Report. hw 828072 . 1998-06-05.

RP FS Report

FEASIBILITY STUDY OF REMEDIAL ALTERNATIVES

ERDLE PERFORATING COMPANY SITE
TOWN OF GATES, NEW YORK
NYSDEC SITE #828072

Prepared for:
Erdle Perforating Company
100 Pixley Industrial Parkway
Rochester, NY

Prepared by:
Radian Engineering, Inc.
Rochester, NY

Radian Project No. 801865.01

June 5, 1998

RADIAN ENGINEERING INC

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Table of Contents

APPENDICES

List of Tables

List of Figures

1

1.0 Introduction

This Feasibility Study of Remedial Alternatives has been prepared by Radian Engineering Inc. (REI) for The Erdle Perforating Company (Erdle) Site in Gates, New York in accordance with the requirements of The Administrative Order on Consent between Erdle and The New York State Department of Environmental Conservation (NYSDEC) dated October 24, 1994.

Phase I and Phase II Remedial Investigations (RI's) were completed by Radian Engineering, Inc. (REI) in June 1995 and December 1996, respectively. An Interim Remedial Measures (IRM) 2-Phase Vapor Extraction System began operations in July 1997 to minimize future migration of groundwater contaminants and reduce contaminant levels in the source area. The IRM operation was stopped in March 1998. An expanded IRM system to accelerate contaminant removal commenced operation in June 1998 and is expected to operate until soil cleanup objectives are met.

1.1 Site Location and Description

The Erdle Perforating Company site is located in the Town of Gates, New York (see Figure 1) and manufactures a variety of perforated metal products. The Erdle plant was constructed in 1968 on a site that was undeveloped farmland, and Erdle has been the only occupant of the building since its construction. The facility is located in an area that is zoned GI (General Industrial) and is surrounded by other commercial and manufacturing companies. Detailed information on the land use within a one-mile radius of the Erdle property is presented in the Phase I RI report and consists of mostly industrial/commercial users. The nearest residences to the facility are located approximately 500 feet away, southeast of the Erdle property.

The overall parcel is flat and within approximately 25 feet east, west, and south of the building the ground surface is either grassed or in its natural state. The portion of the site property north of the building consists of asphalt parking area and landscaped lawns, typical of businesses in commercial/industrial developments. There are wet areas (not NYSDEC-mapped wetlands) at the south and east parts of the parcel that are wooded and relatively inaccessible.

1.1.1 Site Hydrogeology and Surface Water

Site soils are of glacial origin, consisting of stratified drift overlying glacial till. From ground surface, there is approximately 4-5 feet of glacial stratified drift, underlain by a layer of weathered glacial till (which ranges from approximately 2 to 6 feet thick) and unweathered glacial till (which ranges from approximately 3 to 8 feet thick). The glacial stratified drift consists of dark brown clayey silt and brown fine sand (SM), generally massive bedded. The weathered glacial till consists of reddish brown to brownish gray clayey silt (ML), sometimes with gravel. The unweathered glacial till consists of reddish brown to brownish red clayey silt (ML-CL), sometimes with gravel. The weathered glacial till is distinguished from the underlying unweathered glacial till by the presence of minute vertical fractures, infilled with silty clay. The weathered and unweathered glacial tills are laterally consistent across the entire area investigated. Underlying the overburden is carbonate bedrock, encountered at a depth of approximately 13 feet.

The bedrock stratigraphy in the vicinity of the Site consists of sedimentary rocks of Silurian age, ranging from the Upper Clinton Group (Lower Silurian) to the Lower Salina Group (Upper Silurian). This section includes the Thorold Sandstone, Maplewood Shale, Reynales Limestone, Sodus Shale, Williamson Shale, Irondequoit Limestone, Rochester Shale, Lockport Dolomite, Pittsford Shale, and the Salina Formation. The Erdle Perforating Company property and the actual Site are wholly situated on the Lockport Dolomite.

The hydrogeology of the Site consists of two distinct water-bearing zones: 1) an unconfined, low-yielding zone in the overburden, and 2) a confined (artesian) shallow bedrock zone with substantially greater yield. These zones are separated by the unweathered glacial till which acts as a confining layer for the shallow bedrock groundwater flow zone. Borehole sample headspace screening results indicate the unweathered glacial till also inhibits the downward migration of VOCs from the former source. Static water level in wells screened in each zone is approximately 1 to 2 feet below ground surface. Groundwater flow under the Site is generally southward, i.e. towards a marshy area immediately south of the facility in both the overburden and shallow bedrock zones, and this is the likely migration direction for any release. Groundwater contour maps from both phases of the RI are provided in Appendices A and B.

The overburden materials, being made up of fine textured sediments, are substantially lower in hydraulic conductivity than the bedrock. Average hydraulic conductivity for the overburden is 3.4×10^{-5} cm/sec, ranging from 4.1×10^{-7} to 1.4×10^{-4} cm/sec. The unweathered till has a hydraulic conductivity of 6.2×10^{-6} cm/sec. Bedrock hydraulic conductivity averages 1.7×10^{-1} cm/sec and ranges from 7.5×10^{-4} to 3.9×10^{-1} cm/sec. Overburden wells typically go dry and recover slowly during purging and sampling. Bedrock wells, on the other hand, can be pumped at a rate of 20 gallons per minute with approximately 1-foot of drawdown.

The hydraulic gradient across the Site in the overburden flow zone is 0.36 ft/ft, based on information collected during the Phase I investigation. The bedrock hydraulic gradient ranges from 0.0005 to 0.0023 ft/ft. Based on these gradients, the average linear groundwater velocity in the overburden is 0.1 ft/day, while the bedrock average linear groundwater velocity ranges up to 11 ft/day.

Maps obtained from the Monroe County Environmental Management Council indicate that regional groundwater flow in the vicinity of the Site is to the south/southeast. The outcrop belt of the Lockport Dolomite creates a significant east-west trending bedrock ridge that acts as a regional groundwater divide. This divide is located approximately 3000 feet north of the Site. Groundwater occurs in the Lockport Dolomite along bedding planes, vertical joints, and solution cavities. Artesian groundwater conditions typically exist in the Lockport Dolomite, as evidenced at the Site.

Possible downgradient groundwater receptors include several residential areas to the southeast. Information from various Monroe County agencies presented in the Phase I RI Report indicates that all residential areas within a one-mile radius of the site are presently served by the Monroe County Water Authority, which receives its water from Lake Ontario.

Surface water from the former UST location drains south towards a wet area at the south end of the Erdle property. This wet area drains via a poorly defined channel into a north-south trending drainage ditch located along the west property line. This ditch drains approximately 3/4 mile downstream of the Erdle site into Little Black Creek, which in turn joins the Genesee River approximately 2 miles downstream from the confluence of Little Black Creek and the drainage ditch. To the east, a railroad spur constructed on a raised berm extends towards the Erdle Perforating building. This berm prevents surface water runoff from the former UST area from reaching the eastern parts of the parcel. Instead, surface water runoff is contained within the area west of this railroad spur and south of the building, and flows off the property only at the extreme southwest corner of the parcel.

1.2 Initial Discovery and Investigation

A petroleum-based straight oil lubricating agent (perforating oil) was used in the perforating process. Prior to December 1992, an onsite vapor degreasing process was used to remove the perforating oil from Erdle's finished product. The vapor degreasing process used a degreasing solvent composed of approximately 99% trichloroethylene (TCE). From early 1970s until 1987, the mixture of waste TCE (comprised of approximately 50% TCE) and perforating oil from the vapor degreaser was collected in a 2,000-gallon underground storage tank (UST) located at the southwest corner of the building. A second UST, located adjacent to the waste solvent tank, was used to store waste perforating oils. During sampling associated with a 1987 environmental audit, volatile organic compounds (VOCs) were detected in soil and groundwater in the vicinity of the waste solvent tank. Total petroleum hydrocarbons were detected in soil adjacent to the fresh oil tank during tank removal in July 1987. (The waste TCE tank, waste oil tank, and fresh oil tank were removed, as were 164 tons of backfill and topsoil).

Several environmental studies were conducted at the site since the discovery of VOCs in the subsurface at the former tank locations. Included in these investigations was the installation of monitoring wells in 1992, which were subsequently incorporated into the RI well network. These studies are summarized in Table 1 and detailed in the Remedial Investigation/Feasibility Study Workplan. This Final Workplan was prepared by Radian Corporation, submitted to NYSDEC in October 1993 and approved by the NYSDEC on November 29, 1993.

In addition, from 1993 to October 1994 a Consent Order governing the implementation of remedial activities at the Erdle site was negotiated. Field work for the RI/FS commenced after final approval of the Consent Order by all parties, and the Phase I RI was conducted in November-December, 1994. A Phase II RI was conducted in 1996 to complete the information gaps remaining following the Phase I investigation. Details concerning the RIs are presented in the following section.

1.3 Remedial Investigations

The RIs were conducted in two phases and were designed to collect site characterization data of sufficient breadth and quality to support the Feasibility Study (FS). An integral part of this strategy was to develop this database within the limited financial resources of Erdle Perforating Company. To balance these two objectives, the RIs contained the following features:

- A monitoring well network designed to provide groundwater flow direction and contaminant transport information for the overburden and the shallow bedrock groundwater flow zones (installed during Phase I and expanded in Phase II);
- A surface water and sediment sampling program oriented towards confirming the existing data, characterizing background conditions, and determining the presence or absence of contamination at three locations downstream of the former UST location (conducted during Phase I with a supplemental sediment sample during Phase II);
- Site surveys and literature research to describe the regional hydrogeologic setting of the site (Phase I);

- An ecological assessment which included a site walkover (Phase I) and impact analysis through Step 2B, per the document entitled, "Fish and Wildlife Impact Analysis for Inactive Hazardous Waste Sites (June 18, 1991)".
- Full TCL analysis focused on those locations, media, and pathways most likely affected by the former UST leakage, specifically the subsurface soils and groundwater (Phase I). Historical information on the site indicated that the surface pathways (i.e. surface water, soils, or air) were minor;
- Expanded analysis of subsurface soils at key locations to provide additional data on TCL contaminants most likely to be present, given the contamination history of the site (Phase I); and
- Air sampling and analysis focused on the contaminant source location and a background location (Phase I).

The Phase I RI was conducted from November to December 1994. After NYSDEC review of the Phase I RI report, a supplemental Work Plan was developed for a Phase II RI to fill in data gaps and further clarify the extent of contamination. This Work Plan was approved in January 1996 and the Phase II RI was completed during July to August 1996. Figure 2 shows the location of the RI boreholes and monitoring wells in the main study area south of the Erdle Perforating building (an additional upgradient well cluster is located north of the building and is not shown on the figure). Figures and tables from the RIs are annexed in Appendices A and B for reference.

The RIs determined that the principal contaminants of concern at the site are volatile organic compounds (trichloroethene, 1,2-dichloroethene, and vinyl chloride) present in subsurface soils and groundwater under the site. Table 2 presents a list of constituents detected in the various environmental media at the site. Boldface text has been used to indicate constituents which were present at concentrations above the applicable NYSDEC guidance values (footnoted on the table) for each matrix.

VOCs in subsurface soils occur at the greatest concentrations (and above guidance values) within the depth range of 5 to 7 feet, based on RI samples collected near the former source. Dominant constituents were trichloroethene and 1,2-dichloroethene. Soil from shallower intervals near the source (MW-1) had markedly lower concentrations, below NYSDEC guidance values.

Samples from all of the non-background groundwater monitoring wells had detections of VOCs, but exceedances of guidance values occurred mainly in the overburden at the former source and approximately 75 feet downgradient (MW-3). VOCs were also detected in the shallow bedrock wells at concentrations above guidance values at the former source location, at MW-3D, and at the MW-6D location approximately 200 feet downgradient of the former source. Samples from a deeper bedrock well have not contained detectable concentrations of VOCs, indicating that the vertical extent of contamination is limited to the overburden and shallow bedrock. Concentrations in the overburden were 2 to 3 orders of magnitude greater than the bedrock.

VOCs were detected in surface water at the "old" outfall location and at a point towards the southern end of the drainage ditch. Compounds detected above NYSDEC guidance values were 1,2-dichloroethene, trichloroethene, tetrachloroethene, and vinyl chloride. No VOCs were detected in the marsh directly south of the source area, where groundwater from the overburden discharges.

VOCs were also detected in sediment samples from the "old" outfall location at concentrations below NYSDEC action levels. A Phase I RI sediment sample also had metals above NYSDEC guidance levels; but additional sampling and criteria development research during Phase II determined that the metals found during Phase I were below criteria. The "old" outfall location has been inactive for over 6 years and is not considered a source, based on site data.

SVOCs were not detected above NYSDEC guidance values in groundwater, surface water, or sediment samples. Four SVOCs (indicated on Table 2) were present above guidance values at one shallow soil sample location (0 to 1 feet at MW-1) near the former source. SVOCs were not detected in the deeper (5 to 7 foot) sample from the same location.

Metals were detected above NYSDEC guidance values in each of the sampled media (except air), however, for many metals parameters the guidance identifies the cleanup level as "site background." For the Site, subsurface soil samples from the 5-7 foot interval were compared with a background sample taken from the 5-7 foot interval of MW-5 (located upgradient of the building). Surface soil samples, and subsurface soil samples from the 0-1 foot interval, were compared with a sample taken from the 0-1 foot interval at MW-5. The exceedances were typically for metals that either naturally occur in abundance in geologic media or are strongly linked to physical, chemical, or biological processes in soil and groundwater. Spatial variability in concentrations for such metals is high; for example, there was as much variability in concentrations for these metals in soils samples from adjacent depths within the background boring as there was from background to non-background locations. In the case of groundwater, background levels were generally the highest and the exceedances were typically for metals that naturally occur at elevated levels (i.e. iron and manganese) or for major groundwater ions (i.e. sodium).

No PCB compounds were detected in any of the soil or groundwater samples above detection limits. PCB compounds were not detected in any of the surface water or sediment samples.

Flux chamber sampling over the former source detected no impact from possible VOC vapors emanating from the subsurface. Laboratory results from the sampling were converted per U.S. Environmental Protection Agency guidance and NYSDEC guidance to concentrations directly over the waste site (Ca) and maximum potential annual concentrations (Cp). In no case did the Ca or Cp value exceed the relevant NYSDEC guidance value. Details of the air sampling and data reduction are presented in the RI reports.

Sufficient information was obtained during the RIs to evaluate and propose 2-PHASE Extraction as an Interim Remedial Measure (IRM) to begin remediation of the Site. The IRM was proposed in order to remediate source-area soils, thus limiting future contributions of the target compounds to groundwater. Preliminary technology evaluations presented in the RI reports indicated that the following four approaches are appropriate for the site: no-action; excavation and disposal of contaminated soils; conventional pump-and-treat removal of contaminated groundwater from the overburden and bedrock water-bearing zones; and in situ remediation of both soil and groundwater by dual-phase vacuum extraction. The advantages and disadvantages of each of these technologies was considered in the RI reports, with the recognition that a complete FS would be required for final remedial technology selection and implementation.

1.4 Interim Remedial Measures

An Interim Remedial Measures (IRM) has been implemented at the site. The 2-PHASE Extraction System was selected as the IRM to remove VOC's of concern from the saturated and unsaturated zones of the source area. The IRM design is described in detail in the Final Design Report/Start-Up, Operation and Maintenance Manual prepared by REI, March 31, 1997.

The IRM was operated from July 2, 1997 through March 5, 1998 and has been restarted as an expanded system in June 1998. Four extraction wells (EW) screened in the shallow till zone were used for the first two quarters of operation. Four additional wells have been added in the expansion (see Figure 3). The expanded IRM is now in operation. It is expected to operate until soil cleanup objectives are met.

IRM operational and performance data are documented in quarterly operations progress reports submitted to NYSDEC. Two progress reports have been submitted to-date:

- Quarter 1: July – September 1997
- Quarter 2: October – December 1997

Operational data over the first two quarters is summarized as follows:

IRM Operations Summary

Quarter	Water Removal		Vapor Removal	Operating Hours
	Gallons	GPM	SCFM	
1	25,651	0.38	23.8	1433.5
2	32,192	0.55	24.5	1326.7

Performance data over the first two quarters in terms of VOC removal is summarized as follows:

IRM Performance Summary

Quarter	VOC Mass Removal, lbs	
	Vapor	Liquid
1	78.74	0.03
2	30.92	2.59

Mass removal rates of VOC declined significantly over the first two months of operation and reached an approximate equilibrium rate over the last four months of 1997.

Groundwater and soil samples have been taken to assess contaminant concentration reductions during the IRM operation. Significant VOC reduction has been realized in overburden well MW-1 and bedrock wells MW-1D and MW-3D. VOC reduction in MW-1 has resulted from the location of MW-1 within the radius of influence of EW-1. In the bedrock wells, VOC reduction can be attributed to overburden groundwater extraction initiating upwelling and some groundwater removal from the bedrock. Also, deeper overburden concentrations have likely been reduced. However, in overburden wells and MW-2, MW-3, and MW-4, VOC concentrations have remained fairly constant. Soil samples collected from the confirmatory test borings (CB) confirm that VOC concentrations in the shallow overburden are still elevated, probably as a result of the 2-PHASE system's focus on the deeper overburden. The connection of existing wells MW-1, MW-3, and MW-D-2, and new well EW-5 to the IRM system will augment the 2-PHASE system's ability to address the shallow overburden.

Based upon the performance of the IRM to date, and the evaluation of alternatives presented in this Feasibility Study, the expanded IRM could be incorporated directly into a Record of Decision (ROD) for the Erdle site.

2.0 Identification of General Response Action

2.1 General

This section of the Feasibility Study Report identifies the General Response Actions that will serve as the basis for the remedial action alternatives to be evaluated. General Response Actions (and the subsequent remedial technologies and process options) have been limited to those actions that are most likely to be implemented based on the screening criteria.

2.2 Remedial Action Objectives

Remedial Action Objectives are based upon media-specific and general requirements. Media-specific remedial action objectives are based upon reducing potential health risks associated with the contaminants of concern at the Site, which in this case include soil and overburden groundwater. The following remedial action objectives have been established for this Site:

- Prevent human contact with the soil containing contaminants of concern at levels unacceptable to human health;
- Minimize migration of the contaminants of concern from the soil to the groundwater;
- Prevent migration of the contaminants of concern from the groundwater to the surface water to protect human and ecological receptors;
- Prevent human contact with the groundwater and surface water containing the contaminants of concern at levels unacceptable to human health;
- Prevent future off-site migration of the contaminants of concern via groundwater at levels unacceptable to human receptors; and
- Protection of the environment including soils, sediment, and biota.

Cleanup levels for site soils have been calculated based on protection of potential groundwater receptors at the downgradient properly line. Potential groundwater exposures were assumed to be by general human domestic uses (ingestion and bathing). Groundwater standards established by NYSDEC were used for the site contaminants of concern. See Appendix C for the Development of Soil Cleanup Levels.

2.3 General Response Actions

General Response Actions are media-specific actions taken to satisfy the remedial action objectives for the Site. These actions are categorical approaches to remediation that comprise the various technologies and process options. The following General Response Actions have been identified for each of the impacted media at the Site:

2.3.1 Soil

- No Action;
- Institutional Action;
- Excavation and Off-Site Disposal; and
- In-Situ Treatment.

2.3.2 Groundwater

- No Action;
- Institutional Action;
- Groundwater Collection;
- Groundwater Treatment; and
- Vapor Treatment.

Vapor treatment has been included as a General Response Action for groundwater since groundwater extraction and/or treatment processes may generate vapor streams that would require treatment (e.g., 2-PHASE Extraction, soil vapor extraction, etc.).

2.4 Extent of Remediation

The extent of remediation is determined by the extent and location of the contaminants of concern and the remedial action objectives for the Site. The contaminants of concern are primarily limited to the southern side of the facility, adjacent to and south of the former waste solvent tank. All other areas of the Site are essentially free of contaminants of concern, with concentrations (if any) below regulatory and guidance levels. The media to be considered are soil and groundwater.

2.4.1 Soil

Results of soil analyses indicate that the impacted soil at the Site is contained within a 100-foot radius south of the former waste solvent tank on the south side of the manufacturing building. Figure 4 presents a summary of the current subsurface soil analytical results.

2.4.2 Groundwater

Groundwater in the overburden and shallow bedrock aquifers have been impacted in the area of and downgradient (south and southwest) of the former waste solvent tank on the south side of the manufacturing building. Figure 5 presents a summary of the current groundwater analytical results.

2.4.3 Contaminants of Concern

The contaminants of concern identified at the Site are primarily VOCs and are listed in Table 3. These contaminants have been identified because they exceed one or more of the chemical-specific Standards, Criteria and Guidelines identified in the next subsection, and were not eliminated from further investigation and remedial action based on evidence presented in the RI reports.

2.5 Standards, Criteria and Guidelines

Standards, Criteria and Guidelines (SCGs) are divided into the following categories:

- **Chemical-Specific SCGs:** Health or risk-based concentration limits or ranges in various environmental media for specific hazardous substances, pollutants, or chemicals. These limits may take the form of clean-up levels, discharge limits, and/or maximum intake levels (such as for drinking water for humans);
- **Location-Specific SCGs:** Restrictions of remedial activities that are based upon the characteristics of a site or its immediate environment. An example would be restrictions on wetlands development; and
- **Action-Specific SCGs:** Controls or restrictions placed on a particular type or types of remedial activities in a related area, such as hazardous waste management or wastewater treatment.

2.5.1 Chemical Specific SCGs

The source of the contaminants at the Site was a waste solvent tank from degreasing operations. This makes the solvent waste a listed hazardous waste (F001/F002) by the "Contact Rule". Therefore, all media that comes in contact with the waste is subject to RCRA classification if it fails the characteristic criteria.

Risk-based soil cleanup levels were calculated for the site that are protective of public groundwater uses at the site downgradient property line. Contaminants evaluated were the VOCs: 1,2-dichloroethene, trichloroethene, methylene chloride, and vinyl chloride, which had soil concentrations that exceeded the NYSDEC TAGM guidelines for soil cleanup. The soil

Not!

cleanup levels were generated using guidance provided by NYSDEC and U.S. EPA. Calculations are provided in Appendix C.

The following table presents the source area overburden groundwater and soil clean-up criteria calculated from these methods.

	Overburden Soil Clean-Up Criteria (mg/kg)	**Overburden Groundwater Clean-Up Criteria (mg/L)**
Trichloroethylene	6.9	5.5
1,2-Dichloroethylene	3.2	5.5
Vinyl Chloride	0.34	2.2
Methylene Chloride	1.2	5.5

2.5.2 Location-Specific Requirements

During the Phase I RI there were no endangered, threatened or special-concern species documented to exist within a 2-mile radius of the Site. No critical habitats were documented within this range and none of the plant communities observed on-site are of limited range or threatened within New York State.

Although no federal or state wetlands are mapped on the Site, the south area of the Site would meet the federal wetlands criteria. However, this wetland is less then 12.4 acres in size and not protected under New York State regulations. Phase I RI studies indicated that the nearest protected freshwater wetlands, pursuant to Article 24 of the Environmental Conservation Law, is located approximately 1,300 feet west of the Site. This wetland is designated GT-4. The site does not contribute to drainage to this wetland.

The Town of Gates Engineering Department has confirmed that the site is within the 100-year flood plan. Therefore, Executive Order 11988 of May 24, 1997, which requires measures to minimize potential harm to or within the flood plains, is an applicable requirement.

These requirements are considered applicable or relevant requirements in the selection of a remedial alternative.

Then
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guidance

2.5.3 Action-Specific Requirements

Action-specific SCGs pertaining to remedial technologies at the Site define the regulatory framework within which the technologies may be developed and executed. Federal regulations that must be considered in the technology screening include the CERCLA and its amendments under SARA, the Federal Clean Air Act and its amendments, the Clean Water Act and its amendments, and RCRA (40 CFR 262 and 264). The hazardous and Solid Waste amendments to RCRA, including Land Disposal Restrictions, provide additional potential requirements. New York State has promulgated the RCRA mandates through the State Hazardous Waste Management System, 6 NYCRR Parts 370 through 374.

RCRA requirements include groundwater protection, general landfill standards, and standards for waste piles and surface impoundments. Specific SCGs of concern depend on the remedial alternative selected. For example, if hazardous wastes are transported off site, regulations applicable to the transporters of hazardous waste (40 CFR 263 and 6 NYCRR Part 364) would be applicable. Transporters must obtain a USEPA identification number, NYSDEC transporter permit, and comply with the manifest system, which documents the shipment and delivery of hazardous wastes, in accordance with 40 CFR 262.

Remedial Activities at the Site may include excavation and off-site disposal, in-situ treatment, and groundwater collection and treatment. In addition to the above-stated requirements for off-site disposal, on-site container storage of hazardous wastes not meeting small quantity generator criteria for waste held temporarily (less than 90 days) is subject to RCRA requirements (40 CFR 262). Tank storage requirements (e.g. for dewatering activities) are listed in 40 CFR 264.190 through 264.198.

In-situ waste treatment does not trigger RCRA applicability, since it is not considered placement (disposal) of wastes. However, the design and operating standards for the waste treatment unit may be relevant and appropriate (40 CFR 264.601).

Discharges to a publicly owned treatment works (POTW) must not include pollutants that create a fire or explosion hazard, cause corrosive damage, obstruct flow, or increase the temperature of the wastewater so as to cause interference with the treatment plant. Discharges must also comply with local POTW pre-treatment programs and facility discharge requirements.

On-site discharge of treated groundwater is assumed to be to the Monroe County Pure Waters District (MCPWD) sewer via a sanitary drain in the Erdle plant. MCPWD requirements provided for the IRM treatment system discharge are expected to be appropriate for any remedial alternatives requiring onsite discharge.

Certain unit operations that may be part of the groundwater treatment system may involve air discharges (e.g., air stripper or 2-PHASE Extraction). Air discharges must meet the requirements of 6 NYCRR Part 212.

Groundwater monitoring requirements are covered in 40 CFR 264, Subpart F.

3

3.0 Identification of Technology Types and Process Options

3.1 General

This section identifies the potential remedial technologies based on technical implementability. Remedial technologies are selected for each environmental medium (soil and groundwater) and general response action. Corresponding process options are also presented with each remedial technology.

3.2 Remedial Technologies for Soil

3.2.1 No Action

The "No Action" alternative must be examined as required by the National Contingency Plan (NCP). This "technology" includes preserving the existing Site conditions, maintaining the current levels of maintenance and control and performing no additional remedial actions. Since there is currently an IRM operating at the site, the No Action alternative would involve ceasing all IRM activities.

3.2.2 Institutional Action

Institutional Actions for the prevention of direct human contact include permanent deed restrictions, controlling the use and development of the Site, site access controls, and long-term monitoring of the levels of the contaminants of concern.

3.2.3 Excavation and Off-Site Disposal

This technology involves the excavation, transportation, and disposal of part or all of the soils containing the contaminants of concern. Waste would be transported to an approved commercial treatment facility (e.g., a RCRA facility or solid waste facility) for treatment and/or disposal. This technology may be applied to any of the areas of concern at the Site. However, as the amount of soil to be handled increases the less cost-effective this option becomes.

If TCLP limits are exceeded during excavated waste characterization, the soils may be subject to RCRA Land Ban Restrictions, and could not be disposed of off site without treatment unless a treatment variance were in effect.

3.2.4 In-Situ Treatment

The following in-situ treatment technologies are potentially applicable to the Site; none involve soil excavation.

- In-situ biological treatment consisting of the injection, collection, biological treatment and reinjection of nutrient and/or biologically enhanced water across the Site. The feasibility of this option depends upon the hydrogeological characteristics of the Site (e.g., gradient, groundwater levels, K-values, etc.) and the biodegradability of the contaminants of concern.
- In-situ chemical treatment involving the injection, collection, chemical treatment, and reinjection of chemically treated water across the Site. The treated water leaches the contaminants of concern from the soil, where they can be treated using a wide variety of chemical and/or physical treatment processes.
- Vacuum extraction from wells drilled into the area containing the contaminants of concern, thereby volatilizing them from the vadose zone into the vapor stream, and (in dual phase or 2-PHASE extraction) removing groundwater from the saturated zone. The collected vapors/water would be treated and/or discharged.
- In-situ solidification (or stabilization or fixation) consisting of the direct application of additives to the soils to reduce the mobility of the contaminants of concern. Direct application is achieved through soil mixing techniques (large-flighted augers on specially designed drill rigs). With the proper formulation of an additive, the mobility of the contaminants of concern can be reduced to such an extent as they cannot be released or leached from the resultant product.

3.3 Remedial Technologies for Groundwater

3.3.1 No Action

The "No Action" alternative is included as required by the NCP. This "technology" includes conserving the existing Site conditions, maintaining the current levels of maintenance and control and performing no additional remedial actions, along with a groundwater monitoring program. Natural attenuation mechanisms that reduce the concentration and migration of contaminants, such as sorption, biodegradation and dispersion, would be ongoing under this alternative. These mechanisms could be evaluated as part of the long-term monitoring program to determine their effectiveness in remediating site contaminants. Because there is currently an IRM operating at the site, the No Action alternative would involve ceasing all IRM activities.

3.3.2 Institutional Action

Institutional Action would allow for future use of the Site; however, the use of groundwater would be prohibited. To ensure that groundwater is not used, permanent deed restrictions would be established. Because the groundwater table is near the surface, access to groundwater would have to be restricted. In addition, a long-term environmental monitoring program would be developed in conjunction with the appropriate regulatory agencies.

3.3.3 Groundwater Collection

Groundwater collection may be used to prevent the migration of groundwater containing the contaminants of concern off site. Extraction of the overburden groundwater via pumping or vacuum extraction downgradient of and/or within the areas of concern may be applicable.

3.3.4 Groundwater Treatment

If groundwater is collected from the Site, the groundwater may be treated on site, off site, or a combination of both. On-site pre-treatment would be required if the collected and treated groundwater is to be discharged to the POTW. Possible on-site treatment options include carbon adsorption, air stripping and UV-oxidation to remove and/or destroy the contaminants of concern. If extraction rates are not sufficient, groundwater may be temporarily stored on-site for transportation to a commercial treatment facility permitted to receive this type of aqueous waste.

3.3.5 Vapor Treatment

If a contaminated vapor stream is generated either from the extraction process (e.g., 2-PHASE extraction or soil vapor extraction processes) or during the treatment process (e.g., air stripper), the vapor stream may have to be treated prior to discharge to meet the requirements of 6 NYCRR Part 212. Treatment options for VOC-contaminated vapor stream include an adsorptive process (e.g., activated carbon or other adsorptive media) or destruction (e.g., oxidation, either thermal or catalytic).

3.4 Selection of Technologies

A preliminary identification of technologies and process options was presented in the preceding section. At least one process option from each of the technologies presented in this section are considered feasible, based on implementability.

4

4.0 Screening of Technology Types and Process Options

4.1 General

Criteria for the screening of remedial technologies and process options are based on their ability to achieve a permanent and significant decrease in the toxicity, mobility, or volume of the contaminants of concern to the maximum extent practicable. Preference is given to those technologies and process options that provide a permanent additional protection to human health and the environment from the risks (if any) posed by the contaminants of concern. The criteria to be used are based upon a hierarchy of remedial technologies, in which the order of preferable technologies (from the most desirable to the least desirable) is:

- **Destruction:** An irreversible destruction or detoxification of all or most of the contaminants of concern to levels satisfying the remedial action objectives and resulting in no residue containing unacceptable levels of hazardous constituents. This will achieve a permanent reduction in the toxicity of the contaminants of concern.
- **Separation/Treatment:** Separation of the hazardous from non-hazardous constituents, resulting in two waste streams, one with levels of contaminants of concern that meet the remedial action objectives and the other a concentrated waste stream with high levels of the contaminants of concern for treatment. This treatment will achieve a permanent and significant reduction in the volume of the contaminants of concern.
- **Solidification/Chemical Fixation:** This technology will produce a significant and permanent reduction in the mobility of the contaminants of concern. It may or may not significantly reduce the toxicity or volume of the material.
- **Control and Isolation:** This technology produces a significant reduction in the mobility of the contaminants of concern, but with no significant reduction in toxicity or volume. This also may include physical barriers to control the migration of groundwater and the pumping and treating of groundwater.

Preferences will be give to those remedial technologies that have been successfully demonstrated on a full scale or pilot scale under one or more of the following:

- Superfund Innovative Technology Evaluation (SITE) Program;
- At a Federal or state Superfund Site;
- At a Federal Facility;
- At a PRP Site overseen by a State Environmental Agency or the USEPA; or
- Is currently operating under a RCRA Part B permit or a RCRA Research and Development Permit.

A remedial technology that has a documented history of successful treatment will also be given preference.

The evaluation of process options for effectiveness and implementability focuses upon the following:

- Potential effectiveness for handling the estimated areas or volumes of adversely impacted environmental media;
- Ability to meet the remedial action objectives;
- Potential impacts upon human health and the environment during construction and implementation; and
- Estimated success and reliability when applied to the conditions at the Site.

4.2 Technology Screening for Soils

4.2.1 Excavation and Off-Site Disposal

This option would include the excavation of part or all of the soils that exceed cleanup levels, loading of the soils into a transport vehicle, and transportation and disposal of the soils at a secure landfill. The excavation of all of the soils containing the contaminants of concern may not be feasible, due to the proximity of some of these soils to the building foundation and the artesian groundwater conditions in the bedrock. It would be too costly, given the minimal risk to human health and the environment posed by these soils and the risks associated with excavation adjacent to the building footer. Excavation of soils to bedrock would breach the overburden confining layers, resulting in substantial quantities of water to be managed. However, a majority of the adversely impacted soils could be excavated to a depth of approximately 10 feet below ground surface.

As part of this option, a NYSDEC-approved borrow source would need to be identified which is capable of supplying a fill material of similar characteristics to those removed. This material would need to be placed as an engineered fill to maintain the confining properties of the overburden and prevent upwelling and groundwater discharge from the bedrock.

If the soils do not exceed RCRA characteristic levels, the soil may be permitted for acceptance at a solid waste landfill as a "special waste." If not, additional activities may be required, including development of treatment standards that would allow the waste to be treated and then handled by a solid waste facility. Otherwise, regulations would require that the excavated soils be handled as a RCRA hazardous waste at a transport, storage, and disposal facility (TSDF).

Excavation and off-site disposal would permanently and significantly reduce the volume of the contaminants of concern at the Site. By reducing this volume, both the mobility and toxicity of the hazardous constituents would also be reduced. For these reasons, excavation and off-site disposal is considered feasible for some or most of the Site soils and will be retained for further evaluation.

4.2.2 In-Situ Soil Treatment

A. **Biological Treatment**
This process would involve the injection, collection, biological treatment and reinjection of water across the Site. In-situ biological treatment would permanently and significantly reduce the toxicity of the contaminants of concern at the Site. However, due to the relatively high and variable water table, the marshy nature of the site, and the low permeability of the Site soils, groundwater control with reinjection would be extremely difficult to achieve. For this reason, in-situ biological treatment has been deemed not feasible for this Site.

B. **Physical Treatment**
This process would involve the injection, collection, chemical treatment and reinjection of water across the Site. In-situ chemical treatment would permanently and significantly reduce the toxicity of the contaminants of concern at the Site. However, for the same reasons as the biological treatment was excluded, the reinjection associated with physical treatment make it also an extremely difficult technology to achieve. For these reasons, in-situ physical treatment has been deemed not feasible for this Site.

C. **Vacuum Extraction**
This extraction process consists of the installation of an extraction well in the areas containing the contaminants of concern. For single-phase (vapor) vacuum extraction, the well is screened in the vadose zone. A vacuum is placed over the well and the gas phase acts as an in-situ air stripper, with the volatile organic compounds being partitioned from the soil into the vapor phase and removed from the subsurface. The vapor stream is then treated and discharged to the atmosphere. With 2-PHASE Extraction (vapor and groundwater), the well is also screened below the water table. In the case of 2-PHASE Extraction, a liquid phase (the groundwater) is also removed by entertainment into the vapor phase. The phases are separated at the surface and treated as necessary for discharge.

The system utilizes extraction wells screened through the saturated and unsaturated zones to extract soil vapor and groundwater through the application of a high vacuum (up to 28" Hg vacuum). Vapor and water are separated and treated by appropriate means.

Vacuum extraction will permanently and significantly reduce the volume, mobility, and toxicity of the contaminants of concern. However, single-phase vacuum extraction will not significantly reduce contamination in the saturated zone. In addition, single-phase vacuum extraction is most effective in somewhat porous soils, through which the air can pass freely. Since the overburden soils in the areas of concern have a hydraulic conductivity in the range of 10^{-5}, single-phase vacuum extraction has been eliminated from consideration as a feasible process.

2-PHASE extraction will affect contaminants in both the saturated and unsaturated zones. In addition, 2-PHASE extraction is more effective in low permeability soils such as those encountered at the Erdle facility. 2-PHASE extraction has been implemented at the Site as an IRM. As discussed in Section 1.0, the 2-PHASE extraction system has made significant advances in decreasing the levels of the contaminants of concern in the bedrock aquifer. It is anticipated that modification of the system to focus on the overburden would create the same conditions. For these reasons, 2-PHASE extraction will be retained for further consideration.

D. **In-Situ Solidification**

The in-situ solidification process consists of the introduction and in-situ mixing of solidifying agents to the soil, and encapsulation and/or chemical binding of the contaminants of concert within the media. With the formulation of a proper additive for the contaminants of concern, in-situ stabilization would effectively limit the mobility of the contaminants of concern.

Significant amounts of long-term dewatering would be required during the in-situ mixing and hardening of the solidification agent, to prevent the dilution of the solidification agent. Due to the high water table, leaching would be a significant concern and would most likely require high-cost additives to prevent leaching. It is also difficult to monitor the distribution of stabilizing agents through the depths of soil. For these reasons, in-situ stabilization has been eliminated from further consideration as a feasible remedial alternative.

4.3 Technology Screening for Groundwater

4.3.1 Groundwater Collection

Groundwater collection at the Site would be used to prevent the off-site migration of the groundwater containing the contaminants of concern, and to remove contaminants from the subsurface.

A. Pumping Groundwater from Extraction Wells
Properly placed groundwater extraction wells could be used to remove groundwater from the overburden aquifer. Existing monitoring wells and/or the 2-Phase extraction wells could be used because they are located within and downgradient of the source area. Additional wells may be necessary in and around the plume area to enhance recovery activities. Collected groundwater would be treated prior to discharge onsite in the POTW sewer.

The use of pumping wells will produce a hydraulic gradient away from the property line and reduce, if not reverse, localized groundwater flow in the vicinity of the plume. When combined with a remedial technique for soil, groundwater pumping would permanently and significantly reduce the mobility of the contaminants of concern. For these reasons, pumping groundwater from withdrawal wells has been retained as a feasible remedial alternative.

B. Groundwater Extraction via 2-PHASE Extraction
The 2-PHASE Extraction system was described under Section 4.2.2.C.

Groundwater extraction via 2-PHASE Extraction will permanently and significantly reduce the volume, mobility, and toxicity of the contaminants of concern. As discussed in Section 1.0, the existing 2-PHASE extraction system (installed under an IRM) has made significant advances in decreasing the levels of the contaminants of concern in the bedrock aquifer. It is anticipated that modification of the system to focus on the overburden would create the same conditions. For these reasons, groundwater extraction via 2-PHASE extraction will be retained for further consideration.

4.3.2 Groundwater Treatment

A. Off-Site Groundwater Treatment
Off-site treatment of groundwater containing the contaminants of concern collected by a groundwater extraction system would be accomplished by transporting the groundwater to a POTW or commercial aqueous hazardous waste treatment facility. Off-site treatment would require on-site storage of the collected groundwater and periodic pick-up of the groundwater and transportation to the treatment facility.

B. On-Site Groundwater Pre-Treatment
The groundwater containing the contaminants of concern can be pre-treated to a level where it could be accepted by the local POTW. There are a variety of options for treating the collected groundwater to remove the contaminants of concern. The current IRM system has been pre-treating collected groundwater with granular activated carbon for discharge to the POTW. This method has successfully removed the contaminants of concern from the groundwater stream prior to discharge to the POTW with out any exceedances of the sewer district

discharge limitations. The cost has been very low, at approximately $0.02 per gallon to treat the water.

Based on the low groundwater flow rates currently observed in the IRM system (approximately 0.4 gallons per minute from four wells), the relative low cost of carbon treatment, and the success in meeting regulatory guidelines, on-site groundwater treatment via granular activated carbon will be retained for further consideration.

4.3.3 Vapor Treatment

If 2-PHASE Extraction is used as part or all of the treatment system, a vapor stream will also be generated that will require treatment prior to discharge. The current IRM uses adsorption with vapor-phase granular activated carbon. Soil vapor has been generated at an average rate of approximately 25 standard cubic feet per minute. The cost for the vapor phase treatment has been minimal (approximately $0.00075 per cubic foot or $27 per day). There were several detections of the contaminants of concern at the discharge during the first quarter of operation. However, since system operation became more stable, there have been no contaminants of concern released from the vapor treatment system. For these reasons, vapor phase treatment via carbon adsorption will be retained as a feasible alternative.

4.4 Technology Screening Summary

The remedial technologies and corresponding process options selected for consideration in the development of the alternatives are shown on Figures 6 and 7 for soils and groundwater, respectively.

4.5 Development of Alternatives

The remedial alternatives are site- and media-specific remedial technologies and associated process options that, when combined and implemented, will achieve the remediation goals for the Site. The formulation of remedial alternatives from the remedial technologies are based on the following criteria:

- Alternatives may include a range of general response categories, including no action, institutional action, containment, excavation/removal, physical controls and groundwater collection and treatment; and
- Alternatives must address all principal health concerns and environmental remedial action objectives identified for the adversely impacted environmental media at the Site.

Additional information regarding remedial alternatives is provided by "Guidance for Conducting Remedial Investigations and Feasibility Studies Under CERCLA" (OSWER Directive No. 9355.3-01, October 1998).

Based on the above criteria, five remedial alternatives were developed for evaluation at the Erdle site, as shown on Figure 8.

Alternative 1 is "No Action". This alternative is presented as required by the NCP and represents a continuation of existing site conditions (which, in this case, includes ceasing operation of the IRM system). This alternative is the "base case" to which the other alternatives are compared.

Alternative 2 is "Institutional Action". This alternative includes deed restrictions and land and groundwater use to minimize or eliminate potential contact with the adversely impacted media. A fence will also be installed around the southern half of the property, including signs identifying the area as a hazardous waste site.

Alternative 3 is "Excavation and Offsite Disposal". Soils exceeding the health risk based site clean-up levels will be excavated and disposed of off-site. The area will be backfilled with similar soils from an approved fill source. No additional actions would be needed.

Alternative 4 is "Groundwater Extraction and Treatment". A groundwater pump-and-treat system would be constructed to prevent adversely impacted groundwater from leaving the property and remove some of the contamination from the subsurface.

Alternative 5 is "2-Phase Extraction". An expansion of the existing 2-PHASE Extraction IRM would be implemented to focus the remediation on the clean up of the overburden soils and groundwater.

All options, with the exception of the "No Action" and 2-Phase alternatives, would also require a long-term maintenance and monitoring plan to track the effectiveness of the remedy and to identify any problems that may arise over time. The effectiveness of 2-Phase can usually be demonstrated with a shorter-term monitoring plan.

5

5.0 Detailed Evaluation of Alternatives

5.1 General

In this Section, the alternatives developed in the previous section and summarized in Figure 8 undergo a detailed evaluation in order to select the most appropriate and cost-effective remedy.

These alternatives are described as follows:

- **Alternative 1 – No Action**: Involves no activities, short-term or long-term, at the Site.
- **Alternative 2 – Institutional Action**: Involves long-term groundwater monitoring and Site use/access restrictions (including deed restrictions). A permanent fence and hazard signs around the area of concern (southern half of the site) will be installed and maintained, as shown on Figure 9.
- **Alternative 3 – Excavation and Off-Site Disposal**: As shown on Figure 10, this alternative involves the excavation and off-site disposal of soils containing the contaminants of concern in excess of the health risk-based clean-up levels to be protective of human heath and the environment. The area would then be backfilled with similar soils in an engineered backfill.
- **Alternative 4 – Groundwater Extraction and Treatment**: As presented on Figure 11, this option involves the installation of a pump and treat system to extract groundwater from four (4) pumping wells in the overburden (to the top of bedrock) and treat the collected groundwater with granular activated carbon, and discharge to the local POTW.
- **Alternative 5 – 2-PHASE Extraction**: As shown on Figure 12, Alternative 5 involves the enhancement of the existing 2-PHASE extraction system to include four (4) additional wells. Extracted groundwater and soil vapor will be treated with granular activated carbon prior to discharge.

All alternatives, except for the "No Action" and 2-Phase alternatives, would include a long-term maintenance and monitoring program to track the effectiveness of the remedy. For estimating purposes, a 30-year performance of the monitoring program has been included for all alternatives. This performance time may be much less if the monitoring program indicates that there is no further risk to human health and the environment.

The detailed evaluation of alternatives consists of three steps:

1. The costs associated with the implementation and operation of each of the alternatives are estimated.
2. A determination is made of an individual alternative's effectiveness in meeting the following requirements:
   - Protection to human health and the environment;
   - Attainment of Standards, Criteria and Guidelines;
   - Short-term and long-term impacts, effectiveness and implementability; and
   - Provisions for the designed alternative to permanently and significantly reduce the toxicity, mobility or volume of hazardous waste at the Site.

   In order to make this determination, a weighted-matrix scoring system is used to assign numerical values to each alternative, based on how well the alternative satisfies the requirements listed above; and

3. A comparative analysis in which the alternatives are compared to each other using the results of the weighted-matrix scoring system and the cost estimates for each alternative. A recommended remedial alternative will be selected at the conclusion of the comparative analysis.

5.2 Economic Evaluation of Alternatives

To facilitate the evaluation of the cost-effectiveness of each alternative, preliminary capital and annual O&M costs were developed for the individual components (e.g., technologies and process options) selected for the alternatives. Total capital and O&M costs for each alternative are then determined by combining the costs of the appropriate components.

Quantities associated with the remedial activities as they relate to the media of concern (e.g., soil excavation, groundwater extractions, etc.) are developed initially to serve as the basis for this economic evaluation. Specific aspects and quantities for each components used as the basis for the capital and annual O&M costs of the selected remedial technologies are discussed in detail under each technology and presented in Table 4. The capital and annual O&M costs for each component are presented on separate tables.

The sources of the unit prices are presented on the tables. These sources include Means (various years, escalated to 1998 prices), past Radian experience, and quotations from vendors. Several indirect cost items are estimated as percentages of the total direct costs based on past Radian experience and Peters and Timmerhaus "Plant Design and Economics for Chemical

Engineers" (McGraw-Hill, Chemical Engineering Series, Third Edition). These amounts are expressed as percentages of the direct costs, and include the following:

• Mobilization and Demobilization	10%
• Construction Administration and Design Engineering	25%
• Change Order Contingencies	10%
• Bonds and Insurance (to reflect construction at sites containing hazardous wastes)	10%
• Escalation of costs by five percent to account for escalated costs at the time construction is anticipated to occur	5%
• Contractor mark-up for overhead for overhead and profit	25%
• Provisions for Level 'C' personal protective equipment	40% (by item)

Additional Direct Costs for Process Equipment

• Installation (as a percentage of equipment costs)	
✓ Equipment Installation	50%
✓ Instrumentation and Controls	25%
✓ Piping	60%
✓ Electrical	15%
✓ Service Facilities and Yard Improvements	20%

For the evaluation of the alternatives for cost-effectiveness, the capital and annual O&M costs are converted to their equivalent present worth. The annual rate of return on investment was estimated at 10 percent to determine the present worth.

The accuracy of these costs lies within the range of –30% to +50% of actual construction costs.

5.2.1 Estimation of Quantities and Cost Estimating

A. Fencing and Signage

The "Institutional Action" alternative includes site restrictions and signs placed around the Site, in order to restrict access and identify the Site as a hazardous waste site. Approximately 800 feet of fence would be required to surround the southern half of the site, as shown on Figure 10. The fencing will consist of a

6-foot high chainlink fence. One double swing gate will be placed on each side of the building (east and west) for access to the southern portion of the site.

Federal requirements state that signs must be placed at one hundred-foot intervals around the Site, identifying it as a hazardous waste site. This would require twenty (20) signs to completely surround the fenced portion of the Site. The signs shall read "DANGER: HAZARDOUS WASTE SITE: DO NOT ENTER" will be placed at 100-foot intervals around the fence.

Table 5 presents a capital cost estimate for the installation of the fence and signs. Fencing O&M must be performed for 30-years. O&M includes monthly inspections and maintenance and repair of any deficiencies in the fence or signs. Table 6 presents an annual O&M estimate for the fencing and signage.

B. Groundwater Monitoring

A groundwater monitoring program will be implemented as part of all alternatives, except for Alternatives 1 and 2. The groundwater monitoring program will be used to assess the effectiveness of the remedial action. A quarterly sampling program consisting of the analysis of six monitoring wells for volatile organic compounds is assumed. The cost estimate assumes that the sampling program will require two sampling personnel on-site for one day to complete the sampling. The generation of quarterly monitoring reports to be submitted to the appropriate agencies is also included. The annual cost estimate for groundwater monitoring is presented in Table 7.

C. Soil Excavation

Excavation of the adversely impacted soils that exceed the risk-based site clean-up levels would results in an area of excavation 30 feet by 30 feet, to a depth of 10 feet, as shown on Figure 11 (total volume: 333 cubic yards). Additional excavation area has been included in the estimate, to provide the 1-½ on 1 slope required for slope stability (an additional 500 cubic yards). The total volume of excavated soils then becomes 833 cubic yards of soil. Sheet piling may be used for slope stability, and may provide a more cost-effective solution. This would be a design decision.

A capital cost estimate for the excavation and disposal of 833 cubic yards of hazardous soil, dewatering, testing, backfill and restoration of the area is presented in Table 8. There are no O&M activities associated with soil excavation.

D. Dewatering

For estimating purposes, water generation during excavation is assumed to be 2,500 gallons per day. This assumption is based on the hydraulic properties of the overburden defined during the RIs. It is also assumed that the excavation will generate the same flow rate over the course of the excavation and backfill time, estimated to be one week. Therefore, dewatering must collect:

2,500 gal/day * 5 days = 12,500 gallons

It is anticipated that the groundwater treatment system that is currently in place as part of the IRM (granular activated carbon canisters) may be used to treat the collected groundwater and discharge to the POTW.

Capital costs associated with dewatering are included in Table 8, Capital Cost Estimate for Soil Excavation.

E. **Groundwater Extraction**

Groundwater extraction shall be implemented to extract groundwater from the areas exceeding the health risk based clean-up levels. Four (4) groundwater extraction wells with a depth of approximately 15 feet (to top of bedrock) would be placed at the locations shown on Figure 12. Four well pumps to extract the groundwater from these wells shall be installed, with groundwater sensing controllers. It is anticipated that groundwater collection rates will be similar to those encountered as part of the IRM system (e.g., less than 0.5 gallons per minute). A holding tank of 750 gallons (approximately 24-hours surge capacity) will be utilized to store the extracted water, prior to treatment and discharge. The existing groundwater treatment train may be used for the treatment of the collected groundwater.

The capital costs associated with the groundwater extraction system are presented in Table 9. Annual O&M costs are presented in Table 10.

F. **2-PHASE Extraction**

The 2-PHASE Extraction system would consist of an expansion of the existing IRM system. The expansion would consist of the installation of four additional extraction wells at the locations shown on Figure 13. These wells would be connected to the existing piping header system and to the existing 2-PHASE extraction trailer. Since the IRM system was originally designed for higher vapor and groundwater flow rates than were actually encountered, the system as a whole will have acceptable capacity for the expansion.

The capital costs associated with the expansion of the 2-PHASE extraction system are presented in Table 11. Annual O&M costs are presented in Table 12.

5.2.2 Cost Estimates for Alternatives

Table 13 summarizes the capital and annual O&M costs for each alternative, based upon the component costs developed in the previous subsection. For the economic evaluation of the alternatives, the total cost (e.g., capital and O&M costs) for an alternative is converted to a present worth, based upon the performance period of the alternative (1 to 30 years), and a 10-

percent rate of return on the investment. The present worth of each alternative is also presented in Table 13. These costs are discussed below.

A. **Alternative 1 - No Action**
The No Action alternative has no costs associated with it.

B. **Alternative 2 – Institutional Action**
The Institutional Action Alternative No. 2 includes the installation of fencing and signs, maintenance of the fencing and signs and long-term groundwater monitoring. The total capital costs associated with Alternative 2 is estimated to be $73,342. The annual O&M costs are estimated at $25,000. Based on a 30-year O&M performance, the total present worth of the costs for the alternative is estimated at $309,000.

C. **Alternative 3 – Excavation**
The capital costs associated with the Excavation Alternative No. 3 include the excavation and disposal of 833 cubic yards of soil, and dewatering associated with the excavation. Annual O&M costs include long-term groundwater monitoring. The total capital costs associated with Alternative 3 is estimated to be $701,000. The annual O&M costs are estimated at $20,000. The total present worth of the costs, based on a 30-year performance of groundwater monitoring, for the alternative is estimated at $890,000.

D. **Alternative 4 – Groundwater Extraction**
This Alternative No. 4 includes the installation of the groundwater extraction and treatment system, long-term operation of the system and long-term groundwater monitoring. The total capital costs associated with Alternative 4 is estimated to be $136,000. The annual O&M costs are estimated at $87,000. Based on a 30-year performance of the groundwater extraction and treatment and groundwater monitoring, the total present worth of the costs for the alternative is estimated at $956,000.

E. **Alternative 5 – 2-Phase Extraction**
The capital costs associated with this Alternative No. 5 include the expansion of the existing IRM 2-Phase Vapor Extraction System. Annual O&M costs include system operation costs and long-term groundwater monitoring. The total capital costs associated with Alternative 5 is estimated to be $41,000. The annual O&M costs are estimated at $165,000 for the 2-PHASE extraction system and $20,000 for groundwater monitoring. The total present worth of the alternative, based on one year of operation of the 2-PHASE extraction system and 30-year performance of groundwater monitoring, is estimated at $395,000.

5.3 Weighted-Matrix Scoring System

5.3.1 General

The selection of a Site remedy is based upon a quantitative evaluation of the alternatives using the following criteria, weighting factors, and a simple numerical scoring system:

- Short-term impacts and effectiveness (Relative Weight: 10/100);
- Long-term effectiveness and permanence (Relative Weight: 15/100);
- Reduction in the toxicity, mobility or volume of hazardous wastes (Relative Weight: 15/100);
- Implementability (Relative Weight: 15/100);
- Compliance with Standards, Criteria and Guidelines (Relative Weight: 10/100);
- Overall protection to human health and the environment (Relative Weight: 20/100); and
- Cost (Relative Weight: 15/100).

In this scoring system, each alternative is numerically rated against the factors developed for each criterion. This weighted-matrix scoring system is based upon the NYSDEC TAGM, "Selection of Remedial Actions at Inactive Hazardous Waste Sites, dated May 15, 1990. The results of the weighted-matrix scoring system are presented on Table 14, and are discussed below in detail.

5.3.2 Alternative 1 – No Action

A. **Short-Term Impacts and Effectiveness (Score: 10 out of 10).**
Since no construction is required to implement this alternative, there are no associated short-term risks to the community, environment, or workers.

B. **Long-Term Effectiveness and Permanence (Score: 7 out of 15).**
This alternative is currently not determined to be an effective nor permanent remedy to the risks posed by the contaminants of concern. Potential remediation by natural attenuation may be effective in reducing contaminant levels and/or migration. However, this effect cannot be quantified at this time due to data constraints. This remedy receives some points for long-term effectiveness since there is no treated residual left at the site (i.e., since no waste is treated) and there is no operations and maintenance activities associated with the alternative.

C. **Reduction of Toxicity, Mobility, or Volume (Score: 2 out of 15).**
This alternative is currently not determined to reduce the toxicity, mobility, or

volume of any of the hazardous contaminants of the Site. Long-term monitoring will determine the effectiveness of any natural attenuation process. Two scoring points are received, as there is no concentrated waste produced as a result of the remediation.

D. **Implementability (Score: 14 out of 15).**
The No Action alternative is the easiest of the alternatives to implement. Although it fails to provide a long-term remedy, future additional remedial actions to supplement this alternative may be instituted without interfering with existing controls.

E. **Compliance with Standards, Criteria, and Guidelines (Score: 2.5 out of 10).**
The implementation of this alternative would not result in compliance with any chemical-specific SCGs or any appropriate agency advisories, guidelines, or objectives. The alternative would, however, be in compliance with location-specific requirements. The action-specific standards (e.g., technology standards) would not be addressed, and are therefore, not applicable.

F. **Overall Protection to Human Health and the Environment (Score: 3 out of 20).**
Implementation of this alternative provides no additional protection to human health or the environment, and the risks posed by the contaminants of concern would continue due to a lock of on-site controls. However, under current conditions, exposure via the air pathway is acceptable.

G. **Cost (Score 15 out of 15):**
There are no costs associated with this alternative. It is therefore the lowest cost alternative and receives the highest score.

TOTAL WEIGHTED SCORE: 50.5 out of 100

5.3.3 Alternative 2 – Institutional Action

A. **Short-Term Impacts and Effectiveness (Score: 10 out of 10).**
The only construction associated with this alternative is the fence installation. Since the fence installation will occur outside of the adversely impacted areas (e.g., in clean areas), there are no associated short-term risks to the community, environment, or workers.

B. **Long-Term Effectiveness and Permanence (Score: 4 out of 15).**
This alternative is neither an effective nor permanent remedy to the risks posed by the contaminants of concern except for the possible benefits of natural attenuation as considered in Alternative 1. This remedy receives some points for long-term effectiveness since there is no treated residual

left at the (i.e., since no waste is treated) and no environmental controls are part of the remedy.

C. **Reduction of Toxicity, Mobility, or Volume (Score: 2 out of 15).**
This alternative does not in any way reduce the toxicity, mobility, or volume of any of the hazardous contaminants of the Site except for the possible benefits of natural attenuation as considered in Alternative 1. Two points are received as there is no concentrated waste produced as a result of the remediation.

D. **Implementability (Score: 13 out of 15).**
The Institutional Action alternative is easy to implement. Although it fails to provide a long-term remedy, future additional remedial actions to supplement this alternative may be instituted without interfering with existing controls. Extensive coordination with agencies will be required for the long-term groundwater monitoring and reporting.

E. **Compliance with Standards, Criteria, and Guidelines (Score: 2.5 out of 10).**
The implementation of this alternative would not results in compliance with any chemical-specific SCGs or any appropriate agency advisories, guidelines, or objectives. The alternative would, however, be in compliance with location-specific requirements. The action-specific standards (e.g., technology standards) would not be addressed, and are therefore, not applicable.

F. **Overall Protection to Human Health and the Environment (Score: 3 out of 20).**
Implementation of this alternative provides no additional protection to human health or the environment, and the risks posed by the contaminants of concern would continue due to a lock of on-site controls. However, under current conditions, exposure via the air pathway is acceptable.

G. **Cost (Score 9 out of 15):**
The institutional action alternative is the lowest cost alternative, with the exception of No Action, representing a score of 9 out of 15.

H. **TOTAL WEIGHTED SCORE: 42.5 out of 100**

5.3.4 Alternative 3 – Excavation and Off-Site Disposal

A. **Short-Term Impacts and Effectiveness (Score: 8 out of 10).**
Since hazardous materials are excavated under this alternative, there are significant short-term risks to personnel and the environment that must be

managed. However, engineering controls are readily available and easily implemented to control the risks associated with the excavation. Both the excavation activities and the mitigative actions will take less than two years to implement.

B. **Long-Term Effectiveness and Permanence (Score: 12 out of 15).**
This alternative is not a permanent remedy to the risks posed by the contaminants of concern. No waste is treated in this alternative, therefore, no treated residuals remain on-site. All wastes above the health-risk based clean-up levels are removed. However, approximately 40% of the hazardous waste (defined by the contact rule) remains on site. The expected lifetime or duration of this remedy is 25 to 30 years. O&M activities will be required for greater than five years, however the monitoring is minimal compared to other alternatives.

