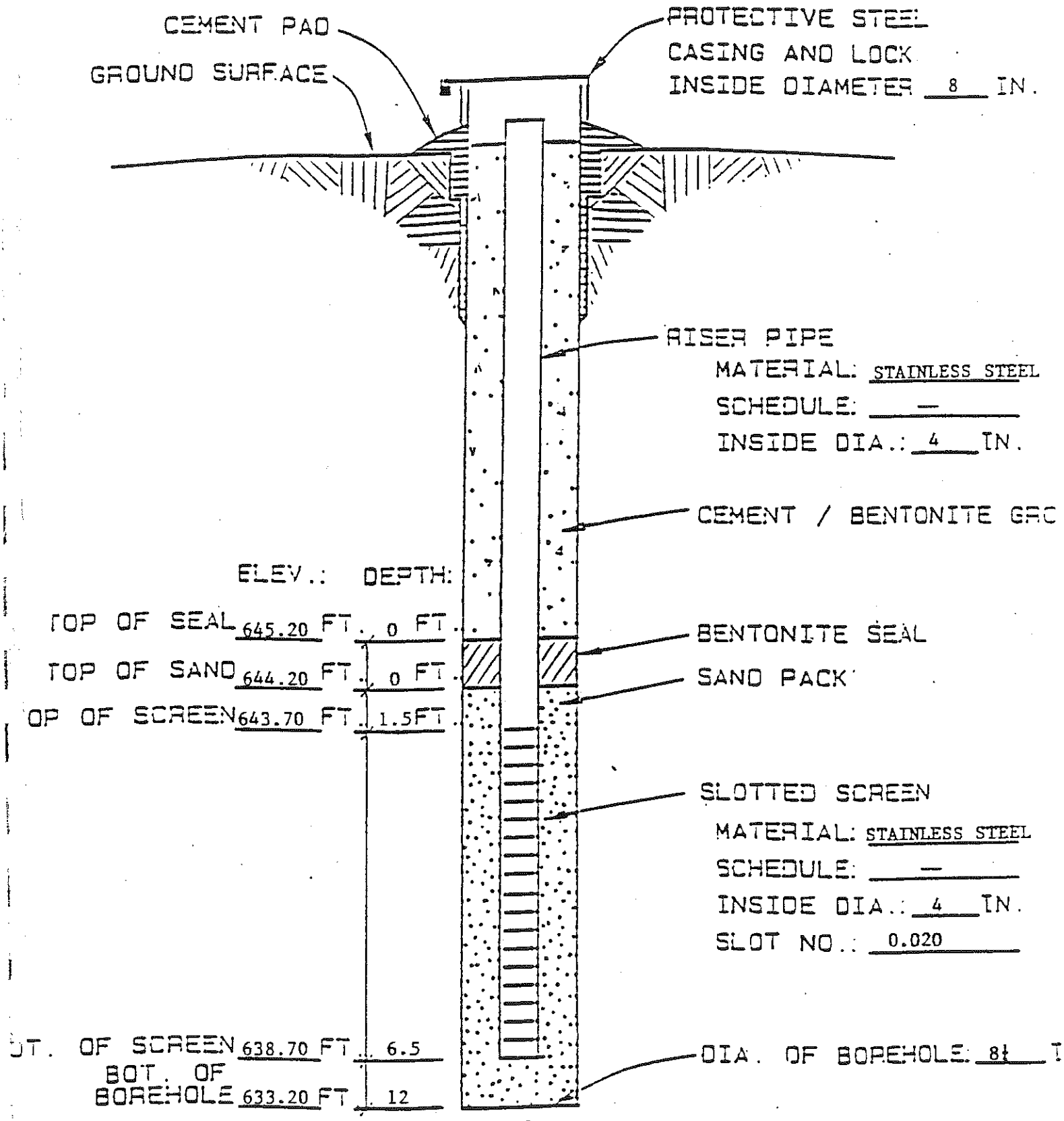
MW-18



Reichhold Chemicals, Inc.
Ferndale, MI

TYPICAL OVERBURDEN MONITORING WELL

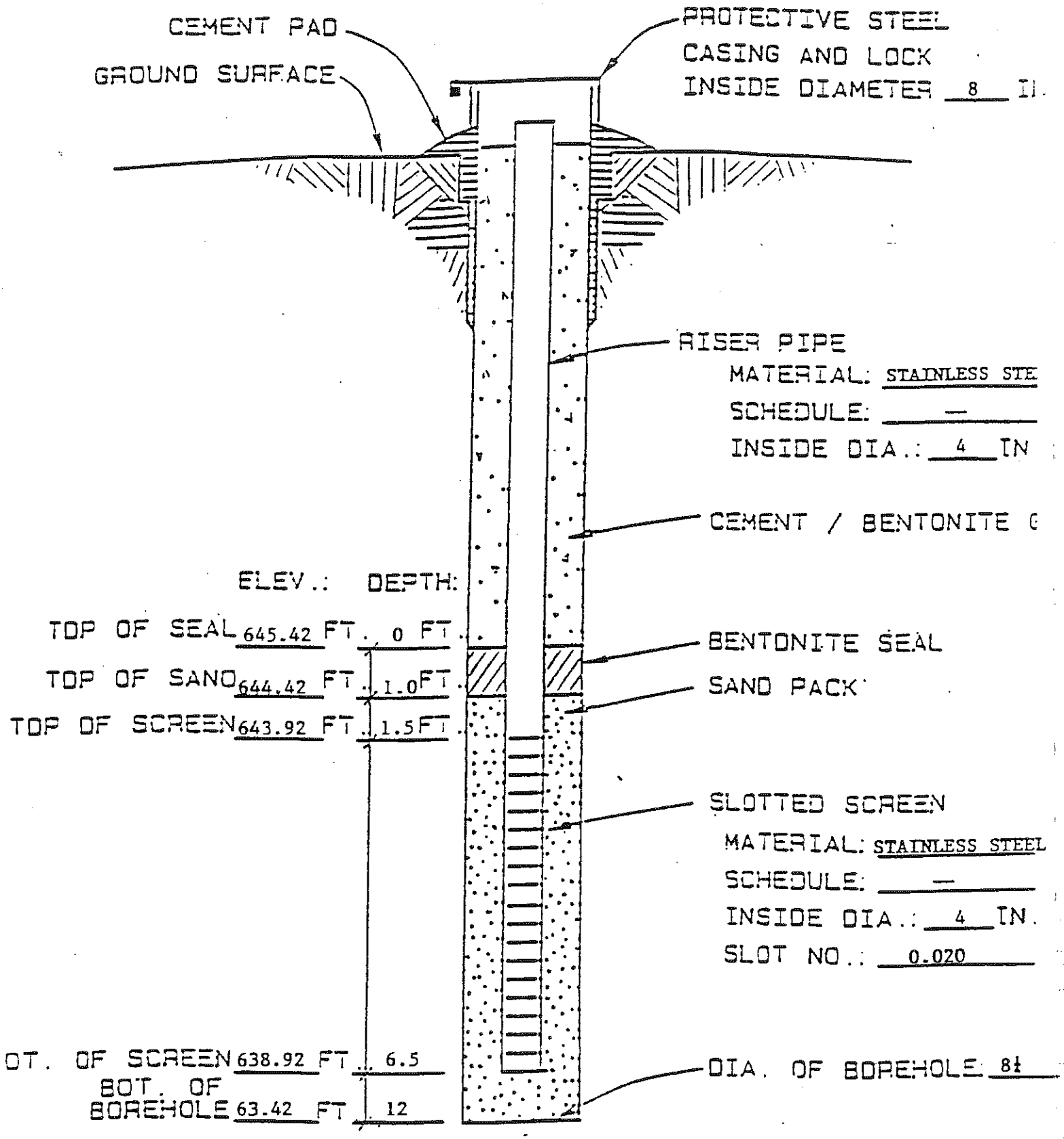
MW-19



Reichhold Chemicals, Inc.
Ferndale, MI

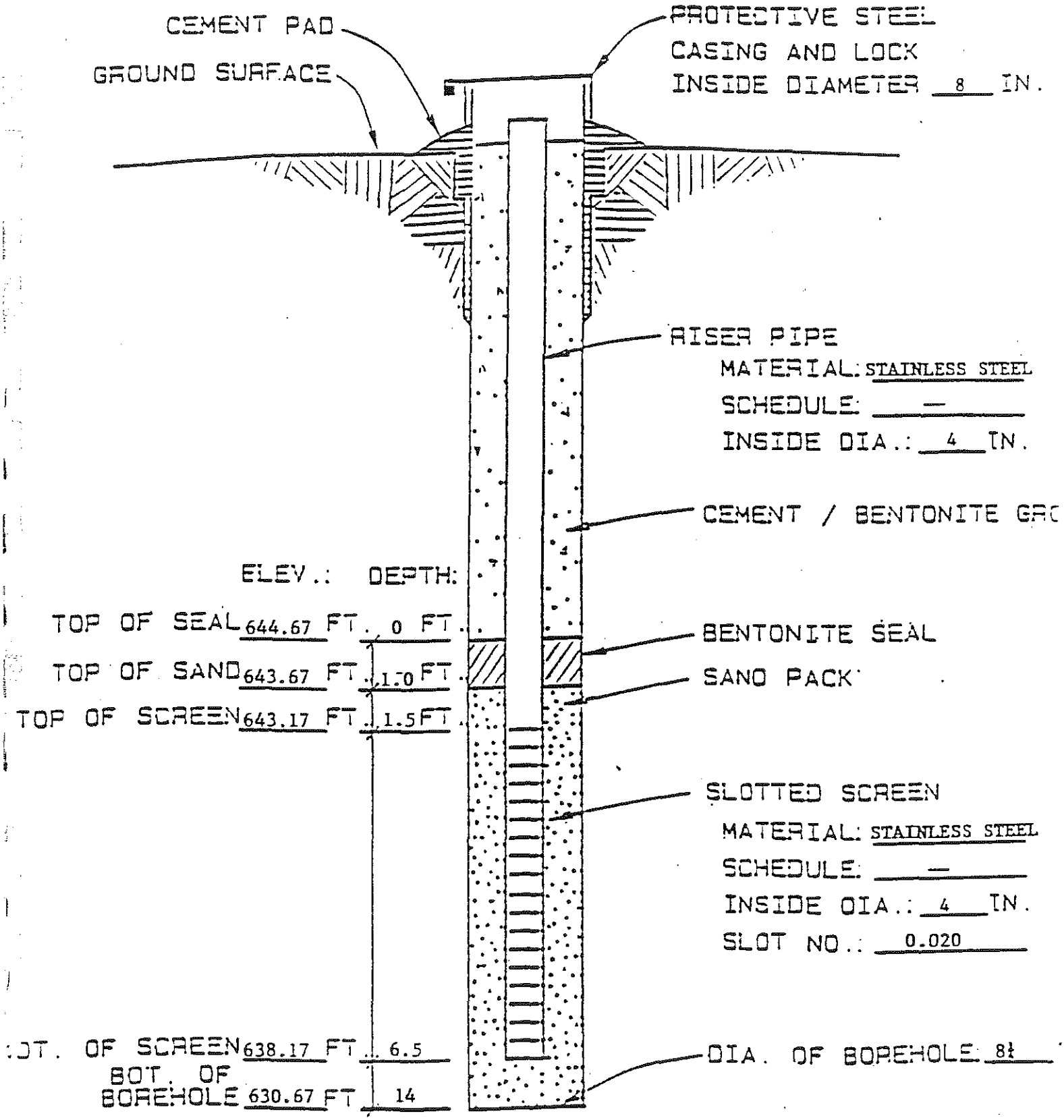
TYPICAL OVERBURDEN MONITORING WELL

MW-20



Reichhold Chemicals, Inc.
Ferndale, MI

TYPICAL OVERBURDEN MONITORING WELL



Reichhold Chemicals, Inc.
Ferndale, MI

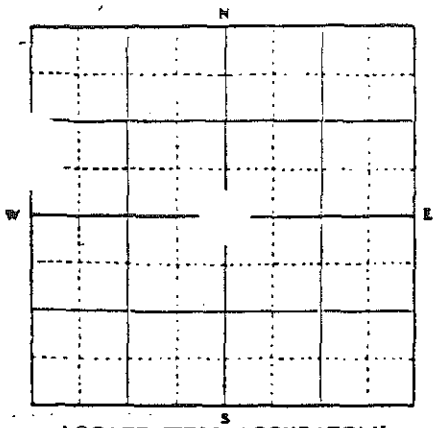
TYPICAL OVERBURDEN MONITORING WELL

STATE OF MICHIGAN
DEPARTMENT OF CONSERVATION

MAR 19 1956

LOG OF OIL, GAS OR TEST WELL

TO BE FILED WITH SUPERVISOR OF WELLS WITHIN 30 DAYS AFTER COMPLETION OF WELL (ACT 61 P. A. 1939 AND ACT 326 P. A. 1937)



LOCATE WELL ACCURATELY

Permit No. BD#64

sa. 8-1-C 3 trays

Owner or Operator: Reichhold Chemicals, Inc.

Address: 601 WOODWARD HEIGHTS BLVD., DETROIT 20, MICH.

Well No. 2 Farm

County: Oakland Township: Royal Oak

Location: NW¼ of SW¼ of NE¼ Sec. 27 Twp. 1 Range 11E Elevation 644 ft.

Footage 1630.46 ft. from North line and 499.64 ft. from West line of quarter section

Type of well: Waste Disposal Total depth 1053 ft. Completed in July 1952

Name of ~~producing~~ formation: Sylvania Top of formation 917

Date drilling begun: November 1951 Date drilling completed: March 5, 1952

Drilling contractor: O. O. Corseant Address: 15101 Eleven Mile Rd., Oak Park, Mich.

WATER ZONES

NAME	FROM	TO	AMOUNT

OIL OR GAS ZONES

NAME	FROM	TO	AMOUNT

CASING AND CEMENTING

SIZE	WHERE SET	CEMENT	AMT. PULLED
6 5/8"	693	To surface	None

STEEL LINES RUN

RUN AT	CORRECTED TO	RUN BY

PERFORATIONS

DATE	FROM	TO	NO. HOLES

ACID OR SHOOTING RECORD

DATE	FROM	TO	GALS. ACID OR QTS. NITRO
Sept. 1953	693	1053	5000

Rotary tools from ..... feet to ..... feet. Cable tools from top ~~xxx~~ to 1053 feet.

Natural initial production first 24 hours none Bbls. After acid or shot none Bbls.

If gas well, cu ft. per 24 hours ..... Rock pressure, lbs. per sq. in. .....

The above information is complete and correct.

Signed P. S. Hewitt

Date March 15, 1956

Title Director of Chemical Research

GS.10 REV. 4/55

GIVE COMPLETE FORMATION RECORD ON REVERSE SIDE

Reichhold Chem., Inc. - Fee No. 2

	Thickness (Feet)	Depth (Feet)
Detroit River: (contd.)		
Dolomite, light gray, very fine grained; a little anhydrite	6	632
Dolomite, light brown-gray, very fine grained, with some carbonaceous bandings & partings; trace pinpoint porosity; a little anhydrite	8	640
Dolomite, light gray-buff, as above; trace pinpoint porosity; some anhydrite	3	643
Dolomite, light gray-brown, sucrosic to very fine crystalline; good porosity	57	700
Dolomite, light gray-brown to light gray, dense; anhydrite, white	10	710
Dolomite, light gray-brown, granular to very fine crystalline with some porosity; a little anhydrite	10	720
Dolomite, light gray-buff, very fine granular, with a few carbonaceous partings & some petroliferous material; a little anhydrite	10	730
Dolomite, buff-brown, very fine granular, increase in carbonaceous partings; trace pinpoint porosity	10	740
Dolomite, light brown, very fine crystalline to gray, very fine granular; anhydrite, blue-white	10	750
Dolomite, light brown to light gray, very fine crystalline to very fine granular; some carbonaceous partings; a little blue-white anhydrite	10	760
Dolomite, light gray-brown, very fine granular, as above; trace pinpoint porosity	10	770
Dolomite, light gray-brown, very fine crystalline to very fine granular with porosity; a little anhydrite	10	780
Dolomite, gray-brown, sucrose	10	790
Dolomite, as above, becoming light brown-gray, dense, abundant carbonaceous partings & stylolites	10	800
Dolomite, light brown-gray, very fine granular, with some carbonaceous partings	10	810
Dolomite, gray-brown, very fine granular to very fine crystalline; trace of anhydrite (sulfur water 820)	10	820
Dolomite, brown & gray-brown, very fine granular to very fine crystalline; good porosity; some anhydrite	10	830
Dolomite, darker gray-brown & brown-gray, as above	10	840
Dolomite, dark gray, as above, limy in part; white black chert	5	845
Dolomite, brown-gray, fine granular to very fine crystalline; some porosity; a little white anhydrite	7	852
Dolomite, light brown-gray, very fine granular with some porosity & some carbonaceous banding; porosity decreases 865-70	18	870
Dolomite, as above, but becoming more dense; trace anhydrite	20	890
Dolomite, light brown-gray, very fine granular; dense to porous, with carbonaceous banding	10	900
Dolomite, gray, very fine granular to very fine crystalline, dense to porous	17 (917)	917
Sylvania-Bois Blanc: (Fye. Report-top Bois Blanc 1005)		
Sandstone, light gray, friable, medium grained, subangular to subrounded, frosted to clear; dolomite, gray to brown-gray, very fine granular to very fine crystalline, sandy in part	5	922
Sand, white, medium grained, sorted, subrounded; minor dolomite, as above	5	927

Reichhold Chem. ., Inc. - Fee No. 2

	Thickness (Feet)	Depth (Feet)
Sylvania-Bois Blanc: (contd.)		
Sand, as above; but medium grained to fine grained	40	967
Samples missing; driller's log-very hard silica sand (heavy sulfur brine 980) (Pre. Report-black sulfur water filled up 100' from top of pipe)	13	980
Sand plus limestone	10	990
Limestone, gritty	5	995
Sand, containing limestone, dense, non-cavernous (Pre. Report-clay lenses 1000-20)	45	1040
Samples resume:		
Dolomite, light gray, very fine granular to very fine crystalline, sandy in part, with some porosity; considerable chert, gray	5	1045
Chert, light gray, dense, fossiliferous, with some dolomite, gray, very fine granular, sandy in part	5	1050
Dolomite, gray, very fine grained, sandy in part, with some chert, as above	5	1055
Sandstone, gray, dolomitic, slightly cherty	5	1060
No further samples; driller's log-sandstone containing limestone, dense, non-cavernous	4	1064
	(147+)	
TOTAL DEPTH		1064

Casing Record:

8¼"	130'	
6 5/8"	693' (120 cem)	

Commenced: 11-16-51
Completed: 3- 5-52
Initial Production: Waste disposal well
Treated: 9-7-53 from 693 to 1053 with 5000 gallons

6-6-56

REICHHOLD CHEMICALS, INC.

Creative Chemistry . . . Your Partner in Progress

Executive Offices · R C I BUILDING, WHITE PLAINS, N. Y.

CABLE: BECKACITE WHITE PLAINS
TELEPHONE WHITE PLAINS 8-6200

ADDRESS REPLY TO
601-707 WOODWARD HEIGHTS BLVD.
DETROIT 20, MICHIGAN

TELEPHONE JORDAN 4-6500

March 16, 1956

Mr. F. W. Terwilliger
State of Michigan
Department of Conservation
Geological Survey Division
Lansing, Michigan

MAR 19 1956

Dear Mr. Terwilliger:

I have filled out the well log form on Reichhold No. 2 waste disposal well as best I can from our old records. The data as submitted will require some interpretation as I am not a geologist by profession. If you require further data, not included in the formation record, do not hesitate to get in touch with me.

I will note, here in this letter, the major showings of water noted.

135 ft.	Fresh water	5-10 g.p.m. on boiling test
240 ft.	Salt water	1.060 sp. gr.
500 ft.	Salt water	
820 ft.	Sulfur containing water	
980 ft.	Heavy sulfur containing brine	

We had Dowell Corp. run a spinner survey on the well and acidize the strata we expected to use. Following the acidizing another survey was run.

Results of first survey

820-830	5 g.p.m.	at 700 psi.
910-970	27 g.p.m.	at 700 psi.

STATE OF MICHIGAN
DEPARTMENT OF CONSERVATION

WELL PLUGGING RECORD

TO BE FILED WITHIN THIRTY DAYS AFTER FINAL ABANDONMENT

RECEIVED
NOV 22 1957
GEOLOGICAL SURVEY

Permit No. BD 64 Date November 22 19 57

Owner or operator Reichhold Chem, Inc Address 601 Woodward Hts., Detroit 20, Mich.

Well No. 2, Farm Fee, Sec. 27, T. 1 N., ~~N.S.~~ R. 11, E. W.

Township Royal Oak County Oakland

Located -- feet from the { N / S } line of quarter Sec. and -- feet from the { E / W } line of quarter Sec.

Type of well Brine disposal (Oil, Gas, or Dry Hole) Name of producing sand Bois Blanc

Top sand 1005 (2) Bottom sand -- Total depth 1064

Date plugging began November 4, 1957 Date plugging completed November 12, 1957

Was permission of Department of Conservation secured before plugging began? Yes

Name of representative of Department who supervised plugging F. W. Terwilliger

OIL, GAS AND WATER SANDS				CASING RECORD	
Name	Content	From	To	Size Casing	Amount Casing Pulled
Sylvania	S/W			8"	130' run, none pulled
				6"	693' " " "

Describe in detail how well was plugged Well was filled from bottom to top with finely cut blue lake clay. Well was allowed to set overnight between fillings. When well was filled, pipe was cut off three feet below ground level and capped with steel plate welded on.

Names of workmen present when well was plugged Hewett, Garaduzi.

Signed Reichhold Chemicals, Inc. By P. S. Hewett

Address Detroit 20, Michigan, Director of Chemical Research (Title)

State of Michigan, County of Oakland ss:

I, P. S. Hewett, do hereby swear that the above statements are true and correct to the best of my knowledge and belief.

P. S. Hewett (Sgd)

Subscribed and sworn to before me this 22nd day of November 19 57

My commission expires Feb 6 1959 Joyce K. Widmer Notary Public

O. K. by Department representative F. W. Terwilliger 11/22/57

12-7-57
Douglas Sanbach

G.S. 19 9-6-38

Date of Completion 3/5/52
Date Last Produced
Last Production BDW
oil-gas-water
Date work is to start will notify

STATE OF MICHIGAN
DEPARTMENT OF CONSERVATION
SUPERVISOR OF WELLS

Leave Blank
Permit No. BD 64
Date Issued
D.P. No.
Date Issued

RECEIVED
NOV 22 1957
GEOLOGICAL SURVEY

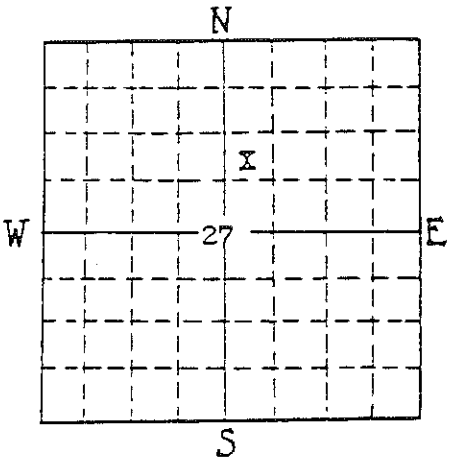
APPLICATION FOR PERMISSION TO:
(Submit in Quadruplicate)

DEEPEN - ~~REPLUG~~ - ~~ABANDON~~
(Cross out those which do not apply)

Supervisor of Wells
Department of Conservation
Lansing 13, Michigan

Lansing Michigan October 1 19 57

In compliance with the provisions of Act 61, Public Acts of 1939, and Act 326, Public Acts 1937 and the rules and regulations issued and adopted thereunder permission is requested to Deepen - ~~abandon or abandon~~ the



Reichhold Chemicals Inc. — Well Owner
Fee #2 — Well Name and Number
NW ¼, SW ¼, NE ¼, Sec. 27 T. 1 N. ~~S~~, R. 11 E. ~~W~~

Royal Oak — Township
Oakland — County

The work to be done by: Company tools
Operator or Contractor

Outline the present condition of the well giving casing, cementing, formation, and production data.

8" - 130'	Drift	128'	Detroit River dol	600'
6" - 693' (120 cem)	Antrim	128'	Sylvania	917'
	Tr. Fm.	202'	Bois Blanc (?)	1005'
	Tr. Lms.	222'		
	Dundee	450'	Total Depth	1064'

Describe the proposed work in detail.

Fill the hole with heavy clay from the total depth to the surface.

When it has been determined that all filling material has settled, cut off casing below ground level and cap with steel plate welded on, or solid cement plug in top of pipe.

CALL THE LANSING FIELD OFFICE WHEN READY TO START PLUGGING.

IF ANY LEAKS DEVELOP, THEY ARE TO REMEDIED IMMEDIATELY.

ALL PITS AND CELLARS MUST BE FILLED AND LEVELLED, AND ALL MATERIAL AND DEBRIS REMOVED FROM THE LOCATION BEFORE FINAL APPROVAL OF PLUGGING OPERATIONS.

Field Office Lansing (Ph. IVanhoe 58144, Ext. 2686)
Approved [signature]
Date November 1, 1957

REICHHOLD CHEMICALS INC.
Name of Company or Operator
P. L. Hewl.
Authorized Representative

Record of proposed work to be filed within 30 days after its completion.

RCI #2 Reichold Chemicals

WELL DRILLED EAST OF 103 BUILDING

0 - 7	Sand
7 - 110	Clay
110 - 128	Hard Pan
128 - 202	Black Slate
202 - 222	Blue Shale
222 - 245	Hard Gray Lime
245 - 257	Blue Shale
257 - 280	Gray Lime
280 - 385	Blue Shale
385 - 437	Gray Shale - Lime
437 - 450	Blue Lime
450 - 453	Gray Lime

STATE OF MICHIGAN
DEPARTMENT OF CONSERVATION
SUPERVISOR OF WELLS

APPLICATION FOR PERMIT TO DRILL A WELL FOR OIL, GAS, GEOLOGICAL TEST, BRINE DISPOSAL, OR KEY WELL FOR SECONDARY RECOVERY

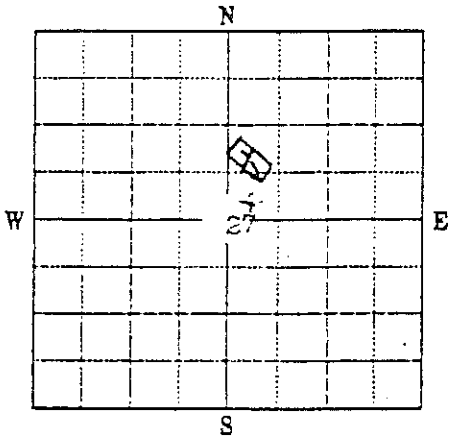
Under Authority of Act 61, P. A. 1939 and Act 326, P. A. 1937

See Reverse Side Before Filling Out This Application

Department of Conservation
Geological Survey Division
Lansing 13, Michigan
Gentlemen:

Ferndale, Michigan October 18, 195

Application is hereby made for permit to drill a well for Waste Disposal



(Locate well and lease accurately on this section plat—640 acres)

Lessee REICHHOLD CHEMICALS, INC. (Owner of lease rights)

Address 601 WOODWARD HEIGHTS BLVD.

FERNDALE, MICHIGAN Phone JO. 4-6500

Lessor REICHHOLD CHEMICALS, INC. (Full name of owner of mineral rights) Well No. 2

Drilling contractor O. O. Corsaut

Address 15101 Eleven Mile Rd. Oak Park, Michigan Phone LI. 1-111

N.W. ¼ of S.W. ¼ of N.E. ¼, Section 27 T 1 N.~~S~~, R 11 E~~W~~.

Township Royal Oak, County Oakland

Acres in lease 11.765

Locate well in two directions from nearest lines of quarter section and property ownership lines:—

1630.46 ft. from north ~~south~~ line of quarter section, 499.64 ft. from ~~east~~ west line of quarter section.

443.25 ft. from north ~~south~~ property line. 5.67 ft. from east ~~west~~ property line.

Number of feet from nearest producing well — Kind of tools to be used Cable (Cable, Rotary, Combination)

Well is to be completed in Detroit River formation. Intended depth 1300'

Program of casing, sealing, and completing well

8" drive pipe to be landed at about 150'.

6" casing to be set on top of Detroit River and cemented to surface.

Well location is in Industrial Plant Site (Cleared farm land. Open grass land. Brush land. Timbered land.)

Are there any lakes, rivers, streams, ditches, drainage-ways, swamps or marshes nearer than 330 feet from well location. No. If yes, describe and give distance from location and specify precautions to be taken to protect fresh water from well wastes. Well about 45' from building - not possible to locate well a greater dista from buildings. Location approved by Travelers Indemnity Company which carries insur on property and furnished required bond. Location approved by city of Ferndale.

Are there any buildings or other structures within 75 feet of the proposed location? Yes (Yes—No)

Applicant agrees to comply with the provisions of Act 61, Public Acts of 1939, and Act 326, Public Acts of 1937, and rules and regulations pertaining to the locating, drilling, casing, sealing, completing, producing, and plugging of wells.

Applicant will notify the nearest field office of the department when ready to commence drilling operations.

Address correspondence and permit to REICHHOLD CHEMICALS, INC.
601 WOODWARD HEIGHTS BLVD., FERNDALE, MICHIGAN Phone JO. 4

Signed REICHHOLD CHEMICALS, INC. (Owner of lease rights)

By Albert G. Lieth Vice Pres. (Authorized representative)

PERMITS MAY BE TRANSFERRED ONLY WITH PERMISSION OF THE SUPERVISOR OF WELLS

October 23, 1951

Mr. Roy Goodspeed
City Engineer
City of Ferndale, Michigan

Dear Sir:

Mr. P. S. Hewett, Director, Chemical Research, Reichhold Chemicals, Inc., has called at this office several times and discussed with the writer and Mr. R. F. Grant, Petroleum Geologist, Geological Survey Division, Department of Conservation, the possibility of drilling a well and using an underground formation for disposal of plant wastes. We have made a rather thorough study of the subsurface geology of the Ferndale area and have made certain recommendations to Mr. Hewett.

It should be understood that the Department of Conservation is in accord with procedure for disposal of wastes to underground formations. The oil industry of the state had disposed of oil field salt water in this manner for many years and has established beyond doubt the success and praticality of this menas of disposal of wastes. More recently many chemical companies and other manufacturing concerns have drilled wells to approved formations under our supervision and thus solved a mean problem in waste disposal.

In the case at hand, we have agreed with Mr. Hewett that a well in the Ferndale area drilled to approximately 1000' would penetrate the Detroit River Formation well below any fresh water zones and that such a formation might take the wastes which constitute a disposal problem. Accordingly, they have made application for a permit to drill such a well and have proposed a casing and sealing program which will provide ample protection to all formation and water bearing zones above the Detroit River Formation. It should be understood that the water present in the Detroit River Formation is a strong salt water. It is proposed that the contractor will drive 8" drive pipe into bedrock at approximately 150 feet. This string of drive pipe will be driven through the fresh water zones on the area and will shut off and protect those fresh water resources. In addition to this 8" casing, A string of 6" casing will be set on the top of the Detroit River Formation, at approximately 900 to 1000 feet, and this string of casing will be sealed by pumping cement through the casing and circulating it to the surface outside the casing thus completely sealing off the space between the outside of the 6" casing and the wall of the hole. This cement will prevent migration of any fluids up or down the hole outside the casing and eliminate the possiblity of contamination of resh water resources.

In view of the great need for adequate disposal of manufacturing wastes as a conservation measure, we recommend highly this proposal to dispose of these wastes into an approved underground formation. We urge that your commission recommend approval of the proposed drilling operation as a means of solving a disposal problem in such a way as to conform with good conservation practice.

Very truly yours,

GEOLOGICAL SURVEY DIVISION
L. W. Price
Petroleum Engineer

LWP:jj

October 23, 1951

TO: W. Angstman, Inspector, Oil Hazard Reduction

FROM: L. W. Price, Petroleum Engineer, Geological Survey Division

SUBJECT: Reichhold Chemicals, Inc., Fee #2, NW SW NE Section 27, T.1N., R.11E., Royal Oak Township, Oakland County.

The subject operator has made application for permit to drill a well for disposal of plant wastes into the Detroit River Formation. A representative of the company has called at this office several times to check on the possibility of such disposal of wastes. They have an old No. 1 well on the property which they have been unable to clean out and use and now they have engaged a reputable water well driller to drill a new well to some 1000 feet for them.

The plant property is small and the well location is squeezed in between the plant and a street. City officials have indicated approval to them of the proposed location asfar as the street and fire hazard angles are concerned. Their plant is insured by Travelers Indemnity Company who also have approved the drilling operation relative to risks which might involve them. They also have furnished the surety bond as required by Act 61. At present the city is delaying approval of the drilling operations because of the angle of fresh water resources in the area. We have recommended a proper casing and sealing program for the well which should adequately protect the fresh water resources and we expect the city will grant approval of the drilling operation accordingly.

There is the matter of a building (the plant) being some 45 feet from the proposed well site. This is the maximum distance they can locate from any building and remain on their property. On the other side of the well there is a high concrete wall between the well site and a street. There is ample room, however, for the water well drilling machine which will drill the well. Ordinarily you would need to check locations in close proximity to buildings and I am wondering if you will want to check this one. They advise there is no alternate location on the property.

It is my understanding that the well driller is ready to commence drilling as soon as the city commission approves the proposed operation relative to the protection to fresh water strata. Please let me know at the earliest convenient time whether or not you will need to check this location and, if so, whether or not you approve the location. If you need to contact a representative of the company, Mr. P. S. Hewett, Director, Chemical Research, is the company representative who has made all the contacts with this office.

LWP:jj
cc:- H. A. Young, Grand Rapids

NOV 1 1951

CITY OF FERNDALE
MICHIGAN

October 30, 1951

Mr. L.W. Price, Petroleum Engineer
Department of Conservation
Lansing 13 Mich.

Dear Sir:

In accordance with your communication of October 23, 1951 to Mr. Roy Goodspeed, City Engineer of the City of Ferndale, the Ferndale City Commission granted permission to the Reichhold Company, Inc., to drill a well approximately 100 feet deep for the disposal of wastes to underground formation.

I am sending a copy of this letter to Mr. P.S. Hewett, Director of Chemical Research for Reichhold Chemicals, Inc.

Very truly yours

T.H. O'Donoghue

T.H. O'Donoghue, City Clerk

THO:ds

December 2, 1955

Mr. P. S. Hewitt
Reichhold Chemicals, Inc.
601 Woodward Heights Boulevard
Ferndale, Michigan

Re: BD#64 - Reichoold Chemicals, Inc., Reichhold Chemicals, Inc. #2, NW¼ SW¼ NE¼ Sec. 27, T.1N., R.11E., Royal Oak Township, Oakland County.

Dear Stan:

I have checked through our regular files as well as the separate file that Rex kept on your well and I can find no Driller's Log. I am enclosing several of our log forms which you can use to file this information. We would like to have two copies returned to us.

One of our typists has your paper to work on and I will return the bulletin to you as soon as possible.

Sincerely,

GEOLOGICAL SURVEY DIVISION
F. W. Terwilliger
Geologist

FWT:jgt
Enclosures

→ R Acker

WATER RESOURCES COMMISSION

Memorandum

To: William Turney
through D. W. Granger

From: K. E. Childs and Wayne Denniston

Subject: Reichhold Chemicals Inc.'s Deep Well Disposal System.

Date: May 14, 1968

District Engineer, Wayne Denniston and Geologist, K. E. Childs visited Reichhold Chemicals, Inc. on May 9, 1968. Mr. Stan Hewitt, Reichhold Representative provided us with information about their deep well disposal system.

Their disposal well was developed in 1953 for injection of phenolic wastes. Initially the well operated at 131 GPM at 100 PSI. After several months of operation, injection pressures increased to excessive amounts. It is believed that precipitates formed by the mixing of the wastes with connate waters of the formation was responsible for the pressure buildup. The well was abandoned in 1957 and plugged in accordance with State Conservation Department standards.

bl

cc: Mr. R. Acker
Mr. W. Denniston
Mr. R. Ives

BD 64

RECEIVED
MAY 16 1968
GEOLOGICAL SURVEY

ATTACHMENT 3

MID020087128

APPENDIX B

RCRA FACILITY INVESTIGATION QUALITY ASSURANCE PLAN
Ferndale, Michigan

Reichhold Chemicals, Inc.
Research Triangle Park, North Carolina

JANUARY 1995

O'BRIEN & GERE
ENGINEERS, INC.

QUALITY ASSURANCE PLAN

3208.076

Final Report

RCRA Facility Investigation Quality Assurance Plan Reichhold Chemicals, Inc. Ferndale, Michigan

Reichhold Chemicals, Inc.
Research Triangle Park, North Carolina

Prepared by:

Richard P. Cawley, C.P.G.
Managing Hydrogeologist

Vernon C. Burrows
Sr. Project Hydrogeologist

Andrew D. Crabb
Scientist

Submitted by:

Donald E. Stone, Jr., P.E.
Vice President

January 1995

O'BRIEN & GERE ENGINEERS, INC.

Raritan Plaza 1
Edison, New Jersey 08837

Contents

1. Project Description 1-1

1.1. Introduction 1-1

1.2. Site Description 1-2

1.3. Site History and Background 1-3

1.4. Process Description 1-3

1.5. Previous Studies 1-4

1.6. Project Objectives 1-4
- 1.6.1. Specific Objectives 1-4
- 1.6.2. Task Objectives and Intended Data Usages 1-5
- 1.6.3. Data Quality Objectives 1-5

1.7. SMWU Identification and Sample Rationale 1-7

2. Project Organization and Responsibility 2-1

2.1. Project Organization 2-1

2.2. Laboratory Responsibilities 2-1

3. Quality Assurance Objectives for Measurement Data in Terms of Precision, Accuracy, Representativeness, Completeness, Comparability 3-1

3.1. Precision 3-1

3.2. Accuracy 3-1

3.3. Representativeness 3-2

3.4. Completeness 3-2

3.5. Comparability 3-3

4. Sampling Procedures 4-1

4.1. Objective 4-1

4.2. Sampling Locations 4-1
- 4.2.1. Documentation of Sample Locations 4-1
- 4.2.2. Specific Sampling Locations 4-1

4.3. Sample Matrices and Field/Lab Parameters 4-2

4.4. Field QA/QC Samples 4-2
4.4.1. Duplicate Samples 4-2
4.4.2. Matrix Spikes (MS) and Matrix Spike Duplicates(MSD) 4-3
4.4.3. Field/Equipment Blanks 4-3
4.4.4. Trip Blanks 4-3

4.5. Sampling Procedures 4-4
4.5.1. Soil Boring Protocol 4-4
4.5.2. Shallow Monitoring Well Completion Protocol . . 4-6
4.5.3. pH Sampling 4-11
4.5.4. Temperature 4-13
4.5.5. Conductivity 4-15
4.5.6. Ground Water Sampling Procedure 4-16
4.5.7. In-Situ Hydraulic Conductivity Testing Standard Operating Procedure 4-20
4.5.8. ECP Procedure and Data Acquisition 4-22
4.5.9. GC Procedure for Soil Analysis 4-35
4.5.10. Decontamination 4-35
4.5.11. Order of Sample Analytical Fraction Collection 4-36
4.5.12. Sample Containers 4-36

5. Sample Custody 5-1

5.1. Field Custody Procedures 5-1

5.2. Laboratory Custody Procedures 5-1

5.3. Final Evidence File Procedures 5-1

5.4. Sample I.D. 5-2

6. Calibration and Frequency 6-1

6.1. Laboratory Equipment Calibration 6-1

6.2. Field Equipment Calibration 6-1

7. Analytical Procedures 7-1

7.1. Field Analytical and Measurement Procedures 7-1

7.2. Laboratory Analytical Procedures 7-1

7.3. Turn Around Times 7-1

8. Data Reduction, Validation, and Reporting 8-1

8.1. Data Reduction 8-1
8.1.1. Field Data Reduction 8-1
8.1.2. Laboratory Data Reduction 8-1

8.2. Data Validation 8-1
8.2.1. Field Data Validation 8-1
8.2.2. Laboratory Data Validation 8-2

8.3. Data Reporting 8-3
8.3.1. Field Data Reporting 8-3
8.3.2. Laboratory Data Reporting 8-3

9. Internal Quality Control Checks 9-1

9.1. Laboratory Quality Control Checks 9-1
9.1.1. GC/MS Tuning 9-1
9.1.2. Calibration 9-1
9.1.3. Blanks 9-1
9.1.4. Surrogate Recovery 9-2
9.1.5. Matrix Spike/Matrix Spike Duplicate/ Laboratory Duplicate 9-2
9.1.6. Field Duplicates 9-2
9.1.7. Internal Standards Performance 9-2
9.1.8. TCL Compound Identification 9-2

9.2. Field Quality Control Checks 9-3
9.2.1. Field Sampling Quality Control 9-3
9.2.2. Field Analytical Procedures Quality Control 9-4

10. Performance and System Audits 10-1

10.1. Laboratory Audits 10-1
10.1.1. Internal Laboratory Audits 10-1
10.1.2. External Laboratory Audits 10-8

10.2. Field Audits 10-8
10.2.1. Internal Field Audits 10-8
10.2.2. External Field Audits 10-10

11. Preventive Maintenance 11-1

11.1. Field Equipment 11-1
11.2. Laboratory Equipment 11-1

12. Specific Routine Procedures Used to Assess Precision Accuracy and Completeness 12-1

12.1. Accuracy Assessment 12-1
12.2. Precision Assessment 12-1
12.3. Completeness Assessment 12-2

13. Corrective Action 13-1

13.1. Field Corrective Action 13-1
13.2. Laboratory Corrective Action 13-2
13.3. Corrective Action During Data Validation and Data Assessment 13-2

14. Quality Assurance Reports to Management 14-1

Tables

1 Contract Laboratory Analytes and Quantitation Limits

2 Summary of Internal Quality Control Procedures and Field Measurements - QA/QC Program

3 Laboratory Control Limits

4 Solid Waste Management Units - South Area

5 Solid Waste Management Units - West Area

6 Solid Waste Management Units - East Area

7 Location, Type, and Number of Samples

8 Matrix Summary and QC Samples

9 Sample Containers and Preservation Requirements

10 Required Holding Times

11 Analytical Method References

Figures

1 Site Location Map
2 East/West/South - Area Locations
3 SWMUs Proposed Sampling Locations - South Area
4 SWMUs Proposed Sampling Locations - East Area
5 SWMUs Proposed Sampling Locations - West Area
6 Off-Site Proposed Sampling Locations
7 Investigatory Logic Algorithm

Attachments

1 Chain of Custody Procedures
2 Waste Management Plan

1. Project Description

1.1. Introduction

This Quality Assurance Plan (QAP) provides quality assurance/quality control (QA/QC) criteria for work efforts associated with the installation of monitoring wells and related sampling tasks necessary to perform a RCRA Facility Investigation (RFI) of the Reichhold Chemicals, Inc. facility (RCI) located in Ferndale, Michigan. This document is site-specific and has been prepared in accordance with the U.S. EPA *Region V guidance document Content Requirements for RCRA Facility Investigations (RFI) Quality Assurance Project Plans, October, 1990.* Prior to deviations from the protocols outlined herein, the Quality Assurance (QA) Officers for this project (refer to Section 2) will be notified. The objectives of this QAP are to provide sufficiently thorough and concise descriptions of the measures to be applied during the RFI that the data generated thereby will be of a known and acceptable level of precision and accuracy. This QAP provides comprehensive information regarding the project description and personnel responsibilities, and sets forth specific procedures to be used during sampling of relevant environmental matrices, other field activities, and analysis of data.

The following items are addressed in this plan:

1. QA objectives for measurement of data, including precision, accuracy, completeness, representativeness, and comparability;
2. sampling procedures;
3. hydrogeological procedures;
4. sample custody;
5. calibration procedures, references and frequency;
6. internal Quality Control (QC) checks and frequency;
7. QA performance audits, system audits and frequency;

8. QA reports to management;

9. preventative maintenance procedures and scheduling;

10. specific procedures to be used to routinely assess data precision, accuracy, completeness, representativeness, and comparability;

11. data validation; and,

12. corrective action.

The facility is currently undertaking a Corrective Action Program to evaluate the nature and extent of releases of hazardous waste constituents from solid waste management units and to identify, develop and implement appropriate corrective measures to adequately protect human health and the environment. The corrective action requirements identified by this program will be integrated into the facility RCRA Part B permit.

The Corrective Action Program as indicated by the U.S. EPA Guidance Document entitled *RCRA Corrective Action Plan - Interim Final*, U.S. EPA\530-SW-88-028, June 1988, is developed in three phases; the RCRA Facility Investigation; Corrective Measures Study (CMS); and Corrective Measures Implementation (CMI). At this time, RCI is proceeding with the initial phases of an RFI.

An environmental characterization of the facility is being proposed by RCI. Portions of the investigation related to solid waste management units and other areas of concern requiring investigation under the RFI program are therefore a subset of the comprehensive environmental characterization that is being performed at the RCI Ferndale plant under RCRA. A Work Plan for the comprehensive environmental characterization of the facility entitled; *RCRA Facility Investigation Work Plan* (the Work Plan) is being submitted under separate cover.

1.2. Site Description

The facility presently owned, and operated until 1988 by RCI is located at 601 Woodward Heights Boulevard in Oakland County, Ferndale, Michigan. The facility coordinates are 42 degrees, 28 minutes, 0 seconds north latitude and 83 degrees, 8 minutes, 0 seconds west longitude. The facility is a closed manufacturing facility

occupying approximately 602,000 square feet on 3 tracts which total 14 acres of land in Ferndale, Michigan (Figure 1 - Site Location Map). The site is bisected by an active northwest-southwest trending railroad track network. This railroad track network, the Grand Trunk Western Railroad, splits the west and south sections of the facility from the east section. RCI also owns nearby properties which were not used for industrial activities.

1.3. Site History and Background

In 1927, synthetic resin and polymer production began in the West Area of the facility. At the beginning of World War II, the present East Area of the plant was developed by the Defense Plant Corporation and was used primarily to manufacture phthalic anhydride. The buildings within the East Area were constructed in their present numerical order. At the termination of the war, RCI assumed control of the East Area of the plant. In the early 1950's, a lumber business within what is now referred to as the South Area was destroyed by fire. RCI purchased and subsequently developed the South Area, utilizing the yard primarily for the storage of finished goods. Figure 2 identifies the locations of each of the separate areas which comprise the facility. The plant manufactured synthetic resins and polymers including phenolic, alkyd and epoxy resins; coppal, styrene and polyester polymers; phthalic anhydride; and distilled glycerin prior to operations termination in 1989.

1.4. Process Description

During the period beginning in 1927 and ending in December, 1988, RCI used the Ferndale plant site for the production of synthetic resins and polymers. Specific classes of products manufactured at the site included:

- Alkyd resins;
- Epoxy ester resins;
- Polyester resins;
- Phenol-formaldehyde resins;
- Urea formaldehyde resins;
- Melamine formaldehyde resins;
- Styrenated alkyd resins; and
- Polyurethane resins.

Waste streams generated included over age or off-specification products, waste waters, and accidental spillage during transfer of raw materials and products. An extensive list of raw materials and solvents was used during the operation of the facility.

1.5. Previous Studies

Following termination of the manufacturing operation in 1988, RCI retained the services of IT Corporation, and later O'Brien and Gere Engineers, Inc., to perform a series of investigations at the Ferndale Site. These investigations were performed from September 1989 through October, 1991 and included two separate invasive studies. The Phase I investigation, performed by IT Corporation in September, 1989, included soil boring and monitoring well installations, and a soil gas survey along the east/west area as well as the South Tank Area Tank Farm. The Phase II study, conducted by O'Brien and Gere Engineers from June 1991 to October 1991, included the installation of additional shallow monitoring wells, a soil boring program, a Ground Penetrating Radar (GPR) survey, and a second ground water sampling event. These investigations are described in detail in the *RCRA Facility Investigation Current Conditions Report*, July 1993, Appendix A to the RFI Work Plan.

1.6. Project Objectives

1.6.1. Specific Objectives

In order to evaluate the nature and extent of release of hazardous wastes or constituents from solid waste management units (SWMUs), a field investigation program will be conducted.

The overall objectives of the field investigations are to obtain sufficient accurate information on environmental conditions to allow identification, evaluation and selection of appropriate corrective measures. The information to be collected during the field investigation phase is presented in Section 3 of the Work Plan.

The scope of work identified in this plan is to:

1. Investigate soils, sediments, and sludges in the vicinity of listed SWMUs, underground storage tanks, sewer lines, fuel lines, and fuel-storage areas.

2. Investigate and monitor ground water hydraulics and ground water quality upgradient and downgradient of suspected source areas.

3. Characterize the geology of the various flow systems and confining layers present at the site.

4. Identify the corrective measures that could be used to rectify environmental contamination that is identified.

5. Prepare closure documents for sites that do not pose a threat to the environment.

Data collected from the field investigation program will be tabulated or graphed and reviewed by the QA Officer. Following validation, the information will be supplied to the RCI Project Supervisor to allow site-wide assessment of environmental conditions.

1.6.2. Task Objectives and Intended Data Usages

Field investigations will include surface soil sampling and soil borings and ground water monitoring. Soil samples will be collected from either surface or subsurface borings in defined areas to further identify possible sources of residual materials. Ground water monitoring will be performed to provide additional ground water quality data pertaining to source area characterization and site wide ground water chemistry.

Target parameters and associated detection limits for laboratory analyses of each matrix are listed in Table 1. Field measurements and reporting charts are listed in Table 2.

1.6.3. Data Quality Objectives

To achieve these project and specific objectives, Data Quality Objectives (DQOs) were established in order to develop an analytical database of sufficient quality to support conclusions made as a result of this investigation. Therefore, requirements for data quality parameters such as: detection limits, precision, accuracy, completeness, representativeness, and comparability are specified in this document.

DQOs are quantitative and qualitative statements specifying the quality of the environmental data required to support the decision-making process. DQOs define the total uncertainty in the data that is acceptable for each specific activity conducted during the in-

vestigation. This uncertainty includes both sampling error and analytical error. Ideally, zero uncertainty is the intent; however, the variables associated with the process (field and laboratory) inherently contribute to the uncertainty of the data. It is the overall objective to keep the total uncertainty within an acceptable range that will not hinder the intended use of the data.

Analytical requirements equivalent to Level IV, as described in the U.S. EPA guidance document: *Data Quality Objectives for Remedial Response Activities* (U.S. EPA 540/G-87/1003), will be achieved for laboratory analyses. This DQO level implies the use of USEPA analytical methods, reporting and deliverable requirements and validation of the data. Field analyses and measurements will adhere to Analytical Levels I and II. Level I implies the use of portable instruments for field screening, while Level II implies the use portable analytical instruments and calibration procedures for in-field measurements. The remainder of this QAP describes the specific approaches that will be taken to achieve the required DQOs. Table 3 lists methods and method specific quality control criteria which will be adhered to during sample collection and analysis.

Data collected during the field investigation will be of sufficient quality to meet these DQOs. In order to assess adherence to DQOs, O'Brien & Gere has developed the QA/QC program described in this QAP.

Two types of analytical support will be utilized to achieve the DQOs necessary for this investigation: field analyses and laboratory analyses.

Field Analyses and Measurements Field analyses will include on-site analysis of pH, specific conductance, and temperature in ground water. These field investigation activities do not require sample collection, but nonetheless involve measurements for which QA concerns are appropriate. These activities will adhere to DQO Analytical Level II.

Laboratory Analyses The method quantitation detection limits are presented in Table 1. Table 3 lists requirements for control limits and audit frequency.

1. Laboratory analysis, analytical QA/QC and data reporting procedures will be based upon Test Methods for Evaluating Solid Waste, SW-846, 3rd Edition, USEPA, (SW-846), and

Methods for Chemical Analysis of Water and Wastes, USEPA, Revised March 1983. Deliverable and reporting requirements for these analyses have been established in order to provide fully validated and documented sample analyses. These analyses will be equivalent to DQO Analytical Level IV. Target parameters will include volatile organics compounds (VOCs), semivolatile organic compounds (SVOCs), and metals.

1.7. SWMU Identification and Sample Rationale

Sixty nine SWMUs have been identified by the Michigan Department of Natural Resources (MDNR) as potential sources or locations of soil and/or ground water contamination. According to the RCRA Facility Assessment (RFA) prepared by the MDNR and incorporated into the Corrective Action Consent Order (CACO), each of these areas has a potential for release of hazardous constituents.

The EPA, in the USEPA Proposed Rule on RCRA Corrective Action for SWMUs at Hazardous Waste Management Facilities, July 1990, indicates that there may be releases at a facility that are not associated with SWMUs. According to this aforementioned document, a definition of a SWMU is:

"Any discernible unit at which solid wastes have been placed at any time, irrespective of whether the unit was intended for the management of solid or hazardous waste. Such units include any area of a facility at which solid wastes have been routinely and systematically released."

Certain types of releases are not considered by the USEPA to be SWMUs using the "routine and systematic" criterion:

a) one-time spill of hazardous wastes

b) leakage from a chemical product storage tank

c) releases from production processes and resultant contamination unless the releases are resultant from systematic and routine practices

The above routine and systematic release criteria for a SWMU tends to preclude certain areas from being classified as SWMUs. Where the definition of a SWMU does not fit the criteria of a systematic or

routine release, these areas may be reclassified as Areas of Concern in the RFI Report. In addition, certain areas had a low release potential due to unit design, types of waste managed and management practices. At such areas, the SWMUs do not have the required criteria for systematic and routine releases may be eliminated after implementation of the RFI.

Tables 4, 5 and 6 are a summation of the recommended investigations at each SWMU identified within the RFA for the south, west and east areas of the site, respectively. Tables 4, 5 and 6 also indicate which SWMUs can be grouped based upon commonality discussed above. Figures 3, 4, and 5 provide a depiction of the SWMUs. Figure 6 depicts the off-site investigatory approach. A total of 69 SWMUs have been identified by the MDNR. Figure 7 is the investigatory logic depiction for the RFI.

Quantitative and qualitative field investigative sampling methods including required laboratory analyses pertaining to the RFI areas are outlined on Table 6 for the RCI Ferndale investigations. Investigative methodologies to be used are listed and described below:

1. Building Foundation Integrity Evaluation
2. Electronic Cone Penetration Testing with Laboratory Prescreening Utilizing a Portable Gas Chromatograph
3. Shallow Soil Sampling
4. Subsurface Soil Borings
5. Monitoring Well Installation
6. Ground Water Sampling
7. In-Situ Hydraulic Conductivity Testing

These methodologies are more fully described in Section 4.

2. Project Organization and Responsibility

2.1. Project Organization

Project organization is discussed in Section 2 of the RFI work plan.

2.2. Laboratory Responsibilities

The contract laboratory will perform laboratory analyses for VOCs, SVOCs, and metals in water and soil matrices as specified in this QAP.

3. Quality Assurance Objectives for Measurement Data In Terms of Precision, Accuracy, Representativeness, Completeness, Comparability

This section discusses the following five quality assurance parameters: precision, accuracy, representativeness, comparability, and completeness (PARCC parameters). Provided below are concise definitions of the PARCC parameters and quantitative requirements for precision, accuracy, and completeness as they pertain to this project for field and laboratory measurements. Further, this section discusses the methods used to measure precision, accuracy, and completeness, as well as, the procedures used to verify that the required representativeness and comparability goals are achieved.

3.1. Precision

Precision describes the reproducibility of results. It is defined as the agreement between the numerical values of two or more measurements that have been made in an identical manner. Precision will be expressed in a variety of manners, including: relative percent difference, percent relative standard duration, percent difference, and range. Precision will be determined through the analysis of laboratory and field duplicate samples. Field duplicate analyses will measure both field and laboratory precision; therefore, the results may contain more variability than laboratory duplicates which measure only laboratory performance. It is also expected that soil duplicate results will have greater variance than water matrices due to difficulties associated with duplicating soil samples. Section 12 contains the procedures and equations used to measure precision. Table 3 specifies the requirements for laboratory precision.

3.2. Accuracy

Accuracy is a measure of closeness of an individual measurement or an average of a number of measurements to the true value, and will be expressed in terms of percent recovery. Accuracy will be determined through the analysis of surrogate spikes, reference standards, and matrix spike samples. The matrix spike sample analysis is designed to provide information about the effect of the sample

matrix on the digestion and measurement methodology. Samples will be spiked with surrogate compounds prior to sample preparation. The evaluation of the results of these surrogate spikes will not necessarily be straightforward. The sample itself may produce effects due to such factors as interferences and high concentrations of analytes. Reference standard recoveries will provide an independent verification on the calibration procedure and the percent recovery of these standards provide will a measure of accuracy. Blank samples will be analyzed to determine if field laboratory contamination is affecting analytical accuracy. Section 12 contains the procedures and equations used to measure accuracy. Table 3 specifies the requirements for laboratory accuracy.

3.3. Representativeness

Representativeness refers to the degree to which a sample taken from a site accurately represents the matrix being sampled. Representativeness will be achieved through the use of standard operation procedures for the collection and preservation of samples as described in this QAP. Two means for achieving representativeness that will be employed during this investigation are as follows:

1. Three to five well volumes will be purged before sampling monitoring wells to ensure that standing water is removed and that the samples are representative of the ground water aquifer.

2. Sampling grids will be designed with sufficient spacing and coverage to obtain a representative cross-section and delineation of an area of contamination.

3.4. Completeness

Completeness refers to the process of obtaining all required data as outlined in this QAP and the Work Plan. Completeness is calculated by determining the percentage of measurements judged to be valid compared to the number of measurements proposed in this QAP. The goal for field and lab completeness for this project will be ninety-five percent. Section 12 contains the procedures and equations used to measure completeness.

3.5. Comparability

Comparability of data refers to the use of consistent procedures, reporting units, standardized methods of field analysis and standardized data format with document control and data validation. Adherence to the standard procedures outlined in this QAP will maximize the probability that data generated from the different laboratories will be validly compared to one another.

4. Sampling Procedures

4.1. Objective

The objective of this sampling section is to document the sampling procedures and practices that will be used in this investigation. Information will be obtained as to the location, amount, and vertical and horizontal extent of residuals at the facility. The methods that will be used to carry out these activities are detailed in the following subsections.

4.2. Sampling Locations

4.2.1. Documentation of Sample Locations

A log book listing the various samples to be collected will be prepared for use at the facility. The log book will also contain the type of sample and analytical matrix for each of the samples to be collected. The sample team leader will be responsible for recording the sampling location and date/time in the field sampling log book. The location will be described, as necessary, in the log book with a sketch that includes distances from field landmarks.

4.2.2. Specific Sampling Locations

Soil boring locations and ECP screening locations are presented in Figures 3, 4, 5 and 6. Tables 4, 5 and 6 discuss rational for selecting these sample locations.

4.3. Sample Matrices and Field/Lab Parameters

The following matrices will be sampled and analyzed as part of the RFI sampling efforts:

1. Ground Water
2. Subsurface Soil

Specific field and laboratory parameters associated with each matrix and/or specific sampling locations are detailed in Table 7.

4.4. Field QA/QC Samples

In order to evaluate data quality, the following QA/QC sample types will be collected during the field investigation. Table 8 lists the number of samples to be collected by matrix type and the number of field QC samples to be collected.

4.4.1. Duplicate Samples

Collection of laboratory duplicate and/or matrix spike duplicate samples will provide for the evaluation of the laboratory's performance by comparing analytical results of two samples from the same location. Field duplicate samples will be collected to evaluate field sample collection procedures. Field duplicate samples are duplicate samples collected from one location and sent to the laboratory blind (with two different sample numbers). Laboratory duplicate or matrix spike duplicate samples will be included for each matrix at a minimum rate of five percent (5%). If fewer than twenty samples are taken during a particular sampling episode, one duplicate collection will be performed. Field duplicate samples will be included for each matrix at a minimum rate of ten percent (10%). If fewer than ten samples are taken during a particular sampling episode, than one duplicate collection will be performed. The rate of duplicate sample collection is listed in Table 8.

Duplicate water samples will be obtained by alternately filling sample containers from the same sampling device for each parameter. Samples for volatile organic analysis from monitor wells will be filled from the same bailer full of water whenever possible and be the first set of containers filled. When other sampling devices are used (bladder pumps), the vials for volatile organics should be alternately filled.

Soil and sediment duplicates shall be collected as separate aliquots of the same soil boring, core sample etc. All samples are collected as grab samples (i.e. no composite).

4.4.2. Matrix Spikes (MS) and Matrix Spike Duplicates (MSD)

MS and MSD samples are additional sample aliquots used primarily to determine the accuracy and efficiency of the analysis extraction, as well as, interferences caused by the matrix. These are collected in the same manner as field duplicates (i.e. grab samples, no compositing) as described above. Relative percent differences between spike samples will indicate the precision of the data. MS and MSD samples are to be included for each matrix at a minimum rate of five percent (5%) each. If fewer than twenty samples are collected during a particular sampling episode, one MS and one MSD collection will be performed. MSD samples will not be collected for analyses that require laboratory duplicate sample collection. The rate of MS and MSD sample collection is listed in Table 8.

4.4.3. Field/Equipment Blanks

Field/equipment blanks will consist of a sample of the distilled water that is the final rinsate of the decontaminated sampling equipment. These blanks will be collected at a minimum frequency of ten percent (10%) per matrix. If fewer than ten samples are taken during a particular sampling episode, one field blank collection will be collected. These samples will be subjected to the same analyses as the environmental samples. The rate of field/equipment blank sample collection is listed in Table 8.

4.4.4. Trip Blanks

Trip blanks will consist of distilled water from the laboratory performing the volatiles analyses. The trip blanks will be shipped in the same containers, at the same time, on the same carrier, and to the same destination as each shipment of samples. The trip blanks will be analyzed for the same volatile organics analyses as those environmental samples contained in the cooler. The rate of trip blank sample collection is listed in Table 8.

4.5. Sampling Procedures

Table 9 lists the sample containers and types of preservatives that will be used for sample collection. Table 10 presents holding times that will be met during sample collection and analysis. The O'Brien & Gere Standard Operating Procedures are as follows for these field efforts. If procedures shall be altered, these modifications must be presented and approved by USEPA Region V in a QAP addendum.

Sample container preparation and criteria are presented in Section 4.5.13. Equipment decontamination procedures are presented in Section 4.5.11. The order of sample analytical fraction collection is presented in Section 4.5.12.

This section discusses the operation of specific brands and models of field analytical equipment. alternative equipment may be used after approval of an operational protocol by the QA officer.

4.5.1. Soil Boring Protocol

Soil borings will be installed as required by Sections 3.04 and 3.06 of the Work Plan.

Drilling and Sampling Procedures

A. Test borings shall be completed using a minimum 3 3/4 inch, hollow stem auger drilling techniques per American Society of Testing Materials (ASTM) D-5902-90. Samples of the encountered subsurface materials shall be collected continuously at each location. The sampling method employed shall be the ASTM D-1586-84 Split Barrel Sampling Method using either a standard 2 foot long 2 inch outside diameter split spoon sampler with a 140 lb. hammer, or a 3 inch outside diameter sampler with a 300 lb. hammer.

B. Upon retrieval of the sampling barrel, the following step by step procedure will be employed:

   1. If VOC analysis is to be performed on a particular boring, 2 - 120 ml wide mouth glass certified clean jars with the proper labeling (the site, boring number, interval sampled, date, and time) will be filled and placed on ice in a cooler after a recovery measurement is taken on the retrieved sample with a tape measure and recorded on a boring field log sheet (attached). Chain of Custody documentation will be initiated at this time in accordance with the Sample

Custody Section of the QAP. The sample number will be written into the field log book in accordance with Section 3.10.2 of the RFI Work Plan.

2. An additional, preweighed, 120 ml, certified clean jar will then be approximately half filled and aluminum foil placed over the top of the jar before the lid is secured. After filling, each jar will be weighed to determine the total amount (gms) of sample collected. After allowing the sample to reach ambient air temperatures, the sample will be screened for VOCs using a PID calibrated per the SOP. The sample will be screened by removing the jar lid and inserting the PID probe tube through the aluminum foil. The results will then be recorded on the Test Boring Log Sheet and referenced in the field logbook. The data will be standardized to compensate for sample size, by dividing the weight of the sample into the recorded PID values.

3. The remaining sample bottles required for the analysis of that particular interval will be labeled as above and filled. They will be placed on ice in the sample cooler. Table 9 illustrates the sample bottle requirements.

4. The sample geology will then be described including:

   1) soil type
   2) color
   3) moisture content
   4) odor and miscellaneous observations such as organic content, and mottling.

   This information will be documented on the Test Boring Log Sheet.

5. QA/QC sampling (duplicates, matrix spikes, matrix spike duplicates, equipment blanks) will be performed in accordance with the descriptions included in Section 4.04.

6. The remainder of the soil sample will be included in the cuttings pile to be transferred to DOT approved drums for analysis in accordance with the Waste Management Plan (Attachment 2 of the QAP).

C. These procedures will be followed for each interval of the boring until the ground water table is encountered.

D. The augers will then be extracted and grouted concurrently. Remaining cuttings will be placed in DOT Approved drums to await analysis in accordance with the Waste Management Plan.

E. The borings will be grouted to the surface by pumping a cement/bentonite grout through tremie pipe to existing grade. The grout will be mixed following calculations from the Halliburton Cementing Tables. This will consist of a mixture of Portland Cement (ASTM C150, Type II), bentonite and water in the proportion of not more than 9 parts by weight of cement to 1 part bentonite with not more than 6 gallons of water per bag of cement.

F. Samples collected for laboratory analysis will be shipped with proper chain of custody documentation within 36 hours of collection, and will arrive at the laboratory within 72 hours of collection.

4.5.2. Shallow Monitoring Well Completion Protocol

Purpose and Scope

Shallow monitoring wells may be completed in selected areas to evaluate possible ground water impacts in potential and/or identified source areas. The proposed wells will be installed to intersect the perched water table. If field screening with an HNu Model 101 photoionization detector indicates potential contamination, a soil and/or water sample will be collected from the perched zone for analysis.

Quality Assurance

A. Acceptable PVC riser pipe manufacturers:

1. Timco Manufacturing Co.
2. Johnson Well Screens
3. Approved Equal

B. Acceptable bentonite manufacturers:

1. American Colloid Co.
2. Dow Chemical Co., Dowell Division
3. Approved Equal

C. Acceptable filter manufacturers:

1. Jessie S. Mori & Son, Inc.
2. Parry Quartz Gravel Co. Silcia Sand
3. Approved Equal

Drilling Procedures

A. Shallow monitoring wells will be completed utilizing 4.25 inch I.D. hollow-stem auger drilling methods per ASTM D-5092-90. Petroleum lubricating oils will not be used on downhole equipment. The wells will be constructed as unconsolidated formation wells as described in the Work Plan.

B. During the drilling of the well, samples of encountered subsurface materials will be collected continuously at each location. The sampling method employed will be the American Society of Testing Materials (ASTM) D-1586-84/Split Barrel Sampling Method using either a standard 2 foot long, 2 inch outside diameter split spoon sampler with a 140 lb. hammer or a 3 inch outside diameter sampler with a 300 lb. hammer.

C. A geologist will be on site during the drilling operations to fully describe each soil sample including: 1) soil type; 2) color; 3) percent recovery; 4) moisture content; 5) odor; and 6) miscellaneous observations, such as organic content. The supervising geologist will be responsible for retaining a representative portion of each sample in a one pint glass jar labeled with:

1) the site;
2) the boring number;
3) the interval sample/interval preserved;
4) the date; and
5) the time of sample collection.

D. Prior to screening, the PID will be calibrated in accordance with the protocols established in the SOP. Upon retrieval of each soil sample, a portion of the sample will be placed in a clean glass jar and aluminum foil will be placed over the jar mouth and secured with a lid. Samples will be allowed to reach ambient air temperature, then screened with the PID for VOCs. This will be accomplished by removing the jar lid and inserting the PID sampling tube through the aluminum foil cover. Total VOC readings

measured in ppm will be recorded on the boring logs adjacent to the sample description.

E. During drilling, the contractor will be responsible for obtaining accurate and representative samples, informing the supervising geologist of changes in drilling pressure, and keeping a separate general log of soils encountered. Included in this log will be a record of blow counts (i.e. the number of blows from a 140 pound soil sample drive weight required to drive the split spoon sampler in 6-inch increments). The drilling contractor is also responsible for installing monitoring wells to levels directed by the supervising geologist following specifications further outlined in this protocol.

F. The borehole diameter will be at a minimum 6 inches at the monitoring wells. If hollow stem augers are utilized, the I.D. of the augers will be a minimum of 4.25 inches.

G. Drill cuttings will be contained in drums, properly labelled, and transported to a designated on-site storage location. They will be handled according to the Waste Management Plan.

Well Casing

A. The well casing will be constructed of 2-inch or 4-inch internal diameter stainless steel at the discretion of the supervising hydrogeologist.

B. Casing lengths will be joined using water tight flushed threaded joints. No oils, lubricants or glues will be used to facilitate well construction.

Well Screens

A. Well screens will be 5 ft lengths, or as specified by the on-site hydrogeologist, of 2-inch or 4-inch internal diameter stainless steel screen, threaded flush joint, continuous wire-wound with 0.010-inch slots. The screen will be installed to straddle the first encountered water bearing zone.

Filter Material

A. The annular space between the well screen and the borehole will be filled with washed silica sand with at least 90 percent of the retained size greater than 0.010 inches. The filter material will extend from the base of the hole to

a depth of 2 feet above the well screen. This measurement will be repeatedly checked using a weighted tape.

Bentonite Seal

A. A bentonite pellet seal or slurry will be installed a minimum of 2 ft above the filter pack. If the filter pack extends above the water table, the pellets will be hydrated with potable water prior to installing grout. If a slurry is used, the volume necessary to fill the annulus a minimum of 2 ft. will be calculated using a conversion chart from the Halliburton Cementing tables. The slurry will be emplaced using a tremie pipe.

Well Grouting

A. Following bentonite seal installation, a cement/bentonite grout will be placed around the outside of the well riser and within the annular space above the bentonite seal to seal off surface water inflow. The cement/bentonite grout annular seal will extend from the top of the bentonite seal (7.A.) to the ground surface.

B. The grout material will consist of a mixture of Portland Cement (ASTM C150, Type II) bentonite and water in the proportion of not more than 9 parts by weight of cement to 1 part of bentonite with not more than 6 gallons of water per bag of cement. Required amounts of grout to be pumped into the annulus will be calculated using the Halliburton Cementing tables.

Well Head Completion

A. In non-traffic areas the acceptable method of finishing a monitoring well will be to install a minimum 4-inch diameter vented steel pipe over the PVC riser. This steel protective cover will be cemented a minimum of 2.5 ft. below the ground surface. In addition, the steel protective cover will extend a minimum of 1 foot and a maximum of 3 ft above the ground surface. This protective steel pipe will be painted prior to installation and allowed to dry thoroughly. The color of the paint will be designated by an RCI representative. A well identification number will be stenciled on each well riser and cover. A concrete pad will be constructed around the protective steel casing. The depth of this pad shall extend a minimum of 9 inches below grade and extend laterally a minimum of 1 foot away from the protective steel casing in all directions. This pad will be sloped so as to allow water to drain away from the well.

B. In traffic areas the wellhead will be completed as follows. A flush manhole cover will be built into a concrete pad. The concrete pad will be 2 ft by 2 ft, and extend a minimum of 9 inches below grade. This apron will be constructed with 3000 psi ready-mix concrete, and be crowned to provide and to meet the finished grade of the surrounding pavement.

Well Development

A. All monitoring wells will be developed or cleared of fine grained materials and sediments that have settled in or around the well during installation to allow the screen to transmit representative portions of the ground water.

B. The development will be by either low yield pumping or bailing of ground water from the well. The determination of which method to use is dependent upon the size and depth of the well and the volume of ground water in the well. For either the pumping or bailing method, a decontaminated pump or bailer will be utilized and subsequently decontaminated after each use. Ground water will be pumped from the bottom of the well. Bailing will utilize a bottom loading stainless steel bailer and new polypropylene rope.

C. Well development will continue until the well yields clear, sediment-free water as approved by the supervising hydrogeologist.

D. Sediment and water generated during well development will be contained in drums provided by the Contractor and stored at a specified location on the Site. Development water may be initially discharged to a settling pan, then pumped to containment, leaving discharged sediment for separate containment.

Control of Contaminated Sampling Materials

Disposable sampling and safety equipment and excess samples may be generated during sampling operations. These materials will be placed into drums (separate drums for solids, decontamination debris, and disposable equipment). Procedures for waste handling are specified in the Waste Management Plan.

4.5.3. pH Sampling

1. Parameters to be measured: pH

2. Range of Measurement (working linear range): 0 to 14

3. Limit of Detection: 0

4. Sample Matrix: Aqueous

5. Principal, Scope and Application: The pHep+[R] digital pH tester allows a quick determination of pH and it covers the full range of pH without the need of an adapter. Some of the features of the pHep+[R] pH tester are:

   - Slope and zero adjustments.
   - Compact size.
   - Digital display liquid-crystal type, 1/10 unit display.
   - Rugged instrument case plus handy carrying case.

6. Interferences and Corrective Actions: Coating of the pH bulb can lead to erroneous readings including shortened span. The type of coating will determine the cleaning technique. Soft coatings can be removed by vigorous stirring or by use of a squirt bottle. Organic chemical or hard coatings should be chemically removed. In no case should the bulb be mechanically cleaned, because abrasion can lead to permanent damage.

7. Precautions: Do not allow water to enter unit anywhere above indicated sample line. Erroneous readings will result.

8. Sample Size, Collection, Preservation, and handling: The aqueous sample will be poured directly from the bailer to a glass jar and pH will be measured immediately.

9. Routine Preventative Maintenance, Including Procedures and Frequency: The only maintenance required is battery replacement and electrode cleaning. Replace batteries every six months to reduce the danger of corrosion due to leaky batteries. To replace batteries, remove the top cover.

10. Reagents and Calibration Standards: Use buffer solutions, 4, 7, and 10 pH.

11. Calibration Procedures:

    1. Remove the unit's protective cap.

    2. Stir the unit in a rinse solution.

    3. Shake the unit with a snap action to remove residual drops of solution.

    4. Stir the unit in a 7.0 buffer and allow the unit to rest against the jar's side.

    5. Allow the reading to stabilize and use the pH meter zero adjustment to make the meter read the buffer value (remember to adjust to the buffer's pH value according to the temperature of the buffer).

    6. Repeat steps 2 & 3.

    7. Stir the unit in a second buffer of pH 4 or 10 and allow the unit to rest against the jar's side.

    8. Allow the reading to stabilize, and use the pH meter slope adjustment to make the meter read the buffer value.

    9. Repeat steps 2 thru 5, and then repeat steps 2 & 3 and 7 & 8. It may be necessary to work back and forth between the two buffers several times to secure adjustments which do not require changing between buffers.

12. Method Setup:

    1. Remove the unit's protective cap.

    2. Vigorously stir the unit in a rinse solution.

    3. Shake the unit with a snap action to remove residual drops of solution.

    4. Stir the unit in the sample and allow the unit to rest against the jar's wall.

    5. Allow the reading to stabilize and then record the reading.

    6. Repeat these steps for each sample determination.

7. Between readings, rinse the electrode with Lab DI water and replace the cap.

13. The following data deliverables will be provided:

    a) Case narrative: briefly describes the sample preparation and analysis, problems encountered and corrective action taken during the process of sample preparation and analysis.

    b) Summary of calibration.

    c) Summary of sample analysis: arranged in increasing order of sample number.

    d) Summary of QC sample analyses.

    e) Instrument readings.

    f) Instrument logbook (including serial number and maintenance and repair history over the period of service provided for this specific project). Daily entries should include name of analyst, parameter measured, comments on the sample analysis and other information that may be deemed of interest.

14. Quality Control Requirements: 5% of pH samples will be checked by duplicate samples.

4.5.4. Temperature

1. Parameters to be measured: Temperature

2. Range of Measurement (working linear range): -2° to +45°C

3. Limit of Detection: -2°C

4. Sample Matrix: Aqueous

5. Principal, Scope and Application: The Key^{R} temperature meter is a battery powered instrument designed to accurately measure temperature. It uses a probe and an electronic design in a compact unit.

6. Interferences and Corrective Actions: If the meter reads very high values, check attachment of probe.

7. Precautions: Do not allow water to enter unit. Erroneous readings will result.

8. Sample Size, Collection, Preservation, and handling: The aqueous sample will be poured directly from the bailer to a glass jar and temperature will be measured immediately.

9. Routine Preventative Maintenance, Including Procedures and Frequency: The only maintenance required is battery replacement. Replace batteries every six months to reduce the danger of corrosion due to leaking batteries. To replace batteries, remove the top of the unit.

10. Reagents and Calibration Standards: The thermometer will be calibrated against an ASTM thermometer before initial use and at least once per month during the project.

11. Calibration Procedures: Place reference thermometer and Key[R] temperature meter in sample solution. Adjust screw on back of unit to match reference thermometer.

12. Method Setup: Allow time for the probe temperature to come to equilibrium with that of the water before reading. Read the temperature from the meter in degrees celsius.

13. The Following Data Deliverables Will Be Provided:

    a. Case narrative: briefly describe the sample preparation and analysis, problems encountered and corrective action taken during the process of sample preparation and analysis.

    b. Summary of calibration.

    c. Summary of sample analysis: arranged in increasing order of sample number.

    d. Instrument readings.

    e. Instrument logbook (including serial number, maintenance and repair history over the period of service provided for this specific project). Daily entries should include name of analyst, parameter measured, comments on the sample

analysis and other information that may be deemed of interest.

14. Quality Control Requirements: 5% of temperature samples will be checked by duplicate samples.

4.5.5. Conductivity

1. Parameters to be measured: micromhos/centimeter (conductivity).

2. Range of Measurement (working linear range): 0 to 2,000 micromhos/cm.

3. Limit of Detection: 10 micromhos/centimeter

4. Sample Matrix: Aqueous

5. Principal, Scope and Application: The Corning PS-17[R] Conductivity Meter is a battery powered instrument designed to accurately measure conductivity.

6. Interferences and Corrective Actions: When the cell test indicates low readings the probable cause is dirty electrodes. Hard water deposits, oils and organic matter are the most likely contaminants. For convenient normal cleaning rinse the electrodes regularly after each measurement with lab DI water.

7. Precautions: Do not allow water level to get above indicated level. Erroneous readings will result.

8. Sample Size, Collection, Preservation, and handling: The aqueous sample will be poured directly from the bailer to a glass jar and conductivity will be measured immediately.

9. Routine Preventative Maintenance, Including Procedures and Frequency: The only maintenance required is battery replacement. Replace batteries every six months to reduce the danger of corrosion due to leaking batteries. To replace batteries, remove the top cover.

10. Reagents and Calibration Standards: The meter will be calibrated against standard 84 and 1,413 micromhos/cm solutions.

11. Calibration Procedures: Calibrate the meter by adjusting the set screw until the meter reads the standard solution value. The meter will be calibrated daily.

12. Method Setup: Put the probe in the solution to be measured, allow reading to stabilize. Read the conductivity valve from the meter.

13. The Following Data Deliverables Will Be Provided:

    a. Case narrative: briefly describe the sample preparation and analysis, problems encountered and corrective action taken during the process of sample preparation and analysis.

    b. Summary of calibration.

    c. Summary of sample analysis: arranged in increasing order of sample number.

    d. Summary of QC sample analyses.

    e. Instrument readings.

    f. Instrument logbook (including serial number, maintenance and repair history over the period of service provided for this specific project). Daily entries should include name of analyst, parameter measured, comments on the sample analysis and other information that may be deemed of interest.

14. Quality Control Requirements: Blanks and field duplicates will be collected.

4.5.6. Ground Water Sampling Procedure

This SOP is being generated as a general guidance document for the completion of ground water sampling events. Procedures listed herein may be altered based on the professional opinion of the field team leader, in conjunction with the regulatory agency.

1. The ground water sampling locations will be collected from each of the newly installed and existing monitoring wells on site.

2. No composite samples will be collected.

3. The following procedures will be employed for the collection of ground water samples:

   - Assemble and inspect field equipment necessary for sample collection, verify that equipment is clean and in proper working order. Note and replace items that are in short supply or that are showing indications of wear.

   - Calibrate applicable equipment according to appropriate SOPs.

   - Examine samples, bottles, and preservatives; contact laboratory immediately if problems are found.

   - Contact laboratory to confirm sample delivery time and method of sample shipment.

   - Establish a well evacuation and sampling schedule for the activities of the day. Wells will be evacuated in general order from least contaminated to most contaminated.

   - Verify that the well is not damaged. Notify the RCI Project Manager if well damage is suspected.

   - An electronic water level indicator will be used to measure the depth to water from the top-of-casing reference point. Measurements will be collected to an accuracy of 0.01 feet and recorded on a Ground Water Sampling Log Sheet.

   - Those parts of the water level monitoring device which were placed within the well will be decontaminated using non-phosphate detergent (Alconox) and rinsed with distilled water. Decontamination solutions will be contained.

   - After determining the water level, the volume of water within the well will be calculated.

   - The volume can be calculated by using the following formula.

$$V = r*r(h)(0.49)$$

Where: V = standing water volume in gallons to be purged

r*r = inside radius of well in inches, squared

h = linear fe of standing water in the casing
(0.49) is a correction factor which includes conversion from inches to feet and the fact that three volumes are to be purged

- A minimum of three well volumes will be evacuated from the well prior to sampling.

- If a well is evacuated to the bottom of the screened interval, and is slow to recharge, only one well volume of water will be purged.

- Wells with water levels that remain 25 feet or less below the top of casing may be evacuated by using one of the following devices:
  - bailer,
  - diaphragm pump,
  - submersible centrifugal pump, or
  - "Waterra" hand pump system.

- For wells which are greater than 4 inches in diameter, a submersible centrifugal pump, submersible bladder pump, or "Waterra" hand pump system will be used.

- During evacuation of the well, the intake opening of the purge device should be positioned just below the surface of the water. If the water level drops during purging, the intake should be lowered as needed to maintain flow.

- Purged water must be collected at each well site in a temporary holding tank and retained at the site for subsequent disposal.

- Samples will be collected when pH, temperature and conductivity readings have stabilized. This occurs when
  - pH is $\pm$ 0.4 units
  - temperature is $\pm$ 2°C
  - conductivity $\pm$ 10% (or 10 micromhos/cm, whichever is greater)

- Non-dedicated well evacuation devices (those not permanently installed in the well) will be decontaminated prior to subsequent use at a well.

- After well evacuation, samples will be collected with a decontaminated bottom loading stainless steel bailer fitted with an appropriate length of polypropylene rope.

- Where practical, the same type of sampling device will be used throughout the site.

- Sample collection will be performed in a way that minimizes unnecessary agitation of the sample. (Sampling devices will be lowered slowly into the well; sample transfer will be performed gently).

- The bailer will be used to check for LNAPL and DNAPL during collection of samples.

    - LNAPL - The bailer will be lowered slowly into the water column and removed before it is completely submersed. The sample will be visually inspected for presence of an LNAPL.

    - DNAPL - The bailer will be lowered to the bottom of the well after sample collection is completed, and emptied into a clear glass jar. If a DNAPL is observed, it will be noted. Sampling will be conducted by methods identified in the Phase II ground water investigation.

- Remove the sample bottles from their transport containers and prepare the bottlers for receiving samples. Inspect labels for proper sample identification. Sample bottles will be kept cool with their caps on until they are ready to receive samples. Arrange the sampling containers to allow for convenient filling. VOC containers will be filled first. These bottles will be filled so that no headspace remains after the bottle is capped. Filter and add preservatives to appropriate samples.

- If the sample bottles cannot be filled quickly, keep then cool with the caps on until they are filled. NOTE: Samples must not be allowed to freeze.

- Fill out a self-adhesive label to include sample location, time, date, and sampler's initials, and place on the respective sample jar.

- Place containers in the appropriate coolers.

4.5.7. In-Situ Hydraulic Conductivity Testing Standard Operating Procedure

This SOP is being generated as a general guidance document for completion of in-situ hydraulic conductivity testing of monitoring wells. Procedures listed herein may be altered based on the professional opinion of the field team leader, in conjunction with the client and the regulatory agency.

1. Target Parameters: Hydraulic Conductivity of the geologic formation in the vicinity of the existing monitoring well.

2. Range of Measurement: Ft/sec to Ft/yr.

3. Limit of Detection: Ft/sec

4. Sample Matrix: Water

5. Principle, Scope, and Application:
   Principle - Hydraulic conductivity testing is used as a technique which, when used in conjunction with ground water flow directions and hydraulic gradient measurements, gives estimates of ground water flow velocities.

   Scope and Application - Hydraulic conductivity test will be performed on both newly installed and existing monitoring wells. The tests will be accomplished using conventional withdrawal and recovery methods which were discussed in Section 4.01.08. If a significant drawdown can not be obtained by this method, an electronic data logging system will be utilized.

6. Interferences and Corrective Actions: Active ground water withdrawal in the vicinity of testing. Measures will be taken so that production withdrawal wells are not in use at the time of testing.

7. Safety Precautions: Level D protective equipment will be worn for the performance of the conductivity tests.

8. Sample Size, Collection, Preservation, and Handling: Not Applicable

9. Apparatus and Materials: A stainless steel, bottom loading bailer and a water level probe will be utilized for the monitoring wells that can be tested with the withdrawal recovery method. For the wells that can not be tested with this method, an electronic data logging system will be used.

10. Routine Preventative Maintenance: Routine battery pack checks are required on data logging equipment. Systems typically contain two 6-volt sealed lead acid cells of 2.6 AH capacity. Back up power is provided by a 3-volt lithium battery.

    The main battery packs should be charged before every data collection event. The backup battery is soldered onto the circuit board and therefore should be checked and replaced by qualified service personnel.

11. Calibration Procedures: Calibrated at factory and sealed

12. Data Treatment: Data from tests conducted on confined aquifers will be evaluated using the Cooper, et al method, after *Cooper Jr., H.H., Bredehoeft, J.D., and Papadopulos, I.S., "Response of a Finite Diameter Well to an Instantaneous Charge of Water"*, Water resources Research - US Geological Survey, Washington, D.C. First Quarter 1967, Vol. 3. No. 1, pp. 9-15.

13. Data Deliverables: Data will be in the form of hydraulic conductivity values for the aquifer materials in the vicinity of the monitoring well being tested. Data will be utilized in the hydrogeologic evaluations of the site and incorporated into the final RFI report.

14. Quality Control Requirements: - Rising and falling head tests will be performed at each well to provide confirmation data. Decontamination will be performed on the displacement slugs used to create positive hydraulic potential differences or the bailer used to create negative hydraulic potential differences and downhole transducers and cables. Equipment will be decontaminated in accordance with the procedures for ground water sampling equipment decontamination included in Section 4.05.12.

4.5.8. ECP Procedure and Data Acquisition

1. Procedure

The Electronic Cone Penetration Test (ECP) consists of smoothly pushing a small diameter, instrumented probe (penetrometer) into the ground while a computer data acquisition system records and analyzes response of the soil to penetration. The ECP penetrometer models a foundation pile under failure load conditions. ECP data are used to develop continuous, high resolution profiles of in-situ soil conditions rapidly, accurately and economically.

Soil resistance to penetration, acting on the tip and along the sides of the penetrometer, is measured during ECP. ECP soil resistance measurements are highly accurate and repeatable, and allow for the determination of stratigraphy and various other geotechnical parameters. Performance of cone penetration testing is specified by ASTM Standard D3441.

A piezometric pressure transducer is added to the basic ECP penetrometer to acquire both geotechnical and hydrogeological data. This test is called a Piezometric Cone Penetration Test (CPTU). A soil electrical conductivity sensor is added to the penetrometer (CPTU-EC) to acquire geotechnical, hydrogeological and geochemical data. Penetrometer groundwater samplers are used during geo-environmental studies.

The CPT(U) penetrometer is mounted at the downhole end of a string of sounding rods. A hydraulic ram is used to push the rod string and penetrometer into the ground at a constant rate of 4 ft. per minute. Electronic signals from the penetrometer sensors are transmitted by a cable, strung through the hollow sounding rods, to a data acquisition and display computer system.

A 3 axle truck is used to carry the penetrometer system. Twenty tons of truck weight and ballast counteract the thrust of the hydraulic ram. The work area is enclosed which allows for all-weather operations. Field computers, groundwater samplers, electrical power, lighting, compressed air, steam cleaner, grout pump, water tank and spare parts are included within the penetrometer truck, providing self-contained operations.

No borehole is required during penetrometer operations because penetrometers are directly thrust into the soil from the ground surface. Pressures of up to 2 million pounds per square foot can be applied to the tip of the penetrometer for penetration of most soils finer than coarse gravel. Asphalt pavements can usually be penetrated by penetrometer methods without predrilling.

Site disturbance is minimized since no borehole cuttings or drilling fluids are generated during penetrometer operations. Personnel exposure to potentially contaminated soil during penetrometer operations is significantly less than exposures during drilling operations. Penetrometer downhole equipment is readily decontaminated by steam cleaning during retrieval, when contaminated soils are encountered. Open holes left after penetrometer retrieval can be sealed using bentonite grout.

Three to nine hundred linear feet of geotechnical ECP (without piezometric or electrical conductivity measurements) can be performed in one day, depending on site access. Depths in excess of 100 ft. can be achieved, depending on site stratigraphy.

An uninstrumented prepunch tool, consisting of a steel tip on the end of the sounding rod string, can be used to push aside subsurface obstructions to increase penetration capabilities. Where soils are exceptionally dense and gravelly, and prevent the use of instrumented penetrometers, the prepunch tool can be used to probe the subsurface to acquire crude information on subsurface conditions. Measurements obtained using the prepunch tool can be similar to those obtained during mechanical (Dutch) cone testing, especially where friction on the sounding rod string is minimal.

2. Signal Conditioning and Recording
CPT(U) data are acquired using an analog to digital data logger and field computer. Test data are displayed on the computer screen in real-time allowing for immediate evaluation of test performance and subsurface conditions. Preliminary sounding logs are provided at the end of each test. Data are recorded on hard disk for in-house data processing and long term storage.

3. Soil Shear Resistance Measurements
The resistance of soil to penetration is measured on the tip and along the sides of the ECP. The conical tip of the penetrometer has a projected cross-sectional area of 15 square centimeters (2.3 square inches), and a diameter of 1.7 inches. The soil resistance acting on the cone tip reflects the deep bearing

capacity of the penetrated soil, and is termed cone or cone end bearing resistance.

The sliding friction between the soil and the penetrometer is measured along a cylindrical sleeve mounted just behind the cone tip. The sleeve has a surface area of 200 square centimeters (31.0 square inches), a length of 5.8 inches, and the same 1.7 inch diameter as the cone tip. The measurement of the soil friction is termed friction sleeve resistance.

Two 30,000 lbs. strain gage loadcells mounted inside the penetrometer are used to measure the cone and end bearing and friction sleeve resistances. The cone measurement has a soil layer resolution of about 2 to 4 inches, and has an accuracy of about +/- 0.5 TSF (tons per square foot). The friction measurement has a layer resolution of about 6 inches, and an accuracy of about +/- 0.07 TSF.

4. Piezometric Measurements

A pressure transducer, mounted inside the penetrometer, is used to measure the soil pre-water pressure response to penetration. Piezometric data, along with soil shear resistance measurements, are simultaneously recorded during penetrometer advance. The CPTU or CPTU-EC piezometric measurements have a soil layer resolution of about 1 inch and an accuracy of about +/- 0.5 ft. of water head pressure.

The volumetric distortion induced by penetrometer advance generates a localized pore water pressure field in a saturated soil. These generated water pressures dissipate almost instantaneously to equilibrium conductions in soils of high permeability, such as coarse sands and gravels. In medium or low permeability soils, the generated pore water pressure requires a significant amount of time to dissipate, so high pressures are measured during CPT(U) in silty or clayey sands and in fine grained soils.

The dissipation of generated pore water pressure can be recorded as a function of time by temporarily pausing during penetrometer advance. This is termed a CPTU dissipation test. If the pauses are sufficiently long for generated pore water pressures to dissipate, a series of potentiometric surface measurements can be obtained in a single CPT(U) sounding. The time rate of dissipation can be used to estimated soil horizontal permeability.

5. Piezometer Saturation
The CPT(U) piezometer filter is saturated with an incompressible liquid so that an instantaneous response (zero lag time) is achieved during CPT(U) profiling operations. High filter saturation levels are indicated by sharp responses at interfaces and immediate regeneration of excess pore water pressures after pauses in penetrometer advance.

Low levels of filter saturation leading to poor profiling measurements can be caused by soil suction, poor equipment preparation, or filter damage or gravel and cemented soils. Clogging of piezometric filters by clay particles can also lead to poor results. Loss of saturation or filter clogging while the CPT(U) penetrometer is below the ground surface is beyond the control of the equipment operator. Thus, the profiling piezometric data portion of CPT(U) is less reproducible than the reproducible CPT(U) soil shear resistance measurements.

6. Soil Electrical Conductivity Measurements
A CPTU-EC penetrometer, incorporating cone end bearing, friction sleeve, piezometric, and soil electrical conductivity sensors can be used to simultaneously acquire geotechnical, hydrogeological and gross geochemical information. The soil electrical conductivity is measured using two electrode system. The electrodes are mounted immediately ahead of the penetrometer friction sleeve. The electrodes are insulated from the steel body of the penetrometer by plastic insulators. The electrical conductivity measurement has a resolution of about 1.5 inches.

A 3 kHz alternating current is applied to the penetrometer electrodes. Alternating current, rather than direct, is used to control soil polarization. An in-phase current is also applied to a reference resistor. Soil electrical conductivity is then computed based on the relative voltages induced across the downhole electrodes and the uphole reference resistor.

7. Penetrometer Geometry
The CPT penetrometer external geometry is specified by ASTM standards. Differences in penetrometer internal design details can lead to some variability in responses between penetrometers of different manufacture, especially in very soft, wet clays. CPTU and CPTU-EC details are not specified by ASTM due to the recent development of these test procedures.

The CPT(U) piezometric measurements during penetrometer advance are dependent upon filter position. Potentiometric surface measurements during pauses in the penetration process are not sensitive to dynamic effects, and reflect undisturbed conditions.

CPTU piezometer filters are mounted either on the cone tip or just ahead of the friction sleeve of the penetrometer. Each position has advantages and disadvantages. Dynamic measurements taken with the cone tip piezometric filter are at a maximum and show high resolution of thin soil seams. However, the cone tip filter is prone to damage on coarse soil particles.

The friction sleeve piezometric filter is better protected from damage on coarse particles. Measurements taken with the friction sleeve filter are often very low or negative, especially in silty or clayey sands and overconsolidated fine grained soils. These low pressures are associated with the elastic rebound (expansion) of the soil, as the soil moves from the intensely loaded region beneath the cone tip to the less loaded region along the friction sleeve. The soil expansion induces suction forces on the piezometric filter, which can decrease filter saturation.

Site details and data usage often determine which CPTU piezometric filter geometry is appropriate for project usage.

8. Downhole Equipment Decontamination

Downhole equipment passes through a rodwashing chamber, mounted at the bottom of the hydraulic ram assembly, as the equipment is being retrieved. High pressure steam can be used to clean soil and groundwater from the exterior surface of the downhole equipment. Alternately, an Alconox/water solution may be used to rinse the rods if the steam cleaner cannot be used.

Rubber seals at the top and bottom of the rodwashing chamber serve both to prevent wash water from leaking onto the ground and to scrape off soil smeared on the surface of the downhole equipment. Waste water will be pumped to storage for eventual disposal. About 1/2 gallon of rinse water is generated for every 10 ft. of sounding rod in the ground.

9. Grouting of Open Hole

A grouting system can be used to seal the hole left after completion of a CPT(U) sounding. A high solids bentonite grout is pumped into the annular space between the 1.5 inch diameter sounding rods and the soil formed by the passage of the 1.7 inch diameter penetrometer. A bypass valve is opened at the end of the sounding and grout is pumped into the hole while the penetrometer is being retrieved. About 3/4 gallon of grout are required to seal every 10 ft. of penetrometer open hole.

In addition to sealing the hole left after penetrometer retrieval, the grout also serves to control possible cross contamination of aquifers during a sounding. The grout can decrease the contact of equipment with contaminated soil, lessening personnel exposure to contamination. The grout can also decrease the amount of soil friction on the sounding rods, which may allow for deeper penetration capabilities.

Grout levels are checked after the penetrometer truck has been moved off the sounding location. Additional grout is added, if necessary, to account for settlement and penetration of the grout into strata of higher permeability.

10. Data Reduction

CPT(U) test data are monitored by an experienced, professional geotechnical engineer as the soundings are performed. Data are recorded on hard disk and may consist of: depth, time, cone and bearing resistance, friction sleeve resistance, generated pore water pressure, soil electrical conductivity and the total load on the penetrometer.

Data are processed for final reporting using an in-house computer system. Prior to final reporting, data pass a quality control review. Routine checking of proper equipment performance is conducted during field testing. Additional office review helps check that the high level of accuracy of digital electronic measurement systems is maintained throughout the study.

In addition to measured data, the following values can be calculated to enhance CPT(U) data interpretation:

friction ratio, FR (in %):
FR = fs/qc * 100 (Eq. 1); and
pore water pressure ratio, Bq (dimensionless):

Bq = (U-Ue)/(qc-Sv) (Eq. 2);

where:

fs is the measured friction sleeve resistance, in TSF;

qc is the measured cone end bearing resistance, in TSF;

U is the measured generated pore water pressure, in TSF;

Ue is the measured or estimated equilibrium pore water pressure, in TSF; and

Sv is the estimated total soil overburden pressure, in TSF.

Measured data and computed parameters are presented in a graphical sounding log format for each sounding. Numerical values have also been tabulated at 0.5 ft. intervals for each sounding. Recorded data at 0.08 ft. intervals are available in an ASCII real format on floppy disk.

CPTU excess pore water pressure dissipation test data are recorded as a function of time during pauses in the penetration process. The CPTU dissipation data can be normalized during the following equation:

- normalized excess pore water pressure
- dissipation level, U* (dimensionless):
- U* = (Ut-Ue)/(UO-Ue) (Eq. 3);

where:

Ut is the excess pore water pressure ar time, t, is TSF;

Ue is the measured or estimated equilibrium, undisturbed pore water pressure (insitu pore water pressure prior to penetrometer insertion), in TSF; and

UO is the excess pore water pressure at time equal to zero, at the start of the dissipation test, in TSF.

The normalized excess pore pressure dissipation level is plotted versus the logarithm of time. In homogeneous soil deposits, the plotted data generally take the shape of a smooth curve beginning at a value of 1.0 at time equal to zero, at the instant the CPTU penetration process is stopped, and falling to 0.0 at the time the excess pore water pressure reaches equilibrium conditions. Boundary effects, especially in thinly bedded deposits, can cause deviation from this ideal curve.

Estimates of horizontal permeability can be calculated using the following equation:

estimated horizontal permeability, kh (in cm/sec):
kh = (((r**2 * T)/t) * RR * (Gw/(2.3 * Sv'))) (Eq. 4);

where:

r is the radial dimension of the CPTU piezometric filter along the axis of the penetrometer, equal to 2.15 cm for the friction sleeve piezometric filter position, and 1.9 cm for the cone tip piezometric filter position;

T is a dimensionless time factor at the 50% normalized dissipation level, equal to 5.5 for the friction sleeve piezometric filter position, and 3.8 for the cone tip piezometric filter position;

t is the measured time, in seconds, at which the normalized dissipation level is 50%;

RR is a dimensionless soil compressibility parameter;

GW is the unit weight of water, in kg/cm^3; and

Sv' is the effective soil vertical overburden pressure, in kg/cm^2.

11. Sounding Log

The CPT(U) sounding logs provide highly repeatable information on subsurface soil and groundwater conditions. Soil layering and saturation are readily apparent, along with the relative strength and consistency of the penetrated soil. Zones of elevated or depressed soil electrical conductivity are also apparent. Inspection of a series of sounding logs can be used to define site conditions with greater ease and accuracy than use of any borehole technique.

Lateral continuity of layers can be developed by overlaying adjacent soundings on a light table while adjusting for elevational differences. Layer characteristics, especially the cone end bearing resistance, are then compared. Matching data patterns can indicate laterally continuous layers.

12. CPT Soil Type Classification

Correlations between penetrometer data and soil classifications have been developed from geotechnical bearing capacity theory and a relational database on adjacent CPT soundings and drilled and sampled boreholes (Douglas and Olsen, 1981). Theory and observation show that the CPT(U) cone end bearing resistance increases exponentially with soil grain size. For example, the cone end bearing resistance of a medium dense sand ranges from about 100 to 300 TSF, while the cone end bearing resistance in a stiff clay ranges from about 5 to 15 TSF. Mixed soils such as clayey or sandy silts have intermediate cone end bearing resistances.

The friction ratio (the friction sleeve divided by the cone end bearing resistance) is related to the fines content of a soil. The friction ratio is typically greater than about 3% in a plastic clay and less than about 1% in a clean sand. A correlation scheme based on both the cone end bearing resistance and friction ration has proved most useful in interpreting soil type classifications from CPT measurements.

CPT soil types reflect the shear response of a soil to penetration. Soil shear response is not entirely controlled by grain size distribution. For instance, the presence of compressible particles, such as mica or organics, in a soil matrix typically decreases cone end bearing resistance and increases friction ratio. This can lead to a CPT soil type classification that would imply a greater percentage of fines than actually present in the soil.

However, soil types predicted from CPT(U) data generally agree well with soil classifications based on grain size distribution methods, such as the Unified Soil Classification System (USCS). Site specific correlation charts may be developed from the generalized data base, if sufficient side-by-side borehole and CPT(U) data are present, and the extent of the project warrants such modifications.

13. CPTU Soil Type Classification

The CPTU piezometric data provide additional information about soil characteristics. The cone end bearing resistance, friction ratio, and piezometric measurements are all useful for classification of mixed soils.

No excess pore water pressures are generated during CPTU in soils of high permeability. Penetration occurs under drained loading conditions. The pore pressure ratio, Bq, defined as the excess pore water pressure divided by the cone end bearing resistance, is zero in high permeability soils.

For soils of permeability of less than about 1.0×10^{-2} to 1.0×10^{-3} cm/sec, partially or fully undrained soil loading with generation of either positive or negative excess pre water pressure occurs during penetrometer advance. Positive, excess pore water pressures are typically measured in mixed soils when using the cone tip piezometric filter. Pore pressure ratios range from about 0.1 to 0.3 in silty or clayey sands. Negative, excess pre water pressures, with negative pore pressure ratios, are typically measured in dense, silty or clayey sands when using the friction sleeve piezometric filter.

Positive, excess pore water pressures are typically measured during penetration of clayey silts or clays when using the cone tip piezometric filter. Pore pressure ratios typically range from 0.4 to 1.0 in these soils. Lower pore pressure ratios are typically associated with overconsolidated soils.

Either positive or negative, excess pore water pressures are measured in clayey silts or clays when using the friction sleeve piezometric filter. Negative pressures are typically associated with heavily overconsolidated soils. Positive pressures are associated with normally or moderately overconsolidated soils.

14. Potentiometric Surfaces

Pore water pressures directly defining potentiometric surfaces are measured during CPTU in high permeability sands and gravels. The CPTU generated pore waste pressures in low permeability soils do not represent equilibrium conditions. Measurements of equilibrium pore water pressures in low permeability soils can be obtained by pausing during the CPT(U) penetration process and allowing generated pressures to dissipate to equilibrium conditions.

15. Soil Saturation
Soil saturation can be evaluated by inspection of the CPTU sounding log. Zero pressure is measured during CPTU in saturated soils. A hydrostatic pressure increase is measured in high permeability soils below the water table. Significant excess pore water pressure is generated in fully saturated, fine grained soils due to penetrometer advance.

Decreased levels of excess pore water pressure generation can be indicative of partially saturated soils. Decreased pressure generation may also occur in organic soils due to both the high compressibility of organic soil particles and the presence of biogenic gases, such as methane and hydrogen sulfide.

16. Horizontal Permeability
Excess pore water pressures are generated by penetrometer advance in lower permeability soils. The magnitude of the generated pore water pressure depends on the saturation, permeability and compressibility of the penetrated soil. Generated pore water pressures can be allowed to dissipate by pausing during the penetration process. The pore water pressure dissipation can be recorded as a function of time and is termed the CPTU dissipation test.

The CPTU dissipation test is somewhat similar to a falling head slug test and can be used to estimate soil horizontal permeability. However, much higher pore water pressures than those during slug testing are induced in low permeability soils by penetrometer advance. The greater changes in water pressure during CPTU dissipation tests require soil compressibility (storage) effects to be included in analyses. The cone end bearing resistance provides an index of soil compressibility for permeability computations.

17. CPT-SPT Correlation
Since many geoscientists are familiar with drilling and split spoon sampling methods of subsurface exploration, penetrometer data have been correlated with the SPT (Standard Penetration Test) N-value to utilize existing expertise. The SPT N-value is defined by ASTM to be the number of blows of a 140 lb. hammer, dropped 30 inches, required to drive a 2 inch outside diameter split spoon sampler 12 inches, after an initial seating drive of 6 inches.

SPT blowcounts have been correlated with CPT data based on numerical modeling of the two penetration processes, and by side-by-side comparisons of the test types (Douglas and others, 1981).

18. Ground Water and Soil Sample Collection
Samples can be collected from various depths without cross contamination because sampler well screens are shielded from the formation in watertight, stainless steel housings. The shield housings prevent ground water from entering the samples until the desired sampling interval is reached. The shield is retracted to allow ground water to flow into the sampler well screens. Samples are then retrieved to the surface for chemical analysis.

In cases where this method is inappropriate, a temporary piezometer well be installed to allow ground water to collect. The ground water may then be retrieved as described above. Soil samples may be retrieved using a retractable stainless steel sampler.

19. Reference
Stratigraphics, Piezometric Cone Penetration Testing, October, 1991.

4.5.9. GC Procedure for Soil Analysis

The following procedure shall be used for semi-quantitative assessment of VOC contamination of soil samples using a portable gas chromatograph.

1. Sample Preparation
Obtain four identical 40-ml VOC vials with septum caps. Label one vial as a sample, a second vial as a blank and the others as 1 ppm standard and 10 ppm standard. To the vial marked "Sample" add 10 to twenty-five grams of soil and 1 mL of methanol. Fill this vial to volume with distilled water and cap so that there is zero head-space.

2. Standards Preparation
Fill the vial marked "blank" to volume and cap so that there is zero head-space. To a 10 ml volumetric flask add 9 mL of methanol. Pipette into this flask 100 ul each of laboratory grade benzene, toluene, ethylbenzene, and xylene. Fill the flask to volume with methanol, cap and invert. This is the stock standard solution. To dilute this solution to 1 ppm and 10 ppm standard solutions obtain two 200 ml volumetric flasks. Fill both

flasks with distilled water to below the volume mark. Into one volumetric flask add 20 uL of the stock solution. Fill the 200 mL flask to volume, cap and invert. Pour this solution into the VOA vial labeled "1 ppm standard" so that there is zero head-space. In the other 200 mL volumetric flask add 200 ul of the stock solution. Fill the flask to volume, cap and invert. Pour this solution into the VOC vial labeled "10 ppm standard" so that there is zero head-space.

Calculate the precise concentration of organic constituents in each standard vial using the density of respective constituents and the following equation:

Stock Solution (S_c):	100 uL * Density (g/L) * $1x10^{-6}$ (uL/L)
1 ppm Standard:	S_c * 0.02 mL/200 mL
10 ppm Standard:	S_c * 0.2 mL/200 mL

3. Sample Analysis
Insert a 3" syringe needle through the septum of a prepared VOC vial to within one inch of the bottom of the vial. Insert a second needle attached to a 10 cc syringe 0.5 inch through the septum. Invert the vial and withdraw 10 cc of liquid from the vial, generating a 10 cc air bubble within the vial. Repeat this for each vial using decontaminated needles. Once a 10 cc bubble is present in each vial, shake each vial for 10 seconds and place each vial in a 25°C water bath. Allow the vials to equilibrate.