C. **Reduction of Toxicity, Mobility, or Volume (Score: 11 out of 15).**
Approximately 40% of the adversely impacted media are treated or destroyed. There are no concentrated hazardous wastes produced as a result of this remedy. The 40% of the media that are removed will be immobilized by removal from the Site. This remedy is irreversible for most site-related contaminants of concern.

D. **Implementability (Score: 12 out of 15).**
Construction of this alternative has relatively small uncertainties, when compared to the other alternatives. The removal technology is very reliable in meeting its performance goal. Construction delays are somewhat likely. Coordination with agencies should be normal. The technology and expertise are of standard practice and easily available.

E. **Compliance with Standards, Criteria, and Guidelines (Score: 7.5 out of 10).**
All chemical-specific and location-specific SCGs would be met. However, compliance with appropriate guidelines and advisories would not be met, since hazardous waste remains on Site.

F. **Overall Protection to Human Health and the Environment (Score: 16 out of 20).**
Unrestricted land and water use would not be viable after the remediation, due to the presence of low levels of the contaminants of concern outside of the excavation area. Exposure via air and soil are acceptable, while exposure to on-site groundwater may not be acceptable. The health-risk based clean-up levels used to determine the volume of soil to be excavated was based on a 1 in 1,000,000 risk, so the residual risk after remediation will meet this level. The magnitude of the residual environmental risk is also acceptable.

G. **Cost (Score 1 out of 15):**
The excavation alternative is the second highest cost alternative, representing a score of 1 out of 15.

H. TOTAL WEIGHTED SCORE: 67.5 out of 100

5.3.5 Alternative 4 – Groundwater Extraction and Treatment

A. Short-Term Impacts and Effectiveness (Score: 8 out of 10).
There are some short-term risks to personnel and the environment that must be managed during well installation. However, engineering controls are readily available and easily implemented to control the risks associated with the drilling operation. Both the drilling activities and the mitigative actions will take less than two years to implement.

B. Long-Term Effectiveness and Permanence (Score: 8 out of 15).
This alternative is not a permanent remedy to the risks posed by the contaminants of concern. The lifetime of the remedial action is estimated at 25 to 30 years. Hazardous waste below the water table will be treated, leaving approximately 50% of the waste untreated. There will be no treated residue left on-site. The operations and maintenance period of the alternative is greater than five years. Environmental control of groundwater flow is part of the remedy, which has a high degree of confidence. Required environmental monitoring is extensive, when compared to other alternatives.

C. Reduction of Toxicity, Mobility or Volume (Score: 12 out of 15).
Approximately 40% of the adversely impacted media are treated or destroyed, since there is no affect on the unsaturated soils. A concentrated waste stream is produced as a result of this remedy. The waste stream (spent granular activated carbon) will be regenerated off-site. Approximately 50% waste will be immobilized, by groundwater extraction and the generation of a one of depression. This remedy is irreversible for most site-related contaminants of concern.

D. Implementability (Score: 10 out of 15).
Construction of this alternative has relatively small uncertainties, when compared to the other alternatives. Groundwater extraction is somewhat reliable in meeting its performance goal, as actual extraction rates and contaminant partitioning are difficult to predict. Future remedial actions may be required to address adversely impacted soils above the saturated zone. Construction delays are somewhat likely. Coordination with agencies should be normal. The technology and expertise are of standard practice and easily available.

E. Compliance with Standards, Criteria, and Guidelines (Score: 6.0 out of 10).
All location-specific SCGs would be met. Chemical-specific soil clean-up levels would not be met; however, groundwater containment will prevent the groundwater from leaving the site and groundwater remediation objectives would

be met. Compliance with appropriate guidelines and advisories would not be met, since hazardous waste remains on Site.

F. **Overall Protection to Human Health and the Environment (Score: 14 out of 20).**
Unrestricted land and water use would not be viable after the remediation, due to the presence of contaminants in the soil above the saturated zone. Exposure via air and groundwater are acceptable, while exposure to on-site soils may not be acceptable. Due to on-site soils exceeding the health-risk based clean-up levels, the residual risk would exceed 1 in 1,000,000. The magnitude of the residual environmental risk is acceptable, since groundwater extraction will contain the only possible transport route for soil contamination.

G. **Cost (Score 0 out of 15):**
The groundwater extraction and treatment alternative is the highest cost alternative, representing a score of 0 out of 15.

H. **TOTAL WEIGHTED SCORE: 58 out of 100**

5.3.6 Alternative 5 – 2-PHASE Extraction

A. **Short-Term Impacts and Effectiveness (Score: 8 out of 10).**
There are some short-term risks to personnel and the environment that must be managed during well installation. However, engineering controls are readily available and easily implemented to control the risks associated with the drilling operation. Both the drilling activities and the mitigative actions will take less than two years to implement.

B. **Long-Term Effectiveness and Permanence (Score: 11 out of 15).**
This alternative is a permanent remedy to the risks posed by the contaminants of concern. The lifetime of the remedial action is estimated at 25 to 30 years and may be considerably less depending on the performance of the system. Hazardous wastes above and below the water table will be treated. There will be no treated residue left on-site. The operations and maintenance period of the alternative is less than five years. Environmental control of groundwater flow is part of the remedy, which has a high degree of confidence. Required environmental monitoring is moderate, when compared to other alternatives.

C. **Reduction of Toxicity, Mobility, or Volume (Score: 15 out of 15).**
Approximately 80% of the adversely impacted media are treated or destroyed. A concentrated waste stream is produced as a result of this remedy. The waste stream (spent granular activated carbon) will be regenerated off-site. Greater than 90% waste will be immobilized by groundwater extraction and the generation of a

cone of depression and subsurface vacuum. This remedy is irreversible for most site-related contaminants of concern.

D. **Implementability (Score: 12 out of 15).**
Construction of this alternative has relatively small uncertainties, when compared to the other alternatives. 2-PHASE extraction is somewhat reliable in meeting its performance goal, as actual extraction rates and contaminant partitioning are difficult to predict. Performance of the ongoing IRM has demonstrated the successful operation of the 2-Phase technology. Future remedial actions should not be required. Construction delays are somewhat likely. Coordination with agencies should be normal. The technology and expertise are of standard practice and easily available.

E. **Compliance with Standards, Criteria, and Guidelines (Score: 6.0 out of 10).**
All chemical-specific and location-specific SCGs would be met. However, compliance with appropriate guidelines and advisories would not be met, as some hazardous waste remains on Site.

F. **Overall Protection to Human Health and the Environment (Score: 20 out of 20).**
Unrestricted land and water use may not be viable after the remediation, due to the presence of low levels of hazardous wastes. Exposure via air, groundwater, and soil are acceptable after remediation. The residual risk would meet the 1 in 1,000,000 level. The magnitude of the residual environmental risk is also acceptable.

G. **Cost (Score 9 out of 15):**
The 2-PHASE extraction alternative is the second lowest cost alternative, representing a score of 9 out of 15.

H. **TOTAL WEIGHTED SCORE: 81.5 out of 100**

5.4 Comparison of Alternatives

This analysis involves a comparative analysis amongst the alternatives to determine which alternative best meets the objectives of this Feasibility Study. Specifically, the results of the weighted matrix scoring system is discussed by Alternative.

Alternatives 1 and 2 are considered totally ineffective, since the contaminants of concern and their associated risks would remain unchanged following the implementation of either alternative. Health risks associated with both soil and groundwater are currently unacceptable. SCGs are also exceeded, and the contaminants of concern may eventually move off-site, increasing the level of risks to human health and the environment.

Alternative 3 would minimize the risks associated with the on-site soils. This would also minimize future risks, by eliminating the source of the contamination. On-site groundwater currently exceeds health-risk based clean-up standards. It is anticipated that biodegradation of the compounds will not be sufficient to prevent off-site migration of the groundwater at levels below the clean-up levels. This would increase the level of risks to human health and the environment.

Alternative 4 would minimize the risks associated with groundwater. This alternative would prevent the off-site migration of the contaminants by controlling groundwater. However, it is not known if residual soil contamination will be present in the unsaturated zone after completion of this remedy. This is also the most costly alternative.

Alternative 5 is the only alternative that addresses both groundwater and soil contamination. The alternative would provide groundwater control and removal of volatile organic compounds from the unsaturated soils. In addition, the alternative is cost-effective since Erdle has established an Interim Remedial Measure consisting of 2-PHASE extraction.

In terms of implementability, Alternatives 1 and 2 would be the least difficult to construct. Short-term risks to the community and the environment are also minimal, since there are no contamination-related activities involved. Following these alternatives, the excavation alternative would be the next easiest to implement, following by Alternatives 5 (only well installation) and 4 (well installation and system construction).

Examination of the present worth values of the preliminary total capital and annual O&M costs for the five alternatives reveals that the range of costs is from no cost for Alternative 1 to $956,000 for Alternative 4. Alternative 5 provides the highest level of protection to human health and the environment, and at the second lowest cost.

An examination of the weighted matrix scoring system shows that Alternative 5 has the highest score (81.5 out of 100). The next highest score is Alternative 3 (67.5 out of 100), which is far behind due to its much higher costs.

In conclusion, Alternative 5 exhibits a protection to human health and the environment in excess of that which is currently present at the Site. Alternative 5 is the only Alternative that addresses both soil and groundwater contamination. Excluding Alternatives 1 and 2, the other alternatives provide less overall protection, increased difficulty in implementation, and greater cost.

Therefore, Alternative 5 is recommended as the preferred Alternative for the remediation of the Erdle Perforating Site.

TABLES

TABLES

Table 1

Site Remedial Action Chronology

Date/ Contractor	Activity	Findings
January 1987 Day Engineering	- Soil samples obtained via split-spoon from three depths at four locations. - Depth to groundwater measured and groundwater samples obtained. - Soil and groundwater samples analyzed for purgeable halocarbons and purgeable aromatics.	- Volatile organic compounds (TCE, 1,2-DCE, and PCE) present in soil and groundwater near the waste TCE tank.
February 1987 Day Engineering	- Non-process-related water found in waste TCE tank. - Integrity test conducted on waste TCE tank	- Tank was not tight, and was judged unfit for use.
July 1987 Day Engineering	- Waste TCE tank, waste oil tank, and fresh oil tank removed. - Thirteen soils samples taken from waste TCE tank excavation. - Three soil samples taken from dark area of fresh oil tank excavation. - Four surface water and sediment samples collected.	- Six holes found in waste TCE tank. Other tanks in good condition. - Soil at the edges of the waste TCE tank excavation contained detectable levels of VOCs. - Soils from fresh oil tank excavation contained petroleum hydrocarbon compounds. - VOCs were detected in the non-contact cooling water stream which emanated from the southwest corner of the building. - Site placed on New York State Registry of Inactive Hazardous Waste Sites (#828072) and ranked as a Class 2 site.
April 1990 Erdle Personnel	- Surface water resampled at three of the Day Engineering locations.	- Maximum concentration of TCE detected was lower than the previous Day Engineering results by a factor of approximately 110.
December 1992 O'Brien & Gere	- Installed monitoring wells MW-1D, MW-2, MW-3, and MW-4 (three overburden, one shallow bedrock). - Groundwater and soil samples analyzed by EPA Methods 8010 and 8020.	- Elevated levels of TCE detected in all groundwater samples. Tetrachloroethane, 1,1,1-trichloroethane, vinyl chloride, and 1,2-dichloroethene were also detected in groundwater samples. Methylene chloride and trichloroethene were detected in soils.
June 1995 Radian Corporation	Phase I Remedial Investigation - Installed monitoring wells MW-1, MW-3D, MW-4D, MW-5, and MW-5D (two overburden, three shallow bedrock). - Collected hydrogeologic characterization data. - Collected surface and subsurface soil samples from a background location, former UST locations, and outfall locations - Collected surface water and sediment samples upstream and downstream of site, and from former outfall locations. - Soil, sediment, surface water, and groundwater samples analyzed for halogenated VOCs and TCL parameters (key locations only). - Collected flux chamber samples at former UST location to evaluate air impacts. - Conducted ecological surveys and impact analysis.	- Principal contaminants of concern determined to be VOCs (primarily trichloroethene and degradation products). - Groundwater flow at the site determined to be south-southwest in the overburden and south in the bedrock. The bedrock groundwater is under artesian conditions. - Groundwater contamination with VOCs was present in overburden and bedrock over 75 feet downgradient of the former source. - Subsurface soil contamination with VOCs present near former UST. - VOCs were detected in surface water and sediment at one of the former outfall locations, but not further downstream. - No air impacts were detected. - No significant fish and wildlife resources are present at the site, and no stress on ecological resources was observed.

Table 1 (Continued)

Date/ Contractor	Activity	Findings
December 1996	<u>Phase II Remedial Investigation</u> • Installed monitoring wells MW-1DD, MW-2D, MW-6, and MW-6D. One of the wells was installed in deeper bedrock at the source area. • Collected groundwater samples from all monitoring wells and analyzed for VOCs • Collected sediment samples from old outfall and analyzed for metals. • Obtained additional hydrogeologic characterization data.	• No VOCs detected deeper source area bedrock well MW-1DD. • VOCs detected at downgradient bedrock well MW-6D. • Metals concentrations in second old outfall sediment sample were lower than Phase I concentrations, and not indicative of a contaminant source.
March 1997	<u>Interim Remedial Measure Work Plan</u> • Design plans and operations manual presented for installation of a 2-PHASE Extraction system as an Interim Remedial Measure.	• Four overburden extraction wells proposed to remove contaminants from the subsurface.
July 1997	<u>Interim Remedial Measure Implementation</u> • 2-PHASE Extraction system began operation.	• Over 100 pounds removed over 6 months of operation in the latter part of 1997. • Bedrock groundwater concentrations decreased one to two orders of magnitude in the former source area.

Table 2

List of Constituents Detected in Various Environmental Media

Media	Volatile Organics	Semivolatile Organics	Metals	
Soil	**1,2-Dichloroethene** **Trichloroethene** 1,1,1-Trichloroethane 1,1-Dichloroethane Tetrachloroethane Toluene Xylenes Benzene Ethylbenzene Methylene Chloride 1,1,2,2-Tetrachloroethane	**Benzo(a)anthracene** **Benzo(a)pyrene** **Chrysene** **Dibenzo(a,h)anthracene** Acenaphthylene Benzo(b)fluoranthene Benzo(ghi)perylene Benzo(k)fluoranthene Fluoranthene Indeno(1,2,3-cd)pyrene Phenanthrene Pyrene 2-Methylnaphthalene Naphthalene 4-Methylphenol	**Aluminum** **Arsenic** **Cadmium** **Calcium** **Chromium** **Copper** **Iron** **Lead** **Magnesium** **Manganese**	**Nickel** **Potassium** **Sodium** **Thallium** **Zinc** Barium Cobalt Potassium Vanadium
Groundwater	**1,2-Dichloroethene** **Trichloroethene** **Vinyl chloride** **Tetrachloroethene** **Toluene** **Methylene chloride** 1,1,1-Trichloroethane 1,1-Dichloroethane Bromodichloromethane Chloroform	2-Methylnaphthalene 4-Methylphenol Di-n-butylphthalate Fluorene Naphthalene Phenanthrene	**Antimony** **Iron** **Lead** **Magnesium** **Manganese** **Silver** **Sodium** Aluminum Barium	Beryllium Cadmium Calcium Cobalt Copper Potassium Vanadium Zinc
Surface Water	**1,2-Dichloroethene** **Trichloroethene** **Tetrachloroethene** **Vinyl chloride**	Di-n-phthalate	**Iron** **Magnesium** **Manganese** **Zinc** Aluminum Arsenic Barium	Calcium Copper Lead Nickel Potassium Sodium Vanadium
Sediment	Acetone Carbon Disulfide 1,2-Dichloroethene Tetrachloroethene Trichloroethene Vinyl chloride	Anthracene Benzo(a)anthracene Benzo(b)fluoranthene Benzo(k)fluoranthene Chrysene Fluoranthene Phenanthrene Pyrene	**Copper** **Lead** Aluminum Barium Cadmium Calcium Chromium Iron	Magnesium Manganese Potassium Thallium Vanadium Zinc

Notes:

1. For soil matrix, boldface indicates that guidance levels in NYSDEC TAGM HWR-92-4046 (Revised January 24, 1994), were exceeded for that compound at one or more locations. See Appendices and Remedial Investigation reports for details.
2. For groundwater and surface water matrix, boldface indicates that guidance levels in NYSDEC TOGS 1.1.1 were exceeded for that compound at one or more locations. See Appendices and Remedial Investigation reports for details.
3. For sediment matrix, boldface indicates that guidance levels in NYSDEC Technical Guidance for Screening Contaminants Sediments were exceeded for that compound at one or more locations. See Appendices and Remedial Investigation reports for details.

Table 3

Summary of Constituents of Concern, Transport Pathways, and Receptors

Media	Constituents Above Guidance Levels (Maximum Concentration)	Location	Transport Pathway	Potential Route of Exposure	Potential Receptors	Pathway Complete?
Surface Soil	VOCs detected (1,2-Dichloroethene at 100 µg/Kg), none above action levels	New outfall (S-1)	Leaching to groundwater, runoff, volatilization (VOCs only)	Dermal absorption, incidental ingestion	Wildlife, plant workers	Yes
	Aluminum (9,370 mg/Kg) *Cadmium (5.1 mg/Kg)* *Calcium (36,300 mg/Kg)* *Chromium (37.2 mg/Kg)* *Copper (126 mg/Kg)* *Iron (20,800 mg/Kg)* *Lead (192 mg/Kg)* *Magnesium (9,880 mg/Kg)* *Manganese (444 mg/Kg)* *Nickel (22.2 mg/Kg)* *Potassium (1,440 mg/Kg)* *Thallium (3.5 mg/Kg)* *Zinc (1,420 mg/Kg)*	New outfall (S-1) and near former UST (MW-1)				
Subsurface Soil	1,2-Dichloroethene (51,000 µg/Kg) Trichloroethene (340,000 µg/Kg) Vinyl Chloride (1,300 µg/Kg) Methylene Chloride (6,000 µg/Kg)	Near former UST (MW-1) and approximately 60 feet south (downgradient) near MW-3 (IRM boring CB-4)	Leaching to groundwater, volatilization (VOCs only)	None	None	No
	Benzo(a)anthracene (700 µg/Kg) *Benzo(a)pyrene (670 µg/Kg)* *Chrysene (680 µg/Kg)* *Dibenzo(a,h,)anthracene (31 µg/Kg)* *Aluminum (11,100 mg/Kg)* *Arsenic (8.1 mg/Kg)* *Calcium (57,000 mg/Kg)* *Chromium (17.1 mg/Kg)* *Iron (24,800 mg/Kg)* *Lead (6.3 mg/Kg)* *Manganese (645 mg/Kg)* *Nickel (24.8 mg/Kg)* *Sodium (533 mg/Kg)* *Thallium (1.1 mg/Kg)* *Zinc (84.8 mg/Kg)*	Near former UST (MW-1)	Leaching to groundwater (metals only)			

Table 3 (Continued)

Media	Constituents Above Guidance Levels (Maximum Concentration)	Location	Transport Mechanism	Potential Route of Exposure	Potential Receptors	Pathway Complete?
Surface Water	1,2-Dichloroethene (1,700 µg/L) Trichloroethene (14 µg/L) Vinyl Chloride (12 µg/L) Tetrachloroethene (1.7 µg/L)	Background (SW-3), old outfall (SW-2) and ditch south (SW-4). Maximum concentrations at old outfall location only.	Runoff, volatilization (VOCs only)	Dermal absorption, ingestion	Wildlife, fish	Yes
	Iron (12,900 µg/L) Magnesium (35,600 µg/L) Manganese (1,360 µg/L) Zinc (355 µg/L)	Old outfall (SW-2)				
Sediment	Cadmium (1.6 mg/Kg) Copper (104 mg/Kg) Lead (71.1 mg/Kg)	Old outfall (SD-2)	Runoff	Dermal absorption, incidental ingestion	Fish, aquatic plants, benthic organisms	Yes
Groundwater	1,2-Dichloroethene (170,000 µg/L) Trichloroethene (550,000 µg/L) Tetrachloroethene (41 µg/L) Vinyl Chloride (15,000 µg/L) Toluene (10,000 µg/L) Chlorobenzene (10 µg/L) Methylene Chloride (4,280 µg/L)	Near former UST (MW-1) and approximately 60 feet southeast and south (downgradient) near MW-2 and MW-3. Maximum concentrations present in overburden groundwater. Bedrock groundwater concentrations are lower. No VOCs detected in deeper bedrock.	Dissolved phase migration with groundwater flow	None	None	No
Air	None	Former UST area sampled	Vapor migration	Inhalation	Wildlife, plant workers	Unknown

Notes:

1. Constituents in italics have been eliminated from further investigation and remedial action based on evidence presented in the Remedial Investigation reports.
2. Maximum concentrations pertain to the entire project history, current concentrations are lower due to ongoing remedial activities.

Table 4

Design Parameters and Quantity Estimates

Remedial Component (Applicable Alternatives)	Quantity	Basis
1. Perimeter Fencing (Alt. No. 2)	800 LF with 2 double gates	Southern property area between building and property line, west of railroad track.
2. Groundwater Monitoring (Alt. Nos. 3, 4, & 5)	Six existing monitoring wells:	Within and downgradient of source area.
3. Excavation of Soil	833 cubic yards (use 1000) – 10 foot depth with a bottom dimension of 30 x 30 feet, slopes cut back at 1 ½ H to 1V per OSHA requirements.	Source area defined by soil VOC levels in excess of NYSDEC TAGM criteria.
4. Groundwater Extraction	Four new monitoring wells in till overburden, average depth of 15 feet each.	Downgradient of existing source area and groundwater contamination.
5. 2-Phase Vapor Extraction	Four new extraction wells(expanded IRM system).	Enhance soil and bedrock VOC removal in source area.

Table 5

Capital Cost Estimate for Fencing and Signs

ITEM NO.	ITEM	UNITS	QUANTITY	UNIT COST	SOURCE	TOTAL COST
1	Clear & Grub	acres	0.25	$ 3,000.00	1	$ 750.00
2	Furnish & Install Chain Link Fence	lf	800	$ 42.00	2	$ 33,600.00
3	Furnish & Install Double Swing Gate	each	2	$ 950.00	2	$ 1,900.00
4	Furnish & Install Warning Signs	each	20	$ 50.00	2	$ 1,000.00

SUBTOTAL **$ 37,250.00**

Mobilization / Demobilization (5%)	$ 1,863.00
Contractor Mark-up for Overhead and Profit (25%)	$ 9,313.00
Construction Administration and Design Engineering (15%)	$ 5,588.00
Escalation to Level 'C' Protection (40% of items 1-2)	$ 13,740.00
Escalation to Midpoint of Construction (5% per year for one year)	$ 1,863.00
Bonds and Insurance (10%)	$ 3,725.00

TOTAL (ROUNDED) **$ 73,000.00**

SOURCES:

1 - Means, 1997: Escalated to 1998 Costs
2 - Quote from contractor for other Superfund Site

Table 6

Annual Operations and Maintenance Cost Estimate
Fencing and Signage

ITEM NO.	ITEM	UNITS	QUANTITY	UNIT COST	SOURCE	TOTAL COST
1	Monthly Fence Inspection	man-hr	36	$ 60.00	1	$ 2,160.00
2	Repair - Mobilization/Demobilization	LS	3	$ 300.00	2	$ 900.00
3	Repair Fence Posts	ea	6	$ 90.00	2	$ 540.00
4	Repair Fence Fabric	lf	60	$ 15.00	2	$ 900.00
5	Replace Signage	ea	3	$ 50.00	2	$ 150.00

TOTAL O&M COSTS (ROUNDED) **$ 5,000.00**

SOURCES:

1 - Radian Engineering, Inc. Estimate
2 - Quote from contractor for other Superfund Site

Table 7

Annual Operations and Maintenance Costs
Groundwater Monitoring

ITEM NO.	ITEM	UNITS	QUANTITY	UNIT COST	SOURCE	TOTAL COST
1	Well Sampling - Labor (Quarterly)	man-hr	64	$ 60.00	1	$ 3,840.00
2	Well Sampling - Equipment	man-days	4	$ 300.00	1	$ 1,200.00
3	Well Sampling - Analyses	samples	24	$ 300.00	1	$ 7,200.00
4	Report Generation	man-hours	96	$ 85.00	1	$ 8,160.00

TOTAL O&M COSTS (ROUNDED) **$ 20,000.00**

SOURCES:

1 - Radian Engineer, Inc. Estimate, based on current monitoring program

Table 8

Capital Cost Estimate
Excavation and Off-Site Disposal
(Assumes Hazardous Waste)

ITEM NO.	ITEM	UNITS	QUANTITY	UNIT COST	SOURCE	TOTAL COST
1	Clear & Grub	acres	0.5	$ 2,841.00	1	$ 1,420.50
2	Excavation	cubic yards	1000	$ 4.00	1	$ 4,000.00
3	Dewatering	days	5	$ 800.00	1	$ 4,000.00
4	Hauling & Disposal	cubic yards	1000	$ 325.00	2	$ 325,000.00
5	Backfill: Purchase & Haul	cubic yards	1000	$ 15.60	1	$ 15,600.00
6	Backfill: Place & Compant	cubic yards	1000	$ 3.80	1	$ 3,800.00
7	Grade and Seed	square yards	400	$ 2.00	1	$ 800.00

SUBTOTAL **$ 354,620.50**

Mobilization / Demobilization (5%)	$ 17,731.00
Contractor Mark-up for Overhead and Profit (25%)	$ 88,655.00
Construction Administration and Design Engineering (15%)	$ 53,193.00
Escalation to Level 'C' Protection (40% of items 1-3)	$ 133,768.00
Escalation to Midpoint of Construction (5% per year for one year)	$ 17,731.00
Bonds and Insurance (10%)	$ 35,462.00

TOTAL (ROUNDED) **$ 701,000.00**

SOURCES:

1 - Means, 1997 escalated to 1998 costs.
2 - Quote from Model City Landfill for T&D of hazardous soils

Table 9

Capital Cost Estimate
Groundwater Extraction System

ITEM NO.	ITEM	UNITS	QUANTITY	UNIT COST	SOURCE	TOTAL COST
1	Well Installations (4)	lf	60	$ 50.00	1	$ 3,000.00
2	Well Heads	each	4	$ 500.00	1	$ 2,000.00
3	Submersible Pumps	each	4	$ 1,200.00	2	$ 4,800.00
5	Equalization Tank (750 gallons)	each	1	$ 600.00	2	$ 600.00
6	Transfer Pump	each	1	$ 2,000.00	2	$ 2,000.00
7	Carbon Adsorption System	each	1	$ 6,000.00	2	$ 6,000.00

SUBTOTAL EQUIPMENT **$ 18,400.00**

Equipment Installation (50% of Equipment)	$ 9,200.00
Instrumentation and Controls (20% of Equipment)	$ 3,680.00
Piping (60% of Equipment)	$ 11,040.00
Electrical (15% of Equipment)	$ 2,760.00
Service Facilities and Improvements (20% of Equipment)	$ 3,680.00

TOTAL DIRECT COSTS **$ 48,760.00**

Mobilization / Demobilization (5%)	$ 2,438.00
Contractor Mark-up for Overhead and Profit (25%)	$ 12,190.00
Construction Administration and Design Engineering (15%)	$ 7,314.00
Escalation to Level 'C' Protection (40% of Equioment Items 1-3)	$ 3,920.00
Escalation to Midpoint of Construction (5% per year for one year)	$ 2,438.00
Change Order Contingencies (10%)	$ 4,876.00
Bonds and Insurance (10%)	$ 4,876.00

TOTAL (ROUNDED) **$ 136,000.00**

SOURCES:

1 - Radian Engineering, Inc. Estimate
2 - Means, 1998

Table 10

Annual Operations and Maintenance Costs
Groundwater Extraction and Treatment

ITEM NO.	ITEM	UNITS	QUANTITY	UNIT COST	TOTAL COST
1	O&M Labor	hr	416	$ 60.00	$ 24,960.00
3	Maintenance	-	-	$ 2,000.00	$ 2,000.00
4	Insurance and Taxes	-	-	$ 1,000.00	$ 1,000.00
5	Maintenance Reserve & Contingency	-	-	$ 1,000.00	$ 1,000.00
6	Granular Activated Carbon	lb	5000	$ 1.50	$ 7,500.00
7	Electricity	kW-hr	65,437	$ 0.10	$ 6,543.72
8	Monitoring (Carbon samples)	samples	24	$ 300.00	$ 7,200.00
9	Monitoring (POTW Parameters)	samples	12	$ 300.00	$ 3,600.00
11	Sewer Use Charge	kgal	263	$ 50.00	$ 13,150.00

TOTAL O&M COSTS (ROUNDED) **$ 67,000.00**

Table 11

Capital Cost Estimate
2-Phase Extraction System

ITEM NO.	ITEM	UNITS	QUANTITY	UNIT COST	SOURCE	TOTAL COST
1	Well Installations (4)	lf	60	$ 50.00	1	$ 3,000.00
2	Well Heads	each	4	$ 500.00	1	$ 2,000.00
3	Piping (materials)	lf	50	$ 8.00	1	$ 400.00

SUBTOTAL EQUIPMENT $ 5,400.00

Equipment Installation (50% of Equipment)	$ 2,700.00
Instrumentation and Controls (20% of Equipment)	$ 1,080.00
Piping (60% of Equipment)	$ 3,240.00
Electrical (15% of Equipment)	$ 810.00
Service Facilities and Improvements (20% of Equipment)	$ 1,080.00

TOTAL DIRECT COSTS $ 14,310.00

Mobilization / Demobilization (5%)	$ 716.00
Contractor Mark-up for Overhead and Profit (25%)	$ 3,578.00
Construction Administration and Design Engineering (15%)	$ 2,147.00
Escalation to Level 'C' Protection (40% of Equioment Items 1-3)	$ 2,000.00
Escalation to Midpoint of Construction (5% per year for one year)	$ 716.00
Change Order Contingencies (10%)	$ 1,431.00
Bonds and Insurance (10%)	$ 1,431.00

TOTAL (ROUNDED) $ 41,000.00

SOURCES:

1 - Subcontractor Quote

Table 12

Annual Operations and Maintenance Costs
2-Phase Extraction and Treatment

ITEM NO.	ITEM	UNITS	QUANTITY	UNIT COST	TOTAL COST
1	2-PHASE System Rental	months	12	$ 5,220.00	$ 62,640.00
2	O&M Labor & Reporting	hr	436	$ 60.00	$ 26,160.00
3	Maintenance	-	-	$ 2,000.00	$ 2,000.00
4	Insurance and Taxes	-	-	$ 1,000.00	$ 1,000.00
5	Granular Activated Carbon	lb	6000	$ 1.50	$ 9,000.00
6	Electricity	kW-hr	196,312	$ 0.10	$ 19,631.16
7	Monitoring (Carbon samples)	samples	24	$ 250.00	$ 6,000.00
8	Monitoring (POTW Parameters)	samples	12	$ 300.00	$ 3,600.00
9	Monitoring (Air samples)	samples	120	$ 100.00	$ 12,000.00
10	Monitoring (Soil Borings)	samples	16	$ 125.00	$ 2,000.00
11	Sewer Use Charge	kgal	420	$ 50.00	$ 21,000.00

TOTAL O&M COSTS (ROUNDED) $ 165,000.00

Table 13

Cost Summary for Remedial Alternatives

CAPITAL COST ITEM	ALT. 1	ALT. 2	ALT. 3	ALT. 4	ALT. 5
Fencing & Signs	-	$ 73,000	-	-	-
Excavation and Disposal (Non-hazardous)	-	-	-	-	-
Excavation and Disposal (Hazardous)	-	-	$ 701,000	-	-
Groundwater Collection & Treatment	-	-	-	$ 136,000	-
2-PHASE Extraction	-	-	-	-	$ 41,000
TOTAL CAPITAL COSTS	**$ -**	**$ 73,000**	**$ 701,000**	**$ 136,000**	**$ 41,000**

OPERATIONS AND MAINTENANCE COST ITEM	ALT. 1	ALT. 2	ALT. 3B	ALT. 4	ALT. 5
Groundwater Monitoring	-	$ 20,000	$ 20,000	$ 20,000	$ 20,000
Fence & Sign Maintenance	-	$ 5,000	-	-	-
Groundwater Treatment	-	-	-	$ 67,000	-
2-PHASE Extraction	-	-	-	-	$ 165,000
TOTAL ANNUAL O&M COSTS	**$ -**	**$ 25,000**	**$ 20,000**	**$ 87,000**	**$ 185,000**
PRESENT WORTH OF O&M COSTS	**$ -**	**$ 235,675**	**$ 188,540**	**$ 820,149**	**$ 353,540**
PRESENT WORTH OF TOTAL COST (CAPITAL PLUS O&M)	***$ -***	***$ 309,000.00***	***$ 890,000.00***	***$ 956,000.00***	***$ 395,000.00***

NOTES:

1. Present worth of groundwater monitoring, fence & sign maintenance, and Groundwater Treatment is based upon a 30-year performance at 10% interest per year.
2. Present worth of 2-PHASE Extraction is based upon a 1-year performance.

TABLE 14

WEIGHTED-MATRIX SCORING SYSTEM FOR REMEDIAL ALTERNATIVES

ALTERNATIVE 1:	No Action
ALTERNATIVE 2:	Institutional Action
ALTERNATIVE 3:	Excavation and Off-Site Disposal
ALTERNATIVE 4:	Groundwater Extraction and Treatment
ALTERNATIVE 5:	2-PHASE Extraction

A. SHORT-TERM EFFECTIVENESS (Weight = 10)

FACTOR	BASIS FOR EVALUATION	WEIGHT	ALTERNATIVE NUMBER				
			1	2	3	4	5
1. Protection of community during remedial actions	- Are there significant short-term risks to the community that must be addressed? (if no, go to factor 2)	Yes - 0 No - 4	4	4	0	0	0
	- Can the risk be easily controlled?	Yes - 1 No - 0	-	-	1	1	1
	- Does the mitigative effort to control risk impact the community lifestyle?	Yes - 0 No - 2	-	-	2	2	2
2. Environmental Impacts	- Are there significant short-term risks to the environment that must be addressed? (If no, go to factor 3)	Yes - 0 No - 4	4	4	0	0	0
	- Are the available mitigative measures reliable to minimize potential impacts?	Yes - 3 No - 0	-	-	3	3	3
3. Time to implement the remedy	- What is the required time to implement the remedy?	<2 yr - 1 >2 yr - 0	1	1	1	1	1
	- Required duration of the mitigative effort to control short-term risk.	<2 yr - 1 >2 yr - 0	1	1	1	1	1
SUBTOTAL (MAXIMUM = 10)			**10**	**10**	**8**	**8**	**8**

TABLE 14 (continued)
WEIGHTED-MATRIX SCORING SYSTEM FOR REMEDIAL ALTERNATIVES

B. LONG-TERM EFFECTIVENESS AND PERMANENCE (Weight = 15)

FACTOR	BASIS FOR EVALUATION	WEIGHT	ALTERNATIVE NUMBER				
			1	2	3	4	5
1. Permanence of the remedial alternative	- Will the remedy be classified as permanent in accordance with Section 2.1(a),(b) or (c) of the NYSDEC TAGM for the "Selection of Remedial Actions at Inactive Hazardous Waste Sites", Sept. 13, 1989? (if yes, go to factor 3)	Yes - 5 No - 0	0	0	0	0	0
2. Lifetime of remedial actions	- Expected lifetime or duration of effectiveness of the remedy	25-30 yr - 4 20-25 yr - 3 15-20 yr - 2 <15 yr - 0	0	0	4	4	4
3. Quantity and nature of waste or residual left at the site after remediation	i. Quantity of untreated hazardous waste left at the site	None - 3 <25% - 2 25-50% - 1 >50% - 0	0	0	1	1	2
	ii. Is there any treated residual left at the site? (if no, go to factor 4)	Yes - 0 No - 2	2	2	2	2	2
	iii. Is the treated residual toxic?	Yes - 0 No - 1	-	-	-	-	-
	iv. Is the treated residual mobile?	Yes - 0 No - 1	-	-	-	-	-
4. Adequacy and reliability of controls	i. Operation and maintenance required for a period of:	<5 yr - 1 >5 yr - 0	1	0	1	0	1
	ii. Are environmental controls required as a part of the remedy to handle potential problems? (if no, go to "iv")	Yes - 0 No - 2	2	2	2	0	0
	iii. Degree of confidence that controls can adequately handle potential problems	Moderate to very confident - 1 Somewhat to not confident - 0	-	-	-	1	1
	iv. Relative degree of long-term monitoring required (compare with other alternatives)	Minimum - 2 Moderate - 1 Extensive - 0	2	0	2	0	1
SUBTOTAL (MAXIMUM = 15)			**7**	**4**	**12**	**8**	**11**

TABLE 14 (continued)
WEIGHTED-MATRIX SCORING SYSTEM FOR REMEDIAL ALTERNATIVES

C. REDUCTION OF TOXICITY, MOBILITY OR VOLUME (Weight = 15)

FACTOR	BASIS FOR EVALUATION	WEIGHT	ALTERNATIVE NUMBER				
			1	2	3	4	5
1. Volume of hazardous waste reduced (reduction in volume or toxicity)	i. Quantity of hazardous waste destroyed or treated	100% - 10 80-99% - 8 60-80% - 6 40-60% - 4 20-40% - 2 <20% - 0	0	0	4	4	6
	ii. Are there any concentrated hazardous wastes produced as a result of (i)? (if no, go to factor 2)	Yes - 0 No - 2	2	2	2	0	0
(If subtotal = 12, go to factor 3)	iii. How is the concentrated hazardous waste stream disposed?	On-site land disposal - 0 Off-site secure land disposal - 1 On-site or off-site destruction or treatment - 2	-	-	-	2	2
2. Reduction in mobility of hazardous waste	i. Method of Reduction - Reduced mobility by containment - Reduced mobility by alternative treatment technology	 1 3	0	0	3	3	3
	ii. Quantity of wastes immobilized	90 - 100% - 2 60 - 90% - 1 <60% - 0	0	0	0	1	2
3. Irreversibility of the destruction or treatment of hazardous waste	- Completely irreversible - Irreversible for most of the hazardous waste constituents - Irreversible for only some of the hazardous waste constituents - Reversible for most of the hazardous waste constituents	3 2 1 0	0	0	2	2	2
SUBTOTAL (MAXIMUM = 15)			**2**	**2**	**11**	**12**	**15**

TABLE 14 (continued)
WEIGHTED-MATRIX SCORING SYSTEM FOR REMEDIAL ALTERNATIVES

D. IMPLEMENTABILITY (Weight = 15)

FACTOR	BASIS FOR EVALUATION	WEIGHT	ALTERNATIVE NUMBER				
			1	2	3	4	5
1. Technical Feasibility							
a. Ability to construct technology	i. Not difficult to construct. No uncertainties in construction	3	3	3	2	2	2
	ii. Somewhat difficult to construct. No uncertainties in construction	2					
	iii. Very difficult to construct and/or significant uncertainties in construction	1					
b. Reliability of technology	i. Very reliable in meeting the specified process efficiencies or performance goals	3	3	3	3	2	2
	ii. Somewhat reliable in meeting the specified process efficiencies or performance goals	2					
c. Schedule of delays due to technical problems	i. Unlikely	2	2	2	1	1	1
	ii. Somewhat likely	1					
d. Need of undertaking additional remedial action, if necessary	i. No future remedial action may be anticipated	2	1	1	2	1	2
	ii. Some future remedial actions may be necessary	1					
2. Administrative Feasibility			2	0	1	1	1
a. Coordination with other agencies	i. Minimal coordination is required	2					
	ii. Required coordination is normal	1					
	iii. Extensive coordination is required	0					
3. Availability of Services and Materials							
a. Availability of prospective technologies	i. Are technologies under consideration generally commercially available for the site-specific application?	Yes - 1 No - 0	1	1	1	1	1
	ii. Will more than one vendor be available to provide a competitive bid?	Yes - 1 No - 0	1	1	1	1	1
b. Availability of necessary equipment and specialists	i. Additional equipment and specialists may be available without significant delay	Yes - 1 No - 0	1	1	1	1	1
SUBTOTAL (MAXIMUM = 15)			**14**	**12**	**12**	**10**	**11**

TABLE 14 (continued)
WEIGHTED-MATRIX SCORING SYSTEM FOR REMEDIAL ALTERNATIVES

E. COMPLIANCE WITH ARARS (Weight = 10)

FACTOR	BASIS FOR EVALUATION	WEIGHT	ALTERNATIVE NUMBER				
			1	2	3	4	5
1. Compliance with chemical-specific ARARs	Meets chemical-specific ARARs	Yes - 2.5 No - 0	0	0	2.5	1.0	2.5
2. Compliance with action-specific ARARs	Meets action-specific ARARs	Yes - 2.5 No - 0	-	-	2.5	2.5	2.5
3. Compliance with location-specific ARARs	Meets location-specific ARARs	Yes - 2.5 No - 0	2.5	2.5	2.5	2.5	2.5
4. Compliance with appropriate criteria, advisories and guidelines	The alternative meets all relevant and appropriate Federal and State guidelines that are not promulgated	Yes - 2.5 No - 0	0	0	0	0	0
SUBTOTAL (MAXIMUM = 10)			**2.5**	**2.5**	**7.5**	**6.0**	**7.5**

F. PROTECTION OF HUMAN HEALTH & THE ENVIRONMENT (Weight = 20)

FACTOR	BASIS FOR EVALUATION	WEIGHT	ALTERNATIVE NUMBER				
			1	2	3	4	5
1. Use of site after remediation	Unrestricted use of the land and water (if yes, go to end of table)	Yes - 20 No - 0	0	0	0	0	0
2. Human health and the environment exposure after the remediation	i. Is the exposure to contaminants via air route acceptable?	Yes - 3 No - 0	3	3	3	3	3
	ii. Is the exposure to contaminants via groundwater/surface water acceptable?	Yes - 4 No - 0	0	0	0	4	4
	iii. Is the exposure to contaminants via sediments/ soil acceptable?	Yes - 3 No - 0	0	0	3	0	3
3. Magnitude of residual public health risks after the remediation	i. Health risk ii. Health risk	<1 in 1,000,000 - 5 <1 in 100,000 - 2	0	0	5	2	5
4. Magnitude of residual environmental risks after the remediation	i. Less than acceptable ii. Slightly greater than acceptable iii. Significant risk still exists	5 3 0	0	0	5	5	5
SUBTOTAL (MAXIMUM = 20)			3	3	16	14	20

G. COST (Weight = 15)

FACTOR	BASIS FOR EVALUATION	WEIGHT	ALTERNATIVE NUMBER				
			1	2	3	4	5
Overall (MAXIMUM = 15)	Scored on a linear scale with 0 and 15 assigned to the highest and the least cost alternatives respectively.	Lowest - 15 Others - Relative	15	9	1	0	9

TABLE 14 (continued)
WEIGHTED-MATRIX SCORING SYSTEM FOR REMEDIAL ALTERNATIVES

SUMMARY

CATEGORY	ALTERNATIVE NUMBER				
	1	2	3	4	5
A. SHORT-TERM EFFECTIVENESS (Weight = 10)	10	10	8	8	8
B. LONG-TERM EFFECTIVENESS AND PERMANENCE (Weight = 15)	7	4	12	8	11
C. REDUCTION OF TOXICITY, MOBILITY OR VOLUME (Weight = 15)	2	2	11	12	15
D. IMPLEMENTABILITY (Weight = 15)	14	12	12	10	11
E. COMPLIANCE WITH ARARS (Weight = 10)	2.5	2.5	7.5	6	7.5
F. PROTECTION OF HUMAN HEALTH & THE ENVIRONMENT (Weight = 20)	3	3	16	14	20
G. COST (Weight = 15)	15	9	1	0	9

TOTAL SCORE (Maximum = 100)	53.5	42.5	67.5	58	81.5

FIGURES

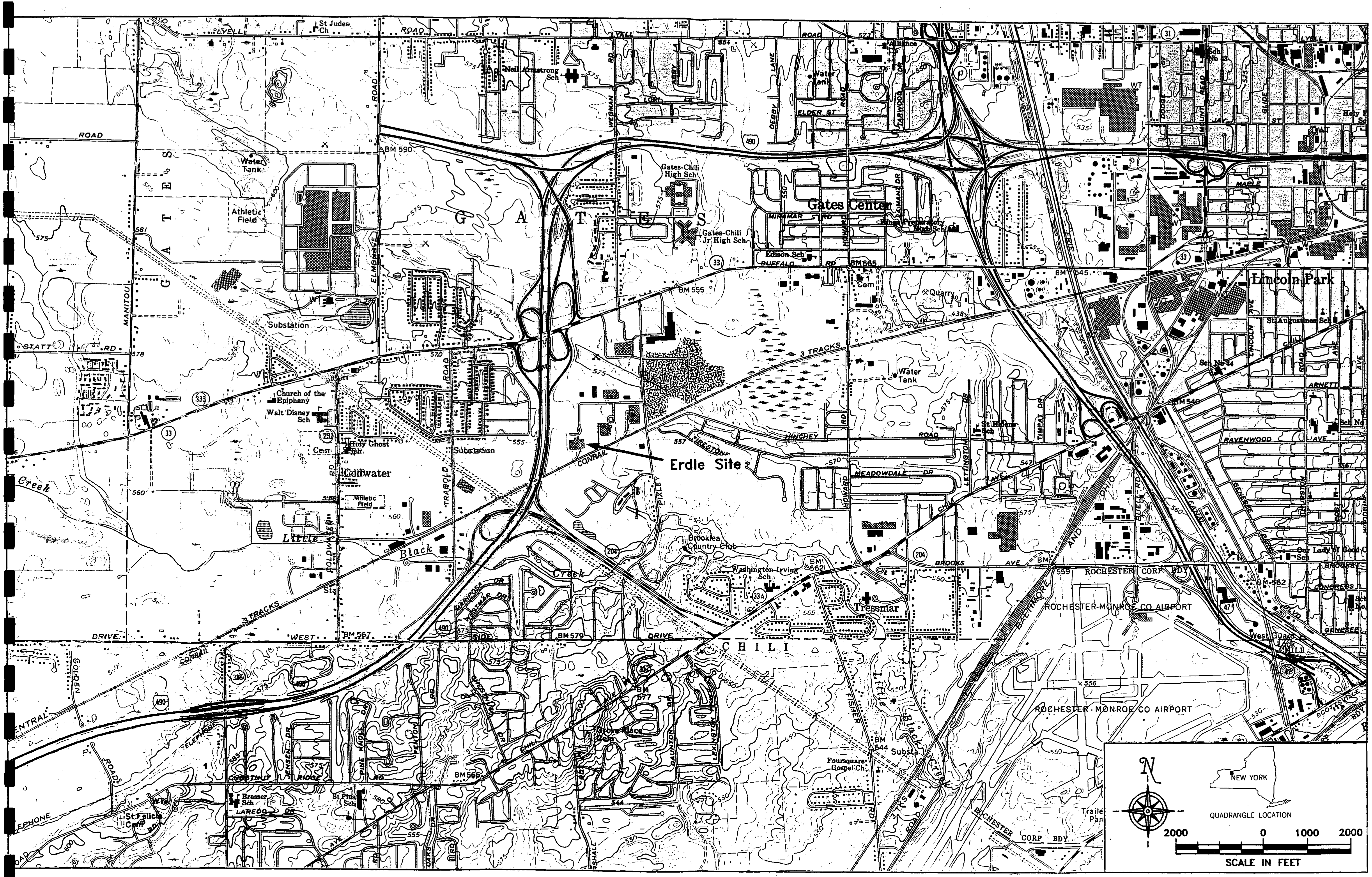


Figure 1: Site Location

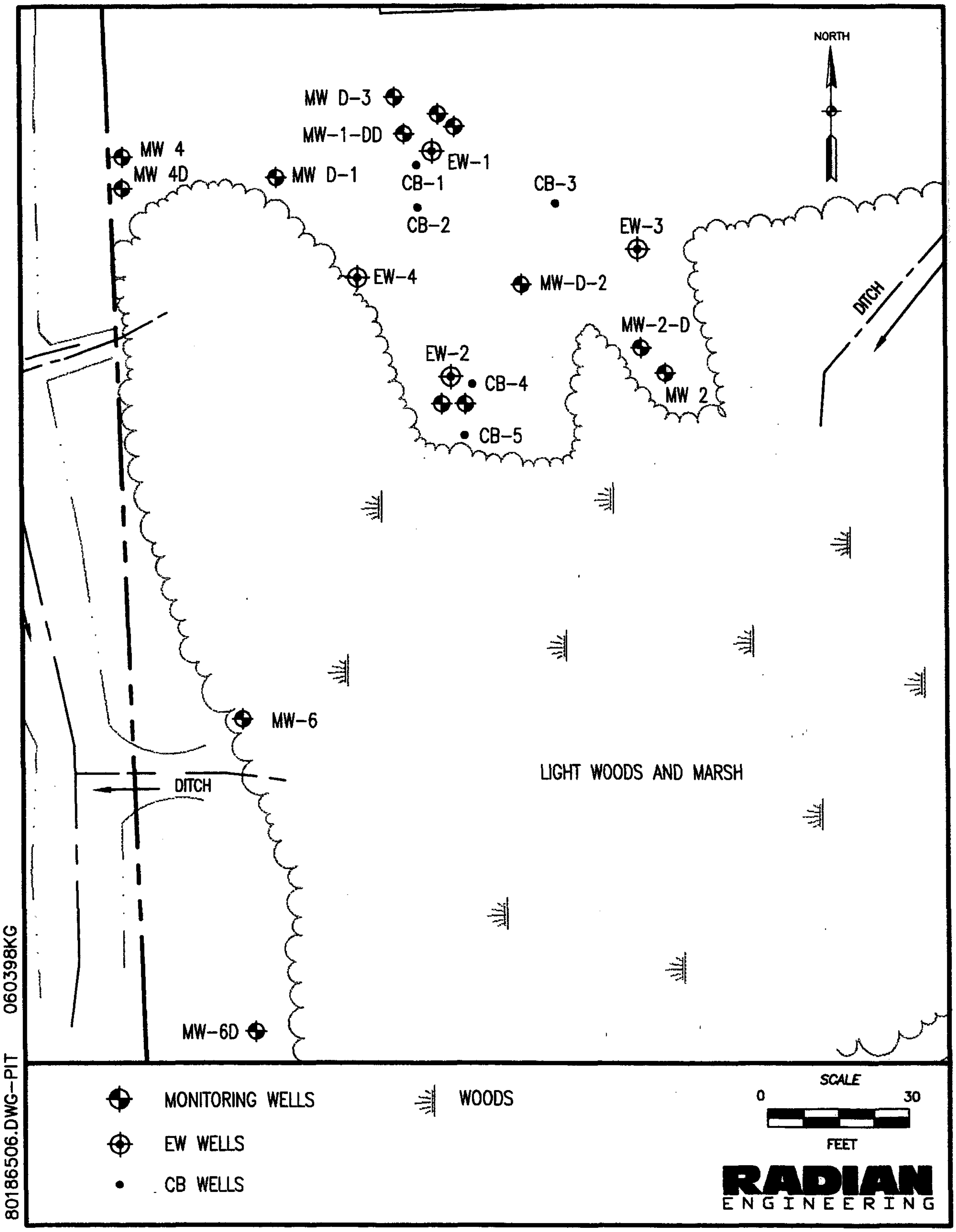


Figure 2. Remedial Investigation and Interim Remedial Measure Borehole Locations.