Using a gas tight syringe, withdraw 50 to 100 uL of headspace gas from each VOA vial and inject into the portable gas chromatograph. Generate a calibration curve for each volatile constituent using the blank, 1 ppm standard and 10 ppm standard.

4. GC Operation
Individual volatile photoionization organic constituents of the head-space samples are separated by the GC column, resulting in detector response which is displayed as a series of peaks on the chromatogram output. Peaks detected in the environmental sample runs will be compared, on the basis of retention time, to the calibration standards. Concentrations of individual constituents will be determined through comparison to the calibration curve.

5. Quality Control
   Quality assurance measures will be taken to increase the validity of the data, including: (1) GC blanks, (2) equipment decontamination, (3) syringe blanks, (4) sampling variability evaluation, and (5) consistent and accurate recordkeeping.

   (1) GC Blanks: GC blanks will be run at the beginning of every day. A GC blank consists of a complete GC run without injection. As appropriate, instrument response from the "blank run" is subtracted from subsequent sample and celebrant runs, thereby minimizing quantification errors associated with integration over baseline variations.

   (2) Equipment Decontamination: The volumetric flasks and syringes will be decontaminated between each sample run. Vials will not be reused.

   (3) Syringe Blanks: A syringe blank consists of injection of a precise aliquot of carrier gas into the GC. A syringe blank will be run after each sample which exhibits detectable levels of VOCs. If necessary, additional syringe blanks will be run until GC baseline performance is achieved.

   (4) Sampling Variability: In order to assess the variability associated with collection of environmental samples at the project site, two sets of replicate samples will be collected and analyzed.

   (5) Consistent and Accurate Recordkeeping: Chromatograms will be mounted in an analytical notebook. Information detailed on each chromatogram will include: Sample number, site name, date/time of collection, date/time of analysis, column and detector type, and gain settings. In addition to the information printed on the chromatograms, field notes will be added as appropriate.

4.5.10. Decontamination

Equipment will be decontaminated, between each sample collected, in the following manner:

1. Equipment will be scrubbed with non-phosphate detergent (i.e. Alconox).

2. Equipment will be rinsed twice with potable water.

3. Equipment will be rinsed twice with distilled (blank) water.

4. Equipment will be allowed to air dry.

5. No solvents will be used in the decon process.

4.5.11. Order of Sample Analytical Fraction Collection

The order of sample analytical fractions collected for matrices will be VOCs, total petroleum hydrocarbons, SVOCs, metals and cyanide.

4.5.12. Sample Containers

Sample containers shall be prepared using the procedures detailed in "Specifications and Guidance" for the Preparation of Contaminant-Free Sample Containers" (USEPA, April 1990). The criteria for containers specified therein will be followed and verified by the container vendor.

5. Sample Custody

5.1. Field Custody Procedures

Field custody procedures document the stepwise procedures used by O'Brien & Gere Engineers to initiate and maintain custody in the field from the point of sample collection/generation through transfers in the field and shipment to an off-site laboratory. A complete sample numbering system which provides a coded number specifying the location, matrix, sampling event number/date, sample type (investigative, field blank, duplicate, matrix spike), etc. is detailed in the following sections. The chronological preparation of custody forms, labels, log sheets and logbooks and instructions for completing each piece of paperwork is detailed in Attachment 1.

5.2. Laboratory Custody Procedures

Laboratory custody procedures are designed to document the stepwise procedure used by the contract laboratory to receive/log-in field samples and maintain custody through sample transfers, sample preparation, sample analysis and final disposal of samples/extracts/digestates. A complete stepwise procedure is detailed in Attachment 1.

5.3. Final Evidence File Procedures

The final evidence file is the original field data, logbooks, field/lab custody files, project reports, photos, original copies of the data deliverables, drawings, data validation reports, data assessment reports and other pertinent documents. The final evidence file will be maintained by the Project Manager or his designee throughout the life of the project. The file will be offered to MDNR at the conclusion of the project and will not be disposed of without the concurrence of MDNR. The file will be stored in a secure, limited-access area by O'Brien & Gere Engineers.

Original laboratory data acquired by the contract laboratory will be stored on electronic media (tape, disk, diskette), depending upon the instrument capabilities, for the life of the project. Data will be kept in a secure, limited-access area by the contract laboratory's designated file custodian.

Files are subject to audit by MDNR and its designated contractors.

5.4. Sample I.D.

A sample I.D. will be used to identify each sample taken during the field investigation sampling program. This sample I.D. will allow retrieval of information regarding a particular sample and will assure that each sample is uniquely numbered. A sample I.D. will consist of: section, SWMU, sample type, sample depth or monitoring well location, and quality control sample. Each time a sample is collected, these five codes will be recorded in three places: field log book, sample tag, and chain of custody. Each code is discussed below.

1. Section

   There are three sections on site. Each section is designated as either South (S), West (W) or East (E).

2. Solid Waste Management Unit

   If the sample is collected in a SWMU, a "U" and the respective SWMU number will be recorded. Otherwise "XXX" will be entered here.

3. Sample Type

   Each time a sample is collected, the field sampler will record the sample type: MW (monitoring well), SS (surface soil), SB (soil boring), CS (core sample) or CP (ECP soil sample).

4. Sample Depth or Monitoring Well Location

   The depth of soil boring samples and monitoring well locations will be recorded, as appropriate (i.e. 1-2 ft).

5. Quality Control Samples

The type of quality control samples will be recorded: matrix spike/matrix spike duplicate (MS/MD), field equipment blank (FB), field duplicate (FD), blind duplicate (BD), trip blank (TB), or normal sample (NS).

To create a sample I.D., combine each of the five codes discussed below in the respective order: section; SWMU; sample type; sample depth or monitoring well location; and quality control samples. An example of a sample I.D. might be:

S - U01 - MW22 - MD

S	U01	MW	22-	MD
Code 1	Code 2	Code 3	Code 4	Code 5

A blind duplicate will be assigned a sample I.D. such as X-X03-MWXX-BD, where "03" is the sequential number of the blind duplicate for a given matrix, in this case monitoring well ground water. An "X" will be used in the code 1 field and two "Xs" in the code 4 field. The code 3 field will indicate the matrix, and the code 5 field will be designated "BD" for blind duplicate.

6. Calibration and Frequency

6.1. Laboratory Equipment Calibration

Calibration of laboratory analytical instrumentation is essential for the generation of reliable data which meets project data quality objectives. Analytical instrument calibration is monitored through the use of control limits which are established for individual analytical methods. Calibration procedures to be followed are detailed in the contract laboratory's analytical SOPs. These procedures specify the type of initial and continuing calibration, calibration materials to be used, range of calibration, frequency of calibration.

The contract laboratory will be responsible for the proper calibration and maintenance of laboratory analytical equipment.

6.2. Field Equipment Calibration

Field equipment used during this investigation will be calibrated in a manner and at a frequency in accordance with the manufacturer's instructions and the SOPs in Section 4. Calibrations performed will be recorded in a field notebook.

Generally, field equipment will be calibrated on a daily basis. The calibration range will be designed to bracket the concentrations of concern.

7. Analytical Procedures

7.1. Field Analytical and Measurement Procedures

Section 4 of this QAP includes complete field analytical and measurement procedures including: pH, temperature and conductivity. These parameters are primarily measured during ground water sampling to ensure that monitoring wells have equilibrated following their installation and purging.

7.2. Laboratory Analytical Procedures

VOCs, SVOCs, and metals have been designated as target parameters for this RFI. The lists of parameters and associated detection limits for water and soil are specified in Table 1. The matrices for this project include ground water, surface soils, and sub-surface soils. Table 7 specifies which parameters will be analyzed for each SWMU and associated matrices.

The procedures are based upon USEPA SW-846 methods.

7.3. Turn Around Times

The laboratory will provide faxed final results no more than two weeks after submission of samples, hard copy results will be delivered no more than four weeks after submission of samples.

Data will be submitted to MDNR no more than 30 days after receipt of hard copy data by RCI.

8. Data Reduction, Validation, and Reporting

8.1. Data Reduction

Data reduction is the process and calculations used to convert raw field or lab measurement/ analytical data into final results with proper reporting units.

8.1.1. Field Data Reduction

Field measurements which are direct readouts (i.e. pH, temperature, specific conductivity) required no reduction or calculation. The field measurement SOPs in Section 4 of the QAP specify how these readouts are obtained.

8.1.2. Laboratory Data Reduction

Laboratory data reduction procedures are specified in the individual contract laboratory SOPs.

8.2. Data Validation

Data validation is the process of qualifying field and laboratory measurements/analyses based upon the cumulative effects of field and lab quality control performance. Outlier quality control performance of calibrations, blanks, duplicates, surrogates, etc. will require qualification of the data as acceptable, estimated quantitatively or unusable.

8.2.1. Field Data Validation

Validation of field data for direct readout instruments will consist of review of the tabulated results for transcription errors, review of calibration records and duplicate results.

8.2.2. Laboratory Data Validation

Validation of VOC, SVOC, and metals data will be performed using the documents "Laboratory Data Validation Functional Guidelines for Evaluating Organics Analyses" (USEPA, February 1988) and "Laboratory Data... Inorganics Analyses" (USEPA, July 1988). Qualifiers and criteria defined in those documents will be used verbatim, where appropriate. Since these guidelines specify guidelines for the validation of CLP data some modification will be required for the validation of this projects data since it will be generated by SW-846 methods. Modifications to the USEPA guidelines will be discussed in the data validation report.

The requirements to be checked for the validation of total petroleum hydrocarbon analyses are as follows:

1. Documentation Completeness
2. Holding Times (Table 10)
3. Methods (Table 11)
4. Analytical Parameters
5. Calibration
6. Blank Analysis
7. Field Duplicate Analysis
8. Laboratory Duplicate Analysis
9. Sample Quantification
10. Detection Limit Verification
11. Overall Data Assessment

Validation work sheets are completed for each type of analysis (i.e. volatile organics, metals etc.) and in turn are used for the preparation of validation reports. Validation reports for lab data will consist of a narrative with the following elements:

- References to the procedures employed to validate the data along with scope, content and use of the report.
- References to the analytical procedures used to generate the data and a definition of data qualifiers.
- Summary of method and/or project-specific quality assurance requirements and references to the documents where specified.
- Summary of data which met and did not meet validation criteria. In addition to the technical validation of the data, a summary of the custody audit will be provided.

- Summary of analytical data in terms of completeness and useability.

8.3. Data Reporting

Data reporting will define the data deliverables used to completely document the analysis: QC summary forms, initial/ continuing calibration data, chromatograms, mass spectra, ICP or GFAA readouts, etc.

8.3.1. Field Data Reporting

Reporting requirements for direct readout instruments will consist of tabulated results of investigative and duplicate results and field logbook entries of calibrations.

8.3.2. Laboratory Data Reporting

Reporting requirements for VOCs, SVOCs, and metals will consist of equivalent or similar deliverables specified in the USEPA Contract Laboratory Program Routine Analytical Services Statements of Work (CLP RAS SOWs) for organic and inorganic analysis.

9. Internal Quality Control Checks

9.1. Laboratory Quality Control Checks

The numbers of QA/QC samples that must be taken for each sample matrix are listed in Table 8. Table 3 contains information regarding the audits, frequency, control limits, and corrective action for acceptability. Following are brief descriptions of the types of laboratory QC checks that will be implemented for this project.

9.1.1. GC/MS Tuning

Tuning and performance criteria will be established to ensure mass resolution, identification, and to some degree, sensitivity. These criteria will not be sampled specific; conformance is determined using standard materials. Therefore, these criteria should be met in all circumstances.

9.1.2. Calibration

Compliance requirements for satisfactory instrument calibration will be established to ensure that the instrument is capable of producing acceptable quantitative data. Initial calibration will demonstrate that the instrument is capable of acceptable performance at the beginning of analysis, and continuing calibration checks document satisfactory maintenance and adjustment of the instrument on a day-to-day basis.

9.1.3. Blanks

The assessment of blank analysis results will evaluate the existence and magnitude of contamination problems. The criteria for evaluation of blanks will apply to blanks associated with the samples, including trip, equipment, and laboratory blanks. If problems with a blank exist, data associated with the project will be carefully evaluated to determine whether or not there is inherent variability in the data for the project, or if the problem is an isolated occurrence not affecting other data.

9.1.4. Surrogate Recovery

Laboratory performance on individual samples will be established by means of spiking activities. Samples for organic analyses will be spiked with surrogate compounds prior to sample preparation. The evaluation of the results of these surrogate spikes will not necessarily be straightforward. The sample itself may produce effects due to such factors as interferences and high concentrations of analytes. Since the effects of the sample matrix are frequently outside the control of the laboratory and may present relatively unique problems, the review and validation of data based on specific sample results is frequently subjective.

9.1.5. Matrix Spike/Matrix Spike Duplicate/Laboratory Duplicate

These data will be generated to determine long-term precision and accuracy of the analytical method on various matrices. These data alone cannot be used to evaluate the precision and accuracy of individual samples.

9.1.6. Field Duplicates

Field duplicate samples will be taken and analyzed as an indication of overall precision. Since these analyses will be cumulative of field and lab precision, the results may have more variability than lab duplicates which measure only lab performance. It will also be expected that soil duplicate results will have a greater variance than water matrices due to difficulties associated with collecting identical field samples.

9.1.7. Internal Standards Performance

Internal Standards (IS) performance criteria will ensure that both GC/MS sensitivity and response are stable during every run.

9.1.8. Compound Identification

The objective of the criteria for GC/MS qualitative analysis will be to minimize the number of erroneous identifications of compounds. An erroneous identification can either be a false positive (reporting a compound present when it is not) or a false negative (not reporting a compound that is present). The identification criteria can be applied much more easily in detecting false positive than false negatives. Negatives, or non-detected compounds, represent an absence of data and are more difficult to assess.

Upon completion of analysis, the results of QA/QC data will be reviewed to verify compliance with the criteria listed. When results are reported to the QA Officer, QA/QC data will be included in the package for review. Matrix spikes and surrogates will be used to monitor the methodology. Recoveries will be compared to the QA/QC criteria presented in Table 3. Matrix spike duplicates and duplicate samples will be incorporated as an indicator of the precision of the sample results. The relative percent difference calculations will also be compared to the QA/QC criteria presented in Table 3.

9.2. Field Quality Control Checks

Table 2 and the field equipment SOPs in Section 4 present a summary of the internal quality control procedures that will serve as the field QA/QC program. Included in Table 2 are the identifications and descriptions of the parameters that will be controlled during field investigation activities, such as sampling and field measurements. The frequency of control checks for each parameter, acceptance criteria for each parameter that is controlled, and corrective action required from field personnel for each controlled parameter that exceeds the acceptance criteria is included in Table 2.

9.2.1. Field Sampling Quality Control

Field sampling crews will be under the direct supervision of a field sampling leader. Bound log books and appropriate data sheets will be used to document the collection of samples and data so that an individual sample or data set can be traced back to its point of origin, sampler and sampling equipment used. Sampling will be performed according to the methods provided in this document. Blind field duplicate samples will be collected by the sampling team. These samples will be sent to the laboratory for analysis in conjunction with the environmental samples. Field sampling precision will be evaluated through the relative percent difference (RPD) of the duplicate sample analyses results. Control limits for field duplicate precision have been established and may be found on Table 3. Decontamination of sampling equipment will be verified through the analysis of equipment blanks. Proper chain of custody protocols, as presented in Attachment 1, will be followed.

9.2.2. Field Analytical Procedures Quality Control

Field measurements of pH, temperature, and specific conductivity will be taken on groundwater samples. The pH meter will be checked against two known standard pH buffers (7 and 10) before and after each day's use. Temperature measurements will be made with a digital Celsius thermometer. The thermometer will be checked periodically against a precision thermometer certified by the National Institute of Standards and Technology. Conductivity readings will be made with a portable specific conductivity meter. The meter will be calibrated against a 0.010 N potassium chloride solution at least twice a day. Detailed SOPs for field equipment are presented in Section 4.

The RAM-1, or equivalent, HNu Photoionization Detector and Explosive Gas Meter which will be used for health and safety purposes and will be calibrated according to the manufacturer's specifications.

10. Performance and System Audits

10.1. Introduction

Field and laboratory performance audits consisting of on-site QA/QC audits will be performed by O'Brien & Gere Engineers' QA Officer at least once during the field characterization program and laboratory analysis program. These audits will evaluate the adherence of the field and laboratory programs to the QA program outlined in this QAP. The results of the field and laboratory audits will be submitted in the RFI Report. The QA Officer will report to the Project Manager the results of the audit. The QA Officer and Project Manager will formulate recommendations to correct deficiencies in the field and laboratory program which are identified by the audits.

10.1. Laboratory Audits

10.1.1. Internal Laboratory Audits

O'Brien and Gere Engineers has designated a QA Officer as indicated in Table 1. Lab performance will be routinely audited through appropriate blanks, spiked samples, standard solutions, etc. specified in each analytical procedure and summarized in Table 3. The QA Officer will maintain a record of such audits. These audits will investigate the total system's response, and the major measurement methods. The QA Officer will report to the Project Manager the result of the assessment of the accuracy, precision, and completeness of the data, results of the performance and system audits, and problems encountered in the analytical procedures. The QA Officer and Data Validator, in conduction with the contract laboratory's QA Coordinator, the analyst, analyst's supervisor, and Project Manager will formulate recommendations to correct deficiencies in the analytical protocol or data. These corrective measures will be in accordance with on-going good laboratory practices and the overall QA/QC Program.

The purpose of laboratory on-site evaluations is to ensure that the systems and procedures described in the QA/QC plan are actually operational in the laboratory and contributing to the production of

accurate and defensible analytical results. The on-site evaluation will be performed by a team of technical professionals who will also review the laboratory's ability to comply with project requirements for analytical services and documentation needed to recreate analytical events. The areas of concern in a laboratory evaluation include:

- Implementation of a scientifically sound QA/QC program addressing accuracy, precision, completeness, comparability, and blank contamination.
- Documentation and record keeping sufficient for technical personnel external to the laboratory to recreate each analytical event.
- Compliance with the project requirements for laboratory analysis.

The evaluation team will use their professional judgment and experience to review the laboratory QA/QC program, noting factors that may affect the quality of analytical results. A QA/QC plan generally will be reviewed prior to the laboratory evaluation, although the review may be done concurrently.

Laboratory evaluations will be announced and scheduled with reasonable consideration for laboratory production schedules; the intention will be to have a constructive session with the active participation of key laboratory personnel responsible for QA/QC. A typical evaluation will involve a visit to tour the laboratory facilities, a detailed examination of each laboratory section, and a debriefing meeting to communicate the audit findings to laboratory personnel. The specific agenda for each evaluation will vary depending on the priorities established by the evaluation team and the activities in the laboratory and may include a review of analytical data specific to the project. A walk-through tour of the laboratory will be conducted to familiarize the evaluation team with the layout, equipment, and facilities. The debriefing gives the laboratory an opportunity to clarify discrepancies and identify corrective actions that can be initiated immediately.

Internal Laboratory Audit Checklist The laboratory evaluation will be based on the criteria described below and the laboratory's implementation of their own QA/QC plan. The following criteria indicate the types of evaluations that will be made by the laboratory evaluation team:

- Comparability of Data
- Calibration and Quantitation
- QC Execution
- Out-of-Control Events
- SOPs
- Sample Management
- Record Keeping
- Instrument Calibration Records
- Corrective Action Reports
- Maintenance Logs
- Data Review
- Limit of Detection
- QC Limits
- Analytical Methods

The evaluation team will check that a QC system is implemented for each analytical section in the laboratory. At a minimum, the system may be that prescribed in the analytical methodology or a more sophisticated system may be developed by the laboratory. The evaluation team will note inconsistencies between the QC systems described in the QA/QC plan and those actually used in the laboratory. The application of QC measures should be consistent among analytical methods. The evaluation of the QC program will address the following elements.

Comparability of Data The evaluation team will review the results of PE sample testing and check for the use of external reference materials obtained from, or traceable to, USEPA or the National Institute of Standards and Technology to establish comparability. The evaluation team will review the frequency of reference materials and the acceptance criteria used. The reference materials should include all analytes in a given method.

Calibration and Quantitation The evaluation team will review the calibration and continuing calibration procedures. This review will include checking the number and concentrations of standards used, the frequency of calibration verifications, and the acceptance criteria for initial and continuing calibration. In addition, responses to out-of-control calibrations will be reviewed. Standard solutions will be checked to ensure that they are not being used beyond expiration dates.

QC Execution The evaluation of QC execution will focus on the use of appropriate types and frequency of QC materials to determine and maintain precision, accuracy, and the absence of

contamination. As a minimum, the QC sample analyses specified in the analytical methods required for the project will form the basis for this evaluation. Among other determinations, the evaluation team will check that spiking solutions contain required method analytes at method-recommended concentrations. Laboratory log books or worksheets will be reviewed to verify batch sizes, check the frequency, type and number of QC materials used in each analytical batch, and check for the use of in-house control limits. The conveyance and implementation of project specific QC requirements to the analysts will also be evaluated. The review will focus on how QC results are used to resolve problems affecting quality and ensure the production of valid data.

Out-of-Control Events The evaluation team will ensure that out-of-control events can be recognized by analysts and that the analysts can initiate an appropriate response. Laboratory-derived control limits will be available to, and used by, the analysts. Analysts will be aware of the conditions requiring documentation of corrective action. The roles of various laboratory personnel involved in corrective actions will be evaluated to ensure that a systematic approach to solving problems exists in the laboratory.

Standard Operating Procedures (SOPs) SOPs will be available for each analytical method employed in the laboratory. SOPs will contain sufficient information so that an analyst can perform the method properly, will reflect what is actually being done in the laboratory, and bear evidence of review and approval by management. The evaluation team will review SOPs for analytical methods required for the project and SOPs for implementing the QA/QC program. At a minimum, each SOP will describe an analytical batch, sample preparation and dilution procedures, instrument conditions, calibration procedures, QC materials, acceptance criteria, corrective actions, and data review procedures. The requirements of standard methods will be included in the SOPs, but the SOPs will not be limited to reproduction of standard methods, which often are incomplete or present alternative approaches for implementation. Variation from USEPA, ASTM, or other standard methods will be noted in the SOP, and separate documentation of the method comparability of these data to the original method must be maintained.

Sample Management The sample storage facilities and the sample management system will be evaluated to ensure that sample integrity is maintained and that QC requirements are defined and implemented. The sample storage facilities will be checked for adequate environmental controls to maintain sample integrity. They will also be checked to verify that conditions are monitored and recorded periodically. QC activities performed by the sample custodian, such as checking sample preservations and chain-of-custody records, will be reviewed. The process for communicating client requirements to the analysts, creating analytical batches, introducing laboratory QC samples, and tracking timely sample movement through the laboratory sections will be reviewed for effectiveness and conformance to QA/QC plan description.

Record Keeping The documentation and reporting of control data are critical to the success of the QA program. Laboratory records will include information necessary to recreate an analytical event. The laboratory record keeping evaluation will focus on ensuring that necessary records exist and are usable to reviewers other than the author.

Instrument Calibration Records Instrument calibration records will provide evidence of the frequency of calibration, the preparation and use of traceable standards, calibration checks, and appropriate responses to out-of-control calibrations. The evaluation team will look for supervisory review of the documents indicated by signatures and dates of review. The records will enable an external reviewer to recreate a calibration event. A review of the standards preparation log, showing receipt of calibration materials and traceability to neat and stock materials, will be conducted. Calibration records for each analytical method will be consistent with method requirements, and QA review of the records will be documented.

Other Analytical Records In addition to calibration records, the evaluation team will review other analytical records relating to the preparation and spiking of QC materials, and sample preparation. The records for the preparation of QC materials will allow an external evaluator to identify the QC materials used, their source, the dates of receipt, the events leading to the preparation of stock, and working QC solutions. In addition, laboratory logs will be reviewed to ascertain whether each spiking event could be uniquely identified. The records will identify which samples were spiked with which solutions and at what concentrations.

In the sample preparation sections, the evaluators will review the documentation of the sample preparation events, including the initial and final volumes of samples and extracts and the volumes and purity of solvents and reagents used. The preparation procedure itself will be reviewed from the SOPs.

QC Records The results for QC materials will be reviewed at the bench level to evaluate that the calculated results are within the specified QC limits. The evaluators will review the frequency of spikes and surrogates used and the availability of warning and action limits to the analysts. If the process of bench-level QC is monitored by the LIMS, a review of the LIMS QC output will be conducted.

QA reviews will be intended to assure that the quality of generated data meets the QA objectives of the laboratory. Summaries of QC data will be useful in identifying trends in analytical methods. Trend analyses will be valuable tools to the section supervisors, helping them to implement corrective actions. The evaluators will review control charts for accuracy and precision of analytical methods and records of how control limits are established and updated.

The evaluation team may review the records of systems audits conducted by the laboratory and check for follow-up corrective actions taken by the supervisors.

Corrective Action Reports The evaluation team will check that corrective action reports are used in all laboratory sections and that all necessary information and signatures appear on the reports. Corrective actions should exist for each out-of-control event. The evaluation team will review corrective action reports for their completeness, supervisor and QC officer approval of the corrective actions taken, return of the system to analytical control, and identification of affected samples. The evaluation team will note the use of corrective action reports by QA personnel to detect and eliminate systematic or recurring problems.

Maintenance Logs The evaluation team will check that maintenance logs are available for major instruments in the laboratory and the entries are complete and include in-house and manufacturer or contractor service. Properly maintained instruments help to minimize out-of-control calibrations and QC sample results. Analysts will have access to preventative manufacturer or

contractor service. Proof that serviced instruments are operating in control prior to the analysis of environmental samples will be evident.

Data Review The process of technical data review, which will evaluate the accuracy and precision of data prior to release, will be examined in each section of the laboratory to ensure that each step of the review process will be documented and that the process prevents the release of invalid data. Documentation of the review process will be available to the evaluation team. The evaluation team will trace the generation of analytical results from data obtained at the bench through the preparation of final reports. The review will determine whether data packages contain sufficient information to ensure that analytical events can be recreated. At a minimum, data packages should identify specific instruments, analytical method and detection limits used, dates of calibration, dates analyses were performed, QC materials used, names of analysts, names and titles of reviewers, dates of review, and explanations of corrections. QA reports will be included in the data packages.

Limits of Detection The evaluation team will ensure that detection limits have been established experimentally for analytes detected using the analytical methods specified in the QAP. Measures to periodically confirm and revalidate detection limits will be noted. Methods for extrapolating reporting limits from experimentally determined detection limits will be evaluated to establish their scientific defensibility.

QC Limits The evaluation team will determine whether experimentally derived control limits are used for batches of samples. Control limits will be established for QC samples, including but not limited to blanks, blank spikes, matrix spikes, surrogate spikes, and duplicates. The control limits will establish acceptable precision, accuracy, and levels of contamination for project samples.

Analytical Methods The evaluation team will ensure that analytical method SOPs and laboratory practice conform to the requirements of the analytical methods specified by the QAP. The review will focus on calibration, the type of gas chromatography columns, QC sample preparation and analysis, and other similar method components.

10.1.2. External Laboratory Audits

The USEPA Region V Central Regional Laboratory is responsible for external lab audits. These audits may include review of SOPs, performance evaluation (PE) samples and an on-site evaluation.

10.2. Field Audits

10.2.1. Internal Field Audits

The purpose of field audits will be to ensure that the systems and procedures described in the QAP are actually operational in the field and contributing to the production of accurate and defensible analytical results. The on-site evaluation will be performed by the QA Officer. The areas of concern in a field audit will include:

- Sampling procedures.
- Decontamination of sampling and drilling equipment.
- Chain of custody procedures.
- Field equipment calibration.
- Standard Operating Procedures.
- Field log books.

Sampling Procedures The field audit will confirm that sampling procedures, locations, numbering system, and field QA/QC samples referenced in Section 4 of the QAP are followed. The following sampling procedures will be audited:

- Drilling/Subsurface Soil Sampling Procedures
- Monitoring Well Completion
- In Situ Hydraulic Conductivity Testing
- Ground Water Sampling
- ECP/Sample Collection

Decontamination of Sampling and Drilling Equipment The field audit will confirm that decontamination procedures referenced in Section 4 of the QAPP are followed. The field auditor will evaluate the following:

1. Decontamination of equipment before and after sampling.
2. Initial decontamination of drilling and well construction equipment.
3. Decontamination of sampling and monitoring equipment entering a well.

4. Observance of decontamination procedures outlined in the QAP.

Chain of Custody Procedure The field audit will help confirm that the field technician is creating an accurate and legally defensible document that can be used to trace possession of a sample from its collection through extraction and final disposal. The audit will evaluate the following:

1. Completion of sample labels (time, analysis, matrix, location, date).
2. Proper completion of chain of custody forms.
3. Proper shipment and sealing of coolers.

Field Equipment Calibration The field audit will help confirm that the field equipment used during this investigation will be calibrated in a manner and at a frequency in accordance with the SOPs in Section 4.

The audit will evaluate the following:

1. Recording of field equipment calibrations in a field log book.
2. Calibration of field equipment on a daily basis.
3. The calibration range will be designed to bracket the concentrations of concern described in Section 4.

Field Log Book The field technician will record pertinent field information in the field log book that may assist in the documentation of specific QA/QC criteria for work efforts associated with the RFI. The field auditor will evaluate the following:

1. The recordings of the sample location, date and time sampled, sample matrix, and analysis required in the field log book.

2. The notation by samplers of meteorological data, equipment employed during collection, abnormalities noted during sampling, evacuation techniques and calculations.

Standard Operating Procedures The field audit will help confirm that the field equipment used during this investigation will be operated in accordance with the standard operating procedures in Section 4. Standard operating procedures undertaken involving field equipment will be recorded in a field notebook. Generally, field equipment will be operated on a daily basis according to SOPs.

The audit will evaluate the following:

1. Monitoring of the accuracy of field measurements of pH, temperature, VOCs, and specific conductance through pre-measurement calibrations.

2. Assessment of pH measurements by performing duplicate measurements on three standard buffer selections, with each measurement within 0.2 standard units of buffer selections.

3. Withdrawal, rinsing with deionized water and reimmersion between each replicate of the electrode.

4. Calibration and verification in the field at the beginning of each day's use.

5. Measurement of temperature using a thermometer with a range of at least -2° to 50°C and with divisions of 1.0°C.

6. Calibration of the thermometer against an ASTM thermometer according to Section 4 SOPs.

7. Measurement of specific conductivity, using a conductivity meter, to the nearest 10 micro mhos/cm within a range of 0 to 2,000 micro mhos/cm.

10.2.2. External Field Audits

External field audits may be conducted by the USEPA Region V Permit Writer and contract support staff.

11. Preventive Maintenance

11.1. Field Equipment

Preventive maintenance procedures will be carried out on field equipment in accordance with the SOPs outlined in Section 4. Each piece of field equipment used during this project will have a specific maintenance instruction sheet accompanying the field equipment. Maintenance activities involving field equipment will be recorded in a field log book.

11.2. Laboratory Equipment

A preventive maintenance schedule will be followed and a maintenance log will be kept for each laboratory instrument. Instrument downtime will be kept to a minimum by maintaining service contracts on essential instrumentation and maintaining a supply of critical spare parts. Laboratory staff will be experienced in cleaning, maintaining, and troubleshooting instrumentation. Maintenance, whether performed by laboratory or manufacturer personnel, will be documented on the appropriate instrument log. Maintenance logs will be kept on every laboratory instrument. Log entries will include reasons for maintenance, maintenance performed, and date and initials of the person performing the maintenance.

The operating temperatures of all ovens, incubators, water baths, refrigerators, coolers, and freezers will be checked daily and recorded in a laboratory notebook. A specific analyst will be assigned the responsibility of performing and recording temperature checks. The analyst's initials, date, time performed, and temperature reading will be recorded for ovens, refrigerators, etc.

12. Specific Routine Procedures Used to Assess Precision Accuracy and Completeness

12.1. Accuracy Assessment

The contract laboratory's QA Coordinator and the O'Brien & Gere Engineers QA Officer will be responsible for data assessment. Data quality assessment will be based on data which has been validated according to the procedures referenced in QAP Section 8.02.

Accuracy is a measure of the nearness of an analytical result, or a set of results, to the true value, and will be expressed in terms of percent recovery (%R). Accuracy will be determined through the analysis of surrogate spikes, reference standards, and matrix spike samples. The matrix spike sample analysis will be designed to provide information about the effect of the sample matrix on the digestion and measurement methodology. Samples will be spiked with surrogate compounds prior to sample preparation. Reference standard recoveries will provide an independent verification on the calibration procedure and the percent recovery of these standards will provide a measure of accuracy.

The percent recovery (%R) or "accuracy" will be calculated by using:

1. Standards: %R = (observed value/true value) x 100

2. Spikes: $\%R = \frac{(\text{conc. spike} + \text{sample}) - \text{sample}}{\text{conc. spike.}} \times 100$

12.2. Precision Assessment

Precision describes the reproducibility of results. It is defined as the agreement between the numerical values of two or more measurements that have made in an identical manner. Precision can be expressed in a variety of manners, including: relative percent difference (RPD), percent relative standard deviation (%RSD), percent difference (PD), and range (R). Precision will be determined through the analysis of laboratory and field duplicate samples. Field duplicate analyses measure both field and laboratory precision; therefore, the results may contain more variability than laboratory

duplicates which measure only laboratory performance. It is also expected that soil duplicate results will have greater variance than water matrices due to difficulties associated with duplicating soil samples. The equations used to calculated precision will be:

$$RPD = \frac{\textit{absolute value of (original sample result - duplicate sample result)}}{\textit{(original sample result + duplicate sample result)/2}} \times 100$$

$$\%RSD = \frac{\textit{standard deviation of results}}{\textit{average of results}} \times 100$$

$$PD = \frac{\textit{absolute (original sample result - duplicate sample result)}}{\textit{original value}} \times 100$$

$$R = \underline{\textit{absolute value of original sample results - duplicate sample result}}$$

12.3. Completeness Assessment

Completeness refers to the process of obtaining the required data as outlined in the Work Plan. Completeness is also defined as the percentage of measurements judged to be valid. Field and analytical data will be specified at 95 percent target completeness for this project. Completeness will be calculated separately for each analytical and field method. Data completeness will be calculated as follows for each individual method:

$$\%\ Completeness = \frac{\textit{Number of Method Results Useable for Qualitative and Quantitative Purposes}}{\textit{Total Number of Results Reported for the Individual Method}} \times 100$$

13. Corrective Action

Corrective action is the process of identifying, recommending, approving and implementing measures to counter unacceptable procedures or outlier quality control performance which can affect data quality. Corrective action can occur during field activities, laboratory analyses, data validation and data assessment. Corrective actions proposed and implemented will be documented in the regular QA reports to management (see QAP section 14). If immediate corrective action is required, telephoned approvals will be documented in additional memoranda.

13.1. Field Corrective Action

Corrective action in the field can be needed when the sample network is changed (i.e. more/fewer samples, sampling locations other than those specified in the QAP, etc.), sampling procedures require modification, field analytical procedures requiring modification, etc. due to unexpected conditions. In general, the field team (technician, Field Operations Manager, Project Manager or QA Officer) may identify the need for corrective action. The level of approval for the corrective action will be at the Field Operations Manager level or higher.

If the corrective action will supplement the existing sampling plan (i.e. additional soil borings) using existing & approved procedures in the QAP, corrective action approved by the Field Operations Manager need only be documented. If corrective action will result in fewer samples (or analytical fractions), alternate locations, etc. and may cause project QA objectives not to be achieved, it may be necessary that all levels of project management including the Project Manager, RCI Project Manager and the USEPA Region V Permit Writer concur with the proposed action. Corrective action resulting from internal field audits should be implemented immediately if data may be adversely affected due to unapproved or improper use of approved methods. The QA Officer shall identify deficiencies and recommended corrective action to the Project Manager and implementation by the Field Operations Manager and field team. Corrective actions will be documented in QA reports to the entire project management team.

13.2. Laboratory Corrective Action

Corrective action in the laboratory may occur prior to, during and after initial analyses. A number of conditions, such as broken sample containers, multiple phases, low/high pH readings, or potentially high concentration samples, may be identified during sample log-in or just prior to analysis. Following consultation with lab analysts and section leaders, the contract laboratory's QC Coordinator shall notify the O'Brien & Gere Engineers Project Manager of these conditions. Concurrence of proposed action by all levels of project management may be necessary if resampling is needed, alternate analytical procedures are needed, or if QA objectives may not be met.

The SOPs specify some conditions during or after analysis that may automatically trigger corrective action or optional procedures. These conditions may include dilution of samples, additional sample extract cleanup, automatic reinjection/reanalysis when certain QC criteria are not met, etc. A summary of method-specific corrective actions are found in QAP Table 3.

These corrective actions will be performed prior to release of data from the contract laboratory. The corrective action will be documented in both the lab's corrective action log and the narrative data report sent from the lab to the O'Brien & Gere Engineers data validator. If corrective action does not rectify the situation, the laboratory will contact the O'Brien & Gere Engineers Project Manager.

13.3. Corrective Action During Data Validation and Data Assessment

O'Brien & Gere Engineers may identify the need for corrective action during either the data validation or data assessment. Potential types of corrective action may include resampling by the field team or reinjection/reanalysis of samples by the contract laboratory. These actions are dependent upon the ability to mobilize the field team, whether the data to be collected is necessary to meet the required QA objectives, the holding time for samples already collected, etc. The corrective action may require all levels of project management to concur.

14. Quality Assurance Reports to Management

The deliverables associated with the tasks identified in the RI/FS Work Plan and monthly progress reports will contain separate QA sections in which data quality information collected during the task is summarized. Those reports will be the responsibility of the Project Manager and will include the QA Officer report on the accuracy, precision, and completeness of the data and the results of the performance and system audits, and corrective actions needed or taken during the project.

TABLES

Table 1 (1 of 5)
Analytes and Quantitation Limits:
METALS: BY SW846 METHODS 6010 and 7000 SERIES

	Quantitation Limits Water (ug/L)	Soil/Sediment (ug/kg)
Aluminum	Type A	Type A
Antimony	Type A	Type A
Arsenic	Type A	Type A
Barium	Type A	Type A
Beryllium	Type A	Type A
Cadmium	Type A	Type A
Calcium	Type A	Type A
Chromium	Type A	Type A
Cobalt	Type A	Type A
Copper	Type A	Type A
Iron	Type A	Type A
Lead	Type A	Type A
Magnesium	Type A	Type A
Manganese	Type A	Type A
Mercury	Type A	Type A
Nickel	Type A	Type A
Potassium	Type A	Type A
Selenium	Type A	Type A
Silver	Type A	Type A
Sodium	Type A	Type A
Thallium	Type A	Type A
Vanadium	Type A	Type A
Zinc	Type A	Type A
Cyanide	Type A	Type A

Note: Type A criteria, as per MERA Operational Memo #15

Table 1 (2 of 5)
Analytes and Quantitation Limits:
VOLATILE ORGANICS: BY SW846 METHOD 8240
TOTAL PETROLEUM HYDROCARBONS

	Quantitation Limits Water ug/L	Soil/Sediment ug/kg
Chloromethane	Type B	Type B
Bromomethane	Type B	Type B
Vinyl Chloride	Type B	Type B
Chloroethane	Type B	Type B
Methylene Chloride	Type B	Type B
Acetone	Type B	Type B
Carbon Disulfide	Type B	Type B
1,1-Dichloroethene	Type B	Type B
1,1-Dichloroethane	Type B	Type B
1,2-Dichloroethene (total)	Type B	Type B
Chloroform	Type B	Type B
1,2-Dichloroethane	Type B	Type B
2-Butanone	Type B	Type B
1,1,1-trichloroethane	Type B	Type B
Carbon Tetrachloride	Type B	Type B
Vinyl Acetate	Type B	Type B
Bromodichloromethane	Type B	Type B
1,2-Dichloropropane	Type B	Type B
cis-1,3-Dichloropropene	Type B	Type B
Trichloroethene	Type B	Type B
Dibromochloromethane	Type B	Type B
1,1,2-Trichloroethane	Type B	Type B
Benzene	Type B	Type B
trans-1,3-Dichloropropene	Type B	Type B
Bromoform	Type B	Type B
4-Methyl-2-pentanone	Type B	Type B
2-Hexanone	Type B	Type B
tetrachloroethene	Type B	Type B
Toluene	Type B	Type B
1,1,2,2-Tetrachloroethane	Type B	Type B
Chlorobenzene	Type B	Type B
Ethyl Benzene	Type B	Type B
Styrene	Type B	Type B
Xylenes (Total)	Type B	Type B
Petroleum Hydrocarbons 1 (mg/L)		Type B

Note: Type B Criteria as per MERA Operational Memo #6, Revision #3, February 4, 1994.

Table 1 (3 of 5)
Analytes and Quantitation Limits:
SEMIVOLATILE ORGANICS: BY SW846 METHOD 8270

	Quantitation Limits Water ug/L	Soil/Sediment ug/kg
Phenol	Type B	Type B
bis (2-Chloroethyl) ether	Type B	Type B
2-Chlorophenol	Type B	Type B
1,3-Dichlorobenzene	Type B	Type B
1,4-Dichlorobenzene	Type B	Type B
Benzyl alcohol	Type B	Type B
1,2-Dichlorobenzene	Type B	Type B
2-Methylphenol	Type B	Type B
bis (2-Chloroisopropyl ether)10	Type B	Type B
4-Methylphenol	Type B	Type B
N-Nitroso-di-n-dipropylamine	Type B	Type B
Hexachloroethane	Type B	Type B
Nitrobenzene	Type B	Type B
Isophorone	Type B	Type B
2-Nitrophenol	Type B	Type B
2,4-Dimethylphenol	Type B	Type B
Benzoic acid	Type B	Type B
bis(2-Chloroethoxy) methane	Type B	Type B
2,4-Dichlorophenol	Type B	Type B
1,2,4-Trichlorobenzene	Type B	Type B
Naphthalene	Type B	Type B
4-Chloroaniline	Type B	Type B
Hexachlorobutadiene	Type B	Type B
4-Chloro-3-methylphenol	Type B	Type B
(para-chloro-meta-cresol)	Type B	Type B
2-Methylnaphthalene	Type B	Type B
Hexachlorocyclopentadiene	Type B	Type B
2,4,6-Trichlorophenol	Type B	Type B
2,4,5-Trichlorophenol	Type B	Type B
2-Chloronaphthalene	Type B	Type B
2-Nitroaniline	Type B	Type B
Dimethylphthalate	Type B	Type B
Acenaphthylene	Type B	Type B

Note: Type B Criteria as per MERA Operational Memo #6, Revision #3, February 4, 1994.

Table 1 (4 of 5)
Analytes and Quantitation Limits:
SEMIVOLATILE ORGANICS: BY SW846 METHOD 8270

	Quantitation Limits Water (ug/L)	Soil/Sediment (ug/kg)
2,6-Dinitrotoluene	Type B	Type B
3-Nitroaniline	Type B	Type B
Acenaphthene	Type B	Type B
2,4-Dinitrophenol	Type B	Type B
4-Nitrophenol	Type B	Type B
Dibenzofuran	Type B	Type B
2,4-Dinitrotoluene	Type B	Type B
Diethylphthalate	Type B	Type B
4-Chlorophenyl-phenyl ether	Type B	Type B
Fluorene	Type B	Type B
4-Nitroaniline	Type B	Type B
4,6-Dinitro-2-methylphenol	Type B	Type B
N-nitorsodiphenylamine	Type B	Type B
4-Bromophenyl-phenylether	Type B	Type B
Hexachlorobenzene	Type B	Type B
Pentachlorophenol	Type B	Type B
Phenanthrene	Type B	Type B
Anthracene	Type B	Type B
Di-n-butylphthalate	Type B	Type B
Fluoranthene	Type B	Type B
Pyrene	Type B	Type B
Butylbenzylphthalate	Type B	Type B
3,3'-Dichlorobenzidine	Type B	Type B
Benzo(a)anthracene	Type B	Type B
Chrysene	Type B	Type B
bis(2-Ethylhexyl)phthalate	Type B	Type B
Di-n-octylphthalate	Type B	Type B
Benzo(b)fluoranthene	Type B	Type B
Benzo(k)fluoranthene	Type B	Type B
Benzo(a)pyrene	Type B	Type B
Indeno (1,2,3-cd)pyrene	Type B	Type B
Dibenz(a,h)anthracene	Type B	Type B
Benzo(g,h,i)perylene	Type B	Type B

Note: Type B Criteria as per MERA Operational Memo #6, Revision #3, February 4, 1994.

Table 1 (5 of 5)
Analytes and Quantitation Limits:
PCBs: BY SW846 METHOD 8080

	Quantitation Limits Water (ug/L)	Soil/Sediment (ug/kg)
Aroclor-1016	Type B	Type B
Aroclor-1221	Type B	Type B
Aroclor-1232	Type B	Type B
Aroclor-1242	Type B	Type B
Aroclor-1248	Type B	Type B
Aroclor-1254	Type B	Type B
Aroclor-1260	Type B	Type B

Note: Type B Criteria as per MERA Operational Memo #6, Revision #3, February 4, 1994.

TABLE 2

SUMMARY OF INTERNAL QUALITY CONTROL PROCEDURES AND FIELD MEASUREMENTS - QA/QC PROGRAM

Analytical Method/ Measurement	Units	Frequency Calibration	Acceptance Criteria	Corrective Action
150.1/pH	Standard Units	Beginning and end of each sampling day	±0.2 units	Step 1. Recalibrate. Step 2. If instrument cannot be recalibrated, repair of replace instrument or probe. Step 3. Document corrective action taken
170.1/Temperature	Degrees Centi-grade	calibrated monthly	±0.5 degrees C	Step 1. Recalibrate. Step 2. If instrument cannot be recalibrated, repair or replace instrument or probe. Step 3. Document corrective action taken.
120.1/specific conductance	Micromhos/ centimeter	calibrated daily	±5.0 percent	Step 1. Recalibrate Step 2. If instrument cannot be recalibrated, repair or replace instrument or probe. Step 3. Document corrective action taken.

Refer to Section 4 for standard operation procedures for each method.

Source: Methods For Chemcial Analysis of Water and Wastes - Revised March 1983, U.S. EPA, Cincinnati, OH. March 1983.

TABLE 3 (1 of 6)
LABORATORY
CONTROL LIMITS:
PCBs

Quality Control Check	Frequency	Acceptance Criteria	Corrective Action
Equipment Blank	1 per sampling event and every ten samples (total of 7)	Same criteria as trip blank	Apply corrective actions indicated for trip blank analysis.
Field Replicate	1 for every 10 field samples (total of 9 will be collected)	RPD $\leq$ 40%	1. Review laboratory QC. 2. If laboratory QC was within control limits the following corrective actions may be taken: Reextraction and reanalysis, evaluate field sampling procedures. 3. Resampling may be necessary.
5 Point Initial Calibration	Prior to sample analysis and whenever continuing calibration criteria is exceeded	If %RSD <20%, the avarage calibration factor for quantitation; alternatively use calibration curve for quantitation	Corrective action is necessary when continuing calibration criteria is not met.
Continuing Calibration Verification	At the beginning of an analysis sequence and every 10 samples	%D <15% for quantitation column; <20% for confirmation column.	1. Reanalyze 2. If criteria are still not met, recalibrate instrument for the affected compounds.
Raagent Blank Analysis	1 per matrix and every 20 samples of similar matrix.	Less than MDL for all compounds of intarest, and peaks that would interfere with sample identification or quantitation must not be present.	1. Reanalyze 2. If limits are still exceeded, clean instrument, and recalibrate. 3. Document corrective action-samples must not be analyzed until blank criteria is met.
Surrogate Analysis (Dacachlorobiphenyl)	All samples, blanks, duplicates, spikes and external check standards	Percent Recovery must be within those limits established by the analytical laboratory for decachlorobiphenyl and retention time shift must be within 2% for packed column analyses.	1. Reanalyze and review method blank surrogate recoveries. 2. If recovary is still outside of limits, and surrogate recovery was met for method blanks, report data indicating that surrogate criteria was not met. 3. If surrogate recovery criteria was not met for method blanks, prepare new surro gate spiking soln. and reanalyze affected samples.
Matrix Spike/Matrix Spike Duplicate Analysis	1 set per every 20 samples of similar matrix	Percent Recovery and RPD must be within those limits established by the analytical laboratory	1. Reanalyze 2. Review reference standard recoveries, if reference standard recovery criteria was not met go directly to step 4. 3. Analyze new MS/MSD sample 4. If still outside of limits, locate and correct problem, recalibrate and reanalyze samples run since last satisfactory MS/MSD sample- Document corrective action.

TABLE 3 (2 OF 6)
LABORATORY
CONTROL LIMITS:
PCBs
(Continued)

Quality Control Check	Frequency	Acceptance Criteria	Corrective Action
Reference Standard	1 per analytical batch.	Within laboratory established recovery limits	1. Reanalyze and examine results of other QC analyses. 2. If recoveries still exceed criteria, and other QC analyses have met criteria, prepare new reference standard and reanalyze. 3. If additional QC criteria has not been met or if reference standard recoveries are not met after repreparation, stop analysis, locate and correct problem. Recalibrate and reanalyze samples since last satisfactory reference standard: document corrective action.
Pesticide Instrument Performance Criteria	Each standard must meet performance criteria.	1. %Degradation of Endrin or Dieldrin must < 25% 2. Retention time of identified compounds must fall within established retention time windows. 3. Peaks must be adequately resolved for primary column identification.	1. Reanalyze affected standard. 2. If criteria is still not met, locate and correct problem, reanalyze calibration stan dard or recalibrate. 3. Document corrective actions and reanalyze samples back to last in control standard.
Compound Quantitation	Each sample, and quality control sample, including confirmation analyses.	Use either the average calibration factor or calibration curve depending on initial calibration RSD criteria.	Not applicable.
Field Duplicate	1 per matrix and analytical batch and every 20 samples of similar matrix	50% RPD for water and 100% RPD for soil	If these criteria are not met, sample results will be evaluated on a case by case basis.
Method Blank	Prior to sample analysis and every 12 hours	Less than 5xQL for phthalates. Less than QL for all others.	1. Run solvent blank. 2. Reanalyze sample. 3. If limits are still exceeded reextract & reanalyze detected samples if within holding times.

TABLE 3 (3 of 6)
LABORATORY CONTROL LIMITS
METALS AND CYANIDE

Audit	Frequency	Control Limit	Corrective Action
Calibration Blank	At beginning and end of run and at a rate of 10% during run	Less than Quantitation Limits	1. Identify and correct problem 2. Recalibrate, document corrective actions. 3. Sample analysis can not begin until calibration blank criteria has been met.
Calibration Verification	Calibrated daily (with minimum of 2 standards for ICP and 4 standards for AA furnace) and each time the instrument is set up; verify at a frequency of 10% or every 2 hours whichever is greater	Calibration correlation coefficients for furnace AA ≥ 0.995 %Recovery 90%-110% for metals %Recovery 80%-120% for cyanide and mercury	1. Reanalyze. 2. If criteria are still not met, identify and correct problem, recalibrate. 3. Sample analysis can not begin until verification have been met.
Preparation Blank	1 per matrix, 1 per digestion batch, and every 20 samples of similar matrix	Less than Quantitation Limits	1. Reanalyze. 2. If limits are still exceeded, clean instrument and recalibrate analytical system. 3. Document corrective action - Samples must not be analyzed until blank criteria is met.
Matrix Spike Sample Analysis	1 per matrix, 1 per digestion batch and every 20 samples of similar matrix	%Recovery 75%-125%	1. Review MSB Results 2. If MSB exceeds limits redigest and reanalyze samples. If MSB does not exceed limits, qualify data
Laboratory Duplicate	Same as spiked sample analysis	RPD ≤ 20% or ± quantitation limit for samples <5xQL	Investigate problem and reextract or reanalyze.
Laboratory Control Sample	1 per digestion batch and matrix type	For soils: Values must be within U.S.EPA established limits; For waters: %Recovery 80%-120%	Investigate problem and write an explanation
Furnace Analysis	Every sample must be injected in duplicate and spiked; method of standard additions is required when sample absorbance or concentration ≥ 50% of spike concentration and %recovery is not within 85%-115%	%RSD of duplicate injections ≤ 20% %Recovery of spikes 85%-115%	1. Reanalyze. 2. If limits are still exceeded, qualify data.
Field Duplicate	1 per matrix and analytical batch and every 20 samples of similar matrix	50% of RPD for waters and 100% RPD for soil	If these criteria are not met, sample results will be evaluated on a case by case basis.

TABLE 3 (4 of 6)
LABORATORY CONTROL LIMITS:
VOLATILE ORGANICS

Audit	Frequency	Control Limits	Corrective Actions
GC/MS Tuning	Prior to sample analysis and every 12 hours	BFB key ions and abundance criteria specified in the method must be met for all 9 ions	1. Identify and correct problem 2. Retune GC/MS and documant corrective action
Method Blank	Prior to sample analysis and avery 12 hours	Less than 5xQL for mathylane chloride, toluena, 2-butanone and acetone; <QL for others	1. Reanalyze 2. If limits are still exceaded, clean instrument, recalibrate analytical system 3. Document corrective action- Samples must not be analyzed until blank critaria is met
Initial Calibration	Prior to sample analysis and whenever continuing calibration criteria is not met	Five concentrations; Minimum Response factor (RF) for System Performance Check Compounds (SPCCs) >0.300 (0.250 for bromoform); Calibration Check Compounds (CCCs) must have % RSD <30%	1. Identify and corract problem (i.e., clean source)' 2. Recalibrate, document corrective actions Sample analysis can not begin until initial calibration criteria has been met
Continuing Calibration	Initially and every 12 hours	Minimum RF >0.300 (0.250 for bromoform) for SPCCs; % Difference <25% for CCCs	1. Reanalyze 2. If criteria is still not met, identify and correct problem, recalibrate. Sample analysis can not begin until continuing calibration criteria for SPCCs and CCCs have been met
Surrogate Spike	All samples and blanks (including MS/MSD samples)	% Recovery within limits establishad by laboratory-Refer to Appendix B	1. Reanalyze and review method blank surrogate recoveries 2. If recovery is still outside limits, and surrogate recovery criteria were mst for method blank, qualify data
MS/MSD	1 per matrix and analytical batch and evary 20 samples of similar matrix	% Recovery within laboratory control limits- Refer to Appendix B limits	1. Reanalyze 2. If still outside limits, consult supervisor 3. The following corrective actions may be taken: Reanalyze, recalibration, and qualify data.
Reference Standard Analysis	1 per analytical batch and every 20 samples	% Recovery within limits specified in method 8240 for 20ug/L standard-Refer to Appendix B	1. Reanalyze 2. If still outsida limits, consult supervisor 3. The following corrective actions may be taken: Reanalyze, recalibration, and qualify data.
Compound Quantitation	Each sample and quality control sample	Internal standard method, as specified in the method	Not applicable
Field Duplicate	1 per matrix and analytical batch and every 20 samples of similar matrix	50% RPD for water and 100% RPD for soil	If these criteria are not met, sample results will be evaluated on a case by case basis

TABLE 3 (5 of 6)
LABORATORY CONTROL LIMITS:
SEMI-VOLATILES ORGANICS

Audit	Frequency	Control Limits	Corrective Actions
GC/MS Tuning	Prior to sample analysis and every 12 hours	DFTPP key ions and abundance criteria specified in the method must be met for all 13 ions.	1. Identify and correct problem 2. Retune GC/MS and document corrective action
Method Blank	Prior to sample analysis and every 12 hours	Less than 5xQL for phthalates. Less than QL for all others.	1. Run solvent blank. 2. Reanalyze sample. 3. If limits are still exceeded reextract & reanalyze detected samples if within holding times.
Initial Calibration	Prior to sample analysis and whenever continuing calibration criteria is not met	Five concentrations; Minimum Response factor (RF) for System Performance Check Compounds (SPCCs) >0.050; Calibration Check Compounds (CCCs) must have % RSD <30%	1. Identify and correct problem (ie clean source) 2. Recalibrate, document corrective actions Sample analysis can not begin until initial calibration criteria has been met
Continuing Calibration	Initially and every 12 hours	Minimum RF >0.050 for SPCCs; % Difference <30% for CCCs	1. Reanalyze 2. If criteria are still not met, identify and correct problem, recalibrate. Sample analysis can not begin until continuing calibration criteria for SPCCs and CCCs have been met
Surrogate Spike	All samples and blanks (including MS/MSD samples)	% Recovery within limits established by Laboratory. Refer to Table Appendix B.	1. Reanalyze and review method blank surrogate recoveries 2. If recovery is still outside limits, and surrogate recovery criteria were met for method blank, qualify data 3. If surrogate recovery criteria were not met for method blank, prepare new surrogate spiking solution and re-extract and reanalyze samples
MS/MSD	1 per matrix and analytical batch and every 20 samples of similar matrix	% Recovery within Laboratory Control Limits. Refer to Appendix B	1. Reanalyze 2. If still outside limits, consult supervisor. 3. The following corrective actions may be taken: Reextraction, Recalibration, and qualify data.
Reference Standard Analysis	1 per analytical batch and every 20 samples	% Recovery within Laboratory Control Limits. If laboratory limits are not available, those specified in method. Refer to Appendix B.	1. Reanalyze 2. If still outside limits, consult supervisor. 3. The following corrective actions may be taken: Reextraction, Recalibration, and qualify data.
Compound Quantitation	Each sample and quality control sample	Internal standard method, as specified in the method	Not applicable
Field Duplicate	1 per matrix and analytical batch and every 20 samples of similar matrix	50% RPD for water and 100% RPD for soil	If these criteria are not met, sample results will be evaluated on a case by case basis

TABLE 3 (6 of 6)
LABORATORY CONTROL LIMITS:
TOTAL RECOVERABLE PETROLEUM HYDROCARBONS

Audit	Frequency	Control Limit	Corrective Action
Method Blank	Prior to sample analysis and every 12 hours	Less than Quantitation Limit for all compounds of interest	1. Reanalyze 2. If limits are still exceeded, clean instrument, recalibrate system. 3. Document corrective action - samples must not be analyzed until blank criteria is met.
Initial Calibration	Prior to sample analysis and when continuing calibration criteria is not met	A minimum of three standards that define the concentration range of samples analyzed	1. Identify and correct problem. 2. Recalibrate, document corrective actions 3. Sample and analysis can not begin until initial calibration criteria has been met.
Continuing Calibration	Each 12 hours	<25% difference from initial calibration	1. Identify and correct problem 2. Recalibrate, document corrective actions 3. Sample and analysis can not begin until initial calibration criteria has been met.
Duplicate Analysis	One per analytical batch, or matrix type, or every 20 samples whichever is most frequent	RPD within 50%.	Investigate problem and reanalyze.
Detection Limit	Established for each system prior to sample analysis and annually.	As specified by method.	NA
Field Duplicate	1 per matrix and analytical batch and every 20 samples of similar matrix	50% RPD for water and 100% RPD for soil	If these criteria are not met, sample results will be evaluated on a case by case basis.

Table 4
RCRA Facility Investigation Work Plan
RCI Ferndale, Michigan Facility

Solid Waste Management Units
South Area
Recommended Investigations

MDNR SWMU No	Name	Reason for Further Investigation	Reason for No Further Investigation	Proposed Method of Investigation
1.	South Tank Farm	-	Interim measure in place. In situ air stripping device in operation.	Incorporate into Corrective Measures.
2.	Building 204 - Product Storage Warehouse	Confirm low release potential	-	Bldg foundation integrity testing followed by biased soil boring installation through foundation
3.	Building 203 - Product Storage Warehouse	Confirm low release potential	-	Bldg foundation integrity testing followed by biased soil boring installation through foundation
4.	Pipe Bridge between Building 203 and 206	-	Low release potential. Overhead pipe bridge contained steam only.	No further investigation.
5.	Building 206 - Product Storage Area	Confirm low release potential	-	No further investigation.
6.	Pipe Tunnel beneath Woodward Heights Ave. Connecting South and West Areas	Unknown piping integrity.	-	Video survey or integrity testing to document leakage potential.
60.	Former Underground Storage Tank	-	Closure Plan submitted to MDNR: Analytical results below detectable levels.	No further investigation. Closure report submitted March, 1990.
61.	Driveway between Gainsboro Ave. and Buildings 204 and 205.	-	No documentation exists regarding storage or spills of hazardous materials. Previous investigations do not indicate environmental impact.	No further investigation.

Table 5
RCRA Facility Investigation Work Plan
RCI Ferndale, Michigan Facility

Solid Waste Management Units
West Area
Recommended Investigations

MDNR SWMU No	Name	Reason for Further Investigation	Reason for No Further Investigation	Proposed Method of Investigation
7.	Inflammable Solvents Tank Farm	Unknown release potential. Tank/containment integrity unknown	-	Bldg foundation integrity evaluation followed by biased soil borings through foundation.
8.	Solvent Pump Station	Unknown release potential.	-	Bldg foundation integrity evaluation followed by biased soil borings through foundation.
9.	Building "B" - Resin Production	Former production area	-	Bldg foundation integrity evaluation followed by biased soil borings through foundation.
10.	Building "C" - Resin Production	Former production area	-	Bldg foundation integrity evaluation followed by biased soil borings through foundation.
11.	Dock "C" - Storage and Processing	Bulk storage area, low release potential	-	Bldg foundation integrity evaluation followed by biased soil borings through foundation.
12.	Building "K" - Storage and Processing	Bulk storage area, low release potential	-	Bldg foundation integrity evaluation followed by biased soil borings through foundation.
13.	Dock "K" - Storage and Processing	Bulk storage area, low release potential	-	Bldg foundation integrity evaluation followed by biased soil borings through foundation.
14.	Inert Gas Generation Building	Phthalic Anhydride and Phenol/Formaldehyde	-	Bldg foundation integrity evaluation followed by biased soil borings through foundation.

Table 5
RCRA Facility Investigation Work Plan
RCI Ferndale, Michigan Facility

Solid Waste Management Units
West Area
Recommended Investigations

MDNR SWMU No	Name	Reason for Further Investigation	Reason for No Further Investigation	Proposed Method of Investigation
15.	Building "N"	Distillation of Glycerin resin and inflammable solvent production	-	Bldg foundation integrity evaluation followed by biased soil borings through foundation.
16.	Pump House	Unknown release potential.	-	Bldg foundation integrity evaluation followed by biased soil borings through foundation.
17.	Tank Farm	Unknown release potential.	-	Bldg foundation integrity evaluation followed by biased soil borings through foundation.
18.	Building "M" - Empty Drum Storage	Confirm low release potential	-	Bldg foundation integrity evaluation followed by biased soil borings through foundation.
19.	Building "L" - adjacent to Building "M"	Eight storage tanks, unknown spill potential.	-	Bldg foundation integrity evaluation followed by biased soil borings through foundation.
20.	Tank Truck Cleaning Building	Miscellaneous storage, Trichloroethene and Carbon Tetrachloride cleaning and storage. Unknown spill potential.	-	Bldg foundation integrity evaluation followed by biased soil borings through foundation.
21.	Storage Tanks adjacent to Tank Truck Cleaning Building	Unknown spill potential.	-	Bldg foundation integrity evaluation followed by biased soil borings through foundation.

Table 5
RCRA Facility Investigation Work Plan
RCI Ferndale, Michigan Facility

Solid Waste Management Units
West Area
Recommended Investigations

MDNR SWMU No	Name	Reason for Further Investigation	Reason for No Further Investigation	Proposed Method of Investigation
22.	Diked Area adjacent to Building "L"	Confirm low release potential	-	Bldg foundation integrity evaluation followed by biased soil borings through foundation.
23.	Garage Area of Building "L"	Miscellaneous storage, Tri-chloroethene storage. Low release potential.	-	Bldg foundation integrity evaluation followed by biased soil borings through foundation.
24.	Resin Drum Storage Shed	Unknown release potential.	-	Bldg foundation integrity evaluation followed by biased soil borings through foundation.
25.	Transformer Storage	-	Low release potential due to unit design. No documentation/reporting of spills. Previous investigations indicate no PCB present throughout facility at concentrations above action levels.	No further investigation.
26.	Diked Area Consisting of 7 Storage Tanks	Confirm low release potential	-	Bldg foundation integrity evaluation followed by biased soil borings through foundation.
27.	Building "D" Annex	Resin processing and filtering. Unknown release potential.	-	Bldg foundation integrity evaluation followed by biased soil borings through foundation.
28.	Building "D"	Resin processing and filtering. Unknown release potential.	-	Bldg foundation integrity evaluation followed by biased soil borings through foundation.
29.	Building "E" - 14 Process Tanks	Resin processing and filtering Unknown release potential.	-	Bldg foundation integrity evaluation followed by biased soil borings through foundation.

Table 5
RCRA Facility Investigation Work Plan
RCI Ferndale, Michigan Facility

Solid Waste Management Units
West Area
Recommended Investigations

MDNR SWMU No	Name	Reason for Further Investigation	Reason for No Further Investigation	Proposed Method of Investigation
30.	Building "F"	Resin processing and filtering. Unknown release potential.	-	Bldg foundation integrity evaluation followed by biased soil borings through foundation.
31.	Building "G"	Phenol sampling.	-	Bldg foundation integrity evaluation followed by biased soil borings through foundation.
32.	Four Storage Tanks	Resin processing and filtering. Unknown release potential.	-	Bldg foundation integrity evaluation followed by biased soil borings through foundation.
33.	Building "H"	Confirm low release potential	-	No further investigation.
59.	Pipe Tunnel from SWMU no. 41 to SWMU no. 13	Unknown piping integrity.	-	Video survey or integrity testing to determine leakage potential.
62.	Area between Railroad Spur on the Northern End of West Area	Loading/unloading area, miscellaneous storage.	-	ECP Screening followed by possible soil borings with subsurface samples.
63.	Driveway and Parking Area west side of West Area	Unknown release potential.	-	ECP Screening followed by possible soil borings with subsurface samples.
64.	Roadway between Two Sets of Buildings which Split the West Area	Unknown release potential.	-	ECP Screening followed by possible soil borings with subsurface samples.

Table 6
RCRA Facility Investigation Work Plan
RCI Ferndale, Michigan Facility

Solid Waste Management Units
East Area
Recommended Investigations

MDNR SWMU No	Name	Reason for Further Investigation	Reason for No Further Investigation	Proposed Method of Investigation
34.	Building 102	Confirm low release potential	-	No further investigation.
35.	Hazardous Reagent Storage Area	Unknown release potential.	-	Bldg foundation integrity evalution followed by biased soil borings through foundation.
36.	Building 100 Maintenance Shop	Confirm low release potential	-	Bldg foundation integrity evalution followed by biased soil borings through foundation.
37.	Heated Storage Bldg. 101A Sample Resin Dispensing	Unknown release potential.	-	Bldg foundation integrity evalution followed by biased soil borings through foundation.
38.	Storage Shed	Confirm low release potential	-	No further investigation.
39.	Building 101B - Misc. Solvent Storage	Low release potential, but unknown containment/ integrity of storage areas.	-	Bldg foundation integrity evalution followed by biased soil borings through foundation.
40.	Hazardous Waste Tank Storage Area	Unknown release potential.	-	Bldg foundation integrity evalution followed by biased soil borings through foundation.

Table 6
RCRA Facility Investigation Work Plan
RCI Ferndale, Michigan Facility

Solid Waste Management Units
East Area
Recommended Investigations

MDNR SWMU No	Name	Reason for Further Investigation	Reason for No Further Investigation	Proposed Method of Investigation
41.	Boiler Room - Hazardous Waste Incineration	Unknown release potential - assumed low release potential due to unit design	-	Bldg foundation integrity evalution followed by biased soil borings through foundation.
42.	Hazardous Waste Container Area	Unknown release potential.	-	Bldg foundation integrity evalution followed by biased soil borings through foundation.
43.	Building 105A - Phthalic Anhydride Production	Unknown release potential.	-	Bldg foundation integrity evalution followed by biased soil borings through foundation.
44.	Hazardous Waste Container Storage Area	Unknown release potential.	-	Bldg foundation integrity evalution followed by biased soil borings through foundation.
45.	Building 103 - Resin and Inflammable Solvent Production	Unknown release potential.	-	ECP Screening with possible soil borings and subsurface soil samples followed by possible groundwater monitoring well.
46.	Building 104A - Phthalic Anhydride Production, Minerva Avenue, RCI owned property	Unknown release potential.	-	Bldg foundation integrity evalution followed by biased soil borings through foundation: ECP screening and possible soil borings on Minerva Avenue property.
47.	Building 104 - Tank Storage Area	-	Area incorporated into DNAPL interim measure.	Incorporate into corrective measures, conduct additional soil borings with subsurface soil samples, if warranted.

Table 6
RCRA Facility Investigation Work Plan
RCI Ferndale, Michigan Facility

Solid Waste Management Units
East Area
Recommended Investigations

MDNR SWMU No	Name	Reason for Further Investigation	Reason for No Further Investigation	Proposed Method of Investigation
48.	Building 104 - Resin Drum Storage	Unknown release potential.	-	Bldg foundation integrity evalution followed by biased soil borings through foundation.
49.	Building 104D - Resin Drum Storage	Unknown release potential.	-	ECP Screening with possible soil borings with subsurface soil sampling.
50.	Inflammable Solvent Tank Farm	Unknown release potential.	-	Bldg foundation integrity evalution followed by biased soil borings through foundation.
51.	Inflammable Solvent Tank Farm	Unknown release potential.	-	Bldg foundation integrity evalution followed by biased soil borings through foundation.
52.	Building 104 - Empty Drum Storage	Confirm low release potential	-	Bldg foundation integrity evalution followed by biased soil borings through foundation.
53.	Building 104E - Phthalic Anhydride Production	Unknown release potential.	-	Bldg foundation integrity evalution followed by biased soil borings through foundation.
54.	Building 105B - Phthalic Anhydride Production	Unknown release potential.	-	Bldg foundation integrity evalution followed by biased soil borings through foundation.
55.	Building 105 - Empty Drum Storage	Confirm low release potential	-	Bldg foundation integrity evalution followed by biased soil borings through foundation.

Table 6
RCRA Facility Investigation Work Plan
RCI Ferndale, Michigan Facility

Solid Waste Management Units
East Area
Recommended Investigations

MDNR SWMU No	Name	Reason for Further Investigation	Reason for No Further Investigation	Proposed Method of Investigation
56.	Building 101 – Phthalic Anhydride Production	Unknown release potential.	–	Bldg foundation integrity evalution followed by biased soil borings through foundation.
57.	Pipe Trench Between SWMU no. 36 and SWMU no. 34	–	No documentation exists regarding storage or spills of hazardous materials. Low release potential.	No further investigation.
58.	Pipe Bridge Between Bldg. 104 and Bldg 105	Unknown release potential.	–	Determination of former usage and release potential investigation.
59.	Pipe Tunnel From SWMU no. 41 to SWMU no. 13	Unknown Piping Integrity.	–	Video survey or integrity testing to document leakage potential
65.	Roadway Inside Wall along Bermuda Ave.	Unknown release potential.	–	ECP Screening with possible soil borings with subsurface soil samples.
66.	Truck Parking Lot	Unknown release potential.	–	ECP Screening with possible soil borings with subsurface soil samples.

Table 6
RCRA Facility Investigation Work Plan
RCI Ferndale, Michigan Facility

Solid Waste Management Units
East Area
Recommended Investigations

MDNR SWMU No	Name	Reason for Further Investigation	Reason for No Further Investigation	Proposed Method of Investigation
67.	Area Adjacent to Train Tracks - Entire Length of Property	Unknown release potential.	-	ECP Screening with possible soil borings with subsurface soil samples.
68.	Deep Well	-	Injection well abandoned over 20 years ago. Closure was overseen and approved by the MDNR. Well is reportedly 1500 feet deep and there is apparently no documentation supporting its use. Additionally, if the well had been used, the well is deep enough to have discharged into brine formations.	No further investigation. Eliminate as a SWMU.

Table 7
RCRA Facility Investigation Work Plan
RCI Ferndale, Michigan Facility

Location, Type and Number of Samples

MDNR SWMU Number	Name	Area	Building Foundation Integrity Evaluation	Foundation Soil Boring Samples	ECP Testing	Maximum Soil Borings	Monitoring Wells	Other	Required Analytical
1.	South Tank Farm	South	No	0	0	0	0	Incorporate into Corrective Measures	None
2.	Building 204 - Product Storage Warehouse	South	Yes	FD#	0	0	0		VOC Semi-VOC
3.	Building 203 - Product Storage Warehouse	South	Yes	FD#	0	0	0		VOC Semi-VOC
4.	Pipe Bridge between Building 203 and 206	South	No	0	0	0	0	Steam pipe only; No Further Investigation	None
5.	Building 206 - Product Storage Area	South	Yes	0	0	0	0		None
6.	Pipe Tunnel beneath Woodward Heights Ave. Connecting South and West Areas	South	No	0	0	0	0	Video survey or integrity testing to document leakage potential, Phase II investigation, if req'd.	None
60.	Former Underground Storage Tank	South	No	0	0	0	0	Closure report submitted March, 1990.	None
61.	Driveway between Gainsboro Ave. and Buildings 204 and 205.	South	No	0	0	0	0	Low release potential; No Further Investigation	None
7.	Inflammable Solvents Tank Farm	West	Yes	FD	0	0	0		VOC Semi-VOC
8.	Solvent Pump Station	West	Yes	FD	0	0	0		VOC Semi-VOC

NOTES:

: Foundation soil borings will be collected from around perimeter of building.

* : Number of monitoring wells is dependent upon results from ECP testing and soil borings.

FD: Number of samples will be field determined.

Table 7
RCRA Facility Investigation Work Plan
RCI Ferndale, Michigan Facility

Location, Type and Number of Samples

MDNR SWMU Number	Name	Area	Building Foundation Integrity Evaluation	Foundation Soil Boring Samples	ECP Testing	Maximum Soil Borings	Monitoring Wells	Other	Required Analytical
9.	Building "B" - Resin Production	West	Yes	FD	0	0	0		VOC Semi-VOC
10.	Building "C" - Resin Production	West	Yes	FD	0	0	0		VOC Semi-VOC
11.	Dock "C" - Storage and Processing	West	Yes	FD	0	0	0		VOC Semi-VOC
12.	Building "K" - Storage and Processing	West	Yes	FD	0	0	0		VOC Semi-VOC
13.	Dock "K" - Storage and Processing	West	Yes	FD	0	0	0		VOC Semi-VOC
14.	Inert Gas Generation Building	West	Yes	FD	0	0	0		VOC Semi-VOC
15.	Building "N"	West	Yes	FD	0	0	0		VOC Semi-VOC
16.	Pump House	West	Yes	FD	0	0	0		VOC Semi-VOC
17.	Tank Farm	West	Yes	FD	0	0	0		VOC Semi-VOC
18.	Building "M" - Empty Drum Storage	West	Yes	FD	0	0	0		VOC Semi-VOC
19.	Building "L" - adjacent to Building "M"	West	Yes	FD	0	0	0		VOC Semi-VOC

NOTES:

: Foundation soil borings will be collected from around perimeter of building.

* : Number of monitoring wells is dependent upon results from ECP testing and soil borings.

FD: Number of samples will be field determined.

Table 7
RCRA Facility Investigation Work Plan
RCI Ferndale, Michigan Facility

Location, Type and Number of Samples

MDNR SWMU Number	Name	Area	Building Foundation Integrity Evaluation	Foundation Soil Boring Samples	ECP Testing	Maximum Soil Borings	Monitoring Wells	Other	Required Analytical
20.	Tank Truck Cleaning Building	West	Yes	FD	0	0	0		VOC Semi-VOC
21.	Storage Tanks adjacent to Tank Truck Cleaning Building	West	Yes	FD	0	0	0		VOC Semi-VOC
22.	Diked Area adjacent to Building "L"	West	Yes	FD	0	0	0		VOC Semi-VOC
23.	Garage Area of Building "L"	West	Yes	FD	0	0	0		VOC Semi-VOC
24.	Resin Drum Storage Shed	West	Yes	FD	0	0	0		VOC Semi-VOC
25.	Transformer Storage	West	No	0	0	0	0	No Further Investigation	None
26.	Diked Area Consisting of 7 Storage Tanks	West	Yes	FD	0	0	0		VOC Semi-VOC
27.	Building "D" Annex	West	Yes	FD	0	0	0		VOC Semi-VOC
28.	Building "D"	West	Yes	FD	0	0	0		VOC Semi-VOC
29.	Building "E" - 14 Process Tanks	West	Yes	FD	0	0	0		VOC Semi-VOC
30.	Building "F"	West	Yes	FD	0	0	0		VOC Semi-VOC

NOTES:

: Foundation soil borings will be collected from around perimeter of building.

* : Number of monitoring wells is dependent upon results from ECP testing and soil borings.

FD: Number of samples will be field determined.

Table 7
RCRA Facility Investigation Work Plan
RCI Ferndale, Michigan Facility

Location, Type and Number of Samples

MDNR SWMU Number	Name	Area	Building Foundation Integrity Evaluation	Foundation Soil Boring Samples	ECP Testing	Maximum Soil Borings	Monitoring Wells	Other	Required Analytical
31.	Building "G"	West	Yes	FD	0	0	0		VOC Semi-VOC
32.	Four Storage Tanks	West	Yes	FD	0	0	0		VOC Semi-VOC
33.	Building "H"	West	Yes	FD	0	0	0		VOC Semi-VOC
59.	Pipe Tunnel from SWMU no. 41 to SWMU no. 13	West	No	0	0	0	0	Video survey or integrity testing, Phase II if req'd.	None
62.	Area between Railroad Spur on the Northern End of West Area	West	No	0	5	5	*		VOC Semi-VOC
63.	Driveway and Parking Area west side of West Area	West	No	0	16	16	*		VOC Semi-VOC
64.	Roadway between Two Sets of Buildings which Split the West Area	West	No	0	7	7	*		VOC Semi-VOC
34.	Building 102	East	Yes	FD	0	0	0		VOC Semi-VOC
35.	Hazardous Reagent Storage Area	East	Yes	FD	0	0	0		VOC Semi-VOC
36.	Building 100 Maintenance Shop	East	Yes	FD	0	0	0		VOC Semi-VOC

NOTES:

: Foundation soil borings will be collected from around perimeter of building.

* : Number of monitoring wells is dependent upon results from ECP testing and soil borings.

FD: Number of samples will be field determined.

Table 7
RCRA Facility Investigation Work Plan
RCI Ferndale, Michigan Facility

Location, Type and Number of Samples

MDNR SWMU Number	Name	Area	Building Foundation Integrity Evaluation	Foundation Soil Boring Samples	ECP Testing	Maximum Soil Borings	Monitoring Wells	Other	Required Analytical
37.	Heated Storage Bldg. 101A Sample Resin Dispensing	East	Yes	FD	0	0	0		VOC Semi-VOC
38.	Storage Shed	East	Yes	FD	1	1	*		VOC Semi-VOC
39.	Building 101B - Misc. Solvent Storage	East	Yes	FD	0	0	0		VOC Semi-VOC
40.	Hazardous Waste Tank Storage Area	East	Yes	FD	0	0	0		VOC Semi-VOC
41.	Boiler Room - Hazardous Waste Incineration	East	Yes	FD	0	0	0		VOC Semi-VOC
42.	Hazardous Waste Container Area	East	Yes	FD	0	0	0		VOC Semi-VOC
43.	Building 105A - Phthalic Anhydride Production	East	Yes	FD	0	0	0		VOC Semi-VOC
44.	Hazardous Waste Container Storage Area	East	Yes	FD	0	0	0		VOC Semi-VOC
45.	Building 103 - Resin and Inflammable Solvent Production	East	Yes	FD	4	4	*		VOC Semi-VOC
46.	Building 104A - Phthalic Anhydride Production	East	Yes	FD	0	0	0		VOC Semi-VOC
47.	Building 104 - Tank Storage Area	East	No	0	0	0	0	Incorporate into Corrective Measures	None

NOTES:

: Foundation soil borings will be collected from around perimeter of building.

* : Number of monitoring wells is dependent upon results from ECP testing and soil borings.

FD: Number of samples will be field determined.

Table 7
RCRA Facility Investigation Work Plan
RCI Ferndale, Michigan Facility

Location, Type and Number of Samples

MDNR SWMU Number	Name	Area	Building Foundation Integrity Evaluation	Foundation Soil Boring Samples	ECP Testing	Maximum Soil Borings	Monitoring Wells	Other	Required Analytical
48.	Building 104 - Resin Drum Storage	East	Yes	FD	0	0	0		VOC Semi-VOC
49.	Building 104D - Resin Drum Storage	East	Yes	FD	3	3	*		VOC Semi-VOC
50.	Inflammable Solvent Tank Farm	East	Yes	FD	0	0	0		VOC Semi-VOC
51.	Inflammable Solvent Tank Farm	East	Yes	FD	0	0	0		VOC Semi-VOC
52.	Building 104 - Empty Drum Storage	East	Yes	FD	0	0	0		VOC Semi-VOC
53.	Building 104E - Phthalic Anhydride Production	East	Yes	FD	0	0	0		VOC Semi-VOC
54.	Building 105B - Phthalic Anhydride Production	East	Yes	FD	0	0	0		VOC Semi-VOC
55.	Building 105 - Empty Drum Storage	East	Yes	FD	0	0	0		VOC Semi-VOC
56.	Building 101 - Phthalic Anhydride Production	East	Yes	FD	0	0	0		VOC Semi-VOC
57.	Pipe Trench Between SWMU no. 36 and SWMU no. 34	East	No	0	0	0	0	No Further Investigation	None

NOTES:

: Foundation soil borings will be collected from around perimeter of building.

* : Number of monitoring wells is dependent upon results from ECP testing and soil borings.

FD: Number of samples will be field determined.

Table 7
RCRA Facility Investigation Work Plan
RCI Ferndale, Michigan Facility

Location, Type and Number of Samples

MDNR SWMU Number	Name	Area	Building Foundation Integrity Evaluation	Foundation Soil Boring Samples	ECP Testing	Maximum Soil Borings	Monitoring Wells	Other	Required Analytical
58.	Pipe Bridge Between Bldg. 104 and Bldg 105	East	No	0	0	0	0	Determination of former usage	None
59.	Pipe Tunnel From SWMU no. 41 to SWMU no. 13	East	No	0	0	0	0	Video survey or integrity testing, Phase II if req'd.	None
65.	Roadway Inside Wall along Bermuda Ave.	East	No	0	7	7	*		VOC Semi-VOC
66.	Truck Parking Lot	East	No	0	6	6	*		VOC
67.	Area Adjacent to Train Tracks - Entire Length of Property	East	No	0	7	7	*		VOC Semi-VOC
68.	Deep Well	East	No	0	0	0	0	No Further Investigation	None

NOTES:

: Foundation soil borings will be collected from around perimeter of building.

* : Number of monitoring wells is dependent upon results from ECP testing and soil borings.

FD: Number of samples will be field determined.

TABLE 8

MATRIX SUMMARY
INVESTIGATIVE AND QC SAMPLES
REICHHOLD CHEMICALS, INC.

RCRA Facility Investigation

Matrix	Environmental Samples	Matrix Spike	Matrix Spike Duplicate** or Laboratory Duplicate***	Field Duplicate	Field/Equipment Blank	Matrix Total****
Ground Water	To be Determined*	5% of total	5% of total	10% of total	10% of total	To be determined
Subsurface Soil (Building Foundations)	70	4 (5%)	4 (5%)	7 (10%)	7 (10%)	92
Subsurface Soil	52	3 (5%)	3 (5%)	6 (10%)	6 (10%)	70
ECP Soil Samples	104	6 (5%)	6 (5%)	11 (10%)	11 (10%)	138

NOTES:

* To be determined based on soil borings and ECP Survey

** Matrix Spike and Matrix Spike Duplicates are collected at a frequency of one set per 20 or less investigative samples.

*** Field duplicates and field blanks are each collected at a frequency of one per 10 or less investigative samples.

**** Matrix Total = # of investigative samples and field duplicates and field blanks.

TABLE 9

REICHHOLD CHEMICALS INC.
RCRA FACILITY INVESTIGATION

SAMPLE CONTAINERS AND PRESERVATION REQUIREMENTS

Analysis	Sample Containers	Preservation
WATER:		
Volatile Organics	2-40 ml glass vials with Teflon backed silicon septum caps	Cool to 4°C HCL to pH less than or equal to 2
Semi-Volatile Organics	4-1 liter amber glass bottles with Teflon lined caps	Cool to 4°C
Metals	1-1 litre polyethylene bottle with poly cap	HNO_3 to pH less than or equal to 2
SOIL SAMPLES:		
Volatile Organics	2-120 ml wide mouth glass vials	Cool to 4°C
Semi-Volatile Organics	2-8 oz. wide mouth glass jar with teflon lined phenolic cap	Cool to 4°C
Metals	1-8 oz. wide mouth glass jar with teflon lined phenolic cap	Cool to 4°C

TABLE 10

REICHHOLD CHEMICALS INC.
RCRA FACILITY INVESTIGATION

REQUIRED HOLDING TIMES

Sample Analysis	Water	Soil
Target Compound List Volatile Organics	14 days	14 days
Target Compound List Semi-Volatile Organics	7 days until extraction 40 days for analysis	7 days until extraction 40 days for analysis
Metals	6 months	6 months
Mercury	28 days	28 days

TABLE 11

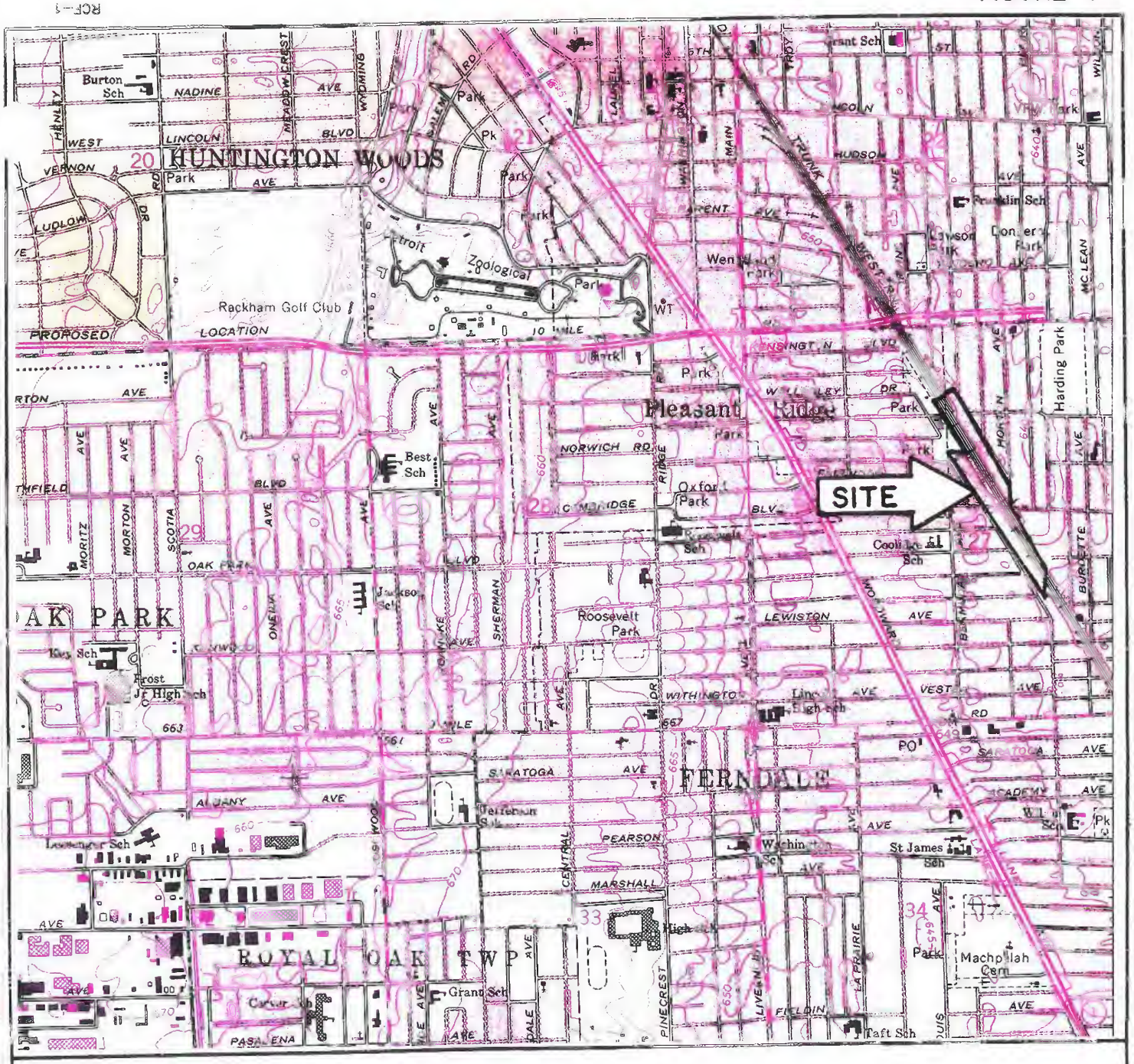
REICHHOLD CHEMICALS, INC.
RCRA FACILITY INVESTIGATION

ANALYTICAL METHOD
REFERENCES

Sample Analysis	EPA Method
Target Compound List Volatiles	8240/5030
Target Compound List Semi-Volatiles	8270/3550
Target Compound List Metals	
ICAP	6010/3010
Furnace AA	
Arsenic	7060/3020
Lead	7421/3020
Selenium	7740/3020
Thallium	7841/3020
Cold Vapor Mercury	7470/7471

FIGURES

FIGURE 1



SITE LOCATION MAP

REICHHOLD CHEMICALS, INC.
FERNDALE, MICHIGAN

THIS MAP TAKEN FROM THE ROYAL OAK, MICHIGAN USGS QUADRANGLE

QUADRANGLE LOCATION

1 ½ 0 1 MILE

1000 0 1000 2000 3000 4000 5000 6000 7000 FEET

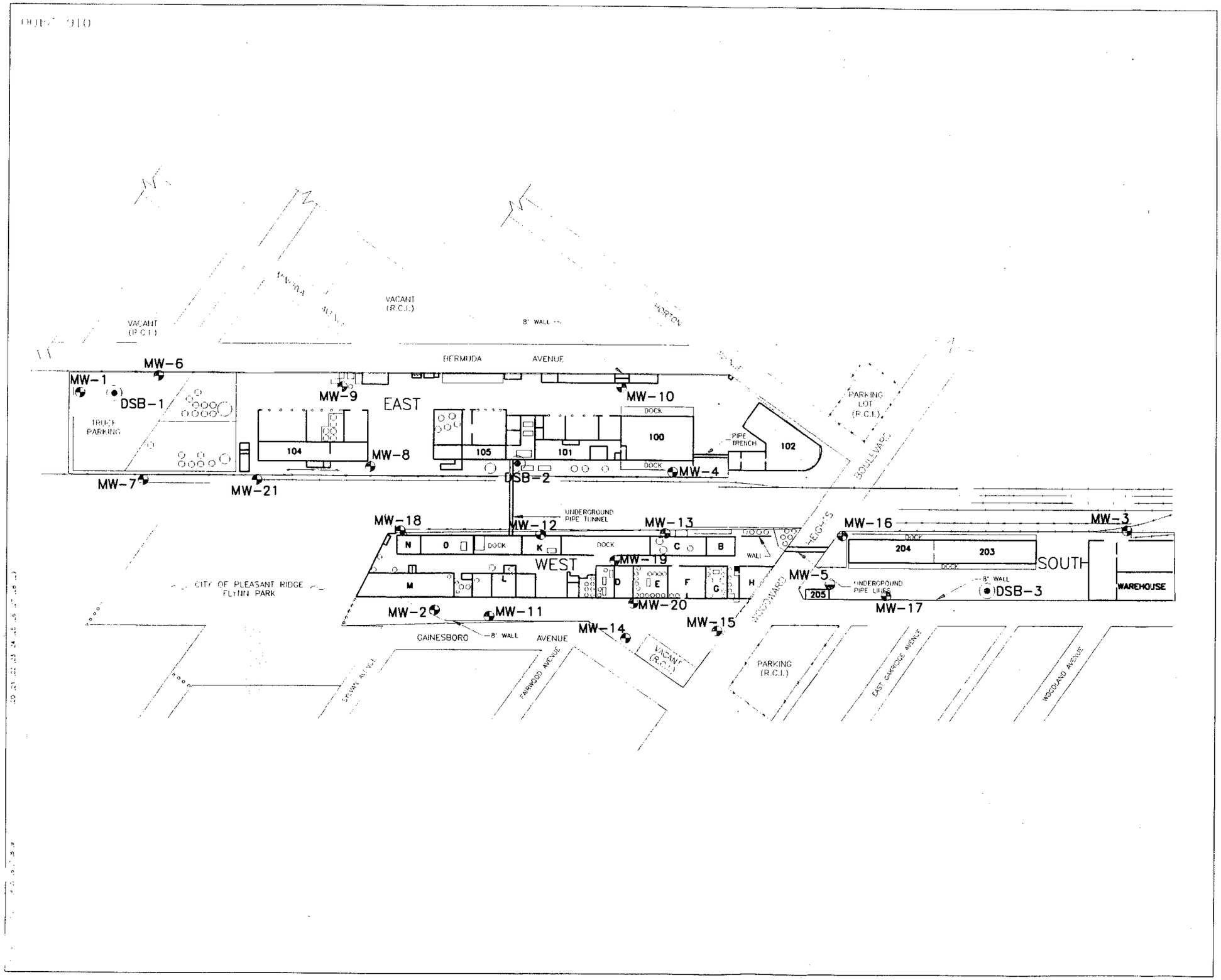
1 .5 0 1 KILOMETER

SCALE 1:24,000

O'BRIEN & GERE ENGINEERS INC.
Edison, New Jersey

FIGURE 2

REICHHOLD CHEMICALS, INC
FERNDALE, MICHIGAN



LEGEND

- MONITORING WELL LOCATION
- MONITORING WELL WAS ABANDONED AND GROUTED
- DEEP SOIL BORING LOCATION

EAST\WEST\SOUTH AREA LOCATIONS

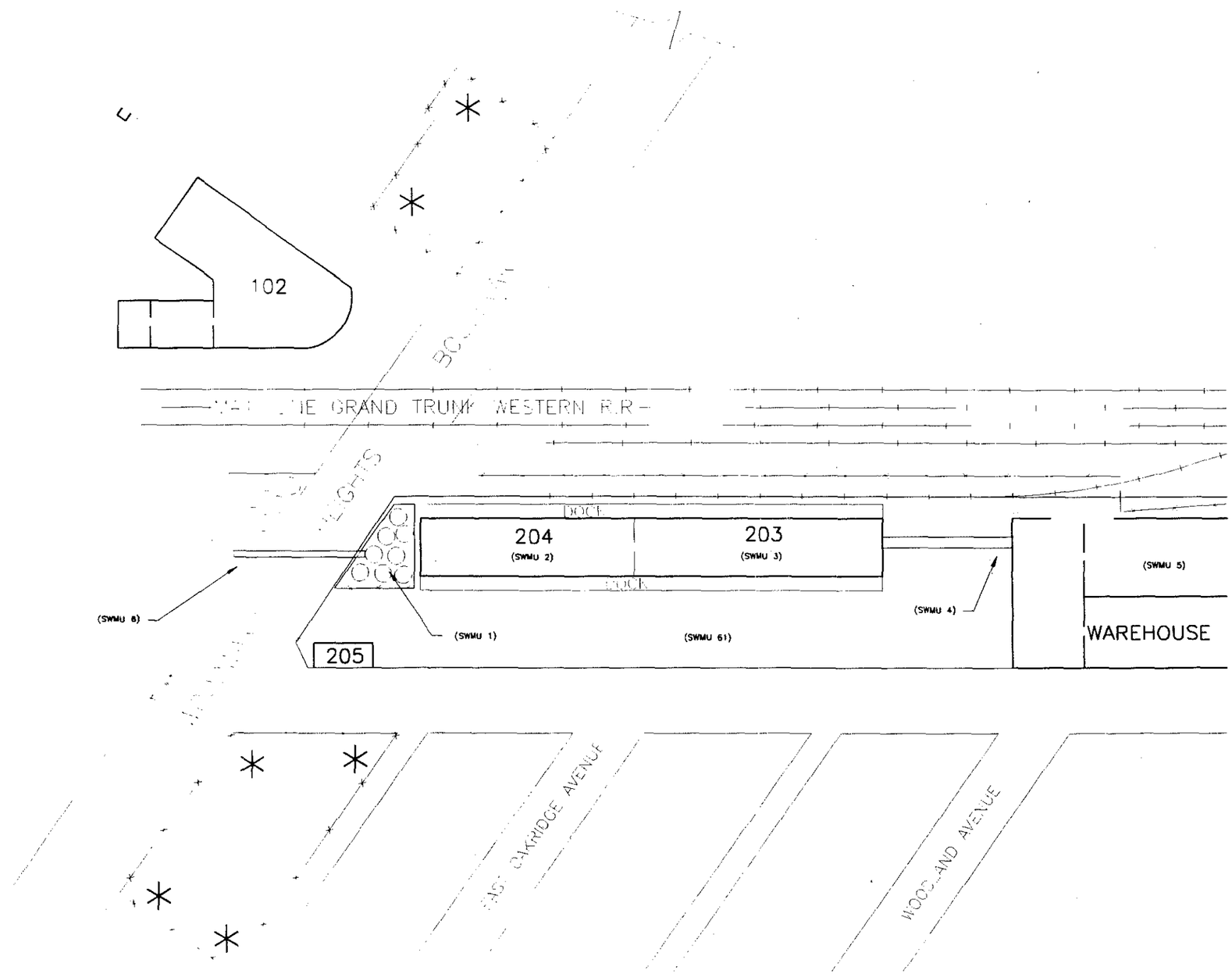
JULY 1993

200 0 200

SCALE IN FEET

O'BRIEN & GERE ENGINEERS, INC

Figure 3



LEGEND

* ECP SCREENING/SOIL BORING LOCATION

REICHHOLD CHEMICALS, INC
FERNDALE, MICHIGAN

PROPOSED
SAMPLING LOCATIONS
SOUTH AREA

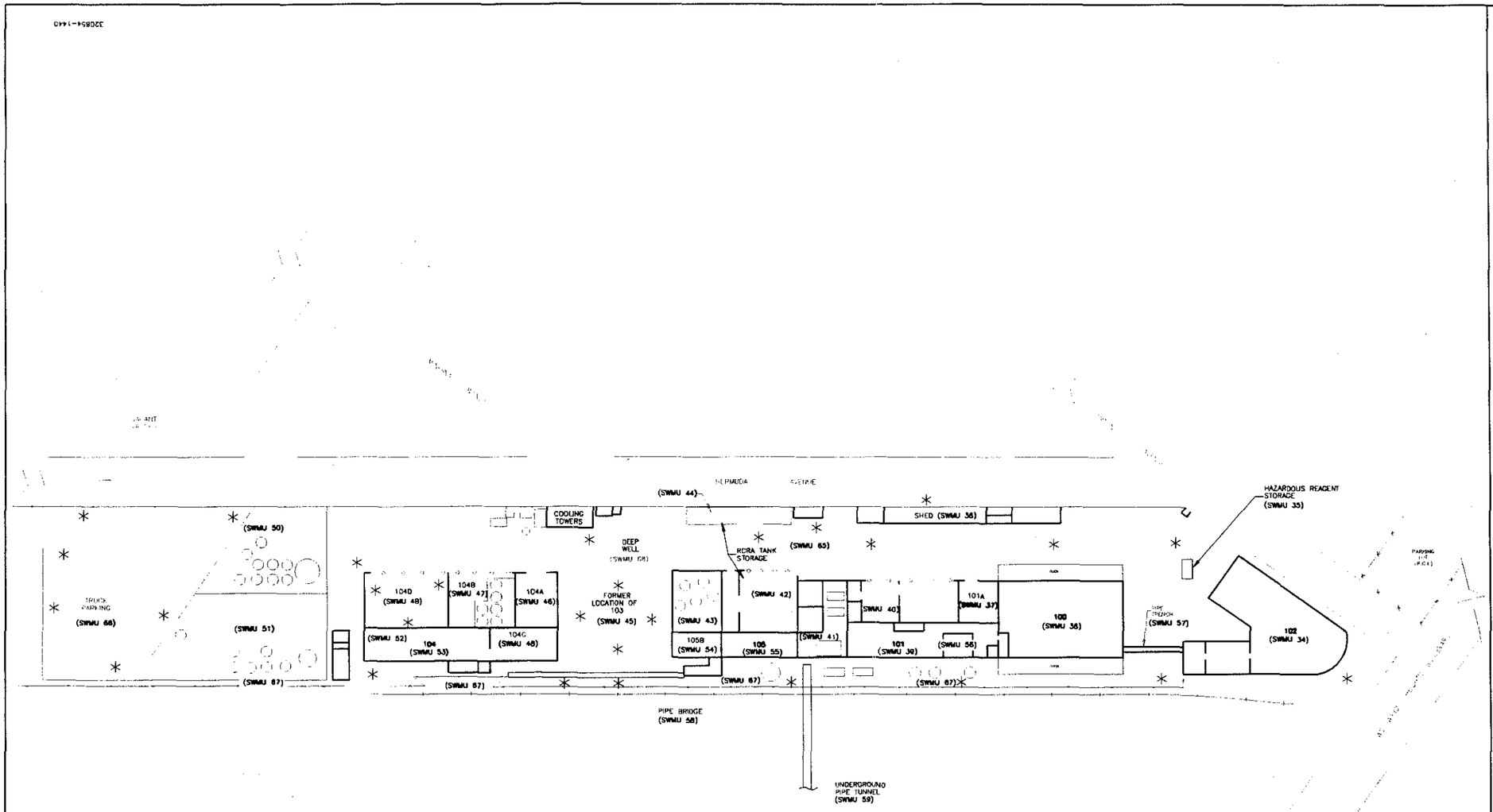
JULY 1993

100 100

SCALE IN FEET

O'BRIEN & GERE

Figure 4



LEGEND

✳ ECP SCREENING/SOIL BORING LOCATION

REICHHOLD CHEMICALS INC.
FERNDALE, MICHIGAN

PROPOSED SAMPLING LOCATIONS EAST AREA

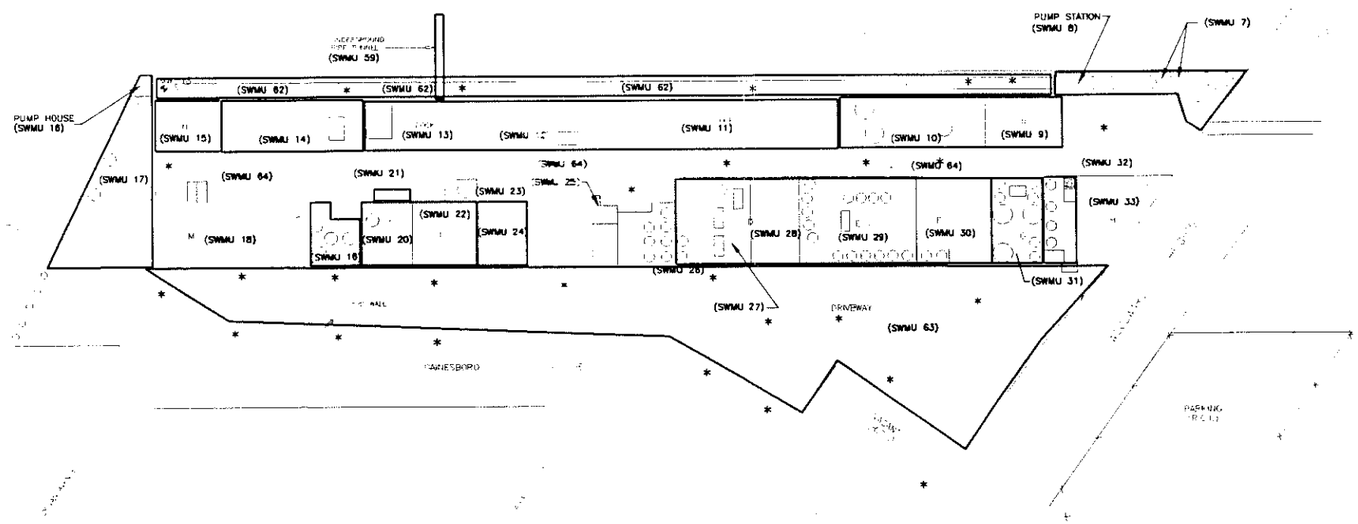
DECEMBER 1994

60 0 60 120

SCALE IN FEET

ENGINEERS INC.

Figure 5



LEGEND

* ECP SCREENING/SOIL BORING LOCATION

REICHHOLD CHEMICALS
INC.
FERNDALE, MICHIGAN

PROPOSED SAMPLING LOCATIONS WEST AREA

DECEMBER 1994

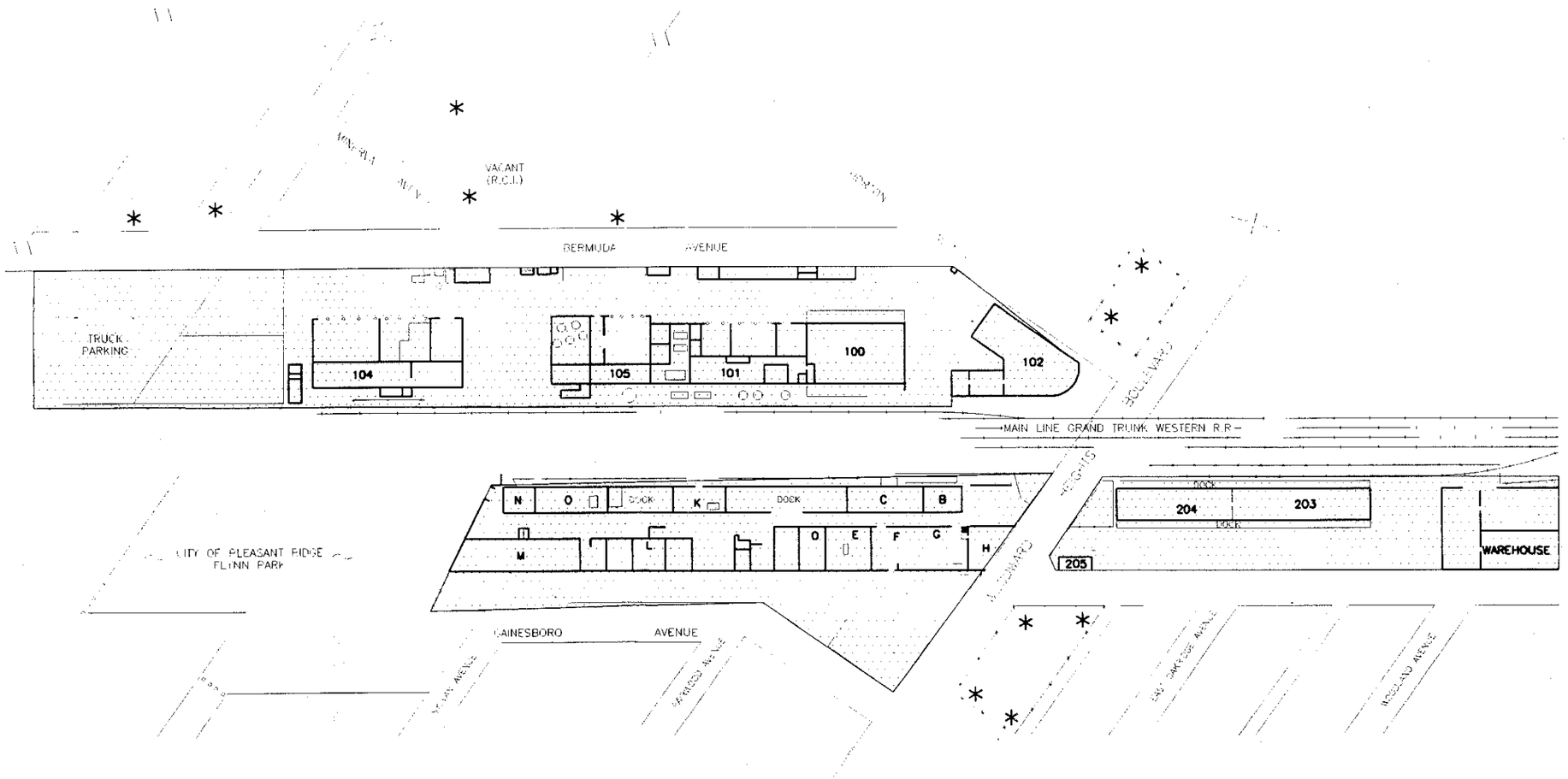
50 0 50 100

SCALE IN FEET

ENGINEERS INC.