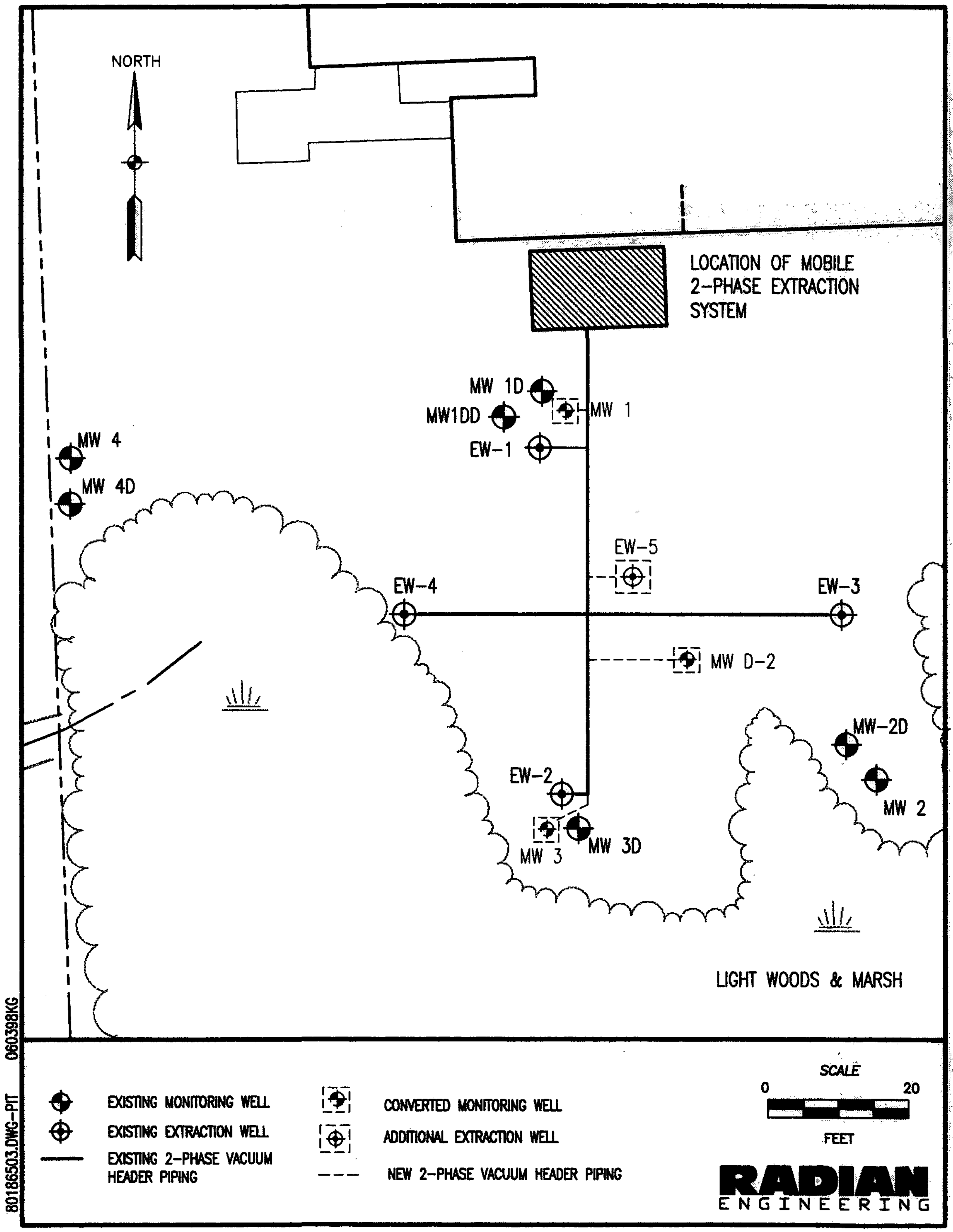
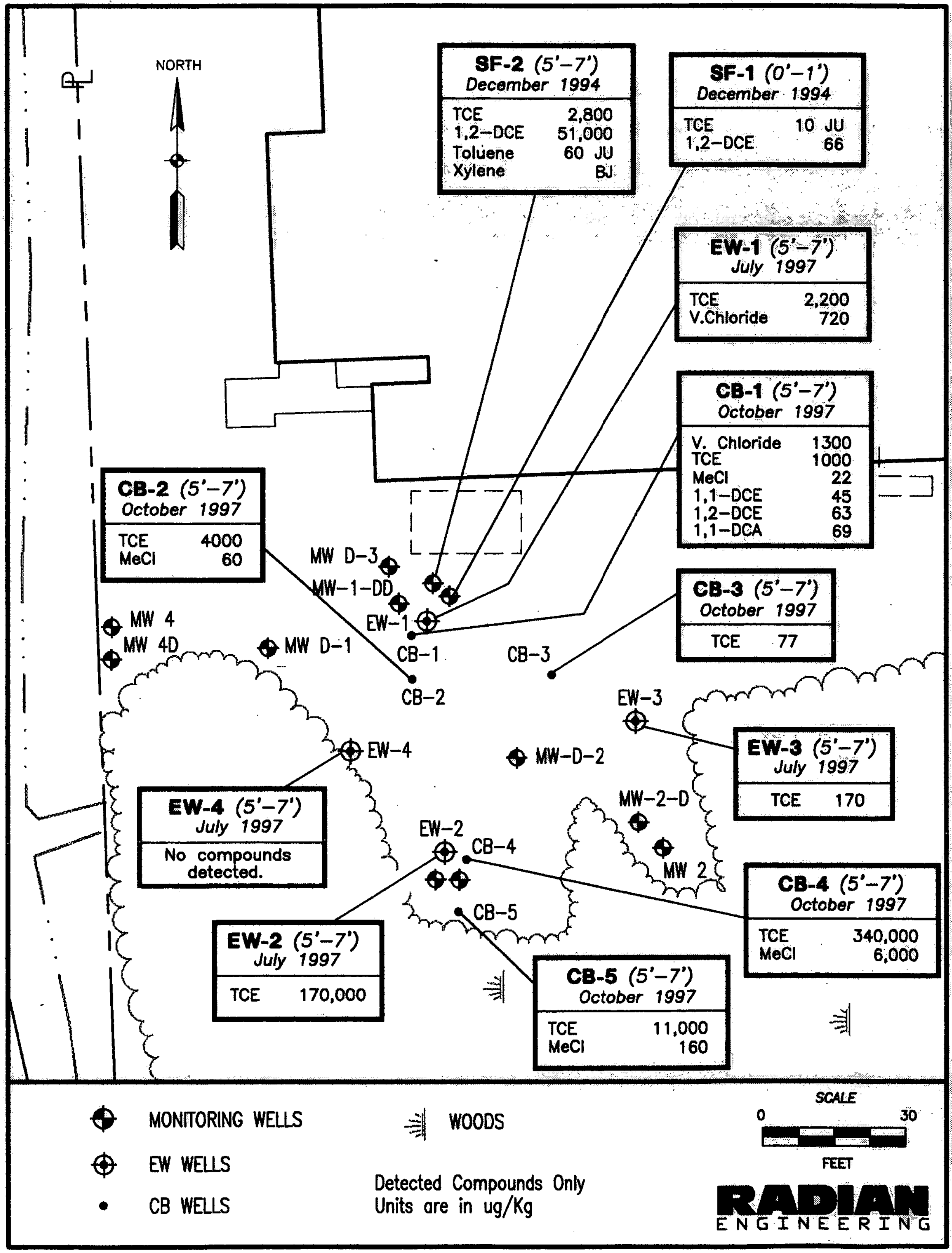
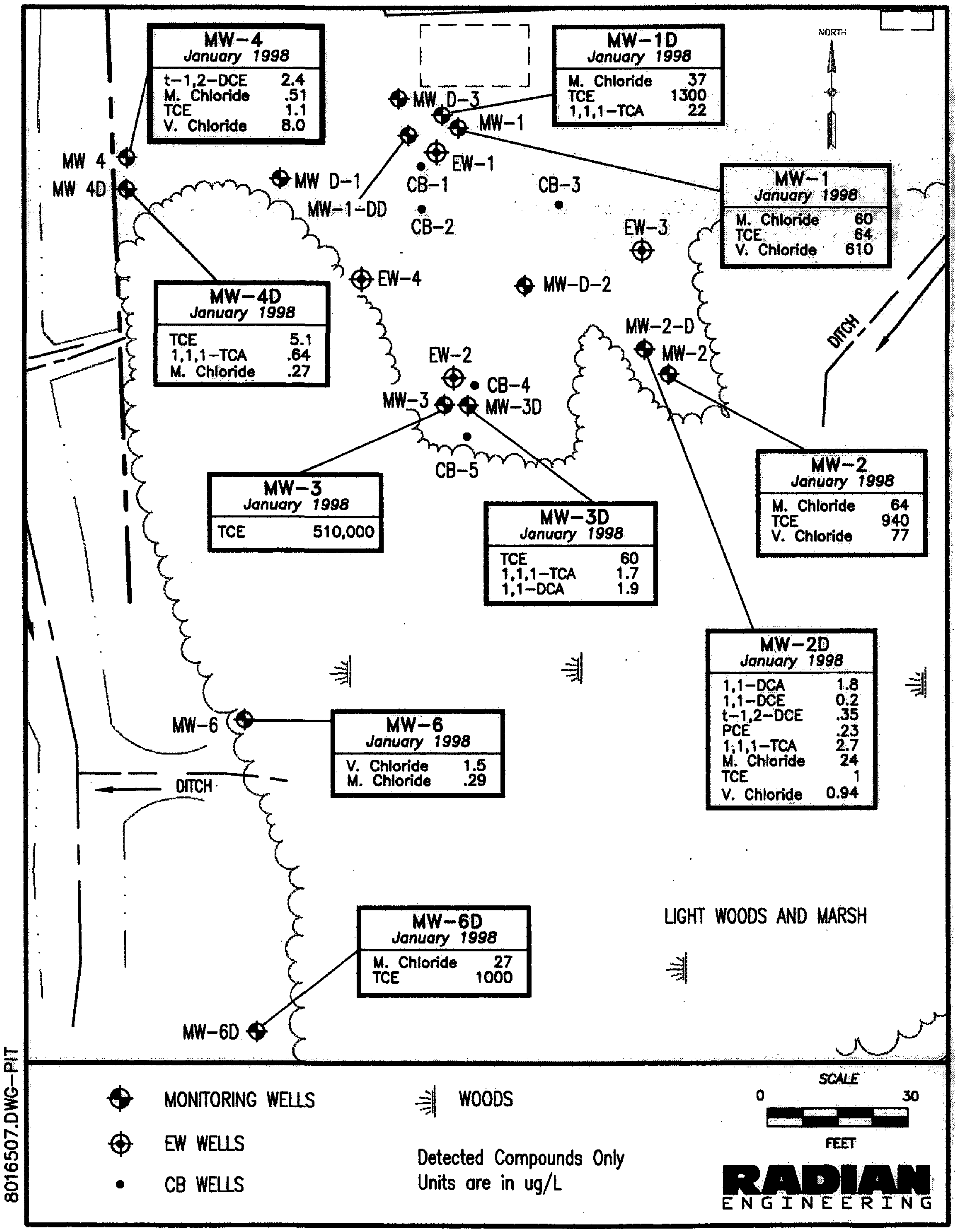


Figure 3: Expanded 2-PHASE Extraction System Layout



80186502.DWG-PIT

Figure 4: Current Subsurface Soil Concentrations



MW-4 January 1998	
t-1,2-DCE	2.4
M. Chloride	.51
TCE	1.1
V. Chloride	8.0

MW-1D January 1998	
M. Chloride	37
TCE	1300
1,1,1-TCA	22

MW-1 January 1998	
M. Chloride	60
TCE	64
V. Chloride	610

MW-4D January 1998	
TCE	5.1
1,1,1-TCA	.64
M. Chloride	.27

MW-3 January 1998	
TCE	510,000

MW-3D January 1998	
TCE	60
1,1,1-TCA	1.7
1,1-DCA	1.9

MW-2 January 1998	
M. Chloride	64
TCE	940
V. Chloride	77

MW-2D January 1998	
1,1-DCA	1.8
1,1-DCE	0.2
t-1,2-DCE	.35
PCE	.23
1,1,1-TCA	2.7
M. Chloride	24
TCE	1
V. Chloride	0.94

MW-6 January 1998	
V. Chloride	1.5
M. Chloride	.29

MW-6D January 1998	
M. Chloride	27
TCE	1000

Detected Compounds Only
Units are in ug/L

Figure 5 - Current Groundwater Concentrations

FIGURE 6

ERDLE PERFORATING, INC.
FEASIBILITY STUDY

SUMMARY OF SELECTED REMEDIAL TECHNOLOGIES FOR SOILS

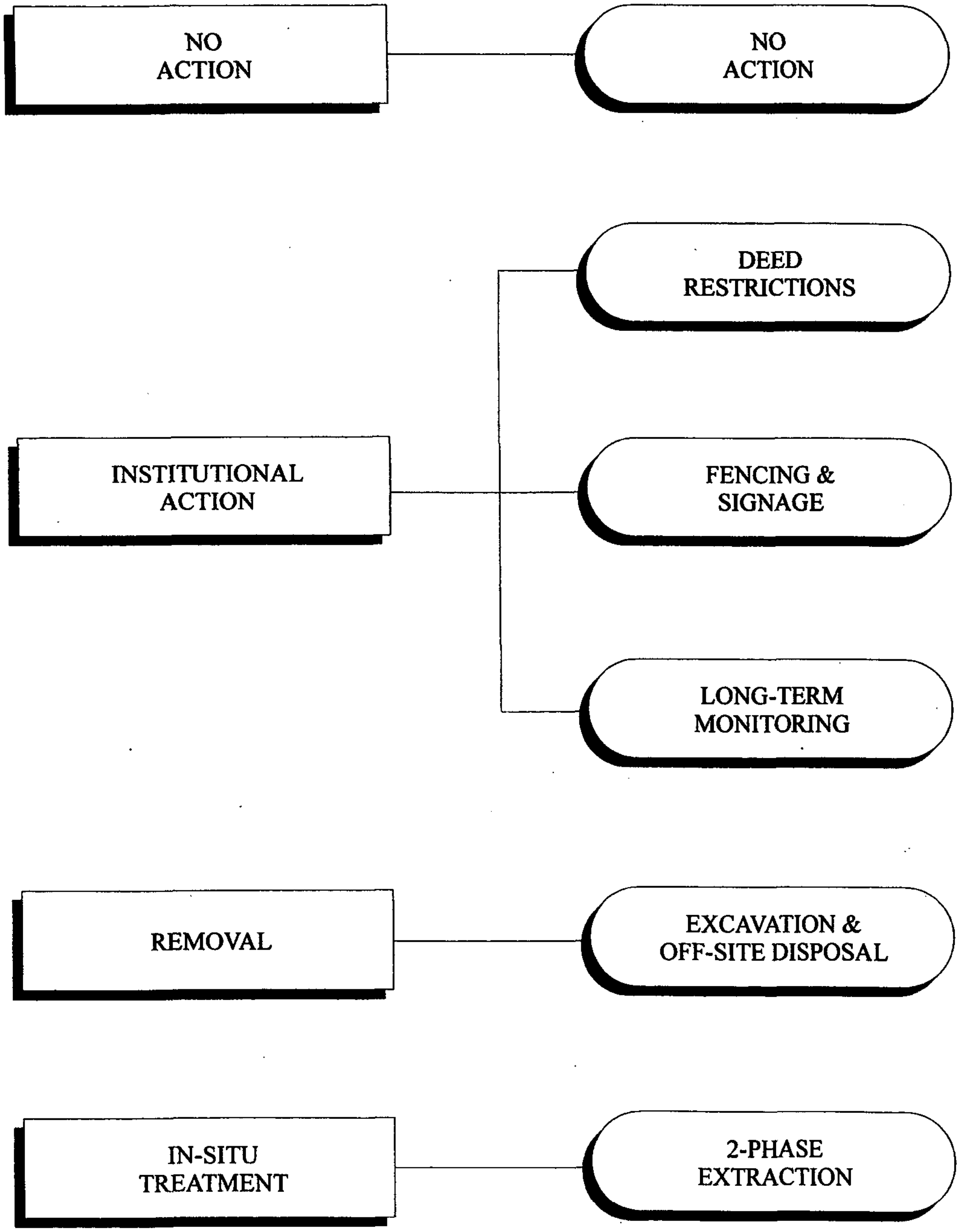


FIG6-C-P.DWG-PIT 06039B:KG

RADIAN
ENGINEERING

FIGURE 7

ERDLE PERFORATING, INC.
FEASIBILITY STUDY

SUMMARY OF SELECTED REMEDIAL TECHNOLOGIES FOR GROUNDWATER

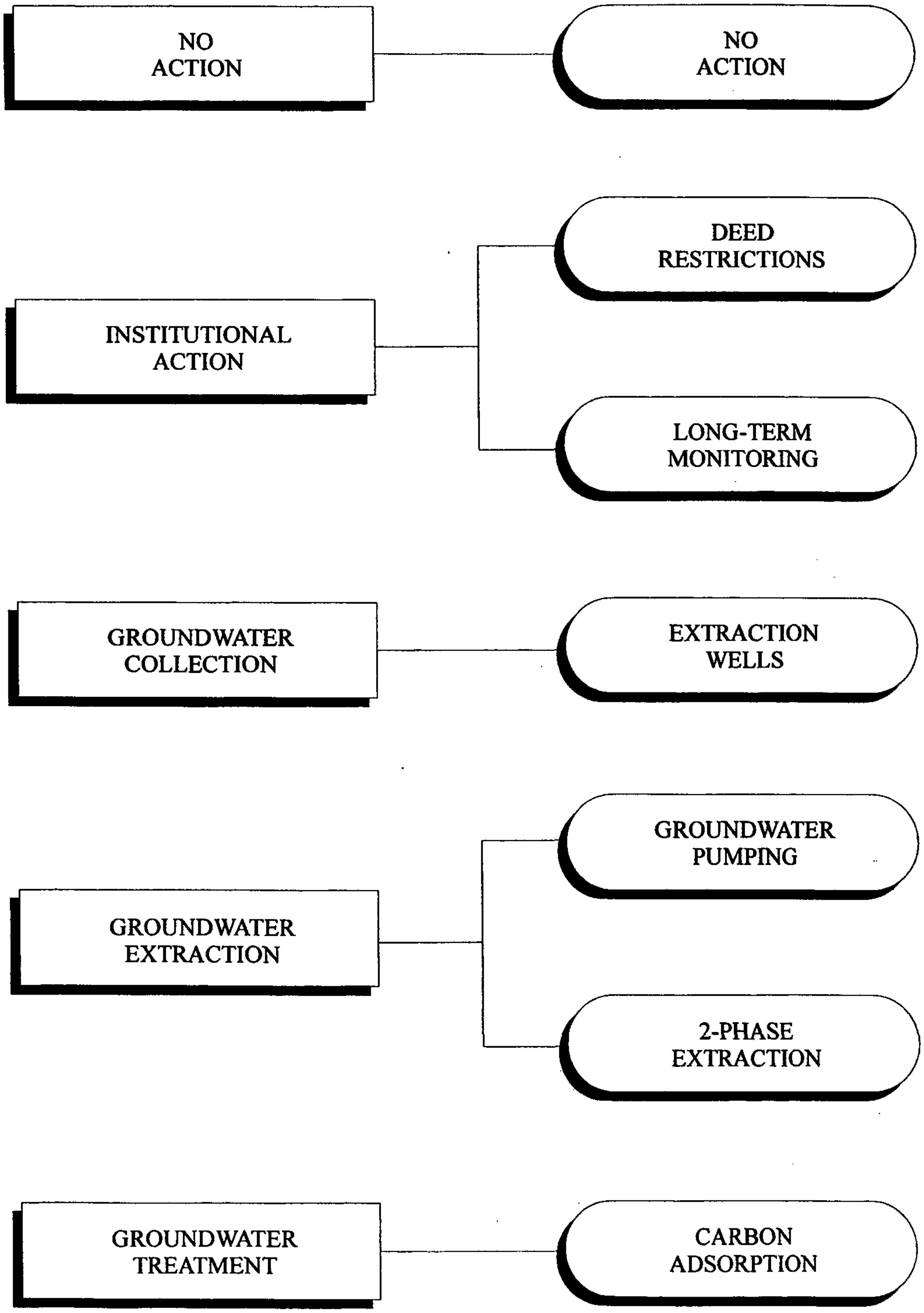


FIG7-C-P.DWG-PIT 06039BKG

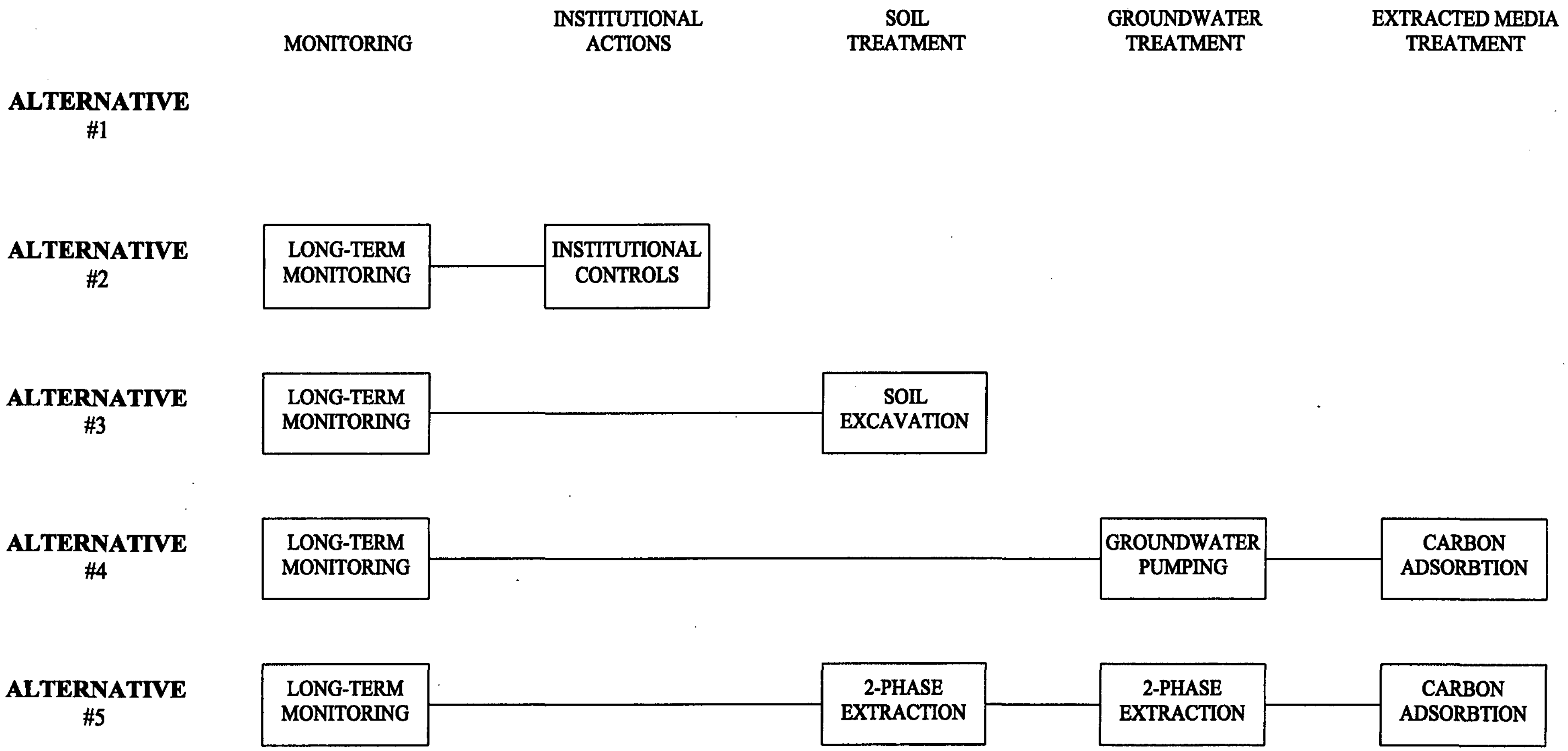
RADIAN
ENGINEERING

FIGURE-8.DWG 060398KG

FIGURE 8

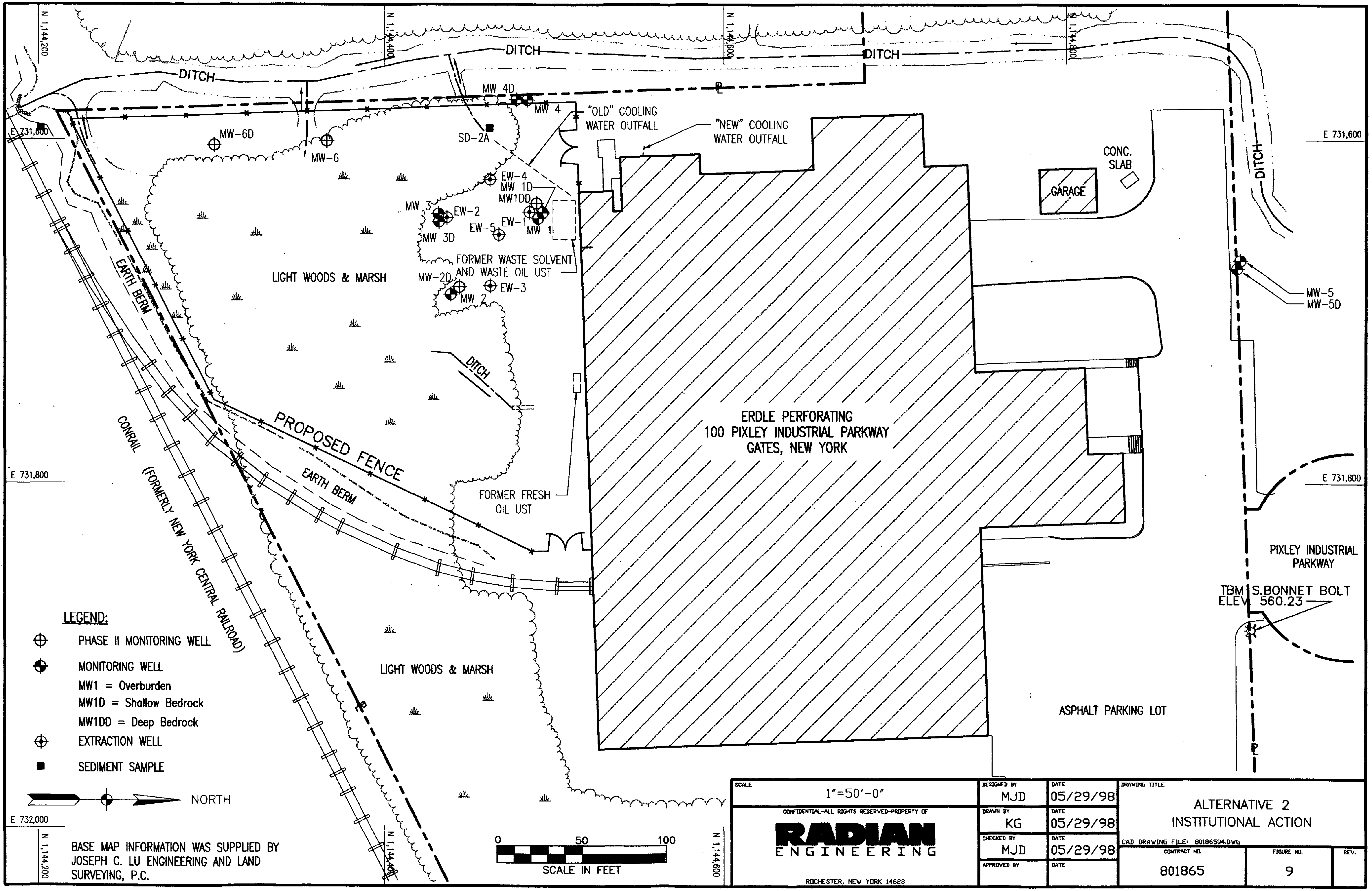
ERDLE PERFORATING, INC.
FEASIBILITY STUDY

REMEDIAL ALTERNATIVES



	MONITORING	INSTITUTIONAL ACTIONS	SOIL TREATMENT	GROUNDWATER TREATMENT	EXTRACTED MEDIA TREATMENT
ALTERNATIVE #1					
ALTERNATIVE #2	LONG-TERM MONITORING	INSTITUTIONAL CONTROLS			
ALTERNATIVE #3	LONG-TERM MONITORING		SOIL EXCAVATION		
ALTERNATIVE #4	LONG-TERM MONITORING			GROUNDWATER PUMPING	CARBON ADSORBTION
ALTERNATIVE #5	LONG-TERM MONITORING		2-PHASE EXTRACTION	2-PHASE EXTRACTION	CARBON ADSORBTION

RADIAN
ENGINEERING



SCALE 1"=50'-0"	DESIGNED BY MJD	DATE 05/29/98	DRAWING TITLE ALTERNATIVE 2 INSTITUTIONAL ACTION
CONFIDENTIAL-ALL RIGHTS RESERVED-PROPERTY OF RADIAN ENGINEERING ROCHESTER, NEW YORK 14623	DRAWN BY KG	DATE 05/29/98	CAD DRAWING FILE: 80186504.DWG
	CHECKED BY MJD	DATE 05/29/98	CONTRACT NO. 801865
	APPROVED BY	DATE	FIGURE NO. 9
			REV.

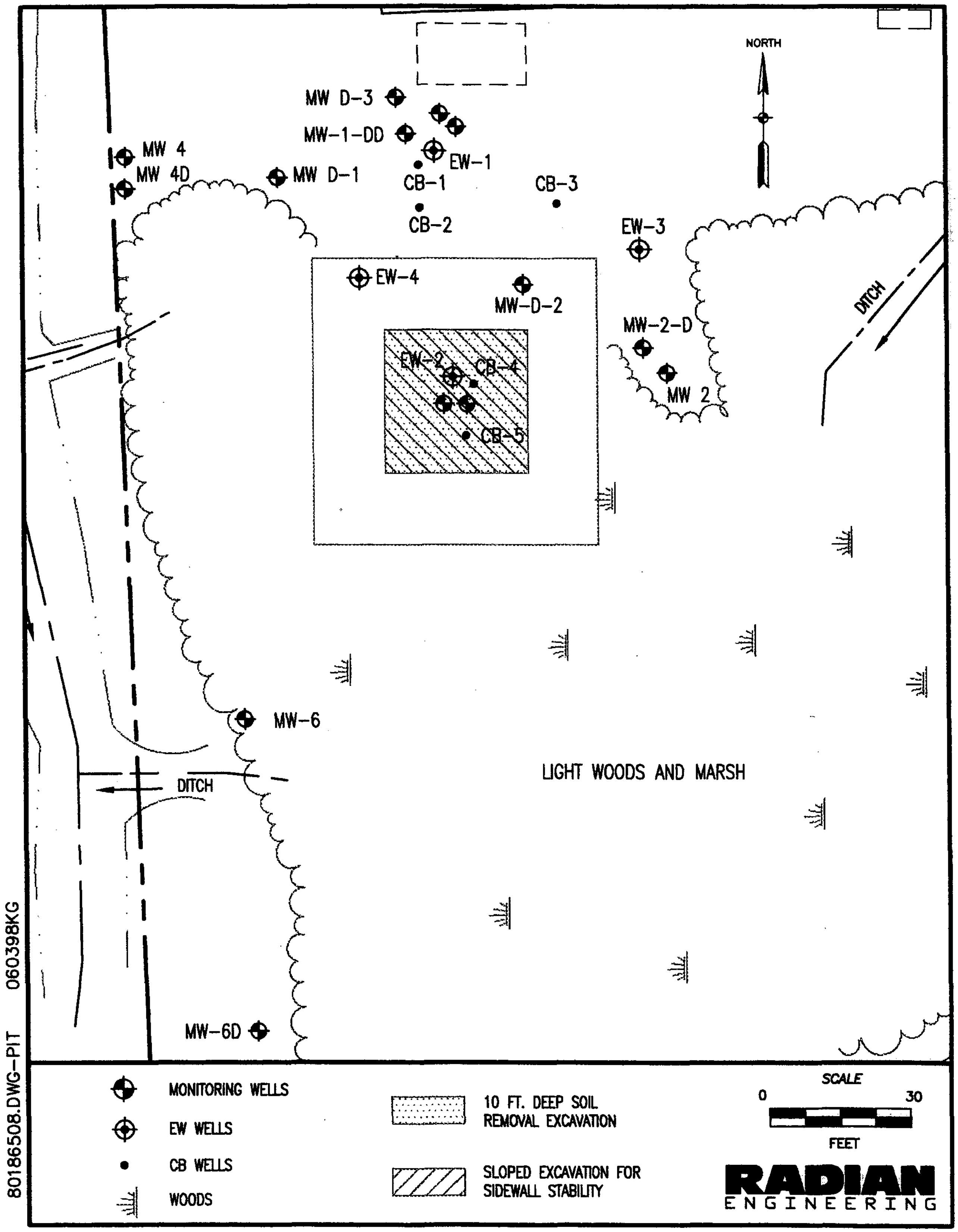
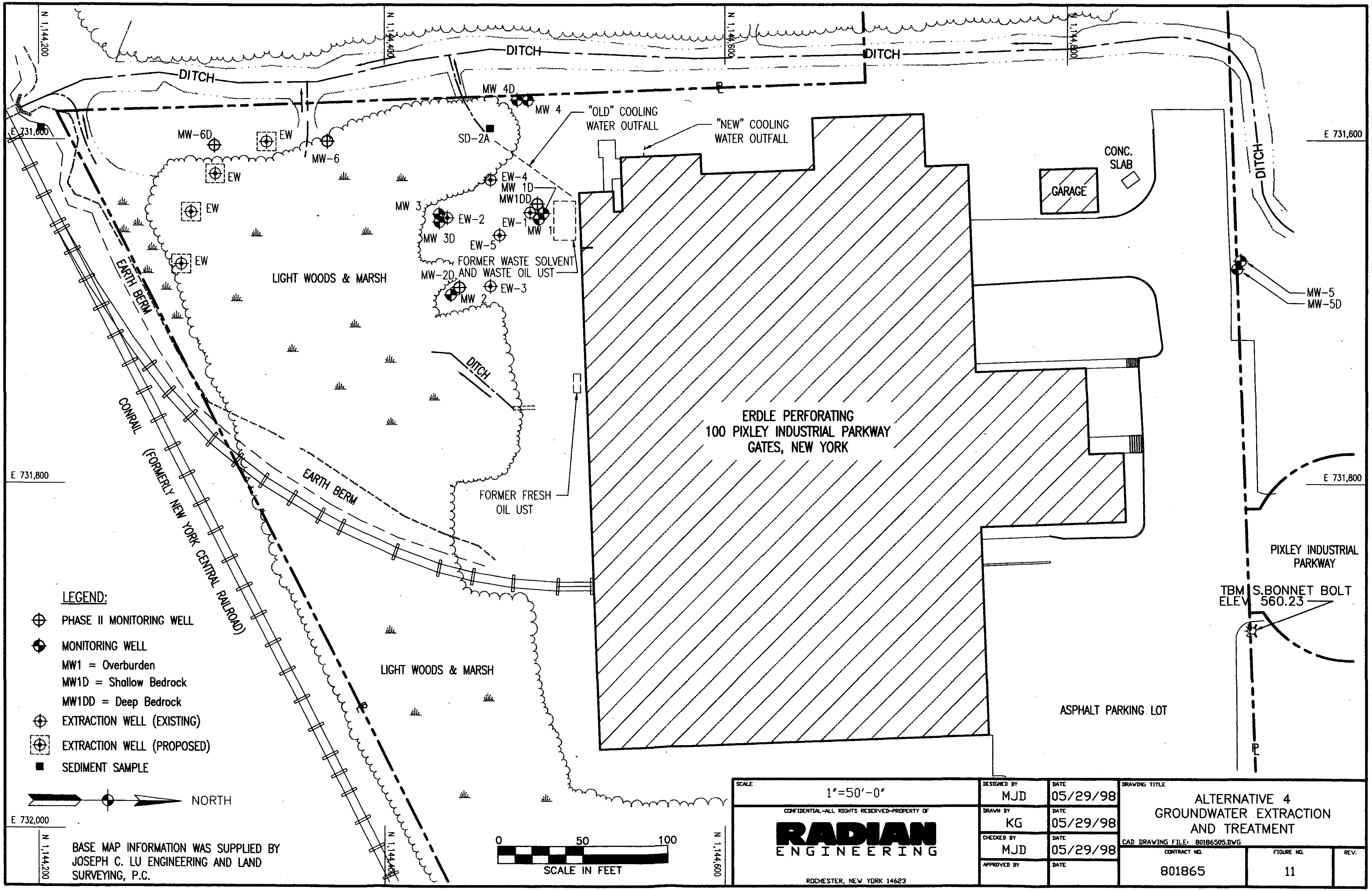


Figure 10: Alternative 3 - Excavation



SCALE 1"=50'-0"	DESIGNED BY MJD	DATE 05/29/98	DRAWING TITLE ALTERNATIVE 4 GROUNDWATER EXTRACTION AND TREATMENT
CONFIDENTIAL–ALL RIGHTS RESERVED–PROPERTY OF RADIAN ENGINEERING ROCHESTER, NEW YORK 14623	DRAWN BY KG	DATE 05/29/98	CAD DRAWING FILE: 80186505.DWG
	CHECKED BY MJD	DATE 05/29/98	CONTRACT NO. 801865
	APPROVED BY	DATE	FIGURE NO. 11

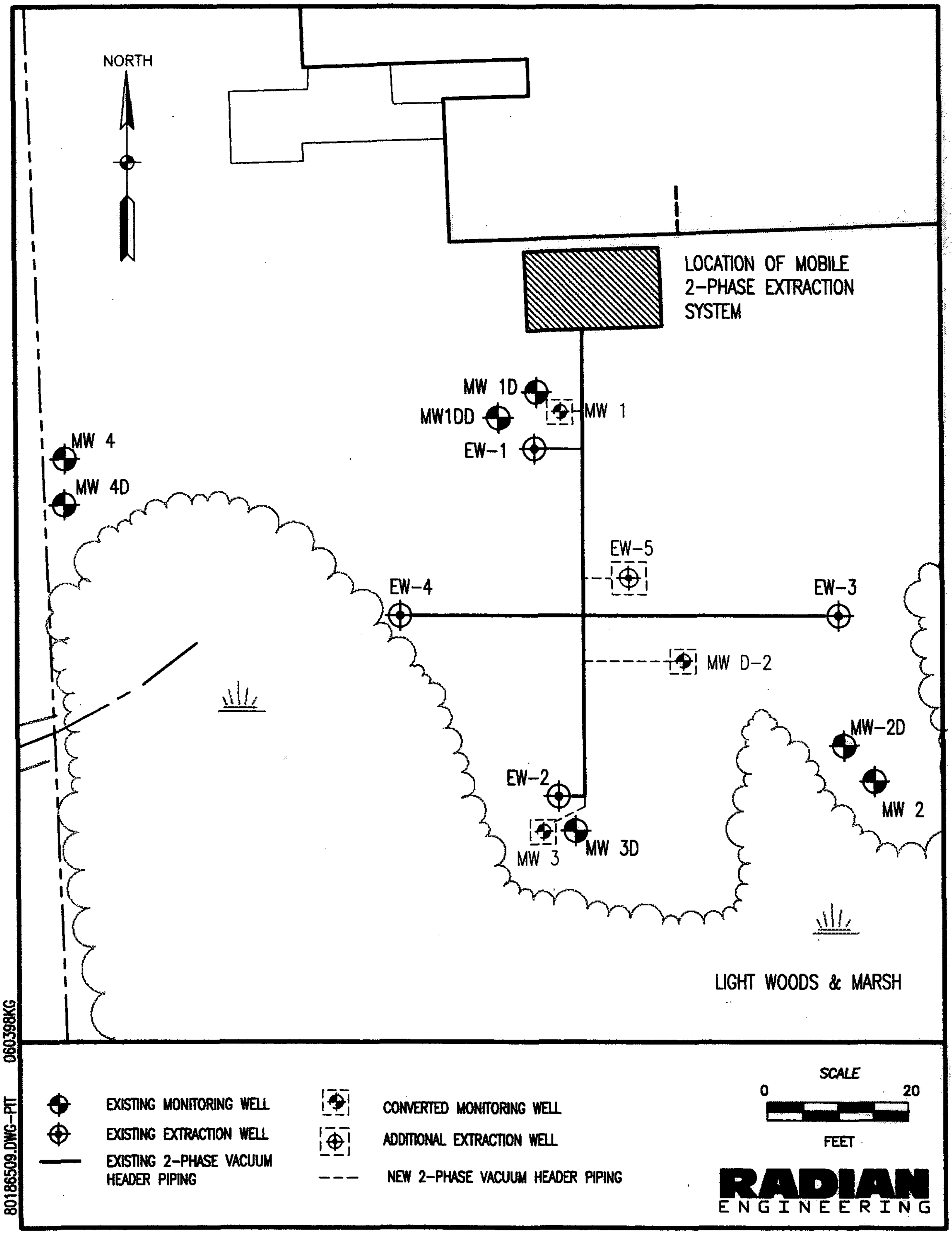


Figure 12: Alternative 5 - 2-PHASE Extraction

A

APPENDIX A

PHASE I
REMEDIAL INVESTIGATION DATA SUMMARY

TABLES

Table 1-1

Summary of Site History, Erdle Perforating Company, Town of Gates, New York

Date/ Contractor	Activity	Findings
January 1987 Day Engineering	• Four soil borings installed. • Soil samples obtained via split-spoon from three depths per location. • Depth to groundwater measured and groundwater samples obtained. • Soil and groundwater samples analyzed for purgeable halocarbons and purgeable aromatics.	• Volatile organic compounds (TCE, 1,2-DCE, and PCE) present in soil near the waste TCE tank. • Volatile organic compounds (TCE, 1,2-DCE, and PCE) present in groundwater near the waste TCE tank.
5 February 1987 Day Engineering	• Non-process-related water found in waste TCE tank. • Integrity test conducted on waste TCE tank	• Tank was not tight, and was judged unfit for use.
July 1987 Day Engineering	• Waste TCE tank, waste oil tank, and fresh oil tank removed. • Thirteen soils samples taken from waste TCE tank excavation. • Three soil samples taken from dark area of fresh oil tank excavation. • Four surface water and sediment samples collected.	• Six holes found in waste TCE tank. Other tanks in good condition. • Soil at the edges of the waste TCE tank excavation contained detectable levels of VOCs. • Soils from fresh oil tank excavation contained petroleum hydrocarbon compounds. • VOCs were detected in the non-contact cooling water stream which emanated from the southwest corner of the building. • Site placed on New York State Registry of Inactive Hazardous Waste Sites (#828072) and ranked as a Class 2 site.
April 1990 Erdle Personnel	• Surface water resampled at three of the Day Engineering locations.	• Maximum concentration of TCE detected was lower than the previous Day Engineering results by a factor of approximately 110.
December 1992 O'Brien & Gere	• Four monitoring wells installed (three shallow, one deep). • Groundwater and soil samples analyzed by EPA Methods 8010 and 8020.	• Elevated levels of TCE detected in all groundwater samples. Tetrachloroethane, 1,1,1-trichloroethane, vinyl chloride, and 1,2-dichloroethene constituents were also detected in groundwater samples. Methylene chloride and trichloroethene were detected in soils.

Table 2-1

Summary of Phase I Remedial Investigation Program

Pathway	Summary of pre-RI Data		RI Sampling/Studies	Rationale
Groundwater	Overburden:	Three downgradient monitoring wells (MW-2, MW-3, MW-4) installed in December 1992. Solvent-related volatile organic compounds (VOCs) detected downgradient of former waste solvent UST.	Installed overburden monitoring wells at a background location (MW-5) and adjacent to the former waste solvent UST (MW-1). Sampled background well (MW-5) and analyzed for halogenated VOCs and metals. Sampled UST well (MW-1) and analyzed for TCL parameters. Conducted hydraulic testing in completed monitoring wells. Identified downgradient receptors in the overburden flow zone through literature research and onsite observations.	Provides hydrogeologic data and upgradient/downgradient monitoring network for overburden groundwater flow zone. Background VOC data provides information on contamination from offsite sources. Background metals data facilitate interpretation of metals data from UST location.
	Bedrock:	One monitoring well located adjacent to the former waste solvent UST was installed in December 1992 (MW-1D). Solvent-related VOCs detected.	Installed top-of-bedrock monitoring wells at the background location (MW-5D) and at the southern and southwestern downgradient overburden well locations (MW-3D and MW-4D, respectively). Sampled background well (MW-5D) and analyzed for TCL parameters. Sampled downgradient wells (MW-3D and MW-4D) for halogenated VOCs. Conducted packer testing of bedrock during well construction. Identified downgradient receptors in the top of bedrock flow zone through literature research and onsite observations.	Provides hydrogeologic data and upgradient/downgradient monitoring network for the top-of-bedrock groundwater flow zone. Top-of-bedrock flow zone considered to be most likely pathway for onsite migration of contamination from offsite. TCL analysis provides full characterization of possible contamination from offsite sources. Downgradient VOC data provides information on extent of contamination in top-of-bedrock flow zone.

Table 2-1 (cont'd)

Pathway	Summary of pre-RI Data	RI Sampling/Studies	Rationale
Soil	Solvent-related VOCs detected in samples adjacent to the former waste solvent UST. Total petroleum hydrocarbons detected in samples at the former fresh oil tank location.	Collected two soil samples from overburden monitoring well boring at the UST location (MW-1): one at the surface (SF-1) and one at the depth of the former tanks (SF-2). Analyzed the shallow sample for halogenated VOCs and the deep sample for TCL parameters. Collected one soil sample (SF-4) from the overburden monitoring well boring at the background location. Analyzed the sample for halogenated VOCs and metals. Collected one subsurface soil sample (SF-3) from the depth of the former fresh oil tank. Analyzed the sample for total VOCs and semivolatile organic compounds (SVOCs).	Deep sample provides full analytical characterization of contamination from the most-contaminated location. Shallow sample determines if surface contamination exists at tank location. Fresh oil tank sample provides characterization of contamination at that location. Background soil sample provides information on contamination from offsite sources.
Surface Water	Solvent-related VOCs detected in samples from former "old" cooling water outfall. No solvent-related VOCs detected at two locations downstream of the site.	Collected background surface water/sediment samples (SW-3/SD-3) and analyzed for halogenated VOCs. Collected surface water/sediment samples from the former "old" cooling water outfall (SW-2/SD-2). Collected surface water/sediment samples from the wet area downstream of the site (SW-1/SD-1 and SW-4/SD-4). Collected a surface soil sample (S-1) from the "new" cooling water outfall ditch (outfall ditch is dry). Conducted surveys and observations for site description and resource identification for Fish and Wildlife Impact Analysis. Completed analysis according to the 18 June 1991 NYSDEC Technical and Administrative Guidance Memorandum (TAGM). Conducted surveys and observations for Habitat Based Assessment. Completed assessment according to TAGM.	Background samples provide information on contamination from offsite sources. Provides updated confirmation data at the "old" cooling water outfall location. Provides updated confirmation of absence of contamination downstream of site. Provides confirmation of absence of contamination from "new" cooling water outfall.
Air	No previous data.	Collected flux chamber samples from the former tank excavation and the background location. Conducted air pathway analysis according to the 2 April 1991 TAGM.	Provides quantitative data on air emissions from the site.

Table 2-2

Summary of Stratigraphy in the Vicinity of Erdle Perforating Company[a]

Unit	Age	Group	Description	Typical Thickness[b]
Bertie Formation	Upper Silurian	Salina	Drab or gray limestone, dolomitic limestone, and dolomite. In Western New York, has been divided into Oatka shale, Falkirk dolomite, Scajaquada shale/dolomite, and Williamsville dolomite. Noted for eurypterid fauna.	50-60 ft
Salina Formation			Two major facies are present: a red and green argillaceous facies (Vernon shale), and a gray to brown more calcareous facies with evaporites (Camillus shale).	600-900 ft
Pittsford Shale			A black shale which occurs only locally in the Rochester area. Consists of thin layers of black and green mottled shale with some thin dolomite layers. May not be present in site vicinity.	10-20 ft
Lockport Dolomite	Middle Silurian	Lockport	Sugary, gray, massive dolomite, sandy in places. Commonly contains small cavities lined with dolomite and other crystals. Resistant unit, which forms the crest of Niagara Falls and the upper falls of the Rochester gorge. Between these areas, is responsible for the Niagara cuesta.	150-300 ft
Rochester Shale		Clinton	Dark bluish gray shale with plentiful limestone layers. Basal 10 feet is brownish gray. Lower 25-30 feet is a weak shale which readily disintegrates to a blue-brown clay. In Rochester area, grades into the overlying Lockport. Contains varied fossils, primarily brachiopods.	85 ft
Irondequoit Limestone			Lower half of formation: massive limestone layers separated by thin dark grey calcareous shales. Upper half: light gray, coarsely crystalline, crinoidal limestone. Crystalline limestones often comprised entirely of crinoid fragments.	18 ft
Williamson Shale			Dark green to black, calcareous to slightly calcareous, fissile, graptolite-bearing shale. Upper part is predominantly dark green and contains a few thin limestones. Ellipsoidal limestone concretions, flattened on bottom, occur in basal portions. This formation thins west of the Genesee Gorge and may not be present in site vicinity.	6 ft
(Hiatus)			(Hiatus)	--

Table 2-2

(Continued)

Unit	Age	Group	Description	Typical Thickness[b]
Sodus Shale	Middle Silurian (cont)	Clinton (cont)	Green to greenish gray, calcareous, slightly silty, fossiliferous shale with thin limestone layers. Dark gray to purple shell layers interbedded with the green. Upper 3 feet of formation contains 3 prominent layers which are 95% calcareous material. This formation thins west of the Genesee Gorge and may not be present in site vicinity.	11-18 ft
Reynales Limestone			Crystalline dolomitic limestones interbedded with layers containing large numbers of Pantamerus laevis. Thin shale partings and cherty beds are present. Reynales formation may also contain the Furnaceville iron ore or hematitic limestone.	17 ft
Maplewood Shale			A smooth, slightly calcareous, green, platy shale. Lower 3 feet may be sandy. Phosphatic nodules characterize the lower Maplewood in Monroe County, and several thin limestone beds occur. Origin is unclear; may represent a winnowing of the Grimsby or a quiet water deposit in an offshore environment.	21 ft
Thorold Sandstone	Lower Silurian		Light gray-green, fine-grained siltstone, with a maximum thickness of 5 feet. Thin shale partings are abundant. The Thorold contains many thin shale breaks (similar to those in the overlying Maplewood Shale, but with a higher percentage of quartz). Represents a readvance of marine conditions (i.e., transgression) from west to east over the Queenston deltaic complex, which spread across the Allegheny Basin during the (Middle Ordovician to Early Silurian) Taconic Orogeny.	5 ft

[a] Adapted from references (6) Grasso, Thomas, "Stratigraphy of the Genesee Gorge at Rochester," presented in New York State Geological Association Guidebook to Field Trips, 45th Annual Meeting, Rochester, New York, Area, September 1973; (8) VanDiver, Bradford B., "Field Guide, Upstate New York," K/H Geology Field Guide Series, Kendall/Hunt Publishing Company, 1980; and (9) New York State Geological Association Guidebook to Field Trips, 28th Annual Meeting, May 1956.

[b] Estimates for typical thicknesses in Rochester area, from observations made at Genesee River Gorge and reported in "New York State Geological Association Guidebook to Field Trips, 28th Annual Meeting, May 1956.

Table 2-3

Summary of Historical Drinking Water Wells in Site Vicinity

Private Drinking Water Wells Within a One-Mile Radius of Erdle Perforating Company (per Monroe County Health Department)[a]		
Ainsworth Lane (2600 ft)	**Buffalo Road (2200 ft - 1 mile)**	**Cherry Road (3600 ft - 1 mile)**
#10	#1605, 1732, 1931, 2046, 2565, 2630, 2639, 2711, 2849, 2923, 2924	#80
Elmgrove Road (4500 ft - 1 mile)	**Hillswood Road (4500 ft)**	**Hinkley Lane (1200 - 3000 ft)**
#944, 984, 988, 994, 1000, 1004	#2	#14
Kingswood Drive (4500 ft)	**Pixley Road (1500-3500 ft)**	**Trabold Road (3000 ft - 1 mile)**
#4, 24	#61, 601, 657, 685, 707, 891, 907, 933, 1020, 1085, 1105	#40, 50, 62, 116, 163, 580, 661, 785, 797, 807, 817, 830, 824
Wegman Road (3200 ft - 1 mile)	**Westside Drive (2600 ft - 1 mile)**	**Woodview Drive (4200 ft)**
#910, 914, 1010	#98, 108, 120, 130, 140, 142, 154, 164, 350, 418, 456	#32

Locations Not Served by Monroe County Water Authority (per Monroe County Environmental Management Council, early 1980s)[b]
#22 Cherry Road
Brooklea Country Club

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[a] These addresses represent any wells for which sampling has historically been requested; additional wells, for which sampling had not been requested, could exist. Conversely, because public supply water is now available to the entire area, many of the listed wells may no longer be in use.

[b] These addresses represent locations which at the time of the survey (early 1980s) were served by water wells. Both of these locations are currently on the public water service.

Table 2-4

New York State SCGs
Erdle Perforating Company, Phase I Remedial Investigation

Media	Reference
Surface and Subsurface Soils	New York State Department of Environmental Conservation, Division Technical and Administrative Guidance Memorandum (TAGM): Determination of Soil Cleanup Objectives and Cleanup Levels (HWR-92-4046), January 24, 1994 (Revised).
Groundwater	New York State Department of Environmental Conservation, Division of Water, "Technical and Operational Guidance Series (TOGS) 1.1.1: Ambient Water Quality Standards and Guidance Values," October 1993. (Contains Part 703 Standards).
Sediment	New York State Department of Environmental Conservation, Division of Fish and Wildlife, Division of Marine Resources, "Technical Guidance for Screening Contaminated Sediments," July 1994.
Surface Water	New York State Department of Environmental Conservation, Division of Water, "Technical and Operational Guidance Series (TOGS) 1.1.1: Ambient Water Quality Standards and Guidance Values," October 1993.
Air	New York State Department of Environmental Conservation, Bureau of Toxic Air Sampling, Division of Air Resources, "Air Pathway Analysis Requirements in the Remedial Investigation." April 2, 1991.
Ecological Assessment	New York State Department of Environmental Conservation, Division of Fish and Wildlife, "Fish and Wildlife Impact Analysis for Inactive Hazardous Waste Sites," June 18, 1991.

Table 3-1

Definition of Laboratory Flags

USEPA-Defined Organic Data Qualifiers:

U	Indicates compound was analyzed for but not detected.
J	Indicates an estimated value. This flag is used either when estimating a concentration for tentatively identified compounds where a 1:1 response is assumed, or when the mass spectral data indicate the presence of a compound that meets the identification criteria but the result is less than the sample quantitation limit but greater than zero.
C	This flag applies to pesticide results where the identification has been confirmed by GC/MS.
B	This flag is used when the analyte is found in the associated blank as well as in the sample.
E	This flag identifies compounds whose concentrations exceed the calibration range of the GC/MS instrument for that specific analyte.
D	This flag identifies all compounds identified in an analysis at a secondary dilution factor.
G	The TCLP Matrix Spike recovery was greater than the upper limit of the analytical method.
L	The TCLP Matrix Spike recovery was lower than the lower limit of the analytical method.
T	This flag is used when the analyte is found in the associated TCLP extraction as well as in the samples.
N	Indicates presumptive evidence of a compound. This flag is only used for tentatively identified compounds, where the identification is based on a mass spectral library search. It is applied to all TIC results.
P	This flag is used for a pesticide/Aroclor target analyte when there is greater than 25% difference for detected concentrations between the two GC columns. The lower of the two values is reported on the Form I and flagged with a "P."
A	This flag indicates that a TIC is a suspected aldol-condensation product.

USEPA-Defined Inorganic Data Qualifiers:

B	Indicates a value greater than or equal to the instrument detection limit, but less than the contract required detection limit.
U	Indicates element was analyzed for but not detected. Report with the detection limit value (e.g., 100).
E	Indicates a value estimated or not reported due to the presence of interference.
S	Indicates value determined by Method of Standard Addition.
N	Indicates spike sample recovery is not within control limits.
*	Indicates duplicate analysis is not within control limits.
+	Indicates the correlation coefficient for Method of Standard Addition is less than 0.995.
M	Indicates duplicate injection results exceeded control limits.
W	Post-digestion spike for Furnace AA analysis is out of control limits (85-115%), while sample absorbance is less than 50% of spike absorbance.

Table 3-2

Definition of Validation Flags

USEPA-Defined Organic Data Qualifiers

J	Estimated value
U	Not detected at associated level; uncertain
N	Tentatively identified
UJ	Quantitation limit may be inaccurate
B	Not detected substantially above level in blank
R	Unusable value

USEPA-Defined Inorganic Data Qualifiers

U	Not detected at associated level
J	Estimated value
R	Unusable value
UJ	Element ND, and quantitation limit uncertain

Table 4-1

Erdle Perforating Company, Phase I Remedial Investigation
Detected Volatile Organic Compounds in Soil Samples

Sample	Sample Location	Parameter	Result (µg/kg)	Laboratory Flags	Validation Flags	Exceeds Guidance?	Guidance Value (µg/kg)[a]
S-1	Surface soil sample, new outfall	1,1,1-Trichloroethane	24				
		1,1-Dichloroethane	7	J			
		1,2-Dichloroethene (Total)	100				
		Tetrachloroethene	16	J			
		Trichloroethene	32				
SF-1	Subsurface soil (0-1 ft), MW-1 boring	1,2-Dichloroethene (Total)	66				
		Trichloroethene	10	J	U		
SF-2	Subsurface soil (5-7 ft), MW-1 boring	**1,2-Dichloroethene (Total)**	**51,000**	**D**		**X**	**8,500**
		Toluene	60	J	U		
		Total Xylenes	250	BJ			
		Trichloroethene	**2,800**			**X**	**700**
SF-2 FD	Subsurface soil (5-7 ft), MW-1 boring	**1,2-Dichloroethene (Total)**	**54,000**	**D**		**X**	**8,500**
		Toluene	65	J	U		
		Total Xylenes	260	BJ			
		Trichloroethene	**2,800**		**U**	**X**	**700**
SF-3	Subsurface soil (5-7 ft), fresh oil tank	Benzene	16				
		Ethylbenzene	43				
		Methylene chloride	20		U		
		Toluene	250		U		
		o-Xylene	73				

Table 4-1

(Continued)

Sample	Sample Location	Parameter	Result (μg/kg)	Laboratory Flags	Validation Flags	Exceeds Guidance?	Guidance Value (μg/kg)[a]
SF-4	Subsurface soil (5-7 ft), MW-5: background (north)	1,1,1-Trichloroethane	14				
		1,1,2,2-Tetrachloroethane	10				
		Methylene chloride	12		U		

[a] NYSDEC TAGM HWR-92-4046, Revised January 24, 1994, "Determination of Soil Cleanup Objectives and Cleanup Levels."

No compounds were detected in SF-5.

Table 4-2

Erdle Perforating Company, Phase I Remedial Investigation
Detected Semivolatile Organic Compounds in Soil Samples

Sample	Sample Location	Parameter	Result (µg/kg)	Laboratory Flags	Validation Flags	Exceeds Guidance?	Guidance Value (µg/kg)[a]
SF-1	Subsurface soil (0-1 ft), MW-1 boring	Acenaphthylene	17	J	J		
		Benzo(a)anthracene	**700**		**J**	**X**	**224**
		Benzo(a)pyrene	**670**		**J**	**X**	**61**
		Benzo(b)fluoranthene	1000		J		
		Benzo(ghi)perylene	300	J	J		
		Benzo(k)fluoranthene	330	J	J		
		Chrysene	**680**		**J**	**X**	**400**
		Dibenzo(a,h)anthracene	**31**	**J**	**J**	**X**	**14**
		Fluoranthene	560		J		
		Indeno(1,2,3-cd)pyrene	310	J	J		
		Phenanthrene	53	J	J		
		Pyrene	1000		J		
SF-2	Subsurface soil (5-7 ft), MW-1 boring	2-Methylnaphthalene	800		J		
		Naphthalene	160	J	J		
		Phenanthrene	410		J		
SF-2 FD	Subsurface soil (5-7 ft), MW-1 boring	2-Methylnaphthalene	790		J		
		Naphthalene	150	J	J		
		Phenanthrene	410		J		

Table 4-2

(Continued)

Sample	Sample Location	Parameter	Result ($\mu g/kg$)	Laboratory Flags	Validation Flags	Exceeds Guidance?	Guidance Value ($\mu g/kg$)[a]
SF-3	Subsurface soil (5-7 ft), fresh oil tank	2-Methylnaphthalene	160	J	J		
		4-Methylphenol	460		J		
		Fluoranthene	98	J	J		
		Phenanthrene	670		J		
		Pyrene	380	J	J		

[a] NYSDEC TAGM HWR-92-4046, Revised January 24, 1994, "Determination of Soil Cleanup Objectives and Cleanup Levels."

Table 4-3

Erdle Perforating Company, Phase I Remedial Investigation
Detected Metals/Inorganics in Soil Samples

Sample	Sample Location	Parameter	Result (mg/kg)	Laboratory Flags	Validation Flags	Exceeds Guidance?	Guidance Value*
S-1	Surface soil sample, new outfall	Aluminum - Total	5940				
		Arsenic - Total	4		J		
		Barium - Total	77.5	B			
		Cadmium - Total	**5.1**	*		X	**1 or SB SB = ND (@ SF-5)**
		Calcium - Total	**25200**	*		X	**SB SB = 10,100 (@ SF-5)**
		Chromium - Total	**37.2**			X	**10 or SB SB = 7.5 (@ SF-5)**
		Cobalt - Total	7.5	B			
		Copper - Total	**126**			X	**25 or SB SB = ND (@ SF-5)**
		Iron - Total	**15300**			X	**2,000 or SB SB = 7,980 (@ SF-5)**
		Lead - Total	**192**	*		X	**SB = 38.2 (@ SF-5)**
		Magnesium - Total	**7290**			X	**SB SB = 2940 (@ SF-5)**
		Manganese - Total	**428**	N*	J	X	**SB SB = 148 (@ SF-5)**
		Nickel - Total	**17.8**			X	**13 or SB SB = 9.2 (@ SF-5)**
		Potassium - Total	499	B			
		Vanadium - Total	12.3	B	J		
		Zinc - Total	**1420**	N		X	**20 or SB SB = 101 (@ SF-5)**

Table 4-3

(Continued)

Sample	Sample Location	Parameter	Result (mg/kg)	Laboratory Flags	Validation Flags	Exceeds Guidance?	Guidance Value*
SF-1	Subsurface soil (0-1 ft), MW-1 boring	**Aluminum - Total**	**9370**			**X**	**SB** **SB = 6,550 (@ SF-5)**
		Arsenic - Total	3.2				
		Barium - Total	97.1				
		Calcium - Total	**36300**	*		**X**	**SB** **SB = 10,100 (@ SF-5)**
		Chromium - Total	**14.4**			**X**	**10 or SB** **SB = 7.5 (@ SF-5)**
		Cobalt - Total	9.1	B			
		Iron - Total	**20800**			**X**	**2,000 or SB** **SB = 7,980 (@ SF-5)**
		Lead - Total	35.6	*			
		Magnesium - Total	**9880**			**X**	**SB** **SB = 2,940 (@ SF-5)**
		Manganese - Total	**444**	N*	J	**X**	**SB** **SB = 148 @ SF-5)**
		Nickel - Total	**22.2**			**X**	**13 or SB** **SB = 9.2 (@ SF-5)**
		Potassium - Total	**1440**			**X**	**SB** **SB = 510 (@ SF-5)**
		Sodium - Total	374	B			
		Thallium - Total	**3.5**		J	**X**	**SB** **SB = ND (@ SF-5)**
		Vanadium - Total	20.8		J		
		Zinc - Total	**94.1**	N	J	**X**	**20 or SB** **SB = 101 (@ SF-5)**

Table 4-3

(Continued)

Sample	Sample Location	Parameter	Result (mg/kg)	Laboratory Flags	Validation Flags	Exceeds Guidance?	Guidance Value*
SF-2	Subsurface soil (5-7 ft), MW-1 boring	**Aluminum - Total**	**11100**			X	**SB** **SB = 8,710 (@ SF-4)**
		Arsenic - Total	4.9				
		Barium - Total	104				
		Calcium - Total	5690	*	J		
		Chromium - Total	**16.5**			X	**10 or SB** **SB = 13.6 (@ SF-4)**
		Cobalt - Total	10.8	B			
		Iron - Total	**23500**			X	**2,000 or SB** **SB = 20,400 (@ SF-4)**
		Magnesium - Total	5770				
		Manganese - Total	330	N*	J		
		Nickel - Total	**21.9**			X	**13 or SB** **SB = 21.2 (@ SF-4)**
		Potassium - Total	924	B			
		Selenium - Total	1.1	BN			
		Sodium - Total	**466**	B		X	**SB** **SB = 384 (@ SF-4)**
		Vanadium - Total	24.8		J		
		Zinc - Total	**84.8**	N	J	X	**20 or SB** **SB = 44.9 (@ SF-4)**
SF-2 FD	Subsurface soil (5-7 ft), MW-1 boring	**Aluminum - Total**	**11700**			X	**SB** **SB = 8,710 (@ SF-4)**
		Arsenic - Total	**8.1**			X	**7.5 or SB** **SB = 4.5 (@ SF-4)**
		Barium - Total	118				

Table 4-3

(Continued)

Sample	Sample Location	Parameter	Result (mg/kg)	Laboratory Flags	Validation Flags	Exceeds Guidance?	Guidance Value*
SF-2 FD (cont)	Subsurface soil (5-7 ft), MW-1 boring	**Calcium - Total**	**57000**	*	J	X	**SB SB = 53,000 (@ SF-4)**
		Chromium - Total	**17.1**			X	**10 or SB SB = 13.6 (@ SF-4)**
		Cobalt - Total	9.4	B			
		Iron - Total	**24800**			X	**2,000 or SB SB = 20,400 (@ SF-4)**
		Lead - Total	**6.3**	*		X	**SB = 5.6 (@ SF-4)**
		Magnesium - Total	7920				
		Manganese - Total	**645**	N*	J	X	**SB SB = 148 (@ SF-4)**
		Nickel - Total	**24.8**			X	**13 or SB SB = 21.2 (@ SF-4)**
		Potassium - Total	1210	B			
		Sodium - Total	**533**	B		X	**SB SB = 384 (@ SF-4)**
		Thallium - Total	**1.1**	B	J	X	**SB SB = ND (@ SF-4)**
		Vanadium - Total	27		J		
		Zinc - Total	**66.3**	N	J	X	**20 or SB SB = 44.9 (@ SF-4)**
SF-4	Subsurface soil (5-7 ft), MW-5: background (north)	Aluminum - Total	8710				
		Arsenic - Total	4.5				
		Barium - Total	72.7				
		Cadmium - Total	1.2	*	J		
		Calcium - Total	53000	*			

Table 4-3

(Continued)

Sample	Sample Location	Parameter	Result (mg/kg)	Laboratory Flags	Validation Flags	Exceeds Guidance?	Guidance Value*
SF-4 (cont)	Subsurface soil (5-7 ft), MW-5: background (north)	Chromium - Total	13.6				
		Cobalt - Total	9.4	B			
		Iron - Total	20400				
		Lead - Total	5.6	*			
		Magnesium - Total	12400				
		Manganese - Total	479	N*	J		
		Nickel - Total	21.2				
		Potassium - Total	1590				
		Sodium - Total	384	B			
		Vanadium - Total	23		J		
		Zinc - Total	44.9	N	J		
SF-5	Subsurface soil (0-1 ft), MW-5: background (north)	Aluminum - Total	6550				
		Arsenic - Total	1.4	B			
		Barium - Total	59.4				
		Calcium - Total	10100	*			
		Chromium - Total	7.5				
		Cobalt - Total	2.4	B			
		Iron - Total	7980				
		Lead - Total	38.2	*			
		Magnesium - Total	2940				
		Manganese - Total	148	N*	J		
		Nickel - Total	9.2	B			

Table 4-3

(Continued)

Sample	Sample Location	Parameter	Result (mg/kg)	Laboratory Flags	Validation Flags	Exceeds Guidance?	Guidance Value[a]
SF-5 (cont)	Subsurface soil (0-1 ft), MW-5: background (north)	Potassium - Total	510	B			
		Sodium - Total	374	B			
		Vanadium - Total	9	B	J		
		Zinc - Total	101	N	J		
Leachable Total Organic Carbon Detections							
S-1	Surface soil sample, new outfall	Leachable Total Organic Carbon	10,600				
SF-1	Subsurface soil (0-1 ft), MW-1 boring	Leachable Total Organic Carbon	6830				
SF-2	Subsurface soil (5-7 ft), MW-1 boring	Leachable Total Organic Carbon	6540				
SF-2 FD	Subsurface soil (5-7 ft), MW-1 boring	Leachable Total Organic Carbon	7150				
SF-3	Subsurface soil (5-7 ft), fresh oil tank	Leachable Total Organic Carbon	6120				

[a] NYSDEC TAGM HWR-92-4046, Revised January 24, 1994, "Determination of Soil Cleanup Objectives and Cleanup Levels."