320855-2400

Figure 6



LEGEND

* ECP SCREENING/SOIL BORING LOCATION

REICHHOLD CHEMICALS, INC
FERNDALE, MICHIGAN

OFF-SITE
PROPOSED SAMPLING
LOCATIONS

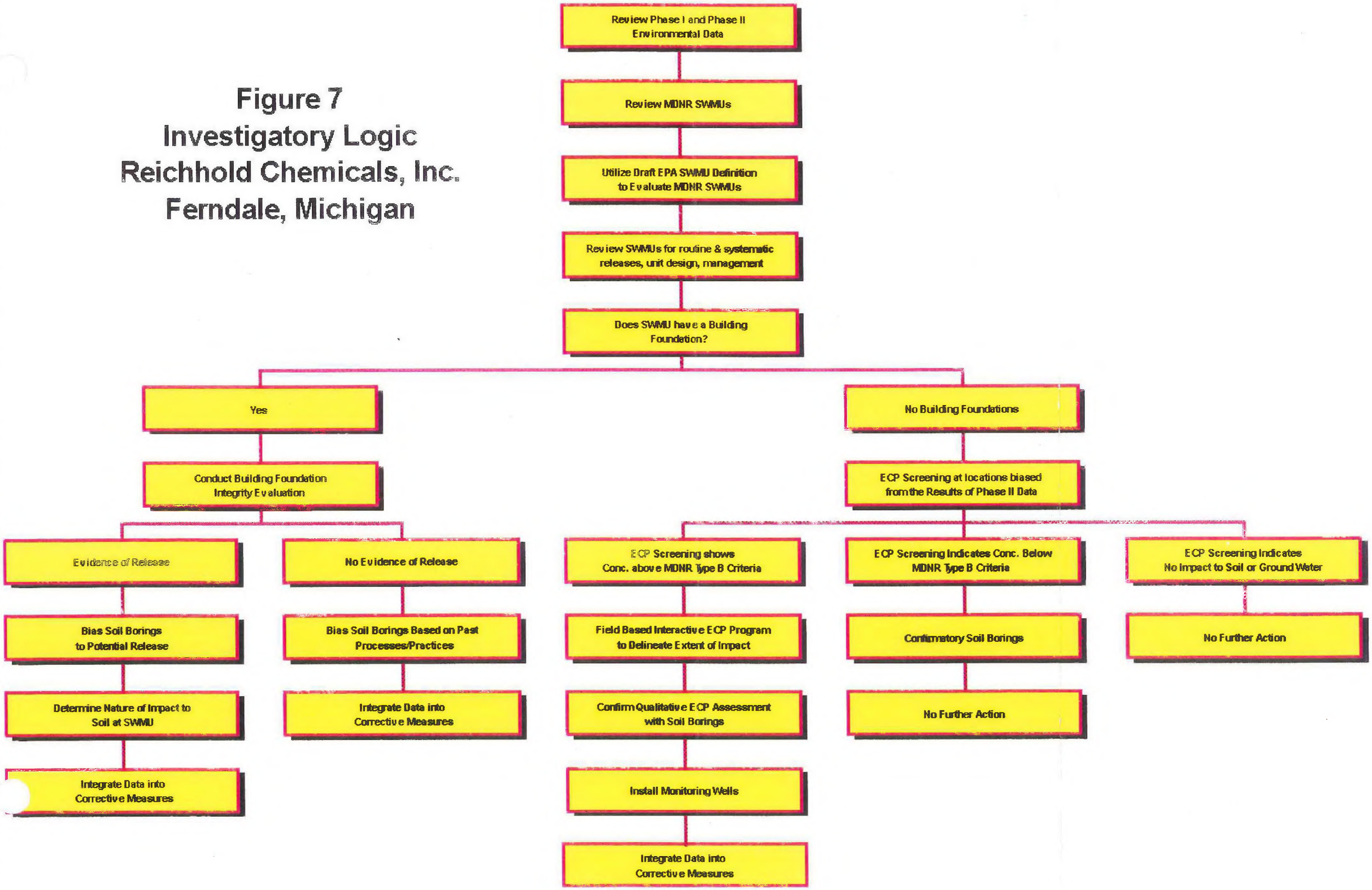
DECEMBER 1994

200 0 200

SCALE IN FEET

O'BRIEN & GERE
ENGINEERS INC

Figure 7
Investigatory Logic
Reichhold Chemicals, Inc.
Ferndale, Michigan



ATTACHMENT 1

CHAIN OF CUSTODY PROCEDURE

A. Chain of Custody Procedures

Chain of custody procedures will be followed throughout this investigation to create accurate and legally defensible documentation that can be used to trace possession of a sample from collection through analysis and final disposal. The chain of custody form will be signed by all handlers of the sample. The QA Officer must produce documentation that traces the samples from the field to the laboratory and through the process of extraction. The National Enforcement Investigation Center of USEPA has defined custody of evidence as follows.

1. In actual physical possession
2. In view after being in physical possession
3. In a locked repository
4. In a secure restricted area

Formal custody procedures will begin in the field. Sample containers will be purchased from an USEPA certified manufacturer (I-Chem series 200 or equivalent). The project manager will discuss sample bottles with the laboratory section leader who will submit to the sample custodian a form requesting the proper containers. After the request is completed and signed, the form will be filed in a binder and kept in the sample tagging room for future reference. Chain of custody forms will be shipped with sample bottles. The field sampler is responsible for filling in the sample location, date and time sampled, sample matrix, and analysis required on the chain of custody and in the field log book.

In the field log book, samplers will note meteorological data, equipment employed during collection, abnormalities noted during sampling, evacuation techniques and calculations. The field sampler will sign the chain of custody when relinquishing custody and will include the form with the sample containers. Sample labels are to be completed for each sample using waterproof ink unless prohibited by weather conditions. For example, a logbook notation would explain that a pencil was used to fill out the sample label since an indelible marker would not function in freezing weather. Comments that the sampler has will be listed on the chain of custody form. The field sampler will also be responsible for filling in the sample labels that are present on every sample bottle.

Field logbooks will provide a means for recording data during field collection activities. Entries will be described in as much detail as possible so that persons going to the site could re-construct a particular situation without reliance on memory. Field logbooks will be bound field survey books or notebooks. Logbooks will be assigned to field personnel, but will be stored in the document control center when not in use. Each logbook will be identified by the project-specific document number. The title page of each logbook will contain the following:

- Person or tasks to which the logbook is assigned;
- Logbook number;
- Project name;
- Project start date; and
- End date.

Entries into the logbook will contain a variety of information. At the beginning of each entry, the date, start time, weather, names of sampling team members, level of personal protection being use, and the signature of the person making the entry will be entered. The names of visitors to the site and the purpose of their visit will be recorded in the field logbook.

Measurements made and samples collected will be recorded. Entries will be made in ink and no erasures will be made. If an incorrect entry is made, the information will be crossed out with a single strike mark. When a sample is collected, or a measurement made, a detailed description of the location of the station, which will include compass and/or distance measurements, will be recorded. The number of the photographs taken of the station, if applicable, will also be noted. Equipment used to make measurements will be identified, along with the date of calibration.

Samples will be collected following the sampling procedures documented in the QAP. The equipment used to collect samples will be noted, along with the time of sampling, sample description, depth at which the sample was collected, volume of sample collected and number of containers used. Sample identification numbers will be assigned prior to sample collection. Field duplicate samples, which will receive a separate sample identification number, will be noted under sample description.

Samples will be shipped to the laboratory by common over-night carrier or will be delivered by O'Brien & Gere Engineers in coolers packed with ice or ice packs to maintain the temperature at 4°C. Jars will be sealed with evidence tape, wrapped in styrofoam sheets, and put in plastic bags to help prevent breakage and cross-contamination.

If commercial vendors are used, they will be required to document the transfer of the package within their organization.

B. Control of Incoming Samples

The contract laboratory will employ sample custodians who are responsible for verifying the receipt of samples. When samples are received, the sample custodian will follow the steps outlined below.

1. Coolers will be checked to verify that the samples listed on the chain of custody were actually received. A notation will be made if there is a discrepancy and the laboratory will contact the QA officer.

2. Samples will be checked and a notation will be made of samples that were received broken or damaged.

3. The chain of custody will be signed and dated to verify time of sample receipt.

4. The sample custodian will record the temperature of the cooler when received and will verify the proper preservation for the parameters requested by checking and recording the pH of each water sample with the exception of VOC samples.

5. Coolers will be checked for low level radiation with a geiger counter.

6. Each sample will be assigned a unique laboratory identification number that will enable the tracking of samples. Numbers will be assigned sequentially. This project will also be assigned a unique project number that contains the client ID and job number.

7. Laboratory report forms will be filled out and distributed to the appropriate laboratory personnel.

8. Samples will be logged into the Laboratory Information Management System (LIMS) and the analyses will be scheduled.

Observations of the sample custodians and comments that they have will be noted on the case file form. If samples are improperly preserved, the QA Officer will be notified.

The sample custodian will assign each sample a unique laboratory sample number which will be input into the computer and recorded onto the sample log-in forms. The sample log-in form will be filed in a three ring binder and will function as a sample receipt log book. The sample custodian will fill out a laboratory report form which will be copied and distributed to the section leaders. The laboratory report contains the date the samples were collected, the date the samples were received, the sample description, the laboratory sample number, and tests that are required.

Each container will be sealed with custody tape at the sampling site and will be shipped in sealed coolers to the laboratory. When the samples are received by the laboratory, the condition of the sealed containers will be recorded on Part I of the sample control record

and the laboratory numbers will be assigned. Samples with red evidence tape will be signed in and out of the locked secured cooler using Part II of the sample control record.

The evidence file will consist of the field chain of custody form, case file form, sample control record, and original laboratory report form, and will be kept on file outside the walk-in cooler. Samples will be stored in a secured, walk-in cooler.

Errors made while completing the chain of custody forms will be corrected by deleting the entry with one line through it, correcting the error, and dating and initialing the correction.

C. Sample Tracking

The tracking system relies on project numbers and sample numbers. Therefore, laboratory sample numbers and client ID numbers will be recorded on raw data and preparation logs. Samples will be primarily tracked using the laboratory sample numbers. Project status will be tracked using project numbers and sample numbers.

Copies of the following items will be stored:

- Documentation of the preparation and analysis of samples, including copies of the analyst's notebooks.

- Bench sheets, graphs, computer printouts, chromatograms, and mass spectra.

- Copies of QA/QC data.

- Instrument logs showing the date and time of analysis, and the identity of the analyst.

- Analytical tracking forms that record the date, time, and the identity of the analyst for each step of the sample preparation, extraction, and analysis.

D. Location and Disposal

Samples will be stored in a locked walk-in cooler. Samples will be signed in and out of the cooler by the chemist performing the analysis. Sample extracts or digestates will be stored in refrigerators in the appropriate laboratory section. Standards will be stored in separate refrigerators in the appropriate laboratory section.

A bin system will be used to help the chemists and technicians locate samples in the cooler. The system will also give direction to the ultimate disposal of the samples. After the chain of custody record is processed, the samples will be placed in a bin in the cooler. Each bin has a unique number which will be transcribed onto the sample bottles, the laboratory report form, and the computer.

The sample custodian will fill out an index card, which is submitted to the section leader responsible for the job. An example of a bin card is included as Figure 14. When the program is complete, the section leader will sign the card and return it to the sample custodian. The section leader will state the method of disposal or whether the samples should be saved. One month after the receipt of the bin card, the sample custodian will dispose of or archive the sample as stated on the card.

Solvent wastes are currently separated into 4 categories:

- chlorinated;
- non-chlorinated;
- PCB (liquid); and
- PCB (solid).

Solvent waste is collected in chemically resistant plastic coated bottles and stored in a well ventilated area until being transferred to an appropriate 55-gallon drum. Mineral acid wastes will be collected in a polyethylene DOT-approved 55-gallon drum. Laboratory hazardous wastes will be manifested and disposed off-site at USEPA approved disposal facilities. Sample extracts and sample digestates will be handled in the same manner as solvent and acid wastes.

The method of sample disposal will depend on the analytical data. The analytical results will be compared to RCRA criteria and a decision will be made in connection with the hazardous waste officer as to the means of disposal. If the sample is classified as hazardous, it will be placed in the appropriate drum in the hazardous waste storage area. Upon filling the drum, the hazardous waste officer will manifest the drum, arrange for disposal and file the disposal log.

E. Storage of Custody File

After the project is completed, O'Brien & Gere Engineers will maintain the RI files along with relevant records, reports, logs, field notebooks, pictures, and subcontractor reports in a secured, limited access area. The laboratory custody file will become part of the final

report. A copy (or copies) of the report will be sent to the client and the original will be retained by the laboratory. Reports will be kept at the laboratory for one year and then stored in an access-restricted warehouse for five years.

F. Record Keeping Forms

The procedures for filling out record keeping forms, labels, and log sheets are discussed in this section. These procedures will create accurate and legally defensible documents that can be used to trace possession of a sample from its collection through analysis and final disposal. Each of the following standard forms, labels and procedures is discussed below:

1. Field log books(s).
2. O'Brien & Gere Engineers sample identification label.
3. Chain of custody record.
4. Custody seal.
5. Control of incoming samples.
6. Sample tracking.
7. Location and disposal.
8. Storage of custody file.

Field Log Book

Field log books will provide a means for recording data during field collection activities. As such, entries will be described in as much detail as possible so that persons going to the site could reconstruct a particular situation without reliance on memory. Field log books will be bound field survey books or notebooks. Log

books will be assigned to field personnel, but will be stored in the document control center when not in use. Each log book will be identified by a project-specific document number. Entries will be made in ink and no erasures will be made. If an incorrect entry is made, the information will be crossed out in a single strike mark. The title of each log book will contain the following:

- person or task for which the log book is assigned;
- log book number;
- project name;
- project start date; and
- end date.

Log book entries will be dated, legible, and contain accurate and inclusive documentation of project activities. Since the log book will form the basis for later written reports, it must contain only facts and observations. Language will be objective, factual, and free of personal feelings or other terminology which might prove inappropriate.

Sample Labels

The sample label will be a white label with black lettering and an adhesive backing. A sample label will be attached to each sample bottle which contains a sample. The label will be attached to the bottle prior to filling the bottle with the sample. In addition, the label will be covered with clear plastic tape so that the label does not peel off or become damaged.

Chain of Custody Form

The chain of custody is an 8 1/2 x 11 inch printed form which will accompany a sample or group of samples as it is transferred from person to person. This form will be designed to create an accurate and legally defensible document that can be used to trace possession of a sample from its collection through analysis and final disposal.

Custody Seal

Custody seals will be consist of 1 inch wide red adhesive tape with black lettering. The custody seal is part of the chain of custody process and is used to prevent tampering with samples after they have been collected in the field.

Procedure For Sample Collection and Completion of Documentation

The following will be the general sequential format of sample collection and custody for the Site. In the event that a field decision is made to modify the order of collection and custody based on field conditions and the past experience of the sampler, the procedure will be deemed complete if the necessary information is present.

Sample Collection and Custody Step-Wise Procedure:

1. **Fill out information in field log book at the beginning of each day to include:**
   - Project name
   - Project start date
   - Date

- Start Time
- Weather
- Names of sampling team members
- Level of personal protection being used
- Signature of person making entry
- Goal of tasks for that day
- Task for which the log book is assigned
- Log book number
- Names of visitors to the site and their stated purpose

2. **Fill out information in field log book associated with pre-sample collection and field activities to include:**
   - Equipment used to make measurements, along with the date of calibration
   - Field conditions (weather, terrain, hazards, etc.)
   - Sample I.D.
   - Sample Location
   - Type of Sample (i.e. environmental, MS/MSD etc.)
   - Container Type
   - Matrix
   - Sample Analysis

3. **Fill out sample label information associated with pre-sample collection to include:**
   - Sample I.D.

- Sample Date
- Project Name
- Preservation

4. **Fill out chain of custody form information associated with pre-sample collection to include:**
   - Sample I.D.
   - Project Name
   - Sample Analysis
   - Date of Sampling
   - Container Type
   - Type of Sample (i.e. environmental, MS/MSD etc.)

5. **Collect samples as specified in SOPs.**

6. **Fill out information in field log book associated with post-sample collection and field activities to include:**
   - Record of field measurements
   - Sample I.D.s
   - Total Approximate Volume of Sample
   - Signature of Sampler
   - Time of Sampling
   - On Site Analysis Results

7. **Fill out sample label information associated with post-sample collection to include:**

- Initials
- Sample Time

8. **Fill out chain of custody form information associated with post-sample collection to include:**

- Each person acting as custodian of the sample must sign the chain of custody.

- Place chain of custody form in a plastic bag, seal, and affix to inside-top of sample container for each sample container.

- Fill out the following criteria:
  - Time of Sampling
  - Sampler name
  - Signature
  - Carrier tracking number
  - Sign the chain of custody form when relinquishing custody and seal the form inside the sample cooler.

- Ship the sample containers to the contract laboratory by common over-night carrier.

[illegible] ENGINEERS

9. **Packaging and Shipping:**

- Place jar in Ziploc (or equivalent) bag.
- Place cushioning material in the bottom of the shipping container.
- Wrap glass sample jars with styrofoam packing.
- Place sample jars in cooler and fill remaining volume of cooler with packing material and ice or ice packs.
- Put paperwork in plastic bags and tape with masking tape to inside lid of cooler.
- Tape drain shut.
- Tape cooler completely around with strapping tape at two locations. Secure lid by taping. Do not cover labels.
- Place contract laboratory's address on top of cooler.

10. **Custody Seal:**

- Wrap the seal across filament tape that has been wrapped around the package.

Laboratory Step-Wise Procedure:

1. **Control of Incoming Samples:**

- Check coolers to verify that the samples listed on the chain of custody were actually received.

- Check samples and make a notation of samples that were received broken or damaged on Part I of the Sample Control Record.

- Sign samples with red evidence tape in and out of the locked secured cooler using Part II of the Sample Control Record.

- Sign and date chain of custody to verify time of sample receipt.

- Record the temperature of the cooler when samples are received and verify the proper preservation for the parameters by checking and recording the pH of the sample.

- Check coolers for low level radiation with a geiger counter.

- Assign each sample a unique laboratory identification number that will enable the tracking of samples. Assign numbers sequentially. Assign a unique project number that contains the client ID and job number.

- Fill out laboratory report forms and distribute them to the appropriate laboratory personnel.

- Log samples into LIMS and schedule the analyses into the laboratory report form.

- Note observations of the sample custodian on the case file form.

- Distribute the laboratory report form to the section leaders from the sample custodian.

2. **Sample Tracking:**

- Record laboratory sample numbers and client ID numbers on raw data and preparation logs.

- Track samples using the laboratory sample numbers.

- Track project status using the laboratory sample numbers.

- Store copies of the following items:
  - Documentation of the preparation and analysis of samples, including copies of the analyst's notebooks.
  - Bench sheets, graphs, computer printouts, chromatograms, and mass spectra.
  - Copies of QA/QC data.
  - Instrument logs showing the date, time, and analyst.

O'BRIEN & GERE ENGINEERS

- Analytical tracking forms that record the date, time, and the identify of the analyst for each step of the sample preparation, extraction, and analysis.

3. **Location and Disposal:**

- Store samples in a locked walk-in cooler.

- Sign samples in and out of the cooler by the chemist performing the analysis.

- Store sample extracts or digestates in refrigerators in the appropriate laboratory section.

- Store standards in separate refrigerators in the appropriate laboratory section.

- Use bin system to locate samples in the cooler.

- Place samples in a bin in the cooler after the chain of custody record is received.

- Transcribe a unique bin number onto the sample bottles, the laboratory report form, and in the computer.

- Fill out an index card (by the sample custodian) and submit the card to the section leader responsible for the job. All analysts within the section responsible for the analysis will sign the card as well.

- Sign the card and return it to the sample custodian when job is complete under the supervision of the Sample Custodian.

- Dispose or save the samples under the supervision of the Section Leader.

- Dispose or archive the sample as stated on the card one month after the receipt of the bin card.

- Compare analytical results to RCRA criteria and make a decision in consultation with the hazardous waste officer as to the means of disposal.

- Place hazardous waste in the appropriate drum in the hazardous waste room. Manifest the drum, upon filling it, and arrange for disposal and file the disposal log under the supervision of the Hazardous Waste Officer.

- Manifest and dispose hazardous waste at an off-site approved disposal facility.

4. **Storage of Custody File:**

- Maintain the RI files along with relevant records, reports, logs, custody records, analytical data, validation/assessment report, field notebooks, pictures, and subcontractors' reports in a secure, limited access area after the project is complete.

- Make the laboratory custody file part of the final report.

- Send a copy (or copies) of the laboratory report to O'Brien & Gere Engineers and retain the original at the laboratory.

- Keep reports at the laboratory for one year and then store in an access-restricted area for five years.

- File will be offered to the MDNR prior to disposal.

ATTACHMENT 2

REICHHOLD CHEMICAL INC.
RCRA FACILITY INVESTIGATION

WASTE MANAGEMENT PLAN

1.0 INTRODUCTION

This document provides an overall management plan for both non-hazardous and hazardous wastes generated in support of field activities at the RCI Ferndale Site. Individual sections describe how each waste will be handled, stored and disposed of in accordance with applicable federal, state, and local laws and regulations governing waste disposal.

2.0 DEFINITIONS AND ASSUMPTIONS

The potential wastes identified above willl be listed as either "contaminated" or "uncontaminated" without regard for whether the concentrations actually exceed regulatory thresholds. The terms "hazardous" and "non-hazardous" will be used in this plan to indicate that laboratory analytical results allow the wastes to be classified as either hazardous or non-hazardous indicating that it contains a listed hazardous waste or exhibits hazardous characteristics based on TCLP analysis.

A tier approach to waste classification will be implemented, whereby:

- Soils removed from suspected source areas which contain detectable amounts of listed waste constituents would be classified as a listed hazardous waste.

O'BRIEN & GERE ENGINEERS

- Soils removed from non-suspected source areas which had field indications of contamination (PID meter readings) would be sampled for TCLP and, if above regulatory levels would be classified as a characteristic hazardous waste.

- Soil removed from non-suspected source areas which do not have field indications of contamination would be presumed to be clean without testing.

Once classified as a hazardous waste, the 90-day accumulation period would begin. Requirements mandated under RCRA will continue to be effective during the off-site transport and disposal.

3.0 WASTE HANDLING PROCESS

3.01 Overview

The collection, storage and disposal of solid and liquid waste generated during this investigation will be classified into one of three categories: general refuse, soil cuttings and cores, and waste water.

In order to secure the soil waste that is generated during the investigation it will be necessary to designate a temporary storage area. This will be a low-traffic storage area equipped with a concrete slab floor, large enough to accommodate all the waste at once. Specific details concerning the temporary storage area, as well as the types of waste to be generated, and the proposed disposal plan will be discussed in the sections that follow.

3.02 General Refuse

General refuse, including used personal protective equipment (PPE), will be collected in plastic trash bags as the waste is generated. The bags will be sent to the temporary storage area.

PPE and other used material will be classified according to the related soil classification. PPE will be sorted according to which boring/well location applies, allowing a direct correlation. PPE and other refuse related to soil which is classified as "clean" according to the tier approach will be handled as ordinary trash and included in RCI's general solid waste. PPE and other refuse will be bagged when generated and retained on-site pending receipt of analytical data.

Bags suspected of containing hazardous materials based on field screening measurements will be placed in a barrel, and temporarily stored pending analytical results of the soil with which the refuse was in contact. A record will be maintained of the bag numbers and bag contents contained in each barrel. Barrels used to contain potentially contaminated refuse will be labeled with an identification number, date collected, and description of contents. These barrels will then be stored at the temporary storage location until they are transported off-site.

3.03 Soil Cuttings and Cores

Soil cuttings and cores will be placed on plastic sheeting during drilling and sampling activities to prevent accidental contamination of surface materials by contaminated soils. An initial HNu screening step will determine if the soil materials are from a suspected source area. Cuttings and samples will be

segregated into discrete intervals and will be screened with a PID. Cuttings and samples will be placed in DOT-approved barrels.

Soil waste will be segregated depending upon the results of a field screening. Apparently clean soil will be stored in barrels. Soils with apparent VOC contamination will be stored in barrels and analyses of metals, VOCs and SVOCs (determined during site characterization) will be used to ascertain whether TCLP limit values could be exceeded. Once the soil wastes are collected and segregated according to the above procedure, an analysis will be made of each soil group to determine if the soil is a hazardous waste via characteristics. If it is not, the soil will be disposed of at an industrial landfill. If it is, the hazardous waste will be manifested and disposed of at a permitted facility.

Barrels containing potentially hazardous waste or from suspected source areas will be given an identification number and will also be labeled with the boring number, the date collected, depth intervals, PID readings and a description of suspected contaminants if applicable. Analytical results from the site characterization will be used to calculate the TCLP limit values for the soil waste. Based on the results of this calculation the soil waste will be segregated again, with the apparently contaminated waste analyzed to determine if the soil is hazardous waste via characteristics. Based on this final analysis, a decision will be made as to the disposition of the soil waste.

3.04 Waste Water

Waste water generated during this project will consist of purge water, well development water and decontamination water. Waste water will be discharged according to site permits and in accordance with local, state and federal regulations.

3.05 Temporary Storage Area

A temporary waste storage and staging area will be required to accommodate the waste generated. Storage containers used in this area will include DOT approved barrels. Barrels transported to the temporary storage area will be secured on pallets. If the storage area is not enclosed or covered, a plastic cover will be placed over the storage containers when the storage area is not in use. The entire area will be placarded as a restricted access area.

3.06 Waste Disposal

For barrels classified as hazardous, waste management contractors will be contracted to transport and dispose of the waste.

Wastes that do not meet the definition of hazardous waste will be transported to an industrial landfill. The characteristics of non-hazardous waste will be documented. This documentation will consist of results of analytical testing, and supporting QA/QC data that will enable the data packages to be independently validated.

D.2.10

FINAL

MID 028 087128

Interim Measures Work Plan
In-Situ Air Stripping System

Reichhold Chemicals, Inc.
Ferndale, Michigan

November 1994

O'BRIEN & GERE
ENGINEERS, INC.

FINAL

Interim Measures Work Plan
In-Situ Air Stripping System

Reichhold Chemicals, Inc.
Ferndale, Michigan

Prepared by:
Gary A. Angyal, P.E.
Project Associate

Donald E. Stone, Jr., P.E.
Vice President

November 1994

O'Brien & Gere Engineers, Inc.
Raritan Plaza I
Edison, New Jersey 08837

Tables

3.1 ISAS VOC Removal Rate Summary

Figures

1 Site Plan
2 ISAS System Layout
3 Proposed Boring Locations
4 Implementation Schedule

Appendices

1 ISAS Operation Status Reports
2 ISAS MDNR Air Permit

1. Introduction

1.1. Purpose and Scope

O'Brien & Gere Engineers, Inc. (O'Brien & Gere) was retained by Reichhold Chemicals, Inc. (RCI) to develop an Interim Measures Work Plan for an in-situ air stripping (ISAS) system at the RCI facility in Ferndale, Michigan. Although the ISAS system is an existing interim measure, this Work Plan is being prepared in accordance with Item 1.1 of the *Interim Measures Work Plan Comments* letter issued by the Michigan Department of Natural Resources (MDNR) on September 23, 1994.

The intent of this Work Plan is to document the operation, maintenance, and performance of the ISAS system since its installation in the South Tank Farm area of the Ferndale facility in May 1993. This Work Plan further identifies future ISAS interim measure activities which may be undertaken pending implementation and review of an interim performance assessment.

The original objectives of the ISAS interim measure undertaken in the South Tank Farm area were as follows:

- To mitigate detected levels of volatile organic compounds (VOC) in the vadose zone within the South Tank Farm area; and,

- To evaluate the feasibility of this technology for remediation in other areas of the site where an in-situ remediation may be favorable based on site conditions and structures, feasibility in mitigating VOC concentrations in underlying soils, and cost-effectiveness.

1.2. Site Description and Background

The RCI facility formerly produced synthetic resins and polymers and discontinued operations in 1989. The facility is located within a small industrialized location surrounded by a residential community. The facility is located at the intersection of Woodward Heights Boulevard and Horton Avenue in Ferndale, Michigan, as shown in Figure 1. Local topography is relatively flat with no floodplains or wetlands within a one mile radius of the facility. There is no drinking water aquifer under or near the facility and drinking water in this area is supplied by the local municipality. The facility overlies a perched saturated zone up to 14 feet thick which mantles an extensive, dense clay aquiclude which is over 100 feet thick.

1.3. Site Closure Environmental Programs

Following the termination of the manufacturing operation in March 1989, RCI implemented two facility closure programs: 1) the closure of the hazardous waste drum and tank storage areas and 2) a limited facility decommissioning program. The RCRA Closure certification report was submitted to the Michigan Department of Natural Resources (MDNR) on January 10, 1992. The limited facility decommissioning program was completed by January 1, 1991. Currently a site-wide facility decommissioning program, including asbestos containing material abatement, is underway which is expected to last 6 months. Upon completion, it is expected that only building 'M', 100, and 101 will remain.

1.4. Environmental Assessment Program

An environmental assessment of the facility is being conducted as part of the plant closure process. Environmental assessment activities were initiated in 1989 when the plant ceased production operations.

A Phase I Environmental Assessment consisting initially of a soil gas survey was conducted to evaluate potential volatile organic concentrations. Additionally, five ground water monitoring wells were installed to evaluate ground water quality and flow direction. During the installation of these ground water monitoring wells, general geotechnical classification of the soils was conducted. The results of the Phase I Environmental Assessment were summarized and presented to the MDNR in November 1989.

A Phase II Environmental Assessment approach was established based upon the findings of the Phase I Sampling program. The Phase II program involved the installation of 17 additional soil borings with subsequent conversion of the soil borings into monitoring wells. Soil samples and ground water samples were analyzed in order to characterize the nature and extent of the environmental impact. An interim Phase II report was submitted to the MDNR in January, 1992. The results of a Ground Penetrating Radar (GPR) survey and a second ground water sampling event conducted at the site have been submitted in draft form to the MDNR (March 1992).

1.5. Work Plan Format

This Work Plan is divided into five sections. Section 2 - Interim Measure Equipment and Operation, provides information regarding site characterization, ISAS system layout and operating parameters, permit and monitoring requirements. Section 3, Interim Measure Implementation Summary, provides a summary of the interim results since the operation began in May 1993. Section 4 - Future Interim Measure Activities, discusses the planned interim performance assessment and contingency activities that may occur based on the results this assessment. Section 5 - Interim Measures Implementation Schedule, presents the proposed schedule for carrying out future ISAS activities as an interim measure for this site.

2. Interim Measure Equipment and Operations

2.1. Site Characterization

The South Tank Farm area formerly contained eight aboveground storage tanks. The tanks were removed in 1990 and the area was paved with asphalt. During the tank decommissioning, the tank foundations were left in place. Each storage tank had a concrete pad approximately 11 feet in diameter. The tank farm was contained within a diked area with a total surface area of approximately 3400 square feet. Previous investigations conducted in this area revealed the presence of VOC compounds in the underlying soils. These investigations were presented in RCI's *Environmental Assessment Work Plan* dated August 2, 1989.

Previous soil gas testing by RCI indicated soil gas levels averaging 3500 parts per million by volume (ppmv) with a range of non-detect to 10,000 ppmv. Soil boring data collected by RCI (two borings) indicated average VOC concentrations in the 0-2' interval below grade of 2000 mg/kg; the 2-4' interval averaged 300 mg/kg. Compounds detected included xylene (primarily), ethylbenzene, acetone, and methylene chloride. Ground water in this area is encountered at approximately four feet below grade. The soils above the water table in this area are characterized as silty fine to medium sand with traces of coarse sand.

Because of the elevated concentrations of VOC in the South Tank Farm soils, this area was chosen to evaluate the feasibility of in-situ air stripping. Although the ground water is shallow, other favorable characteristics of this area include impermeable asphalt paving and favorable soil characteristics. Figure 1 depicts this area in a general site plan of the facility.

2.2. ISAS System Layout and Operating Equipment

The ISAS system includes two extraction wells (EW) and six inlet wells (IW). Each well extends approximately four feet below grade. The extraction wells are constructed of 4" diameter stainless steel screen (0.02 slot) that extends from approximately 6 inches below grade to the top of the water table, where it is capped. The inlet wells are constructed of 2" diameter PVC screen (0.02 slot) installed in a similar manner. All wells are installed with a gravel packing around the screened interval and a cement-bentonite cap around the riser. The maximum distance between and extraction well and an inlet well is 25 feet. The attached Figure 2 presents the system layout. The ISAS system is designed to extract VOCs from soil

above the water table. Both the vapor extraction wells and air inlet wells are installed within the impacted soil area. A vacuum applied to the extraction well induces a negative pressure creating a flow of air from the passive air inlet through the soil to the extraction well. As the air saturated with VOC vapors flow through the soils, it is replenished with clean air through the inlet wells. The VOCs located within the unsaturated zone are volatilized. The VOC-laden air is then discharged to vapor phase carbon canisters to remove the VOCs from the air stream which is then vented to the atmosphere.

The ISAS equipment is mobile and mounted on a trailer consisting of a 10 horsepower EG&G Rotron electric blower, liquid separator tank, interconnecting piping, instrumentation/controls, vapor phase carbon treatment and continuous air quality monitoring sensors.

2.2.1. Direct drive blower

The blower mechanism is a regenerative tubing type direct drive 10 horsepower blower rated at 150 SCFM at 5" Hg vacuum. It is powered by an electric motor with variable frequency drive (VFD) allowing continuous range of speeds from 0 to 4000 RPM The blower is constructed of aluminum and has an explosion-proof impeller to prevent sparking.

2.2.2. Inlet and system piping

Inlet piping is constructed of 3" Schedule 40 aluminum piping, including a 10 micron filter and a 15-foot flex hose for connection to the vacuum extraction well. A liquid separator knock-out tank is located prior to the vacuum blower. The associated piping from the ISAS trailer to the dual carbon treatment canisters is constructed of PVC. The exhaust stack is constructed of 3" aluminum, to a height of 47 feet above ground level.

2.2.3. Control panel

The control system is housed in a NEMA 4 enclosure, equipped with heaters and manual reset. The system also includes pilot and alarm lights. Safety features include high discharge temperature and vacuum shut-off switches.

2.2.4. VOC vapor monitoring system

Continuous vapor monitoring sensors are located after the first stage dual carbon treatment and after the second stage dual carbon canister treatment prior to exhaust stack discharge. The vapor monitoring sensor alarm conditions are set at 50 pm and 200 ppm, with the 50 ppm condition signaling a light on the control cabinet. The 200 ppm condition will automatically shut off the ISAS blower. The GAS-TECH vapor monitor control cabinet is located inside a NEMA 4 enclosure.

2.2.5. Vapor phase carbon treatment

Dual carbon treatment canisters provide primary and secondary vapor phase treatment. Two 55-gallon carbon canisters provide first stage primary treatment followed by a second set of two 55-gallon carbon canisters to provide polishing treatment. The treated air stream exiting the second stage treatment canisters is discharged to atmosphere via a 47-foot high exhaust stack.

2.3. Operation and Maintenance Procedures

Upon ISAS system start-up and balancing, it is designed to operate continuously with periodic operator monitoring and air sample collection. Periodic monitoring includes temperature, system pressure and air flow rate measurements, and ground water level recording. Additionally, all interconnecting pipework is checked for integrity, as are the connections to the extraction wells. The blower speed is adjusted based on these parameters so that the system operates within safe limits for temperature and pressure. Routine maintenance items include checking and emptying (if necessary) any condensation from the knock-out pot. Carbon canisters are also monitored for breakthrough and changed out if necessary. After the primary carbon canisters are spent, the secondary units are moved to the first stage positions and new 55-gallon carbon canisters are installed in the second stage position. Routine maintenance on the blower (such as lubrication) follows vendor-specified procedures.

Air samples are taken periodically at the system inlet (prior to carbon treatment), intermediate (between the two sets of carbon canisters) and effluent (after carbon treatment). Additional air monitoring is conducted by a photoionization (HNu) meter. Procedures for air flow rate, temperature and pressure measurement

are provided in the *ISAS Start-up and Operation Status Report*, October 1993, which is presented in Appendix 1.

2.4. Permit Requirements

The ISAS system is permitted to operate in accordance with Permit No. 1113-91 issued by the Air Quality Division of the Michigan Department of Natural Resources. The permit was issued on October 30, 1992 and includes the following monitoring requirements:

- Monitor and record the flow rate and total VOC concentration of the influent stream to the control on a weekly basis until 10 valid samples are obtained;
- Monitor and record the flow rate and total VOC concentration of the influent stream to the control on a monthly basis during operating periods thereafter; and,
- Report the data, including calculation of VOC emission rates, to the District Supervisor within 30 days of the end of the quarter in which the data was collected.

Other operating requirements such as stack height and continuous monitoring for breakthrough are also specified. The permit is provided as Appendix 2 to this Work Plan.

3. Interim Measure Implementation Summary

3.1. Start-up Activities

Start-up of the ISAS system was initiated on May 25, 1993. Initially, the system was connected to extraction well EW-2 for the first two days. However, vacuum influence testing did not create a measurable air transfer/vacuum influence at the perimeter inlet wells. Therefore, on May 27, 1993, the system was connected to EW-1 and has continued to induce a vacuum at that well through the remainder of the first reporting period (May 25 - September 24, 1993).

During the first week of ISAS equipment operation, air samples were collected every day. Additional monitoring was conducted for air flow rate, pressure and temperature. The system operated approximately 8 hours per day during the first week of start-up. Air flow rate at EW-2 (while connected during the first two days) was approximately 50 cfm. The air flow rate increased to 145 cfm when the connection was changed to EW-1 on May 27, 1993. The inlet wells observed to be most influenced by the vacuum on EW-1 were IW-1 and IW-2. The ISAS system vacuum measured was approximately 2" Hg and the blower speed was approximately 40% of maximum.

The ISAS system did not operate from June 2 - June 14, 1993. From June 14 through July 4, 1993, the system operated five days per week, 24 hours per day. Since the week of July 12 through September 10, 1993, the system operated continuously seven days per week, 24 hours per day. Since June, the blower was maintained at 80 scfm, with a blower speed dial setting of 40%. Total cumulative hours of operation for this period was approximately 2,200 hours.

On July 15, 1993, a vacuum influence test was conducted at the inlet wells. The vacuum flex line was moved to each extraction and inlet well and vacuum readings were recorded on the other wells. Extraction well EW-2 did not create a measurable vacuum influence at the perimeter inlet wells, similar to the findings during the first two days of start-up. However, the water column in EW-2 was drawn upward, leaving only 1 foot of the 3.7' screen interval of that well exposed. The depth to water recorded in the inlet wells was varied from 4' to 5' below grade.

Other wells besides EW-2 which exhibited little, if any, measurable vacuum (regardless of where the vacuum source was connected) included IW-5 and IW-6. It is believed that underground obstructions (such as the tank foundations) or very tight consolidated

soils may be the cause for low and non-vacuum detection influence readings at these wells.

The data collected during this operating quarter is presented within the first quarterly status report submitted to MDNR (Appendix 1).

3.2. Quarterly Operation, Monitoring and Status Reports

The ISAS system has been operating seasonally since start-up period which was initiated in May, 1993. In accordance with air permit requirements, quarterly status reports were submitted to MDNR routinely within 30 days of each respective operating period. These status reports are presented in Appendix 1 of this Work Plan. This section describes some of the operating conditions during each period. Air samples were also collected during active operating periods; a discussion of the air sampling results is provided in Section 3.3 below.

The second operating period in which data was collected was from September 25 - December 24, 1993. On September 29, 1993, the ISAS vapor extraction hook-up was moved from EW-1 to IW-4. This adjustment was made to enhance the area of influence of the ISAS system within the South Tank Farm area. The air flow rate was reduced to approximately 15 cfm due to the high vacuum which was observed through connection at this well.The system was operated for a total period of 1,992 hours and was shutdown for the winter months on December 17, 1993. The operation status report for this operating period was submitted by January 24, 1994.

From December 17 through June 24, 1994, the ISAS system remained shutdown. Status reports dated April 18, 1994 and July 21, 1994 reflect this condition.

On June 25, 1994, the ISAS system was restarted at Inlet Well IW-4. The system operated for a total of 2,196 hours during the period. The operation status report dated October 21, 1994 documented this status to the MDNR.

The system will be shut down during the month of December 1994. Continued operation of the ISAS interim measure in the South Tank Farm area will be contingent upon the results of the interim performance assessment. This assessment, and contingency activities

which may be undertaken, are discussed in Section 4 of this Work Plan.

3.3. Interim Results Summary

During all periods of active operation, air samples were collected and analyzed for methylene chloride, ethylbenzene, xylene and acetone using charcoal sorbent tubes and NIOSH analytical methods. A complete description of the sampling methodology is presented within the first operations status report (Appendix 1). This section will summarize the cumulative pounds of VOC removed during ISAS system operation. Detailed summary tables and analytical reports are presented in the respective operations status reports which are provided as Appendices to this Work Plan. Table 3-1 below summarizes the operating hours and pounds of total VOC removed by the ISAS System.

Table 3-1. ISAS VOC removal rate summary

Sample Date	Representative Hours of Operation	Flowrate (CFM)	Vacuum Connection	VOC Removed (Lbs)	Cumulative VOC Removed (Lbs)
5/25/93	8	50	EW-2	0.04411	0.04411
5/26/93	8	57	EW-2	0.03923	0.08334
5/27/93	8	128	EW-1	0.50010	0.58344
5/28/93	8	145	EW-1	0.96924	1.55267
6/02/93	8	80	EW-1	0.39161	1.94428
6/18/93	168	80	EW-1	12.17653	14.12080
6/30/93	480	104	EW-1	31.33063	45.45143
7/22/93	528	80	EW-1	6.80983	52.26126
8/13/93	672	80	EW-1	5.07842	57.33967
9/10/93	360	80	EW-1	1.40659	58.74626
10/13/93	768	15	IW-4	1.18476	59.93102
10/27/93	528	15	IW-4	0.59290	60.52392
11/18/93	696	15	IW-4	2.96327	63.48719
6/29/94	864	15	IW-4	0.12243	63.60962
7/31/94	1016	26	IW-4	0.23492	63.84454
9/11/94	316	25	IW-4	0.04227	63.88681
TOTAL	6436	--	--	--	63.88681

In summary, the ISAS system removed approximately 64 pounds of VOC during an operating period of 6436 hours since May, 1993. The predominant VOCs measured in the ISAS system were xylene (40.8 ppmv maximum), with lesser amounts of acetone (12.3 ppmv maximum) and ethylbenzene (6.5 ppmv maximum)also being removed. Methylene chloride was also detected in the system, but only at maximum concentrations of 1.5 ppmv.

Based on the sampling data, it appears that the majority of VOCs which were removed by the ISAS system occurred over the initial three months of operation. Thereafter, the VOC removal rates dropped significantly, even when switching the vacuum connection to a new well (IW-4). When the system was restarted in June 1994, very low VOC removal rates continued to be observed. Because the VOC removal rates seem to have tailed down to minimum detection levels over the course of the ISAS interim operation, it may be possible that the system has approached the maximum VOC removal of which it is capable based on the current inlet and extraction well configuration. Future courses of action for this system are presented in Section 4 below.

4. Future Interim Measure Activities

4.1. Interim Performance Assessment

Based on data collected since the ISAS system start-up in May 1993, it appears that the ISAS system has removed a majority of the VOC compounds that were amenable to ISAS based on the current extraction and inlet well network. In order to better assess the residual conditions of the area, it is proposed that four soil borings be located in the South Tank Farm area and two in the adjacent driveway area. Each boring will be advanced to the ground water interface (approximately four feet below grade). Two samples from each boring will be collected for volatile organic analysis (EPA Method 8240 including xylenes and acetone) Additionally, MW-16 and MW-5 will be monitored for VOC to assess the current ground water quality in that area for potential impact to the ISAS operations.

Figure 3 presents the proposed soil boring locations. Soil boring installation, sampling, and soil analysis will be conducted in accordance with the Quality Assurance Project Plan and Health and Safety Plan which are included in the *RFI Work Plan* which was previously submitted to MDNR.

4.2. Contingency Activities

Upon receipt of results, the data will be evaluated with respect to the concentrations and extent of VOC in South Tank Farm area. Depending on the residual concentrations of VOC in the soils, a decision will be made regarding the further operation of the ISAS system in this area. If the results indicate that no further action is required, RCI will document the final soil conditions as part of a draft IM Report indicating that the ISAS system has achieved its objectives and will no longer operate in this area. If this is the case, use of the system may be proposed for other areas of the site. This decision will be contingent upon further characterization of the site and assessment for the viability of ISAS in specific areas. If the ISAS system is moved, a new air permit will likely be required.

Should the concentrations justify the continued use of ISAS, RCI will propose a supplemental extraction well/inlet well network and up to an additional three to six months of operation to further enhance the removal of VOCs in this area. A draft IM Report will be prepared upon completion of this supplemental operation. Components of the additional ISAS operation will include the following:

4.2.1. Supplemental extraction well/inlet well system

If the results of the interim performance assessment suggests that additional remediation by ISAS is necessary, RCI proposes to enhance the operation of the current system by installing supplemental extraction and inlet wells. Initially, RCI proposes to confirm the existence of the subsurface structures (tank foundations) which may have been affecting the performance of the present ISAS system. The location of the tank foundations will be verified by conducting a one-day soil boring program. Since no sampling would occur, it is estimated that 15-20 borings would be placed in the area. The borings will be advance until refusal, or six feet, whichever is encountered first. In addition to providing subsurface information, the borings can also provide for an enhanced area of influence. Therefore, it is proposed that the borings not be grouted at this time. Additionally, RCI proposes the placement of a limited number of borings (5-10) in the driveway area to document the subsurface conditions in this area. Previous soil gas data indicated elevated levels of VOC in this area, also.

Following completion of the above boring program, RCI proposes to install up to two new extraction wells and four new inlet wells in the tank farm and driveway areas.

4.2.2. Continued operation of ISAS system

Once the supplemental well system is installed, RCI proposes to operate the ISAS system for up to an additional six months. Upon system start-up, an untreated air sample will be collected once daily for a period of one week. An air sample will be collected weekly for the next three weeks, and then once per month for the remaining operating period to six months, if necessary. VOC monitoring data will also be collected throughout the operating period at a frequency of three times per week by a photization detection instrument, in addition to flow rate, pressure and temperature data. If, after three months, the ISAS system appears to be no longer effective in removing VOCs from the South Tank Farm area, then the ISAS interim measure will be discontinued at this point and a second phase performance assessment (if justified) will be conducted followed by preparation of a draft IM report.

4.2.3. Second phase performance assessment

If appreciable amounts of VOC are removed after three to six months of supplemental ISAS operation, up to six borings will be advanced four feet below grade. Each sample will be analyzed for VOC (EPA 8240 + acetone and xylenes). Additionally, MW-5 and MW-16 will be resampled for the same VOC parameters. This sampling program will be used to assess the performance of the supplemental ISAS operation. Soil boring, sampling and analytical procedures will be conducted in accordance with the Quality Assurance Project Plan and Health and Safety Plan included within the *RFI Work Plan.*

4.3. Progress Reports

Once the ISAS system is started-up, two quarterly reports will be submitted to MDNR in accordance with the current air permit. This interval is twice the minimum six-month progress report schedule specified in paragraph 35.D of the Corrective Action Order. The first operation progress report will also provide a recommendation as to whether continued operation of the ISAS system is justified.

4.4. Draft IM Report

The draft IM Report will incorporate the information presented within this Work Plan, along with any new data that is generated. If no further action is pursued as a result of the interim performance assessment discussed in Section 4.1 above, then these results will be provided in the draft IM Report.

If the ISAS system continues to operate (3 to 6 months), the results will be documented using the quarterly air monitoring reports as backup documentation. The results of the second phase soil boring program (upon ISAS system shutdown) will also be presented as part of final Interim Measure documentation.

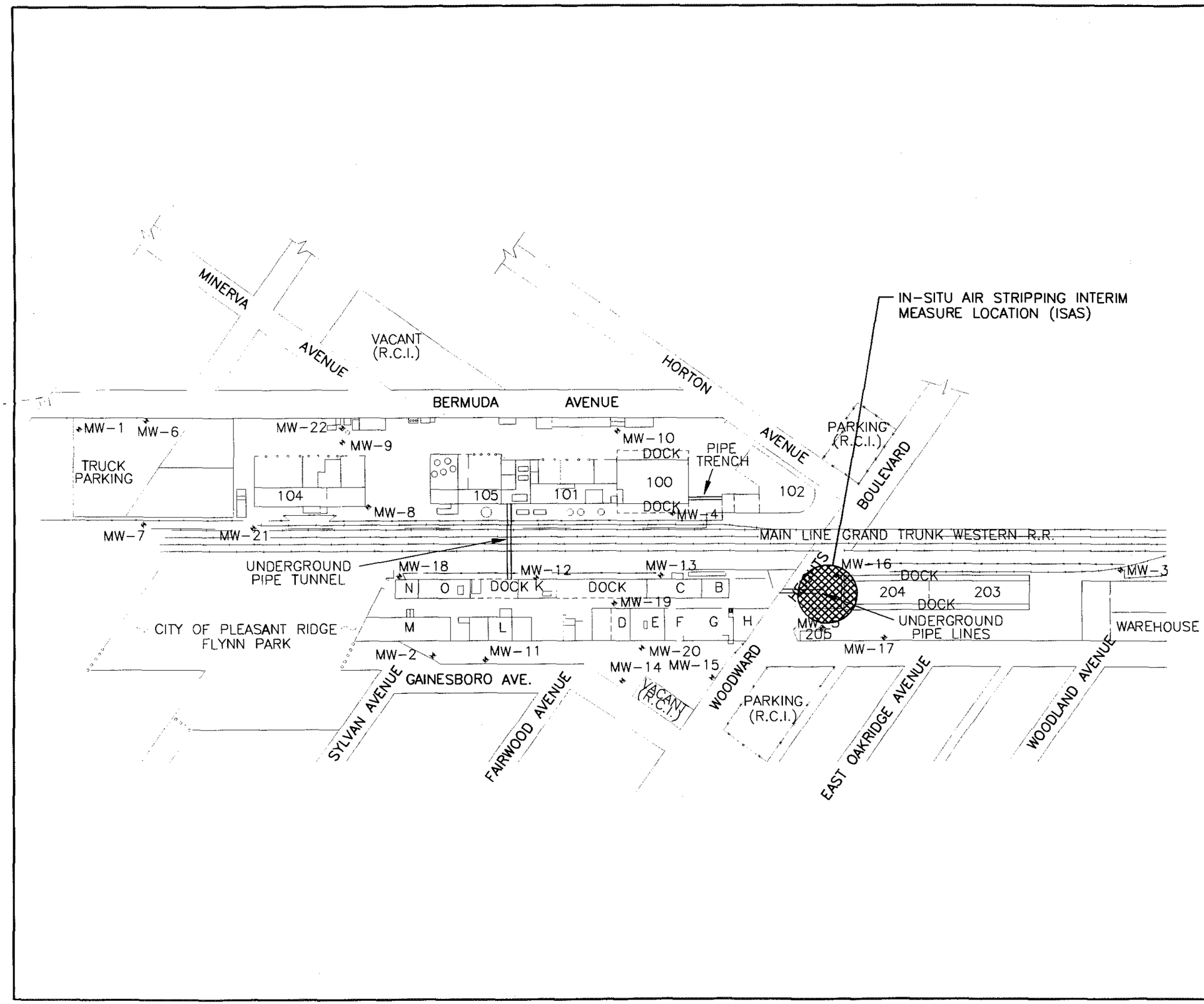
5. Interim Measure Implementation Schedule

5.1. Implementation Schedule

The attached Figure 4 presents the anticipated schedule for implementation of future ISAS interim measure activities. The schedule and deliverables will be dependent upon the outcome of the interim performance assessment. As such, schedules have been developed under no further action and continued operation scenarios.