Table 4-4

Erdle Perforating Company, Phase I Remedial Investigation
Detected Volatile Organic Compounds in Groundwater Samples

Sample	Sample Location	Parameter	Result (µg/L)	Laboratory Flags	Validation Flags	Guidance Exceeded?	Guidance Value* (µg/L)
GW-1	Groundwater sample, MW-1, adjacent to solvent tank	**1,2-Dichloroethene (Total)**	**150000**		J	X	5
		Trichloroethene	**6400**	BJ	J	X	5
		Vinyl chloride	**13000**		J	X	2
GW-2	Groundwater sample, field duplicate of GW-1	**1,2-Dichloroethene (Total)**	**170000**			X	5
		Toluene	**10000**	BJ	U	X	5
		Trichloroethene	**8800**	BJ		X	5
		Vinyl chloride	**15000**			X	2
GW-3	Groundwater sample, MW-5: background (north)	Methylene chloride	0.32		U		
GW-4	Groundwater sample, MW-4D: downgradient (southwest)	1,1,1-Trichloroethane	3.3		J		
		1,1-Dichloroethane	0.52		J		
		Methylene chloride	0.31		U		
		Trichloroethene	**13**		J	X	5
GW-5	Groundwater sample, MW-3D: downgradient (south)	**Trichloroethene**	**380**		J	X	5
GW-6	Groundwater sample, MW-5D: background (north)	1,1,1-Trichloroethane	2	J			
		Chlorobenzene	**10**	BJ	U	X	5
		Toluene	**10**	BJ	U	X	5
		Trichloroethene	**10**	BJ	U	X	5

Table 4-4

(Continued)

Sample	Sample Location	Parameter	Result (µg/L)	Laboratory Flags	Validation Flags	Guidance Exceeded?	Guidance Value[a] (µg/L)
GW-7	Groundwater sample, MW-1D: adjacent to solvent tank	**1,2-Dichloroethene (Total)**	**1300**			**X**	**5**
		Tetrachloroethene	**41**	**J**		**X**	**5**
		Toluene	**20**	**BJ**		**X**	**5**
		Trichloroethene	**6000**	**B**		**X**	**5**
GW-8	Groundwater sample, MW-2: downgradient (southeast)	**Trichloroethene**	**1600**		**J**	**X**	**5**
		Vinyl chloride	**88**		**J**	**X**	**2**
GW-9	Groundwater sample, MW-3: downgradient (south)	**Methylene chloride**	**4280**		**J**	**X**	**5**
		Trichloroethene	**350000**		**J**	**X**	**5**
GW-10	Groundwater sample, MW-4: downgradient (sw)	Bromodichloromethane	0.31		J		
		Chloroform	3.6		J		
		Methylene chloride	0.24		U		
		Trichloroethene	1.4		J		
		Vinyl chloride	**37**		**J**	**X**	**2**

[a] NYSDEC TOGS 1.1.1, "Ambient Water Quality Standards and Guidance Values." Revised October 1993.

Table 4-5

Erdle Perforating Company, Phase I Remedial Investigation
Detected Semivolatile Organic Compounds in Groundwater Samples

Sample	Sample Location	Parameter	Result (µg/L)	Laboratory Flags	Validation Flags	Guidance Exceeded?	Guidance Value[a]
GW-1	Groundwater sample, MW-1, adjacent to solvent tank	2-Methylnaphthalene	9	J			
		4-Methylphenol	10	J	N		
		Di-n-butyl phthalate	2	J			
		Naphthalene	7	J			
		Phenanthrene	2	J			
GW-2	Groundwater sample, field duplicate of GW-1	2-Methylnaphthalene	8	J			
		4-Methylphenol	6	J	N		
		Di-n-butyl phthalate	2	J			
		Fluorene	0.8	J			
		Naphthalene	6	J			
		Phenanthrene	2	J			
GW-6	Groundwater sample, MW-5D: background (north)	Di-n-butyl phthalate	0.4	J			
GW-7	Groundwater sample, MW-1D: adjacent to solvent tank	Di-n-butyl phthalate	0.7	J			
		Phenanthrene	0.9	J			

[a] NYSDEC TOGS 1.1.1, "Ambient Water Quality Standards and Guidance Values." Revised October 1993.

Table 4-6

Erdle Perforating Company, Phase I Remedial Investigation
Detected Metals/Inorganics in Groundwater Samples

Sample	Sample Location	Parameter	Result (µg/L)	Laboratory Flags	Validation Flags	Guidance Exceeded?	Guidance Value*
GW-1	Groundwater sample, MW-1, adjacent to solvent tank	Aluminum - Total	2650	N*	J		
		Antimony - Total	**7**	BN	R	X	3
		Barium - Total	78.3	B			
		Cadmium - Total	0.78	B			
		Calcium - Total	392000				
		Cobalt - Total	8.4	B			
		Copper - Total	5.4	B			
		Iron - Total	**16100**			X	300
		Lead - Total	2	BNW	R		
		Magnesium - Total	**81300**			X	35,000
		Manganese - Total	**4820**			X	300
		Potassium - Total	19500				
		Sodium - Total	**81500**		J	X	20,000
		Vanadium - Total	4	B			
		Zinc - Total	75.1	E	J		
GW-2	Groundwater sample, field duplicate of GW-1	Aluminum - Total	2550	N*	J		
		Barium - Total	73.3	B			
		Cadmium - Total	0.83	B			
		Calcium - Total	381000				
		Cobalt - Total	7.1	B			
		Copper - Total	5	B			

Table 4-6

(Continued)

Sample	Sample Location	Parameter	Result (µg/L)	Laboratory Flags	Validation Flags	Guidance Exceeded?	Guidance Value*
GW-2 (cont)	Groundwater sample, field duplicate of GW-1	**Iron - Total**	**17000**			**X**	**300**
		Lead - Total	3	N	R		
		Magnesium - Total	**77800**			**X**	**35,000**
		Manganese - Total	**4320**			**X**	**300**
		Potassium - Total	19000				
		Sodium - Total	**88500**		J	**X**	**20,000**
		Vanadium - Total	3.3	B			
		Zinc - Total	109	E	J		
GW-3	Groundwater sample, MW-5: background (north)	Barium - Total	85.8	B			
		Beryllium - Total	0.5	B			
		Cadmium - Total	8				
		Calcium - Total	421000				
		Cobalt - Total	17.3	B			
		Copper - Total	46.5				
		Iron - Total	**9010**			**X**	**300**
		Lead - Total	**26**	N	J	**X**	**25**
		Magnesium - Total	**172000**			**X**	**35,000**
		Manganese - Total	**1230**			**X**	**300**
		Nickel - Total	24.7	B			
		Potassium - Total	9530				
		Sodium - Total	**78600**		J	**X**	**20,000**
		Vanadium - Total	19.4	B			

Table 4-6

(Continued)

Sample	Sample Location	Parameter	Result (µg/L)	Laboratory Flags	Validation Flags	Guidance Exceeded?	Guidance Value*
GW-3 (cont)	Groundwater sample, MW-5: background (north)	Zinc - Total	129	E	J		
GW-6	Groundwater sample, MW-5D: background (north)	**Antimony - Total**	**37.4**	BN	R	X	**3**
		Barium - Total	202				
		Cadmium - Total	0.57	B			
		Calcium - Total	137000				
		Cobalt - Total	2.8	B			
		Copper - Total	2.9	B			
		Iron - Total	191				
		Magnesium - Total	**47400**			X	**35,000**
		Manganese - Total	204				
		Potassium - Total	8140				
		Silver - Total	**114**	N	J	X	**50**
		Sodium - Total	**512000**			X	**20,000**
		Zinc - Total	154	E	J		
GW-7	Groundwater sample, MW-1D: adjacent to solvent tank	**Antimony - Total**	**8.2**	BN	R	X	**3**
		Barium - Total	192	B			
		Calcium - Total	141000				
		Iron - Total	257				
		Lead - Total	14	N	J		
		Magnesium - Total	**46400**			X	**35,000**
		Manganese - Total	174				
		Mercury - Total	0.36				

Table 4-6

(Continued)

Sample	Sample Location	Parameter	Result ($\mu g/L$)	Laboratory Flags	Validation Flags	Guidance Exceeded?	Guidance Value[a]
GW-7 (cont)	Groundwater sample, MW-1D: adjacent to solvent tank	Potassium - Total	5130		J		
		Sodium - Total	**487000**			X	**20,000**
		Zinc - Total	137	E	J		
Total Hardness Detections							
GW-1	Groundwater sample, MW-1, adjacent to solvent tank	Total Hardness	1320				
GW-2	Groundwater sample, field duplicate of GW-1	Total Hardness	1120				
GW-6	Groundwater sample, MW-5D: background (north)	Total Hardness	607				
GW-7	Groundwater sample, MW-1D: adjacent to solvent tank	Total Hardness	587				

[a]NYSDEC TOGS 1.1.1, "Ambient Water Quality Standards and Guidance Values." Revised October 1993.

Table 4-7

Erdle Perforating Company, Phase I Remedial Investigation
Detected Volatile Organic Compounds in Surface Water/Sediments

Sample	Sample Location	Parameter	Result[a]	Laboratory Flags	Validation Flags	Guidance Exceeded?	Guidance Value[b]
SW-2	Surface water, old outfall	**1,2-Dichloroethene (Total)**	1700			X	5
		Trichloroethene	14	J		X	3
		Vinyl chloride	12	J	J	X	0.3
SW-3	Surface water: background, ditch (north)	**Tetrachloroethene**	1.7			X	0.7
SW-4	Surface water, ditch (south)	**Tetrachloroethene**	2.9			X	0.7
		Trichloroethene	6.4			X	3
		Vinyl chloride	0.37	J		X	0.3
SD-1	Sediment sample, marsh	Acetone	92		J		
		Carbon Disulfide	2	J	J		
SD-2	Sediment sample, old outfall	1,2-Dichloroethene (Total)	10,000	D			
		Tetrachloroethene	39		J		
		Trichloroethene	160				
		Vinyl chloride[c]	48		J		
SD-4	Sediment sample, ditch (south)	1,2-Dichloroethene (Total)	4	J	U		
		Acetone	45		J		

[a] Results are in units of ug/L (surface water samples) or ug/kg (sediment samples).

[b] Surface Water: NYSDEC TOGS 1.1.1, "Ambient Water Quality Standards and Guidance Values." Revised October 1993.

Sediments: NYSDEC, Division of Fish and Wildlife, Division of Marine Resources: Technical Guidance for Screening Contaminated Sediments, July 1994.

[c] This vinyl chloride result converts to 0.003 μg/gOC, compared with a guidance value of 0.07 μg/gOC.

Table 4-8

Erdle Perforating Company, Phase I Remedial Investigation Detected Detected Semivolatile Organic Compounds in Surface Water/Sediments

Sample	Sample Location	Parameter	Result[a]	Laboratory Flags	Validation Flags	Guidance Exceeded?	Guidance Value[b]
SW-2	Surface water, old outfall	Di-n-butyl phthalate	10	BJ	U		
SD-1	Sediment sample, marsh	Anthracene	55	J	J		
		Benzo(a)anthracene	160	J	J		
		Benzo(b)fluoranthene	240	J	J		
		Benzo(k)fluoranthene	110	J	J		
		Chrysene	200	J	J		
		Fluoranthene[c]	260	J	J		
		Phenanthrene[d]	220	J	J		
		Pyrene	420	J	J		

[a] Results are in units of ug/L (surface water samples) or ug/kg (sediment samples).

[b] Surface Water: NYSDEC TOGS 1.1.1, "Ambient Water Quality Standards and Guidance Values." Revised October 1993.
Sediments:NYSDEC, Division of Fish and Wildlife, Division of Marine Resources: Technical Guidance for Screening Contaminated Sediments, July 1994.

[c] This value converts to 4.15 μg/gOC, compared with a guidance value of 1,020 μg/gOC.

[d] This value converts to 3.50 μg/gOC, compared with a guidance value of 120 μg/gOC.

Table 4-9

Erdle Perforating Company, Phase I Remedial Investigation
Detected Metals/Inorganics in Surface Water/Sediment Samples

Sample	Sample Location	Parameter	Result[a]	Laboratory Flags	Validation Flags	Guidance Exceeded?	Guidance Value[b]
SW-2	Surface water, old outfall	Aluminum - Total	7300				
		Arsenic - Total	3.7	B	J		
		Barium - Total	142	B			
		Calcium - Total	193000	*			
		Copper - Total	21	B			
		Iron - Total	**12900**			**X**	**300**
		Lead - Total	22.6	*			
		Magnesium - Total	**35600**			**X**	**35,000**
		Manganese - Total	**1360**	**N***	**J**	**X**	**300**
		Nickel - Total	28	B			
		Potassium - Total	5820				
		Sodium - Total	29100				
		Vanadium - Total	13	B	J		
		Zinc - Total	**355**	**N**	**J**	**X**	**300**
SD-1	Sediment sample, marsh	Aluminum - Total	6270		J		
		Barium - Total	59.6	B	J		
		Calcium - Total	6220	*	J		
		Chromium - Total	9.3		J		
		Copper - Total	14.9	B	J		
		Iron - Total	10700		J		
		Lead - Total	**40.6**	*****	**J**	**X**	**31**

Table 4-9

(Continued)

Sample	Sample Location	Parameter	Result[a]	Laboratory Flags	Validation Flags	Guidance Exceeded?	Guidance Value[b]
SD-1 (continued)	Sediment sample, marsh	Magnesium - Total	1980	B	J		
		Manganese - Total	96.8	N*	J		
		Potassium - Total	665	B	J		
		Thallium - Total	3.7	B	J		
		Vanadium - Total	11.2	B	J		
		Zinc - Total	**198**	N	**J**	**X**	**120**
SD-2	Sediment sample, old outfall	Aluminum - Total	5120				
		Arsenic - Total	2.9	B	J		
		Barium - Total	44.8	B			
		Cadmium - Total	**1.6**	*	**J**	**X**	**0.6**
		Calcium - Total	11900	*			
		Chromium - Total	35.1				
		Cobalt - Total	3.2	B			
		Copper - Total	**104**			**X**	**16**
		Iron - Total	8100				
		Lead - Total	**71.1**	*		**X**	**31**
		Magnesium - Total	5350				
		Manganese - Total	89.3	N*	J		
		Nickel - Total	15.9				
		Potassium - Total	432	B			
		Selenium - Total	1.2	BN	J		
		Thallium - Total	3.4		J		

Table 4-9

(Continued)

Sample	Sample Location	Parameter	Result[a]	Laboratory Flags	Validation Flags	Guidance Exceeded?	Guidance Value[b]
SD-2 (cont)	Sediment sample, old outfall	Vanadium - Total	10.4	B	J		
		Zinc - Total	**410**	N	J	X	120
Total Hardness/Total Organic Carbon Detections							
SW-2	Surface water, old outfall	Total Hardness	595				
SD-1	Sediment sample, marsh	Leachable Total Organic Carbon	62,600				
SD-2	Sediment sample, old outfall	Leachable Total Organic Carbon	16,900				
SD-3	Sediment sample, background	Leachable Total Organic Carbon	8810				

[a] Results are in units of ug/L (surface water samples) or mg/kg (sediment samples).
[b] Surface Water: NYSDEC TOGS 1.1.1, "Ambient Water Quality Standards and Guidance Values." Revised October 1993.
Sediments:NYSDEC, Division of Fish and Wildlife, Division of Marine Resources: Technical Guidance for Screening Contaminated Sediments, July 1994.

Table 4-10

Air Results Summary

	Laboratory Results (ng)				Ca (ug/m^3)[a]		Cp (ug/m^3)[b]		
	A1-A	A1-B	A1-CS-A	A1-CS-B	Total A1	Total A1-CS	Total A1	Total A1-CS	NYS ACG (ug/m^3)[c]
Chloroethane	3	0	0	0	1.41E-11	0	4.14E-04	0	63000
Methylene chloride	550	0	12000	6300	2.58E-09	8.45E-08	5.16E-05	2.49E+00	27
Acetone	97	0	510	0	4.55E-10	2.36E-09	9.09E-06	6.93E-02	14000
Carbon disulfide	20	0	3	15	9.37E-11	8.31E-11	1.87E-06	2.45E-03	7.0
1,2-Dichloroethene	18	0	16	0	8.44E-11	7.39E-11	1.69E-06	2.17E-03	360
Chloroform	8	0	8	8	3.75E-11	7.39E-11	7.50E-07	2.17E-03	23
1,2-Dichloroethane	0	0	2	0	0	9.24E-12	0	2.72E-04	3.9E-02
2-Butanone	0	0	110	0	0	5.08E-10	0	1.49E-02	300
1,1,1-Trichloroethane	7	0	8	7	3.28E-11	6.93E-11	6.56E-07	2.04E-03	1000
Vinyl acetate	0	3	0	0	1.41E-11	0	2.81E-07	0	NA
Trichloroethene	16	0	14	0	7.50E-11	6.46E-11	1.50E-06	1.90E-03	4.5E-01
Chlorobenzene	22	0	0	0	1.03E-10	0	2.06E-06	0	20.0
Xylenes	25	0	31	0	1.17E-10	1.43E-10	2.34E-06	4.21E-03	300

[a] Ca = Concentration directly over waste site.

[b] Cp = Maximum potential annual concentration.

[c] From: New York State Department of Environmental Conservation, Bureau of Toxic Air Sampling, Division of Air Resources, "Air Pathway Analysis Requirements in the Remedial Investigation," April 2, 1991.

Table 4-11

Summary of Detections Above NYS ACGs, by Compound

Compound	Media In Which Detected Above NYS SCG
Volatile Organic Compounds	
1,2-DCE	Groundwater, soil, surface water, sediment[a]
TCE	Groundwater, soil, surface water
Vinyl chloride	Groundwater, surface water
Tetrachloroethene	Groundwater, surface water
Toluene	Groundwater (one location only)
Methylene chloride	Groundwater (one location only)
Semivolatile Organic Compounds	
Benzo(a)anthracene	Soil
Benzo(a)pyrene	Soil
Chrysene	Soil
Dibenzo(a,h)anthracene	Soil
Metals	
Aluminum, arsenic, calcium, chromium, nickel, potassium, thallium	Soil only
Antimony, silver	Groundwater only
Cadmium, copper	Soil and sediment only
Iron, magnesium, manganese	Soil, surface water, groundwater
Lead, Sodium	Soil and groundwater
Zinc	Soil, surface water, sediment

[a] Although NYS guidance is not listed for 1,2-dichloroethene, it was detected at 10,000 μg/L at SD-2.

Table 4-12

Summary of Detections Above NYS ACGs, by Media

Media	Contaminants Present Above NYS SCG		
	Volatile Organics	Semivolatile Organics	Metals
Soil	1,2-Dichloroethene Trichloroethene	Benzo(a)anthracene Benzo(a)pyrene Chrysene Dibenzo(a,h)anthracene	Aluminum Arsenic Cadmium Calcium Chromium Copper Iron Lead Magnesium Manganese Nickel Potassium Sodium Thallium Zinc
Groundwater	1,2-Dichloroethene Trichloroethene Vinyl chloride Tetrachloroethene Toluene Methylene chloride	None	Antimony Iron Lead Magnesium Manganese Silver Sodium
Surface Water	1,2-Dichloroethene Trichloroethene Tetrachloroethene Vinyl chloride	None	Iron Magnesium Manganese Zinc
Sediment	None[a]	None	Cadmium Copper Lead Zinc

[a] Although NYS guidance is not listed for 1,2-dichloroethene in sediments, it was detected at 10,000 μg/L at SD-2.

Table 4-13

Wetlands Classifications

ID	Ecological System	Class	Subclass	Water Regime (Non-Tidal)	Special Modifiers
PFO1A	Palustrine	Forested	Broad-leaved Deciduous	Temporary	-
PFO1E	Palustrine	Forested	Broad-leaved Deciduous	Seasonal Saturated	-
PEM5E	Palustrine	Emergent	Narrow-leaved Persistent	Seasonal Saturated	-
PSS1E	Palustrine	Scrub/Shrub	Broad-leaved Deciduous	Seasonal Saturated	-
PFO/SS1E	Palustrine	Forested, Scrub/shrub	Broad-leaved Deciduous	Seasonal Saturated	-
PSS1/EM5E	Palustrine	Scrub/Shrub, Emergent	Broad-leaved Deciduous, Narrow-leaved Persistent	Seasonal Saturated	-
PEM5Bd	Palustrine	Emergent	Narrow-leaved Persistent	Saturated	Partially Drained, Ditched
POWZx	Palustrine	Openwater	Unknown Bottom	Intermittently Exposed,Permanent	Excavated

Table 4-14

Land Use Descriptions

Land Use Classification Codes	Description	Acreage
R1	Residential, 0.25 acre lots	74.9
R2	Residential, multi-family	54.3
R3	Residential, 1+ acre lots	8.1
F	Forested	78.7
OS	Open Space	54.1
MV	Mixed Vegetation	82.3
W	Water	1.8
I	Industrial	75.2
C	Commercial	7.5
Tp	Transportation, paved road	56.3
Tr	Transportation, railroad	9.3

Table 4-15

Fate and Transport Summary

Chemical	Surface Soil	Subsurface Soil	Sediment	Surface Water	Groundwater	Transport	Most Likely Exposure Routes
1,2-Dichloroethene		X	X[a]	X	X	Volatilization	Air
Trichloroethene		X		X	X	Leaching, runoff, volatilization	Air, water
Methylene chloride					X	Volatilization, leach, and runoff	Air
Vinyl chloride				X	X	Volatilization	Air
Tetrachloroethane				X	X	Volatilization	Air
Toluene					X	Volatilization	Air
Benzo(a)anthracene		X				None, unless disturbed	None, unless disturbed
Benzo(a)pyrene		X				None, unless disturbed	None, unless disturbed
Chrysene		X				None, unless disturbed	None, unless disturbed
Dibenzo(a,h)anthracene		X				None, unless disturbed	None, unless disturbed
Antimony					X	Partition to water	Surface and groundwater
Cadmium	X					Partition to water, bioaccumulation	Surface water, fish

[a] Sediment standard not listed for this compound, but was detected at 10,000 μg/kg at SD-2, old outfall.

Table 4-16

Evaluation of Potential Pathways

Potentially Exposed Media	Contaminants Detected?	Potential Route of Exposure	Potential Receptors	Pathway Complete?
Surface Soil	Yes	Dermal absorption, incidental ingestion	Wildlife	Yes
Subsurface Soil	Yes	None	None	No
Surface Water	Yes	Dermal absorption, ingestion	Wildlife, fish downstream	Yes
Sediment	Yes[a]	None	Fish, aquatic plants	No
Groundwater	Yes	None[b]	None[b]	No
Air	Yes[c]	Inhalation	Wildlife	No

[a] NYS standards were exceeded only for certain nutrient metals. However, sediment standard not listed for this compound, which was detected at 10,000 μg/kg at SD-2, old outfall.

[b] No usage of groundwater for drinking water was identified within a one-mile radius of the site; well water may be used for other purposed (irrigation, for example).

[c] Below NYS ACGs.

FIGURES

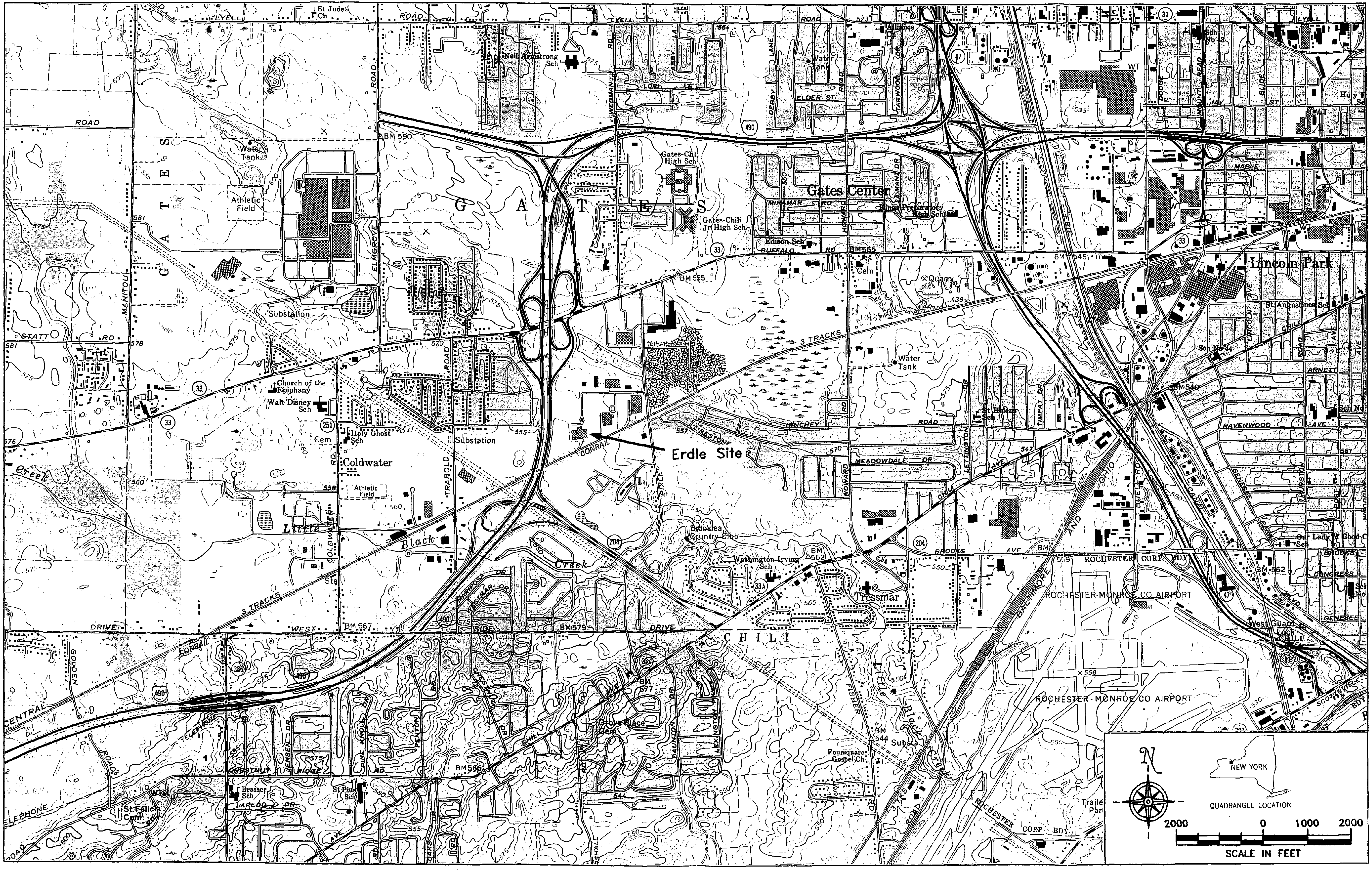
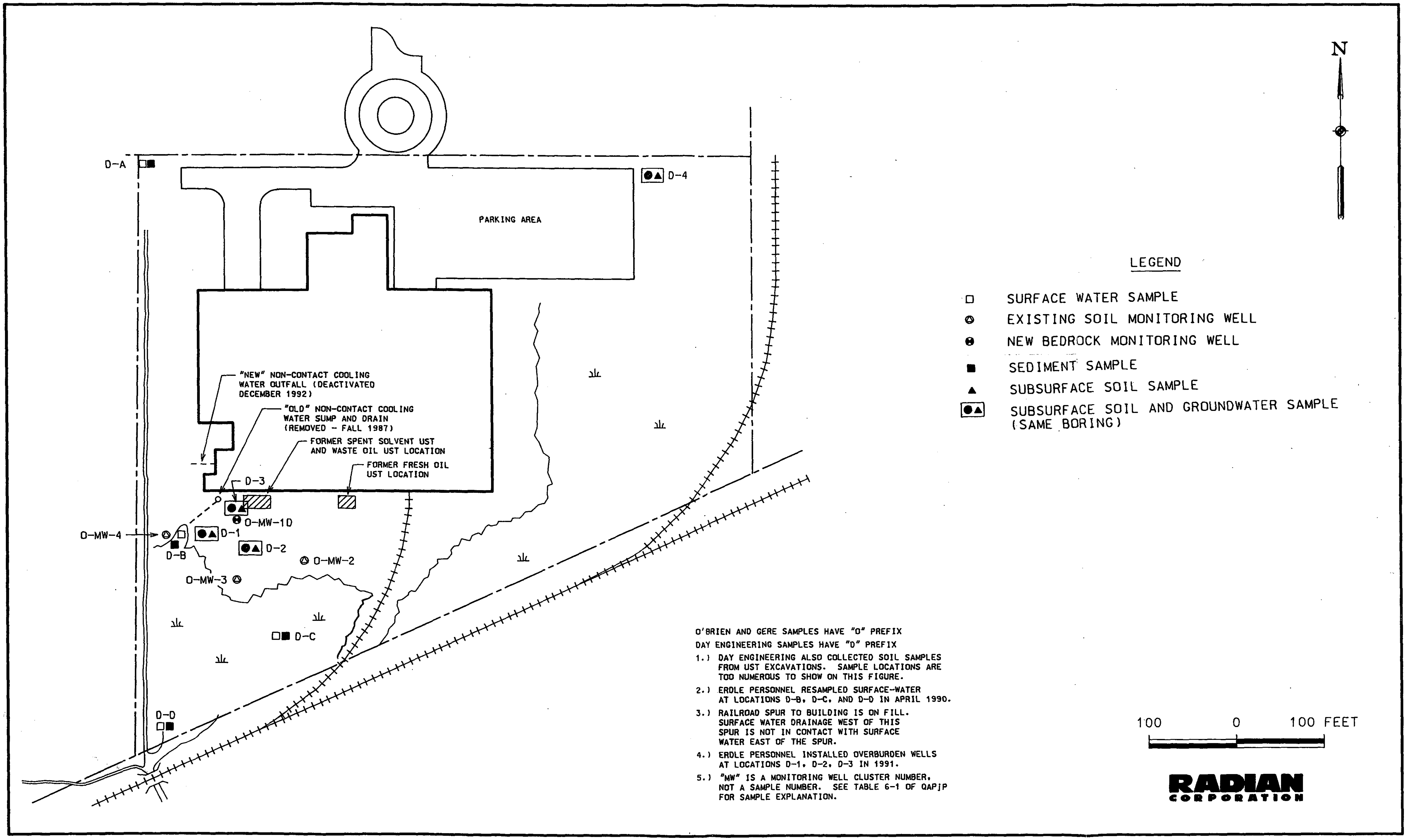


Figure 1–1. Site Topography

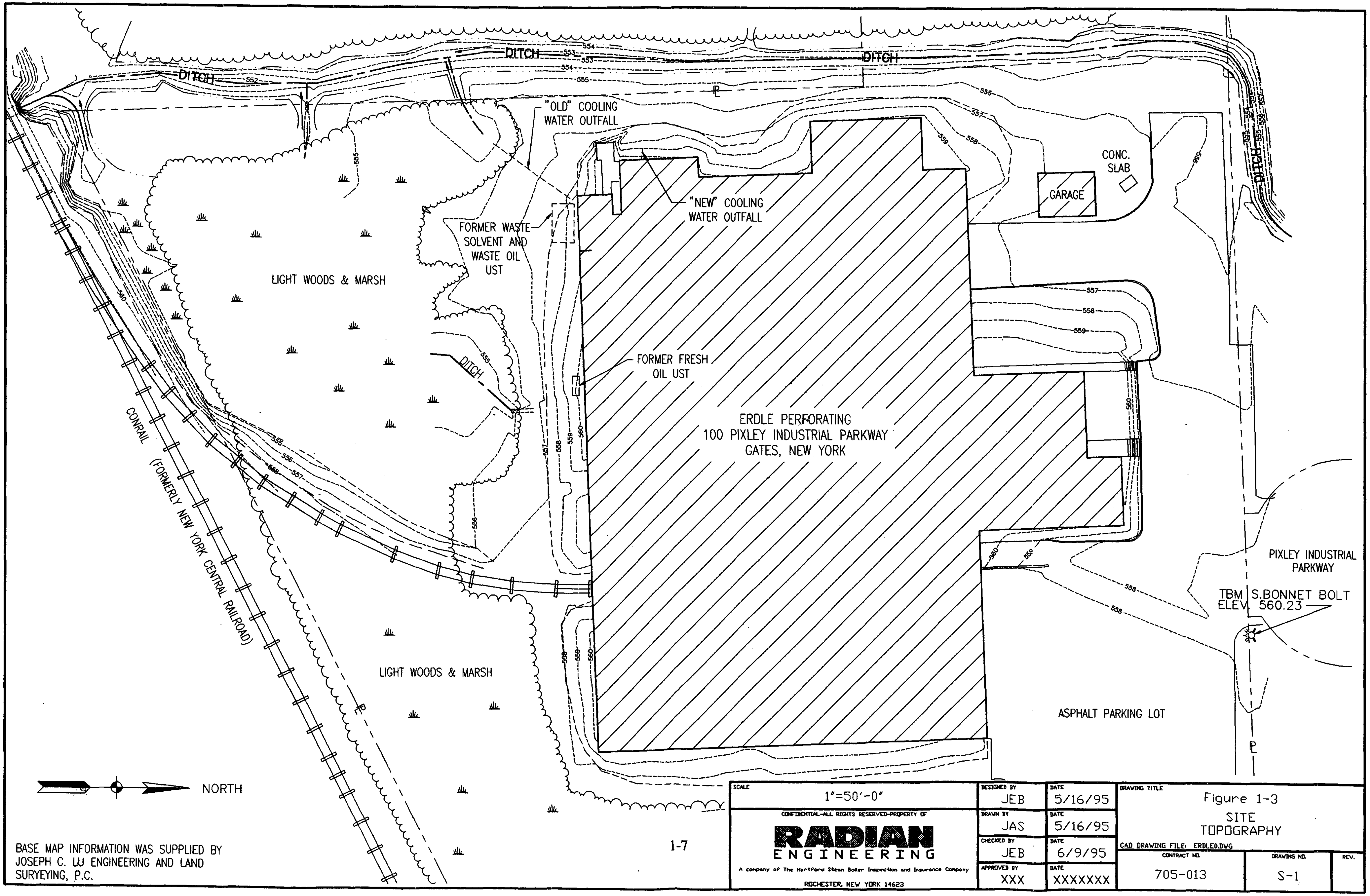


O'BRIEN AND GERE SAMPLES HAVE "O" PREFIX

DAY ENGINEERING SAMPLES HAVE "D" PREFIX

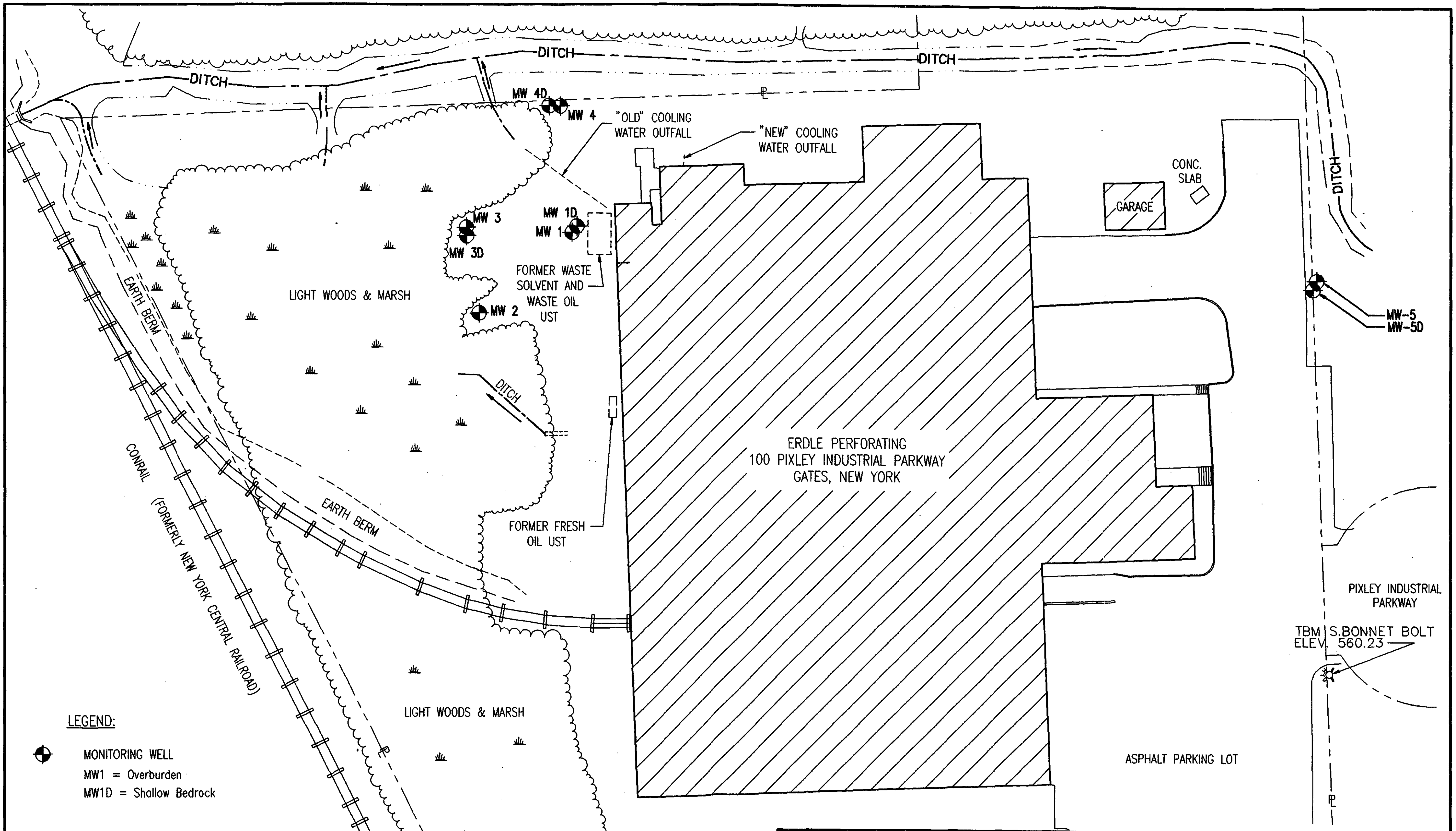
1.) DAY ENGINEERING ALSO COLLECTED SOIL SAMPLES FROM UST EXCAVATIONS. SAMPLE LOCATIONS ARE TOO NUMEROUS TO SHOW ON THIS FIGURE.
2.) ERDLE PERSONNEL RESAMPLED SURFACE-WATER AT LOCATIONS D-B, D-C, AND D-D IN APRIL 1990.
3.) RAILROAD SPUR TO BUILDING IS ON FILL. SURFACE WATER DRAINAGE WEST OF THIS SPUR IS NOT IN CONTACT WITH SURFACE WATER EAST OF THE SPUR.
4.) ERDLE PERSONNEL INSTALLED OVERBURDEN WELLS AT LOCATIONS D-1, D-2, D-3 IN 1991.
5.) "MW" IS A MONITORING WELL CLUSTER NUMBER, NOT A SAMPLE NUMBER. SEE TABLE 6-1 OF QAPjP FOR SAMPLE EXPLANATION.

Figure 1-2. Historical Sampling Locations



BASE MAP INFORMATION WAS SUPPLIED BY JOSEPH C. LU ENGINEERING AND LAND SURVEYING, P.C.

SCALE 1"=50'-0"	DESIGNED BY JEB	DATE 5/16/95	DRAWING TITLE Figure 1-3 SITE TOPOGRAPHY
CONFIDENTIAL-ALL RIGHTS RESERVED-PROPERTY OF RADIAN ENGINEERING A company of The Hartford Steam Boiler Inspection and Insurance Company ROCHESTER, NEW YORK 14623	DRAWN BY JAS	DATE 5/16/95	CAD DRAWING FILE: ERDLE0.DWG
	CHECKED BY JEB	DATE 6/9/95	CONTRACT NO. 705-013
	APPROVED BY XXX	DATE XXXXXXX	DRAWING NO. S-1 REV.



LEGEND:

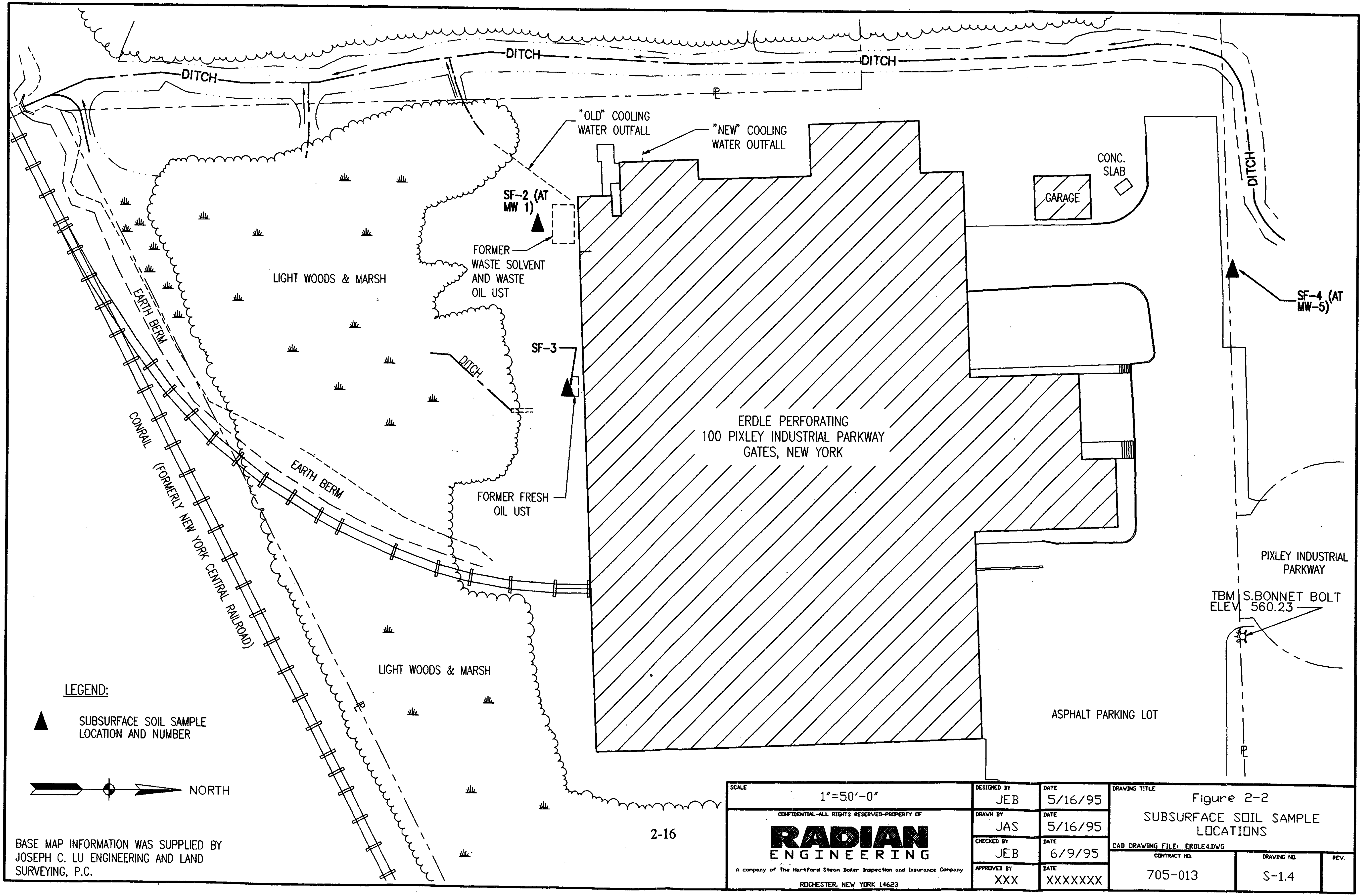
⊕ MONITORING WELL

MW1 = Overburden

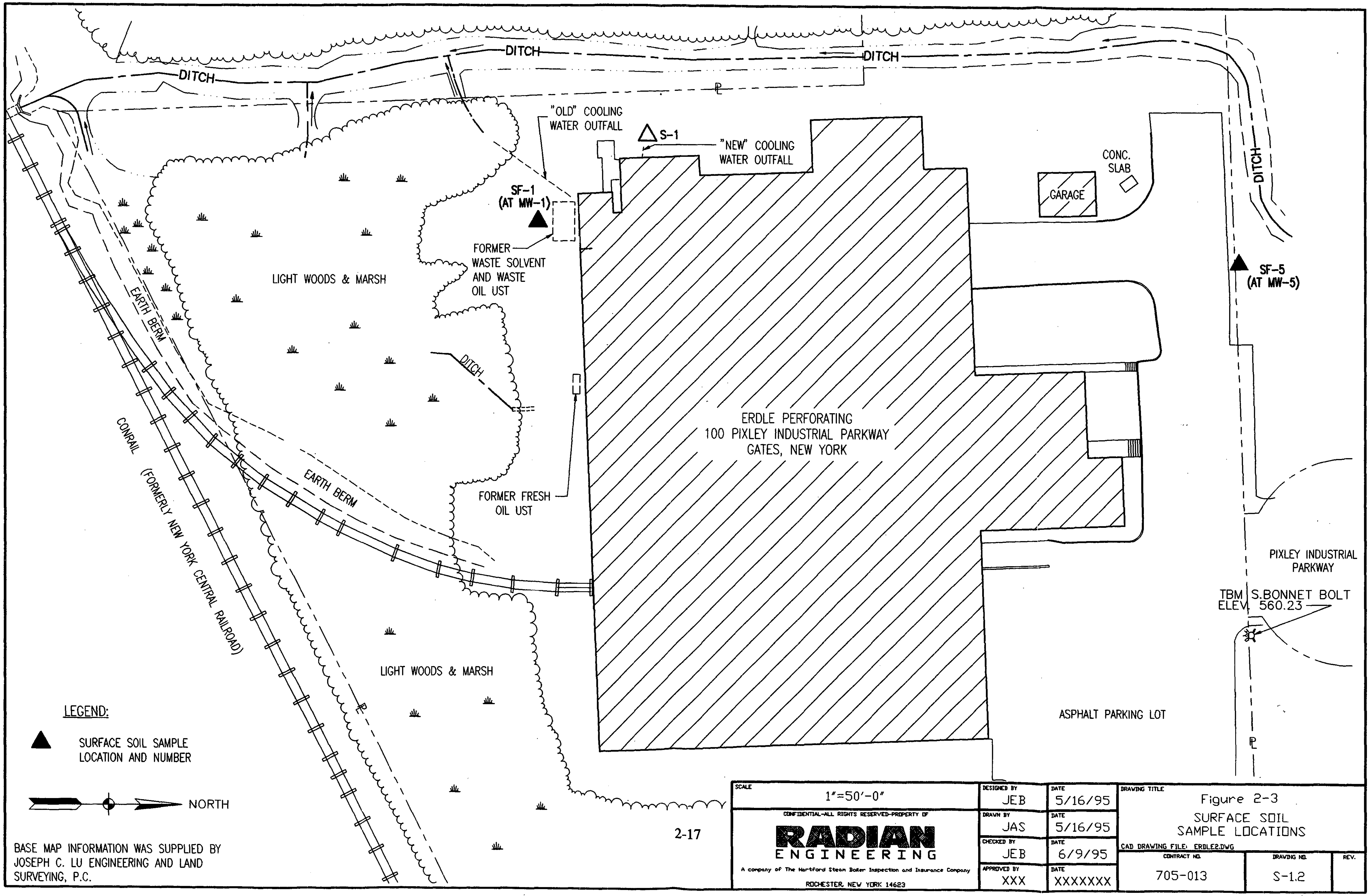
MW1D = Shallow Bedrock

BASE MAP INFORMATION WAS SUPPLIED BY
JOSEPH C. LU ENGINEERING AND LAND
SURVEYING, P.C.

SCALE 1"=50'-0"	DESIGNED BY JEB	DATE 5/16/95	DRAWING TITLE Figure 2-1 MONITORING WELL LOCATIONS		
CONFIDENTIAL-ALL RIGHTS RESERVED-PROPERTY OF RADIAN ENGINEERING A company of The Hartford Steam Boiler Inspection and Insurance Company ROCHESTER, NEW YORK 14623	DRAWN BY JAS	DATE 5/16/95			
	CHECKED BY JEB	DATE 6/9/95	CAD DRAWING FILE: ERDLE1.DWG		
	APPROVED BY XXX	DATE XXXXXXX	CONTRACT NO. 705-013	DRAWING NO. S-1.1	REV.

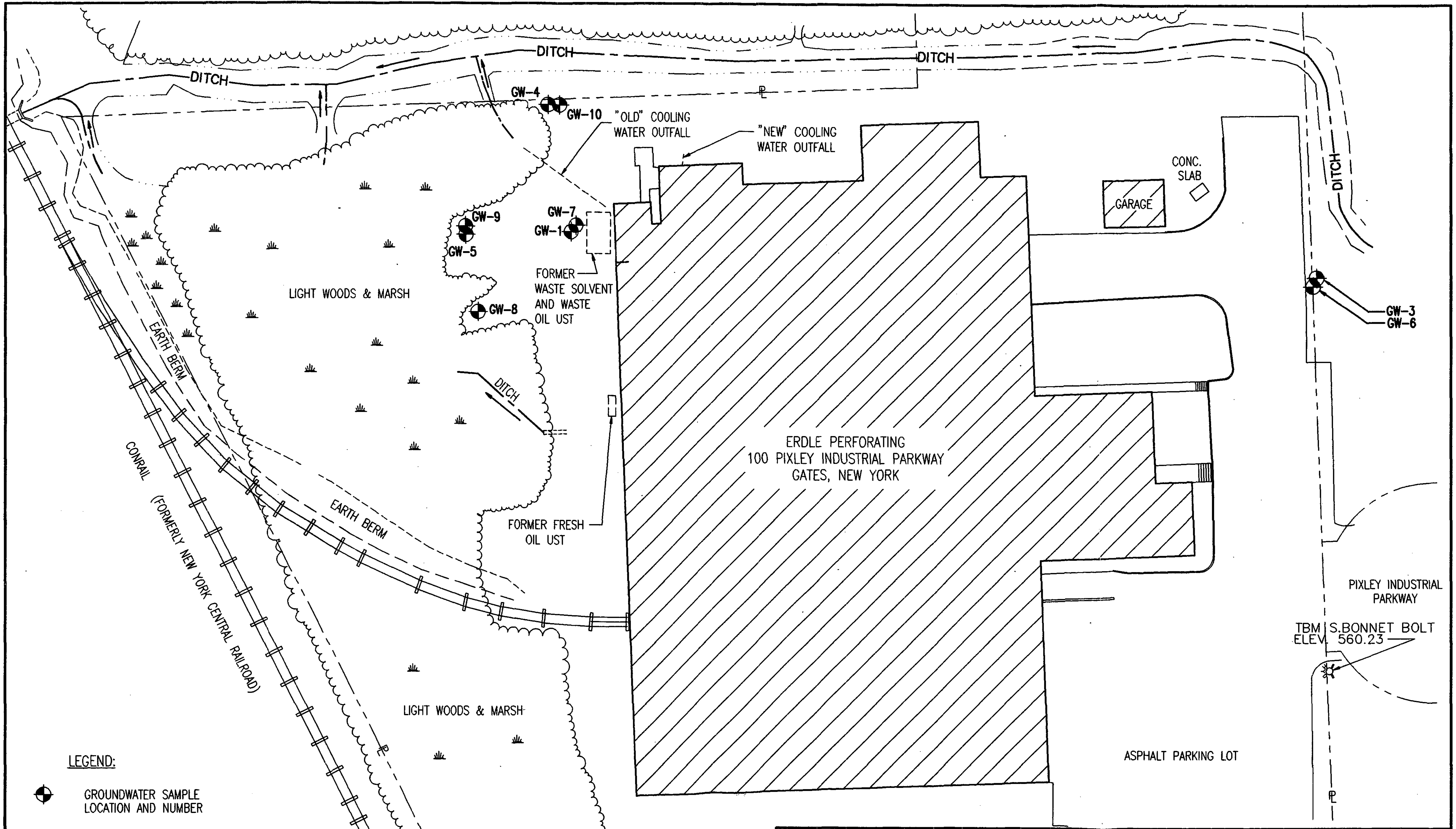


SCALE	DESIGNED BY	DATE	DRAWING TITLE
1"=50'-0"	JEB	5/16/95	Figure 2-2
CONFIDENTIAL-ALL RIGHTS RESERVED-PROPERTY OF	DRAWN BY JAS	DATE 5/16/95	SUBSURFACE SOIL SAMPLE LOCATIONS
RADIAN ENGINEERING A company of The Hartford Steam Boiler Inspection and Insurance Company ROCHESTER, NEW YORK 14623	CHECKED BY JEB	DATE 6/9/95	CAD DRAWING FILE: ERDLE4.DWG
	APPROVED BY XXX	DATE XXXXXXX	CONTRACT NO. 705-013 / DRAWING NO. S-1.4 / REV.



BASE MAP INFORMATION WAS SUPPLIED BY JOSEPH C. LU ENGINEERING AND LAND SURVEYING, P.C.

SCALE	DESIGNED BY	DATE	DRAWING TITLE
1"=50'-0"	JEB	5/16/95	Figure 2-3
CONFIDENTIAL-ALL RIGHTS RESERVED-PROPERTY OF	DRAWN BY JAS	DATE 5/16/95	SURFACE SOIL SAMPLE LOCATIONS
RADIAN ENGINEERING	CHECKED BY JEB	DATE 6/9/95	CAD DRAWING FILE: ERDLE2.DWG
A company of The Hartford Steam Boiler Inspection and Insurance Company ROCHESTER, NEW YORK 14623	APPROVED BY XXX	DATE XXXXXXX	CONTRACT NO. 705-013 · DRAWING NO. S-1.2 · REV.



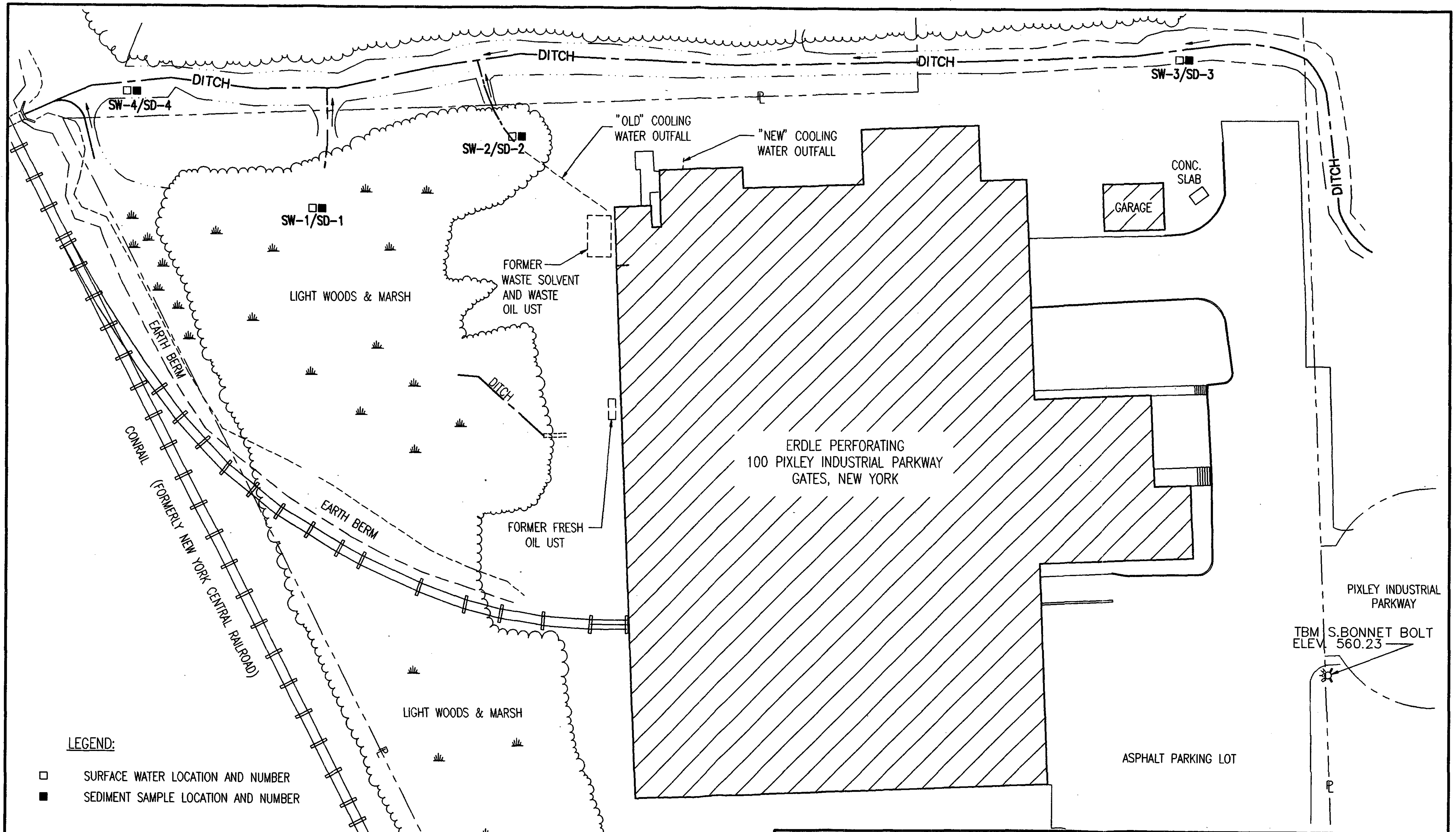
LEGEND:

⊕ GROUNDWATER SAMPLE LOCATION AND NUMBER

NORTH

BASE MAP INFORMATION WAS SUPPLIED BY JOSEPH C. LU ENGINEERING AND LAND SURVEYING, P.C.

SCALE 1"=50'-0"	DESIGNED BY JEB	DATE 5/16/95	DRAWING TITLE Figure 2-4 GROUNDWATER SAMPLE LOCATIONS		
CONFIDENTIAL-ALL RIGHTS RESERVED-PROPERTY OF RADIAN ENGINEERING A company of The Hartford Steam Boiler Inspection and Insurance Company ROCHESTER, NEW YORK 14623	DRAWN BY JAS	DATE 5/16/95	CAD DRAWING FILE: ERDLE6.DWG		
	CHECKED BY JEB	DATE 6/9/95	CONTRACT NO. 705-013	DRAWING NO. S-1.6	REV.
	APPROVED BY XXX	DATE XXXXXXX			



LEGEND:

□ SURFACE WATER LOCATION AND NUMBER

■ SEDIMENT SAMPLE LOCATION AND NUMBER

BASE MAP INFORMATION WAS SUPPLIED BY
JOSEPH C. LU ENGINEERING AND LAND
SURVEYING, P.C.