FIGURE 1

3208147-1200



LEGEND

- APPROX. MONITORING WELL LOCATION
- CHAIN LINK FENCE
- PROPERTY LINE

REICHHOLD CHEMICALS, INC.
FERNDALE, MICHIGAN

ISAS INTERIM MEASURE LOCATION PLAN

NOVEMBER 1994

200 0 200 400

1" = 200'

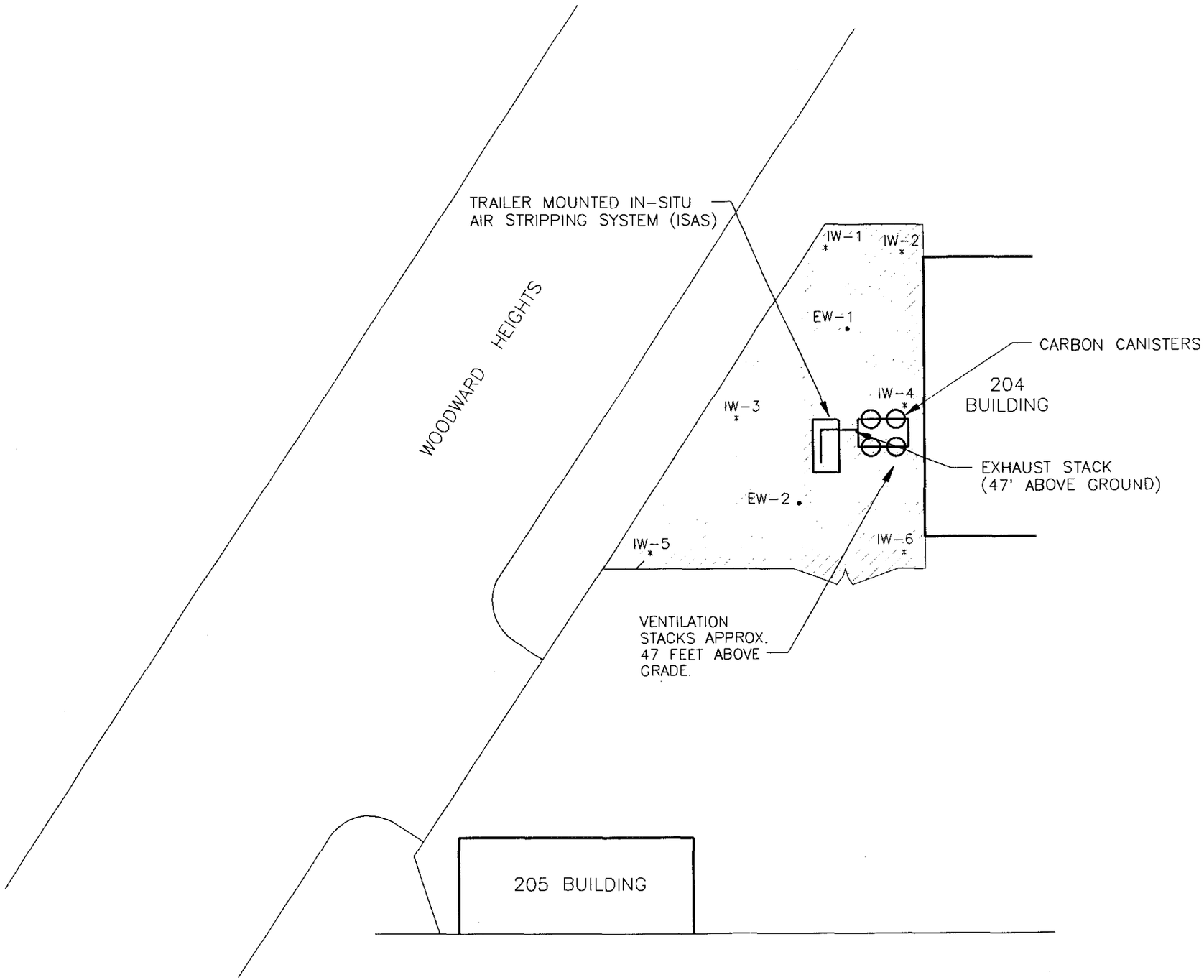
FILE NO.

DESC

O'BRIEN & GERE ENGINEERS, INC.

FIGURE 2

3208145-240



LEGEND

IW-1 *	INJECTION WELL
EW-1 •	EXTRACTION WELL
○	CARBON CANISTERS
▭	FORMER LOCATION OF SOUTH TANK FARM

REICHHOLD CHEMICALS, INC.
FERNDALE, MICHIGAN

IN-SITU AIR
STRIPPING SYSTEM
(ISAS) LAYOUT

NOVEMBER 1994

20 0 20 40

1" = 20'

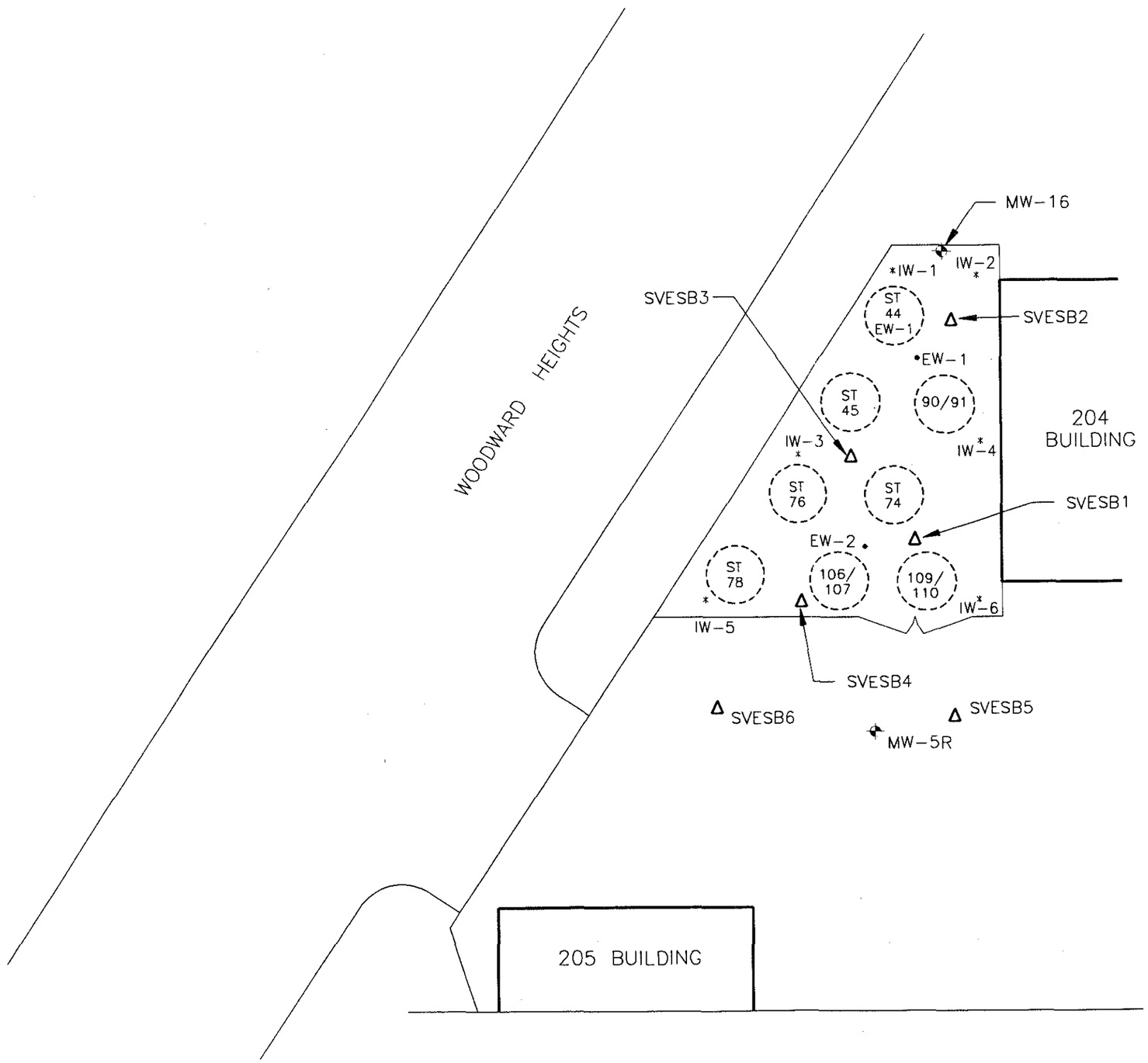
FILE NO.

DESC

O'BRIEN & GERE ENGINEERS, INC.

FIGURE 3

3208146-240



LEGEND

IW-1 *	INJECTION WELL
EW-1 •	EXTRACTION WELL
(ST 45)	FORMER ABOVE GROUND STORAGE TANK FOUNDATION
Δ	PROPOSED SOIL BORING LOCATION
✦	EXISTING MONITORING WELL

REICHHOLD CHEMICALS, INC.
FERNDALE, MICHIGAN

IN-SITU AIR STRIPPING PROPOSED BORING LOCATIONS

NOVEMBER 1994

20 0 20 40

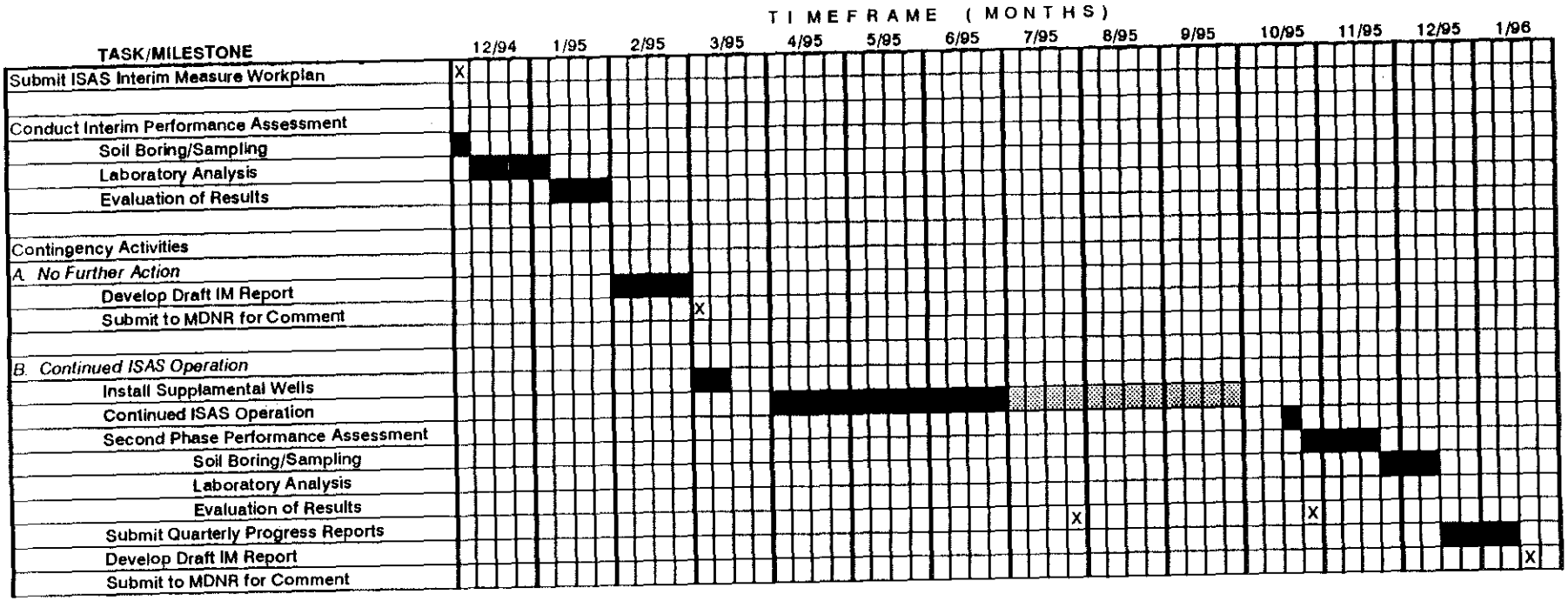
1" = 20'

FILE NO.

DESC

O'BRIEN & GERE ENGINEERS, INC.

FIGURE 4
REICHHOLD CHEMICALS, INC.
ISAS INTERIM MEASURE
IMPLEMENTATION SCHEDULE



Appendix 1

ISAS Operation Status Reports

OBG
OPERATIONS, INC.

October 14, 1993

Mr. Fred H. Reith
District Supervisor
Air Quality Division
Department of Natural Resources
38980 W. Seven Mile Road
Livonia, MI 48152

Re: Reichhold Chemicals, Inc.
Ferndale, MI
Permit No. 1113-91

Subj: Operation Status Report - dated October 1993

Dear Mr. Reith:

On behalf of Reichhold Chemicals, Inc., and in accordance with the requirements of Permit No. 1113-91, attached please find the Operation Status Report dated October 1993 for the Reichhold Chemicals, Inc. facility in Ferndale, Michigan.

The attached Operation Status Report contains Start-up and Operation data for the South Tank Farm In-Situ Air Stripping System for a period from system start-up on May 25, 1993 through reporting period of September 24, 1993.

If you have any questions, please feel free to contact me at (313)347-4136.

Very truly yours,

OBG OPERATIONS, INC.

Marvin D. Rivers, P.E.
Operations Specialist

MDR/ask:L2.45

Attachments

cc: Mr. John W. Knaub - Reichhold Chemicals,Inc., Durham, NC
Mr. Don E. Stone, P.E. - O'Brien & Gere Engineers, Edison, NJ
Mr. Scott J. Adamowski, P.E. - O'Brien & Gere Engineers, Novi, MI
Mr. Scott L. Cormier - O'Brien & Gere Engineers, Novi, Mi
Mr. Greg C. Miller - OBG Operations, Syracuse, NY

OPERATION STATUS REPORT

ISAS Start-up and Operation period of:

June 1993 - September 1993

Reichhold Chemicals, Inc.
Ferndale, Michigan Facility

- South Tank Farm -

In-Situ Air Stripping Soil System, ISAS

October 1993

Prepared by:
OBG Operations, Inc.
39500 Orchard Hill Place, Suite 300
Novi, MI 48375
(313) 347-4136

REICHHOLD CHEMICALS, INC.
Ferndale, Michigan

In-Situ Air Stripping System,ISAS

- South Tank Farm -

October 1993

Operation Status Report
For Period: June 1993 - September 1993

TABLE OF CONTENTS

		Page
1.0	Purpose and Scope	1
2.0	Background	1
3.0	In-Situ Air Stripping System (ISAS) Technology	1
4.0	ISAS, Operating Equipment	1
5.0	Air Stripping Collection	3
6.0	Air Flow Measurement	4
7.0	Operations and Data Review	5
8.0	Conclusion	6

Tables:
- -Record Data Tables

Figures:
- -Site Plan Drawing No. G-1
- -ISAS - Site Plan
- -ISAS - Equipment Layout Plan

Attachments:
- -Laboratory Analytical Reports

REICHHOLD CHEMICALS, INC.
Ferndale, MI

In-Situ Air Stripping System

1.0 Purpose and Scope

OBG Operations, Inc. has been retained by Reichhold Chemicals, Inc. to collect field data and maintain the operation of the In-Situ Air Stripping System (ISAS) at the Reichhold Chemicals, Ferndale facility.

The purpose of this report is to submit field data collected and provide a field operating status of the ISAS system in compliance with Permit No. 1113-91 issued by the Air Quality Division of the Michigan Department of Natural Resources. Field start-up testing began the week of May 24, 1993. This report will present data collected from start-up in May 1993 through September 1993.

2.0 Background

The Ferndale facility is a former chemical manufacturing plant that was closed and decommissioned in 1990. A Phase I hydrogeologic investigation was conducted at the facility consisting of a soil gas survey and the installation of various monitoring wells. In particular, the former South Tank Farm Area was observed to be impacted with VOCs. See attached Drawing No. G-1 of the August 1991 Air Permit Application for the general Site Plan and Figure 1 for a detailed view of the former South Tank Farm Area. The results of this investigation indicated the presence of volatile organic compounds (VOCs) in both the soil and ground water. To initiate remediation of the soil in the former south tank farm area, RCI installed an In-Situ Soil Air Stripping System (ISAS).

3.0 In-Situ Air Stripping System (ISAS) Technology

The ISAS is designed to extract volatile organic compounds (VOCs) from soil above the water table. Both the vapor extraction well and air inlet wells are installed within the impacted soil area. A vacuum applied to the extraction well induces a negative pressure creating a flow of air from the passive air inlet through the soil to the extraction well. As the air saturated with VOC vapors flow through the soils, it is replenished with clean air through the inlet wells. The VOCs located within the unsaturated zone are volatilized. The VOC laden air is then discharged to vapor phase carbon canisters to remove the VOCs from the air stream which is then vented to the atmosphere.

4.0 ISAS Operating Equipment

The ISAS equipment is mobile and mounted on a trailer and consists of a 10Hp EG & G Rotron electric blower, liquid separator tank, interconnecting pipe work, instrumentation/controls, vapor phase carbon treatment and continuous air quality monitoring sensors. The ISAS equipment was designed by O'Brien & Gere Engineers, Inc. and fabricated by Specialized Process Equipment, Inc. of Syracuse, New York. The major pieces of equipment operation consist of the following:

4.1 Direct Drive Blower:
The blower mechanism is a regenerative-tubing type direct drive 10 horsepower blower rated at 150 SCFM at 5" Hg vacuum. It is powered by an electric motor with variable frequency drive (VFD) allowing continuous range of speeds from 0 to 4000

RPM. The blower is constructed of aluminum and has an explosion proof impeller to prevent sparking.

4.2 Inlet and System Piping:
Inlet piping is constructed of 3" Schedule 40 aluminum piping, including a 10 micron filter and a 15-foot flex hose for connection to the vacuum extraction well (VEW). A liquid separator knock-out tank is located prior to the vacuum blower. The associated piping from the ISAS trailer to the dual carbon treatment canisters is PVC. The exhaust stack is constructed of 3" aluminum, to a height of 47 feet above ground level.

4.3 Control Panel:
The control system is housed in a weather tight NEMA 4 enclosure, equipped with heaters and manual reset. The system also includes pilot and alarm lights. Safety features include high discharge temperature and vacuum shut-off switches.

4.4 VOC Vapor Monitoring System:
Continuous vapor monitoring sensors are located after the first stage dual carbon treatment and after the second stage dual carbon canister treatment prior to exhaust stack discharge. The vapor monitoring sensor alarm conditions are set at 50 ppm and 200 ppm, with the 50 ppm condition signaling a light on the control cabinet. The 200 ppm condition will automatically shut off the SVE blower. The GAS-TECH vapor monitor control cabinet is located inside a NEMA-4 enclosure.

4.5 Additional Controls:
For proper operation of the ISAS, temperature, pressure, vacuum readings and air flow rates will be monitored.

4.6 Vapor Phase Carbon Treatment:
Dual carbon treatment canisters provide primary and secondary vapor phase treatment. Two-55 gallon carbon canisters provide first stage primary treatment and two-55 gallon carbon canisters provide the secondary, second stage carbon treatment prior to vapor exhausting up the 47-foot high exhaust stack.

After the primary carbon units are spent, the secondary units will be moved to the first stage positions and new 55-gallon carbon canisters will be installed in the second stage position.

4.7 Extraction and Inlet Wells:
Extraction wells (EWs) are constructed of 4 inch diameter stainless steel to a depth of approximately 6 feet below grade with the ss tubing extending 2 feet above grade. A 4 foot well screen interval extends from approximate finish grade to the bottom of the well.

Inlet wells (IWs) are constructed of 2 inch diameter stainless steel to a depth of approximately 5 feet below grade, with the ss tubing extending 1'-8" above grade. A 3 foot well screen interval extends from approximate finish grade to the bottom of the well.

The distance from the extraction wells to the air inlet/monitoring wells vary from 15 feet to 29 feet. Actual IW to EW distances are noted on the attached South Tank Farm site plan layout, Figure No.1.

5.0 Air Sample Collection

Air is drawn from the extraction well under negative vacuum pressure by the regenerative vacuum blower mounted on the ISAS equipment trailer. The exhaust air from the regenerative vacuum blower passes through carbon canisters for the treatment and removal of VOCs prior to discharge to the atmosphere.

Air samples are collected at the influent, intermediate and effluent. The influent sampling port is located prior to the first carbon treatment canister. Since a dual carbon treatment system is used in this application, there are two intermediate sampling locations after each of the primary carbon treatment canisters. Effluent air sampling is located after the secondary carbon treatment on the exhaust stack piping prior to the air discharge to the atmosphere.

Air samples are extracted through an air sampling port in the air piping system using an air sampling pump. The air sample is passed through a charcoal tube where the VOC contaminants are absorbed. A calibrated air sampling pump is used to collect and calculate the air volume passed through the charcoal tube sample. The laboratory analyzes the charcoal tube to determine the concentration of the desired constituents. Analytical results are reported in units of parts per million, ppm.

The air sampling pump provides an air inlet and outlet connection. Plastic tubing is connected from the air stream sampling port to the air inlet on the air sampling pump. Charcoal tubes are installed in the plastic tubing line between the air sample port and the air sampling pump. The air sample is collected on the charcoal tube prior to the air passing through the air sampling pump.

Initially, double charcoal tube set-up was used to collect an air sample, providing a primary and secondary charcoal tube sample for laboratory analysis. The secondary charcoal tube is intended to capture the constituents which may have saturated the primary sampling tube and "breakthrough". The initial influent air sample analytical results indicated the secondary charcoal tube was reporting non-detect concentrations. Therefore, after the first week of air sample collection only a single charcoal tube is used to collect air samples.

The air samples collected in the charcoal sorbent tubes are laboratory analyzed for the following constituents using the noted NIOSH analytical methods.

Constituent	NIOSH Method
methylene chloride	1005
ethylbenzene	1300
xylene	1500 & 1501
acetone	1500 & 1501

Kemron Environmental Services, located at 39830 Grand River, B-2, Novi, Michigan 48375 is the laboratory which has performed the charcoal tube air sample analysis.

In accordance with the air permit, influent air samples are to be collected on a weekly basis for VOC concentration determination until 10 valid samples are obtained. Thereafter, samples are to be collected on a monthly basis. During the operating period of May 24 through September 24,1 993, 10 influent air samples were collected for laboratory analysis of VOC. Additional samples were monitored in the field for total VOC concentration by use of a photoionization (HNu) meter. Samples were not obtained during timeframes associated with of equipment shutdown.

6.0 Air Flow Rate Measurement

Air flow rate measurement reported in units of cubic feet per minute (scfm) is calculated using two techniques. One method uses a Solomat instrument to directly measure air speed in units of feet per minute (ft/min) then multiply by the air flow cross sectional area for the scfm. The second technique uses a Dwyer flow sensor to allow the measurement of differential air pressure then calculate the air flow (scfm).

6.1 Solomat Instrument - The Solomat wind vane probe in inserted through an air sampling port on the exhaust stack. The Solomat instrument provides a direct air speed reading in units of feet per minute (ft/min). The air flow rate (scfm) is calculated by multiplying the air speed (ft/min) by the air flow cross sectional area.

The air speed (ft/min) is measured at the center of the exhaust stack pipe. Three air speed measurements are recorded and averaged for the reported air speed measurement. In accordance with DWYER Instruments, Inc. air velocity measurement techniques, when measuring air velocity at the center of laminar air flow, multiply the calculated air flow (scfm) by a factor of (.9) to allow for the average cross sectional air flow.

6.2 DWYER Air Flow Sensor - A second technique used to verify the air flow rate (scfm) is a DWYER Instruments, Inc. Air Flow Sensor, Series DS-200. The DWYER air flow sensor is secured to the exhaust stack through a threaded 3/8 inch, NPT air sampling port. After air flow data is collected, the sensor is removed and the sampling port is plugged with a 3/8 inch plug cap.

The air flow sensor is provided with attachments for high and low pressure connections for the measurement of differential air pressure. The differential pressure P is measured in units of inches of water column (in/H_2O) and is used in a formula to calculate air flow (scfm). A magnehelic gage is used to measure the differential pressure. Also, the Solomat pressure probe connected to the DWYER air flow sensor is used to provide a direct digital reading for differential pressure in units of in/H_2O. The magnehelic gage reading and the Solomat pressure probe reading provided the same results. The static air flow line pressure is measured with a pitot tube, again using the Solomat pressure probe to measure the static pressure, P in units of pounds per square inch, psig. The gage pressure, psig, is converted to atmospheric pressure, psia for proper formula units. The temperature probe, also provided with the Solomat instrument is used to measure the air flow temperature in degrees fahrenheit (F).

The attached equations are used to calculate the air flow rates.

7.0 Operations and Data Review

7.1 Equipment Operation

Initial start-up testing and vacuum influence monitoring indicated EW-2 did not create a measurable air transfer/vacuum influence at the perimeter monitoring wells. Therefore, the ISAS equipment has not operated continuously at EW-2. Rather, the system was connected to EW-1 and has operated predominantly at extraction well No. 1 for the reporting period.

During the first week of ISAS equipment operation and the initial charcoal tube air sample collection, the ISAS equipment was only operated while an OBG Operations representative was on site. The ISAS equipment did not operate from June 2, 1993 through June 14, 1993. From June 14 through July 4, 1993 the ISAS operated five days per week, 24-hours per day. Since the week of July 12 through September 10, 1993 the ISAS has operated continuously seven days a week, 24-hours per day.

Total cumulative operating hours from ISAS start-up in May 25, 1993 through September 24, 1993 is approximately 2,200 hours.

Since July 15, 1993, the ISAS regenerative vacuum blower has been maintained at a 40% speed dial setting and a frequency drive reading of approximately 23. The blower air flow rate is measured to be approximately 80 SCFM, at these settings.

7.2 Vacuum Influence:

On July 15, 1993 a soil vapor extraction SVE influence test was conducted. The ISAS - vacuum extraction line was connected to each well, (extraction and inlet wells) the vacuum influence was then recorded (in/H_2O) at each of the perimeter air inlet/monitoring wells. The ISAS vacuum blower remained at a constant speed dial setting of 60%.

Data collected is listed on the attached Vacuum Influence Table No. 2.

Prior to vacuum extraction at EW-2, DTW was measured to be 5.7' below TOC. For an approximate 3.7' of screen interval exposed. During the SVE testing period, the water column in EW-2 was drawn upward, leaving only 12 inches of screen interval exposed. Extraction well No. 2 did not create measurable vacuum influence at the perimeter air inlet/monitoring wells. Underground obstruction or very tight consolidated soils may be the cause for low and non-vacuum detection influence readings from EW-2.

A depth to water level was recorded at a few inlet monitoring wells, IW-2, DTW = 5.2' for approximately .1' water depth and IW-6, DTW = 4.0 for approximately 1.2' water depth.

Measurable air/vacuum transfer is detected east of EW-1 with vapor extraction hook-up at EW-1. Likewise, with the SVE at IW-1 and IW-2 vacuum is detected at EW-1. Vacuum influence is considerably decreased at IW-3 and IW-4. Vacuum influence is not measurable at IW-5 or IW-6. With the SVE hook-up at IW-4, a H-nu reading of 50 ppm was recorded.

7.3 Analytical Data Review:

The air permit application dated August 1991 estimated the total constituent concentration (ppm) to be extracted from the soil at 600 ppm, with breakdown of concentrations, ppm as follows: Methylene Chloride (0.3 ppm), Ethylbenzene (74.9 ppm), Xylene (539 ppm) and Acetone (4.37 ppm).

Actual charcoal tube air sample analysis have detected a maximum of 55.73 ppm reported June 18, 1993, with a breakdown of constituent concentrations as follows: Methylene chloride (1.547 ppm), Ethylbenzene (3.951 ppm) Xylene (40.78 ppm) and Acetone (9.446 ppm). As originally estimated, xylene is the primary source of reported concentration of the constituents being analyzed.

Air Sample Analytical and Operation Data Table No.3 and the attached graph indicate concentration levels having decreased from the peak reporting date of June 18, 1993 to near non-detectable limits reported September 10, 1993.

Table No.3 and the attached graph represent air sample data collected from extraction well, EW-1. The graph data points represent air sample collection dates of: 5/27, 5/28, 6/02, 6/18, 6/30, 7/22, 8/13 and 9/10/93.

Table No.3 also lists air sample analytical results for intermediate and effluent sampling, while operating at EW-1. Extraction well, EW-2, operation data and air sampling results are also listed on Table No.3.

Field Data Inspection sheets are attached for each air sample collection date. The data sheets list the air sample analytical results and Kemron Laboratory report number. Kemron Environmental Services analytical reports and chain of custody sheets are also attached for each air sampling date.

7.4 Constituent Removal Rate

Based on the reported VOC constituent concentrations from the laboratory, VOC removal rates were calculated in average pounds per hour over the sample interval and total (cumulative) pounds removed. These results are presented in the attached Table No.4. The mass removal rates were calculated by converting the VOC concentrations into mole percentages and multiplying the resultant mass value by the molar flow rate of the gas stream as measured by cfm readings. For the reporting period, it is estimated that 59 pounds of VOC were removed from the vadose zone by the ISAS system. The maximum calculated removal rate was 0.12 pounds/hour based on the 5/28/93 sample collection. The average hourly removal rate for the reporting period was 0.026 pounds/hour.

8.0 Conclusion

Based on the data collected, the emissions from this system are in compliance with Permit No. 1113-91.

Influent air sample analytical results indicate constituent concentrations (ppm reading) are much lower than originally anticipated. Concentration levels have decreased from a total, ppm reading of 55.73 ppm reported June 18, 1993 to 3.34 ppm reported September 10, 1993. An estimated 59 pounds of VOC were removed by the system during the reporting time period.

On September 29, 1993, the ISAS vapor extraction hook-up was moved from EW-1 to IW-4. This adjustment was made to enhance the area of influence of the ISAS system in the South Tank Farm area.

The next status report will provide a summary of results for the operating period of September 24 through December 24, 1993 in accordance with the approved air permit. Air samples will be collected on a minimum monthly basis during the next reporting period.

2.54

TABLES: FIELD RECORD DATA

Reichhold Chemicals, Inc.
Ferndale, Michigan

South Tank Farm
In-Situ Air Stripping System, ISAS

Field Data Collected for
Report Dated October 1993

Data Collection Period

May 26, 1993 to September 10, 1993

REICHHOLD CHEMICALS, INC.
Ferndale, MI

In-Situ Air Stripping System, ISAS
Extraction Well and Inlet Well Data

TABLE No. 1

Well No.	D.T.B.	T.O.C. Ht. above Fin. Grd.	From TOC to Screen	DTW 7/15/93	DTW 10/8/93
EW-1	6.0	2.0	1.6	0.0	0.0
EW-2	6.7	2.0	2.5	5.7	6.0
IW-1	5.3	1.6	1.6	0.0	0.0
IW-2	5.3	1.3	1.6	5.20	0.0
IW-3	4.6	1.6	2.0	0.0	0.0
IW-4	5.3	1.6	2.0	0.0	0.0
IW-5	5.0	1.6	2.0	0.0	4.0
IW-6	5.2	1.6	2.0	4.0	4.6

Notes:

D.T.B.= Depth to Bottom
T.O.C.= Top of Casing
D.T.W.= Depth to Water
E.W. = Extraction Well
I.W. = Inlet Well

File: WellData

REICHHOLD CHEMICALS, INC.
Ferndale, MI

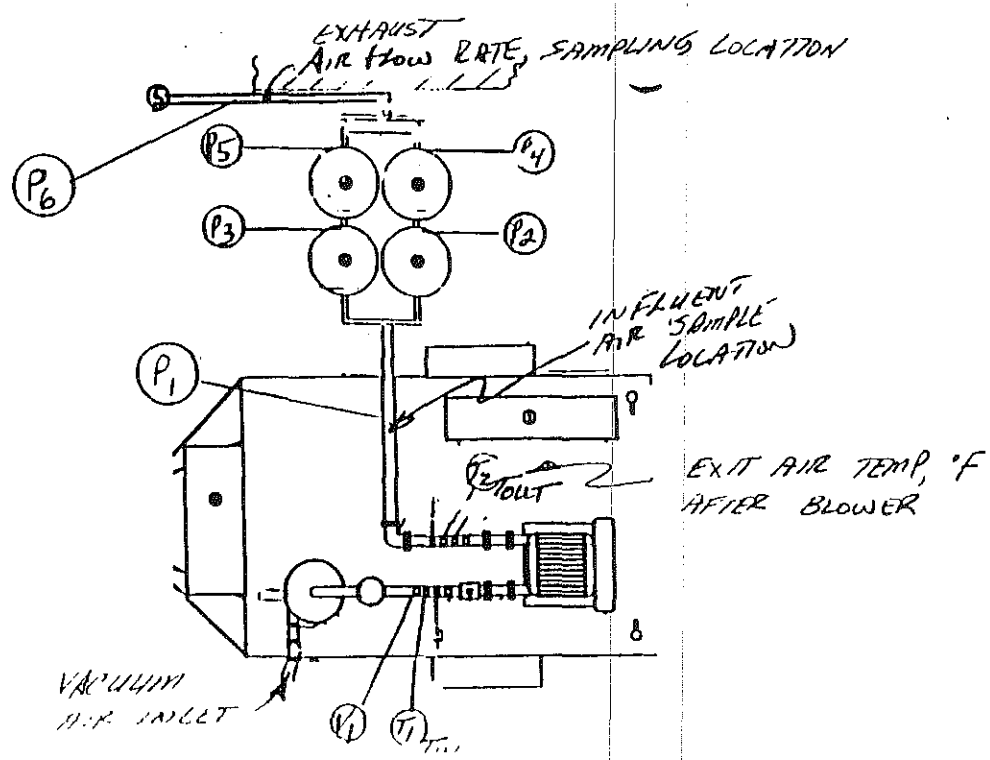
South Tank Farm, ISAS Testing
Vacuum Influence Testing July 15, 1993

TABLE No. 2

SVE Location	Influence Vacuum readings, in/H2O								VACUUM		Line Pres.		AIR FLOW		H-nu	Exit
	EW-1	EW-2	IW-1	IW-2	IW-3	IW-4	IW-5	IW-6	in/Hg	in/H2O	P1	P2	ft/min	SCFM	ppm	Air
EW-1	SVE	0.02	2.63	2.68	0.08	0.4	0	0.02		11	19.3	1.9	2300	113	8	125
EW-2	0	SVE	0	0	0	0	0	0	3.8		3.8	0.35	1000	44	0	125
IW-1	1.21	0	SVE	1.21	0.06	0.2	0	0.01	2.5		6.5	0.5	1400	102	N/A	
IW-2	2.38	0	2.3	SVE	0.08	0.38	0	0.01		17.5	16.1	1.6	2300	113	N/A	135
IW-3	0.02	0	0.02	0.02	SVE	0.03	0	0	4		1.8	0.15	600	26	40	150
IW-4	0.09	0.01	0.08	0.08	0.04	SVE	0	0.04	3.5		2.6	0.2	700	30	50	165
IW-5	0	0	0	0	0	0.02	SVE	0	3.8		0.3	0.05	80	N/A	13	150
IW-6	0	0	0	0	0	0	0	SVE	3.9		0.5	0	150	N/A	0	160

SVE = Soil Vapor Extraction, connection location
Ambient Air Temperature, 88 degrees, sunshine
Speed Dial at constant 60%
Frequency Drive reading 37.0
Blower ambient air flow w/o vacuum = 3000 ft/min. or 132 scfm.
Calculated Air Flow, scfm = 3in Dia (area) x ft/min x .9
(.049) x ft/min x .9

File: 7-15-93



REICHHOLD CHEMICALS, INC.
FERNDALE, MI

In-Situ Air Stripping System, ISAS
Air Sample Analytical and Operation Data

TABLE No. 3

EXTRACTION WELL NO. 1

DATE	Air Sample Location	H-NU	Acetone	Ethyl-Benzene	Methylene Chloride	Xylene	Speed Dial Setting	Freq.	Air Flow (CFM)
05/27	Influent	N/R	2.336	4.724	0.015	21.553	65%	41.14	128
05/28	Influent	25 ppm	12.255	6.525	0.004	33.93	70%		145
06/02	Influent	30 ppm	9.738	4.371	0.011	20.993	45%	27.95	90
06/18	Influent	N/R	9.446	3.951	1.547	40.78	40%	23.14	80
06/30	Influent	N/R	0.637	0.512	1.508	33.357	60%	35.8	104
07/22	Influent	N/R	0.046	0.304	1.06	7.921	40%	23	80
08/13	Influent	3 ppm	0.564	0.427	0.739	4.004	40%	23	80
09/10	Influent	N/R	1.259	0.229	0.081	1.774	40%	23	80

Note:

1. Data from the above table is incorporated on the attached graph.
2. The less than symbol (<) is omitted from some values to represent graph points.
3. 5/27/93, EW-1, CO_2 reading = 3350ppm

EXTRACTION WELL NO. 1

07/23/93	Intermed.	N/R	<0.278	<0.015	<0.019	<0.015	40%	23	80
08/13/93	Intermed.	N/R	<0.439	<0.024	<0.030	<0.024	40%	23	80
08/13/93	Effluent	N/R	<0.477	<0.026	<0.019	<0.015	40%	23	80
07/15/93	Influent	2 ppm					40%	23	80
08/25/93	Influent	8 ppm					40%	23	80

EXTRACTION WELL NO. 2

05/25/93	Influent	4.5 ppm	4.636	0.429	<0.008	3.639	52%	33.28	50
05/26 #1	Influent	N/R	0.331	0.306	<0.035	1.838	60%	37.58	57
05/26 #2	Influent	6 ppm	4.254	0.394	<0.022	2.134	60%	37.58	57
08/25/93	Influent	4 ppm							

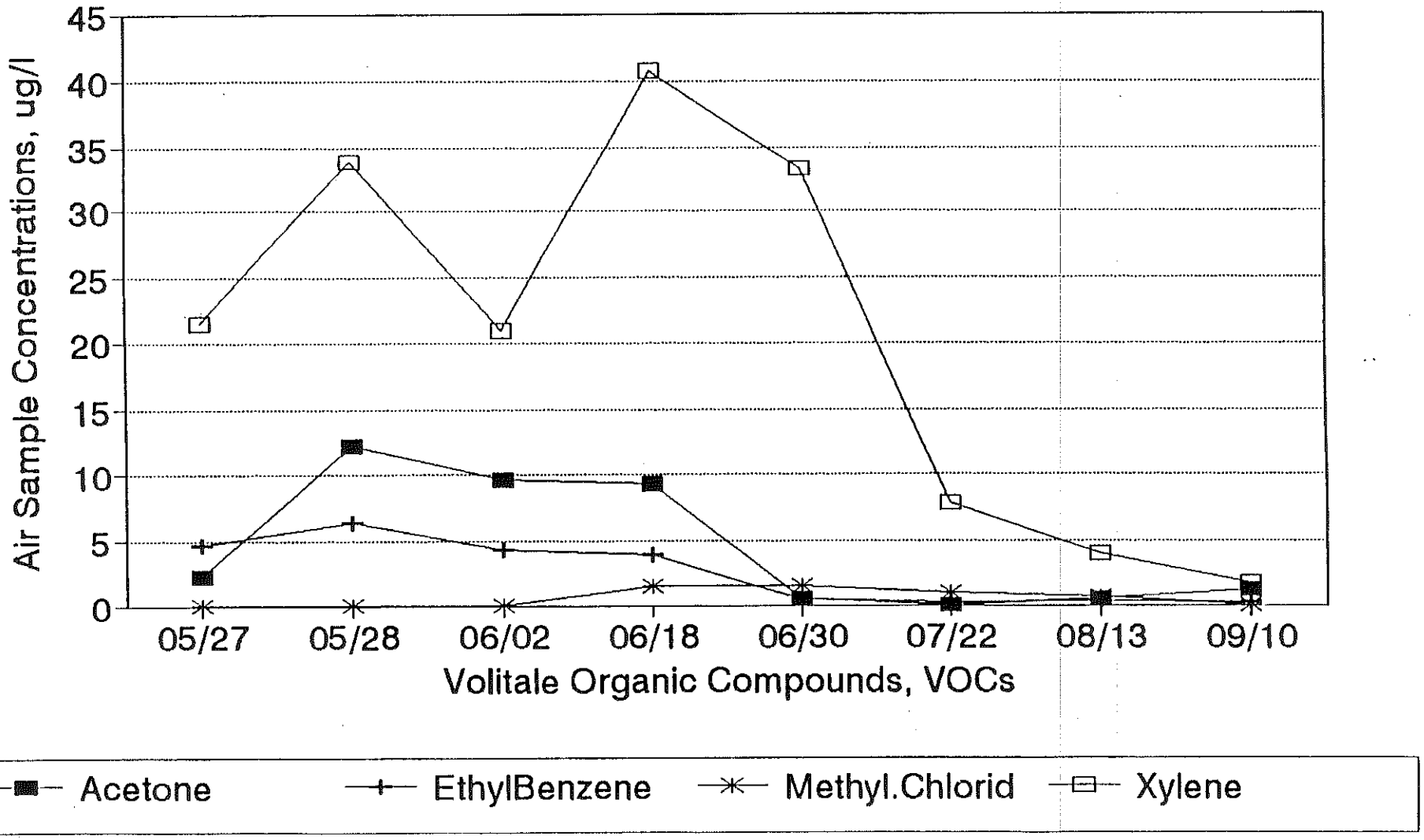
5/26/93 EW-2, CO_2 reading = 975 ppm.

Analytical results are reported in units, ppm

File: SVEDATA

REICHHOLD CHEMICALS, INC.

In-Situ Air Stripping System, ISAS



REICHHOLD CHEMICALS, INC.
FERNDALE, MI SITE
ISAS REMOVAL RATE SUMMARY TABLE No.4

5/25/93	EW#2	CFM =	50	HOURS ON =	8
Analyte		Concentration (ppmv)		Lbs/Hr Removed	
Ethylbenzene		0.0492		0.00004	
Xylene		3.639		0.00322	
Acetone		4.636		0.00225	
			TOTAL	0.00551	
POUNDS REMOVED OVER SAMPLE INTERVAL				0.04411	
CUMULATIVE POUNDS REMOVED				0.04411	

5/26/93	EW#2	CFM =	57	HOURS ON =	8
Analyte		Concentration (ppmv)		Lbs/Hr Removed	
Ethylbenzene		0.394		0.00040	
Xylene		2.134		0.00215	
Acetone		4.254		0.00235	
			TOTAL	0.00490	
POUNDS REMOVED OVER SAMPLE INTERVAL				0.03923	
CUMULATIVE POUNDS REMOVED				0.08334	

5/27/93	EW#1	CFM =	128	HOURS ON =	8
Analyte		Concentration (ppmv)		Lbs/Hr Removed	
Ethylbenzene		4.724		0.01071	
Xylene		21.553		0.04887	
Acetone		2.336		0.00290	
Methylene Chloride		0.015		0.00003	
			TOTAL	0.06251	
POUNDS REMOVED OVER SAMPLE INTERVAL				0.50010	
CUMULATIVE POUNDS REMOVED				0.58344	

5/28/93	EW#1	CFM =	145	HOURS ON =	8
Analyte		Concentration (ppmv)		Lbs/Hr Removed	
Ethylbenzene		6.525		0.01676	
Xylene		33.93		0.08716	
Acetone		12.255		0.01723	
Methylene Chloride		0.004		0.00001	
			TOTAL	0.12115	
POUNDS REMOVED OVER SAMPLE INTERVAL				0.96924	
CUMULATIVE POUNDS REMOVED				1.55267	

6/02/93	EW#1	CFM =	90	HOURS ON =	8
Analyte		Concentration (ppmv)		Lbs/Hr Removed	
Ethylbenzene		4.371		0.00697	
Xylene		20.993		0.03347	
Acetone		9.738		0.00850	
Methylene Chloride		0.011		0.00001	
			TOTAL	0.04895	
POUNDS REMOVED OVER SAMPLE INTERVAL				0.39161	
CUMULATIVE POUNDS REMOVED				1.94428	

6/18/93	EW#1	CFM =	80	HOURS ON =	168
Analyte		Concentration (ppmv)		Lbs/Hr Removed	
Ethylbenzene		3.951		0.00560	
Xylene		40.78		0.05780	
Acetone		9.446		0.00733	
Methylene Chloride		1.547		0.00176	
			TOTAL	0.07248	
POUNDS REMOVED OVER SAMPLE INTERVAL				12.17653	
CUMULATIVE POUNDS REMOVED				14.12080	

6/30/93	EW#1	CFM =	104	HOURS ON =	480
Analyte		Concentration (ppmv)		Lbs/Hr Removed	
Ethylbenzene		0.512		0.00094	
Xylene		33.357		0.06146	
Acetone		0.637		0.00064	
Methylene Chloride		1.508		0.00223	
			TOTAL	0.06527	
POUNDS REMOVED OVER SAMPLE INTERVAL				31.33063	
CUMULATIVE POUNDS REMOVED				45.45143	

7/22/93	EW#1	CFM =	80	HOURS ON =	528
Analyte		Concentration (ppmv)		Lbs/Hr Removed	
Ethylbenzene		0.304		0.00043	
Xylene		7.921		0.01123	
Acetone		0.046		0.00004	
Methylene Chloride		1.06		0.00120	
			TOTAL	0.01290	
POUNDS REMOVED OVER SAMPLE INTERVAL				6.80983	
CUMULATIVE POUNDS REMOVED				52.26126	

8/13/93	EW#1	CFM =	80	HOURS ON =	672
Analyte		Concentration (ppmv)		Lbs/Hr Removed	
Ethylbenzene		0.427		0.00061	
Xylene		4.004		0.00567	
Acetone		0.564		0.00044	
Methylene Chloride		0.739		0.00084	
			TOTAL	0.00756	
POUNDS REMOVED OVER SAMPLE INTERVAL				5.07842	
CUMULATIVE POUNDS REMOVED				57.33967	

9/10/93	EW#1	CFM =	80	HOURS ON =	360
Analyte		Concentration (ppmv)		Lbs/Hr Removed	
Ethylbenzene		0.229		0.00032	
Xylene		1.774		0.00251	
Acetone		1.259		0.00098	
Methylene Chloride		0.081		0.00009	
			TOTAL	0.00391	
POUNDS REMOVED OVER SAMPLE INTERVAL				1.40659	
CUMULATIVE POUNDS REMOVED				58.74626	

REPORTING PERIOD: 5/24/93 – 9/24/93	
TOTAL HOURS OF OPERATION	2248
TOTAL POUNDS VOC REMOVED	58.7

NOTE:
"HOURS ON" is the hours of operation over a "sample interval" during which the VOC concentrations measured are assumed valid. The interval selected is from the sample collection date listed to the next sample collection date.

SUBJECT	SHEET	BY	DATE	JOB NO
REYNOLD CHEMICALS, INC 6.0 AIR FLOW RATE CALCULATION		MDRivera	10-8-93	

REF: DWYER INSTRUMENTS, INC.
P O Box 373
MICHIGAN CITY, INDIANA 46360
(219) 879-8000

DWYER SERIES DS-200 FLOW SENSOR
BULLETIN F-51

$$\text{Flow, } Q(\text{SCFM}) = 128.8 \times K \times D^2 \times \sqrt{\frac{P \times \Delta P}{(T+460) \times S_g}}$$

K = Flow Coefficient
for 3" sch. 40 PVC, K = .645

D = inside Diameter, in²

P = Static Line Pressure, psia
psia = (psig + 14.7)

ΔP = Differential Pressure, in/H_2O

T = °F + 460 = °Rankin

S_g = Sp Gr @ 60°F
(for Air use S_g = 1)

As an air flow calculation example for field data collected 6/02/93 with speed dial @ 45% frequency reading 27.95

Static Pressure, P = .040 psig
Differential Pressure, ΔP = .52 in/H_2O
Air Temperature, T = 70°F

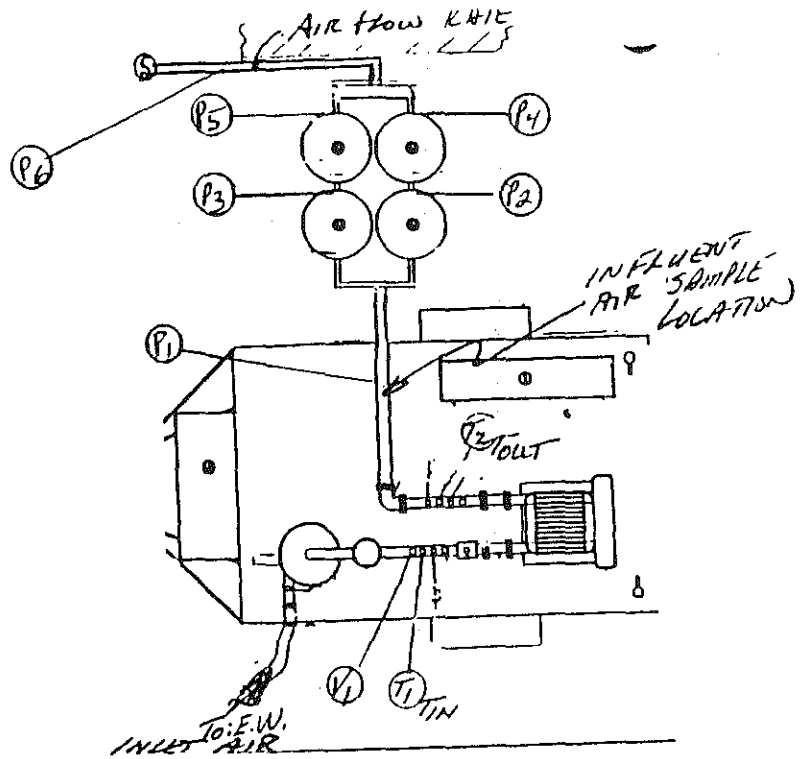
$$\text{Flow, } Q(\text{scfm}) = 128.8 \times (.645) \times (3)^2 \times \sqrt{\frac{(.040+14.7) \times .52}{(70+460) \times 1}}$$

$$= 128.8 \times (.645) \times (3)^2 \times .120$$

$$= 90 \text{ scfm}$$

REICHHOLD CHEMICALS, INC.
FERNDALE, MI

In-Situ Air Stripping System, ISAS
Field Data Inspection Date 9/10/93



FIELD DATA: 9/10/93 Extraction Well No. 1	
Air Temp.	
Tin	
Tout	
H-nu	ppm
Oxygen, O2	N/R %
Carbon Dioxide, CO2	N/R ppm
Exotox, explo.	N/R %
Air Flow Data:	
Speed Dial	40 %
Freq. Reading	23
ISAS Vacuum, in/Hg	< 2 in/Hg
At 3" Dia. Exhaust	
Air Speed, ft/min	ft/min
Air flow= ft/min*Area*.9	80 cfm
Air Flow Pressure, static	psig
Flow Sensor, Diff. Pres.	in/H2O
Exhaust Air Temp.	
Calculated Air Flow, cfm	cfm

INLET Well No.	Vacuum Reading (in/H2O)
IW-1	N/R
IW-2	N/R
IW-3	N/R
IW-4	N/R
IW-5	N/R
IW-6	N/R

Line Velocity Pres. Location	in/H2O
P1	N/R
P2	N/R
P3	N/R
P4	N/R
P5	N/R
P6	N/R

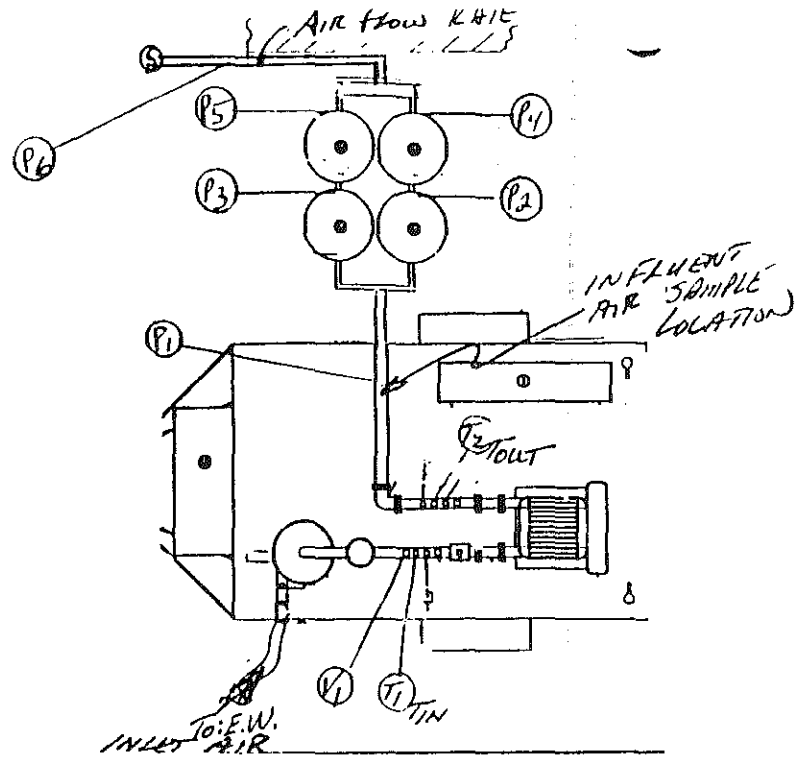
Extraction Well No. 1

Laboratory Analytical Data				COMMENTS:
Methylene Chloride	Ethyl Benzene	Xylene	Acetone	
<0.081ppm	0.229 ppm	1.774 ppm	<1.259 ppm	9/10/93, Influent Kemron Report No. 93-09-103

File: 9-19-93

REICHHOLD CHEMICALS, INC.
FERNDALE, MI

In-Situ Air Stripping System, ISAS
Field Data Inspection Date 8/13/93



FIELD DATA: 8/13/93 Extraction Well No. 1		INLET Well No.	Vacuum Reading (in/H2O)
Air Temp.			
Tin		IW-1	N/R
Tout		IW-2	N/R
H-nu	3 ppm	IW-3	N/R
Oxygen, O2	N/R %	IW-4	N/R
Carbon Dioxide, CO2	N/R ppm	IW-5	N/R
Exolox, explo.	N/R %	IW-6	N/R
Air Flow Data:			
Speed Dial	40 %		
Freq. Reading			
ISAS Vacuum, in/Hg	< 2 in/Hg		
At 3" Dia. Exhaust			
Air Speed, ft/min	ft/min		
Air flow= ft/min*Area*.9	80 cfm		
Air Flow Pressure, static	psig		
Flow Sensor, Diff. Pres.	in/H2O		
Exhaust Air Temp.			
Calculated Air Flow, cfm	cfm		

Line Velocity Pres. Location	in/H2O
P1	N/R
P2	N/R
P3	N/R
P4	N/R
P5	N/R
P6	N/R

Extraction Well No. 1

Laboratory Analytical Data				COMMENTS:
Methylene Chloride	Ethyl Benzene	Xylene	Acetone	
0.739 ppm	0.427 ppm	4.004 ppm	0.564 ppm	Influent Kemron Report No. 93-08-108
<0.030 ppm	<0.024	<0.024	<0.439	Intermediate at location P3 Kemron Report No. 93-08-108
<0.032 ppm	<0.026 ppm	<0.026 ppm	<0.477	Effluent at location P6 Kemron Report No. 93-08-108