SCALE 1"=50'-0"

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ENGINEERING

A company of The Hartford Steam Boiler Inspection and Insurance Company

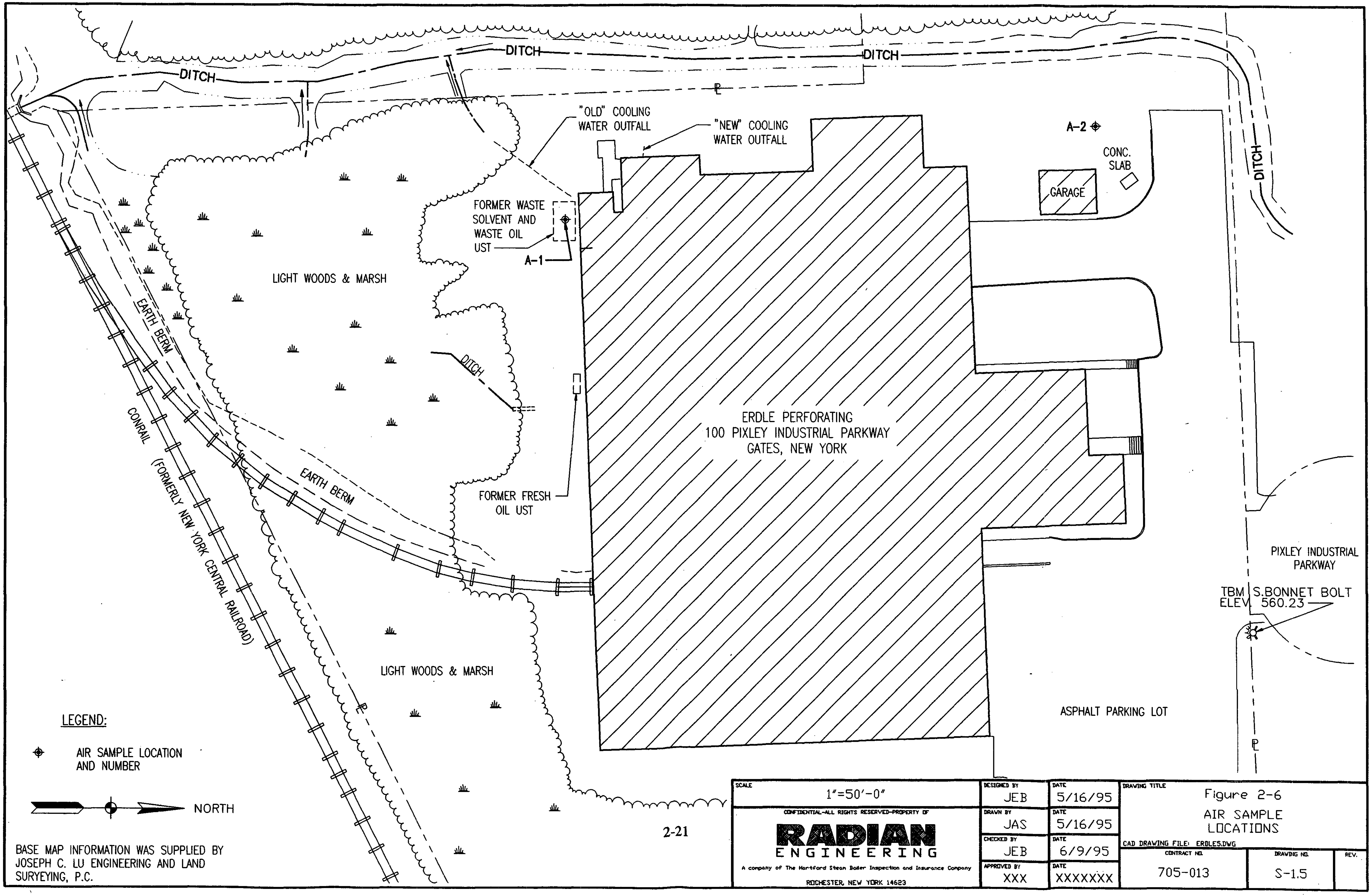
ROCHESTER, NEW YORK 14623

DESIGNED BY	JEB	DATE	5/16/95
DRAWN BY	JAS	DATE	5/16/95
CHECKED BY	JEB	DATE	6/9/95
APPROVED BY	XXX	DATE	XXXXXXX

DRAWING TITLE
Figure 2-5
SURFACE WATER/SEDIMENT
SAMPLE LOCATIONS

CAD DRAWING FILE: ERDLE3.DWG

CONTRACT NO.	DRAWING NO.	REV.
705-013	S-1.3	



LEGEND:

⊕ AIR SAMPLE LOCATION AND NUMBER

BASE MAP INFORMATION WAS SUPPLIED BY JOSEPH C. LU ENGINEERING AND LAND SURVEYING, P.C.

SCALE 1"=50'-0"	DESIGNED BY JEB	DATE 5/16/95	DRAWING TITLE Figure 2-6 AIR SAMPLE LOCATIONS
CONFIDENTIAL-ALL RIGHTS RESERVED-PROPERTY OF RADIAN ENGINEERING A company of The Hartford Steam Boiler Inspection and Insurance Company ROCHESTER, NEW YORK 14623	DRAWN BY JAS	DATE 5/16/95	CAD DRAWING FILE: ERDLES.DWG
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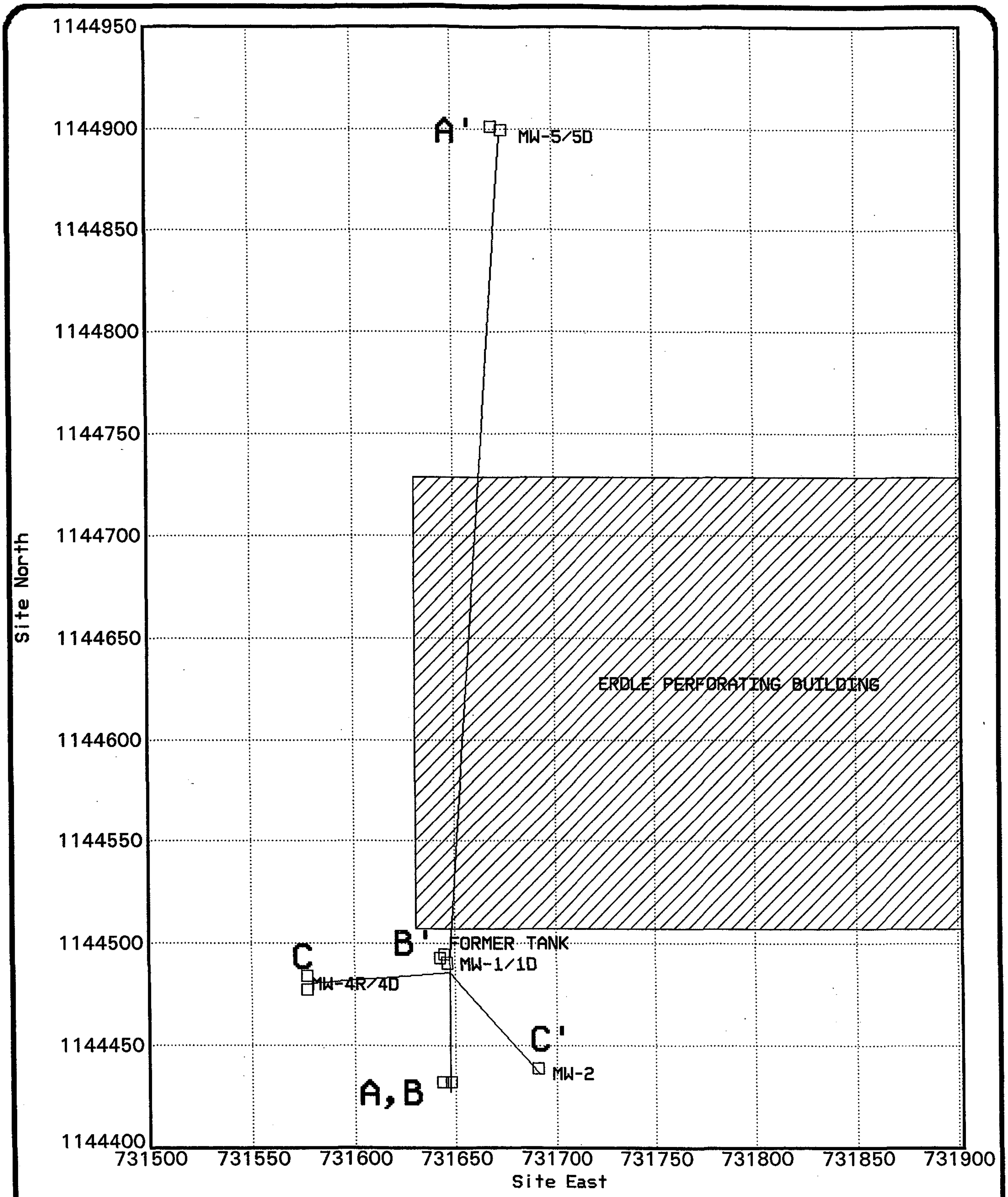
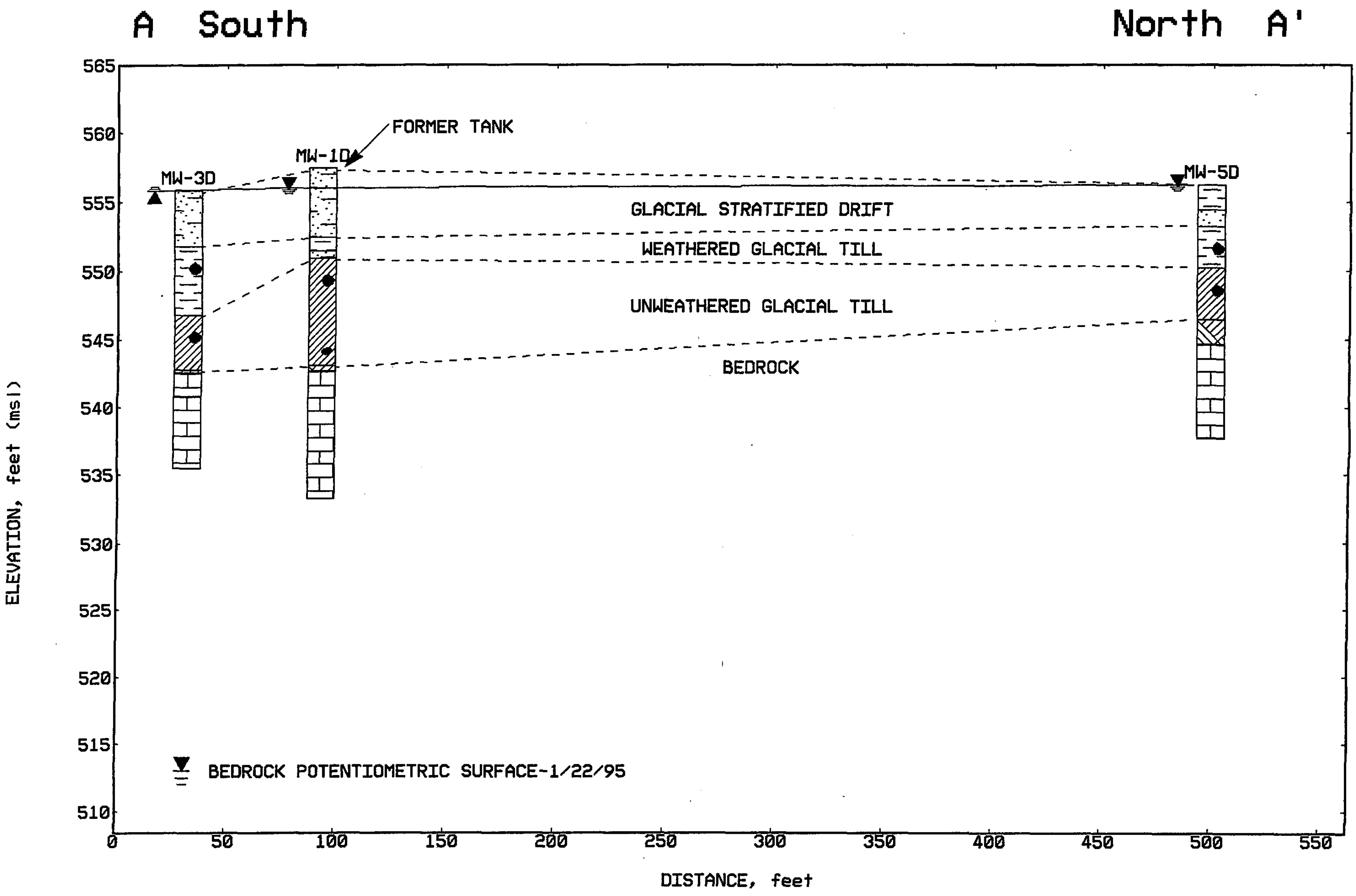
	APPROVED BY XXX	DATE XXXXXXX	DRAWING NO. S-1.5
			REV.



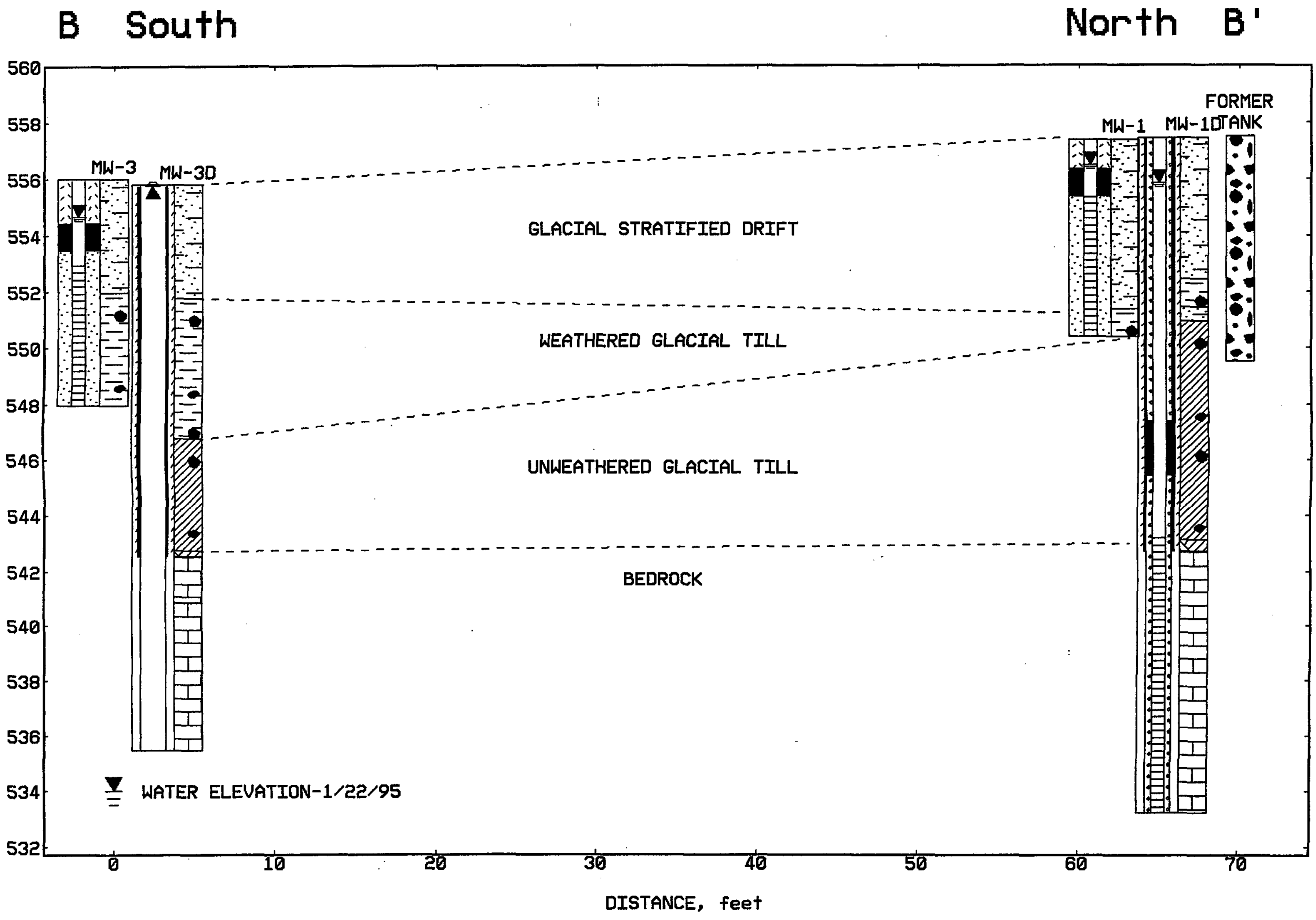
RADIAN

PROJECT	**Phase I Remedial Investigation - Erdle Facility**	JOB NO. DATE	**705-013** **6/1/95**

Figure 4-1. Cross Section Locations



RADIAN	Figure 4-2 GENERAL N-S CROSS SECTION	
	705-013	ERD_GNNS

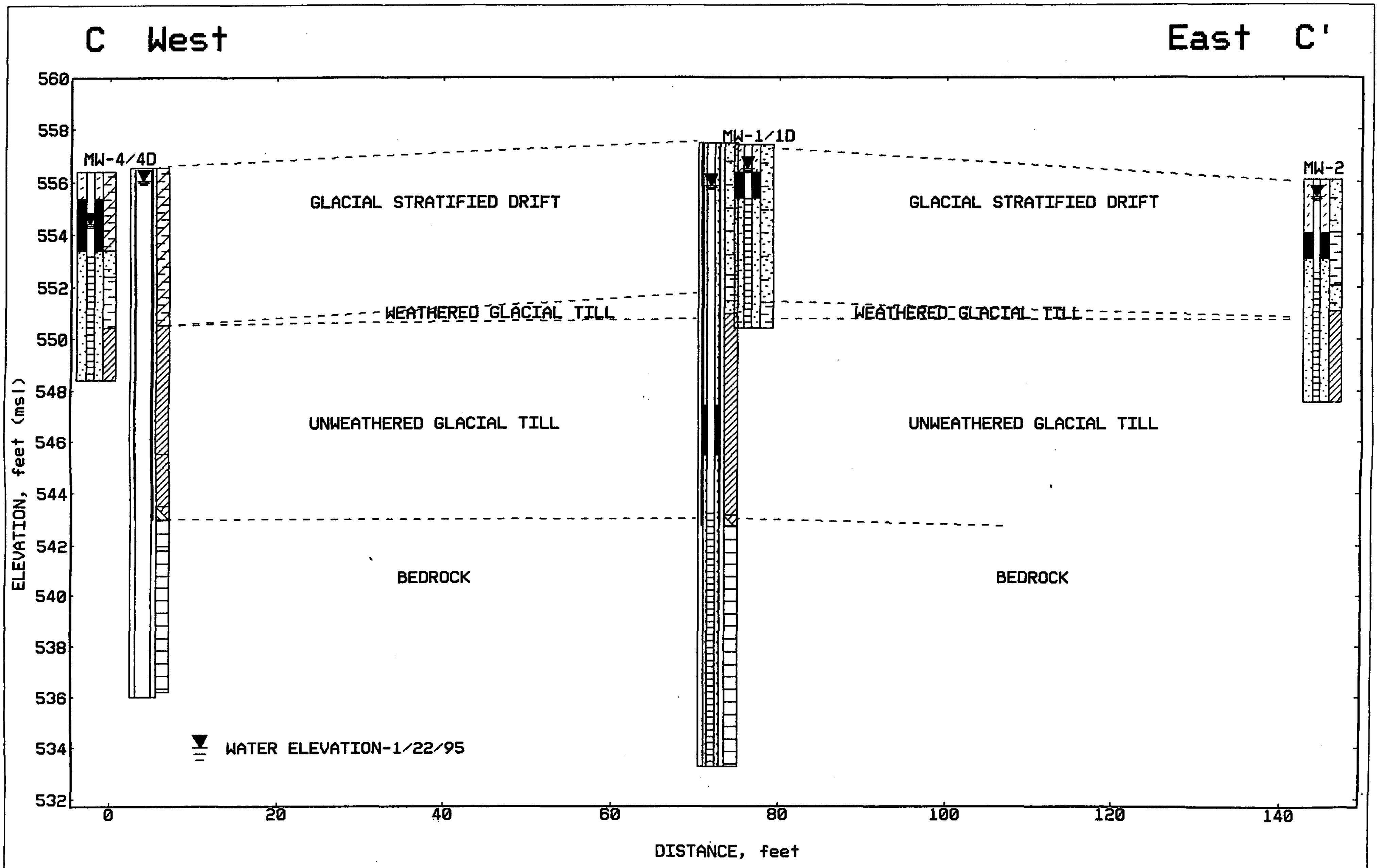


RADIAN

Figure 4-3

DETAILED N-S CROSS SECTION

705-013	ERD_DTNS



RADIAN	Figure 4-4 DETAILED E-W CROSS SECTION	
	705-013	ERD_DTNS

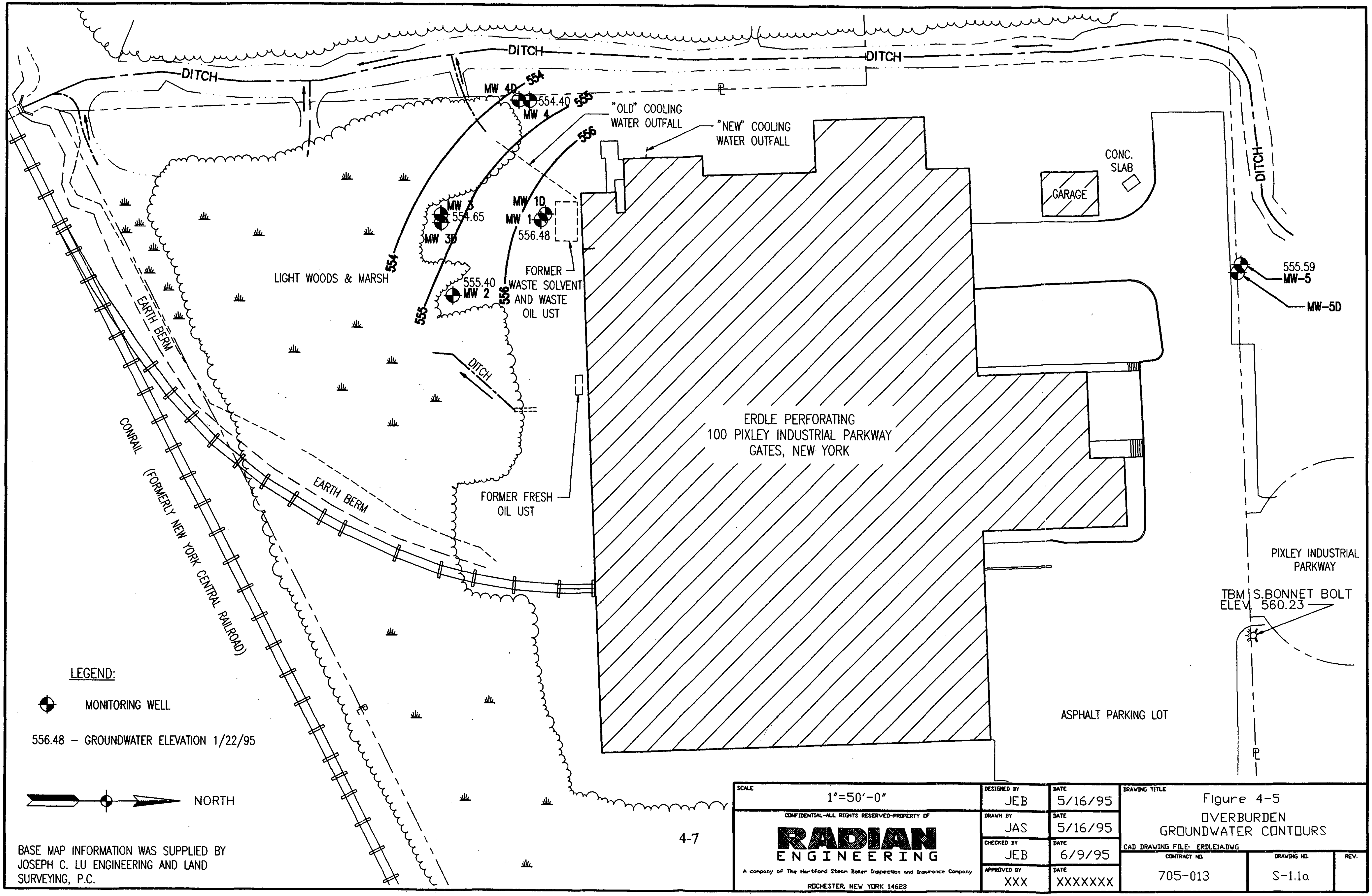
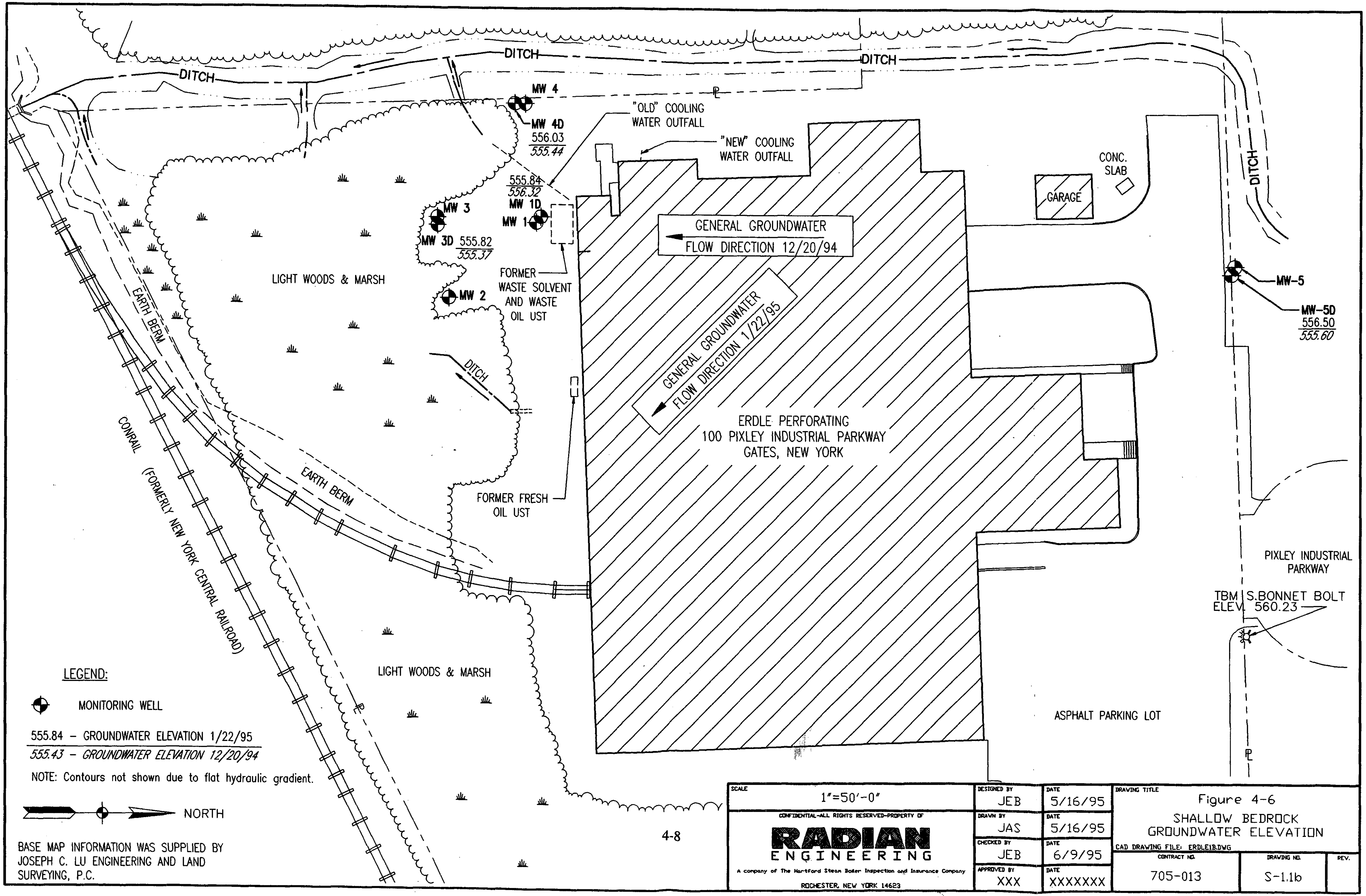


Figure 4-5
OVERBURDEN GROUNDWATER CONTOURS

SCALE 1"=50'-0"	DESIGNED BY JEB	DATE 5/16/95	DRAWING TITLE Figure 4-5 OVERBURDEN GROUNDWATER CONTOURS	
CONFIDENTIAL-ALL RIGHTS RESERVED-PROPERTY OF RADIAN ENGINEERING A company of The Hartford Steam Boiler Inspection and Insurance Company ROCHESTER, NEW YORK 14623	DRAWN BY JAS	DATE 5/16/95	CAD DRAWING FILE: ERDLE1A.DWG	
	CHECKED BY JEB	DATE 6/9/95	CONTRACT NO. 705-013	DRAWING NO. S-1.1a
	APPROVED BY XXX	DATE XXXXXXX	REV.	



LEGEND:

MONITORING WELL

555.84 – GROUNDWATER ELEVATION 1/22/95

555.43 – GROUNDWATER ELEVATION 12/20/94

NOTE: Contours not shown due to flat hydraulic gradient.

BASE MAP INFORMATION WAS SUPPLIED BY
JOSEPH C. LU ENGINEERING AND LAND
SURVEYING, P.C.

SCALE 1"=50'-0"	DESIGNED BY JEB	DATE 5/16/95
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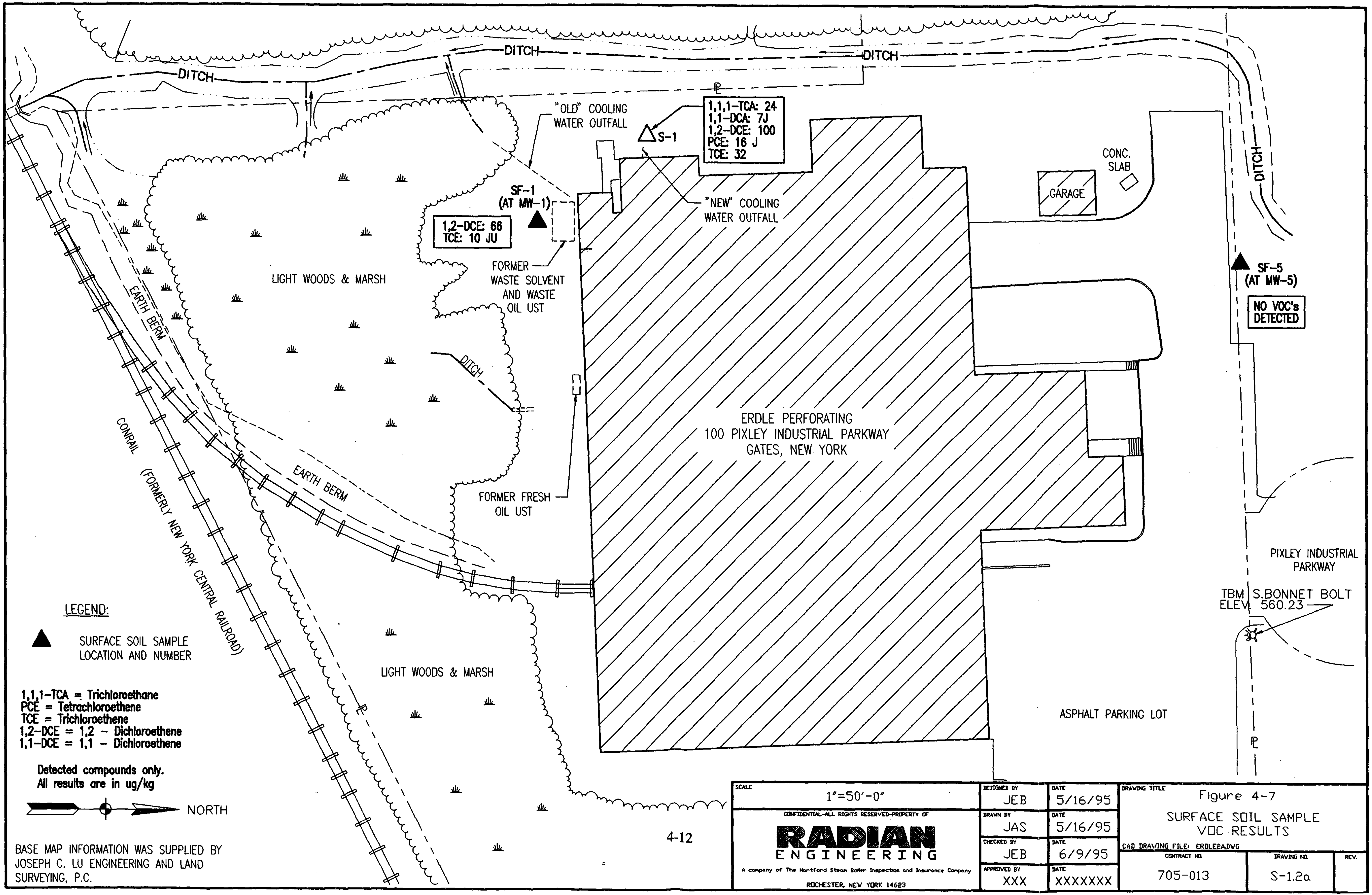
	CHECKED BY JEB	DATE 6/9/95
	APPROVED BY XXX	DATE XXXXXXX

DRAWING TITLE

Figure 4-6
SHALLOW BEDROCK
GROUNDWATER ELEVATION

CAD DRAWING FILE: ERDLE1B.DWG

CONTRACT NO.	DRAWING NO.	REV.
705-013	S-1.1b	



LEGEND:

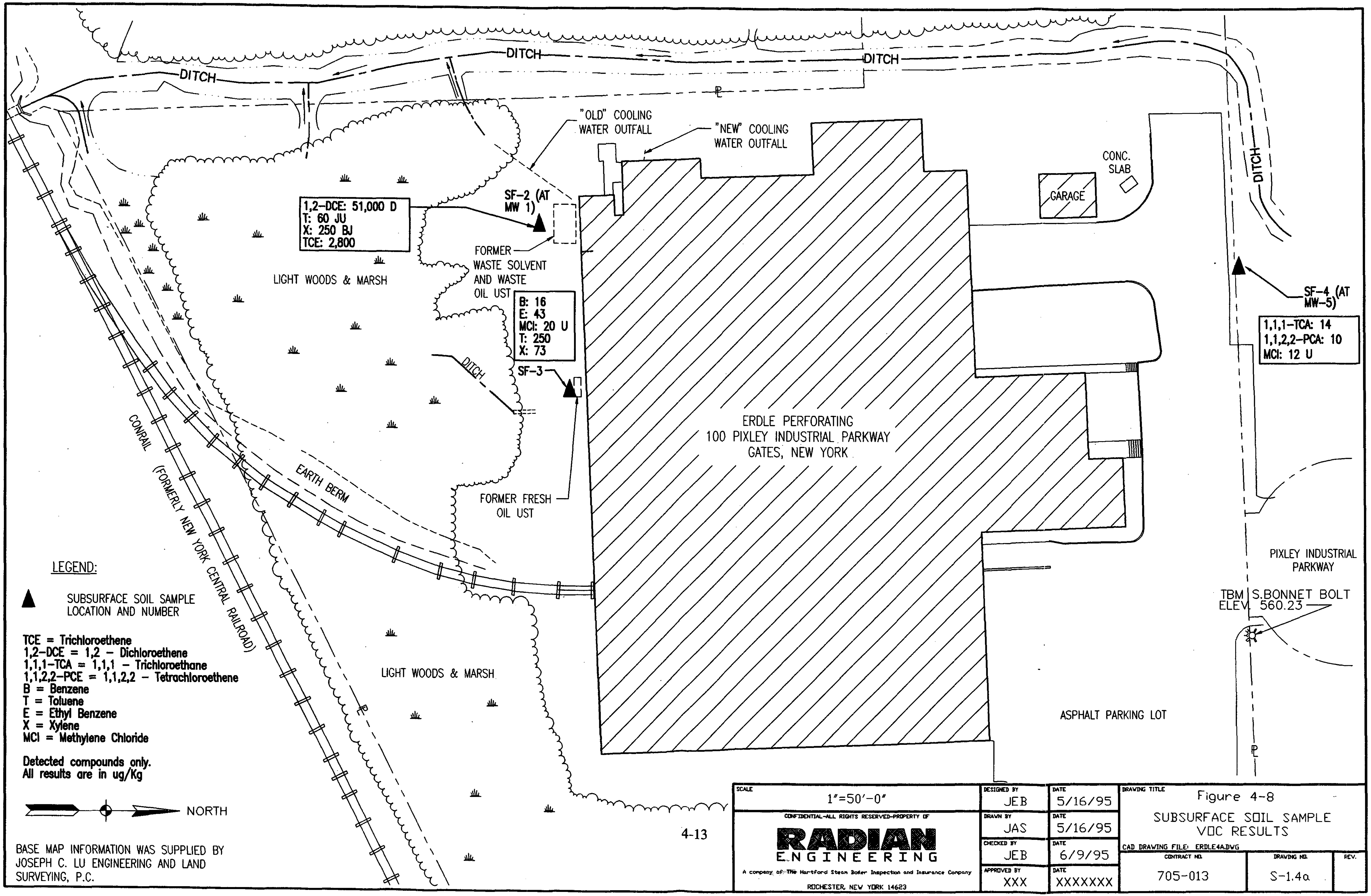
▲ SURFACE SOIL SAMPLE LOCATION AND NUMBER

1,1,1-TCA = Trichloroethane
PCE = Tetrachloroethene
TCE = Trichloroethene
1,2-DCE = 1,2 - Dichloroethene
1,1-DCE = 1,1 - Dichloroethene

Detected compounds only.
All results are in ug/kg

BASE MAP INFORMATION WAS SUPPLIED BY JOSEPH C. LU ENGINEERING AND LAND SURVEYING, P.C.

SCALE	DESIGNED BY	DATE	DRAWING TITLE
1"=50'-0"	JEB	5/16/95	Figure 4-7
CONFIDENTIAL-ALL RIGHTS RESERVED-PROPERTY OF RADIAN ENGINEERING A company of The Hartford Steam Boiler Inspection and Insurance Company ROCHESTER, NEW YORK 14623	DRAWN BY JAS	DATE 5/16/95	SURFACE SOIL SAMPLE VOC RESULTS
	CHECKED BY JEB	DATE 6/9/95	CAD DRAWING FILE: ERDLE2A.DWG
	APPROVED BY XXX	DATE XXXXXXX	CONTRACT NO. 705-013 · DRAWING NO. S-1.2a · REV.



1,2-DCE: 51,000 D
T: 60 JU
X: 250 BJ
TCE: 2,800

B: 16
E: 43
MCl: 20 U
T: 250
X: 73

1,1,1-TCA: 14
1,1,2,2-PCA: 10
MCl: 12 U

LEGEND:

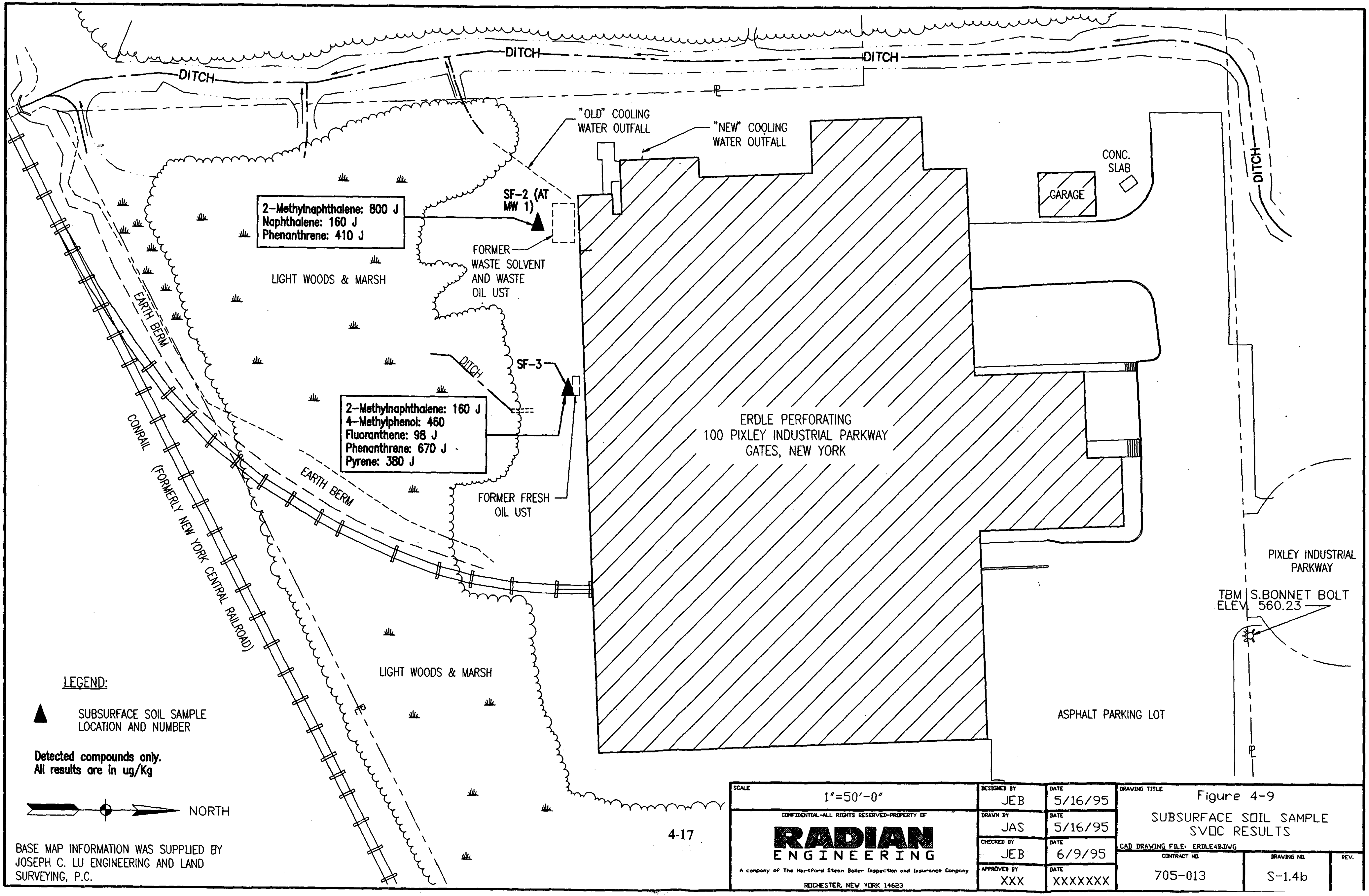
▲ SUBSURFACE SOIL SAMPLE LOCATION AND NUMBER

TCE = Trichloroethene
1,2-DCE = 1,2 - Dichloroethene
1,1,1-TCA = 1,1,1 - Trichloroethane
1,1,2,2-PCE = 1,1,2,2 - Tetrachloroethene
B = Benzene
T = Toluene
E = Ethyl Benzene
X = Xylene
MCl = Methylene Chloride

Detected compounds only.
All results are in ug/Kg

BASE MAP INFORMATION WAS SUPPLIED BY
JOSEPH C. LU ENGINEERING AND LAND
SURVEYING, P.C.

SCALE 1"=50'-0"	DESIGNED BY JEB	DATE 5/16/95	DRAWING TITLE Figure 4-8 SUBSURFACE SOIL SAMPLE VOC RESULTS
CONFIDENTIAL-ALL RIGHTS RESERVED-PROPERTY OF RADIAN ENGINEERING A company of The Hartford Steam Boiler Inspection and Insurance Company ROCHESTER, NEW YORK 14623	DRAWN BY JAS	DATE 5/16/95	CAD DRAWING FILE: ERDLE4A.DWG
	CHECKED BY JEB	DATE 6/9/95	CONTRACT NO. 705-013
	APPROVED BY XXX	DATE XXXXXXX	DRAWING NO. S-1.4a REV.



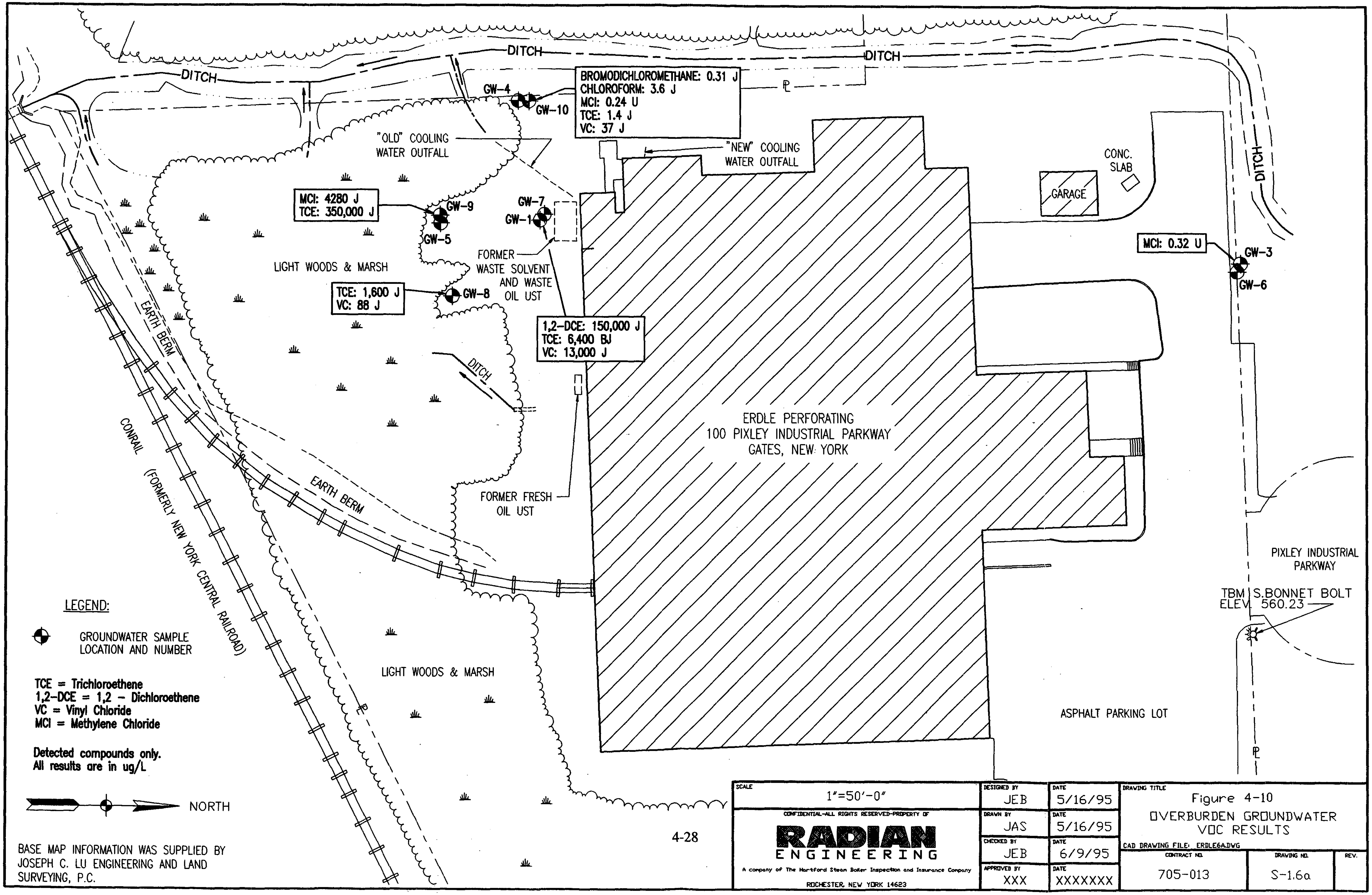
LEGEND:

▲ SUBSURFACE SOIL SAMPLE LOCATION AND NUMBER

Detected compounds only.
All results are in ug/Kg

BASE MAP INFORMATION WAS SUPPLIED BY JOSEPH C. LU ENGINEERING AND LAND SURVEYING, P.C.

SCALE	DESIGNED BY	DATE	DRAWING TITLE
1"=50'-0"	JEB	5/16/95	Figure 4-9 SUBSURFACE SOIL SAMPLE SVOC RESULTS
CONFIDENTIAL-ALL RIGHTS RESERVED-PROPERTY OF RADIAN ENGINEERING A company of The Hartford Steam Boiler Inspection and Insurance Company ROCHESTER, NEW YORK 14623	DRAWN BY JAS	DATE 5/16/95	CAD DRAWING FILE: ERDLE4B.DWG
	CHECKED BY JEB	DATE 6/9/95	CONTRACT NO. 705-013
	APPROVED BY XXX	DATE XXXXXXX	DRAWING NO. S-1.4b REV.



LEGEND:

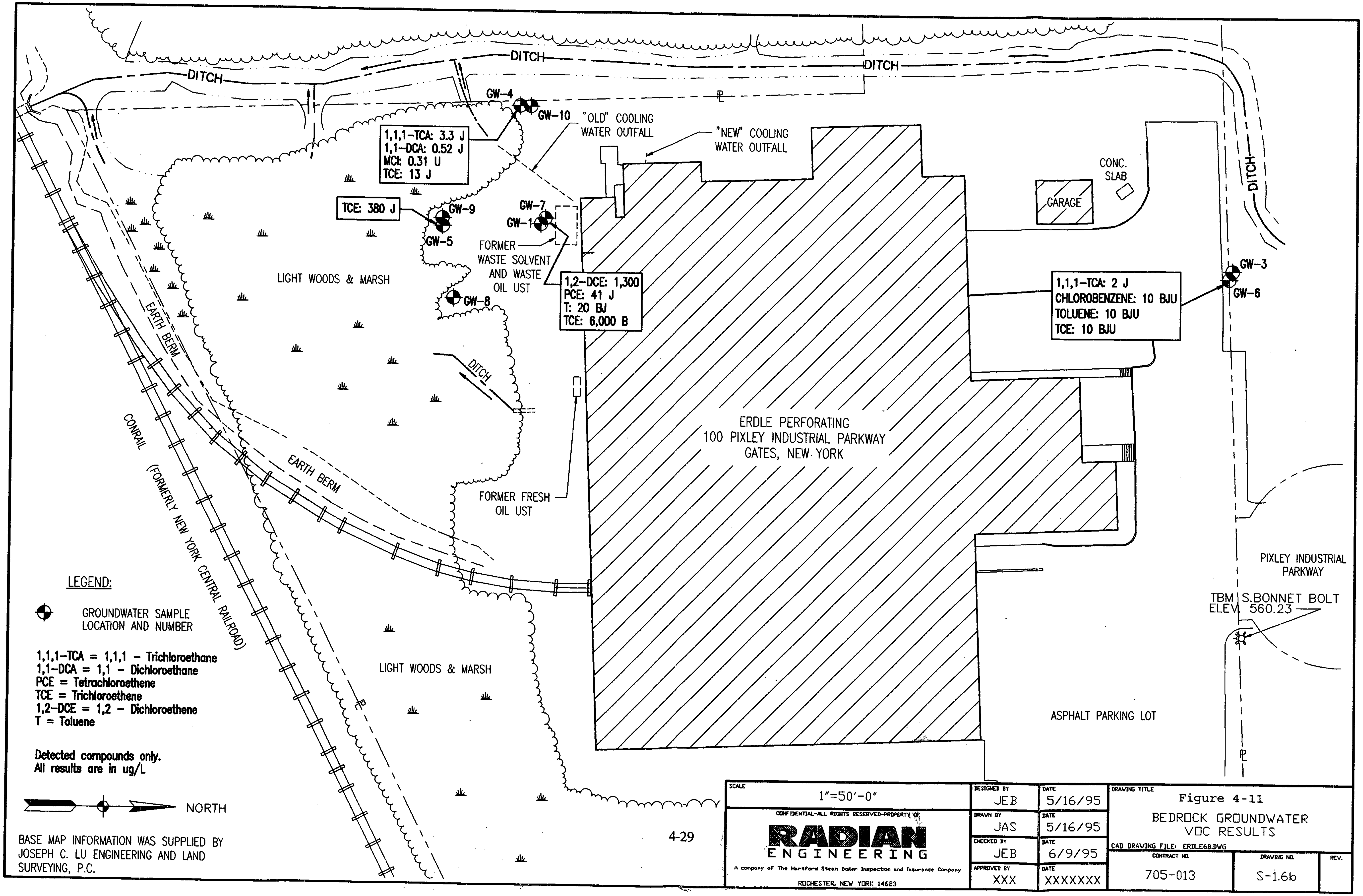
⊕ GROUNDWATER SAMPLE LOCATION AND NUMBER

TCE = Trichloroethene
1,2-DCE = 1,2 - Dichloroethene
VC = Vinyl Chloride
MCl = Methylene Chloride

Detected compounds only.
All results are in ug/L

BASE MAP INFORMATION WAS SUPPLIED BY JOSEPH C. LU ENGINEERING AND LAND SURVEYING, P.C.

SCALE 1"=50'-0"	DESIGNED BY JEB	DATE 5/16/95	DRAWING TITLE Figure 4-10 OVERBURDEN GROUNDWATER VOC RESULTS
CONFIDENTIAL-ALL RIGHTS RESERVED-PROPERTY OF RADIAN ENGINEERING A company of The Hartford Steam Boiler Inspection and Insurance Company ROCHESTER, NEW YORK 14623	DRAWN BY JAS	DATE 5/16/95	CAD DRAWING FILE: ERDLE6A.DWG
	CHECKED BY JEB	DATE 6/9/95	CONTRACT NO. 705-013
	APPROVED BY XXX	DATE XXXXXXX	DRAWING NO. S-1.6a REV.



LEGEND:

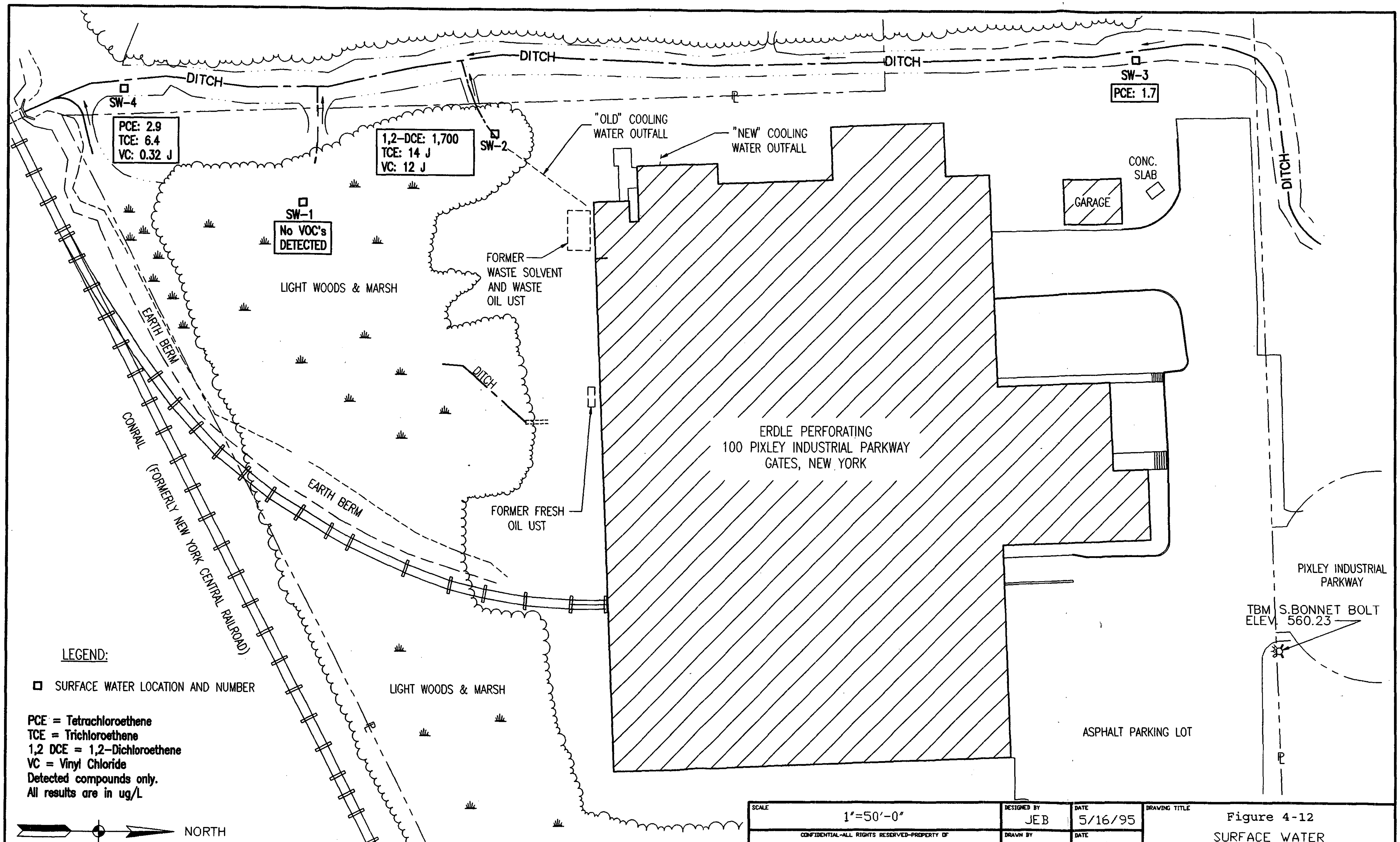
⊕ GROUNDWATER SAMPLE LOCATION AND NUMBER

1,1,1-TCA = 1,1,1 – Trichloroethane
1,1-DCA = 1,1 – Dichloroethane
PCE = Tetrachloroethene
TCE = Trichloroethene
1,2-DCE = 1,2 – Dichloroethene
T = Toluene

Detected compounds only.
All results are in ug/L

BASE MAP INFORMATION WAS SUPPLIED BY
JOSEPH C. LU ENGINEERING AND LAND
SURVEYING, P.C.

SCALE 1"=50'-0"	DESIGNED BY JEB	DATE 5/16/95	DRAWING TITLE Figure 4-11 BEDROCK GROUNDWATER VOC RESULTS	
CONFIDENTIAL-ALL RIGHTS RESERVED-PROPERTY OF RADIAN ENGINEERING A company of The Hartford Steam Boiler Inspection and Insurance Company ROCHESTER, NEW YORK 14623	DRAWN BY JAS	DATE 5/16/95	CAD DRAWING FILE: ERDLE6B.DWG	
	CHECKED BY JEB	DATE 6/9/95	CONTRACT NO. 705-013	DRAWING NO. S-1.6b
	APPROVED BY XXX	DATE XXXXXXX	REV.	



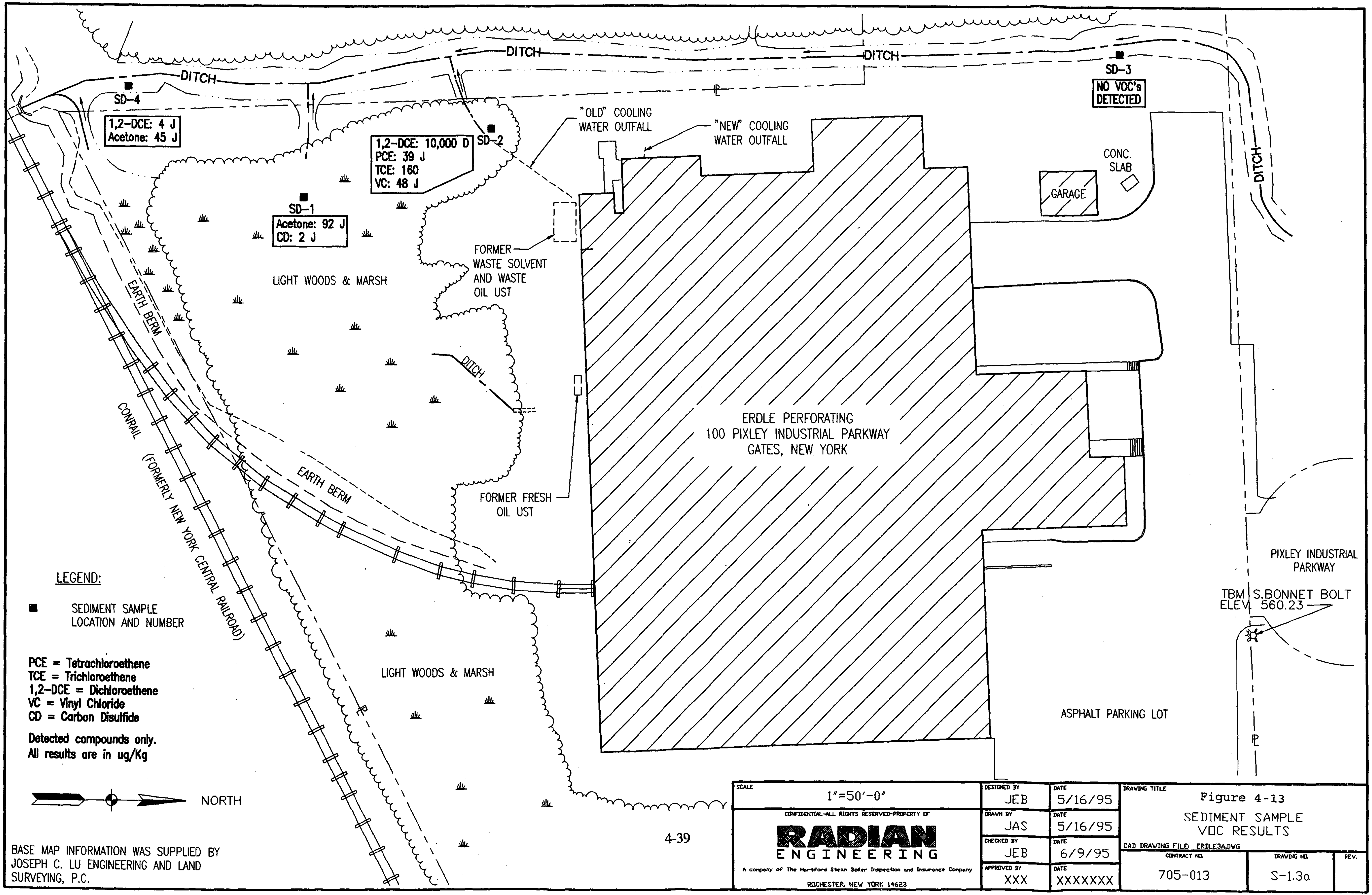
LEGEND:

□ SURFACE WATER LOCATION AND NUMBER

PCE = Tetrachloroethene
TCE = Trichloroethene
1,2 DCE = 1,2-Dichloroethene
VC = Vinyl Chloride
Detected compounds only.
All results are in ug/L

BASE MAP INFORMATION WAS SUPPLIED BY
JOSEPH C. LU ENGINEERING AND LAND
SURVEYING, P.C.

SCALE 1"=50'-0"	DESIGNED BY JEB	DATE 5/16/95	DRAWING TITLE Figure 4-12 SURFACE WATER VOC RESULTS
CONFIDENTIAL-ALL RIGHTS RESERVED-PROPERTY OF RADIAN ENGINEERING A company of The Hartford Steam Boiler Inspection and Insurance Company ROCHESTER, NEW YORK 14623	DRAWN BY JAS	DATE 5/16/95	
	CHECKED BY JEB	DATE 6/9/95	CAD DRAWING FILE: ERDLE3B.DWG
	APPROVED BY XXX	DATE XXXXXXX	CONTRACT NO. 705-013 · DRAWING NO. S-1.3b · REV.



LEGEND:

■ SEDIMENT SAMPLE LOCATION AND NUMBER

PCE = Tetrachloroethene
TCE = Trichloroethene
1,2-DCE = Dichloroethene
VC = Vinyl Chloride
CD = Carbon Disulfide

Detected compounds only.
All results are in ug/Kg

BASE MAP INFORMATION WAS SUPPLIED BY JOSEPH C. LU ENGINEERING AND LAND SURVEYING, P.C.

SCALE 1"=50'-0"	DESIGNED BY JEB	DATE 5/16/95	DRAWING TITLE Figure 4-13 SEDIMENT SAMPLE VOC RESULTS
CONFIDENTIAL-ALL RIGHTS RESERVED-PROPERTY OF RADIAN ENGINEERING A company of The Hartford Steam Boiler Inspection and Insurance Company ROCHESTER, NEW YORK 14623	DRAWN BY JAS	DATE 5/16/95	CAD DRAWING FILE: ERDLE3A.DWG
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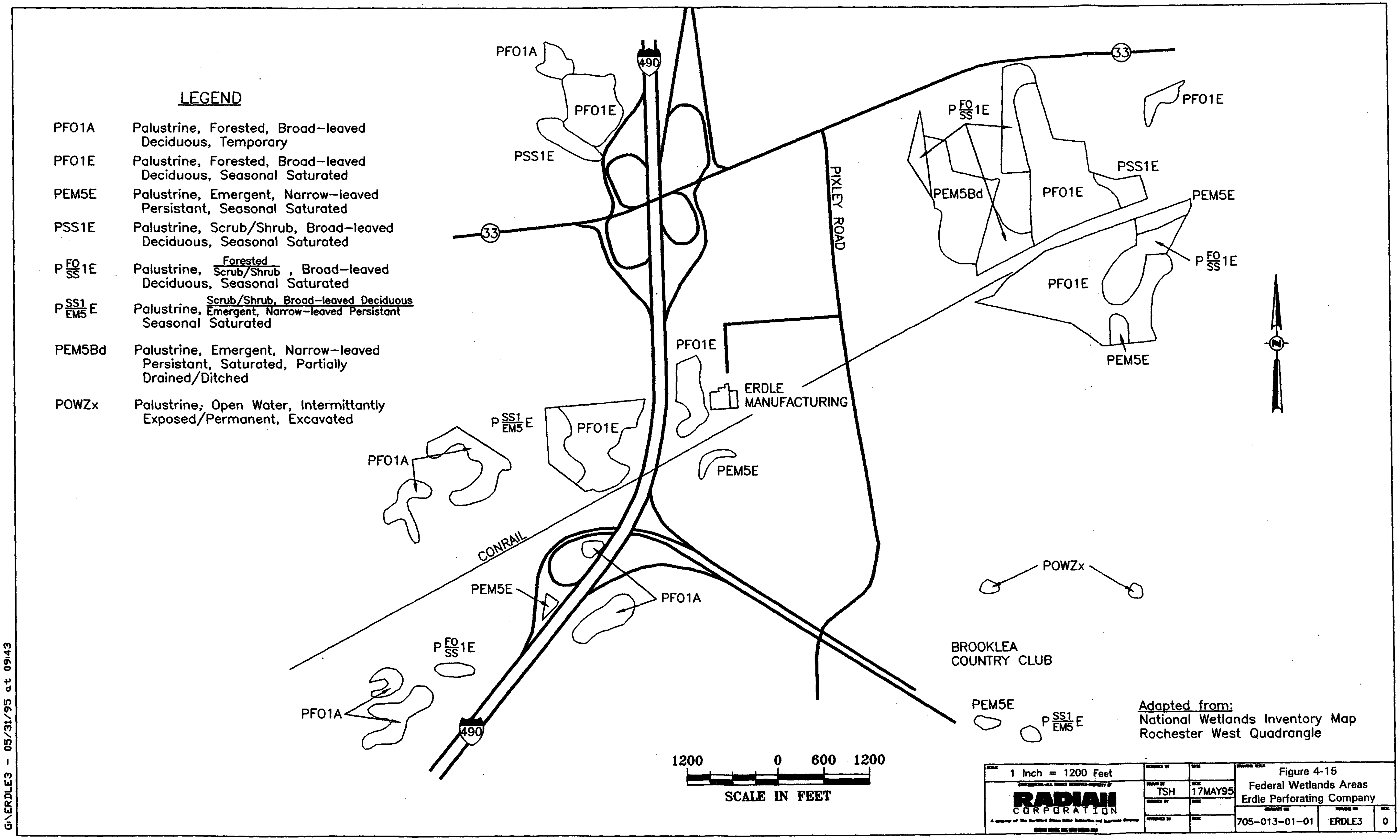

Adapted from:
National Wetlands Inventory Map
Rochester West Quadrangle

1 Inch = 1200 Feet

RADIAN CORPORATION

TSH 17MAY95

Figure 4-15
Federal Wetlands Areas
Erdle Perforating Company

705-013-01-01 ERDLE3 0

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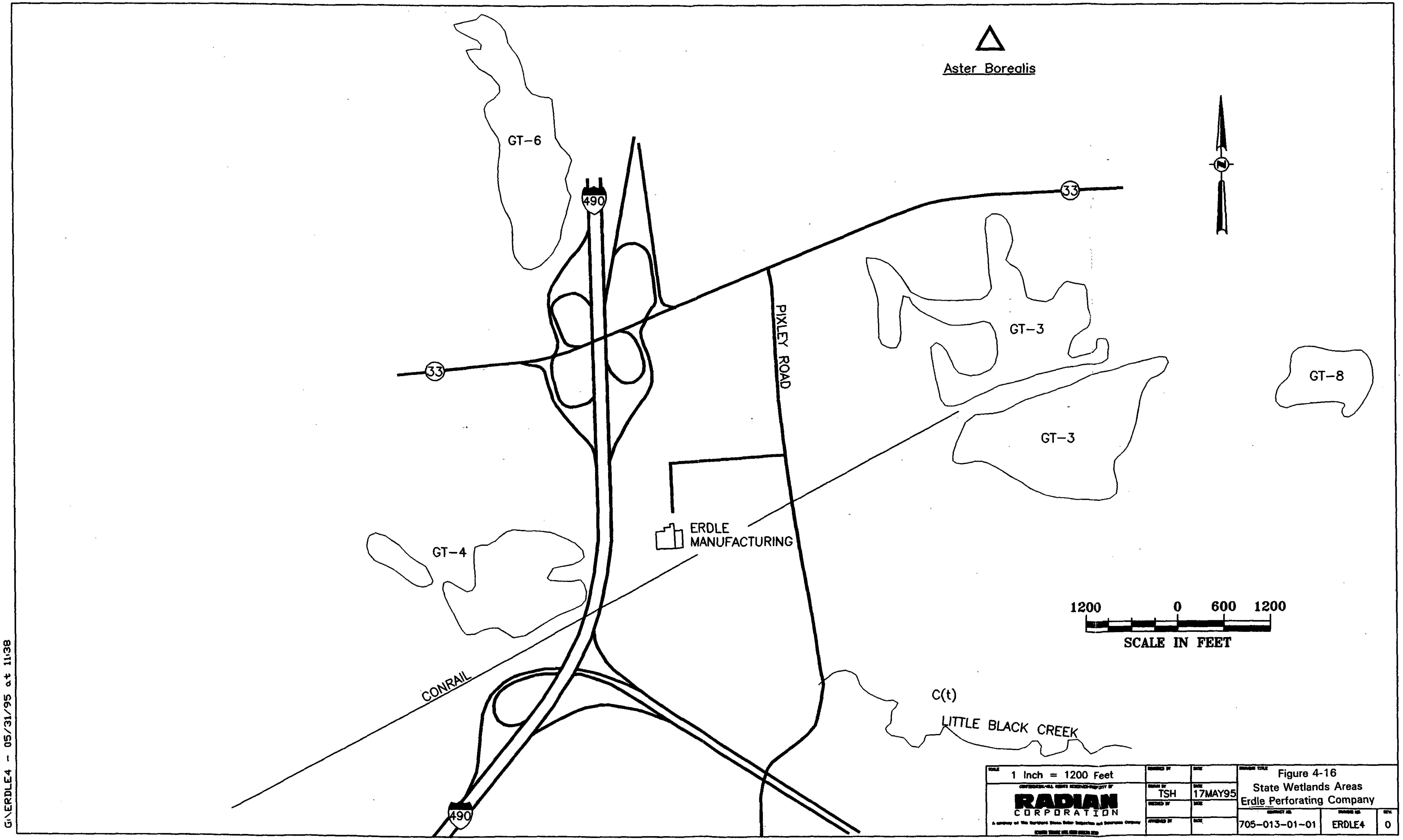


1 Inch = 1200 Feet

RADIAN
CORPORATION

TSH 17MAY95

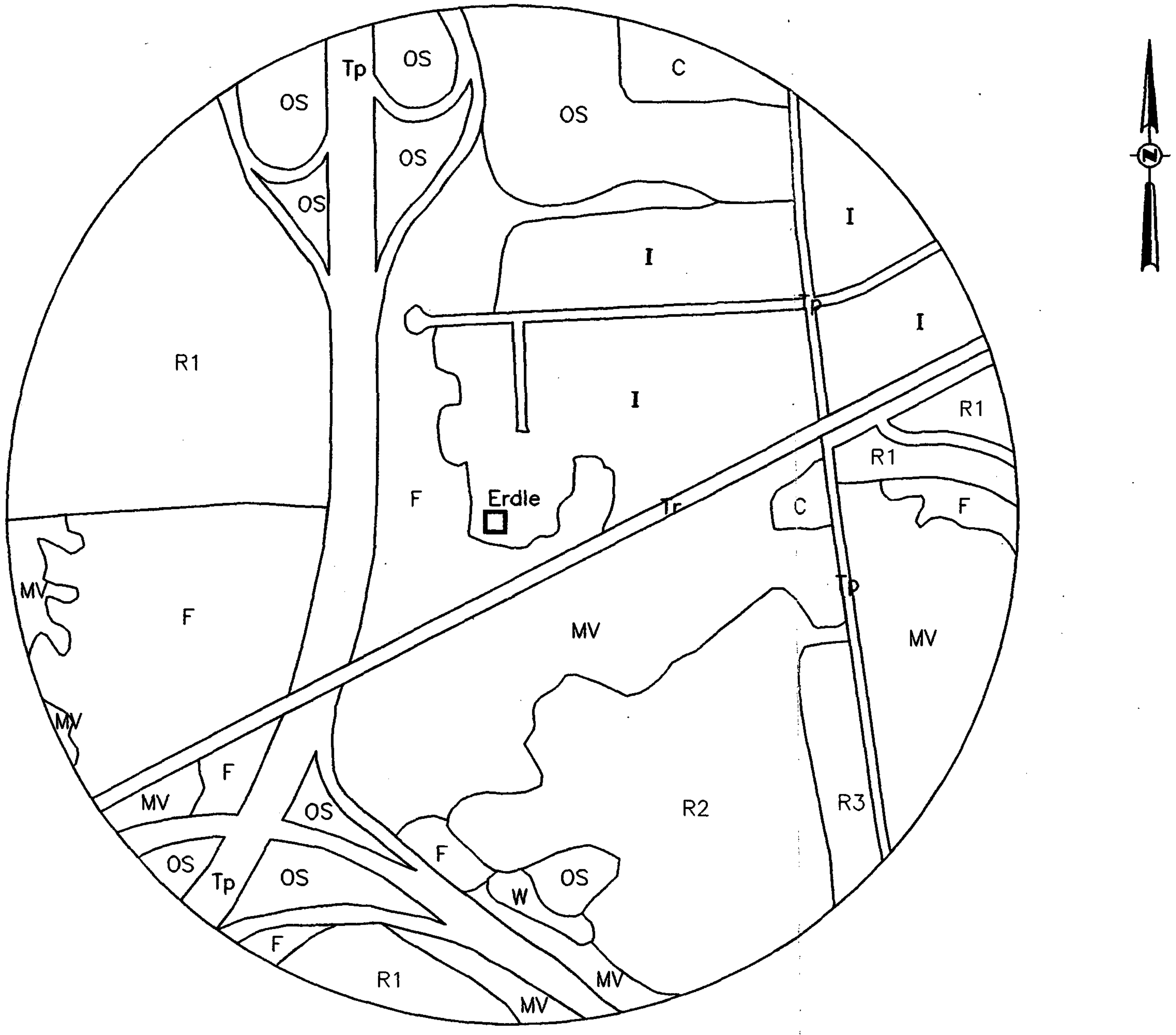
Figure 4-16
State Wetlands Areas
Erdle Perforating Company

705-013-01-01 ERDLE4 0

G:\ERDLE4 - 05/31/95 at 11:38

Land Use/Land Cover Classification Within 0.5 Miles of Erdle Manufacturing

Land Class Codes	Description
R1	Residential, 1/4 acre lots
R2	Residential, multi-family
R3	Residential, 1+ acre lots
F	Forested
OS	Open Space
MV	Mixed vegetation, sparce, sporadic low shrubs, grass/weed cover, some trees
W	Water
I	Industrial
C	Commercial
Tp	Transportation-paved road
Tr	Transportation-railroad



800 0 400 800
SCALE IN FEET

1 Inch = 800 Feet

RADIAN CORPORATION

TSH 17MAY95

Figure 4-17
Land Use Classifications
Erdle Perforating Company

705-013-01-01 ERDLE1 0

G:\ERDLE1 - 05/17/95 at 15:06

B

APPENDIX B

PHASE II
REMEDIAL INVESTIGATION DATA SUMMARY

TABLES

DRAFT

Table 1

Definition of Laboratory Flags

USEPA-Defined Organic Data Qualifiers:

U	Indicates compound was analyzed for but not detected.
J	Indicates an estimated value. This flag is used either when estimating a concentration for tentatively identified compounds where a 1:1 response is assumed, or when the mass spectral data indicate the presence of a compound that meets the identification criteria but the result is less than the sample quantitation limit but greater than zero.
C	This flag applies to pesticide results where the identification has been confirmed by GC/MS.
B	This flag is used when the analyte is found in the associated blank as well as in the sample.
E	This flag identifies compounds whose concentrations exceed the calibration range of the GC/MS instrument for that specific analyte.
D	This flag identifies all compounds identified in an analysis at a secondary dilution factor.
G	The TCLP Matrix Spike recovery was greater than the upper limit of the analytical method.
L	The TCLP Matrix Spike recovery was lower than the lower limit of the analytical method.
T	This flag is used when the analyte is found in the associated TCLP extraction as well as in the samples.
N	Indicates presumptive evidence of a compound. This flag is only used for tentatively identified compounds, where the identification is based on a mass spectral library search. It is applied to all TIC results.
P	This flag is used for a pesticide/Aroclor target analyte when there is greater than 25% difference for detected concentrations between the two GC columns. The lower of the two values is reported on the Form I and flagged with a "P."
A	This flag indicates that a TIC is a suspected aldol-condensation product.

USEPA-Defined Inorganic Data Qualifiers:

B	Indicates a value greater than or equal to the instrument detection limit, but less than the contract required detection limit.
U	Indicates element was analyzed for but not detected. Report with the detection limit value (e.g., 100).
E	Indicates a value estimated or not reported due to the presence of interference.
S	Indicates value determined by Method of Standard Addition.
N	Indicates spike sample recovery is not within control limits.
*	Indicates duplicate analysis is not within control limits.
+	Indicates the correlation coefficient for Method of Standard Addition is less than 0.995.
M	Indicates duplicate injection results exceeded control limits.
W	Post-digestion spike for Furnace AA analysis is out of control limits (85-115%), while sample absorbance is less than 50% of spike absorbance.

DRAFT

Table 2

Definition of Validation Flags

USEPA-Defined Organic Data Qualifiers

J	Estimated value
L	Biased low
H	Biased high
U	Not detected at associated level; uncertain
N	Tentatively identified
UJ	Quantitation limit may be inaccurate
B	Not detected substantially above level in blank
R	Unusable value

USEPA-Defined Inorganic Data Qualifiers

U	Not detected at associated level
J	Estimated value
R	Unusable value
UJ	Element ND, and quantitation limit uncertain

DRAFT

Table 3

Erdle Perforating Company, Remedial Investigation
Detected Volatile Organic Compounds in Groundwater Samples

Sample	Sample Location	Parameter	Result (μg/L)	Laboratory Flags	Validation Flags	Guidance Exceeded?	Guidance Value[a] (μg/L)
			PHASE I RESULTS				
GW-1	Groundwater sample, MW-1, overburden adjacent to solvent tank	**1,2-Dichloroethene (Total)**	**150000**		**J**	**X[b]**	**5**
		Trichloroethene	**6400**	**BJ**	**J**	**X**	**5**
		Vinyl chloride	**13000**		**J**	**X**	**2**
GW-2	Groundwater sample, field duplicate of GW-1	**1,2-Dichloroethene (Total)**	**170000**			**X**	**5**
		Toluene	**10000**	**BJ**	**U**	**X**	**5**
		Trichloroethene	**8800**	**BJ**		**X**	**5**
		Vinyl chloride	**15000**			**X**	**2**
GW-3	Groundwater sample, MW-5 overburden: background (north)	Methylene chloride	0.32	J	U		
GW-4	Groundwater sample, MW-4D shallow bedrock: downgradient (southwest)	1,1,1-Trichloroethane	3.3		J		5
		1,1-Dichloroethane	0.52		J		5
		Methylene chloride	0.31	J	U		
		Trichloroethene	**13**		**J**	**X**	**5**
GW-5	Groundwater sample, MW-3D shallow bedrock: downgradient (south)	**Trichloroethene**	**380**		**J**	**X**	**5**
GW-6	Groundwater sample, MW-5D shallow bedrock: background (north)	1,1,1-Trichloroethane	2	J			5
		Chlorobenzene	**10**	**BJ**	**U**	**X**	**5**
		Toluene	**10**	**BJ**	**U**	**X**	**5**
		Trichloroethene	**10**	**BJ**	**U**	**X**	**5**

DRAFT

Table 3
(Continued)

Sample	Sample Location	Parameter	Result ($\mu g/L$)	Laboratory Flags	Validation Flags	Guidance Exceeded?	Guidance Value[a] ($\mu g/L$)
GW-7	Groundwater sample, MW-1D shallow bedrock: adjacent to solvent tank	**1,2-Dichloroethene (Total)**	**1300**			X	5
		Tetrachloroethene	**41**	J		X	5
		Toluene	**20**	BJ		X	5
		Trichloroethene	**6000**	B		X	5
GW-8	Groundwater sample, MW-2 overburden: downgradient (southeast)	**Trichloroethene**	**1600**		J	X	5
		Vinyl chloride	**88**		J	X	2
GW-9	Groundwater sample, MW-3 overburden: downgradient (south)	**Methylene chloride**	**4280**	J	J	X	5
		Trichloroethene	**350000**		J	X	5
GW-10	Groundwater sample, MW-4 overburden: downgradient (southwest)	Bromodichloromethane	0.31		J		
		Chloroform	3.6		J		
		Methylene chloride	0.24	J	U		
		Trichloroethene	1.4		J		
		Vinyl chloride	**37**		J	X	2
PHASE II RESULTS							
2-GW-7 (dup of 2-GW-1)	Groundwater sample (duplicate), MW-1, overburden adjacent to solvent tank, Phase II	**1,2-Dichloroethene (Total)**	**72**		J	X	5
		Trichloroethene	**420**		J	X	5
		Vinyl chloride	**2200**		J	X	2
2-GW-1D	Groundwater sample, MW-1D, shallow bedrock adjacent to solvent tank, Phase II	**Trichloroethene**	**9900**	D	J	X	5
2-GW-1DD	Groundwater sample, MW-1DD, deep bedrock adjacent to solvent tank, Phase II	O-Xylene	0.26	--	JH		5

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Table 3
(Continued)

Sample	Sample Location	Parameter	Result (μg/L)	Laboratory Flags	Validation Flags	Guidance Exceeded?	Guidance Value[a] (μg/L)
2-GW-2	Groundwater sample, MW-2, overburden downgradient (southeast), Phase II	**Trichloroethene**	**1000**		**J**	**X**	**5**
		Vinyl Chloride	**98**		**J**	**X**	**2**
2-GW-2D	Groundwater sample, MW-2D, shallow bedrock downgradient (southeast), Phase II	1,1-Dichloroethane	2.4		J		5
		1,2-Dichloroethene (Total)	1.0		J		5
		1,1,1-Trichloroethane	3.9		J		5
		Trichloroethene	**13**		**J**	**X**	**5**
2-GW-3	Groundwater sample, MW-3, overburden downgradient (south), Phase II	**Trichloroethene**	**550000**	**D**	**J**	**X**	**5**
2-GW-3D	Groundwater sample, MW-3D, shallow bedrock downgradient (south), Phase II	**Trichloroethene**	**850**	**D**	**J**	**X**	**5**
2-GW-4	Groundwater sample, MW-4, overburden downgradient (southwest), Phase II	1,2-Dichloroethene (Total)	2.6		J		5
		Trichloroethene	2.3		J		5
		Vinyl Chloride	**18**		**J**	**X**	**2**
2-GW-4D	Groundwater sample, MW-4D, shallow bedrock downgradient (southwest), Phase II	1,1-Dichloroethane	0.64		J	X	5
		1,1,1-Trichloroethane	2.5		J	X	5
		Trichloroethene	**29**		**J**	**X**	**5**
2-GW-5	Groundwater sample, MW-5, overburden background well north of site, Phase II	1,1-Dichloroethane	1.7		J	X	5
2-GW-5D	Groundwater sample, MW-5D, shallow bedrock background well north of site, Phase II	1,1-Dichloroethane	0. 43		J	X	5
		1,1,1-Trichloroethane	0.91		J		5
		Trichloroethene	**0.44**		**J**	**X**	**5**

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Table 3
(Continued)

Sample	Sample Location	Parameter	Result (μg/L)	Laboratory Flags	Validation Flags	Guidance Exceeded?	Guidance Value[a] (μg/L)
2-GW-6	Groundwater sample MW-6, overburden downgradient (south), Phase II	**Vinyl chloride**	**2.2**		**J**	**X**	**2**
2-GW-6D	Groundwater sample MW-6D, shallow bedrock downgradient (property line to south), Phase II	**Trichloroethene**	**1400**	**D**	**J**	**X**	**5**

[a] NYSDEC TOGS 1.1.1, "Ambient Water Quality Standards and Guidance Values." Revised October 1993.
[b] "X" and bold type indicate guidance exceeded.

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Table 4

Erdle Perforating Company, Remedial Investigation
Detected Metals/Inorganics in Surface Water/Sediment Samples

Sample	Sample Location	Parameter	Result[a]	Laboratory Flags	Validation Flags	Guidance Exceeded?	Guidance Value[b]
		PHASE I RESULTS					
SW-2	Surface water, old outfall	Aluminum - Total	7300				
		Arsenic - Total	3.7	B	J		
		Barium - Total	142	B			
		Calcium - Total	193000	*			
		Copper - Total	21	B			
		Iron - Total	**12900**			**X**	**300**
		Lead - Total	22.6	*			
		Magnesium - Total	**35600**			**X**	**35,000**
		Manganese - Total	**1360**	**N***	**J**	**X**	**300**
		Nickel - Total	28	B			
		Potassium - Total	5820				
		Sodium - Total	29100				
		Vanadium - Total	13	B	J		
		Zinc - Total	**355**	**N**	**J**	**X**	**300**

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Table 4
(Continued)

Sample	Sample Location	Parameter	Result[a]	Laboratory Flags	Validation Flags	Guidance Exceeded?	Guidance Value[b]
SD-1	Sediment sample, marsh	Aluminum - Total	6270		J		
		Barium - Total	59.6	B	J		
		Calcium - Total	6220	*	J		
		Chromium - Total	9.3		J		
		Copper - Total	14.9	B	J		
		Iron - Total	10700		J		
		Lead - Total	40.6	*	J		61
		Magnesium - Total	1980	B	J		
		Manganese - Total	96.8	N*	J		
		Potassium - Total	665	B	J		
		Thallium - Total	3.7	B	J		
		Vanadium - Total	11.2	B	J		
		Zinc - Total	198	N	J		700

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Table 4
(Continued)

Sample	Sample Location	Parameter	Result[a]	Laboratory Flags	Validation Flags	Guidance Exceeded?	Guidance Value[b]
SD-2	Sediment sample, old outfall	Aluminum - Total	5120				
		Arsenic - Total	2.9	B	J		
		Barium - Total	44.8	B			
		Cadmium - Total	1.6	*	J		31
		Calcium - Total	11900	*			
		Chromium - Total	35.1				
		Cobalt - Total	3.2	B			
		Copper - Total	**104**			**Maybe**	**65-155**
		Iron - Total	8100				
		Lead - Total	**71.1**	*		**X**	**61**
		Magnesium - Total	5350				
		Manganese - Total	89.3	N*	J		
		Nickel - Total	15.9				
		Potassium - Total	432	B			
		Selenium - Total	1.2	BN	J		
		Thallium - Total	3.4		J		
		Vanadium - Total	10.4	B	J		
		Zinc - Total	410	N	J		700
PHASE II RESULTS							
SD-2A	Sediment sample, old outfall, Phase II	Aluminum	6550		JH		
		Antimony	1.4	U			2
		Arsenic	2.3	B			6

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Table 4
(Continued)

Sample	Sample Location	Parameter	Result[a]	Laboratory Flags	Validation Flags	Guidance Exceeded?	Guidance Value[b]
SD-2A	Sediment sample, old outfall, Phase II, con't	Barium	39.3	B			
		Beryllium	0.28	B			
		Cadmium	0.05	U			0.6
		Calcium	20200				
		Chromium	18.3				26
		Cobalt	3.7	B			
		Copper	33.4		J		65-155
		Iron	10200				2.0%
		Lead	42.9				61
		Magnesium	9150				
		Manganese	117				460
		Mercury	0.11	U			0.15
		Nickel	12.6				16
		Potassium	583	B			
		Selenium	0.99	U			
		Silver	0.49	U			1
		Sodium	378	B			
		Thallium	1.3	U			
		Vanadium	14.7				

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Table 4
(Continued)

Sample	Sample Location	Parameter	Result[a]	Laboratory Flags	Validation Flags	Guidance Exceeded?	Guidance Value[b]
SD-2A	Sediment sample, old outfall, Phase II, con't	Zinc	364				700
		Cyanide	ND				
Total Hardness/Total Organics Detections (Analyzed for Phase I Only)							
SW-2	Surface water, old outfall	Total Hardness	595 mg/L				None
SD-1	Sediment sample, marsh	Leachable Total Organic Carbon	62,600 mg/L				None
SD-2	Sediment sample, old outfall	Leachable Total Organic Carbon	16,900 mg/L				None
SD-3	Sediment sample, background	Leachable Total Organic Carbon	8810 mg/L				None

[a] Results are in units of μg/L (surface water samples) or mg/kg (sediment samples).

[b] Surface Water: NYSDEC TOGS 1.1.1, "Ambient Water Quality Standards and Guidance Values." Revised October 1993.

Sediments: NYSDEC, Division of Fish and Wildlife, Division of Marine Resources: Technical Guidance for Screening Contaminated Sediments, July 1994.

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Table 5

Summary of Phase II Detections Above NYSSCGs, by Compound

Compound	Media In Which Detected Above NYSSCG
Volatile Organic Compounds	
1,2-DCE (total)	Groundwater
TCE	Groundwater
Vinyl chloride	Groundwater
Semivolatile Organic Compounds	
(SVOCs not analyzed for during Phase II)	
Metals	
None	Sediment

NOTE: During Phase II, only the following samples were collected/analyzed: groundwater for halogenated VOCs, and sediment for metals.

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Table 6

Summary of Phase II Detections Above NYSSCGs, by Media

	Contaminants Present Above NYSSCG		
Media	Volatile Organics	Semivolatile Organics	Metals
Soil	No soil samples collected.	No soil samples collected.	No soil samples collected.
Groundwater	1,2-Dichloroethene Trichloroethene Vinyl chloride	No SVOC analysis conducted on groundwater samples.	No metals analysis conducted on groundwater samples.
Surface Water	No surface water samples collected.	No surface water samples collected.	No surface water samples collected.
Sediment	Sediment samples not analyzed for VOCs.	Sediment samples not analyzed for SVOCs.	None

NOTE: During Phase II, only the following samples were collected/analyzed: groundwater for halogenated VOCs, and sediment for metals.

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Table 7

Evaluation of Potential Pathways

Potentially Exposed Media	Contaminants Detected?	Potential Route of Exposure	Potential Receptors	Pathway Complete?
Surface Soil	Yes	Dermal absorption, incidental ingestion	Wildlife	Yes
Subsurface Soil	Yes	None	None	No
Surface Water	Yes	Dermal absorption, ingestion	Wildlife, fish, downstream	Yes
Sediment	Yes	Dermal absorption, incidental ingestion	Fish, aquatic plants, benthic organisms	Yes
Groundwater	Yes	None	None	No
Air	Unknown	Inhalation	Wildlife	Unknown

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Table 8

Evaluation of Detected Concentrations Vs. Surface Water/Sediment Criteria

Analyte/Media	Criteria	Exceedances
1,2-DCE/Water	3,900 μg/L	None
Cadmium/Sediment	31	None
Copper/Sediment	65 - 155 mg/kg (trout)	SD-2 (104 mg/kg)
Lead/Sediment	61 mg/kg	SD-2 (71.1 mg/kg)
Zinc/Sediment	700 mg/kg (trout)	None

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Table 9

Revised Air Results Summary (Formerly Table 4-10 of Phase I RI Report)

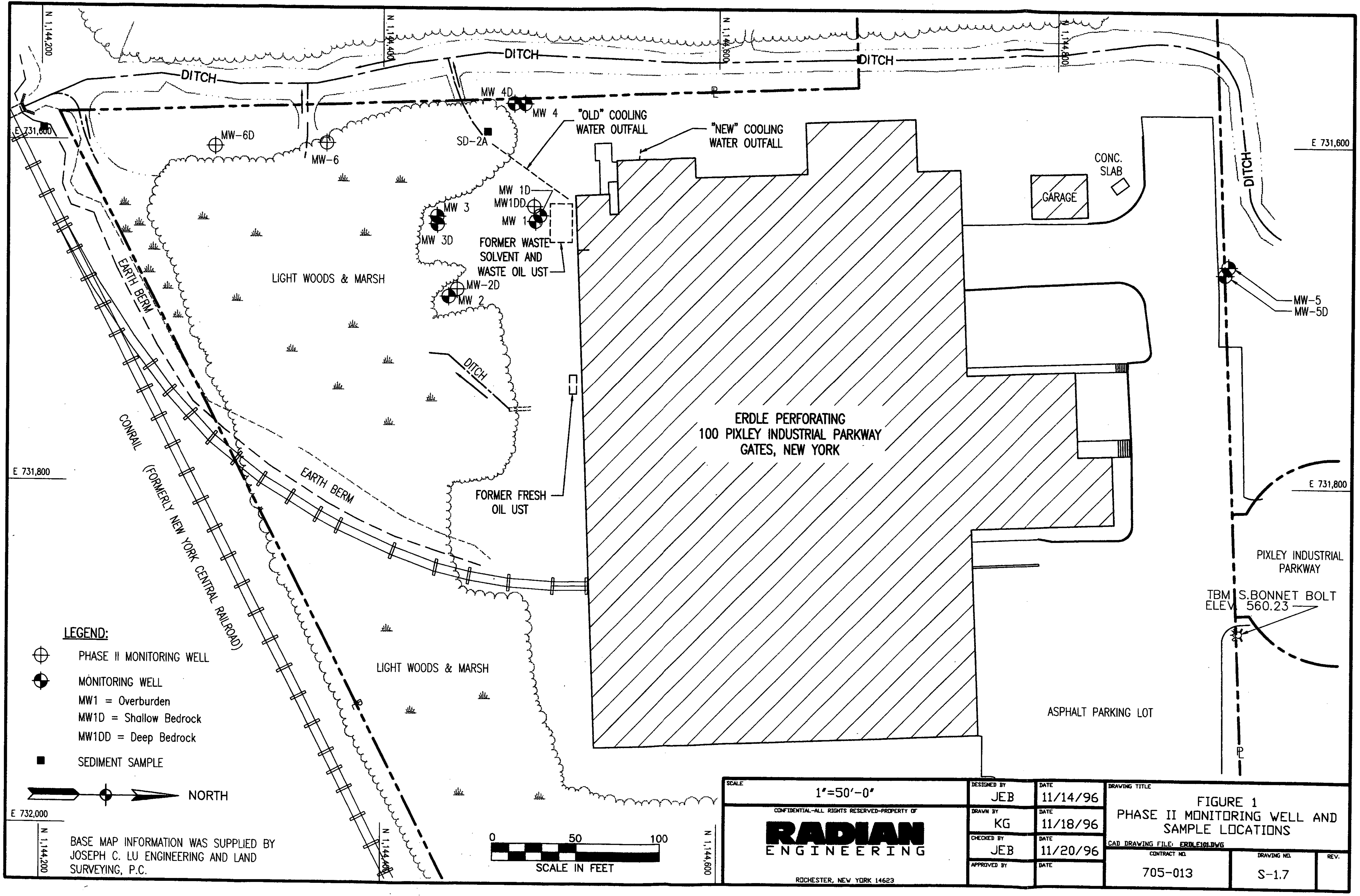
	Laboratory Results (ng)				Ca (ug/m^3)[a]		Cp (ug/m^3)[b]		
	A1-A	A1-B	A1-CS-A	A1-CS-B	Total A1	Total A1-CS	Total A1	Total A1-CS	NYS ACG (ug/m^3)[c]
Chloroethane	3 J	0 J	0 J	0 J	1.41E-11	0	4.14E-04	0	63000
Methylene chloride	550 J	0 J	12000 J	6300 J	2.58E-09	8.45E-08	5.16E-05	2.49E+00	27
Acetone	97 J	0 J	510 J	0 J	4.55E-10	2.36E-09	9.09E-06	6.93E-02	14000
Carbon disulfide	20 J	0 J	3 J	15 J	9.37E-11	8.31E-11	1.87E-06	2.45E-03	7.0
1,2-Dichloroethene	18 J	0 J	16 J	0 J	8.44E-11	7.39E-11	1.69E-06	2.17E-03	360
Chloroform	8 J	0 J	8 J	8 J	3.75E-11	7.39E-11	7.50E-07	2.17E-03	23
1,2-Dichloroethane	0 J	0 J	2 J	0 J	0	9.24E-12	0	2.72E-04	3.9E-02
2-Butanone	0 J	0 J	110 J	0 J	0	8E-10	0	1.49E-02	300
1,1,1-Trichloroethane	7 J	0 J	8 J	7 J	3.28E-11	6.93E-11	6.56E-07	2.04E-03	1000
Vinyl acetate	0 J	3 J	0 J	0 J	1.41E-11	0	2.81E-07	0	NA
Trichloroethene	16 J	0 J	14 J	0 J	7.50E-11	6.46E-11	1.50E-06	1.90E-03	4.5E-01
Chlorobenzene	22 J	0 J	0 J	0 J	1.03E-10	0	2.06E-06	0	20.0
Xylenes	25 J	0 J	31 J	0 J	1.17E-10	1.43E-10	2.34E-06	4.21E-03	300

[a] Ca = Concentration directly over waste site.

[b] Cp = Maximum potential annual concentration.

[c] From: New York State Department of Environmental Conservation, Bureau of Toxic Air Sampling, Division of Air Resources, "Air Pathway Analysis Requirements in the Remedial Investigation," April 2, 1991.

FIGURES



BASE MAP INFORMATION WAS SUPPLIED BY JOSEPH C. LU ENGINEERING AND LAND SURVEYING, P.C.

SCALE
1"=50'-0"

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ROCHESTER, NEW YORK 14623

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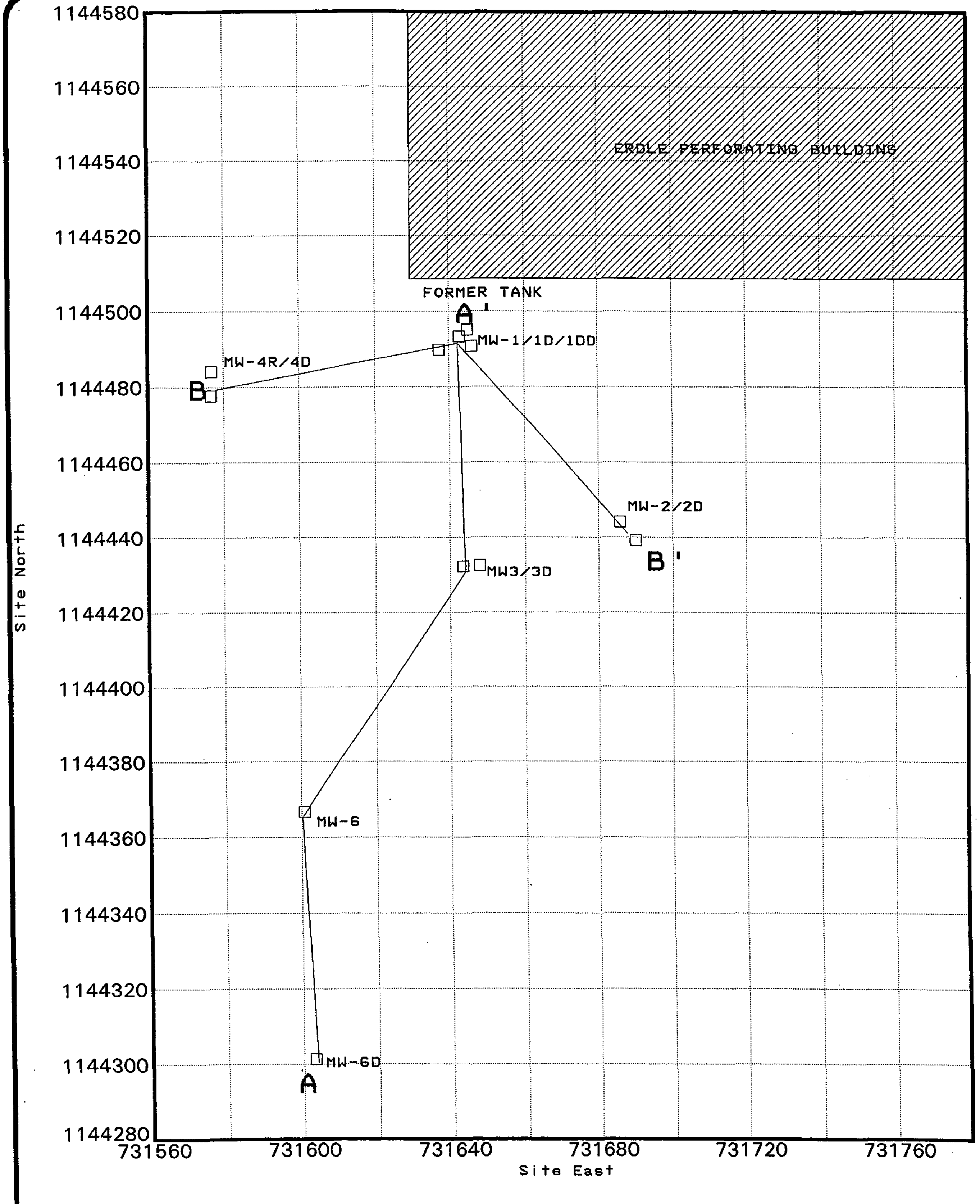
DRAWN BY	KG	DATE	11/18/96
CHECKED BY	JEB	DATE	11/20/96
APPROVED BY		DATE	

DRAWING TITLE

FIGURE 1
PHASE II MONITORING WELL AND
SAMPLE LOCATIONS

CAD DRAWING FILE: ERDLE101.DWG

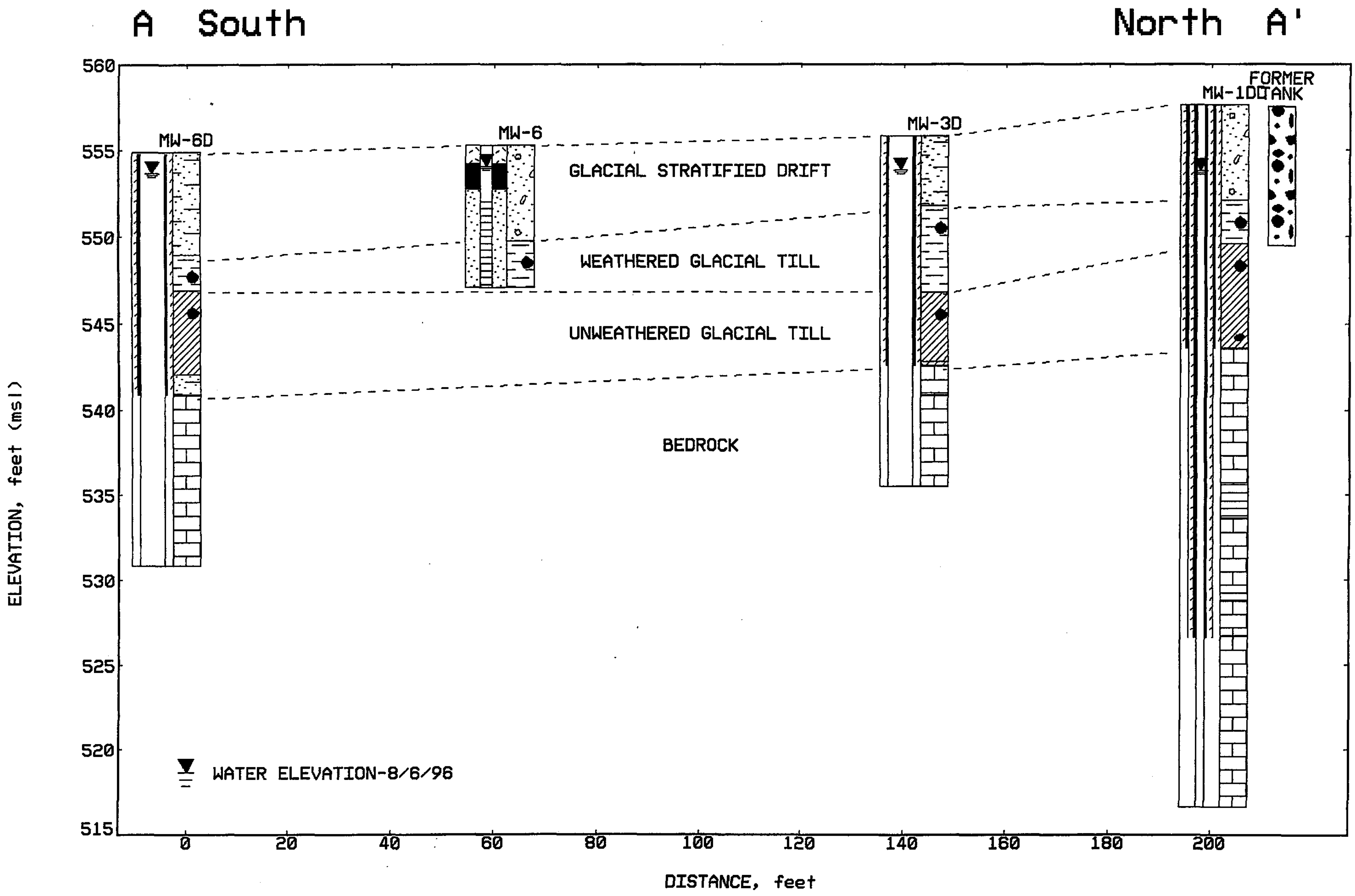
CONTRACT NO.	DRAWING NO.	REV.
705-013	S-1.7	



RADIAN

PROJECT **Phase II Remedial Investigation - Erdle Facility** JOB NO. **705-013**
DATE **11/20/96**

Figure 2. Cross Section Locations



RADIAN	Figure 3 PHASE II N-S CROSS SECTION	
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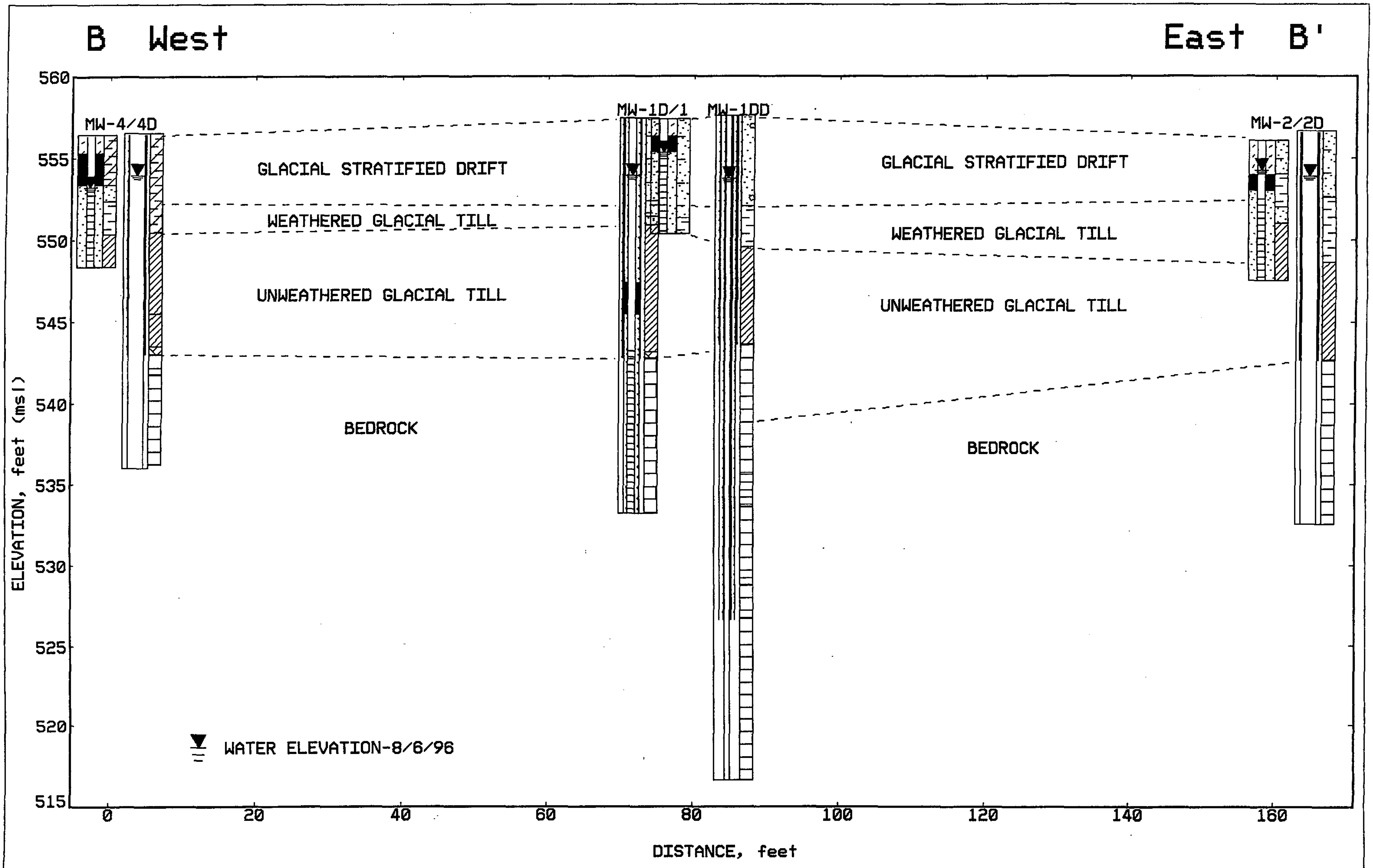
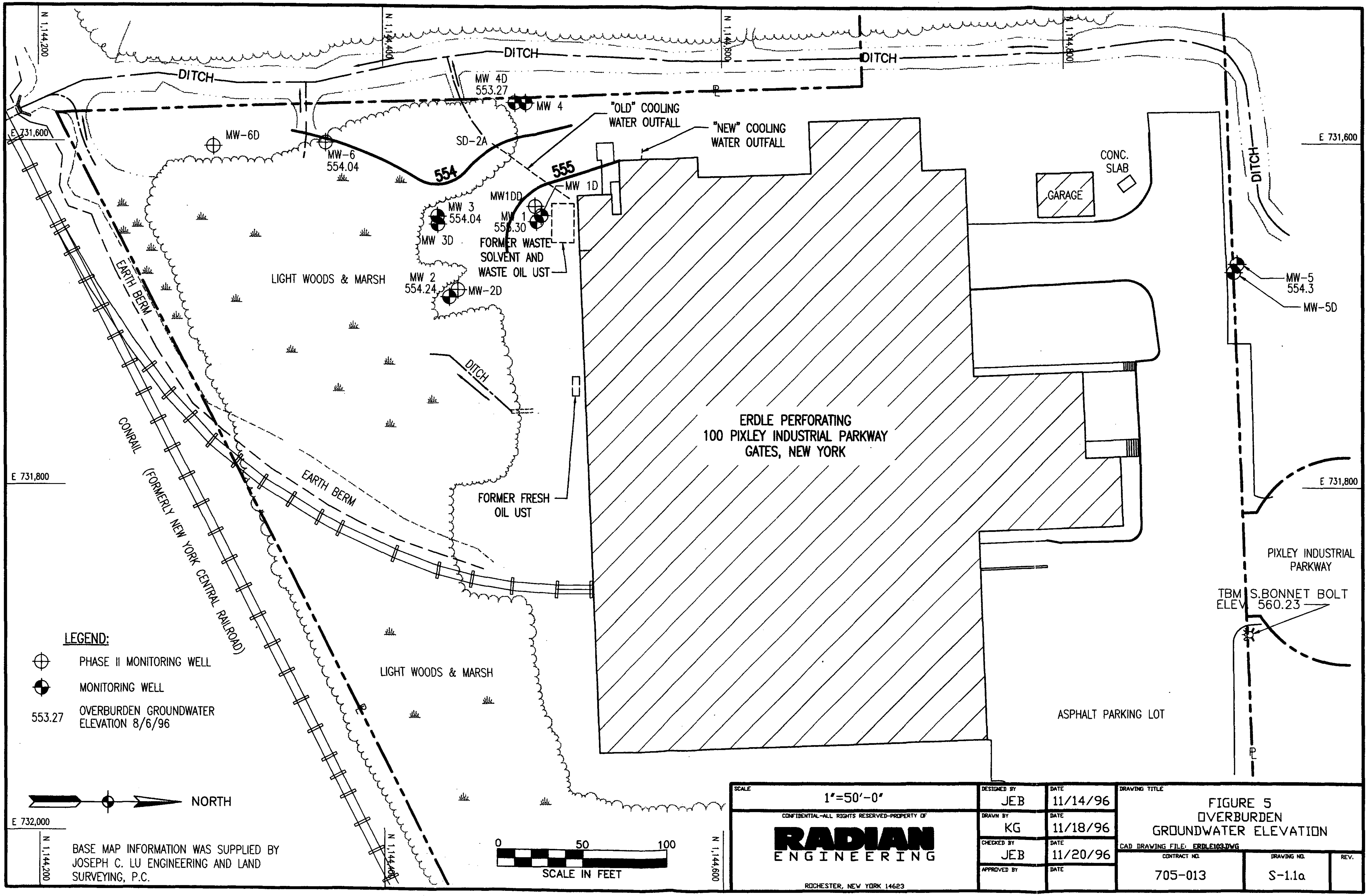


RADIAN	Figure 4 PHASE II E-W CROSS SECTION	
	705-013	ERD2DTEW



LEGEND:

⊕	PHASE II MONITORING WELL
◐	MONITORING WELL
553.27	OVERBURDEN GROUNDWATER ELEVATION 8/6/96

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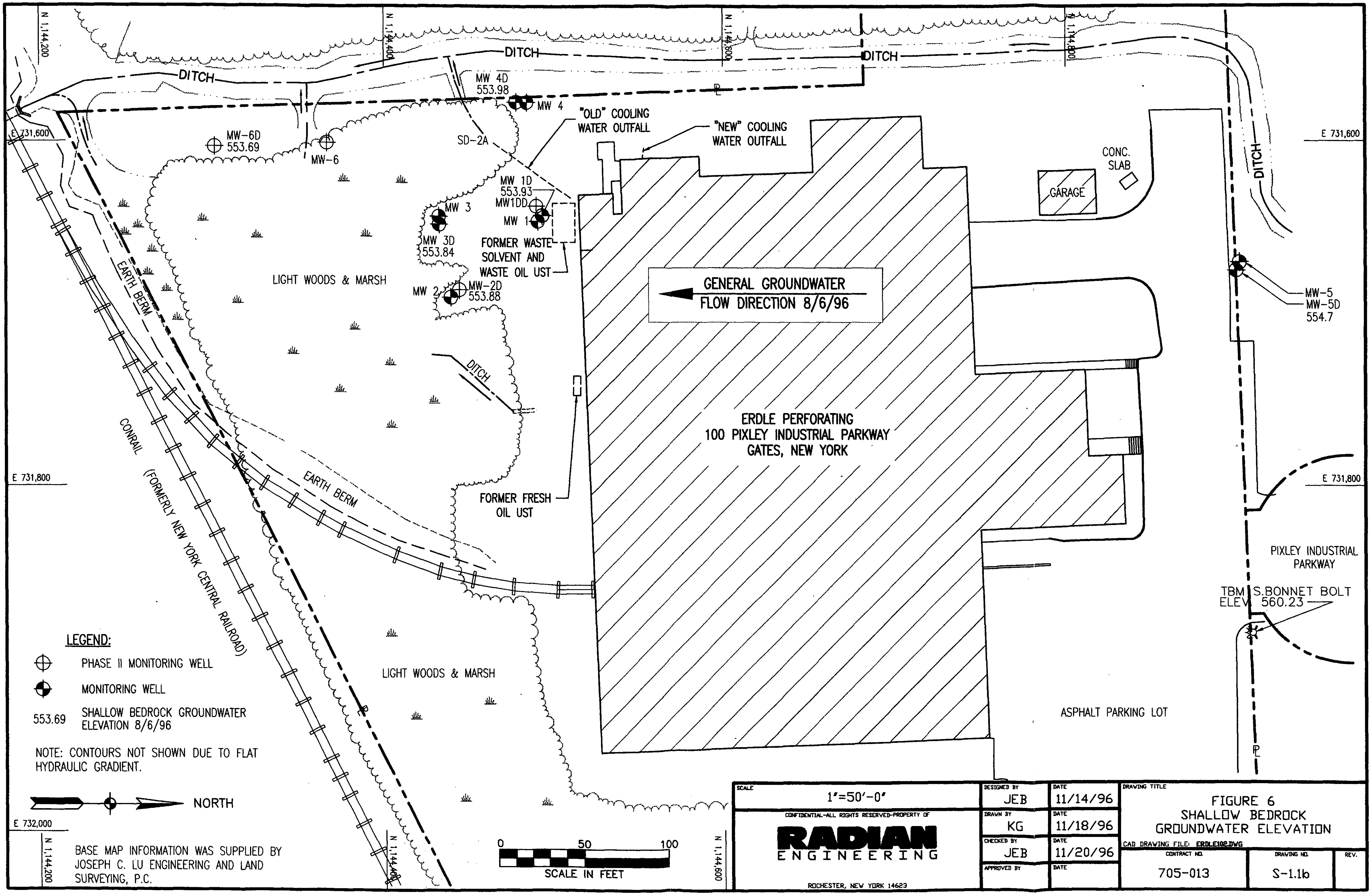
SCALE 1"=50'-0"	DESIGNED BY JEB	DATE 11/14/96	DRAWING TITLE FIGURE 5 OVERBURDEN GROUNDWATER ELEVATION CAD DRAWING FILE: ERDLE103.DWG
CONFIDENTIAL-ALL RIGHTS RESERVED-PROPERTY OF RADIAN ENGINEERING ROCHESTER, NEW YORK 14623	DRAWN BY KG	DATE 11/18/96	CONTRACT NO. 705-013
	CHECKED BY JEB	DATE 11/20/96	DRAWING NO. S-1.1a
	APPROVED BY	DATE	REV.



SCALE 1"=50'-0"	DESIGNED BY JEB	DATE 11/14/96	DRAWING TITLE FIGURE 6 SHALLOW BEDROCK GROUNDWATER ELEVATION
CONFIDENTIAL-ALL RIGHTS RESERVED-PROPERTY OF RADIAN ENGINEERING ROCHESTER, NEW YORK 14623	DRAWN BY KG	DATE 11/18/96	CAD DRAWING FILE: ERDLE102.DWG
	CHECKED BY JEB	DATE 11/20/96	CONTRACT NO. 705-013
	APPROVED BY	DATE	DRAWING NO. S-1.1b REV.

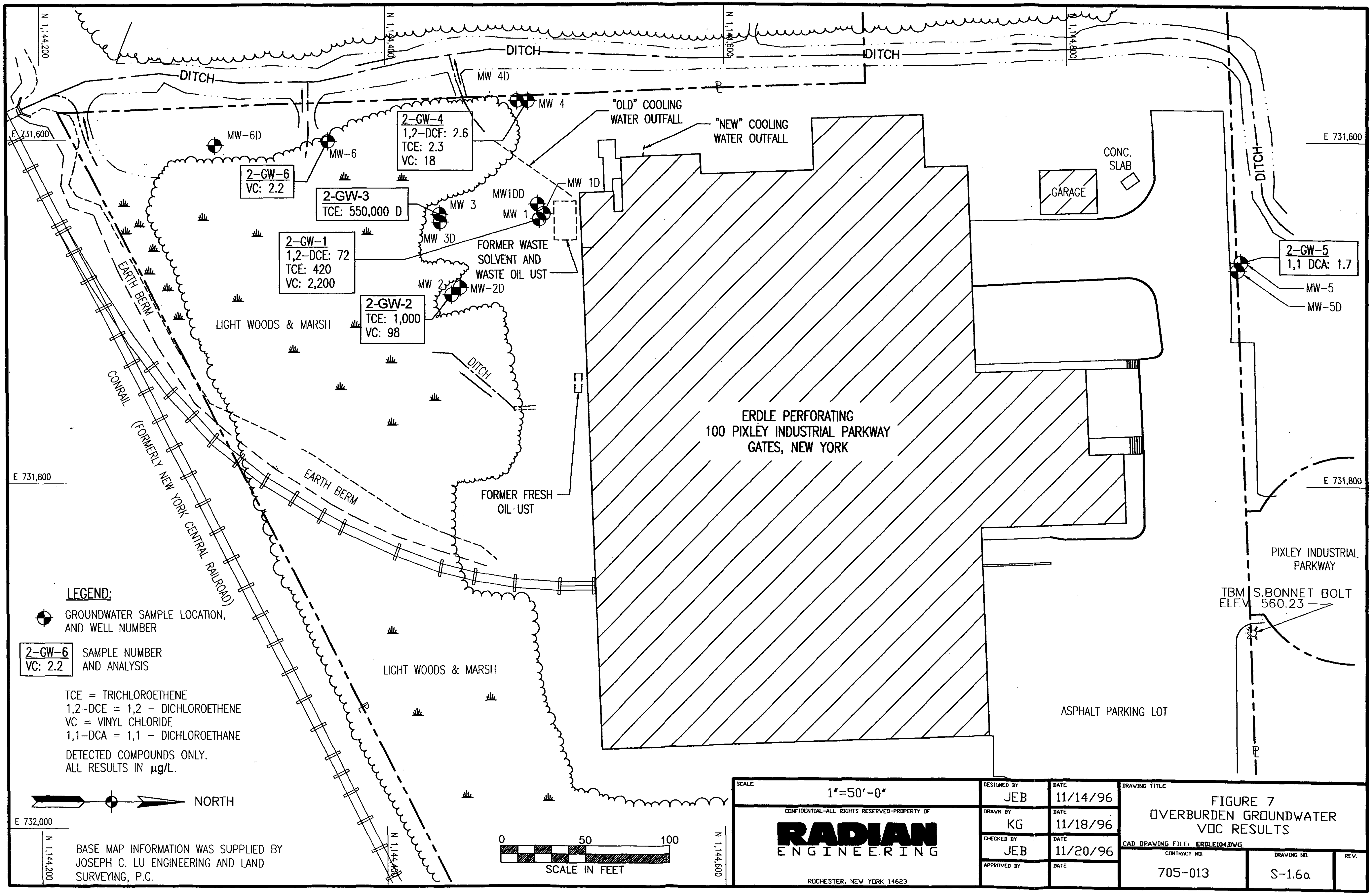
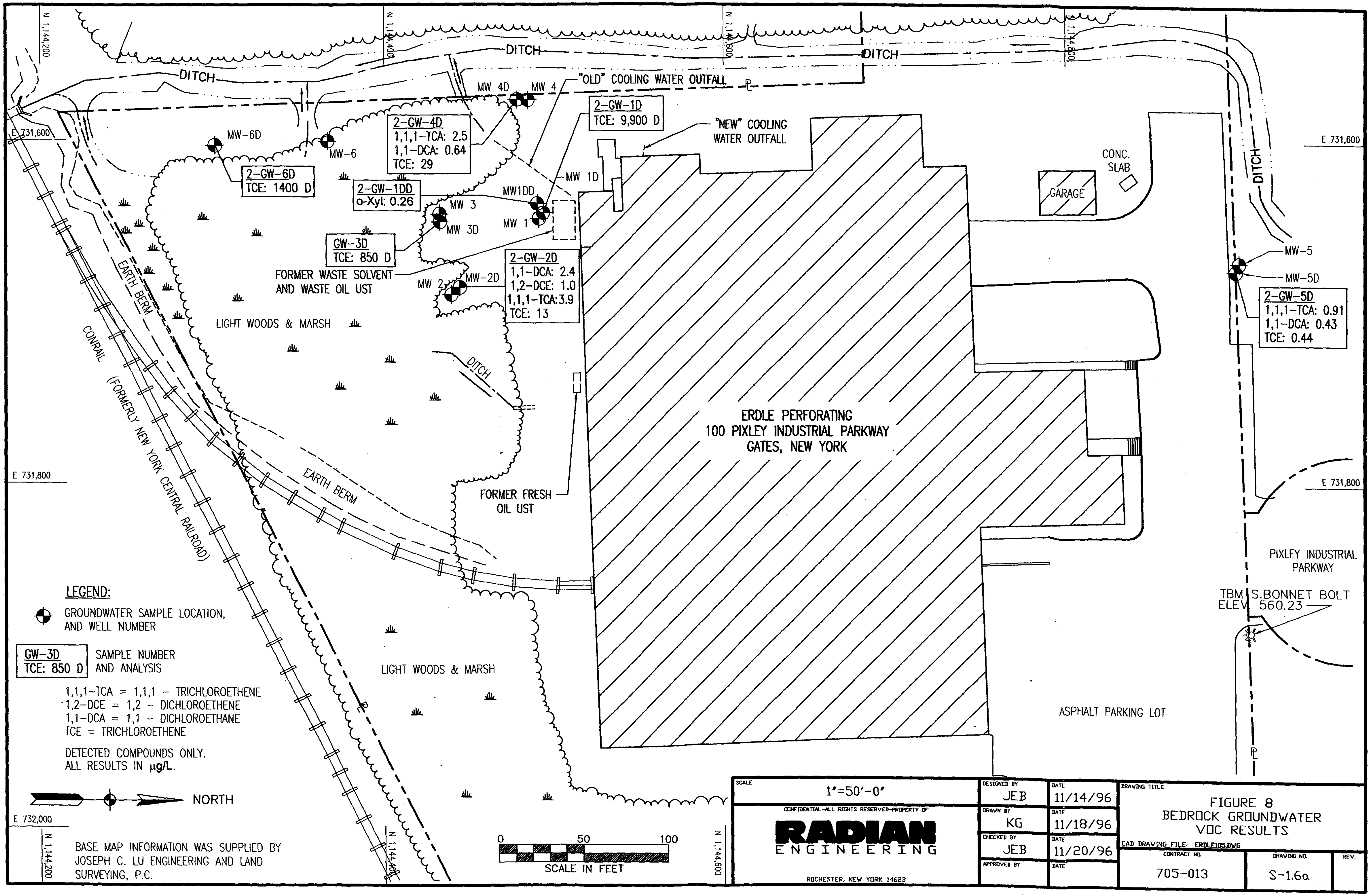


FIGURE 7
OVERBURDEN GROUNDWATER
VOC RESULTS



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DRAWING TITLE

FIGURE 8
BEDROCK GROUNDWATER
VOC RESULTS

CAD DRAWING FILE: ERDLE105.DWG

CONTRACT NO.	DRAWING NO.	REV.
705-013	S-1.6a	

APPENDIX C

DEVELOPMENT OF SOIL CLEANUP LEVELS

DEVELOPMENT OF SOIL CLEANUP LEVELS

ERDLE PERFORATING COMPANY SITE
TOWN OF GATES, NEW YORK

Prepared For:
Erdle Perforating

Prepared By:
Radian Engineering Inc.
Rochester, NY

May 1998

Table of Contents

APPENDICES

List of Tables

List of Figures

1.0 Introduction

The purpose of this report is to develop soil cleanup objectives for the Erdle Perforating Company Site located in the town of Gates, New York. The soil cleanup levels generated in this document are intended to be protective of local ground water so that groundwater concentrations at the fenceline downgradient (south) of the Erdle site meet State of New York groundwater standards. The cleanup levels were generated using guidance provided by New York State Department of Environmental Conservation (NYSDEC) and the U.S. EPA. The cleanup levels have been developed on the basis of site-specific groundwater data collected by Radian at the Erdle site.

The specific tasks included in the development of soil cleanup levels for the Erdle site are as follows:

1. Determine chemical-specific groundwater dilution/attenuation factors (DAFs) from the groundwater source to an assumed point of exposure (POE) 100 feet downgradient of the source. The projected groundwater concentrations at the POE are the New York State Groundwater Standards/Criteria published in the Division Technical and Administrative Guidance Memorandum: Determination of Soil Cleanup Objectives and Cleanup Levels, New York Department of Environmental Conservation, January, 1994. The New York State criteria for each constituent are listed in Table 1.
2. Calculate acceptable groundwater concentrations for each constituent at the source by means of the chemical-specific DAFs discussed in Step 1.
3. Calculate acceptable soil concentrations from the acceptable groundwater source concentrations described in Step 2 using New York State guidance. These acceptable soil concentrations are the recommended soil cleanup levels for the site.

Details of steps 1, 2 and 3 are provided in Sections 3.0, 4.0 and 5.0, respectively.

The risk assessment follows guidance provided in the following documents:

- Division Technical and Administrative Guidance Memorandum (TAGM): Determination of Soil Cleanup Objectives and Cleanup Levels, New York Department of Environmental Conservation, January 1994.
- Soil Screening Guidance, Technical Background Document, Office of Solid Waste and Emergency Response, USEPA, May 1996.
- RISKPRO Environmental Pollution Modeling System, General Sciences Corporation, 1994

- AT123D: Analytical Transient One-, Two, and Three-Dimensional Simulation of Waste Transport in the Aquifer System, U.S. EPA, June 4, 1985
- BIOSCREEN Natural Attenuation Decision Support System, USEPA, August 1996
- U.S. EPA Region III RBC Table, April 15, 1998

2.0 Constituents Of Concern (COCs)

The chemical constituents (COCs) evaluated in this report are constituents with soil concentrations greater than soil cleanup levels listed in Appendix C-1 (Table 1) of TAGM from samples collected in 1994 and 1997 (See Figure C-1). The purpose of this report is to develop alternate soil cleanup levels based on site-specific groundwater data. The COCs include the following organic compounds:

- 1,2-dichloroethene (Total)
- Methylene Chloride
- Trichloroethene
- Vinyl Chloride

3.0 Determination of Chemical-Specific Dilution/Attenuation Factors (DAFS) in the Saturated Zone

The U.S. EPA's Soil Screening Guidance describes dilution/attenuation factors (DAFs) as follows: "As contaminants in soil leachate move through soil and ground water, they are subjected to physical, chemical, and biological processes that tend to reduce the eventual contaminant concentration at the receptor point (i.e., drinking water well). These processes include adsorption onto soil and aquifer media, chemical transformation (e.g., hydrolysis, precipitation), biological degradation, and dilution due to mixing of the leachate with ambient ground water. The reduction in concentration can be expressed succinctly by a DAF, which is defined as the ratio of contaminant concentration in soil leachate to the concentration in ground water at the receptor point. When calculating Soil Screening Levels (SSLs), a DAF is used to backcalculate to the target soil leachate concentration from an acceptable ground water concentration (e.g., MCLG). For example, if the acceptable ground water concentration is 0.05 mg/L and the DAF is 10, the target leachate concentration would be 0.5 mg/L)".

For this report, the ratio of the acceptable groundwater concentration to the target leachate concentration was determined by means of the Analytical Transient 123 Dimensional Model (AT123D) of the RISKPRO Environmental Modeling System which used site-specific groundwater parameters to predict groundwater concentrations downgradient of the source. The AT123D model is used in risk assessments by the U.S. EPA to evaluate a chemical's behavior when released into a groundwater system. The model has also been used by a number of state environmental departments, including Louisiana, Mississippi, Wisconsin, Pennsylvania, Illinois, New Jersey, by other Federal government agencies, by large corporations, by environmental consulting firms, and by other national governments, such as Environment Canada. The AT123D model produces results which estimate chemical groundwater concentrations (mg/L) at times (days), distances (meters), and depths (meters) specified by the user.

Appendix C-1 provides printouts of the complete input and output data of the AT123D model.

The following sections present and discuss the data used in the AT123D model to estimate groundwater concentrations.

3.1 Groundwater Fate and Transport Data

Since the purpose of AT123D model is to predict groundwater concentrations, data which affect groundwater flow and contaminant movement in the saturated zone are required by the model. Among these are porosity of the saturated zone, hydraulic conductivity, hydraulic gradient, dispersivity, potential chemical decay or attenuation, density of soil and water, and the mass of each chemical entering the aquifer. The following are the default fate and transport parameters used by the AT123D model:

- Porosity of Saturated Zone - 0.30 (estimated)
- Hydraulic Conductivity – 3.4 x 10^{-5} cm/sec (site-specific measurement from Remedial Investigation)
- Hydraulic Gradient - 0.009 (site-specific measurement from monitoring well water level data)
- Longitudinal Dispersivity – 10 feet (calculated by ASTM approach, 0.1 x 100 ft (distance to receptor))
- Lateral Dispersivity – 3.3 feet (calculated by ASTM, 0.33 x longitudinal)
- Vertical Dispersivity – 0.5 feet (calculated by ASTM, 0.05 x longitudinal)
- Molecular Diffusion - No molecular diffusion was assumed.
- Dimensions of groundwater source – 25 m x 10 m ft x 3 m (80 x 30 x 10 ft^3)
- Decay Constant - The decay constant was set to zero, the model's default. This is considered as a conservative approach since it assumes that chemicals do not decay or are attenuated.

3.2 Mass Input into the AT123D Model

The AT123D model requires an initial chemical release rate in order to estimate groundwater concentrations. This rate is expressed in kg/hour and assumes a continuous release rate of chemicals into the saturated zone.

The mass input term assumes that the concentration of a constituent at the source is 1.0 mg/L (Since no chemical-specific decay or attenuation is assumed, this concentration is independent of the type of chemical being modeled. The concentration of 1 mg/L is used for modeling purposes to determine the dilution ratio). This concentration is multiplied by the site-specific volumetric flow rate through the source of 3.9 x 10^{-3} m^3/day.

The following is the calculation of the mass loading rate:

$$1.0\ \mathrm{mg/L} \times 3.9 \times 10^{-3}\ \mathrm{m^3/day} \times 1{,}000\ \mathrm{L/m^3} \times 10^{-6}\ \mathrm{kg/mg} \times 1\ \mathrm{day/24\ hour} = 1.63 \times 10^{-7}\ \mathrm{kg/hour}$$

from where?

For this report, the highest concentration predicted by the model (See Appendix A) along the centerline from the source to 20 meters (60 ft) feet downgradient were used to conservatively estimate ~~the dilution~~ ratio. The ratio of the source to the downgradient concentration is 1 mg/L / 8.52×10^{-4} mg/L = 1,100. The value of 1,100 is then used to estimate the acceptable groundwater concentration at the source so that concentrations at the POE meet State of New York groundwater standards.

3.3 Model Confirmation

The results of the AT123D Model were confirmed by another groundwater model, the U.S. EPA's Bioscreen Model. The Bioscreen model was run for 1,2-DCE, methylene chloride, TCE and vinyl chloride and the ratios generated by the Bioscreen modeling ranged from approximately 750 to 2,000, which are in the range of the dilutions produced by the AT123D Model. The input and output data for the Bioscreen Model are included in Appendix C-2.

4.0 Calculation of Acceptable Groundwater Concentrations at the Source

Acceptable groundwater concentrations at the source are concentrations in onsite ground water expected to be protective of potential downgradient receptors. These concentrations are determined by backcalculating from acceptable concentrations at the point of exposure (POE) using the DAFs discussed in Section 3.0. The acceptable concentrations at the POE are the New York State Groundwater Standards listed in TAGM. For the COCs at the Erdle site these Standards are as follows:

NYSDEC Groundwater Standards

1,2-Dichloroethene –	0.005 mg/L
Methylene chloride –	0.005 mg/L
Trichloroethene –	0.005 mg/L
Vinyl Chloride -	0.002 mg/L

Multiplying the NYSDEC Standards by the groundwater DAF (1,100) gives:

Acceptable GW Concentrations at the Source

1,2-Dichloroethene –	5.5 mg/L
Methylene chloride –	5.5 mg/L
Trichloroethene –	5.5 mg/L
Vinyl Chloride –	2.2 mg/L

The groundwater source is considered to be in the saturated zone directly beneath the onsite soil from which the COCs have migrated by leaching.

5.0 Calculation of Soil Cleanup Objectives from the Acceptable Groundwater Source Concentrations

This section describes the methodologies employed in estimating soil cleanup levels for the Erdle Perforating facility. The procedures used follow the guidance of TAGM for converting groundwater concentrations to acceptable soil cleanup concentrations. Part B of TAGM guidance states: "When the contaminated soil is in the unsaturated zone above the water table, many mechanisms are at work that prevent all of the contamination that would leave the contaminated soil from impacting groundwater. These mechanisms occur during transport and may work simultaneously. They include the following: (1) volatility, (2) sorption and desorption, (3) leaching and diffusion, (4) transformation and degradation, (5) change in concentration of contaminants after reaching and/or mixing with the groundwater surface. To account for these mechanisms, a correction factor of 100 is used to establish soil cleanup objectives. The value of 100 for the correction is consistent with the logic used by EPA in its Dilution Attenuation Factor (DAF) approach for EP Toxicity and TCLP. (Federal Register/Vol. 55, No. 61, March 29, 1990/Pages 11826-27). Soil cleanup objectives are calculated by multiplying the allowable soil concentration by the attenuation factor".

The correction factor of 100 recommended in TAGM is assumed to be included in the DAF calculated in Section 3.0 and is not used to calculate the cleanup objectives for the Erdle facility.

The determination of soil cleanup levels for the Erdle site involves the following:

1. Calculation of an Allowable Soil Concentration as prescribed in Part A of TAGM. According to the following formula given in Part A of TAGM:

Allowable Soil Concentration (Cs) = foc x Koc x Cw

Where:

foc = fraction of organic carbon of the natural soil medium
Koc = partition coefficient between water and soil media
Cw = the acceptable water concentration at the source (Section 4.0)

The value of foc used in this report is 0.01 which is the value recommended by TAGM if the actual organic carbon content of the soil is not known. The values of Koc are chemical-specific and are given in Appendix A of TAGM (See Table 1 of this Report).

Allowable Soil Concentrations

1,2-Dichloroethene –	3.2 mg/kg
Methylene chloride –	1.2 mg/kg
Trichloroethene –	6.9 mg/kg
Vinyl Chloride –	1.3 mg/kg

2. The final step in determining soil cleanup levels for the Erdle facility is to compare the Allowable Soil Concentrations calculated in Step 1 with health-based criteria for direct exposure to constituents in soil. These criteria are designed to be protective of persons who may be directly exposed to COCs in soil by ingestion, dermal absorption and inhalation. The direct contact criteria used in this report are provided in Appendix C-1, Table 1 of TAGM. TAGM does not provide a direct contact value for vinyl chloride. Therefore, the health-based soil value for vinyl chloride (0.34 mg/kg) was obtained from the U.S. EPA Region III's Risk-Based Concentration Tables (4/15/98). The health-based soil concentrations are then compared to the Allowable Soil Concentrations calculated in Step 2 and the lower concentration is the Recommended Soil Cleanup Objective. From this comparison, the Recommended Soil Cleanup Objectives for the Erdle site which are protective of direct contact exposures and ground water are:

Recommend Soil Cleanup Objectives for Erdle Perforating Site

1,2-Dichloroethene –	3.2 mg/kg
Methylene chloride –	1.2 mg/kg
Trichloroethene –	6.9 mg/kg
Vinyl Chloride –	0.34 mg/kg

The calculations and data used in calculating the cleanup objectives are provided in Table 1.

TABLES

Table 1. Calculation of Soil Cleanup Objectives

	Cw NYDEP GW Standard (mg/L)	DAF (GW) Dilution from GW source to POE (ratio)[a]	Acceptable Groundwater Concentration at Source[b] (mg/L)	Koc (L/kg)	foc (1%)	Kd (L/kg)	Soil Cleanup Level for Groundwater Protection[c] (mg/kg)	Soil Cleanup Level for Direct Contact[d] (mg/kg)	Recommended Soil Cleanup Objective (mg/kg)
1,2-Dichloroethene (Total)	0.005	1,100	5.50	59	0.01	0.59	3.2	2000	3.2
Methylene Chloride	0.005	1,100	5.50	21	0.01	0.21	1.2	93	1.2
Trichloroethene	0.005	1,100	5.50	126	0.01	1.26	6.9	64	6.9
Vinyl Chloride	0.002	1,100	2.20	57	0.01	0.57	1.3	0.34	0.34

(a) - from Bioscreen Model
(b) - NYDEP GW Standard x DAF
Kd = Soil-Water Partition Coefficient (L/kg) = Koc x foc
Koc = Soil Organic Carbon/Water Partition Coefficient (L/kg)
foc = fraction of organic carbon in soil above water table = 0.01
(c) - (GW at source) x Kd
(d) - Risk-based level for direct contact with soil (TAGM)

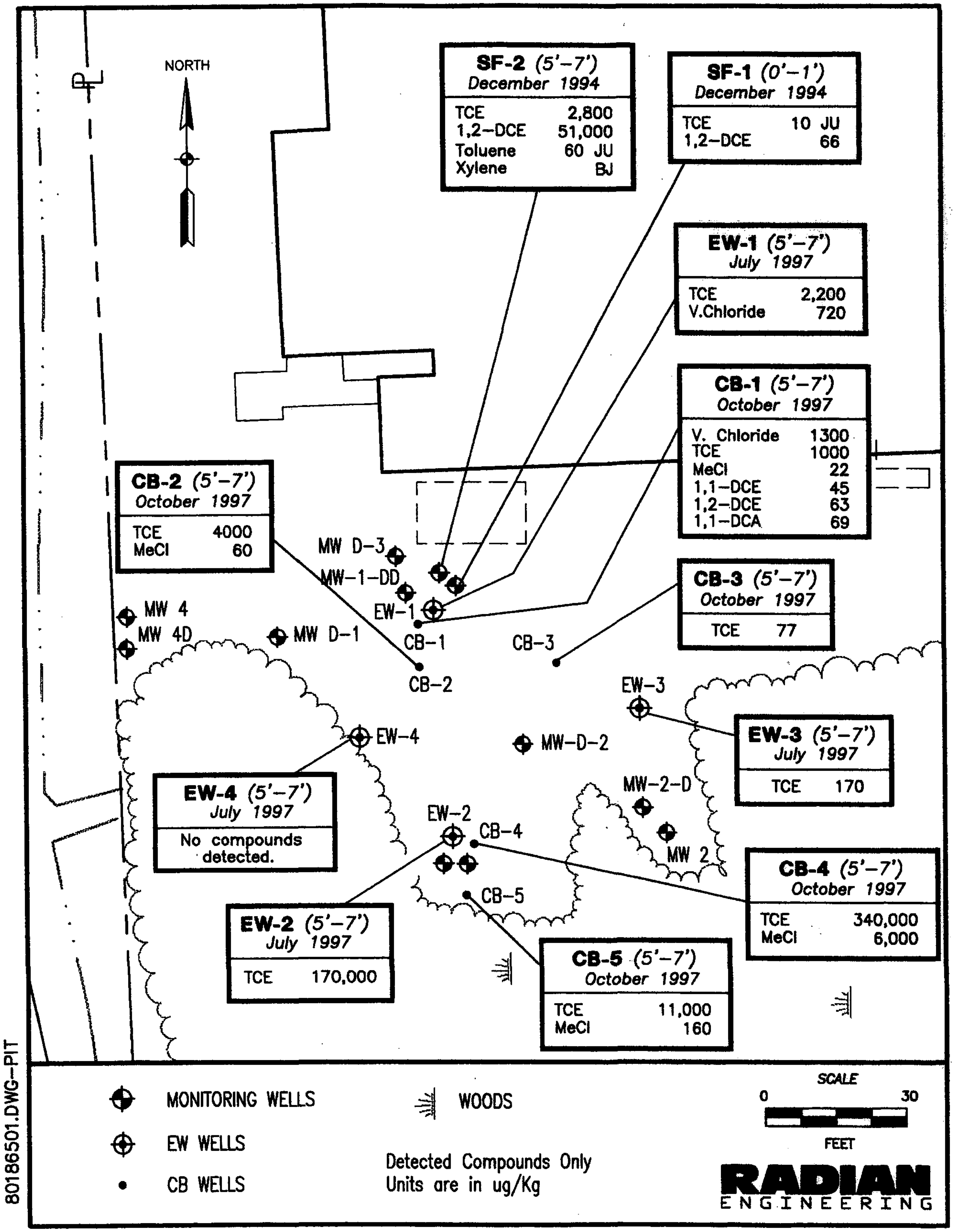

Figure C-1: Current Subsurface Soil Concentrations in Excess of NYSDEC TAGM 4046 Criteria

APPENDIX C-1

AT123D MODEL INPUT AND OUTPUT DATA

```
Erdle Perforating
AT087- Based on 1 mg/L GW source concentration


NO. OF POINTS IN X-DIRECTION .......................    6
NO. OF POINTS IN Y-DIRECTION .......................    5
NO. OF POINTS IN Z-DIRECTION .......................    5
NO. OF ROOTS: NO. OF SERIES TERMS .................  400
NO. OF BEGINNING TIME STEP .........................    2
NO. OF ENDING TIME STEP ............................   13
NO. OF TIME INTERVALS FOR PRINTED OUT SOLUTION ....    1
INSTANTANEOUS SOURCE CONTROL = 0 FOR INSTANT SOURCE    1
SOURCE CONDITION CONTROL = 0 FOR STEADY SOURCE ....    0
INTERMITTENT OUTPUT CONTROL = 0 NO SUCH OUTPUT ....    1
CASE CONTROL =1 THERMAL, = 2 FOR CHEMICAL, = 3 RAD     2


AQUIFER DEPTH, = 0.0 FOR INFINITE DEEP (METERS) ...  0.1000E+03
AQUIFER WIDTH, = 0.0 FOR INFINITE WIDE (METERS) ...  0.5000E+04
BEGIN POINT OF X-SOURCE LOCATION (METERS) ......... -0.1250E+02
END POINT OF X-SOURCE LOCATION (METERS) ...........  0.1250E+02
BEGIN POINT OF Y-SOURCE LOCATION (METERS) ......... -0.5000E+01
END POINT OF Y-SOURCE LOCATION (METERS) ...........  0.5000E+01
BEGIN POINT OF Z-SOURCE LOCATION (METERS) .........  0.0000E+00
END POINT OF Z-SOURCE LOCATION (METERS) ...........  0.1500E+01


POROSITY ..........................................  0.3000E+00
HYDRAULIC CONDUCTIVITY (METER/HOUR) ...............  0.1230E-02
HYDRAULIC GRADIENT ................................  0.9000E-02
LONGITUDINAL DISPERSIVITY (METER) .................  0.3050E+01
LATERAL DISPERSIVITY (METER) ......................  0.1000E+01
VERTICAL DISPERSIVITY (METER) .....................  0.1500E+00
DISTRIBUTION COEFFICIENT, KD (M**3/KG) ............  0.0000E+00
HEAT EXCHANGE COEFFICIENT (KCAL/HR-M**2-DEGREE C)..  0.0000E+00


MOLECULAR DIFFUSION MULTIPLY BY POROSITY (M**2/HR)   0.0000E+00
DECAY CONSTANT (PER HOUR) .........................  0.0000E+00
BULK DENSITY OF THE SOIL (KG/M**3) ................  0.1922E+04
ACCURACY TOLERANCE FOR REACHING STEADY STATE ......  0.1000E-01
DENSITY OF WATER (KG/M**3) ........................  0.1000E+04
TIME INTERVAL SIZE FOR THE DESIRED SOLUTION (HR) ..  0.2190E+05
DISCHARGE TIME (HR) ...............................  0.2628E+06
WASTE RELEASE RATE (KCAL/HR), (KG/HR), OR (CI/HR) .  0.1630E-06


RETARDATION FACTOR ................................  0.1000E+01
RETARDED DARCY VELOCITY (M/HR) ....................  0.3690E-04
RETARDED LONGITUDINAL DISPERSION COEF. (M**2/HR) ..  0.1125E-03
RETARDED LATERAL DISPERSION COEFFICIENT (M**2/HR) .  0.3690E-04
RETARDED VERTICAL DISPERSION COEFFICIENT (M**2/HR).  0.5535E-05







DISTRIBUTION OF DISSOLVED CHEMICALS IN PPM AT  0.0000E+00 HRS
  (ADSORBED CHEMICAL CONC. =   0.0000E+00 * DISSOLVED CHEMICAL CONC.)


                Z =        0.00
                                                      X
  Y          0.         10.         20.         30.         40.         50.


200.   0.000E+00   0.000E+00   0.000E+00   0.000E+00   0.000E+00   0.000E+00
```

```
  100.  0.000E+00  0.000E+00  0.000E+00  0.000E+00  0.000E+00  0.000E+00
    0.  0.000E+00  0.000E+00  0.000E+00  0.000E+00  0.000E+00  0.000E+00
 -100.  0.000E+00  0.000E+00  0.000E+00  0.000E+00  0.000E+00  0.000E+00
 -200.  0.000E+00  0.000E+00  0.000E+00  0.000E+00  0.000E+00  0.000E+00


                    Z =       5.00
                                                         X
    Y          0.         10.         20.         30.         40.        50.


  200.  0.000E+00  0.000E+00  0.000E+00  0.000E+00  0.000E+00  0.000E+00
  100.  0.000E+00  0.000E+00  0.000E+00  0.000E+00  0.000E+00  0.000E+00
    0.  0.000E+00  0.000E+00  0.000E+00  0.000E+00  0.000E+00  0.000E+00
 -100.  0.000E+00  0.000E+00  0.000E+00  0.000E+00  0.000E+00  0.000E+00
 -200.  0.000E+00  0.000E+00  0.000E+00  0.000E+00  0.000E+00  0.000E+00


                    Z =      10.00
                                                         X
    Y          0.         10.         20.         30.         40.        50.


  200.  0.000E+00  0.000E+00  0.000E+00  0.000E+00  0.000E+00  0.000E+00
  100.  0.000E+00  0.000E+00  0.000E+00  0.000E+00  0.000E+00  0.000E+00
    0.  0.000E+00  0.000E+00  0.000E+00  0.000E+00  0.000E+00  0.000E+00
 -100.  0.000E+00  0.000E+00  0.000E+00  0.000E+00  0.000E+00  0.000E+00
 -200.  0.000E+00  0.000E+00  0.000E+00  0.000E+00  0.000E+00  0.000E+00


                    Z =      15.00
                                                         X
    Y          0.         10.         20.         30.         40.        50.


  200.  0.000E+00  0.000E+00  0.000E+00  0.000E+00  0.000E+00  0.000E+00
  100.  0.000E+00  0.000E+00  0.000E+00  0.000E+00  0.000E+00  0.000E+00
    0.  0.000E+00  0.000E+00  0.000E+00  0.000E+00  0.000E+00  0.000E+00
 -100.  0.000E+00  0.000E+00  0.000E+00  0.000E+00  0.000E+00  0.000E+00
 -200.  0.000E+00  0.000E+00  0.000E+00  0.000E+00  0.000E+00  0.000E+00


                    Z =      20.00
                                                         X
    Y          0.         10.         20.         30.         40.        50.


  200.  0.000E+00  0.000E+00  0.000E+00  0.000E+00  0.000E+00  0.000E+00
  100.  0.000E+00  0.000E+00  0.000E+00  0.000E+00  0.000E+00  0.000E+00
    0.  0.000E+00  0.000E+00  0.000E+00  0.000E+00  0.000E+00  0.000E+00
 -100.  0.000E+00  0.000E+00  0.000E+00  0.000E+00  0.000E+00  0.000E+00
 -200.  0.000E+00  0.000E+00  0.000E+00  0.000E+00  0.000E+00  0.000E+00




     DISTRIBUTION OF DISSOLVED CHEMICALS IN PPM AT  0.2190E+05 HRS
       (ADSORBED CHEMICAL CONC. =   0.0000E+00 * DISSOLVED CHEMICAL CONC.)


                    Z =       0.00
                                                         X
    Y          0.         10.         20.         30.         40.        50.


  200.  0.347E-03  0.323E-03  0.447E-06  0.000E+00  0.000E+00  0.000E+00
  100.  0.419E-03  0.391E-03  0.541E-06  0.000E+00  0.000E+00  0.000E+00
    0.  0.447E-03  0.417E-03  0.576E-06  0.000E+00  0.000E+00  0.000E+00
```

```
 -100.   0.419E-03   0.391E-03   0.541E-06   0.000E+00   0.000E+00   0.000E+00
 -200.   0.285E-03   0.266E-03   0.368E-06   0.000E+00   0.000E+00   0.000E+00


                    Z =       5.00
                                                                X
   Y          0.         10.         20.         30.         40.         50.


  200.   0.886E-08   0.825E-08   0.114E-10   0.000E+00   0.000E+00   0.000E+00
  100.   0.107E-07   0.998E-08   0.138E-10   0.000E+00   0.000E+00   0.000E+00
    0.   0.114E-07   0.106E-07   0.147E-10   0.000E+00   0.000E+00   0.000E+00
 -100.   0.107E-07   0.998E-08   0.138E-10   0.000E+00   0.000E+00   0.000E+00
 -200.   0.729E-08   0.679E-08   0.939E-11   0.000E+00   0.000E+00   0.000E+00


                    Z =      10.00
                                                                X
   Y          0.         10.         20.         30.         40.         50.


  200.  -0.480E-08  -0.447E-08  -0.619E-11   0.000E+00   0.000E+00   0.000E+00
  100.  -0.581E-08  -0.541E-08  -0.748E-11   0.000E+00   0.000E+00   0.000E+00
    0.  -0.619E-08  -0.577E-08  -0.797E-11   0.000E+00   0.000E+00   0.000E+00
 -100.  -0.581E-08  -0.541E-08  -0.748E-11   0.000E+00   0.000E+00   0.000E+00
 -200.  -0.395E-08  -0.368E-08  -0.509E-11   0.000E+00   0.000E+00   0.000E+00


                    Z =      15.00
                                                                X
   Y          0.         10.         20.         30.         40.         50.


  200.  -0.236E-08  -0.220E-08  -0.305E-11   0.000E+00   0.000E+00   0.000E+00
  100.  -0.286E-08  -0.266E-08  -0.369E-11   0.000E+00   0.000E+00   0.000E+00
    0.  -0.305E-08  -0.284E-08  -0.393E-11   0.000E+00   0.000E+00   0.000E+00
 -100.  -0.286E-08  -0.266E-08  -0.369E-11   0.000E+00   0.000E+00   0.000E+00
 -200.  -0.194E-08  -0.181E-08  -0.251E-11   0.000E+00   0.000E+00   0.000E+00


                    Z =      20.00
                                                                X
   Y          0.         10.         20.         30.         40.         50.


  200.  -0.729E-09  -0.679E-09  -0.939E-12   0.000E+00   0.000E+00   0.000E+00
  100.  -0.881E-09  -0.821E-09  -0.114E-11   0.000E+00   0.000E+00   0.000E+00
    0.  -0.939E-09  -0.875E-09  -0.121E-11   0.000E+00   0.000E+00   0.000E+00
 -100.  -0.881E-09  -0.821E-09  -0.114E-11   0.000E+00   0.000E+00   0.000E+00
 -200.  -0.599E-09  -0.559E-09  -0.773E-12   0.000E+00   0.000E+00   0.000E+00




     DISTRIBUTION OF DISSOLVED CHEMICALS IN PPM AT  0.4380E+05 HRS
       (ADSORBED CHEMICAL CONC. =    0.0000E+00 * DISSOLVED CHEMICAL CONC.)


                    Z =       0.00
                                                                X
   Y          0.         10.         20.         30.         40.         50.


  200.   0.111E-02   0.103E-02   0.672E-05   0.324E-10   0.000E+00   0.000E+00
  100.   0.132E-02   0.122E-02   0.752E-05   0.357E-10   0.000E+00   0.000E+00
    0.   0.140E-02   0.130E-02   0.781E-05   0.368E-10   0.000E+00   0.000E+00
 -100.   0.132E-02   0.122E-02   0.752E-05   0.357E-10   0.000E+00   0.000E+00
 -200.   0.942E-03   0.873E-03   0.651E-05   0.324E-10   0.000E+00   0.000E+00
```

```
                    Z =        5.00
                                                                   X
   Y           0.          10.          20.          30.          40.          50.


  200.   0.263E-07   0.245E-07   0.114E-09   0.488E-15   0.000E+00   0.000E+00
  100.   0.316E-07   0.293E-07   0.128E-09   0.537E-15   0.000E+00   0.000E+00
    0.   0.335E-07   0.312E-07   0.134E-09   0.554E-15   0.000E+00   0.000E+00
 -100.   0.316E-07   0.293E-07   0.128E-09   0.537E-15   0.000E+00   0.000E+00
 -200.   0.222E-07   0.206E-07   0.108E-09   0.488E-15   0.000E+00   0.000E+00


                    Z =       10.00
                                                                   X
   Y           0.          10.          20.          30.          40.          50.


  200.  -0.135E-07  -0.126E-07  -0.381E-10  -0.127E-15   0.000E+00   0.000E+00
  100.  -0.163E-07  -0.151E-07  -0.438E-10  -0.140E-15   0.000E+00   0.000E+00
    0.  -0.173E-07  -0.161E-07  -0.458E-10  -0.144E-15   0.000E+00   0.000E+00
 -100.  -0.163E-07  -0.151E-07  -0.438E-10  -0.140E-15   0.000E+00   0.000E+00
 -200.  -0.112E-07  -0.105E-07  -0.352E-10  -0.127E-15   0.000E+00   0.000E+00


                    Z =       15.00
                                                                   X
   Y           0.          10.          20.          30.          40.          50.


  200.  -0.322E-08  -0.308E-08   0.858E-10   0.551E-15   0.000E+00   0.000E+00
  100.  -0.423E-08  -0.404E-08   0.935E-10   0.606E-15   0.000E+00   0.000E+00
    0.  -0.462E-08  -0.440E-08   0.962E-10   0.626E-15   0.000E+00   0.000E+00
 -100.  -0.423E-08  -0.404E-08   0.935E-10   0.606E-15   0.000E+00   0.000E+00
 -200.  -0.210E-08  -0.204E-08   0.873E-10   0.551E-15   0.000E+00   0.000E+00


                    Z =       20.00
                                                                   X
   Y           0.          10.          20.          30.          40.          50.


  200.  -0.199E-08  -0.186E-08  -0.409E-11  -0.932E-17   0.000E+00   0.000E+00
  100.  -0.241E-08  -0.224E-08  -0.478E-11  -0.102E-16   0.000E+00   0.000E+00
    0.  -0.256E-08  -0.239E-08  -0.503E-11  -0.106E-16   0.000E+00   0.000E+00
 -100.  -0.241E-08  -0.224E-08  -0.478E-11  -0.102E-16   0.000E+00   0.000E+00
 -200.  -0.165E-08  -0.154E-08  -0.365E-11  -0.932E-17   0.000E+00   0.000E+00




    DISTRIBUTION OF DISSOLVED CHEMICALS IN PPM AT  0.6570E+05 HRS
      (ADSORBED CHEMICAL CONC. =    0.0000E+00 * DISSOLVED CHEMICAL CONC.)


                    Z =        0.00
                                                                   X
   Y           0.          10.          20.          30.          40.          50.


  200.   0.145E-02   0.133E-02   0.368E-04   0.672E-08   0.000E+00   0.000E+00
  100.   0.166E-02   0.152E-02   0.401E-04   0.716E-08   0.000E+00   0.000E+00
    0.   0.173E-02   0.159E-02   0.412E-04   0.732E-08   0.000E+00   0.000E+00
 -100.   0.166E-02   0.152E-02   0.401E-04   0.716E-08   0.000E+00   0.000E+00
 -200.   0.135E-02   0.123E-02   0.367E-04   0.672E-08   0.000E+00   0.000E+00


                    Z =        5.00
```

```
                                                            X
  Y          0.         10.         20.         30.         40.         50.


 200.   0.301E-07   0.276E-07   0.765E-09   0.197E-12   0.000E+00   0.000E+00
 100.   0.346E-07   0.317E-07   0.829E-09   0.210E-12   0.000E+00   0.000E+00
   0.   0.362E-07   0.333E-07   0.852E-09   0.215E-12   0.000E+00   0.000E+00
-100.   0.346E-07   0.317E-07   0.829E-09   0.210E-12   0.000E+00   0.000E+00
-200.   0.275E-07   0.252E-07   0.761E-09   0.197E-12   0.000E+00   0.000E+00


                  Z =       10.00
                                                            X
  Y          0.         10.         20.         30.         40.         50.


 200.  -0.114E-07  -0.105E-07  -0.145E-09  -0.234E-13   0.000E+00   0.000E+00
 100.  -0.134E-07  -0.123E-07  -0.159E-09  -0.249E-13   0.000E+00   0.000E+00
   0.  -0.141E-07  -0.130E-07  -0.164E-09  -0.255E-13   0.000E+00   0.000E+00
-100.  -0.134E-07  -0.123E-07  -0.159E-09  -0.249E-13   0.000E+00   0.000E+00
-200.  -0.994E-08  -0.917E-08  -0.143E-09  -0.234E-13   0.000E+00   0.000E+00


                  Z =       15.00
                                                            X
  Y          0.         10.         20.         30.         40.         50.


 200.   0.869E-08   0.776E-08   0.398E-09   0.153E-13   0.000E+00   0.000E+00
 100.   0.911E-08   0.812E-08   0.437E-09   0.164E-13   0.000E+00   0.000E+00
   0.   0.924E-08   0.823E-08   0.450E-09   0.168E-13   0.000E+00   0.000E+00
-100.   0.911E-08   0.812E-08   0.437E-09   0.164E-13   0.000E+00   0.000E+00
-200.   0.938E-08   0.841E-08   0.399E-09   0.153E-13   0.000E+00   0.000E+00


                  Z =       20.00
                                                            X
  Y          0.         10.         20.         30.         40.         50.


 200.  -0.134E-08  -0.125E-08  -0.455E-12   0.349E-14   0.000E+00   0.000E+00
 100.  -0.161E-08  -0.150E-08  -0.928E-12   0.372E-14   0.000E+00   0.000E+00
   0.  -0.172E-08  -0.159E-08  -0.111E-11   0.380E-14   0.000E+00   0.000E+00
-100.  -0.161E-08  -0.150E-08  -0.928E-12   0.372E-14   0.000E+00   0.000E+00
-200.  -0.113E-08  -0.105E-08  -0.178E-12   0.349E-14   0.000E+00   0.000E+00




    DISTRIBUTION OF DISSOLVED CHEMICALS IN PPM AT  0.8760E+05 HRS
      (ADSORBED CHEMICAL CONC. =    0.0000E+00 * DISSOLVED CHEMICAL CONC.)


                  Z =        0.00
                                                            X
  Y          0.         10.         20.         30.         40.         50.


 200.   0.200E-02   0.184E-02   0.888E-04   0.108E-06   0.000E+00   0.000E+00
 100.   0.228E-02   0.209E-02   0.948E-04   0.113E-06   0.000E+00   0.000E+00
   0.   0.238E-02   0.219E-02   0.969E-04   0.115E-06   0.000E+00   0.000E+00
-100.   0.228E-02   0.209E-02   0.948E-04   0.113E-06   0.000E+00   0.000E+00
-200.   0.184E-02   0.169E-02   0.886E-04   0.108E-06   0.000E+00   0.000E+00


                  Z =        5.00
                                                            X
  Y          0.         10.         20.         30.         40.         50.
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  200.   0.731E-07  0.671E-07  0.638E-08  0.185E-10  0.000E+00  0.000E+00
  100.   0.810E-07  0.745E-07  0.673E-08  0.194E-10  0.000E+00  0.000E+00
    0.   0.840E-07  0.772E-07  0.685E-08  0.197E-10  0.000E+00  0.000E+00
 -100.   0.810E-07  0.745E-07  0.673E-08  0.194E-10  0.000E+00  0.000E+00
 -200.   0.689E-07  0.632E-07  0.637E-08  0.185E-10  0.000E+00  0.000E+00


                  Z =       10.00
                                                               X
    Y          0.         10.         20.         30.         40.         50.


  200.  -0.165E-07 -0.153E-07 -0.291E-09 -0.241E-12  0.000E+00  0.000E+00
  100.  -0.195E-07 -0.180E-07 -0.314E-09 -0.254E-12  0.000E+00  0.000E+00
    0.  -0.206E-07 -0.191E-07 -0.322E-09 -0.259E-12  0.000E+00  0.000E+00
 -100.  -0.195E-07 -0.180E-07 -0.314E-09 -0.254E-12  0.000E+00  0.000E+00
 -200.  -0.142E-07 -0.132E-07 -0.289E-09 -0.241E-12  0.000E+00  0.000E+00


                  Z =       15.00
                                                               X
    Y          0.         10.         20.         30.         40.         50.


  200.   0.929E-09  0.670E-09  0.271E-09 -0.238E-13  0.000E+00  0.000E+00
  100.   0.294E-09  0.599E-10  0.294E-09 -0.240E-13  0.000E+00  0.000E+00
    0.   0.379E-10 -0.185E-09  0.302E-09 -0.241E-13  0.000E+00  0.000E+00
 -100.   0.294E-09  0.599E-10  0.294E-09 -0.240E-13  0.000E+00  0.000E+00
 -200.   0.205E-08  0.171E-08  0.272E-09 -0.238E-13  0.000E+00  0.000E+00


                  Z =       20.00
                                                               X
    Y          0.         10.         20.         30.         40.         50.


  200.  -0.184E-08 -0.172E-08  0.508E-11 -0.603E-13  0.000E+00  0.000E+00
  100.  -0.224E-08 -0.210E-08  0.527E-11 -0.631E-13  0.000E+00  0.000E+00
    0.  -0.240E-08 -0.224E-08  0.532E-11 -0.640E-13  0.000E+00  0.000E+00
 -100.  -0.224E-08 -0.210E-08  0.527E-11 -0.631E-13  0.000E+00  0.000E+00
 -200.  -0.150E-08 -0.140E-08  0.553E-11 -0.603E-13  0.000E+00  0.000E+00




       DISTRIBUTION OF DISSOLVED CHEMICALS IN PPM AT  0.1095E+06 HRS
         (ADSORBED CHEMICAL CONC. =   0.0000E+00 * DISSOLVED CHEMICAL CONC.)


                  Z =        0.00
                                                               X
    Y          0.         10.         20.         30.         40.         50.


  200.   0.219E-02  0.201E-02  0.160E-03  0.694E-06  0.120E-09  0.000E+00
  100.   0.243E-02  0.223E-02  0.169E-03  0.725E-06  0.125E-09  0.000E+00
    0.   0.252E-02  0.231E-02  0.172E-03  0.735E-06  0.126E-09  0.000E+00
 -100.   0.243E-02  0.223E-02  0.169E-03  0.725E-06  0.125E-09  0.000E+00
 -200.   0.209E-02  0.191E-02  0.160E-03  0.694E-06  0.120E-09  0.000E+00


                  Z =        5.00
                                                               X
    Y          0.         10.         20.         30.         40.         50.
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  200.   0.231E-06   0.215E-06   0.425E-07   0.391E-09   0.108E-12   0.000E+00
  100.   0.245E-06   0.228E-06   0.443E-07   0.407E-09   0.112E-12   0.000E+00
    0.   0.249E-06   0.232E-06   0.450E-07   0.412E-09   0.114E-12   0.000E+00
 -100.   0.245E-06   0.228E-06   0.443E-07   0.407E-09   0.112E-12   0.000E+00
 -200.   0.229E-06   0.213E-06   0.425E-07   0.391E-09   0.108E-12   0.000E+00


                    Z =       10.00
                                                                X
   Y             0.          10.          20.          30.          40.          50.


  200.  -0.125E-07  -0.115E-07  -0.281E-09   0.268E-12   0.308E-15   0.000E+00
  100.  -0.146E-07  -0.134E-07  -0.303E-09   0.271E-12   0.320E-15   0.000E+00
    0.  -0.153E-07  -0.142E-07  -0.310E-09   0.272E-12   0.324E-15   0.000E+00
 -100.  -0.146E-07  -0.134E-07  -0.303E-09   0.271E-12   0.320E-15   0.000E+00
 -200.  -0.111E-07  -0.102E-07  -0.279E-09   0.268E-12   0.308E-15   0.000E+00


                    Z =       15.00
                                                                X
   Y             0.          10.          20.          30.          40.          50.


  200.   0.840E-08   0.749E-08   0.316E-09  -0.704E-12  -0.143E-15   0.000E+00
  100.   0.881E-08   0.784E-08   0.351E-09  -0.734E-12  -0.148E-15   0.000E+00
    0.   0.894E-08   0.795E-08   0.364E-09  -0.744E-12  -0.150E-15   0.000E+00
 -100.   0.881E-08   0.784E-08   0.351E-09  -0.734E-12  -0.148E-15   0.000E+00
 -200.   0.910E-08   0.814E-08   0.317E-09  -0.704E-12  -0.143E-15   0.000E+00


                    Z =       20.00
                                                                X
   Y             0.          10.          20.          30.          40.          50.


  200.  -0.172E-08  -0.160E-08  -0.723E-10  -0.333E-12  -0.141E-16   0.000E+00
  100.  -0.201E-08  -0.186E-08  -0.761E-10  -0.348E-12  -0.147E-16   0.000E+00
    0.  -0.212E-08  -0.196E-08  -0.775E-10  -0.354E-12  -0.148E-16   0.000E+00
 -100.  -0.201E-08  -0.186E-08  -0.761E-10  -0.348E-12  -0.147E-16   0.000E+00
 -200.  -0.151E-08  -0.140E-08  -0.720E-10  -0.333E-12  -0.141E-16   0.000E+00




      DISTRIBUTION OF DISSOLVED CHEMICALS IN PPM AT  0.1314E+06 HRS
        (ADSORBED CHEMICAL CONC. =    0.0000E+00 * DISSOLVED CHEMICAL CONC.)


                    Z =        0.00
                                                                X
   Y             0.          10.          20.          30.          40.          50.


  200.   0.261E-02   0.242E-02   0.242E-03   0.254E-05   0.192E-08   0.000E+00
  100.   0.291E-02   0.270E-02   0.254E-03   0.263E-05   0.199E-08   0.000E+00
    0.   0.302E-02   0.280E-02   0.258E-03   0.266E-05   0.201E-08   0.000E+00
 -100.   0.291E-02   0.270E-02   0.254E-03   0.263E-05   0.199E-08   0.000E+00
 -200.   0.245E-02   0.227E-02   0.241E-03   0.254E-05   0.192E-08   0.000E+00


                    Z =        5.00
                                                                X
   Y             0.          10.          20.          30.          40.          50.


  200.   0.665E-06   0.636E-06   0.172E-06   0.350E-08   0.383E-11   0.000E+00
  100.   0.695E-06   0.664E-06   0.178E-06   0.362E-08   0.396E-11   0.000E+00
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    0.   0.705E-06   0.674E-06   0.180E-06   0.366E-08   0.400E-11   0.000E+00
 -100.   0.695E-06   0.664E-06   0.178E-06   0.362E-08   0.396E-11   0.000E+00
 -200.   0.661E-06   0.632E-06   0.172E-06   0.350E-08   0.383E-11   0.000E+00


                      Z =        10.00
                                                         X
    Y           0.         10.          20.         30.         40.         50.


  200.  -0.160E-07  -0.148E-07  -0.182E-09  -0.460E-12  -0.455E-14   0.000E+00
  100.  -0.190E-07  -0.176E-07  -0.200E-09  -0.459E-12  -0.469E-14   0.000E+00
    0.  -0.201E-07  -0.186E-07  -0.206E-09  -0.459E-12  -0.473E-14   0.000E+00
 -100.  -0.190E-07  -0.176E-07  -0.200E-09  -0.459E-12  -0.469E-14   0.000E+00
 -200.  -0.138E-07  -0.127E-07  -0.179E-09  -0.460E-12  -0.455E-14   0.000E+00


                      Z =        15.00
                                                         X
    Y           0.         10.          20.         30.         40.         50.


  200.   0.448E-09   0.222E-09   0.168E-09  -0.523E-12   0.140E-14   0.000E+00
  100.  -0.208E-09  -0.407E-09   0.187E-09  -0.552E-12   0.145E-14   0.000E+00
    0.  -0.471E-09  -0.659E-09   0.194E-09  -0.562E-12   0.146E-14   0.000E+00
 -100.  -0.208E-09  -0.407E-09   0.187E-09  -0.552E-12   0.145E-14   0.000E+00
 -200.   0.156E-08   0.126E-08   0.170E-09  -0.523E-12   0.140E-14   0.000E+00


                      Z =        20.00
                                                         X
    Y           0.         10.          20.         30.         40.         50.


  200.  -0.193E-08  -0.180E-08  -0.201E-11   0.468E-12   0.114E-14   0.000E+00
  100.  -0.234E-08  -0.218E-08  -0.245E-11   0.480E-12   0.118E-14   0.000E+00
    0.  -0.249E-08  -0.232E-08  -0.261E-11   0.484E-12   0.119E-14   0.000E+00
 -100.  -0.234E-08  -0.218E-08  -0.245E-11   0.480E-12   0.118E-14   0.000E+00
 -200.  -0.158E-08  -0.148E-08  -0.156E-11   0.468E-12   0.114E-14   0.000E+00




     DISTRIBUTION OF DISSOLVED CHEMICALS IN PPM AT  0.1533E+06 HRS
       (ADSORBED CHEMICAL CONC. =    0.0000E+00 * DISSOLVED CHEMICAL CONC.)


                      Z =         0.00
                                                         X
    Y           0.         10.          20.         30.         40.         50.


  200.   0.270E-02   0.252E-02   0.333E-03   0.656E-05   0.143E-07   0.000E+00
  100.   0.296E-02   0.275E-02   0.347E-03   0.677E-05   0.147E-07   0.000E+00
    0.   0.305E-02   0.284E-02   0.353E-03   0.685E-05   0.148E-07   0.000E+00
 -100.   0.296E-02   0.275E-02   0.347E-03   0.677E-05   0.147E-07   0.000E+00
 -200.   0.260E-02   0.242E-02   0.332E-03   0.656E-05   0.143E-07   0.000E+00


                      Z =         5.00
                                                         X
    Y           0.         10.          20.         30.         40.         50.


  200.   0.147E-05   0.146E-05   0.488E-06   0.181E-07   0.534E-10   0.000E+00
  100.   0.152E-05   0.151E-05   0.504E-06   0.187E-07   0.550E-10   0.000E+00
    0.   0.154E-05   0.153E-05   0.509E-06   0.188E-07   0.555E-10   0.000E+00
 -100.   0.152E-05   0.151E-05   0.504E-06   0.187E-07   0.550E-10   0.000E+00
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 -200.   0.147E-05   0.146E-05   0.488E-06   0.181E-07   0.534E-10   0.000E+00


                     Z =       10.00
                                                            X
   Y          0.          10.         20.         30.        40.         50.


  200.  -0.132E-07  -0.123E-07  -0.524E-09  -0.463E-11   0.189E-13   0.000E+00
  100.  -0.153E-07  -0.142E-07  -0.554E-09  -0.482E-11   0.194E-13   0.000E+00
    0.  -0.161E-07  -0.149E-07  -0.564E-09  -0.488E-11   0.195E-13   0.000E+00
 -100.  -0.153E-07  -0.142E-07  -0.554E-09  -0.482E-11   0.194E-13   0.000E+00
 -200.  -0.118E-07  -0.109E-07  -0.522E-09  -0.463E-11   0.189E-13   0.000E+00


                     Z =       15.00
                                                            X
   Y          0.          10.         20.         30.        40.         50.


  200.   0.871E-08   0.780E-08   0.429E-09   0.306E-11   0.354E-14   0.000E+00
  100.   0.913E-08   0.816E-08   0.468E-09   0.315E-11   0.367E-14   0.000E+00
    0.   0.927E-08   0.827E-08   0.481E-09   0.319E-11   0.371E-14   0.000E+00
 -100.   0.913E-08   0.816E-08   0.468E-09   0.315E-11   0.367E-14   0.000E+00
 -200.   0.941E-08   0.845E-08   0.430E-09   0.306E-11   0.354E-14   0.000E+00


                     Z =       20.00
                                                            X
   Y          0.          10.         20.         30.        40.         50.


  200.  -0.144E-08  -0.132E-08   0.251E-10   0.294E-11   0.585E-14   0.000E+00
  100.  -0.172E-08  -0.158E-08   0.244E-10   0.303E-11   0.603E-14   0.000E+00
    0.  -0.182E-08  -0.167E-08   0.241E-10   0.306E-11   0.610E-14   0.000E+00
 -100.  -0.172E-08  -0.158E-08   0.244E-10   0.303E-11   0.603E-14   0.000E+00
 -200.  -0.122E-08  -0.112E-08   0.254E-10   0.294E-11   0.585E-14   0.000E+00




    DISTRIBUTION OF DISSOLVED CHEMICALS IN PPM AT  0.1752E+06 HRS
      (ADSORBED CHEMICAL CONC. =   0.0000E+00 * DISSOLVED CHEMICAL CONC.)


                     Z =        0.00
                                                            X
   Y          0.          10.         20.         30.        40.         50.


  200.   0.305E-02   0.287E-02   0.427E-03   0.136E-04   0.663E-07   0.265E-10
  100.   0.336E-02   0.316E-02   0.444E-03   0.140E-04   0.680E-07   0.271E-10
    0.   0.348E-02   0.327E-02   0.450E-03   0.141E-04   0.686E-07   0.273E-10
 -100.   0.336E-02   0.316E-02   0.444E-03   0.140E-04   0.680E-07   0.271E-10
 -200.   0.289E-02   0.272E-02   0.427E-03   0.136E-04   0.663E-07   0.265E-10


                     Z =        5.00
                                                            X
   Y          0.          10.         20.         30.        40.         50.


  200.   0.276E-05   0.285E-05   0.110E-05   0.646E-07   0.415E-09   0.220E-12
  100.   0.285E-05   0.294E-05   0.114E-05   0.663E-07   0.425E-09   0.225E-12
    0.   0.288E-05   0.297E-05   0.115E-05   0.669E-07   0.429E-09   0.227E-12
 -100.   0.285E-05   0.294E-05   0.114E-05   0.663E-07   0.425E-09   0.225E-12
 -200.   0.276E-05   0.284E-05   0.110E-05   0.646E-07   0.415E-09   0.220E-12
```

```
                    Z =       10.00
                                                                X
     Y          0.           10.          20.          30.          40.          50.


   200.  -0.148E-07  -0.135E-07   0.413E-09   0.400E-10   0.237E-12   0.720E-16
   100.  -0.177E-07  -0.162E-07   0.411E-09   0.410E-10   0.243E-12   0.737E-16
     0.  -0.188E-07  -0.172E-07   0.410E-09   0.414E-10   0.245E-12   0.743E-16
  -100.  -0.177E-07  -0.162E-07   0.411E-09   0.410E-10   0.243E-12   0.737E-16
  -200.  -0.125E-07  -0.114E-07   0.416E-09   0.400E-10   0.237E-12   0.720E-16


                    Z =       15.00
                                                                X
     Y          0.           10.          20.          30.          40.          50.


   200.  -0.190E-08  -0.238E-08  -0.107E-08  -0.113E-09  -0.114E-11  -0.100E-14
   100.  -0.261E-08  -0.307E-08  -0.108E-08  -0.116E-09  -0.117E-11  -0.102E-14
     0.  -0.290E-08  -0.334E-08  -0.108E-08  -0.117E-09  -0.118E-11  -0.103E-14
  -100.  -0.261E-08  -0.307E-08  -0.108E-08  -0.116E-09  -0.117E-11  -0.102E-14
  -200.  -0.785E-09  -0.134E-08  -0.107E-08  -0.113E-09  -0.114E-11  -0.100E-14


                    Z =       20.00
                                                                X
     Y          0.           10.          20.          30.          40.          50.


   200.  -0.189E-08  -0.177E-08   0.117E-12  -0.129E-11  -0.290E-13  -0.315E-16
   100.  -0.230E-08  -0.215E-08  -0.178E-13  -0.131E-11  -0.297E-13  -0.323E-16
     0.  -0.245E-08  -0.229E-08  -0.802E-13  -0.132E-11  -0.299E-13  -0.326E-16
  -100.  -0.230E-08  -0.215E-08  -0.178E-13  -0.131E-11  -0.297E-13  -0.323E-16
  -200.  -0.155E-08  -0.145E-08   0.561E-12  -0.129E-11  -0.290E-13  -0.315E-16




        DISTRIBUTION OF DISSOLVED CHEMICALS IN PPM AT  0.1971E+06 HRS
          (ADSORBED CHEMICAL CONC. =   0.0000E+00 * DISSOLVED CHEMICAL CONC.)


                    Z =        0.00
                                                                X
     Y          0.           10.          20.          30.          40.          50.


   200.   0.307E-02   0.292E-02   0.525E-03   0.242E-04   0.223E-06   0.296E-09
   100.   0.334E-02   0.317E-02   0.545E-03   0.249E-04   0.228E-06   0.303E-09
     0.   0.344E-02   0.326E-02   0.551E-03   0.251E-04   0.230E-06   0.305E-09
  -100.   0.334E-02   0.317E-02   0.545E-03   0.249E-04   0.228E-06   0.303E-09
  -200.   0.297E-02   0.283E-02   0.525E-03   0.242E-04   0.223E-06   0.296E-09


                    Z =        5.00
                                                                X
     Y          0.           10.          20.          30.          40.          50.


   200.   0.454E-05   0.488E-05   0.213E-05   0.178E-06   0.213E-08   0.334E-11
   100.   0.467E-05   0.501E-05   0.218E-05   0.182E-06   0.217E-08   0.341E-11
     0.   0.471E-05   0.506E-05   0.220E-05   0.184E-06   0.219E-08   0.343E-11
  -100.   0.467E-05   0.501E-05   0.218E-05   0.182E-06   0.217E-08   0.341E-11
  -200.   0.454E-05   0.487E-05   0.213E-05   0.178E-06   0.213E-08   0.334E-11


                    Z =       10.00
                                                                X
```

```
   Y          0.         10.         20.         30.         40.         50.


 200.   -0.124E-07  -0.114E-07  -0.147E-09   0.197E-10   0.694E-13  -0.462E-15
 100.   -0.145E-07  -0.133E-07  -0.167E-09   0.201E-10   0.721E-13  -0.471E-15
   0.   -0.153E-07  -0.140E-07  -0.174E-09   0.203E-10   0.730E-13  -0.474E-15
-100.   -0.145E-07  -0.133E-07  -0.167E-09   0.201E-10   0.721E-13  -0.471E-15
-200.   -0.110E-07  -0.101E-07  -0.145E-09   0.197E-10   0.694E-13  -0.462E-15


                  Z =       15.00
                                                          X
   Y          0.         10.         20.         30.         40.         50.


 200.   -0.178E-08  -0.388E-08  -0.517E-08  -0.532E-09  -0.630E-11  -0.821E-14
 100.   -0.161E-08  -0.379E-08  -0.527E-08  -0.544E-09  -0.645E-11  -0.839E-14
   0.   -0.156E-08  -0.377E-08  -0.530E-08  -0.549E-09  -0.650E-11  -0.846E-14
-100.   -0.161E-08  -0.379E-08  -0.527E-08  -0.544E-09  -0.645E-11  -0.839E-14
-200.   -0.109E-08  -0.323E-08  -0.517E-08  -0.532E-09  -0.630E-11  -0.821E-14


                  Z =       20.00
                                                          X
   Y          0.         10.         20.         30.         40.         50.


 200.   -0.166E-08  -0.156E-08  -0.857E-10  -0.581E-11  -0.414E-13   0.975E-16
 100.   -0.195E-08  -0.182E-08  -0.892E-10  -0.595E-11  -0.426E-13   0.992E-16
   0.   -0.205E-08  -0.192E-08  -0.904E-10  -0.599E-11  -0.430E-13   0.998E-16
-100.   -0.195E-08  -0.182E-08  -0.892E-10  -0.595E-11  -0.426E-13   0.992E-16
-200.   -0.145E-08  -0.136E-08  -0.854E-10  -0.581E-11  -0.414E-13   0.975E-16




     DISTRIBUTION OF DISSOLVED CHEMICALS IN PPM AT  0.2190E+06 HRS
       (ADSORBED CHEMICAL CONC. =    0.0000E+00 * DISSOLVED CHEMICAL CONC.)


                  Z =        0.00
                                                          X
   Y          0.         10.         20.         30.         40.         50.


 200.    0.337E-02   0.324E-02   0.623E-03   0.388E-04   0.593E-06   0.167E-08
 100.    0.369E-02   0.354E-02   0.644E-03   0.398E-04   0.606E-06   0.171E-08
   0.    0.380E-02   0.365E-02   0.651E-03   0.401E-04   0.610E-06   0.172E-08
-100.    0.369E-02   0.354E-02   0.644E-03   0.398E-04   0.606E-06   0.171E-08
-200.    0.320E-02   0.309E-02   0.623E-03   0.388E-04   0.593E-06   0.167E-08


                  Z =        5.00
                                                          X
   Y          0.         10.         20.         30.         40.         50.


 200.    0.682E-05   0.764E-05   0.366E-05   0.407E-06   0.804E-08   0.261E-10
 100.    0.700E-05   0.783E-05   0.375E-05   0.416E-06   0.821E-08   0.266E-10
   0.    0.706E-05   0.789E-05   0.378E-05   0.419E-06   0.827E-08   0.268E-10
-100.    0.700E-05   0.783E-05   0.375E-05   0.416E-06   0.821E-08   0.266E-10
-200.    0.682E-05   0.763E-05   0.366E-05   0.407E-06   0.804E-08   0.261E-10


                  Z =       10.00
                                                          X
   Y          0.         10.         20.         30.         40.         50.
```

```
 200.  -0.155E-07  -0.144E-07  -0.108E-09  -0.339E-10  -0.145E-11  -0.529E-14
 100.  -0.185E-07  -0.172E-07  -0.121E-09  -0.343E-10  -0.147E-11  -0.540E-14
   0.  -0.196E-07  -0.182E-07  -0.126E-09  -0.345E-10  -0.148E-11  -0.544E-14
-100.  -0.185E-07  -0.172E-07  -0.121E-09  -0.343E-10  -0.147E-11  -0.540E-14
-200.  -0.133E-07  -0.123E-07  -0.105E-09  -0.339E-10  -0.145E-11  -0.529E-14


                    Z =       15.00
                                                              X
   Y          0.          10.          20.          30.          40.         50.


 200.  -0.945E-08  -0.111E-07  -0.559E-08  -0.664E-09  -0.116E-10  -0.298E-13
 100.  -0.103E-07  -0.120E-07  -0.570E-08  -0.679E-09  -0.119E-10  -0.304E-13
   0.  -0.107E-07  -0.123E-07  -0.574E-08  -0.684E-09  -0.119E-10  -0.306E-13
-100.  -0.103E-07  -0.120E-07  -0.570E-08  -0.679E-09  -0.119E-10  -0.304E-13
-200.  -0.833E-08  -0.101E-07  -0.559E-08  -0.664E-09  -0.116E-10  -0.298E-13


                    Z =       20.00
                                                              X
   Y          0.          10.          20.          30.          40.         50.


 200.  -0.172E-08  -0.156E-08   0.112E-09   0.144E-10   0.297E-12   0.751E-15
 100.  -0.213E-08  -0.194E-08   0.115E-09   0.147E-10   0.303E-12   0.767E-15
   0.  -0.228E-08  -0.208E-08   0.115E-09   0.148E-10   0.305E-12   0.773E-15
-100.  -0.213E-08  -0.194E-08   0.115E-09   0.147E-10   0.303E-12   0.767E-15
-200.  -0.138E-08  -0.124E-08   0.113E-09   0.144E-10   0.297E-12   0.751E-15




      DISTRIBUTION OF DISSOLVED CHEMICALS IN PPM AT  0.2409E+06 HRS
        (ADSORBED CHEMICAL CONC. =    0.0000E+00 * DISSOLVED CHEMICAL CONC.)


                    Z =        0.00
                                                              X
   Y          0.          10.          20.          30.          40.         50.


 200.   0.335E-02   0.326E-02   0.722E-03   0.575E-04   0.133E-05   0.682E-08
 100.   0.362E-02   0.352E-02   0.745E-03   0.587E-04   0.136E-05   0.695E-08
   0.   0.372E-02   0.361E-02   0.753E-03   0.592E-04   0.136E-05   0.699E-08
-100.   0.362E-02   0.352E-02   0.745E-03   0.587E-04   0.136E-05   0.695E-08
-200.   0.324E-02   0.317E-02   0.722E-03   0.575E-04   0.133E-05   0.682E-08


                    Z =        5.00
                                                              X
   Y          0.          10.          20.          30.          40.         50.


 200.   0.953E-05   0.111E-04   0.579E-05   0.813E-06   0.242E-07   0.142E-09
 100.   0.976E-05   0.114E-04   0.591E-05   0.829E-06   0.247E-07   0.144E-09
   0.   0.983E-05   0.115E-04   0.596E-05   0.835E-06   0.249E-07   0.145E-09
-100.   0.976E-05   0.114E-04   0.591E-05   0.829E-06   0.247E-07   0.144E-09
-200.   0.953E-05   0.111E-04   0.579E-05   0.813E-06   0.242E-07   0.142E-09


                    Z =       10.00
                                                              X
   Y          0.          10.          20.          30.          40.         50.


 200.  -0.129E-07  -0.119E-07  -0.428E-09  -0.133E-10  -0.294E-13   0.866E-14
```

```
 100.  -0.150E-07  -0.138E-07  -0.455E-09  -0.136E-10  -0.332E-13   0.879E-14
   0.  -0.157E-07  -0.146E-07  -0.464E-09  -0.137E-10  -0.346E-13   0.884E-14
-100.  -0.150E-07  -0.138E-07  -0.455E-09  -0.136E-10  -0.332E-13   0.879E-14
-200.  -0.115E-07  -0.106E-07  -0.427E-09  -0.133E-10  -0.294E-13   0.866E-14


                     Z =       15.00
                                                                X
   Y            0.          10.          20.          30.          40.          50.


 200.  -0.555E-08  -0.851E-08  -0.782E-08  -0.959E-09  -0.195E-10  -0.783E-13
 100.  -0.545E-08  -0.851E-08  -0.796E-08  -0.980E-09  -0.199E-10  -0.798E-13
   0.  -0.543E-08  -0.853E-08  -0.801E-08  -0.987E-09  -0.200E-10  -0.803E-13
-100.  -0.545E-08  -0.851E-08  -0.796E-08  -0.980E-09  -0.199E-10  -0.798E-13
-200.  -0.485E-08  -0.786E-08  -0.782E-08  -0.959E-09  -0.195E-10  -0.783E-13


                     Z =       20.00
                                                                X
   Y            0.          10.          20.          30.          40.          50.


 200.  -0.156E-08  -0.143E-08  -0.136E-10   0.673E-11   0.447E-12   0.409E-14
 100.  -0.184E-08  -0.170E-08  -0.157E-10   0.683E-11   0.455E-12   0.416E-14
   0.  -0.195E-08  -0.180E-08  -0.165E-10   0.687E-11   0.458E-12   0.418E-14
-100.  -0.184E-08  -0.170E-08  -0.157E-10   0.683E-11   0.455E-12   0.416E-14
-200.  -0.135E-08  -0.123E-08  -0.134E-10   0.673E-11   0.447E-12   0.409E-14

STEADY STATE SOLUTION HAS NOT BEEN REACHED BEFORE FINAL SIMULATING TIME




     DISTRIBUTION OF DISSOLVED CHEMICALS IN PPM AT  0.2628E+06 HRS
       (ADSORBED CHEMICAL CONC. =    0.0000E+00 * DISSOLVED CHEMICAL CONC.)


                     Z =        0.00
                                                                X
   Y            0.          10.          20.          30.          40.          50.


 200.    0.360E-02   0.355E-02   0.818E-03   0.801E-04   0.262E-05   0.221E-07
 100.    0.392E-02   0.386E-02   0.843E-03   0.817E-04   0.267E-05   0.225E-07
   0.    0.404E-02   0.397E-02   0.852E-03   0.823E-04   0.268E-05   0.226E-07
-100.    0.392E-02   0.386E-02   0.843E-03   0.817E-04   0.267E-05   0.225E-07
-200.    0.344E-02   0.340E-02   0.818E-03   0.801E-04   0.262E-05   0.221E-07
```

USE TO CALCULATE GW OBJECTIVE AT SOURCE

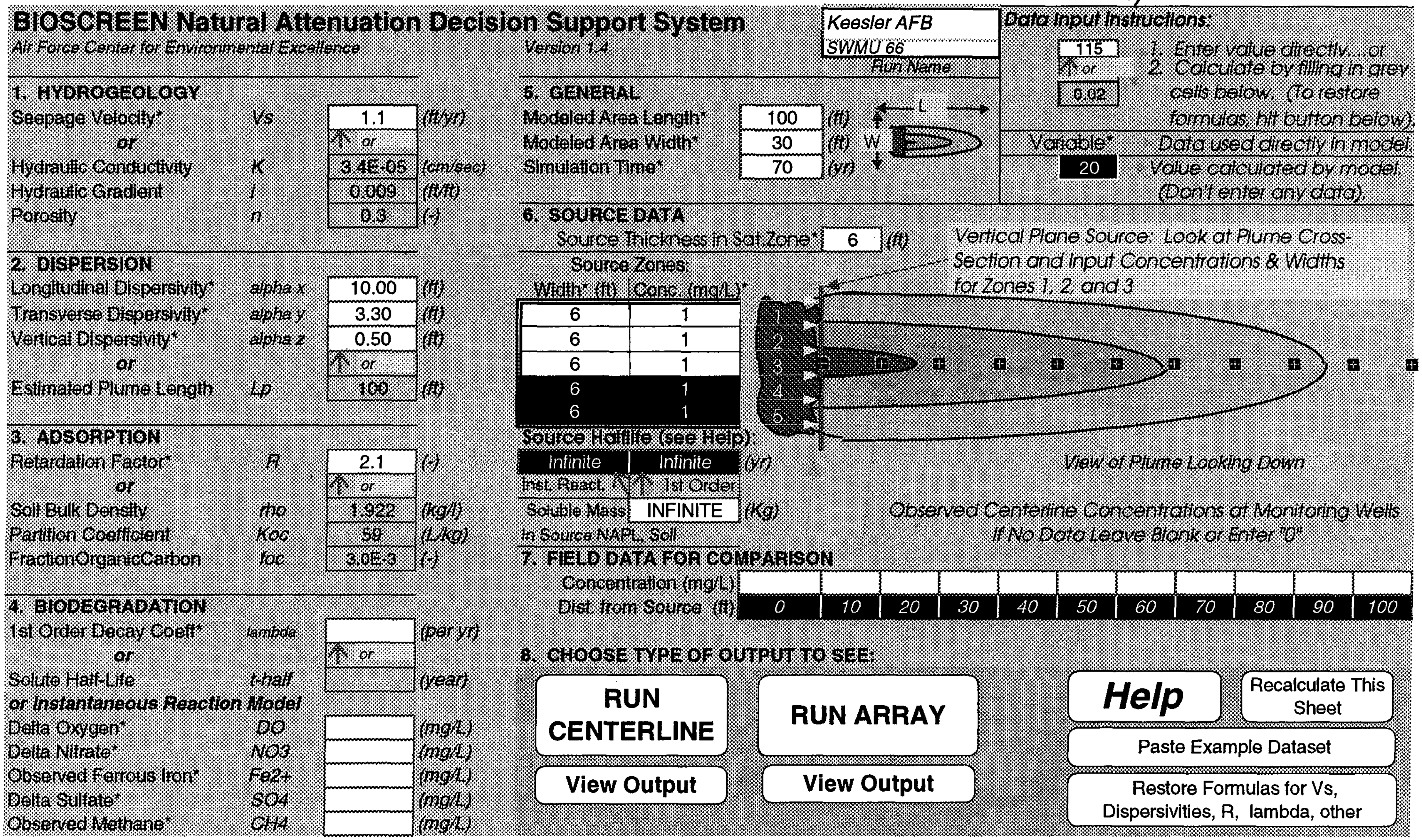
```
                     Z =        5.00
                                                                X
   Y            0.          10.          20.          30.          40.          50.


 200.    0.126E-04   0.153E-04   0.857E-05   0.146E-05   0.614E-07   0.587E-09
 100.    0.129E-04   0.157E-04   0.874E-05   0.149E-05   0.625E-07   0.597E-09
   0.    0.130E-04   0.158E-04   0.880E-05   0.150E-05   0.629E-07   0.601E-09
-100.    0.129E-04   0.157E-04   0.874E-05   0.149E-05   0.625E-07   0.597E-09
-200.    0.126E-04   0.153E-04   0.857E-05   0.146E-05   0.614E-07   0.587E-09


                     Z =       10.00
                                                                X
   Y            0.          10.          20.          30.          40.          50.
```

```
 200.  -0.147E-07  -0.132E-07   0.644E-09   0.127E-09   0.627E-11   0.617E-13
 100.  -0.176E-07  -0.160E-07   0.644E-09   0.130E-09   0.637E-11   0.628E-13
   0.  -0.187E-07  -0.170E-07   0.644E-09   0.130E-09   0.641E-11   0.631E-13
-100.  -0.176E-07  -0.160E-07   0.644E-09   0.130E-09   0.637E-11   0.628E-13
-200.  -0.124E-07  -0.111E-07   0.647E-09   0.127E-09   0.627E-11   0.617E-13

                   Z =       15.00
                                                         X
  Y            0.          10.          20.          30.          40.          50.


 200.  -0.114E-07  -0.136E-07  -0.714E-08  -0.980E-09  -0.261E-10  -0.163E-12
 100.  -0.123E-07  -0.145E-07  -0.728E-08  -0.100E-08  -0.266E-10  -0.166E-12
   0.  -0.126E-07  -0.149E-07  -0.733E-08  -0.101E-08  -0.268E-10  -0.167E-12
-100.  -0.123E-07  -0.145E-07  -0.728E-08  -0.100E-08  -0.266E-10  -0.166E-12
-200.  -0.102E-07  -0.126E-07  -0.714E-08  -0.980E-09  -0.261E-10  -0.163E-12

                   Z =       20.00
                                                         X
  Y            0.          10.          20.          30.          40.          50.


 200.  -0.144E-08  -0.118E-08   0.359E-09   0.694E-10   0.323E-11   0.332E-13
 100.  -0.184E-08  -0.155E-08   0.365E-09   0.706E-10   0.329E-11   0.337E-13
   0.  -0.199E-08  -0.169E-08   0.367E-09   0.710E-10   0.330E-11   0.339E-13
-100.  -0.184E-08  -0.155E-08   0.365E-09   0.706E-10   0.329E-11   0.337E-13
-200.  -0.109E-08  -0.862E-09   0.359E-09   0.694E-10   0.323E-11   0.332E-13
```

APPENDIX C-2

BIOSCREEN INPUT AND OUTPUT DATA

1,2-DCE



BIOSCREEN Natural Attenuation Decision Support System

Air Force Center for Environmental Excellence

Version 1.4

Keesler AFB

SWMU 66

Run Name

Data Input Instructions:

115 — 1. Enter value directly....or

↑ or — 2. Calculate by filling in grey cells below. (To restore formulas, hit button below).

0.02

Variable* — Data used directly in model.

20 — Value calculated by model. (Don't enter any data).

1. HYDROGEOLOGY

Seepage Velocity*	Vs	1.1	(ft/yr)
or		↑ or	
Hydraulic Conductivity	K	3.4E-05	(cm/sec)
Hydraulic Gradient	i	0.009	(ft/ft)
Porosity	n	0.3	(-)

2. DISPERSION

Longitudinal Dispersivity*	alpha x	10.00	(ft)
Transverse Dispersivity*	alpha y	3.30	(ft)
Vertical Dispersivity*	alpha z	0.50	(ft)
or		↑ or	
Estimated Plume Length	Lp	100	(ft)

3. ADSORPTION

Retardation Factor*	R	2.1	(-)
or		↑ or	
Soil Bulk Density	rho	1.922	(kg/l)
Partition Coefficient	Koc	59	(L/kg)
FractionOrganicCarbon	foc	3.0E-3	(-)

4. BIODEGRADATION

1st Order Decay Coeff*	lambda		(per yr)
or		↑ or	
Solute Half-Life	t-half		(year)
or Instantaneous Reaction Model			
Delta Oxygen*	DO		(mg/L)
Delta Nitrate*	NO3		(mg/L)
Observed Ferrous Iron*	Fe2+		(mg/L)
Delta Sulfate*	SO4		(mg/L)
Observed Methane*	CH4		(mg/L)

5. GENERAL

Modeled Area Length*	100	(ft)
Modeled Area Width*	30	(ft)
Simulation Time*	70	(yr)

6. SOURCE DATA

Source Thickness in Sat.Zone* 6 (ft)

Vertical Plane Source: Look at Plume Cross-Section and Input Concentrations & Widths for Zones 1, 2, and 3

Source Zones:

Width* (ft)	Conc. (mg/L)*
6	1
6	1
6	1
6	1
6	1

Source Halflife (see Help):

Infinite	Infinite	(yr)
Inst. React. ↑	↑ 1st Order	

Soluble Mass in Source NAPL, Soil: INFINITE (Kg)

View of Plume Looking Down

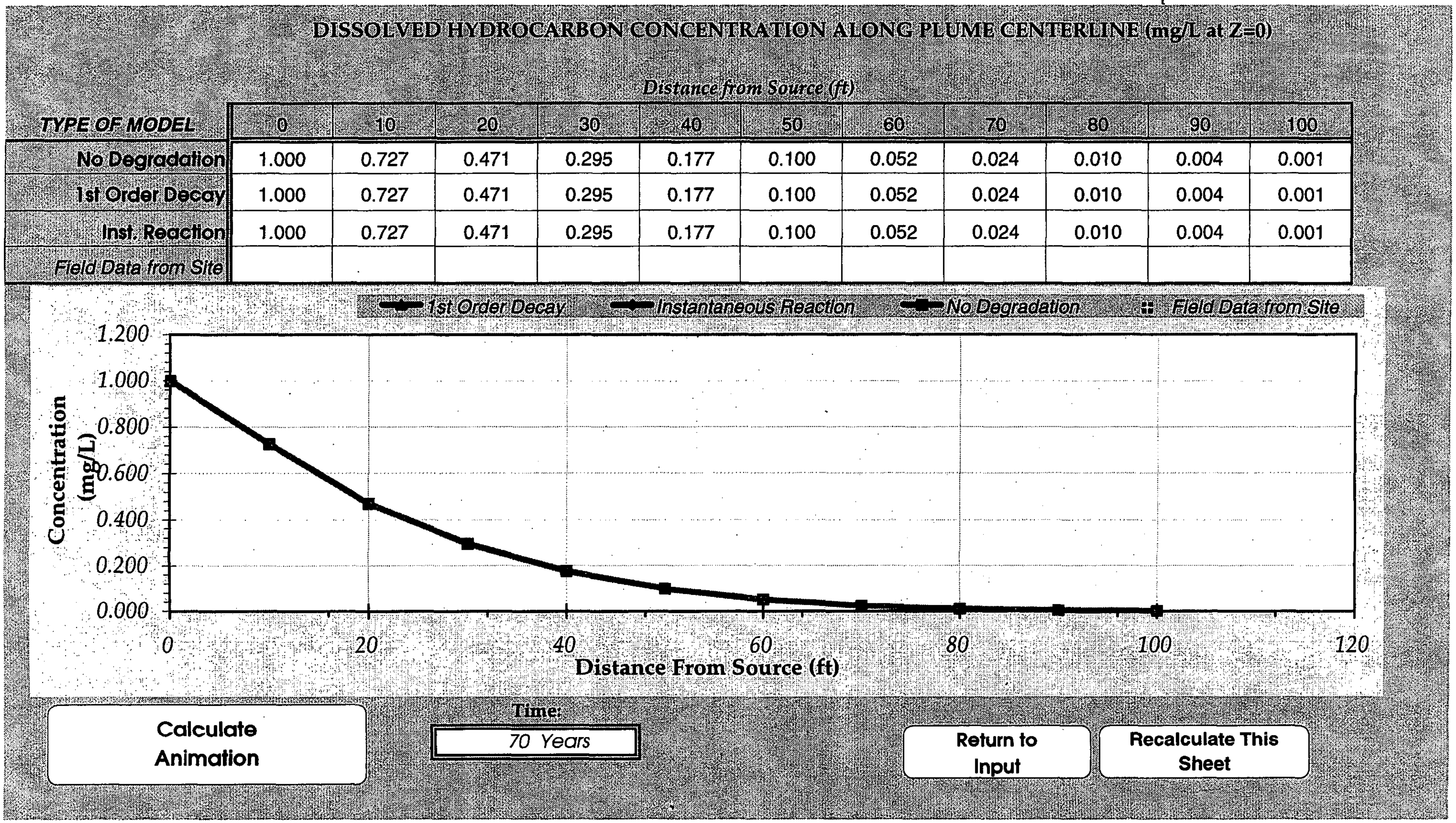
Observed Centerline Concentrations at Monitoring Wells
If No Data Leave Blank or Enter "0"

7. FIELD DATA FOR COMPARISON

Concentration (mg/L)											
Dist. from Source (ft)	0	10	20	30	40	50	60	70	80	90	100

8. CHOOSE TYPE OF OUTPUT TO SEE:

1,2-DCE



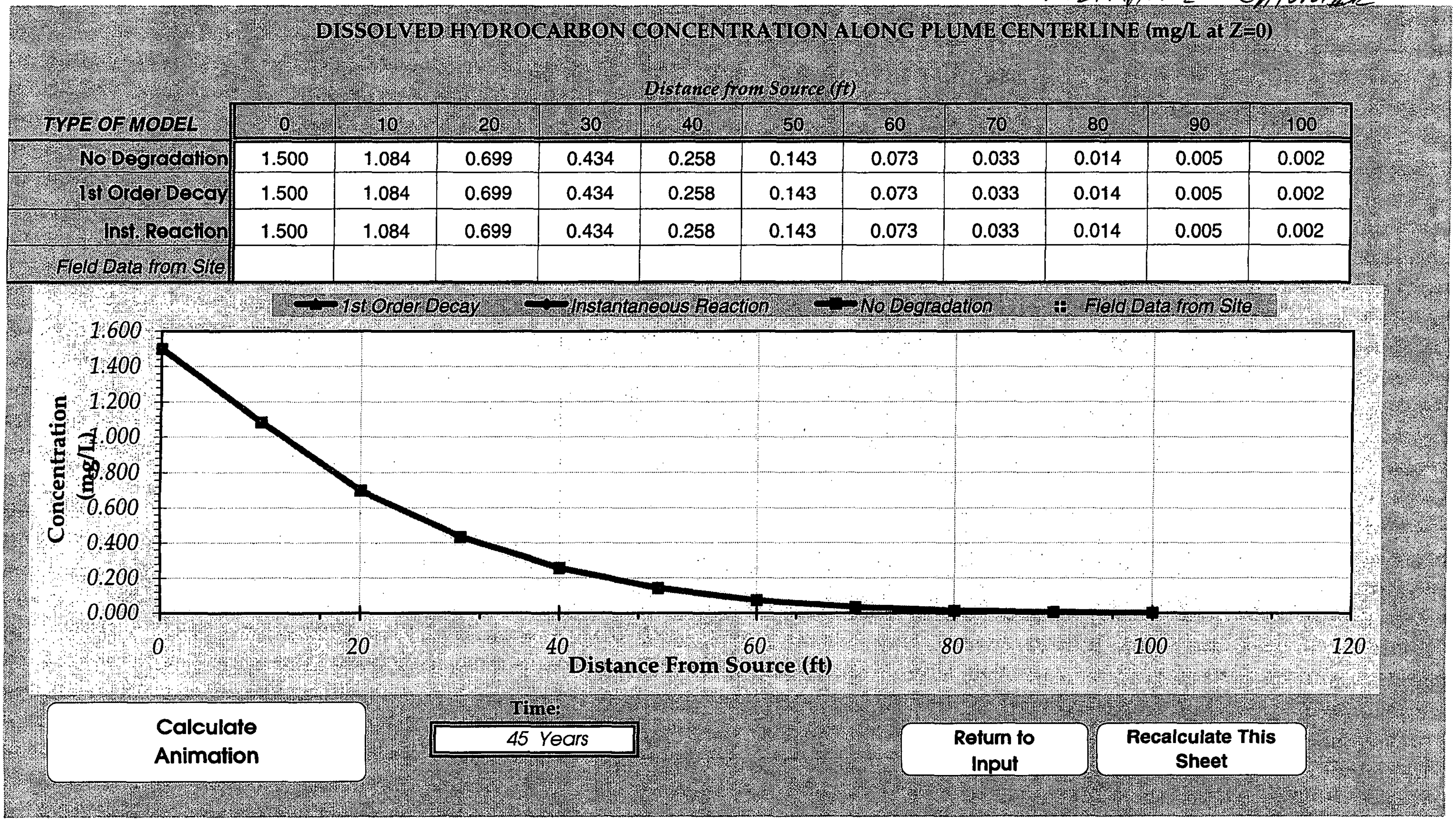
DISSOLVED HYDROCARBON CONCENTRATION ALONG PLUME CENTERLINE (mg/L at Z=0)

Distance from Source (ft)

TYPE OF MODEL	0	10	20	30	40	50	60	70	80	90	100
No Degradation	1.000	0.727	0.471	0.295	0.177	0.100	0.052	0.024	0.010	0.004	0.001
1st Order Decay	1.000	0.727	0.471	0.295	0.177	0.100	0.052	0.024	0.010	0.004	0.001
Inst. Reaction	1.000	0.727	0.471	0.295	0.177	0.100	0.052	0.024	0.010	0.004	0.001
Field Data from Site											

Time: 70 Years

methylene chloride

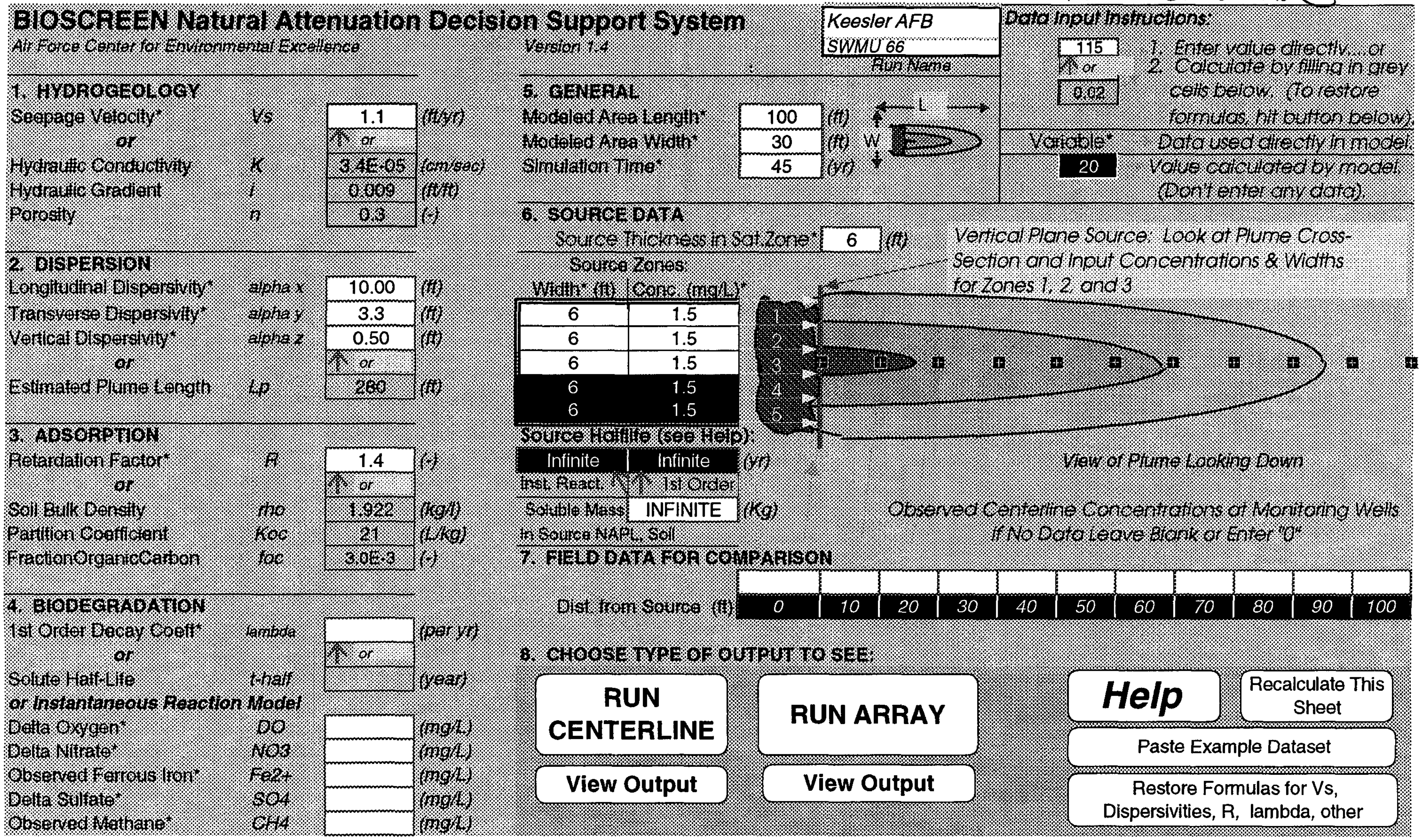


DISSOLVED HYDROCARBON CONCENTRATION ALONG PLUME CENTERLINE (mg/L at Z=0)

	Distance from Source (ft)										
TYPE OF MODEL	0	10	20	30	40	50	60	70	80	90	100
No Degradation	1.500	1.084	0.699	0.434	0.258	0.143	0.073	0.033	0.014	0.005	0.002
1st Order Decay	1.500	1.084	0.699	0.434	0.258	0.143	0.073	0.033	0.014	0.005	0.002
Inst. Reaction	1.500	1.084	0.699	0.434	0.258	0.143	0.073	0.033	0.014	0.005	0.002
Field Data from Site											

Time: 45 Years

methylene chloride



BIOSCREEN Natural Attenuation Decision Support System

Air Force Center for Environmental Excellence

Version 1.4

Keesler AFB

SWMU 66

Run Name

Data Input Instructions:

115 1. Enter value directly... or

↑ or 2. Calculate by filling in grey

0.02 cells below. (To restore formulas, hit button below).

Variable* Data used directly in model.

20 Value calculated by model. (Don't enter any data).

1. HYDROGEOLOGY

Seepage Velocity*	Vs	1.1	(ft/yr)
or		↑ or	
Hydraulic Conductivity	K	3.4E-05	(cm/sec)
Hydraulic Gradient	i	0.009	(ft/ft)
Porosity	n	0.3	(-)

2. DISPERSION

Longitudinal Dispersivity*	alpha x	10.00	(ft)
Transverse Dispersivity*	alpha y	3.3	(ft)
Vertical Dispersivity*	alpha z	0.50	(ft)
or		↑ or	
Estimated Plume Length	Lp	280	(ft)

3. ADSORPTION

Retardation Factor*	R	1.4	(-)
or		↑ or	
Soil Bulk Density	rho	1.922	(kg/l)
Partition Coefficient	Koc	21	(L/kg)
FractionOrganicCarbon	foc	3.0E-3	(-)

4. BIODEGRADATION

1st Order Decay Coeff*	lambda		(per yr)
or		↑ or	
Solute Half-Life	t-half		(year)
or Instantaneous Reaction Model			
Delta Oxygen*	DO		(mg/L)
Delta Nitrate*	NO3		(mg/L)
Observed Ferrous Iron*	Fe2+		(mg/L)
Delta Sulfate*	SO4		(mg/L)
Observed Methane*	CH4		(mg/L)

5. GENERAL

Modeled Area Length*	100	(ft)
Modeled Area Width*	30	(ft)
Simulation Time*	45	(yr)

6. SOURCE DATA

Source Thickness in Sat.Zone* 6 (ft)

Vertical Plane Source: Look at Plume Cross-Section and Input Concentrations & Widths for Zones 1, 2, and 3

Source Zones:

Width* (ft)	Conc. (mg/L)*
6	1.5
6	1.5
6	1.5
6	1.5
6	1.5

View of Plume Looking Down

Source Halflife (see Help):		
Infinite	Infinite	(yr)
Inst. React. ↑	↑ 1st Order	
Soluble Mass	INFINITE	(Kg)
In Source NAPL, Soil		

Observed Centerline Concentrations at Monitoring Wells

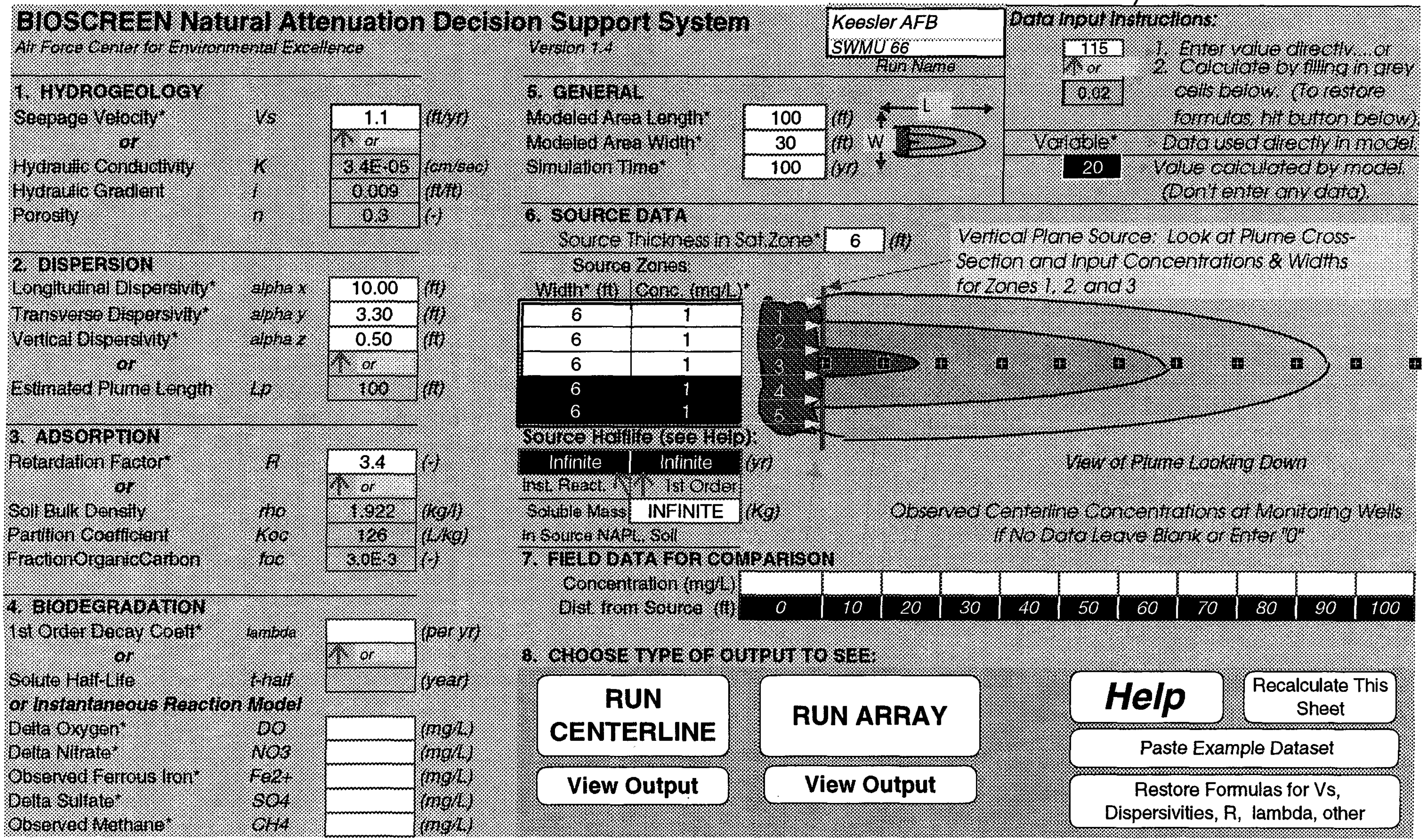
If No Data Leave Blank or Enter "0"

7. FIELD DATA FOR COMPARISON

Dist. from Source (ft)	0	10	20	30	40	50	60	70	80	90	100

8. CHOOSE TYPE OF OUTPUT TO SEE:

TCE



BIOSCREEN Natural Attenuation Decision Support System

Air Force Center for Environmental Excellence

Version 1.4

Keesler AFB
SWMU 66
Run Name

Data Input Instructions:

115 — 1. Enter value directly....or
↑ or
0.02 — 2. Calculate by filling in grey cells below. (To restore formulas, hit button below).

Variable* — Data used directly in model.
20 — Value calculated by model. (Don't enter any data).

1. HYDROGEOLOGY

Seepage Velocity*	Vs	1.1	(ft/yr)
or		↑ or	
Hydraulic Conductivity	K	3.4E-05	(cm/sec)
Hydraulic Gradient	i	0.009	(ft/ft)
Porosity	n	0.3	(-)

2. DISPERSION

Longitudinal Dispersivity*	alpha x	10.00	(ft)
Transverse Dispersivity*	alpha y	3.30	(ft)
Vertical Dispersivity*	alpha z	0.50	(ft)
or		↑ or	
Estimated Plume Length	Lp	100	(ft)

3. ADSORPTION

Retardation Factor*	R	3.4	(-)
or		↑ or	
Soil Bulk Density	rho	1.922	(kg/l)
Partition Coefficient	Koc	126	(L/kg)
FractionOrganicCarbon	foc	3.0E-3	(-)

4. BIODEGRADATION

1st Order Decay Coeff*	lambda		(per yr)
or		↑ or	
Solute Half-Life	t-half		(year)
or Instantaneous Reaction Model			
Delta Oxygen*	DO		(mg/L)
Delta Nitrate*	NO3		(mg/L)
Observed Ferrous Iron*	Fe2+		(mg/L)
Delta Sulfate*	SO4		(mg/L)
Observed Methane*	CH4		(mg/L)

5. GENERAL

Modeled Area Length*	100	(ft)
Modeled Area Width*	30	(ft)
Simulation Time*	100	(yr)

6. SOURCE DATA

Source Thickness in Sat.Zone* 6 (ft)

Vertical Plane Source: Look at Plume Cross-Section and Input Concentrations & Widths for Zones 1, 2, and 3

Source Zones:

Width* (ft)	Conc. (mg/L)*
6	1
6	1
6	1
6	1
6	1

Source Halflife (see Help):

Inst. React.	1st Order	
Infinite	Infinite	(yr)

Soluble Mass in Source NAPL, Soil: INFINITE (Kg)

View of Plume Looking Down

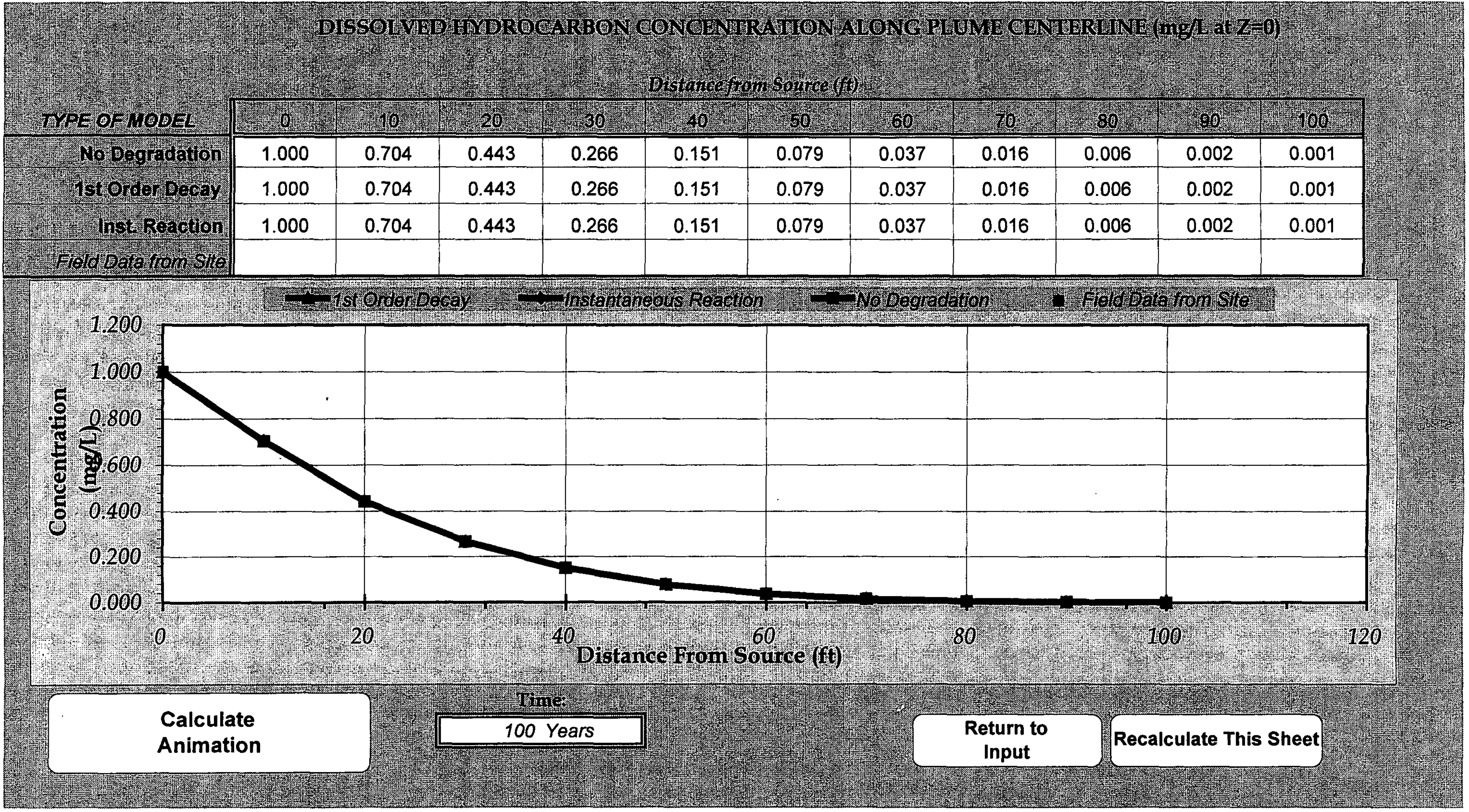
7. FIELD DATA FOR COMPARISON

Observed Centerline Concentrations at Monitoring Wells
If No Data Leave Blank or Enter "0"

Concentration (mg/L)											
Dist. from Source (ft)	0	10	20	30	40	50	60	70	80	90	100

8. CHOOSE TYPE OF OUTPUT TO SEE:

TCE



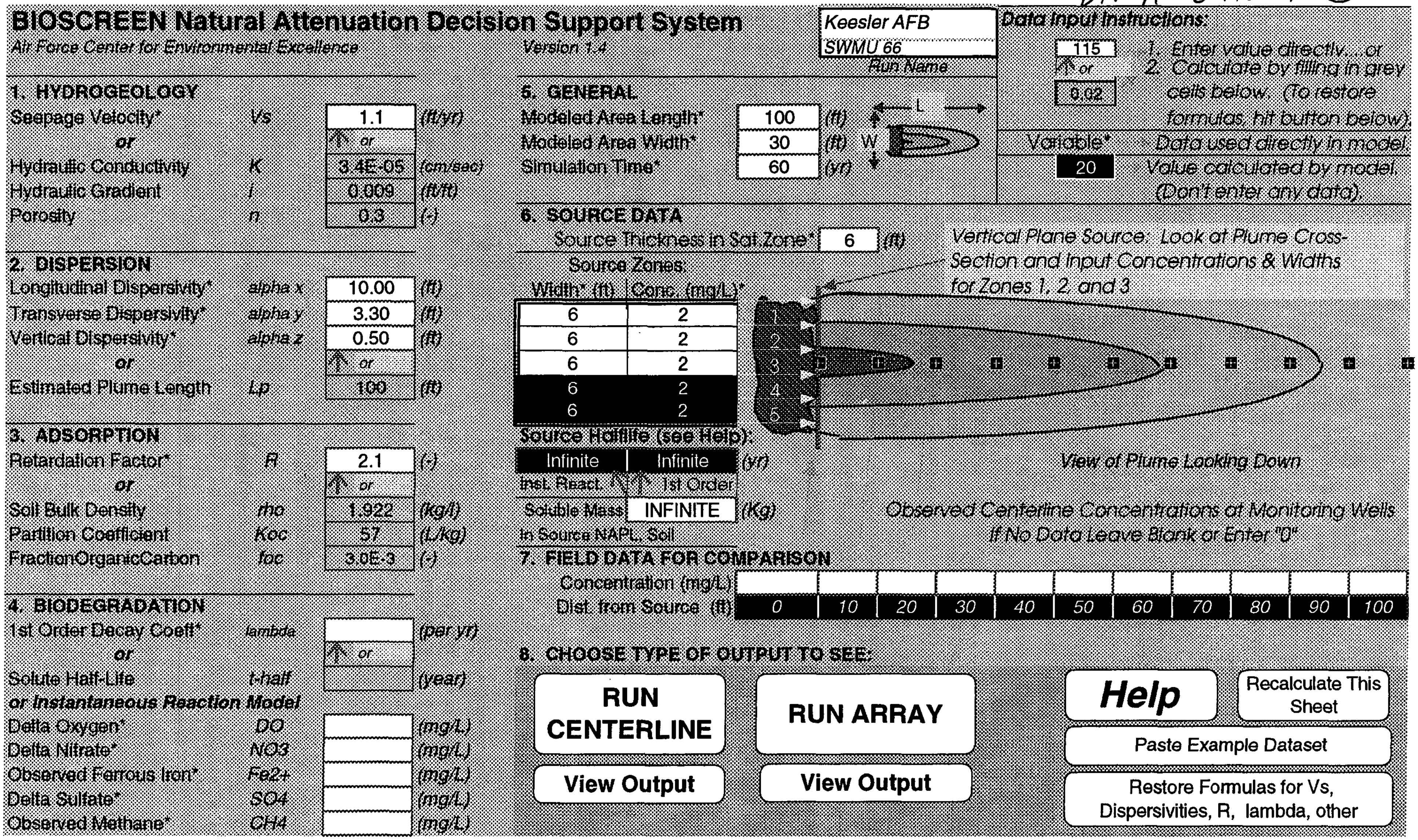
DISSOLVED HYDROCARBON CONCENTRATION ALONG PLUME CENTERLINE (mg/L at Z=0)

Distance from Source (ft)

TYPE OF MODEL	0	10	20	30	40	50	60	70	80	90	100
No Degradation	1.000	0.704	0.443	0.266	0.151	0.079	0.037	0.016	0.006	0.002	0.001
1st Order Decay	1.000	0.704	0.443	0.266	0.151	0.079	0.037	0.016	0.006	0.002	0.001
Inst. Reaction	1.000	0.704	0.443	0.266	0.151	0.079	0.037	0.016	0.006	0.002	0.001
Field Data from Site											

Time: 100 Years

Vinyl chloride



BIOSCREEN Natural Attenuation Decision Support System

Air Force Center for Environmental Excellence

Version 1.4

Keesler AFB
SWMU 66
Run Name

Data Input Instructions:

115 — 1. Enter value directly....or
or
0.02 — 2. Calculate by filling in grey cells below. (To restore formulas, hit button below).

Variable* — Data used directly in model.

20 — Value calculated by model. (Don't enter any data).

1. HYDROGEOLOGY

Seepage Velocity*	Vs	1.1	(ft/yr)
or		or	
Hydraulic Conductivity	K	3.4E-05	(cm/sec)
Hydraulic Gradient	i	0.009	(ft/ft)
Porosity	n	0.3	(-)

2. DISPERSION

Longitudinal Dispersivity*	alpha x	10.00	(ft)
Transverse Dispersivity*	alpha y	3.30	(ft)
Vertical Dispersivity*	alpha z	0.50	(ft)
or		or	
Estimated Plume Length	Lp	100	(ft)

3. ADSORPTION

Retardation Factor*	R	2.1	(-)
or		or	
Soil Bulk Density	rho	1.922	(kg/l)
Partition Coefficient	Koc	57	(L/kg)
FractionOrganicCarbon	foc	3.0E-3	(-)

4. BIODEGRADATION

1st Order Decay Coeff*	lambda		(per yr)
or		or	
Solute Half-Life	t-half		(year)
or Instantaneous Reaction Model			
Delta Oxygen*	DO		(mg/L)
Delta Nitrate*	NO3		(mg/L)
Observed Ferrous Iron*	Fe2+		(mg/L)
Delta Sulfate*	SO4		(mg/L)
Observed Methane*	CH4		(mg/L)

5. GENERAL

Modeled Area Length*	100	(ft)
Modeled Area Width*	30	(ft)
Simulation Time*	60	(yr)

6. SOURCE DATA

Source Thickness in Sat.Zone* 6 (ft)

Vertical Plane Source: Look at Plume Cross-Section and Input Concentrations & Widths for Zones 1, 2, and 3

Source Zones:

Width* (ft)	Conc. (mg/L)*
6	2
6	2
6	2
6	2
6	2

View of Plume Looking Down

Source Halflife (see Help):

Infinite | Infinite (yr)
Inst. React. | 1st Order

Soluble Mass INFINITE (Kg)
In Source NAPL, Soil

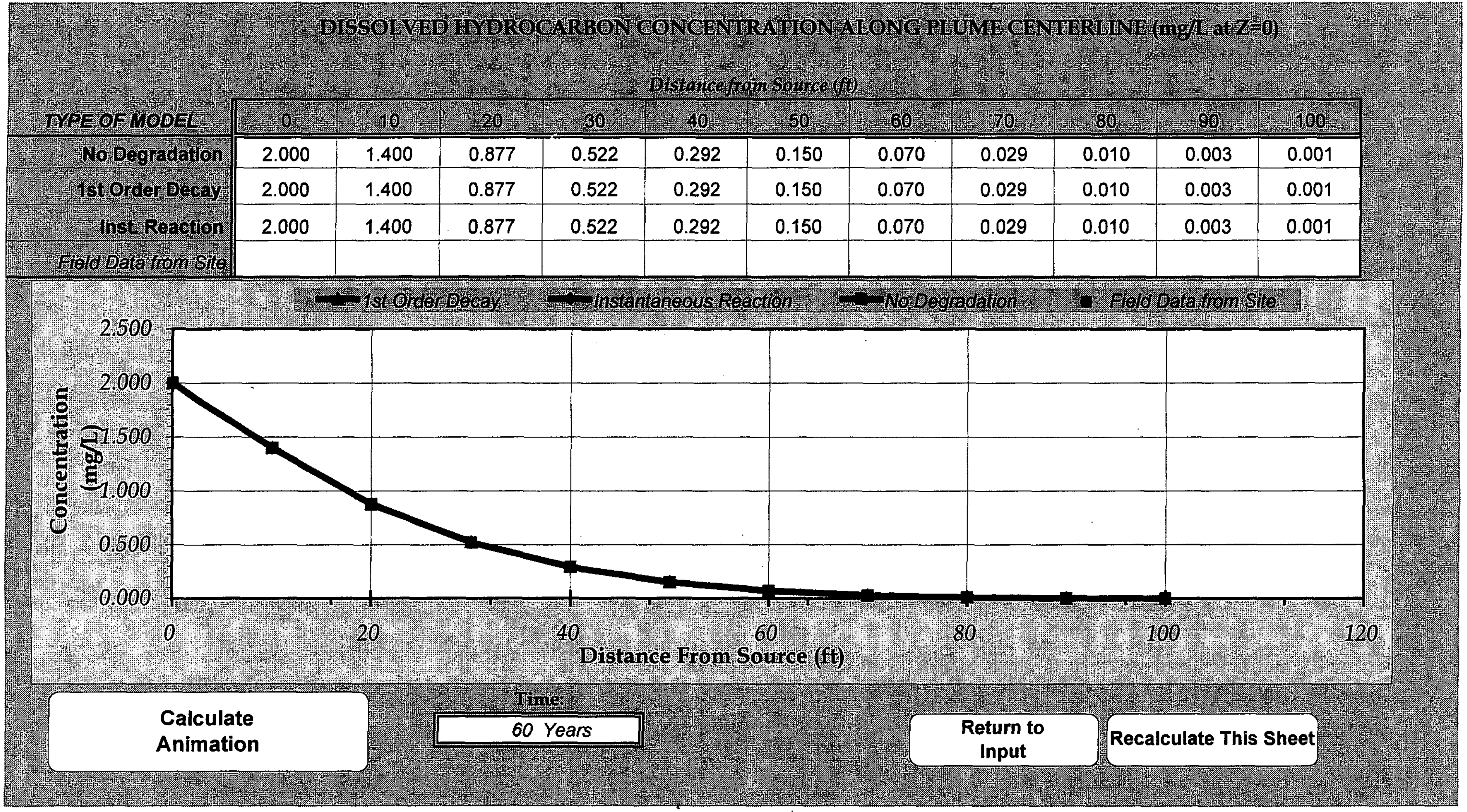
7. FIELD DATA FOR COMPARISON

Observed Centerline Concentrations at Monitoring Wells
If No Data Leave Blank or Enter "0"

Concentration (mg/L)											
Dist. from Source (ft)	0	10	20	30	40	50	60	70	80	90	100

8. CHOOSE TYPE OF OUTPUT TO SEE:

vinyl chloride



DISSOLVED HYDROCARBON CONCENTRATION ALONG PLUME CENTERLINE (mg/L at Z=0)

	Distance from Source (ft)										
TYPE OF MODEL	0	10	20	30	40	50	60	70	80	90	100
No Degradation	2.000	1.400	0.877	0.522	0.292	0.150	0.070	0.029	0.010	0.003	0.001
1st Order Decay	2.000	1.400	0.877	0.522	0.292	0.150	0.070	0.029	0.010	0.003	0.001
Inst. Reaction	2.000	1.400	0.877	0.522	0.292	0.150	0.070	0.029	0.010	0.003	0.001
Field Data from Site											

Time: 60 Years