File: 8-13-93

REICHHOLD CHEMICALS, INC.
FERNDALE, MI

In-Situ Air Stripping System, ISAS
Field Data Inspection Date 7/22/93

FIELD DATA: 7/22/93 Extraction Well No. 1	
Air Temp.	
Tin	
Tout	
H-nu	3 ppm
Oxygen, O2	N/R %
Carbon Dioxide, CO2	N/R ppm
Exotox, explo.	N/R %
Air Flow Data:	
Speed Dial	40 %
Freq. Reading	23
ISAS Vacuum, in/Hg	< 2 in/Hg
At 3" Dia. Exhaust	
Air Speed, ft/min	ft/min
Air flow= ft/min*Area*.9	80 cfm
Air Flow Pressure, static	psig
Flow Sensor, Diff. Pres.	in/H2O
Exhaust Air Temp.	
Calculated Air Flow, cfm	cfm

INLET Well No.	Vacuum Reading (in/H2O)
IW-1	N/R
IW-2	N/R
IW-3	N/R
IW-4	N/R
IW-5	N/R
IW-6	N/R

Line Velocity Pres. Location	in/H2O
P1	N/R
P2	N/R
P3	N/R
P4	N/R
P5	N/R
P6	N/R

Extraction Well No. 1

Laboratory Analytical Data				COMMENTS:
Methylene Chloride	Ethyl Benzene	Xylene	Acetone	
1.060 ppm	0.304 ppm	7.921 ppm	<0.046 ppm	7/22/93, Influent Kemron Report No. 93-07-202
<0.019 ppm	<0.015	<0.015	<0.278	7/23/93, Intermediate at location P2 Kemron Report No. 93-08-072

File: 7-22-93

REICHHOLD CHEMICALS, INC.
FERNDALE, MI

In-Situ Air Stripping System, ISAS
Field Data Inspection Date 6/30/93

FIELD DATA: 6/30/93 Extraction Well No. 1	
Air Temp.	
Tin	
Tout	110
H-nu	ppm
Oxygen, O2	%
Carbon Dioxide, CO2	N/R ppm
Exotox, explo.	%
Air Flow Data:	
Speed Dial	60 %
Freq. Reading	35.8
ISAS Vacuum, in/Hg	< 2 in/Hg
At 3" Dia. Exhaust	
Air Speed, ft/min	2350 ft/min
Air flow= ft/min*Area*.9	104 cfm
Air Flow Pressure, static	2.2 in/H2O .08 psig
Flow Sensor, Diff. Pres.	.035 in/H2O
Exhaust Air Temp.	
Calculated Air Flow, cfm	cfm

INLET Well No.	Vacuum Reading (in/H2O)
IW-1	1.81
IW-2	1.91
IW-3	.05
IW-4	.30
IW-5	.01
IW-6	.01

Line Velocity Pres.	
Location	in/H2O
P1	20.5
P2	12.6
P3	12.6
P4	3.8
P5	4.4
P6	1.9

Extraction Well No. 1

Laboratory Analytical Data				COMMENTS:
Methylene Chloride	Ethyl Benzene	Xylene	Acetone	
1.508 ppm	0.512 ppm	33.357 ppm	0.637 ppm	21.93 l of air sampled. Kemron Report No. 93-07-013

File: 6-30-93

REICHHOLD CHEMICALS, INC.
FERNDALE, MI

In-Situ Air Stripping System, ISAS
Field Data Inspection Date 6/18/93

FIELD DATA: 6/18/93 Extraction Well No. 1	
Air Temp.	
Tin	90
Tout	110
H-nu	ppm
Oxygen, D2	%
Carbon Dioxide, CD2	N/R ppm
Exotox, explo.	%
Air Flow Data:	
Speed Dial	40 %
Freq. Reading	23.14
ISAS Vacuum, in/Hg	< 2 in/Hg
At 3" Dia. Exhaust	
Air Speed, ft/min	ft/min
Air flow= ft/min*Area*.9	cfm
Air Flow Pressure, static	in/H2D psig
Flow Sensor, Diff. Pres.	in/H2D
Exhaust Air Temp.	
Calculated Air Flow, cfm	80 cfm

INLET Well No.	Vacuum Reading (in/H2O)
IW-1	N/R
IW-2	N/R
IW-3	N/R
IW-4	N/R
IW-5	N/R
IW-6	N/R

Line Velocity Pres.	
Location	in/H2O
P1	N/R
P2	N/R
P3	N/R
P4	N/R
P5	N/R
P6	N/R

Extraction Well No. 1

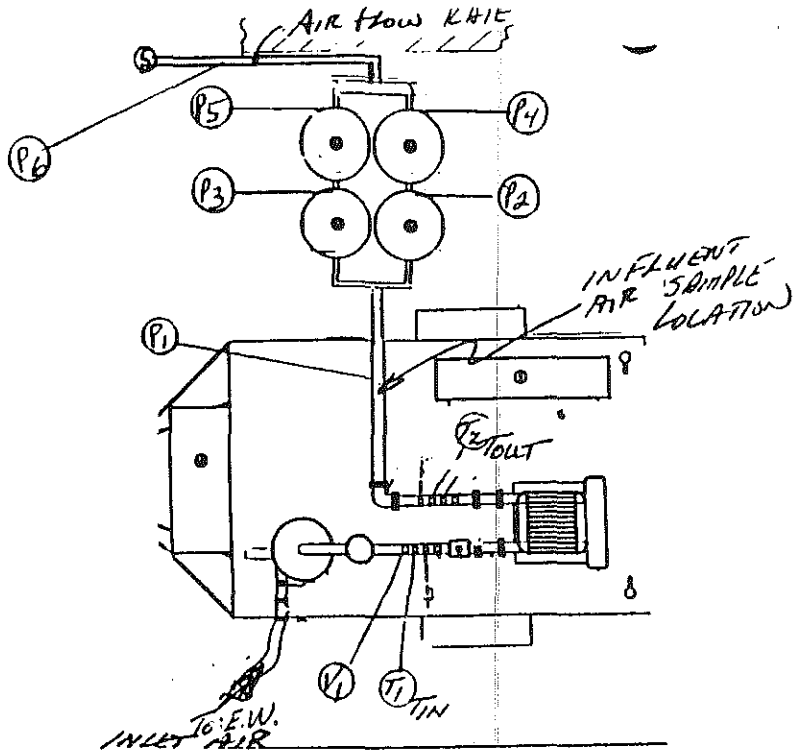
Laboratory Analytical Data			
Methylene Chloride	Ethyl Benzene	Xylene	Acetone
1.547 ppm	3.951 ppm	40.78 ppm	9.446 ppm

COMMENTS:
Hot & Humid day
59.28 l of air sampled.
Kemron Report No. 93-06-221

File: 6-18-93

REICHHOLD CHEMICALS, INC.
FERNDALE, MI

In-Situ Air Stripping System, ISAS
Field Data Inspection Date 6/02/93



FIELD DATA: 6/02/93 Extraction Well No. 1	
Air Temp.	70
Tin	72
Tout	86
H-nu	30 ppm
Oxygen, O2	21.2%
Carbon Dioxide, CO2	N/R ppm
Exotox, explo.	0%
Air Flow Data:	
Speed Dial	45 %
Freq. Reading	27.95
ISAS Vacuum, in/Hg	< 2 in/Hg
At 3" Dia. Exhaust	
Air Speed, ft/min	2200 ft/min
Air flow= ft/min*Area*.9	90 cfm
Air Flow Pressure, static	1.17 in/H2O .040 psig
Flow Sensor, Diff. Pres.	.52 in/H2O
Exhaust Air Temp.	70
Calculated Air Flow, cfm	90 cfm

INLET Well No.	Vacuum Reading (in/H2O)
IW-1	1.20
IW-2	1.30
IW-3	.06
IW-4	.26
IW-5	.00
IW-6	.00

Line Velocity Pres. Location	in/H2O
P1	11.0
P2	6.8
P3	6.7
P4	1.9
P5	2.2
P6	1.0

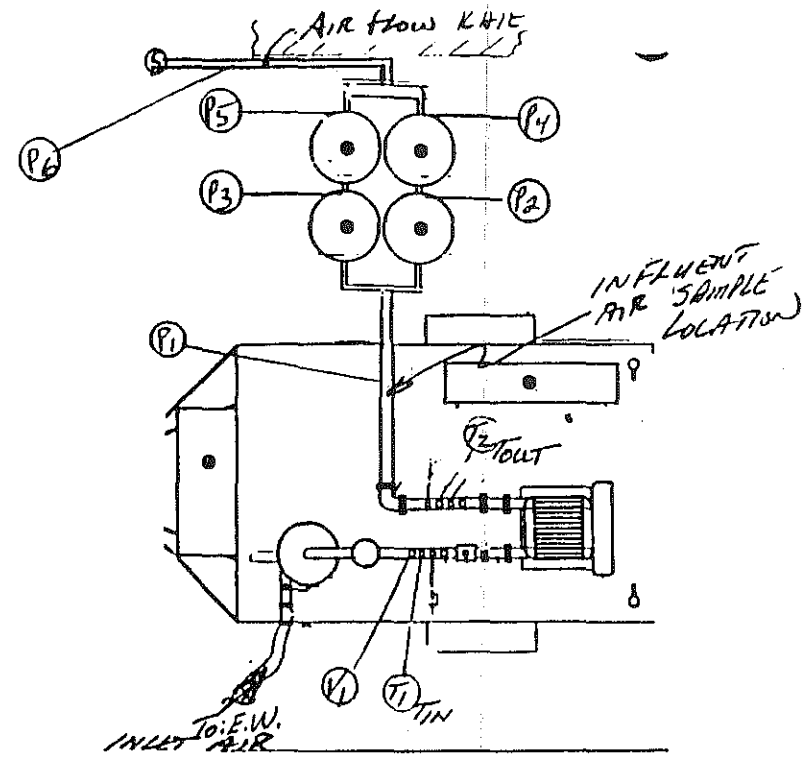
Extraction Well No. 1

Laboratory Analytical Data				COMMENTS:
Methylene Chloride	Ethyl Benzene	Xylene	Acetone	
<0.011 ppm	4.371 ppm	20.993 ppm	9.738 ppm	25.96 l of air sampled. Kemron Report No. 93-06-045

File: 6-02-93

REICHHOLD CHEMICALS, INC.
FERNDALE, MI

In-Situ Air Stripping System, ISAS
Field Data Inspection Date 5/28/93



FIELD DATA: 5/28/93 Extraction Well No. 1	
Air Temp.	80
Tin	75
Tout	85
H-nu	25 ppm
Oxygen, O2	21.2%
Carbon Dioxide, CO2	N/R ppm
Air Flow Data:	
Speed Dial	70 %
Freq. Reading	
ISAS Vacuum, in/Hg	2.5 in/Hg
At 3" Dia. Exhaust	
Air Speed, ft/min	3300 ft/min
Air flow= ft/min*Area*.9	145 cfm
Air Flow Pressure, static	2.7 in/H2O ____ psig
Flow Sensor, Diff. Pres.	1.2 in/H2O
Exhaust Air Temp.	70
Calculated Air Flow, cfm	

INLET Well No.	Vacuum Reading (in/H2O)
IW-1	1.88
IW-2	2.0
IW-3	.08
IW-4	.36
IW-5	.00
IW-6	.02

Line Velocity Pres. Location	in/H2O
P1	23
P2	14.2
P3	14.0
P4	4.4
P5	4.9
P6	2.14

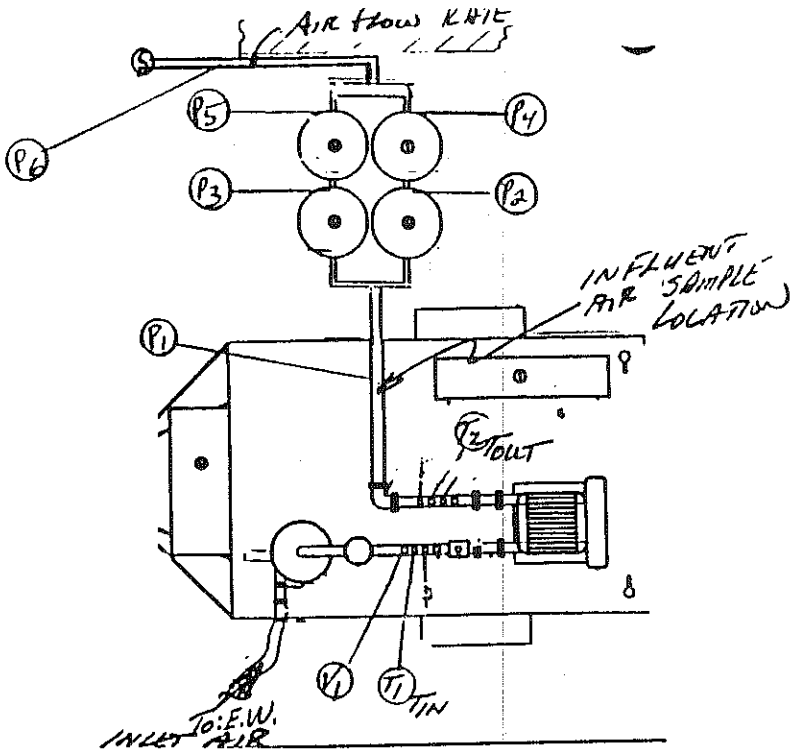
Extraction Well No. 1

Laboratory Analytical Data				COMMENTS:
Methylene Chloride	Ethyl Benzene	Xylene	Acetone	
<0.004 ppm	6.525 ppm	33.930 ppm	12.255 ppm	67.1 l of air sampled Kemron Report No. 93-06-20

File: 5-28-93

REICHHOLD CHEMICALS, INC.
FERNDALE, MI

In-Situ Air Stripping System, ISAS
Field Data Inspection Date 5/27/93



FIELD DATA: 5/27/93 Extraction Well No. 1	
Air Temp.	
Tin	60
Tout	75
H-nu	N/R
Oxygen, O2	21.2%
Carbon Dioxide, CO2	2300 ppm
Air Flow Data:	
Speed Dial	65%
Freq. Reading	41.13
ISAS Vacuum, in/Hg	2.2 in/Hg
At 3" Dia. Exhaust	
Air Speed, ft/min	2900 ft/min
Air flow= ft/min*Area*.9	128 cfm
Air Flow Pressure, static	.085 psig
Flow Sensor, Diff. Pres.	.88 in/H2O
Exhaust Air Temp.	70
Calculated Air Flow, cfm	117 cfm

INLET Well No.	Vacuum Reading (in/H2O)
IW-1	1.72
IW-2	1.85
IW-3	.08
IW-4	.30
IW-5	.00
IW-6	.02

Line Velocity Pres.	
Location	in/H2O
P1	20.5
P2	12.8
P3	12.6
P4	4.0
P5	4.5
P6	1.9

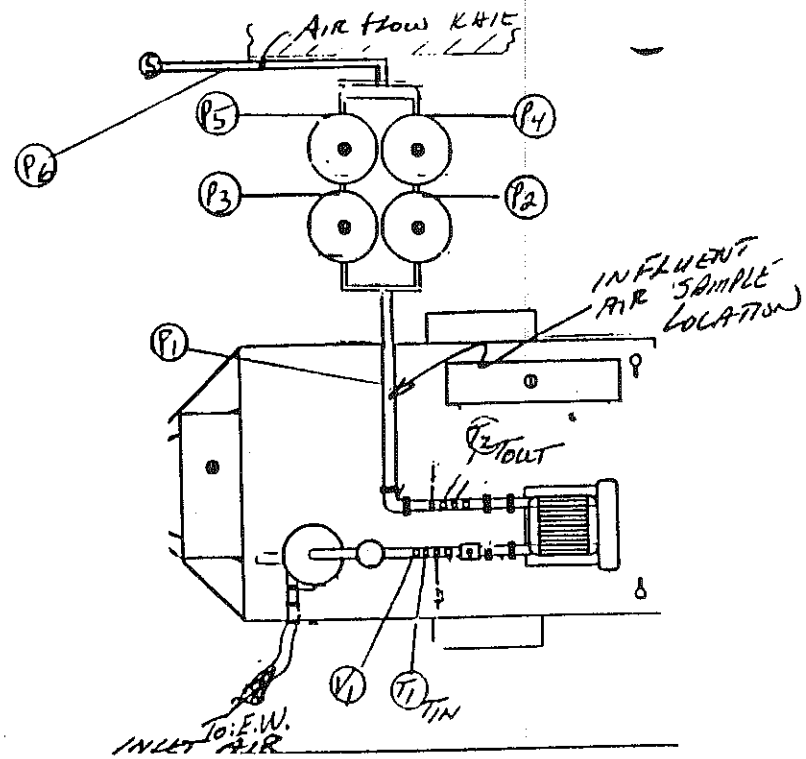
Extraction Well No. 1

Laboratory Analytical Data				COMMENTS:
Methylene Chloride	Ethyl Benzene	Xylene	Acetone	
<0.015 ppm	4.724 ppm	21.553 ppm	2.336 ppm	19.17 l of air sampled Kemron Report No. 931010

File: 5-27-93

REICHHOLD CHEMICALS, INC.
FERNDALE, MI

In-Situ Air Stripping System, ISAS
Field Data Inspection Date 5/26/93



FIELD DATA: 5/26/93 Extraction Well No. 2	
Air Temp.	77
Tin	83
Tout	105
H-nu	6.0 ppm
Oxygen, O2	21.3 %
Carbon Dioxide, CO2	1150 ppm
Exotox, explo.	0%
Air Flow Data:	
Speed Dial	60 %
Freq. Reading	37.58
ISAS Vacuum, in/Hg	3.5 in/Hg
At 3" Dia. Exhaust	
Air Speed, ft/min	1300 ft/min
Air flow= ft/min*Area*.9	57 cfm
Air Flow Pressure, static	1.17 in/H2O .014 psig
Flow Sensor, Diff. Pres.	.15 in/H2O
Exhaust Air Temp.	75
Calculated Air Flow, cfm	48 cfm

INLET Well No.	Vacuum Reading (in/H2O)
IW-1	.00
IW-2	.00
IW-3	.00
IW-4	.025
IW-5	.00
IW-6	.00

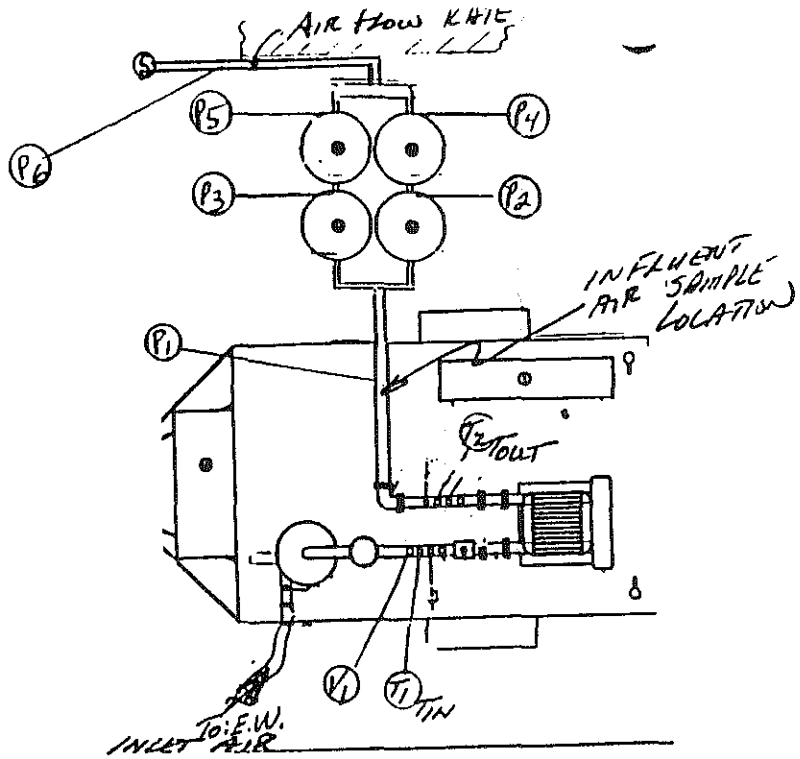
Line Velocity Pres. Location	in/H2O
P1	4.42
P2	2.65
P3	2.65
P4	.73
P5	.90
P6	.32

Laboratory Analytical Data				COMMENTS:
Methylene Chloride	Ethyl Benzene	Xylene	Acetone	
<0.0035 ppm	0.306 ppm	1.838 ppm	0.331 ppm	8.12 l of air sampled. Sample line briefly disconnected Therefore, new sampled started. Kemron Report No. 931000
<0.022 ppm	0.394 ppm	2.134 ppm	4.254 ppm	12.93 l of air sampled Kemron Report No. 931000

File: 5-26-93

REICHHOLD CHEMICALS, INC.
FERNDALE, MI

In-Situ Air Stripping System, ISAS
Field Data Inspection Date 5/25/93



FIELD DATA: 5/25/93 Extraction Well No. 2	
Air Temp.	60
Tin	55
Tout	74
H-nu	4.5 ppm
Oxygen, O2	21.1 %
Carbon Dioxide, CO2	> 5000 ppm
Exotox, explo. meter	0%
Air Flow Data:	
Speed Dial	52 %
Freq. Reading	33.28
ISAS Vacuum, in/Hg	3.0 in/Hg
At 3" Dia. Exhaust	
Air Speed, ft/min	1150 ft/min
Air flow= ft/min*Area*.9	50 cfm
Air Flow Pressure, static	N/R in/H2O N/R psig
Flow Sensor, Diff. Pres.	.13 in/H2O
Exhaust Air Temp.	68
Calculated Air Flow, cfm	46 cfm

INLET Well No.	Vacuum Reading (in/H2O)
IW-1	.03
IW-2	.00
IW-3	.03
IW-4	.00
IW-5	.00
IW-6	.00

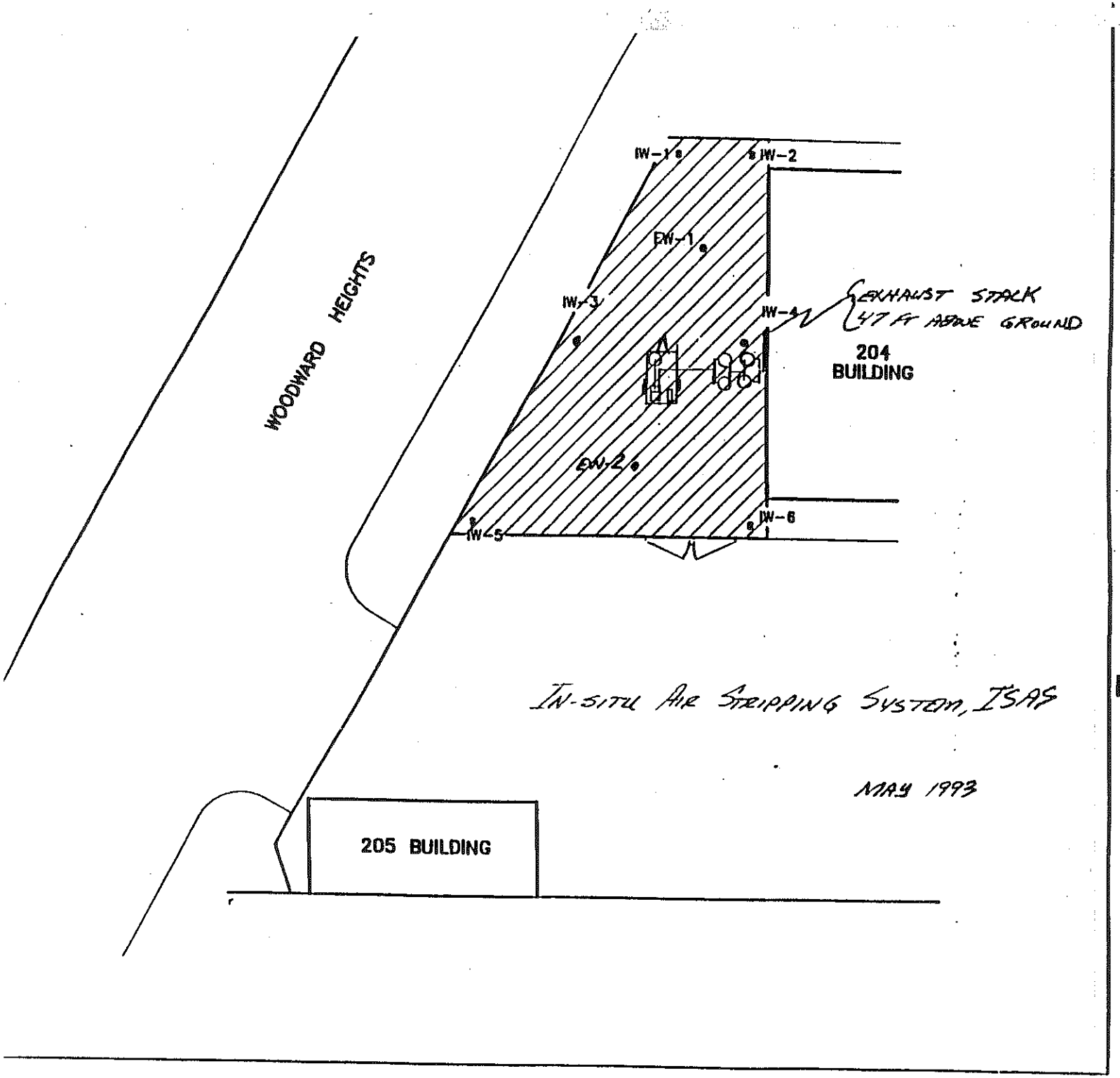
Line Velocity Pres. Location	in/H2O
P1	N/R
P2	N/R
P3	N/R
P4	N/R
P5	N/R
P6	N/R

Extraction Well No. 2

Laboratory Analytical Data				COMMENTS:
Methylene Chloride	Ethyl Benzene	Xylene	Acetone	
<0.008 ppm	0.0492 ppm	3.639 ppm	4.636 ppm	36.0 l of air sampled Kemron Report No. 930982

File: 5-25-93

SITE PLANS



LEGEND

IW-1	INJECTION WELL
EW-1	EXTRACTION WELL
	FORMER LOCATION OF SOUTH TANK FARM

IN-SITU VAPOR EXTRACTION WELL LOCATIONS

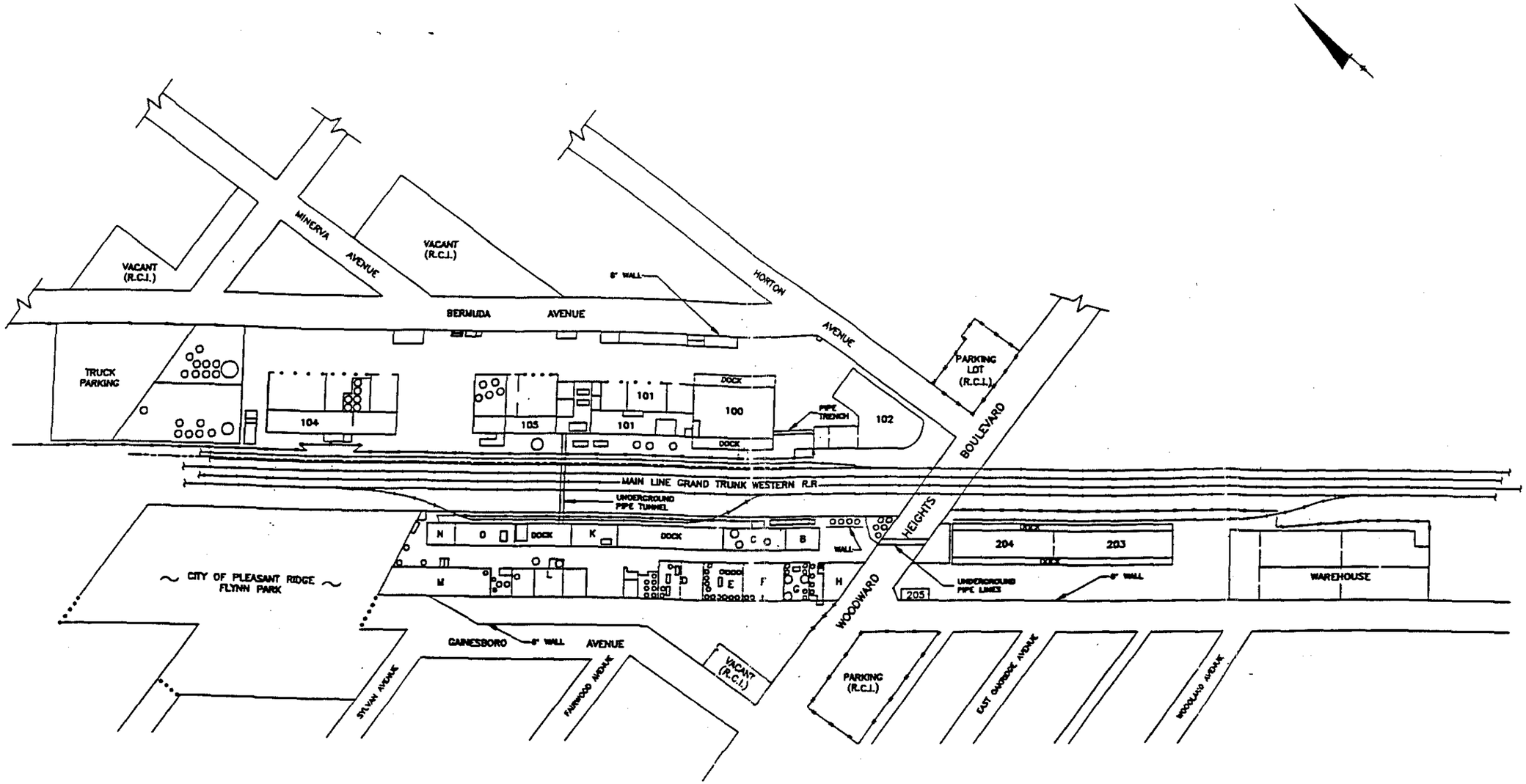
REICHHOLD CHEMICAL INCORPORATED FERNDALE, MICHIGAN

20 0 20

SCALE: ~~1" = 20'~~ N.T.S.

FILE NO. 3208-036

ENGINEERS INC



BUILDING LOCATIONS

1" = 100' 100 0 100 200

NO.	DATE	REVISION	INIT.

O'BRIEN & GERE ENGINEERS, INC.

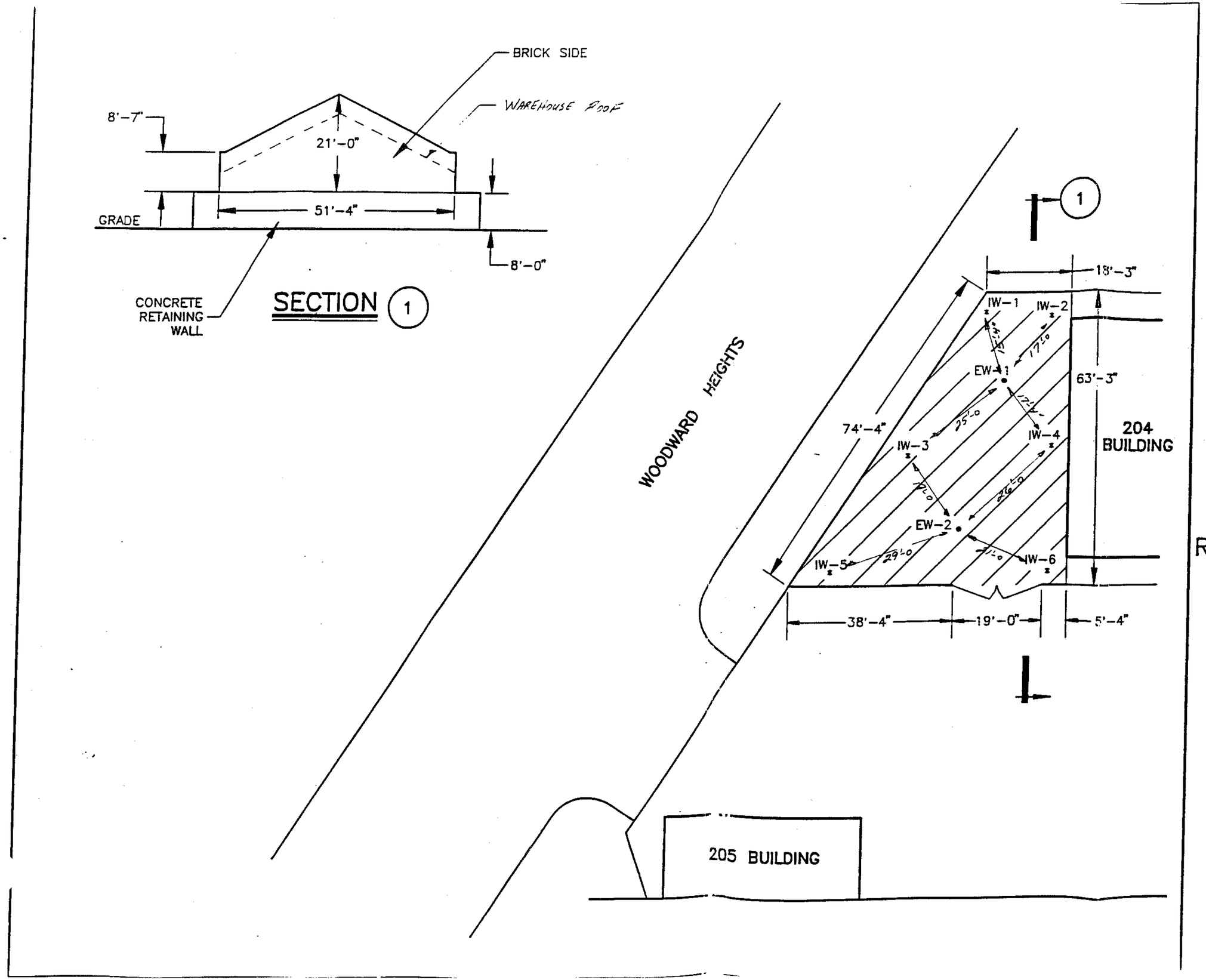
REICHHOLD CHEMICALS INC.
FERNDALE, MICHIGAN

GENERAL
SITE PLAN

FILE NO. 3208-035-01F
DATE

G-1

FIGURE 1



LEGEND

IW-1	INJECTION WELL
EW-1	EXTRACTION WELL
	FORMER LOCATION SOUTH TANK FARM

IN-SITU
VAPOR EXTRACTIO
WELL LOCATIONS
REICHHOLD CHEMICA
INCORPORATED
FERNDALE, MICHIGA

SITE PLAN

20 0 20

SCALE IN FEET

FILE NO. 3208-036-001

LABORATORY ANALYTICAL RESULTS

Reichhold Chemicals, Inc.
Ferndale, Michigan

South Tank Farm

In-Situ Air Stripping System, ISAS

Analytical Results for
Air Samples Collected:

5/25/93, 5/26,93, 5/27/93, 5/28/93
6/02/93, 6/18/93, 6/30/93, 7/22/93, 7/23/93
8/13/93 and 9/10/93

KEMRON ENVIRONMENTAL SERVICES
39830 GRAND RIVER B-2
NOVI, MICHIGAN 48375

Phone: (313)474-4200

OBG OPERATIONS
39500 ORCHARD HILL STE 300
NOVI, MI 48375

Attn: MARVIN RIVERS
Invoice Number:

Order #: 93-09-103
Date: 09/20/93 15:08
Work ID: RCI-SVE
Date Received: 09/16/93
Date Completed: 09/20/93
Client Code: OBGO_147

SAMPLE IDENTIFICATION

Sample Number	Sample Description
01	9-10-93/INFLUENT

Sample Number	Sample Description

Certified By
Charles O'Bryan

KEMRON ENVIRONMENTAL SERVICES
TEST RESULTS BY SAMPLE

Sample: 01A 9-10-93/INFLUENT Collected:

Test Description	Result	Det Limit	Units	Analyzed	By
Acetone	<1.259	10 ug	ppm	09/20/93	JE
Ethyl Benzene	0.229	1 ug	ppm	09/20/93	JE
Methylene Chloride	<0.081	1 ug	ppm	09/20/93	JE
Xylene	1.774	1 ug	ppm	09/20/93	JE

KEMRON ENVIRONMENTAL SERVICES
TEST METHODOLOGIES

Acetone Method: NIOSH 1300

Ethyl Benzene Method: NIOSH 1501

Methylene Chloride Method: NIOSH 1005

Xylene Method: NIOSH 1501

ENVIRONMEN[illegible] [illegible]ERVICES
[illegible] 4[illegible]
313-474-4200
313-474-0601 (FAX)

McLean, VA (Hqtrs.)
Huntington Station, NY
Marietta, OH
Atlanta, GA
Cincinnati, OH
Jupiter, FL
General Information 1-800-777-1741

CHAIN-OF-CUSTODY RECORD / SAMPLE LOG

Company Name: [illegible]	Project Contact: [illegible]	Kemron Acct. No.:
Telephone No.: [illegible]	Project Name: [illegible]	Page 1 of 1
Project No.: [illegible]	P.O. No.:	
Sampler (print) [illegible]	Signature [illegible]	

ANALYTICAL REQUEST

Client Sample No.	Air	Solid	Fluid	Date	Time	Sample Volume	Sample Identification	Number of Samples	Methyl chloride	Ethylbenzene	Xylene	Acetone									TURNAROUND REQUIREMENTS OR COMMENTS
[illegible]	X			[illegible]	12.3[illegible]	3.34	Influent	1	X	X	X	X									
					12.3[illegible]																1.545 [illegible] count
																					x .458 ml/count
																					3.340 ml
																					3.34 l
																					[illegible]

Relinquished by: (Signature	Date	Time	Received by: (Signature)	Relinquished by: (Signature)	Date	Time	Received by: (Signature)
[illegible]	[illegible]	[illegible]					

Relinquished by: (Signature)	Date	Time	Received for Laboratory by: (Signature)	Date	Time	Remarks:
			[illegible]	[illegible]		

W-AD6

White – Lab Yellow – Field

[illegible]	0.4	1	ml	08/17/93 JE
Methylene Chloride	0.[illegible]	1 ug	ppm	08/17/93 JE
Xylene	4.004	1 ug	ppm	08/17/93 JE

Sample: 02A INTERMEDIATE Collected:

KEMRON ENVIRONMENTAL SERVICES
39830 GRAND RIVER B-2
NOVI, MICHIGAN 48375

Phone: (313)474-4200

OBG OPERATIONS
39500 ORCHARD HILL STE 300
NOVI, MI 48375

Attn: MARVIN RIVERS
Invoice Number:

Order #: 93-08-108
Date: 08/17/93 09:31
Work ID: RCI/ISAS
Date Received: 08/13/93
Date Completed: 08/17/93
Client Code: OBGO_147

SAMPLE IDENTIFICATION

Sample Number	Sample Description
01	INFLUENT
02	INTERMEDIATE
03	EFFLUENT

Charles O'Bryan

Certified By
Charles O'Bryan

TEST METHODOLOGIES

Acetone Method: NIOSH 1300

Ethyl Benzene Method: NIOSH 1501

Methylene Chloride Method: NIOSH 1005

Xylene Method: NIOSH 1501

KEMRON ENVIRONMENTAL SERVICES
39830 GRAND RIVER B-2
NOVI, MICHIGAN 48375

Phone: (313)474-4200

OBG OPERATIONS
39500 ORCHARD HILL STE 300
NOVI, MI 48375

Attn: MARVIN RIVERS
Invoice Number:

Order #: 93-08-072
Date: 08/16/93 10:54
Work ID: PCI-ISAS
Date Received: 08/10/93
Date Completed: 08/16/93
Client Code: OBGO_147

SAMPLE IDENTIFICATION

Sample Number	Sample Description
01	INTERMEDIATE

Sample Number	Sample Description

Charles O'Bryan

Certified By
Charles O'Bryan

REMRON ENVIRONMENTAL SERVICES
TEST RESULTS BY SAMPLE

Sample: 01A INTERMEDIATE

Collected:

Test Description	Result	Det Limit	Units	Analyzed	By
Acetone	<0.278	10 ug	ppm	08/16/93	JE
Ethyl Benzene	<0.015	1 ug	ppm	08/16/93	JE
Methylene Chloride	<0.019	1 ug	ppm	08/16/93	JE
Xylene	<0.015	1 ug	ppm	08/16/93	JE

Acetone Method: NIOSH 1300

Ethyl Benzene Method: NIOSH 1501

Methylene Chloride Method: NIOSH 1005

Xylene Method: NIOSH 1501

ENVIRONMEN ERVICES
ovi chi 48
313-474-4200
313-474-0601 (FAX)
ar Id
Huntington Station, NY
Marietta, OH
A , G
Cincinnati, OH
Jupiter, FL
General Information 1-800-777-1741

CHAIN-OF-CUSTODY RECORD / SAMPLE LOG

Company Name: QBG Operations, Inc
Project Contact: Marvin Rivers
Kemron Acct. No.:
Telephone No.: 313 347-4136
Project Name: Reichhold Chemicals, RCI
Page 1 of 1
Project No.: RCI - ISAS
P.O. No.:
Sampler (print): Marvin Rivers
Signature: Marvin Rivers

ANALYTICAL REQUEST

Client Sample No.	Air	Solid	Fluid	Date	Time	Sample Volume	Sample Identification	Number of Samples	Methylene Chloride	Ethylbenzene	Xylene	Acetone	TURNARDUND REQUIREMENTS OR COMMENTS
Intermediate	X			7/23/93	2:00	15.13 l	INTERMEDIATE	1	X	X	X	X	
													32 401 counts
													x .467 ml/counts
													= 15131.27
													= 15.13 l
													SKC model 222-3
													Serial No. 1-108-04
													.467 ml/count
									NIOSH METHOD	1005	1300	1500/1501	1500/1501

Relinquished by: (Signature)	Date	Time	Received by: (Signature)	Relinquished by: (Signature)	Date	Time	Received by: (Signature)
Marvin Rivers	8/10/93	1:00	8-13-93 8:15				

Relinquished by: (Signature)	Date	Time	Received for Laboratory by: (Signature)	Date	Time	Remarks:

W AD6 White--Lab Yellow Field

KEMRON ENVIRONMENTAL SERVICES
39830 GRAND RIVER B-2
NOVI, MICHIGAN 48375

Phone: (313)474-4200

OBG OPERATIONS
39500 ORCHARD HILL STE 300
NOVI, MI 48375

Attn: MARVIN RIVERS
Invoice Number:

Order #: 93-07-202
Date: 07/29/93 09:44
Work ID: RCI-SVE
Date Received: 07/23/93
Date Completed: 07/29/93
Client Code: OBGO_147

SAMPLE IDENTIFICATION

Sample Number	Sample Description
01	7-22-93/INFLUENT

Sample Number	Sample Description

Charles O'Bryan

Certified By
Charles O'Bryan

REMRON ENVIRONMENTAL SERVICES
TEST RESULTS BY SAMPLE

Sample: 01A 7-22-93/INFLUENT Collected:

Test Description	Result	Det Limit	Units	Analyzed	By
Acetone	<0.046	10 ug	ppm	07/29/93	JE
Ethyl Benzene	0.304	1 ug	ppm	07/29/93	JE
Methylene Chloride	1.060	1 ug	ppm	07/29/93	JE
Xylene	7.921	1 ug	ppm	07/29/93	JE

Acetone Method: NIOSH 1300

Ethyl Benzene Method: NIOSH 1501

Methylene Chloride Method: NIOSH 1005

Xylene Method: NIOSH 1501

313-474-0601 (FAX)
Marietta, OH
Jupiter, FL
General Information 1-800-777-1741

CHAIN-OF-CUSTODY RECORD / SAMPLE LOG

Company Name: OBG Operations, Inc	Project Contact: Marvin Rivers	Kemron Acct. No.: OBG 0147
Telephone No.: (313) 347-4136	Project Name: Reichhold Chemicals, RCI	Page 1 of 1
Project No.: RCI-SVE	P.O. No.:	
Sampler (print): M Rivers	Signature: Marvin Rivers	

ANALYTICAL REQUEST

Client Sample No.	Air	Solid	Fluid	Date	Time	Sample Volume	Sample Identification	Number of Samples	Methylene chloride	Ethylbenzene	Xylene	Acetone	TURNAROUND REQUIREMENTS OR COMMENTS
7-22-93	X			7/22/93	10:50 AM 9:15 PM		influent	1	X	X	X	X	One charcoal tube
													48 HR analysis (No extra fee) per chuck O'Brien
													188211 counts @ .488 ml/count
													= 91846.97 ml
													= 91.85 l

Wiosh method: 1005, 1300, 1500/1501, 1500/1501

Relinquished by: (Signature)	Date	Time	Received by: (Signature)	Relinquished by: (Signature)	Date	Time	Received by: (Signature)
Marvin Rivers	7/23/93	12:30					

Relinquished by: (Signature)	Date	Time	Received for Laboratory by: (Signature)	Date	Time	Remarks:

W-AD6

White—Lab Yellow—Field

KEMRON ENVIRONMENTAL SERVICES
39830 GRAND RIVER B-2
NOVI, MICHIGAN 48375

Phone: (313)474-4200

OBG OPERATIONS
39500 ORCHARD HILL STE 300
NOVI, MI 48375

Attn: MARVIN RIVERS
Invoice Number:

Order #: 93-07-013
Date: 07/06/93 15:24
Work ID: REICHHOLD, RCE-ISAS
Date Received: 07/01/93
Date Completed: 07/06/93
Client Code: OBGO_147

* Not Analyzed. Breakthrough was not noted in the primary. tube.

SAMPLE IDENTIFICATION

Sample Number	Sample Description	Sample Number	Sample Description
01	PRIMARY 6/30		

Charles O'Bryan
Certified By
Charles O'Bryan

TEST RESULTS BY SAMPLE

Sample: 01A PRIMARY 6/30 Collected:

Test Description	Result	Det Limit	Units	Analyzed	By
Acetone	0.637	10 ug	ppm	07/06/93	JE
Ethyl Benzene	0.512	1 ug	ppm	07/06/93	JE
Methylene Chloride	1.508	1 ug	ppm	07/06/93	JE
Xylene	33.357	1 ug	ppm	07/06/93	JE

Sample: 01B SECONDARY 6/30 Collected:

Test Description	Result	Det Limit	Units	Analyzed	By
Acetone	*	10	ppm		
Ethyl Benzene	*	1	ppm		
Methylene Chloride	*	1	ppm		
Xylene	*	1	ppm		

Acetone Method: NIOSH 1300

Ethyl Benzene Method: NIOSH 1501

Methylene Chloride Method: NIOSH 1005

Xylene Method: NIOSH 1501

...RONMENTAL ...ICES
..., M... ga... 75
313-474-4200
313-474-0601 (FAX)
Mc...
Huntington Station, NY
Marietta, OH
General Information 1-800-777-1741
...an
Cincinnati, OH
Jupiter, FL

HAIN-OF-CUSTODY RECORD / SAMPLE LOG

Company Name: OBS Operations, Inc
Project Contact: Marvin Rivers
Kemron Acct. No.:
Telephone No.: (313) 347-4136
Project Name: Reichhold, RCI-ISAS
Page 1 of 1
Project No.: RCI-ISAS
P.O. No.:
Sampler (print): Marvin Rivers
Signature: Marvin Rivers

ANALYTICAL REQUEST

Client Sample No.	Air	Solid	Fluid	Date	Time	Sample Volume	Sample Identification	Number of Samples	Constituent	As Previously Listed	TURNAROUND REQUIREMENTS OR COMMENTS
Primary 6-30	X			6/30/93	11:45/2:05		Primary 6-30-93	1 EA	X		Charcoal tube
Secondary 6-30	X						Secondary 6-30-93	1 EA			Air Sample
											for the (4)
											Constituents
											previously listed
											& analyzed.
											392865
											347920
											44945 Counts
											@ .488 ml/count
											= 21933 ml
											Model 222-3
											Serial No. 1-210-05

Relinquished by: (Signature)	Date	Time	Received by: (Signature)	Relinquished by: (Signature)	Date	Time	Received by: (Signature)
Marvin Rivers	6/30/93	2:30	Gina M. Obray				

Relinquished by: (Signature)	Date	Time	Received for Laboratory by: (Signature)	Date	Time	Remarks:

W-AD6 White—Lab Yellow—Field

KEMRON ENVIRONMENTAL SERVICES
39830 GRAND RIVER B-2
NOVI, MICHIGAN 48375

Phone: (313)474-4200

OBG OPERATIONS
39500 ORCHARD HILL STE 300
NOVI, MI 48375

Attn: MARVIN RIVERS
Invoice Number:

Order #: 93-06-221
Date: 06/25/93 15:53
Work ID: RCI-ISAS
Date Received: 06/24/93
Date Completed: 06/25/93
Client Code: OBGO_147

* Not Analyzed. Breakthrough was not noted in the primary tube.

SAMPLE IDENTIFICATION

Sample Number	Sample Description
01	618/PRIMARY

Sample Number	Sample Description

Charles O'Bryan
Certified By
Charles O'Bryan

KEMRON ENVIRONMENTAL SERVICES
TEST RESULTS BY SAMPLE

Sample: 01A 618/PRIMARY Collected:

Test Description	Result	Det Limit	Units	Analyzed	By
Acetone	9.446	10 ug	ppm	06/25/93	JE
Ethyl Benzene	3.951	1 ug	ppm	06/25/93	JE
Methylene Chloride	1.547	1 ug	ppm	06/25/93	JE
Xylene	40.780	1 ug	ppm	06/25/93	JE

Sample: 01B 618/SECONDARY Collected:

Test Description	Result	Det Limit	Units	Analyzed	By
Acetone	*	10 ug	ppm	06/25/93	JE
Ethyl Benzene	*	1 ug	ppm	06/25/93	JE
Methylene Chloride	*	1 ug	ppm	06/25/93	JE
Xylene	*	1 ug	ppm	06/25/93	JE

KEMRON ENVIRONMENTAL SERVICES
TEST METHODOLOGIES

Acetone Method: NIOSH 1300

Ethyl Benzene Method: NIOSH 1501

Methylene Chloride Method: NIOSH 1005

Xylene Method: NIOSH 1501

NVIRONMENTAL CES
313-474-4200
313-474-0601 (FAX)
Huntington Station, NY
Marietta, OH
Cincinnati, OH
Jupiter, FL
General Information 1-800-777-1741

HAIN-OF-CUSTODY RECORD / SAMPLE LOG

ompany Name: OBG Operations, Inc	Project Contact: Marvin Rivers	Kemron Acct. No.:
elephone No.: 313-347-4136	Project Name: Reichhold RCI-ISAS	Page 1 of 1
roject No.: RCI-ISAS	P.O. No.:	
ampler (print): Marvin Rivers	Signature: Marvin Rivers	

ANALYTICAL REQUEST

Client Sample No.	Air	Solid	Fluid	Date	Time	Sample Volume	Sample Identification	Number of Samples	Methylene chloride	Ethylbenzene	Xylene	Acetone	TURNAROUND REQUIREMENTS OR COMMENTS
Primary	X			6-18-93	7:30	59.28	Primary 6-18-93	1 EA	X	X	X	X	
Secondary	X			6-18-93	3:30		Secondary 6-18-93	1 EA					
													24 HR Turnaround
									NIOSH METHOD	1005	1300	1500/1501	1500/1501
													295586
													174103
													121478 counts
													SKC [illegible] 222-3
													[illegible] ml/count
													121478 [illegible]
													[illegible]

Relinquished by: Signature	Date	Time	Received by: (Signature)	Relinquished by: (Signature)	Date	Time	Received by: (Signature)
Marvin Rivers	6-24-93	3:00					

Relinquished by: (Signature)	Date	Time	Received for Laboratory by: (Signature)	Date	Time	Remarks:
			[illegible]	6/24		

AD6 White—Lab Yellow—Field

KEMRON ENVIRONMENTAL SERVICES
39830 GRAND RIVER B-2
NOVI, MICHIGAN 48375

Phone: (313)474-4200

OBG OPERATIONS
39500 ORCHARD HILL STE 300
NOVI, MI 48375

Attn: MARVIN RIVERS
Invoice Number:

Order #: 93-06-045
Date: 06/04/93 11:43
Work ID: RCI
Date Received: 06/03/93
Date Completed: 06/04/93
Client Code: OBGO_147

SAMPLE IDENTIFICATION

Sample Number	Sample Description
01	6-2 INFLUENT

Sample Number	Sample Description

Charles O'Bryan

Certified By
Charles O'Bryan

KEMRON ENVIRONMENTAL SERVICES
TEST RESULTS BY SAMPLE

Sample: 01A 6-2 INFLUENT

Collected:

Test Description	Result	Det Limit	Units	Analyzed	By
ACETONE	9.738	10 ug	ppm	06/04/93	JE
Ethyl Benzene	4.371	1 ug	ppm	06/04/93	JE
Methylene Chlorine	<0.011	1 ug	ppm	06/04/93	JE
Xylene	20.993	1 ug	ppm	06/04/93	JE

Method: NIOSH 1300

Method: NIOSH 1501

VIRONMENTAL SERVICES ... 474 ... 00
313-474-0601 (FAX)
McLean, VA (Hdqtrs.)
Hu... ...ton ...ion,
Marietta, OH
Atlanta, GA
Cincinnati, OH
Jupiter, FL
General Information 1-800-777-1741

HAIN-OF-CUSTODY RECORD / SAMPLE LOG

ompany Name: OBG Operations, Inc
lephone No.: (313) 347-4136
oject No.: RCI
P.O. No.:
mpler (print): Marvin Rivers
Signature: Marvin Rivers

Project Contact: Marvin Rivers
Project Name: Reichhold Chemicals, RCI
Kemron Acct. No.:
Page 1 of 1

Client Sample No.	Air	Solid	Fluid	Date	Time	Sample Volume	Sample Identification	Number of Samples	Methylene Chloride	Ethylbenzene	Xylene	Acetone	TURNAROUND REQUIREMENTS OR COMMENTS
5-28	X			5/28/93	8 1/2 hrs	charcoal tube	Influent - Primary Secondary		X	X	X	X	
													24 hr turnaround
													137597 Counts x .488 ml/count = 67147.336 ml = 67.147 l
								NIOSH METHOD:	1005	1300	1500/1501	1500/1501	

Relinquished by: (Signature)	Date	Time	Received by: (Signature)	Relinquished by: (Signature)	Date	Time	Received by: (Signature)
Marvin Rivers	6/1/93	8:00	Lena M. Gray				

Relinquished by: (Signature)	Date	Time	Received for Laboratory by: (Signature)	Date	Time	Remarks:

AD6

White—Lab Yellow—Field

KEMRON ENVIRONMENTAL SERVICES
39830 GRAND RIVER B-2
NOVI, MICHIGAN 48375

Phone: (313)474-4200

OBG OPERATIONS
39500 ORCHARD HILL STE 300
NOVI, MI 48375

Attn: MARVIN RIVERS
Invoice Number:

Order #: 93-06-020
Date: 06/04/93 09:38
Work ID: RCI
Date Received: 06/02/93
Date Completed: 06/03/93
Client Code: OBGO_147

SAMPLE IDENTIFICATION

Sample Number	Sample Description
01	5-28

Sample Number	Sample Description

Charles O'Bryan
Certified By

KEMRON ENVIRONMENTAL SERVICES
REGULAR TEST RESULTS BY TEST

ACETONE
Method: NIOSH 1300

Minimum: Maximum:

Samp	Sample Description	Result	Units	Limit	Prepared	Analyzed	By
01A	5-28	12.255	ppm	10	06/03/93	06/03/93	JE

Ethyl Benzene
Method: NIOSH 1501

Minimum: Maximum:

Samp	Sample Description	Result	Units	Limit	Prepared	Analyzed	By
01A	5-28	6.525	ppm	1	06/03/93	06/03/93	JE

Methylene Chlorine
Method: NIOSH 1005

Minimum: Maximum:

Samp	Sample Description	Result	Units	Limit	Prepared	Analyzed	By
01A	5-28	<0.004	ppm	1	06/03/93	06/03/93	JE

Xylene
Method: NIOSH 1501

Minimum: Maximum:

Samp	Sample Description	Result	Units	Limit	Prepared	Analyzed	By
01A	5-28	33.930	ppm	1	06/03/93	06/03/93	JE

KEMRON ENVIRONMENTAL SERVICES
TEST RESULTS BY SAMPLE

Sample: 01A 5-28 Collected: Category: 1

Test Description	Result	Det Limit	Units	Analyzed	By
ACETONE	12.255	10	ppm	06/03/93	JE
Ethyl Benzene	6.525	1	ppm	06/03/93	JE
Methylene Chlorine	<0.004	1	ppm	06/03/93	JE
Xylene	33.930	1	ppm	06/03/93	JE

Method: NIOSH 1300

Method: NIOSH 1501

IRONMENTAL SE... ES
313-474-4200
313-474-0601 (FAX)
Huntington Station, NY
Marietta, OH
Cincinnati, OH
Jupiter, FL
General Information 1-800-777-1741

AIN-OF-CUSTODY RECORD / SAMPLE LOG

...pany Neme: OBG Operations, Inc	Project Contact: Marvin Rivers	Kemron Acct. No.:
...phone No.:	Project Name: Reichhold Chemicals, RCI	Page 1 of 1
...ect No.: RCI	P.O. No.:	
...pler (print) ...PORT 006 ... Marvin Rivers	Signature Marvin Rivers	

ANALYTICAL REQUEST

...ent Sample No.	Air	Solid	Fluid	Date	Time	Sample Volume	Sample Identification	Number of Samples	Methylene Chloride	Ethylbenzene	Xylene	Acetone	TURNAROUND REQUIREMENTS OR COMMENTS
...6-2-Influ	X			6-2-93	1:20 / 4:15	[illegible]	influent		X	X	X	X	
...IVED 06/0													
...RTED 06/0													
								NIOSH METHOD	1005	1300	1500/1501	1500/1501	

...linquished by: ...ignature	Date	Time	Received by: (Signature)	Relinquished by: (Signature)	Date	Time	Received by: (Signature)
Marvin Rivers	6-3-93	12:00	[illegible]				

...linquished by: ...ignature)	Date	Time	Received for Laboratory by: (Signature)	Date	Time	Remarks:

...D6 White—Lab Yellow—Field

Kemron Environmental Services
39830 Grand River B-2
Novi, Michigan 48375-2108
(313) 474-4200 (313) 474-0601 FAX

ANALYTICAL REPORT FORM

TO: OBG OPERATIONS
ATTN: MARVIN RIVERS
39500 ORCHARD HILL/STE300
NOVI
MI 48375-
Job Number: RCI-5127

Report Number : 931010
Date Received : 05/28/93
Date Reported : 06/04/93

Sample #	Client Id	Sample Description	Analyte	Result	Units
4309826	5/27	INFULENT	METHYLENE CHLORIDE	<0.015	ppm
4309826	5/27	INFULENT	ETHYL BENZENE	4.724	ppm
4309826	5/27	INFULENT	XYLENE	21.553	ppm
4309826	5/27	INFULENT	ACETONE	2.336	ppm

Method: METHYLENE CHLORIDE NIOSH 1005 Det. Limit: 1 ug
Method: ETHYL BENZENE NIOSH 1501 Det. Limit: 1 ug
Method: XYLENE NIOSH 1501 Det. Limit: 1 ug
Method: ACETONE NIOSH 1300 Det. Limit: 10 ug

ANALYST: JE
Date: 06/04/93

Charles O'Bryan
Charles O'Bryan
Laboratory Manager

NVIRONMENTAL SERVICES
vi, ... iga ... 337...
313-474-4200
313-474-0601 (FAX)
Mc...n, V... (...dqtrs.)
Huntington Station, NY
Marietta, OH
Atlanta, GA
Cincinnati, OH
Jupiter, FL
General Information 1-800-777-1741

HAIN-OF-CUSTODY RECORD / SAMPLE LOG

ompany Name: CBG Operations	Project Contact:	Kemron Acct. No.:
elephone No.: (313) 347-4136	Project Name: Reichhold Chemicals, RCI	Page 1 of 1
roject No.:	P.O. No.: RCI 5127	
ampler (print): Marvin Rivers	Signature: Marvin Rivers	

ANALYTICAL REQUEST

Client Sample No.	Air	Solid	Fluid	Date	Time	Sample Volume	Sample Identification	Number of Samples	Methylene Chloride	Ethylbenzene	Xylene	acetone	TURNAROUND REQUIREMENTS OR COMMENTS
5-27	X			5/27/93	12:14 / 8:20	charcoal tube	influent < Primary & Secondary	1 / 1	X	X	X	X	39294 counts x .488 ml/d = 19175 ml

Relinquished by: (Signature)	Date	Time	Received by: (Signature)	Relinquished by: (Signature)	Date	Time	Received by: (Signature)
Marvin Rivers	5-27-93	3:30					

Relinquished by: (Signature)	Date	Time	Received for Laboratory by: (Signature)	Date	Time	Remarks:

V-AD6 White—Lab Yellow—Field

Kemron Environmental Services
39830 Grand River B-2
Novi, Michigan 48375-2108
(313) 474-4200 (313) 474-0601 FAX

ANALYTICAL REPORT FORM

TD: OBG OPERATIONS
TTN: MARVIN RIVERS
39500 ORCHARD HILL/STE300
NOVI
MI 48375-
ob Number: RCI 5/25/REICHHOLD CHEMICAL

Report Number : 930982
Date Received : 05/26/93
Date Reported : 05/27/93

ample #	Client Id	Sample Description	Analyte	Result	Units
4309630	5/25 INFU		METHYLENE CHLORIDE	<0.008	ppm
4309630	5/25 INFU		ETHYL BENZENE	0.492	ppm
4309630	5/25 INFU		XYLENE	3.639	ppm
4309630	5/25 INFU		ACETONE	4.636	ppm

Method: METHYLENE CHLORIDE NIOSH 1005 Det. Limit: 1 ug
Method: ETHYL BENZENE NIOSH 1501 Det. Limit: 1 ug
Method: XYLENE NIOSH 1501 Det. Limit: 1 ug
Method: ACETONE NIOSH 1300 Det. Limit: 10 ug

ANALYST: JE
Date: 05/27/93

Charles O'Bryan
Laboratory Manager

Kemron Environmental Services
39830 Grand River B-2
Novi, Michigan 48375-2108
(313) 474-4200 (313) 474-0601 FAX

ANALYTICAL REPORT FORM

TO: OBG OPERATIONS
ATTN: MARVIN RIVERS
39500 ORCHARD HILL/STE300
NOVI
MI 48375-
Job Number: RCI 5/26/93

Report Number : 931000
Date Received : 05/27/93
Date Reported : 05/28/93

Sample #	Client Id	Sample Description	Analyte	Result	Units
4309774	5/26 #1	INFLUENET	METHYLENE CHLORIDE	<0.035	ppm
4309774	5/26 #1	INFLUENET	ETHYL BENZENE	0.306	ppm
4309774	5/26 #1	INFLUENET	XYLENE	1.838	ppm
4309774	5/26 #1	INFLUENET	ACETONE	0.331	ppm
4309775	5/26 #2	INFLUENET	METHYLENE CHLORIDE	<0.022	ppm
4309775	5/26 #2	INFLUENET	ETHYL BENZENE	0.394	ppm
4309775	5/26 #2	INFLUENET	XYLENE	2.134	ppm
4309775	5/26 #2	INFLUENET	ACETONE	4.254	ppm

Method: METHYLENE CHLORIDE NIOSH 1005 Det. Limit: 1 ug
Method: ETHYL BENZENE NIOSH 1501 Det. Limit: 1 ug
Method: XYLENE NIOSH 1501 Det. Limit: 1 ug
Method: ACETONE NIOSH 1300 Det. Limit: 10 ug

ANALYST: JE
Date: 05/28/93

Charles O'Bryan
Charles O'Bryan
Laboratory Manager

NVIRONMENTAL ... ICES
... M... gar ... 75
313-474-4200
313-474-0601 (FAX)
Mc..., VA (Hqtrs.) ... Atlanta, GA
Huntington Station, NY
Marietta, OH
Cincinnati, OH
Jupiter, FL
General Information 1-800-777-1741

HAIN-OF-CUSTODY RECORD / SAMPLE LOG

ompany Name: OBS Operations	Project Contact: Marvin Rivers	Kemron Acct. No.:
elephone No.: (313) 347-4136	Project Name: [illegible]	Page 1 of 1
roject No.:	P.O. No.: RCI 5/26/93	
ampler (print): Marvin Rivers	Signature: Marvin Rivers	

ANALYTICAL REQUEST

Client Sample No.	Air	Solid	Fluid	Date	Tima	Sample Volume	Sampla Identification	Number of Samples	Methylene chloride	Ethylbenzene	Xylene	Acetone									TURNAROUND REQUIREMENTS OR COMMENTS
5/26 #1	X			5-26-93	12:13 - 1:13	charcoal tube	influent < Primary & Secondary		X	X	X	X		16651 counts	x .488 ml/ct	= 8125.69 ml	= 8.125 l				A.S.A.P.
5/26 #2	X			5/26 93	1:50 - 3:40		influent < Primary & secondary		X	X	X	X		26495 counts	x .483 ml/ct	= 12929.56 ml	= 12.93 l				
Sample No. 5/26 #1							the influent supply was briefly disconnected therefore sampling pump was stopped		NIOSH METHOD 1005	1300	1500/1501	1500 MEN									
For the charcoal tube sample [illegible] for sample [illegible] sampling air volume - 23848 counts x .488 ml/ct																					

Relinquished by: (Signature)	Date	Tima	Received by: (Signature)	Relinquished by: (Signature)	Date	Time	Received by: (Signature)
			[illegible]				

Relinquished by: (Signature)	Date	Time	Received for Laboratory by: (Signature)	Date	Time	Remarks:

AD6 White Lab Yellow Field

Gary Angyal
Raleigh

OBG
OPERATIONS, INC.

January 24, 1994

Mr. Fred H. Reith
District Supervisor
Air Quality Division
Department of Natural Resources
38980 West Seven Mile Road
Livonia, MI 48152

Re: Reichhold Chemicals, Inc.
Ferndale, MI Permit # 1113-91

Subject: Operations Status Report 4th Quarter 1993

Dear Mr. Reith:

On behalf of Reichhold Chemicals, Inc. and in accordance with the requirements of Permit No. 1113-91, provided herein is the 4th Quarter 1993 Operations Status Report for the Reichhold Chemicals, Inc. facility in Ferndale, Michigan. The permit allows the operation of the In-situ Air Stripping System (ISAS) at the facility. The previous Operations Status Report was submitted to your office on October 14, 1993 and covered the operating period from start-up (May 24, 1993) through September 24, 1993.

This report includes data from September 25, 1993 through December 24, 1993. A complete description of the ISAS and monitoring procedures was provided in the October 1993 submittal. The attached table provides operating data for this reporting period. The ISAS operated for 1,992 hours during the period and removed 4.7 pounds of volatile organics from the vadose zone, based on vapor stream analyses. During this period, the system was connected to vadose zone well IW-4.

On December 17, 1993, the system was shutdown for the winter months. It is expected to start-up by the 2nd quarter of 1994. During the shutdown, additional inlet and extraction wells may be installed to enhance volatile organic removal from the vadose zone. These changes will not affect the ISAS components, operation, or maximum permitted emissions based on the permit application.

OBG Operations, Inc., an O'Brien & Gere Limited Company
5000 Brittonfield Parkway / Suite 100 / PO Box 4762 / Syracuse, NY 13221-4762 / (315) 437-8800 / Fax (315) 463-7440

We will provide you with the next status report by April 24, 1994. If you should have any questions regarding the data presented herein, please feel free to contact me at (315) 437-8800.

Very truly yours,
OBG Operations, Inc.

Greg C. Miller

Greg C. Miller
Vice President

Attachments

cc: Mr. John W. Knaub, Reichhold Chemicals, Inc.
Mr. Donald E. Stone, O'Brien & Gere Engineers, Inc.
Mr. Scott J. Adamowski, O'Brien & Gere Engineers, Inc.

REICHHOLD CHEMICALS, INC.
FERNDALE, MI SITE
ISAS REMOVAL RATE SUMMARY TABLE
REPORTING PERIOD: SEPTEMBER 25 - DECEMBER 24, 1993

10/13/93 IW-4	CFM =	15	HOURS ON =	768
Analyte	Concentration (ppmv)		Lbs/Hr Removed	
Ethylbenzene	0.279		0.00007	
Xylene	3.441		0.00091	
Acetone	0.32		0.00005	
Methylene Chloride	2.382		0.00051	
		TOTAL	0.00154	
POUNDS REMOVED OVER SAMPLE INTERVAL			1.18476	
CUMULATIVE POUNDS REMOVED			1.18476	

10/27/93 IW-4	CFM =	15	HOURS ON =	528
Analyte	Concentration (ppmv)		Lbs/Hr Removed	
Ethylbenzene	0.159		0.00004	
Xylene	2.352		0.00063	
Acetone	0.377		0.00005	
Methylene Chloride	1.881		0.00040	
		TOTAL	0.00112	
POUNDS REMOVED OVER SAMPLE INTERVAL			0.59290	
CUMULATIVE POUNDS REMOVED			1.77766	

11/18/93 IW-4	CFM =	15	HOURS ON =	696
Analyte	Concentration (ppmv)		Lbs/Hr Removed	
Ethylbenzene	0.513		0.00014	
Xylene	14.323		0.00381	
Acetone	0.867		0.00013	
Methylene Chloride	0.887		0.00019	
		TOTAL	0.00426	
POUNDS REMOVED OVER SAMPLE INTERVAL			2.96327	
CUMULATIVE POUNDS REMOVED			4.74093	

REPORTING PERIOD: 9/25/93 - 12/24/93	
TOTAL HOURS OF OPERATION =	1992
TOTAL POUNDS VOC REMOVED =	4.7

NOTE:
"HOURS ON" is the hours of operation over a "sample interval" during which the VOC concentrations measured are assumed valid. The interval selected is from the sample collection date listed to the next sample collection date.

KEMRON ENVIRONMENTAL SERVICES
39830 GRAND RIVER B-2
NOVI, MICHIGAN 48375

Phone: (313)474-4200

OBG OPERATIONS
39500 ORCHARD HILL STE 300
NOVI, MI 48375

Attn: MARVIN RIVERS
Invoice Number:

Order #: 93-10-203
Date: 10/29/93 11:13
Work ID: RCI-ISAS
Date Received: 10/28/93
Date Completed: 10/29/93
Client Code: OBGO_147

SAMPLE IDENTIFICATION

Sample Number	Sample Description
01	10-13-93/IW-R INFLUENT

Sample Number	Sample Description

Certified By
Charles O'Bryan

TEST RESULTS BY SAMPLE

Sample: 01A 10-13-93/IW-R INFLUENT Collected:

Test Description	Result	Det Limit	Units	Analyzed	By
Acetone	<0.320	10 ug	ppm	10/29/93	JE
Ethyl Benzene	0.279	1 ug	ppm	10/29/93	JE
Methylene Chloride	2.382	1 ug	ppm	10/29/93	JE
Xylene	3.441	1 ug	ppm	10/29/93	JE

Acetone Method: NIOSH 1300

Ethyl Benzene Method: NIOSH 1501

Methylene Chloride Method: NIOSH 1005

Xylene Method: NIOSH 1501

/IRONMENTAL SE ES
N dic
313-474-4200
313-474-0601 (FAX)
Huntington Station, NY
Marietta, OH
Cincinnati, OH
Jupiter, FL
General Information 1-800-777-1741

AIN-OF-CUSTODY RECORD / SAMPLE LOG

pany Name:	Project Contact:	Kemron Acct. No.:
phone No.:	Project Name:	Page of
ect No.:	P.O. No.:	
pler (print)	Signature	

ANALYTICAL REQUEST

ent Sample No.	Air	Solid	Fluid	Date	Time	Sample Volume	Sample Identification	Number of Samples												TURNAROUND REQUIREMENTS OR COMMENTS

linquished by: gnature	Date	Time	Received by: (Signature)	Relinquished by: (Signature)	Date	Time	Received by: (Signature)
d by:	Date	Time	Received for Laboratory by: (Signature)	Date	Time	Remarks:	

KEMRON ENVIRONMENTAL SERVICES
39830 GRAND RIVER B-2
NOVI, MICHIGAN 48375

Phone: (313)474-4200

OBG OPERATIONS
39500 ORCHARD HILL STE 300
NOVI, MI 48375

Attn: MARVIN RIVERS
Invoice Number:

Order #: 93-10-204
Date: 10/29/93 11:13
Work ID: RCI-ISAS
Date Received: 10/28/93
Date Completed: 10/29/93
Client Code: OBGO_147

SAMPLE IDENTIFICATION

Sample Number	Sample Description
01	10-27-93/IW-4 INFLUENT

Sample Number	Sample Description

Charles O'Bryan
Certified By
Charles O'Bryan

KEMRON ENVIRONMENTAL SERVICES
TEST RESULTS BY SAMPLE

Sample: 01A 10-27-93/IW-4 INFLUENT Collected:

Test Description	Result	Det Limit	Units	Analyzed	By
Acetone	<0.377	10 ug	ppm	10/29/93	JE
Ethyl Benzene	0.159	1 ug	ppm	10/29/93	JE
Methylene Chloride	1.881	1 ug	ppm	10/29/93	JE
Xylene	2.352	1 ug	ppm	10/29/93	JE

Acetone Method: NIOSH 1300

Ethyl Benzene Method: NIOSH 1501

Methylene Chloride Method: NIOSH 1005

Xylene Method: NIOSH 1501

VIRC[illegible]NTAL [illegible]
[illegible] 4-4[illegible]
313-474-0601 (FAX)
McLean, VA (Floors.)
Huntington Station, NY
Marietta, OH
Atlanta, GA
Cincinnati, OH
Jupiter, FL
General Information 1-800-777-1741

[illegible]AIN-OF-CUSTODY RECORD / SAMPLE LOG

[illegible]npany Name: [illegible] Operations	Project Contact: [illegible]	Kemron Acct. No.: [illegible]
[illegible]phone No.: 313-347-4136	Project Name: [illegible]	Page [illegible] of [illegible]
[illegible]ject No.: [illegible]	P.O. No.:	
[illegible]npler (print): M. Rivers	Signature: [illegible]	

ANALYTICAL REQUEST

[illegible]ient Sample No.	Air	Solid	Fluid	Date	Time	Sample Volume	Sample Identification	Number of Samples	[illegible]	[illegible]	[illegible]	[illegible]	TURNAROUND REQUIREMENTS OR COMMENTS
[illegible]-27-93	X			10-27-93	9:50	11.16 L	IW-4 influent	X	X	X	X	X	one charcoal tube
													[illegible]
													[illegible]
													[illegible]
													11.16 L
													[illegible]
													[illegible]

[illegible]inquished by: [illegible]nature	Date	Time	Received by: (Signature)	Relinquished by: (Signature)	Date	Time	Received by: (Signature)
[illegible]	[illegible]/93	5:-5					

[illegible]inquished by: [illegible]nature)	Date	Time	Received for Laboratory by: (Signature)	Date	Time	Remarks:

[illegible]6

White – Lab Yellow – Field

Gary Angyal —
for your review before sending out, as
per Greg Miller —
Callen - OBG Operations - Syr.
fax: 315-463-7440

DRAFT

April 18, 1994

Mr. Fred H. Reith
District Supervisor
Air Quality Division
DEPARTMENT OF NATURAL RESOURCES
38980 West Seven Mile Road
Livonia, MI 48152

Re: Reichhold Chemicals, Inc. - Ferndale, Michigan
Permit #1113-91

Subject: Operations Status Report
1st Quarter 1994

Dear Mr. Reith:

On behalf of Reichhold Chemicals, Inc., and in accordance with the requirements of Permit #1113-91, provided herein is the 1st quarter Operations Status Report for the Reichhold Chemical facility in Ferndale, Michigan. The permit allows the operation of the In-situ Air Stripping System (ISAS) at the facility. The current Operations Status Report covers the operating period from December 25, 1993 through March 24, 1994.

On December 17, 1993, the system was shutdown for the winter months and remains out of service at this time. It is expected to be restarted during the 2nd quarter of 1994.

We will provide you with the next status report by July 24, 1994. If you should have any questions regarding the project, please feel free to contact me at (315) 437-8800.

Very truly yours,
OBG Operations, Inc.

Greg C. Miller
Vice President

cc: Mr. John W. Knaub - Reichhold Chemicals, Inc.
Mr. Donald E. Stone - O'Brien & Gere Engineers, Inc.
Mr. Scott J. Adamowski - O'Brien & Gere Engineers, Inc.

GCM/cmw

TEST RESULTS BY SAMPLE

Sample: 01A INFLUENT

Collected:

Test Description	Result	Det Limit	Units	Analyzed	By
Acetone	<0.867	10 ug	ppm	12/03/93	JE
Ethyl Benzene	0.513	1 ug	ppm	12/03/93	JE
Methylene Chloride	0.887	1 ug	ppm	12/03/93	JE
Xylene	14.323	1 ug	ppm	12/03/93	JE

Sample: 02A INTERMEDIATE

Collected:

Test Description	Result	Det Limit	Units	Analyzed	By
Acetone	<0.798	10 ug	ppm	12/03/93	JE
Ethyl Benzene	0.247	1 ug	ppm	12/03/93	JE
Methylene Chloride	<0.055	1 ug	ppm	12/03/93	JE
Xylene	0.657	1 ug	ppm	12/03/93	JE

Sample: 03A EFFLUENT

Collected:

Test Description	Result	Det Limit	Units	Analyzed	By
Acetone	<0.369	10 ug	ppm	12/03/93	JE
Ethyl Benzene	<0.020	1 ug	ppm	12/03/93	JE
Methylene Chloride	<0.025	1 ug	ppm	12/03/93	JE
Xylene	<0.020	1 ug	ppm	12/03/93	JE

cc/. VCB, GAA.
f.b: 3208.058 #2

OBG
OPERATIONS, INC.

1984 - 1994
10 YEARS OF EXCELLENCE
OBG Operations, Inc.

July 21, 1994

RECEIVED
JUL 25 1994
O'B & G
EDISON

Mr. Fred H. Reith
District Supervisor
Air Quality Division
Department of Natural Resources
38980 West Seven Mile Road
Livonia, MI 48152

Re: Reichhold Chemicals, Inc. - Ferndale, Michigan
Permit #1113-91

Subject: Operations Status Report
2nd Quarter 1994

Dear Mr. Reith:

On behalf of Reichhold Chemicals, Inc., and in accordance with the requirements of Permit #1113-91, provided herein is the 2nd quarter Operations Status Report for the Reichhold Chemical facility in Ferndale, Michigan. The permit allows the operation of the In-situ Air Stripping System (ISAS) at the facility. The current Operations Status Report covers the operating period from March 25, 1994 through June 24, 1994

During this operating period, the system remained shut down and out of service. It was restarted during the last week of June. Operating data will be provided as part of the next status report.

We will provide you with the next status report by October 24, 1994. If you should have any questions regarding the project, please feel free to contact me at (315) 437-8800.

Very truly yours,
OBG Operations, Inc.

Greg C. Miller

Greg C. Miller
Vice President

cc: Mr. John W. Knaub - Reichhold Chemicals, Inc.
Mr. Donald E. Stone - O'Brien & Gere Engineers, Inc.
Mr. Scott J. Adamowski - O'Brien & Gere Engineers, Inc.

GCM/bc#5

O'BRIEN & GERE
OPERATIONS, INC.

TO Gary Angyal

October 21, 1994

Mr. Fred H. Reith, District Supervisor
Air Quality Division
Department of Natural Resources
38980 West Seven Mile Road
Livonia, MI 48152

Re: Reichhold Chemicals, Inc.
Ferndale, MI Permit # 1113-91
Subject: Operations Status Report 3rd Quarter 1994

Dear Mr. Reith:

On behalf of Reichhold Chemicals, Inc. and in accordance with the requirements of Permit No. 1113-91, provided herein is the 3rd Quarter 1994 Operations Status Report for the Reichhold Chemicals, Inc. facility in Ferndale, Michigan. The permit allows the operation of the In-situ Air Stripping System (ISAS) at the facility.

This report includes data from June 25, 1994 through September 24, 1994. A complete description of the ISAS and monitoring procedures was provided in the October 1993 submittal. The attached table provides operating data for this reporting period. The ISAS operated for 2,196 hours during the period and removed <0.4 pounds of volatile organics from the vadose zone, based on vapor stream analyses. During this period, the system was primarily connected to vadose zone well IW-4.

Although effluent concentrations sampled were less than detection limits, two of the carbon canisters were replaced as part of overall system maintenance based on hours of operation since system start-up in May 1993.

We will provide you with the next status report by January 24, 1995. If you should have any questions regarding the data presented herein, please feel free to contact me at (315) 437-8800.

Very truly yours,
O'Brien & Gere Operations, Inc.

Greg C. Miller

Greg C. Miller
Vice President

Attachments

cc: Mr. John W. Knaub, Reichhold Chemicals, Inc.
Mr. Donald E. Stone, O'Brien & Gere Engineers, Inc.
Mr. Scott J. Adamowski, O'Brien & Gere Engineers, Inc.

O'Brien & Gere Operations, Inc., an O'Brien & Gere Company
5000 Brittonfield Parkway / PO Box 4762 / Syracuse, NY 13221-4762 / (315) 437-8800 or (800) 435-0797
Fax (315) 463-7440

REICHHOLD CHEMICALS, INC.
FERNDALE, MICHIGAN SITE
ISAS REMOVAL RATE SUMMARY TABLE
REPORTING PERIOD: JUNE 25 - SEPTEMBER 24, 1994

06/29/94	IW-4	CFM =	15	HRS ON =	864
Analyte		Concentration (ppmv)		Lbs/Hr Removed	
Acetone		<	0.542	<	0.00011
Ethyl Benzene		<	0.045	<	1.07E-05
Methylene Chloride		<	0.056	<	1.07E-05
Xylene		<	0.045	<	1.07E-05
				TOTAL <	0.000142
POUNDS REMOVED OVER SAMPLE INTERVAL					0.12243
CUMULATIVE POUNDS REMOVED					0.12243

07/31/94	IW-4	CFM =	26	HRS ON =	1016
Analyte		Concentration (ppmv)		Lbs/Hr Removed	
Acetone		<	0.795	<	0.000178
Ethyl Benzene		<	0.044	<	1.8E-05
Methylene Chloride		<	0.054	<	1.77E-05
Xylene		<	0.044	<	1.8E-05
				TOTAL <	0.000231
POUNDS REMOVED OVER SAMPLE INTERVAL					0.234918
CUMULATIVE POUNDS REMOVED					0.357349

09/11/94	IW-4	CFM =	25	HRS ON =	316
Analyte		Concentration (ppmv)		Lbs/Hr Removed	
Acetone		<	0.47	<	0.000103
Ethyl Benzene		<	0.026	<	1.04E-05
Methylene Chloride		<	0.032	<	1.03E-05
Xylene		<	0.026	<	1.04E-05
				TOTAL <	0.000134
POUNDS REMOVED OVER SAMPLE INTERVAL					0.042269
CUMULATIVE POUNDS REMOVED					0.399618

REPORTING PERIOD: 6/25/94 - 9/24/94		
TOTAL HOURS OF OPERATION =		2198
TOTAL POUNDS OF VOC REMOVED =	<	0.399618

Note:
"HOURS ON" is the hours of operation over a "sample interval" during which the VOC concentrations are assumed valid. The interval selected is from the sample collection date listed to the next sample collection date.
The 6/29/94 sampling interval also takes into account hours of operation that occured since system start-up on 12:00 PM on 6/25/94. The 09/11/94 sampling interval includes hours through 09/24/94, the end date of the reporting period.

KEMRON ENVIRONMENTAL SERVICES
[illegible] Grand Rivers [illegible]
N[illegible], Michigan [illegible]75
313-474-4200
313-474-0601 (FAX)

OTHER LOCATIONS
McLe[illegible] VA ([illegible]rs.) [illegible]nta,
Huntington Station, NY
Cincinnati, OH
Marietta, OH
Jupiter, FL
General Information 1-800-777-1741

CHAIN-OF-CUSTODY RECORD / SAMPLE LOG

Company Name: OBG Operations
Telephone No.: 313-789-7182
Project No.: RCI-
P.O. No.:
Sampler (print): M. Rapp
Signature: Matt Rapp

Project Contact: Matt Rapp
Project Name: Reichhold Chemical
Kemron Acct. No.:
Page 1 of 1

ANALYTICAL REQUEST

Client Sample No.	Air	Solid	Fluid	Date	Time	Sample Volume	Sample Identification	Number of Samples	Acetone	Ethyl Benzene	Methylene Chloride	Xylene	TURNAROUND REQUIREMENTS OR COMMENTS
6-29-94	X			6/29	7:30pm	5l	Influent	1	X	X	X	X	10,248 x .488 ÷ 1000 = 5l
6-29-94	X			6/29	8:15pm	5l	Intermediate (E)	1	X	X	X	X	10,248 x .488 ÷ 1000 = 5l
6-29-94	X			6/29	9:00pm	5l	Intermediate (W)	1	X	X	X	X	10,250 x .488 ÷ 1000 = 5l
6-29-94	X			6/29	9:35pm	6.39l	Effluent	1	X	X	X	X	13,096 x .488 ÷ 1000 = 6[illegible]

will call w/ TA

Relinquished by: (Signature)	Date	Time	Received by: (Signature)	Relinquished by: (Signature)	Date	Time	Received by: (Signature)
Matt Rapp	7-1-94	4:35pm					

Relinquished by: (Signature)	Date	Time	Received for Laboratory by: (Signature)	Date	Time	Remarks:
			[illegible]	7/1/94	4:36	

OCT-21-1994 17:03 FROM O'BRIEN & GERE MI. TO 131546374400129 P.03

KEMRON ENVIRONMENTAL SERVICES
39830 GRAND RIVER B-2
NOVI, MICHIGAN 48375

Phone: (810)474-4200

OBG OPERATIONS
39500 ORCHARD HILL STE 300
NOVI, MI 48375

Attn: MATT RAPP
Invoice Number:

Order #: 94-07-015
Date: 07/05/94 14:06
Work ID: RCI
Date Received: 07/01/94
Date Completed: 07/05/94
Client Code: OBGO_147

SAMPLE IDENTIFICATION

Sample Number	Sample Description
01	6-29-94/INFLUENT
02	6-29-94 INTER E
03	6-29-94 INTER W
04	6-29-94 EFFLUENT

Charles O'Bryan

Certified By
Charles O'Bryan

KEMRON ENVIRONMENTAL SERVICES
TEST RESULTS BY SAMPLE

Sample: 01A 6-29-94/INFLUENT Collected:

Test Description	Result	Det Limit	Units	Analyzed	By
Acetone	<0.842	10 ug	ppm	07/05/94	JE
Ethyl Benzene	<0.045	1 ug	ppm	07/05/94	JE
Methylene Chloride	<0.056	1 ug	ppm	07/05/94	JE
Xylene	<0.045	1 ug	ppm	07/05/94	JE

Sample: 02A 6-29-94 INTER E Collected:

Test Description	Result	Det Limit	Units	Analyzed	By
Acetone	<0.842	10 ug	ppm	07/05/94	JE
Ethyl Benzene	<0.045	1 ug	ppm	07/05/94	JE
Methylene Chloride	<0.056	1 ug	ppm	07/05/94	JE
Xylene	0.083	1 ug	ppm	07/05/94	JE

Sample: 03A 6-29-94 INTER W Collected:

Test Description	Result	Det Limit	Units	Analyzed	By
Acetone	<0.842	10 ug	ppm	07/05/94	JE
Ethyl Benzene	<0.045	1 ug	ppm	07/05/94	JE
Methylene Chloride	<0.056	1 ug	ppm	07/05/94	JE
Xylene	0.106	1 ug	ppm	07/05/94	JE

Sample: 04A 6-29-94 EFFLUENT Collected:

Test Description	Result	Det Limit	Units	Analyzed	By
Acetone	<0.659	10 ug	ppm	07/05/94	JE
Ethyl Benzene	<0.036	1 ug	ppm	07/05/94	JE
Methylene Chloride	<0.045	1 ug	ppm	07/05/94	JE
Xylene	<0.036	1 ug	ppm	07/05/94	JE

KEMRON ENVIRONMENTAL SERVICES
TEST METHODOLOGIES

Acetone Method: NIOSH 1300

Ethyl Benzene Method: NIOSH 1501

Methylene Chloride Method: NIOSH 1005

Xylene Method: NIOSH 1501

ENVIRONMENTAL SERVICES
Nov., Michigan 48...
313-474-4200
313-474-0601 (FAX)

...ean, Ind.
Huntington Station, NY
Marietta, OH

Cincinnati, OH
Jupiter, FL
General Information 1-800-777-1741

CHAIN-OF-CUSTODY RECORD / SAMPLE LOG

Company Name: OBG Operation
Project Contact: Matt Rapp
Kemron Acct. No.:
Telephone No.: 810-789-7182
Project Name: Reichhold Chemical
Page 1 of 1
Project No.: RCI-SUE
P.O. No.:
Sampler (print): MR
Signature: Matt Rapp

ANALYTICAL REQUEST

Client Sample No.	Air	Solid	Fluid	Date 1994	Time	Sample Volume	Sample Identification	Number of Samples	Acetone	Ethylbenzene	Methylene Chloride	Xylene	TURNAROUND REQUIREMENTS OR COMMENTS
8-31-94	X			7/31	10:00	5.3l	Influent	1	X	X	X	X	
7-31-94	X			7/31	11:05	6.6l	Intermediate (E)	1	X	X	X	X	
7-31-94	X			7/31	12:15	6.5l	Intermediate (W)	1	X	X	X	X	
7-31-94	X			7/31	1:30	~~5.5l~~ 6.1l	Effluent	1	X	X	X	X	

Relinquished by: (Signature)	Date	Time	Received by: (Signature)	Relinquished by: (Signature)	Date	Time	Received by: (Signature)
Matt Rapp	8-2-94	7:15	Terri Ourdoff				

Relinquished by: (Signature)	Date	Time	Received for Laboratory by: (Signature)	Date	Time	Remarks:

KEMRON ENVIRONMENTAL SERVICES
39830 GRAND RIVER B-2
NOVI, MICHIGAN 48375

Phone: (810)474-4200

ODG OPERATIONS
39500 ORCHARD HILL STE 300
NOVI, MI 48375

Attn: MATT RAPP
Invoice Number:

Order #: 94-08-022
Date: 08/17/94 15:32
Work ID: RCI-SUE
Date Received: 08/02/94
Date Completed: 08/17/94
Client Code: ODGO_147

SAMPLE IDENTIFICATION

Sample Number	Sample Description
01	7-31-94/INFLUENT
02	7-31-94/INTERMEDIATE E
03	7-31-94/INTERMEDIATE W
04	7-31-94/EFFLUENT

Certified By
Charles O'Bryan

KEMRON ENVIRONMENTAL SERVICES
TEST RESULTS BY SAMPLE

Sample: 01A 7-31-94/INFLUENT Collected:

Test Description	Result	Det Limit	Units	Analyzed	By
Acetone	<0.795	10 ug	ppm	08/17/94	JE
Ethyl Benzene	<0.044	1 ug	ppm	08/17/94	JE
Methylene Chloride	<0.054	1 ug	ppm	08/17/94	JE
Xylene	<0.044	1 ug	ppm	08/17/94	JE

Sample: 02A 7-31-94/INTERMEDIATE E Collected:

Test Description	Result	Det Limit	Units	Analyzed	By
Acetone	<0.639	10 ug	ppm	08/17/94	JE
Ethyl Benzene	<0.035	1 ug	ppm	08/17/94	JE
Methylene Chloride	<0.044	1 ug	ppm	08/17/94	JE
Xylene	<0.035	1 ug	ppm	08/17/94	JE

Sample: 03A 7-31-94/INTERMEDIATE W Collected:

Test Description	Result	Det Limit	Units	Analyzed	By
Acetone	<0.639	10 ug	ppm	08/17/94	JE
Ethyl Benzene	<0.035	1 ug	ppm	08/17/94	JE
Methylene Chloride	<0.044	1 ug	ppm	08/17/94	JE
Xylene	<0.035	1 ug	ppm	08/17/94	JE

Sample: 04A 7-31-94/EFFLUENT Collected:

Test Description	Result	Det Limit	Units	Analyzed	By
Acetone	<0.691	10 ug	ppm	08/17/94	JE
Ethyl Benzene	<0.038	1 ug	ppm	08/17/94	JE
Methylene Chloride	<0.047	1 ug	ppm	08/17/94	JE
Xylene	<0.038	1 ug	ppm	08/17/94	JE

KEMRON ENVIRONMENTAL SERVICES
TEST METHODOLOGIES

Acetone Method: NIOSH 1300

Ethyl Benzene Method: NIOSH 1501

Methylene Chloride Method: NIOSH 1005

Xylene Method: NIOSH 1501

KEMRON ENVIRONMENTAL SERVICES
398 [illegible] River [illegible]
Novi, Michigan 48[illegible]
313-474-4200
313-474-0601 (FAX)

OTHER LOCATIONS
McLean, VA (Hdqtrs.) Atlanta, GA
Huntington Station, NY Cincinnati, OH
Marietta, OH Jupiter, FL
General Information 1-800-777-1741

CHAIN-OF-CUSTODY RECORD / SAMPLE LOG

Company Name: OBG Operation
Project Contact: Matt Rapp
Kemron Acct. No.:
Telephone No.: 810-789-7182
Project Name: Reichhold Chemical
Page 1 of 1
Project No.: RCI-SUE
P.O. No.:
Sampler (print): Matt Rapp
Signature: Matt Rapp

ANALYTICAL REQUEST

Client Sample No.	Air	Solid	Fluid	Date 1994	Time	Sample Volume	Sample Identification	Number of Samples	Acetone	Ethyl Benzene	Methylene Chloride	Xylene	TURNAROUND REQUIREMENTS OR COMMENTS
9-11-94	X			9/11	700pm	8.96l	Influent						18,356 x .488 ÷ 1000 = 8.96
9-11-94	X			9/11	800pm	6.17l	Intermediate (E)						12644 x .488 ÷ 1000 = 6.17
9-11-94	X			9/11	900pm	6.59l	Intermediate (W)						13500 x .488 ÷ 1000 = 6.59
9-11-94	X			9/11	1000pm	10.34l	Effluent						21180 x .488 ÷ 1000 = 10.34

Relinquished by: (Signature)	Date	Time	Received by: (Signature)	Relinquished by: (Signature)	Date	Time	Received by: (Signature)
Matt Rapp	9-13-94	10:00		Tommy Miller	9/16	5:30	[illegible]

Relinquished by: (Signature)	Date	Time	Received for Laboratory by: (Signature)	Date	Time	Remarks:

KEMRON ENVIRONMENTAL SERVICES
39830 GRAND RIVER B-2
NOVI, MICHIGAN 48375

Phone: (810)474-4200

OBG OPERATIONS
39500 ORCHARD HILL STE 300
NOVI, MI 48375

Attn: MATT RAPP
Invoice Number:

Order #: 94-09-150
Date: 09/26/94 11:17
Work ID: RCI-SUE
Date Received: 09/16/94
Date Completed: 09/26/94
Client Code: OBGO_147

SAMPLE IDENTIFICATION

Sample Number	Sample Description
01	9-11-94/INFLUENT
02	9-11-94/INTERMEDIATE E
03	9-11-94/INTERMEDIATE W
04	9-11-94/EFFLUENT

Charles O'Bryan

Certified By
Charles O'Bryan

Order # 94-09-150
09/26/94 11:17

KEMRON ENVIRONMENTAL SERVICES
TEST RESULTS BY SAMPLE

Sample: 01A 9-11-94/INFLUENT Collected:

Test Description	Result	Det Limit	Units	Analyzed	By
Acetone	<0.470	10 ug	ppm	09/23/94	JE
Ethyl Benzene	<0.026	1 ug	ppm	09/23/94	JE
Methylene Chloride	<0.032	1 ug	ppm	09/23/94	JE
Xylene	<0.026	1 ug	ppm	09/23/94	JE

Sample: 02A 9-11-94/INTERMEDIATE E Collected:

Test Description	Result	Det Limit	Units	Analyzed	By
Acetone	<0.682	10 ug	ppm	09/23/94	JE
Ethyl Benzene	<0.037	1 ug	ppm	09/23/94	JE
Methylene Chloride	<0.047	1 ug	ppm	09/23/94	JE
Xylene	<0.037	1 ug	ppm	09/23/94	JE

Sample: 03A 9-11-94/INTERMEDIATE W Collected:

Test Description	Result	Det Limit	Units	Analyzed	By
Acetone	<0.639	10 ug	ppm	09/23/94	JE
Ethyl Benzene	<0.035	1 ug	ppm	09/23/94	JE
Methylene Chloride	<0.044	1 ug	ppm	09/23/94	JE
Xylene	<0.035	1 ug	ppm	09/23/94	JE

Sample: 04A 9-11-94/EFFLUENT Collected:

Test Description	Result	Det Limit	Units	Analyzed	By
Acetone	<0.406	10 ug	ppm	09/23/94	JE
Ethyl Benzene	<0.022	1 ug	ppm	09/23/94	JE
Methylene Chloride	<0.028	1 ug	ppm	09/23/94	JE
Xylene	<0.022	1 ug	ppm	09/23/94	JE

KEMRON ENVIRONMENTAL SERVICES
TEST METHODOLOGIES

Acetone Method: NIOSH 1300

Ethyl Benzene Method: NIOSH 1501

Methylene Chloride Method: NIOSH 1005

Xylene Method: NIOSH 1501

Appendix 2

ISAS System MDNR Air Permit

STATE OF MICHIGAN

NATURAL RESOURCES COMMISSION
HARRY DEVUYST
EISELE
JON E. GUYER
JES P. HILL
DAVID HOLLI
O. STEWART MYERS
JOEY M. SPANO

JOHN ENGLER, Governor

DEPARTMENT OF NATURAL RESOURCES

Stevens T. Mason Building, P.O. Box 30028, Lansing, MI 48909

ROLAND HARMES, Director

October 30, 1992

Mr. John W. Knaub
Reichhold Chemicals, Inc.
800 Capitola Drive
Durham, N.C. 27713

Dear Mr. Knaub:

This letter is in reference to your Permit to Install application for remediation of contaminated soil using vapor extraction with dual phase carbon adsorption control, located at 707 Woodward Heights Blvd., Ferndale, Michigan. This application, identified as No. 1113-91, has been evaluated and approved by the Air Quality Division, pursuant to the delegation of authority from the Michigan Air Pollution Control Commission.

This approval is based upon and subject to compliance with all administrative rules of the Commission and conditions stipulated in the attached supplement. Please review these conditions thoroughly so that you may plan for and take the actions necessary to ensure compliance with all of these conditions. Also note that Condition No. 1 requires you to apply, in writing, for a permit to operate within 30 days after completion of construction.

You are advised that contaminants discharged to the surface waters and/or groundwaters; materials disposed of on land; hazardous waste storage, treatment, and disposal; and resource recovery facilities must be approved by other divisions of the Department of Natural Resources. Additionally, your plant environment must be in compliance with all applicable requirements of the Departments of Public Health and Labor.

Please notify Ms. Janet L. Gonzales, Esq., 60 Amherst, Pleasant Ridge, Michigan of the process start-up date prior to operation.

Thank you for your cooperation. Please contact me if you have any questions regarding this permit.

Sincerely,

Linda L. Davis, Senior Engineer
Chemical Process Unit
Permit Section
Air Quality Division
517-373-7054

LLD:ms
Enclosure
cc: Fred Rieth
Hugh Griffith, O'Brien & Gere

SUPPLEMENT TO PERMIT NO. 1113-91

Reichhold Chemicals, Inc.
Ferndale, Michigan

October 27, 1992

GENERAL CONDITIONS

1. Rule 208(2) - Not more than 30 days after completion of the installation, Applicant shall apply, in writing, for a Permit to Operate. Completion of the installation is deemed to occur not later than commencement of a trial operation pursuant to Rule 201(4). Written application should be sent to: Chief, Permit Unit, Air Quality Division, Department of Natural Resources, P.O. Box 30028, Lansing, Michigan 48909.

2. Rule 201(4) - Trial operation of the equipment is permitted until the Michigan Air Pollution Control Commission acts upon the Permit to Operate. Operation of the equipment shall permanently cease upon denial of the Permit to Operate by the Commission.

3. Rule 208(3)(a) and (c) - Applicant shall demonstrate compliance with all Commission rules and with all general and special conditions of this permit prior to issuance of the Permit to Operate.

4. Rule 201 - Applicant shall not reconstruct, alter, modify, expand, or relocate this equipment unless plans, specifications, and an application for a Permit to Install are submitted to and approved by the Commission.

5. Rule 901 - Operation of this equipment shall not result in the emission of an air contaminant which causes injurious effects to human health or safety, animal life, plant life of significant value, or property, or which causes unreasonable interference with the comfortable enjoyment of life and property.

6. Rule 208(3)(b) - Operation of this equipment shall not interfere with the attainment or maintenance of the air quality standard for any air contaminant.

7. Operation of this equipment shall not result in significant deterioration of air quality.

8. Rule 912 - Applicant shall provide notification of any abnormal conditions or malfunction of process or control equipment covered by this application, resulting in emissions in violation of the Commission rules or of any permit conditions for more than two hours, to the District Supervisor. Such notice shall be made as soon as reasonably possible, but not later than 9:00 a.m. of the next working day. Applicant shall also, within 10 days, submit to the District Supervisor, a written detailed report, including probable causes, duration of violation, remedial action taken, and the steps which are being undertaken to prevent a reoccurrence.

19. Applicant shall monitor and record the flow rate and total VOC concentration of the influent stream to the control on a weekly basis in a manner and with instrumentation acceptable to the Air Quality Division until 10 valid samples are obtained. Thereafter, the influent stream to the control shall be monitored for these parameters on a monthly basis. All data, including calculation of VOC emission rates shall be submitted to the District Supervisor in an acceptable format within 30 days following the end of the quarter in which the data were collected. Any request for a change in the sampling frequency must be submitted to the District Supervisor, Air Quality Division, for review and approval.

20. The exhaust gases from the system and control shall be discharged unobstructed vertically upwards to the ambient air from a stack with a maximum diameter of 4 inches at an exit point not less than 47 feet above ground level.

21. Applicant shall equip and maintain the control with a monitor capable of detecting breakthrough of the carbon, and initiating system shutdown if breakthrough occurs.

LLD:ms

DEPARTMENT OF NATURAL RESOURCES
AIR QUALITY DIVISION
P.O. BOX 30028
SING, MICHIGAN 48909

STATE OF MICHIGAN

AIR USE PERMIT APPLICATION

SEP 23 1991
PERMIT SECTION

APPLICATION NO. 7713-C

AIR QUALITY DIVI
AUG 26 19
PERMIT SECTIO

FOR AUTHORITY TO INSTALL, CONSTRUCT, RECONSTRUCT, RELOCATE, OR ALTER, AND OPERATE PROCESS, FUEL-BURNING, OR REFUSE-BURNING EQUIPMENT AND/OR CONTROL EQUIPMENT (PERMITS TO INSTALL AND OPERATE ARE REQUIRED BY ADMINISTRATIVE RULES PURSUANT TO ACT 348, P.A. 1965, AS AMENDED).

1. APPLICANT: Business License Name of Corporation, Partnership, Individual Owner, Government Agency
Reichhold Chemicals, Inc.

2. MAILING ADDRESS: Number and Street; City or Village; State; Zip Code
800 Capitola Drive, Durham, NC 27713

3. EQUIPMENT OR PROCESS LOCATION: Number and Street; City, Village or Township
707 Woodward Heights Blvd., Ferndale, MI — COUNTY: Oakland — ZIP CODE: 48220

4. GENERAL NATURE OF BUSINESS:
Chemical Manufacturing (Ferndale, MI Facility is no longer operating)

5. EQUIPMENT OR PROCESS DESCRIPTION:

Soil Vapor Extraction ~~Pilot~~ System - This pilot system will remove volatile organic compound (VOC) - laden air from the unsaturated zone of the soil. The VOC - laden air will pass through activated carbon canisters to remove VOCs prior to discharge to the environment. Please refer to the enclosed Air Permit Supporting Information for additional details on this pilot system.

6. ESTIMATED COST:
Air Pollution Control Equipment $ 50,000 ; Total Project $ 90,000

7. ACTION AND TIMING:

	ESTIMATED STARTING DATE	ESTIMATED COMPLETION DATE
[X] Installation, construction, reconstruction, or alteration	9/91	3/92
[ ] Relocation		
[ ] Change of Ownership		

8. NAME OF PRIOR OWNER AS IN ITEM 1 ABOVE, AND PRIOR AIR USE PERMIT NUMBER, IF ANY:
NAME — PERMIT NO.

9. NAME AND TITLE OF OWNER OR AUTHORIZED MEMBER OF FIRM
Name Mr. John W. Knaub — Signature See attached Authorization Form
Title: Senior Environmental Engineer — Date: 8-21-91 — Phone No. (919) 544-9225

10. CONTACT PERSON IF DIFFERENT THAN ITEM 9:
Name Mr. Scott J. Adamowski — Phone No. (313) 347-4350

DISPOSITION OF APPLICATION: FOR DNR USE ONLY

Receipt of all information required by Rule 203	2-6-92	
Permit to install approved * on	10-27-92	Signature Robert Miller
Permit to operate approved * on		Signature
Application/permit voided on		Signature
Application/permit canceled on		Signature

DEPARTMENT OF NATURAL RESOURCES
AIR QUALITY DIVISION
P.O. BOX 30028
LANSING, MICHIGAN 48909

STATE OF MICHIGAN

AIR USE PERMIT APPLICATION

FOR AUTHORITY TO INSTALL, CONSTRUCT, RECONSTRUCT, RELOCATE, OR ALTER, AND OPERATE PROCESS, FUEL-BURNING, OR REFUSE-BURNING EQUIPMENT AND/OR CONTROL EQUIPMENT (PERMITS TO INSTALL AND OPERATE ARE REQUIRED BY ADMINISTRATIVE RULES PURSUANT TO ACT 348, P.A. 1965, AS AMENDED).

APPLICATION NO. 1113-0

AIR QUALITY DIVIS

OCT 24 199

PERMIT SECTIO

1. APPLICANT: Business License Name of Corporation, Partnership, Individual Owner, Government Agency
OBG Operations, Inc.

2. MAILING ADDRESS: Number and Street; City or Village; State; Zip Code
5000 Brittonfield Parkway Suite 100, P.O. Box 4762, Syracuse, NY 13221

3. EQUIPMENT OR PROCESS LOCATION: Number and Street; City, Village or Township
707 Woodward Heights Blvd, Ferndale, MI

COUNTY: Oakland

ZIP CODE: 48220

4. GENERAL NATURE OF BUSINESS:
Operations/Maintenance Management

5. EQUIPMENT OR PROCESS DESCRIPTION:

Soil Vapor Extraction Pilot System - This pilot system will remove volatile organic compound (VOC) - laden air from the unsaturated zone of the soil. The VOC - laden air will pass through activated carbon canisters to remove VOCs prior to discharge to the environment. Please refer to the additional Air Permit Supporting Information for additional details on this pilot system.

6. ESTIMATED COST:
Air Pollution Control Equipment $ 50,000 ; Total Project $ 90,000

7. ACTION AND TIMING:

	ESTIMATED STARTING DATE	ESTIMATED COMPLETION DATE
[X] Installation, construction, reconstruction, or alteration	12/91	6/92
[ ] Relocation		
[ ] Change of Ownership		

8. NAME OF PRIOR OWNER AS IN ITEM 1 ABOVE, AND PRIOR AIR USE PERMIT NUMBER, IF ANY:
NAME PERMIT NO.

9. NAME AND TITLE OF OWNER OR AUTHORIZED MEMBER OF FIRM
Name: Mr. Greg C. Miller Signature: Greg C. Miller
Title: General Manager Date: 10-18-91 Phone No. (315) 437-8800

10. CONTACT PERSON IF DIFFERENT THAN ITEM 9:
Name Phone No. ( )

DISPOSITION OF APPLICATION: FOR DNR USE ONLY

Receipt of all information required by Rule 203: 2-6-92

Permit to install approved * on: 10-27-92 Signature: Robert Miller

Permit to operate approved * on: Signature:

Application/permit voided on: Signature:

Application/permit denied on: Signature: