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ARCADIS GERAGHTY & MILLER

Interim Measures/Corrective Measures Report

General Motors Corporation
Moraine, Ohio

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1. Introduction

This Interim Measures/Corrective Measures (IM/CM) report was prepared to address the existing groundwater conditions at the Delphi Harrison Thermal Systems Moraine Plant (Delphi Thermal Moraine), the General Motors Truck Group Moraine Assembly Plant (Moraine Assembly), and the General Motors Powertrain Group, Moraine Engine Plant (Moraine Engine), located in Moraine, Ohio (Figure 1-1). The IM/CM Report contains a summary of the multi-phased Resource Conservation and Recovery Act (RCRA) Facility Investigation (RFI) that was completed for these facilities, the conclusions from the Baseline Risk Assessment, the corrective action completion strategy, screening of corrective measures for groundwater, a summary of the interim measures results, and the recommended final site-wide remedy. This IM/CM Report serves as the site-wide corrective measures report for the three facilities.

The Supplemental RFI identified that the primary source area of volatile organic compounds (VOCs) in shallow groundwater at the three facilities is located at the Area of Interest (AOI) 7 - Former Oil House Area, north of Moraine Engine (Figure 1-1). The Baseline Risk Assessment concluded that under current site conditions there was no unacceptable risk associated with constituents detected in soil/waste at the AOIs and Solid Waste Management Units (SWMUs) investigated in the RFI. However, constituents detected in groundwater at AOI 7 may migrate to the extent that reasonably expected future uses of groundwater might be affected. Therefore, the focus of this report is a site-wide remedy that addresses the source of the groundwater contamination and the downgradient plume. The final remedy incorporates:

- The capture zone interim measures (hydraulic control with a pump and treat system for the upper aquifer and hydraulic control for the lower aquifer);
- The Former Oil House Area interim measures (in-situ remediation technologies at and downgradient of the source area);
- Institutional actions (the three facilities will remain industrial); and
- A site-wide groundwater monitoring program.

1.1 Interim Measures/Corrective Measures Objectives

Site-specific interim measures/corrective measures objectives were established to guide the development and evaluation of completion strategies and corrective measures alternatives. These objectives are based on the RFI results, including the Baseline Risk Assessment conclusions; requirements of the Administrative Order (as amended); and United States Environmental Protection Agency (U.S. EPA) guidance (U.S. EPA, 1994). The interim measures/corrective measures objectives address the VOCs in groundwater, exposure routes and receptors identified in the Baseline Risk Assessment, and a media-specific cleanup standard.

The interim measures/corrective measures objectives for the upper aquifer are as follows:

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1. To reduce VOC mass in the upper aquifer groundwater above the upper clay till in the primary source area (AOI 7);
2. To limit future migration from the source area to downgradient portions of the upper aquifer and into the lower aquifer;
3. To actively address VOCs that have already migrated downgradient from the source area in order to expedite remediation of the downgradient plume;
4. To prevent the migration of VOCs at concentrations exceeding the Safe Drinking Water Act (SDWA) Maximum Contaminant Levels (MCLs) beyond the existing plume boundary; and
5. To continue implementing the final corrective measures until the groundwater RTLs ~~cleanup objectives~~ are met on-site and MCLs can be met and maintained at the point(s) of compliance (POC) without active remedial measures.

define RTLs?

The interim measures/corrective measures objectives for the lower aquifer are as follows:

1. To maintain the lower aquifer as usable groundwater for on-site industrial purposes and for potential off-site, downgradient drinking water uses, and
2. To meet and maintain MCLs at the downgradient POC without active remedial measures.

These objectives are further discussed in Section 2.0.

1.2 Site Background

The Moraine Engine and Moraine Assembly facilities occupy approximately 300 acres, while the adjacent Delphi Thermal Moraine facility occupies approximately 165 acres. The facilities are located in the City of Moraine in Montgomery County in southwestern Ohio. A small portion of the Moraine Assembly facility is located in the City of Kettering. Figure 1-1 presents the location of each facility, property boundaries, and site features.

The General Motors Corporation (GM) site has been used for industrial purposes since the property was acquired in the mid-1920's. Frigidaire (a division of GM) produced appliances from the late 1920's until 1979. GM announced the shut down of all Frigidaire operations in January 1979. During 1980 and 1981, the majority of the former Frigidaire Plant 2 was converted to the Moraine Engine facility, and the former Frigidaire Plant 3 and the northeast corner of former Frigidaire Plant 2 were converted to the Moraine Assembly facility. Since 1981, Moraine Engine operations have included the machining, painting (this operation was discontinued in September 1995), and assembly of diesel truck engines. Operation of the Moraine Engine plant ceased in the fall of 2000. The plant building is currently undergoing decommissioning for demolition which is scheduled to be completed by the spring of 2001. The future use of the Moraine Engine property will remain industrial, it will be converted to a haulaway lot for GM operations and a portion will be leased to Norfolk Southern for expanded railroad operations. Since 1981, Moraine Assembly operations initially included the manufacture, assembly, and painting of small trucks, but currently Chevrolet Blazers, GM Jimmies, and Oldsmobile Bravadas are produced at this facility. Delphi Thermal Moraine's major operations, which began in 1941, are the machining and assembly of automotive air conditioning compressors, accumulator dehydrators, and miscellaneous air conditioning valves. Located immediately north of Delphi Thermal Moraine, is the newly constructed DMAX Engine Plant, which began operations in July 2000 and assembles the Duramax engine.

1.3 Site Regulatory History

Delphi Thermal Moraine contains the North and South Settling Lagoons that are shown on Figure 1-1. The North and South Settling Lagoons were operated during the time periods listed below.

- The North Settling Lagoon began operating in 1972 and was taken out of service in 1989;

  - Per RCRA Part A permit (June 13, 1988), contains listed waste codes: F006, F007, F009, F012, F019.
  - 1972 – 1979: received industrial wastewater containing metal plating wastes (zinc, nickel, and chrome), cutting fluids, pickling wastes, oils, porcelain sludges, electro-deposition paint rinse waters, and other industrial wastewaters; and non-contact cooling water and storm water runoff.
  - 1980 – 1984: received non-contact cooling water and storm water runoff.
  - 1984: process wastewaters diverted to an on-site pre-treatment facility.

- The South Settling Lagoon began operating in 1965 and was taken out of service in 1989:
  - Per RCRA Part A permit (June 13, 1988), contains listed waste codes: F006, F007, F009, F012, F019.
  - 1965 – 1979: received industrial wastewater containing zinc plating wastes, anodizing wastes, pickling wastes, oils, porcelain sludges, and other industrial wastewaters; and non-contact cooling water and storm water runoff.
  - 1980 – 1985: received dilute acid and alkali rinses from small cleaning and non-cyanodic electroplating processes; water softening sludges; non-contact-cooling water; storm water runoff; and fly ash dewatering filtrate.
  - 1985: process wastewaters diverted to an on-site pre-treatment facility.

GM filed a RCRA Part A Application with the Ohio Environmental Protection Agency (Ohio EPA) for interim status in November 1980. GM began detection monitoring at the North and South Settling Lagoons in February 1981. In 1984, assessment monitoring began for the North Settling Lagoon due to a statistical exceedance in specific conductivity. By October 1988, GM expanded the groundwater monitoring assessment plan network for the North Settling Lagoon and expanded the groundwater detection network in the South Settling Lagoon in accordance with an agreed consent order with the State of Ohio. Since 1988, the North Settling Lagoon and South Settling Lagoon have remained in assessment and detection monitoring programs, respectively. The assessment and detection monitoring programs will continue until the lagoon closure activities discussed below are completed. After closure, groundwater monitoring for the lagoons is planned to be conducted as part of the site-wide groundwater monitoring program under RCRA Corrective Action (under current negotiations with Ohio EPA).

Delphi Thermal Moraine submitted closure plans for the North and South Settling Lagoons to U.S. EPA and Ohio EPA in November 1985 and revised closure plans in November 1989. GM and Ohio EPA agreed to defer the closure of the lagoons pending resolution of other GM closure plans and the implementation of the corrective action order at the site. The North and South Settling Lagoons were evaluated as SWMUs in the RFI at Delphi Thermal Moraine. During the summer of 1999, GM met with the Ohio EPA to resume negotiations concerning the development of the closure plan for the lagoons. An agreed-upon approach was submitted to Ohio EPA in the Lagoon Closure Plan in June 2000 (Conestoga-Rovers & Associates, 2000) and approved by Ohio EPA on August 24, 2000. The plan calls for in-situ solidification of the lagoon sludge, backfilling to grade, and installing a soil cover system on the South Lagoon and an asphalt cover on the North Lagoon. GM began implementation of the closure plan on September 11, 2000. Solidification and the majority of backfilling were completed by late November 2000. Final backfilling and cover installation will be completed by early summer 2001.

Delphi Thermal Moraine received an Administrative Order (Docket No. V-W-91R-2) from the U.S. EPA Region V, which became effective on January 30, 1991. The Administrative Order, issued under Section 3008(h) of RCRA, as amended, 42 U.S.C. 6928(h), required Delphi Thermal Moraine to implement a RCRA Corrective Action program at the Moraine facility which included conducting an RFI and a CMS, if necessary.

GM is currently meeting the requirements of the original Administrative Order through the two-phased RFI investigation at the Delphi Thermal Moraine facility completed in 1992 through 1994 and by implementing capture zone interim measures in 1995 and 1996. The initial Interim Measure was implemented per the Final Interim Measures Design Plans (Geraghty & Miller, Inc. 1995), which was approved by the U.S. EPA in a July 31, 1995 letter. The initial, on-going interim measures consist of controlling migration of VOCs in the upper and lower aquifers at the southern property boundary through groundwater extraction at wells TW-2 and DN-13, respectively (Figure 1-1). The groundwater recovered by the upper aquifer recovery well TW-2 is treated using an air stripper tower and discharged through GM's National Pollutant Discharge Elimination System (NPDES) permitted outfall to the Great Miami River. During the first four years of operation (1996 through 1999), the system recovered and treated a total of 231,658,610 gallons at an average flowrate of 150 gallons per minute (ARCADIS Geraghty & Miller, 2000a). DN-13 is a deep aquifer well that Montgomery County has been utilizing in their Pump-to-Waste Program since March 1990, as a protective measure for their well field located downgradient of the GM site, because this well field could be used as a drinking water source for emergency purposes. The interim measure consists of continued pumping of DN-13 at a rate of approximately 2.6 million gallons per day (mgd).

The results of the first phase of the RFI, completed in late 1992 and early 1993, at Delphi Thermal Moraine, was submitted to the U.S. EPA in July 1993 (Geraghty & Miller, Inc. 1993b). A second phase of the RFI was completed in 1994. The findings of both phases of the RFI for Delphi Thermal Moraine, including a Baseline Risk Assessment, were reported to the U.S. EPA in a 1996 draft RCRA Facility Investigation Final Report (final issue date was April 2000 [ARCADIS Geraghty & Miller 2000b and ENVIRON Corporation 2000a]). The draft RFI report determined that there were no unacceptable risks associated with soil/waste present in SWMUs investigated, and therefore, it was concluded that a Corrective Measures Study (CMS) was not necessary for the SWMUs investigated in the RFI at Delphi Thermal Moraine. The U.S. EPA submitted comments to GM on the 1996 draft RFI report dated June 11, 1996 and GM responded to these comments on September 11, 1996. The U.S. EPA provided a reply to the comment responses in correspondence to GM dated October 1, 1996. To address the U.S. EPA's concerns identified in this correspondence, GM agreed to add the Moraine Engine and Moraine Assembly facilities into the Corrective Action program.

The U.S. EPA issued an Amendment to the Administrative Order (Docket No. VW-R-002-91), effective on April 24, 1997, which incorporated the two additional facilities into the program. GM conducted a Supplemental RFI at the two adjacent facilities. A multi-phased investigation was completed during the Supplemental RFI. In 1997 and 1998, investigation activities were completed for six AOIs identified during the Supplemental Description of Current Conditions (DOCC) as having potentially managed hazardous constituents (Geraghty & Miller, Inc. 1997a). The result of the investigations determined that for all of the AOIs, excluding AOI 7, no evidence of a significant release of hazardous constituents was found. In 1998, additional investigations were conducted at AOI 7 - Former Oil House Area, because this AOI had released hazardous constituents to soil and groundwater. The findings of the Supplemental RFI for Moraine Engine and Moraine Assembly, including a Supplemental Baseline Risk Assessment, were reported in the draft Supplemental RFI

Report submitted to the U.S. EPA in 1999 (final issue date was April 2000 [ARCADIS Geraghty & Miller 2000c and ENVIRON Corporation 2000b]). The Supplemental RFI Report determined that constituent concentrations in soils at the AOIs do not pose an unacceptable risk. However, the Supplemental RFI determined that existing constituents in groundwater at AOI 7 had the potential to affect future uses of groundwater. Therefore, GM recommended interim measures to address VOCs in groundwater associated with AOI 7.

A Primary Groundwater Source Area (AOI 7) Interim Measures Work Plan was submitted to the U.S. EPA in June 1999 and was approved by the U.S. EPA in July 1999 (ARCADIS Geraghty & Miller, Inc. 1999). This Work Plan recommended a combination of in-situ technologies to address chlorinated VOCs in shallow groundwater. The recommended in-situ technologies were implemented and monitored from September 1999 to May 2000. In addition, to provide a basis for evaluating the performance of these interim measures, the Work Plan proposed that a comprehensive site-wide groundwater sampling event be conducted to establish a baseline data set. This baseline sampling was completed during August to October 1999.

The U.S. EPA submitted comments to GM, dated February 1, 2000, on the Draft RFI and Draft Supplemental RFI reports. As stated in U.S. EPA's February 1, 2000 correspondence, a CMS report was necessary for the site; however, the IMS report described in the AOI 7 Interim Measures Work Plan could serve as the CMS if it adequately addressed the subject matter. GM submitted responses to the U.S. EPA's comments on February 24, 2000. In April 2000, GM submitted the final RFI report for Delphi Thermal Moraine (ARCADIS Geraghty & Miller, Inc. 2000b and ENVIRON Corporation 2000a) and the final Supplemental RFI report for Moraine Engine and Moraine Assembly (ARCADIS Geraghty & Miller, Inc. 2000c and ENVIRON Corporation 2000b) to the U.S. EPA. GM received approval with comments on these reports from the U.S. EPA, dated June 16, 2000 and June 28, 2000. GM submitted responses to the U.S. EPA's comments on July 28, 2000.

In March 2000, GM submitted to the U.S. EPA a draft Site-Wide Groundwater Monitoring Plan to monitor the effectiveness of the interim measures and monitor groundwater quality upgradient and downgradient of the land-based units, including the North and South Settling Lagoons (ARCADIS Geraghty & Miller, Inc. 2000d). GM received approval with comments on this plan from the U.S. EPA, dated June 16, 2000 and June 28, 2000. GM submitted responses to the U.S. EPA's comments on July 28, 2000. The U.S. EPA submitted an additional set of comments to GM on

September 15, 2000 and GM submitted responses to the U.S. EPA's comments on November 17, 2000. As proposed in the draft Site-Wide Groundwater Monitoring Plan, GM completed the first annual sampling event in September 2000.

1.4 Site Characterization

This site characterization section contains a summary of information presented in the Delphi Thermal Moraine DOCC (Geraghty & Miller, Inc. 1991), the Moraine Engine and Moraine Assembly Supplemental DOCC (Geraghty & Miller, Inc. 1997a), the Delphi Thermal Moraine RFI (ARCADIS Geraghty & Miller, Inc., 2000b) and the Moraine Engine and Moraine Assembly Supplemental RFI (ARCADIS Geraghty & Miller, Inc., 2000c).

1.4.1 Surface Water and Drainage Features

Moraine and the surrounding region are within the Great Miami River drainage basin. The river generally flows north to south in the vicinity of the site and is closest to the site at the southwestern end of the Delphi Thermal Moraine facility. The river is approximately 3,600 feet (ft) west of the northern end of the Delphi Thermal Moraine facility and bends to as close as 700 ft near the South Settling Lagoon; approximately 2,800 ft west of the southwest corner of the Moraine Engine facility; and approximately 4,500 ft west of the northern end of the Moraine Assembly facility (Figure 1-1). No major tributaries to the Great Miami River pass through the facilities, however, Holes Creek which discharges to the Great Miami River is located approximately 2,500 ft south of the site. The Flood Insurance Rate Map for Moraine (presented as Figure 2-2 in the Supplemental DOCC) shows that the area affected by the 100-year flood does not include the GM facilities.

Storm water from the East Haulaway and the former West Haulaway areas (the former West Haulaway is now the location of the DMAX Engine Plant) is discharged into an unnamed drainage ditch located east and south of the West Haulaway, which was assessed during the RFI (ARCADIS Geraghty & Miller, Inc. 2000b). This ditch originates in west Kettering, flows east to west across the Moraine Assembly facility, then north to south along the east side of the DMAX Engine Plant, then east to west along the south side of the DMAX Engine Plant. The ditch eventually discharges into the Great Miami River through GM's NPDES permitted outfall.

1.4.2 Local Demography and Land Use

The Delphi Thermal Moraine facility, Moraine Engine facility, and the western portion of the Moraine Assembly facility are located in an area zoned for general industry, while the eastern portion of the Moraine Assembly facility is located in an area zoned for light industry. Areas adjacent to the site are zoned for general industry, light industry, general business, neighborhood business, and one- and two-family residential uses. Area zoning and land use information is presented in greater detail in the Supplemental DOCC (Geraghty & Miller, Inc, 1997a).

1.4.3 Hydrogeology

The Delphi Thermal Moraine, Moraine Engine, and Moraine Assembly facilities lie over the Great Miami River buried valley aquifer, which consists of valley fill deposits composed of sand and gravel outwash separated by locally discontinuous silt and clay units, referred to as till zones. Beneath the site, these glacial deposits have been divided into the following hydrogeologic units: the upper sand and gravel unit, the regional till zone, and the lower sand and gravel unit. The upper sand and gravel unit is generally 30 ft, and in some areas, up to 70 ft thick and contains minor till lenses. The unit is considered a water-table aquifer. In addition, the upper aquifer beneath the AOI 7 area is divided into an upper and lower portion by the presence of an upper clay till. The upper clay till is continuous beneath the AOI 7 area at a depth ranging from approximately 25 ft to over 40 ft below land surface (ft bls). The water table is located approximately 4 to 12 ft above the top of the upper clay till.

The regional till zone has a varied thickness and continuity, but appears to be discernible throughout the region; it ranges from being absent to being present in excess of 50 ft thick beneath the site. The regional till zone overlies at least 50 ft, and in some areas, over 100 ft of sand and gravel that comprise the lower unit. This lower unit is a fully saturated, semi-confined aquifer throughout most of the Dayton area; however, there are locations where the regional till is thin or discontinuous. In areas where the regional till is absent, the upper and lower aquifers respond as one hydrogeologic unit. Consequently, aquifer parameters across the site vary with the thickness and distribution of the till layer. Additional information on site hydrogeologic units is presented in the RFI Report (ARCADIS Geraghty & Miller, Inc. 2000b) and the Supplemental DOCC (Geraghty & Miller, Inc. 1997a).

Depth-to-water measurements and water-level elevations measured on September 13, 1999, for the upper aquifer are summarized in Table 1-1. The water-table surface on

September 13, 1999 (Figure 1-2) shows flow in the upper aquifer is generally from northeast to southwest over the majority of the site. A groundwater capture zone, centered around Capture Well TW-2 located in the southwest corner of Landfill L1, is evident at the southern end of the Delphi Thermal Moraine facility. TW-2, screened in the upper aquifer, began operation on January 31, 1996. The September 13, 1999 water-level measurements show the water level in Well TW-2 is lower than the water levels to the west in monitoring well GM-16, to the southwest in monitoring well GM-17, and to the south in monitoring well WSU-24, indicating a localized reversal of groundwater flow south/southwest of Capture Well TW-2.

Hydraulic characteristics of the water-table aquifer were determined by evaluation of data from pumping tests conducted in 1985 and in 1989. The median hydraulic conductivity (K) value estimated from pumping test data was 1,650 ft per day (ft/day), and effective porosity was assumed to be 0.3 to 0.5. Using average hydraulic gradients for September 1999, groundwater flow velocities in the upper aquifer ranged from 2.62 ft/day to 4.37 ft/day.

Water-level elevations, presented on Table 1-1, were measured in the deep monitoring wells and production wells on September 13, 1999. The potentiometric surface on September 13, 1999 (Figure 1-3) shows groundwater flow in the lower aquifer to be generally from northeast to southwest, with a groundwater capture zone centered around County Well DN-13. County Well DN-13 is located southwest of the Delphi Thermal Moraine facility in the Dryden Road North Wellfield. The Pump-to-Waste Program at the Dryden Road North Wellfield, began in 1990 and was in operation during the September 1999 baseline groundwater monitoring event. Groundwater flow velocity in the lower aquifer ranged between 0.83 ft/day and 1.39 ft/day.

The lower aquifer is currently used as a nonpotable industrial water supply at the Moraine Engine and Moraine Assembly facilities, and as a public water supply in West Carrollton (2 miles south of the facilities), and has the potential for use as an emergency drinking water supply downgradient of the facilities.

1.5 Summary of RFI Activities

The RFI included completion of a background soil investigation and development of a groundwater flow model to support the baseline risk assessment. These RFI activities are discussed in this section. A summary of the SWMUs/AOIs that were investigated during the RFI at all three facilities are presented below, along with an overview of the sampling programs completed during the multi-phased investigations.

1.5.1 RFI Background Soil Investigation

In order to evaluate potential releases of inorganic hazardous constituents from SWMUs/AOIs, a background soil investigation was conducted in 1992. To obtain background soil concentrations, 12 boreholes were drilled to a total depth of 16 ft in an area not known to be associated with current or former manufacturing operations or affected by waste management activities at the Delphi Thermal Moraine facility. Both shallow and deep samples were collected from these borings. Additional information on the background soil investigation is presented in the Soil Background Analytical Results Report (Geraghty & Miller, Inc., 1993a) and the Delphi Thermal Moraine RFI report (ARCADIS Geraghty & Miller, Inc., 2000b).

1.5.2 Groundwater Flow Model

A three-dimensional steady-state groundwater flow model was developed to support the characterization and assessment of hydrogeologic conditions, the RFI investigations, the Baseline Risk Assessment, and the capture zone interim measures. The model construction and calibration was documented in the 1994 Revised Three-Dimensional Steady-State Flow Model Construction and Calibration report (Geraghty & Miller, Inc., 1994a).

1.5.3 Summary of Investigations at Delphi Thermal Moraine

During the Delphi Thermal Moraine RFI, three landfills (Landfill L1, L2, and L3), five underground storage tanks (USTs T4, T5/T6, T11, T12), the Waste Pile/Staging Area, the Liquid Waste Burner, and the Fill Area were investigated. The two surface impoundments (North and South Settling Lagoons) were further evaluated during the RFI using data previously collected for the RCRA closure program. Additional areas of investigation were also addressed during the RFI. These areas included the Background Area, Surface Water/Sediment Locations, and the groundwater quality south of Landfill L1. Locations of the SWMUs and additional areas of investigation are shown on Figure 1-4. Descriptions of the SWMUs and additional areas investigated during the RFI are excerpted from the RFI report and presented in Appendix A. Two rounds of groundwater sampling were also conducted during the Delphi Thermal Moraine RFI. Table 1-2 presents a summary of the RFI groundwater, soil, surface water/sediment and waste sampling programs completed between 1992 and 1994.

1.5.4 Summary of Investigations at Moraine Engine/Moraine Assembly

During the Moraine Engine and Moraine Assembly Supplemental RFI, investigations were completed at the following six AOIs: AOI 7 - Former Oil House Area, AOI 13 - Buildings 4, 6, and 13, AOI 17 - Building 15, AOI 34 - Excavation Area 1, AOI 35 - Excavation Area 2, and AOI 36 - Former Southwest Above Ground Storage Tanks (ASTs). Locations of the AOIs are shown on Figure 1-5. Descriptions of the AOIs investigated during the Supplemental RFI are excerpted from the Supplemental RFI report and presented in Appendix A. One round of groundwater sampling was also conducted during the Moraine Engine and Moraine Assembly Supplemental RFI (wells located at Moraine Engine, Moraine Assembly, and Delphi Thermal Moraine). Additional groundwater sampling was conducted along with the AOI 7 soil investigation. Table 1-3 presents a summary of the Supplemental RFI groundwater and soil sampling programs completed between 1997 and 1998.

1.6 Summary of RFI Findings and Conclusions

Based on the results of the RFI, GM concludes that constituents in soil/waste at the SWMUs (including landfills and lagoons) and soil at the AOIs do not pose an unacceptable risk under current and reasonably expected land use and groundwater use conditions. However, the assessment of risk posed by existing groundwater conditions in the primary source area AOI 7 indicates that further action is warranted for this area, as further discussed in Section 3.0. The sections presented below contain a summary of the conclusions from the RFI. A more detailed discussion is presented in the final RFI Report (Volume I [ARCADIS Geraghty & Miller, Inc. 2000b and c] and Volume II [ENVIRON Corporation, 2000a and b]).

1.6.1 RFI Findings

Implementation of the RFI accomplished the media-specific objectives listed below.

<u>Soil</u>

1. Determine if a release of hazardous constituents has occurred from the SWMUs/AOIs.

2. Define the nature and extent of any hazardous constituents released from the SWMUs/AOIs required to support the Baseline Risk Assessment.

Waste

1. Define the areal extent of waste in the landfills.

2. Characterize shallow soil/waste constituents in landfills at the site for the Baseline Risk Assessment by sampling and analysis.

3. Characterize deep waste/soil contamination from hazardous constituents at landfills for the Baseline Risk Assessment by sampling groundwater immediately downgradient from the units.

Sediment/Surface Water

Provide a characterization of on-site sediment/surface water to be used in the Baseline Risk Assessment.

Groundwater

1. Collect site-wide data to characterize groundwater with respect to flow direction, occurrence, and concentrations of Appendix IX constituents and cis-1,2-dichloroethene (cis-1,2-DCE).

2. Collect data further downgradient of the site to characterize groundwater with respect to flow direction, occurrence, and concentrations of Appendix IX VOC constituents and cis-1,2-DCE.

3. Collect data that will support the site-wide Baseline Risk Assessment.

4. Evaluate site-wide natural attenuation of VOCs.

The sludge present in the North and South Settling Lagoons was also evaluated during the RFI. Characterization data collected in support of the preparation of RCRA closure plans for these two SWMUs was utilized in the Baseline Risk Assessment.

The primary objective of the Baseline Risk Assessment was to address the following questions.

1. Do constituents in soil/waste at any of the SWMUs at Delphi Thermal Moraine pose an unacceptable risk, which warrants corrective measures?

2. Do constituents in soil at any of the AOIs at Moraine Engine or Moraine Assembly pose an unacceptable risk, which warrants corrective measures?

3. Do constituents in groundwater at any of the SWMUs or AOIs at the three GM facilities pose an unacceptable risk, which warrants corrective measures?

Presented below is a discussion of how each of these objectives was achieved during the RFI and a conclusion regarding the need for additional investigative activities.

1.6.1.1 Soil

To accomplish the RFI objectives at the nine SWMUs where soil was considered a medium of potential concern (West Tank Farm, T12, T5/T6, T4, T11, Waste Pile/Staging Area, South Tank Farm, Liquid Waste Burner, and Fill Area), a review of historical data was completed and RFI soil sampling was conducted at Delphi Thermal Moraine. Additionally, an analysis of background soil conditions was completed to provide a basis for evaluating constituent concentrations at SWMUs relative to naturally occurring concentrations of these constituents.

The results obtained from the two rounds of RFI soil sampling at Delphi Thermal Moraine provided the information necessary to complete an evaluation of the presence of any suspected release, as well as sufficient detail on the nature and extent of any release to support an evaluation in the Baseline Risk Assessment of risks posed by the SWMUs. Soil analytical results and sampling locations are presented in Appendix A.

To accomplish the RFI objectives at the Moraine Engine and Moraine Assembly facilities, six AOIs where soil was considered a medium of potential concern (AOIs 7, 13, 17, 34, 35, 36) were investigated, a review of historical data was completed and RFI soil sampling was conducted. The soil sampling results provided information necessary to complete an evaluation of the presence of any suspected release, as well as sufficient detail on the nature and extent of any release to support an evaluation of risks posed by the AOI in the Baseline Risk Assessment. Soil analytical results and sampling locations are presented in Appendix A.

Based on the RFI soil sampling results, adequate data had been collected to characterize the SWMUs/AOIs and no additional activity was necessary to support the Baseline Risk Assessment. The Baseline Risk Assessment determined that constituents in soil at the SWMUs and AOIs do not present an unacceptable risk under reasonable maximum exposure via direct contact, airborne transport, or groundwater transport for the current and reasonably expected land use and groundwater use scenarios evaluated. Therefore, further remedial action was not warranted for soils at the SWMUs/AOIs. GM has proposed conducting an additional soil and groundwater investigation at the Waste Pile/Staging Area, as part of the Site-wide Groundwater Monitoring Program. Data to be collected from the Waste Pile/Staging Area investigation will be evaluated per the procedures presented in the Baseline Risk Assessment (ENVIRON Corporation 2000a and b).

1.6.1.2 Waste

Waste was considered a potential concern at the three inactive landfills at the Delphi Thermal Moraine facility and the sludge present in the North and South Settling Lagoons. To accomplish the RFI objectives at Landfills L1, L2, and L3, a review of historical data was completed, a geophysical survey was completed, where possible, one round of RFI waste sampling was conducted, and two rounds of groundwater sampling were conducted.

The areal extent of the landfills was adequately delineated during the RFI, through a review of aerial photography and topographical and physical land features, and the geophysical assessment completed at L2 and L3. The verified boundaries of the landfills were then used to develop a random grid to ensure the shallow sampling provided a representative characterization of waste constituents of potential concern in surface materials at these SWMUs. The deep wastes were also characterized through an evaluation of groundwater quality in monitor wells located immediately downgradient of the landfills. Waste analytical results and sampling locations, including the North and South Settling Lagoons are presented in Appendix A.

No supplemental characterization of the North and South Settling Lagoons was conducted during the RFI. Rather, sludge characterization data collected in support of the preparation of RCRA closure plans for these two SWMUs was sufficient for use in the RFI Baseline Risk Assessment.

The results of the Baseline Risk Assessment indicate that constituents present in the waste at these SWMUs do not present an unacceptable risk under reasonable maximum exposures via direct contact, airborne transport, or groundwater transport for the current and reasonably expected land use and groundwater use scenarios evaluated. Therefore, no further remedial action was warranted for waste at the SWMUs.

1.6.1.3 Surface Water/Sediment

Surface water and sediment were considered media of potential concern at Delphi Thermal Moraine due to the presence of the drainage ditch on the north end of the facility. To accomplish the RFI objectives, surface water and sediment samples were collected within the drainage ditch at locations upstream and downstream of the facility.

The results obtained from the RFI sampling provided the information necessary to characterize this media, and no supplemental investigative activity was necessary to support the Baseline Risk Assessment. Surface water and sediment analytical results and sampling locations are presented in Appendix A.

A review of the RFI sampling for these surface water/sediment, indicated that constituents detected in the downstream surface water and sediment samples were at concentrations similar to upstream concentrations. Additionally, an evaluation of topographical and land-use features between the drainage ditch and the SWMUs at the north end of the facility, and a comparison with constituents detected in these SWMUs, indicated that the concentration of constituents detected in the downstream surface water and sediment samples were likely attributable to either natural background or off-site sources. Based on this evaluation, no remedial activities were warranted for surface water/sediment.

1.6.1.4 Groundwater

To accomplish the RFI objectives for groundwater, two rounds of groundwater sampling were conducted from a well network which consisted of 36 monitor wells during Phase I and 42 monitor wells during Phase II at the Delphi Thermal Moraine facility. Additionally, an analysis of background groundwater conditions was completed to provide a basis for evaluating the presence of both naturally and non-naturally occurring constituents coming onto the Delphi Thermal Moraine facility from upgradient sources.

The investigative strategies for characterizing site-wide groundwater quality included evaluating groundwater results upgradient and downgradient of each SWMU, evaluating groundwater results upgradient and downgradient of the site, and using the site-specific groundwater flow model to support the Baseline Risk Assessment by estimating concentrations of constituents which may migrate from the Delphi Thermal Moraine facility. This level of groundwater data and evaluation provided a detailed understanding of the presence of constituents of potential concern beneath and downgradient of Delphi Thermal Moraine. Groundwater analytical results and sampling locations are presented in Appendix A. VOC concentrations at each well sampled in the upper and lower aquifers in 1993/1994 during the RFI are posted on Figures 1-6 and 1-7, respectively.

To accomplish the RFI objectives for groundwater at the Moraine Engine and Moraine Assembly facilities, site-wide sampling for VOCs, AOI-specific sampling, and bioattenuation indicator parameter sampling were conducted. In addition, water level measurements were collected and three shallow monitor wells were installed. The RFI concluded that the groundwater objectives had been met and no additional groundwater investigative activities were required to support development of the Baseline Risk Assessment. Groundwater analytical results and sampling locations are presented in Appendix A. VOC concentrations at each well sampled in the upper and lower aquifers in 1998 during the Supplemental RFI are posted on Figures 1-8 and 1-9, respectively.

As concluded in the Baseline Risk Assessment, the combined effect of constituents in soil/waste at the SWMUs and AOIs did not pose an unacceptable risk via groundwater transport under the current and reasonably expected future use scenarios evaluated. Specifically, as indicated in Sections 1.6.1.1 and 1.6.1.2, under current and reasonably likely future groundwater use conditions, potential leaching of constituents from soil/waste is not predicted to cause concentrations at points of groundwater use to exceed MCLs (or similar risk-based drinking water concentrations for constituents without MCLs), with or without capture zone interim measures. Only in the very unlikely event that the Miami Shores and Dryden Road South well fields are both needed to supply water in an emergency, potential leaching of constituents from soil/waste at the SWMUs (primarily Landfill L1 and the Waste Pile/Staging Area) is predicted to cause concentrations at Dryden Road South to exceed MCLs for a few constituents (tetrachloroethene [PCE], trichloroethene [TCE], lead and/or nickel) without capture zone interim measures.

However, these results are expected to overstate potential reasonable maximum exposures because of the low likelihood that the Dryden Road South well field would be used. Also the predicted effects attributed to Landfill L1 actually may be from upgradient groundwater at AOI 7, and the predicted effects attributed to the Waste Pile/Staging Area are not supported by on-site groundwater monitoring data. In the corresponding scenarios, which account for the current interim measures, potential leaching of constituents from soil/waste at the SWMUs and AOIs is not predicted to cause concentrations at points of potential but unlikely groundwater use to exceed MCLs (or similar risk-based drinking water concentrations for constituents without MCLs).

The Baseline Risk Assessment did identify the potential for constituents in groundwater at AOI 7 to affect groundwater quality at some points of current and reasonably expected future groundwater use under the scenarios evaluated. Specifically, the migration of PCE and TCE in groundwater from AOI 7 is predicted to cause concentrations in groundwater at the Moraine Engine and Moraine Assembly industrial production wells to exceed MCLs under several groundwater use scenarios (including those with the capture zone interim measures). However, groundwater from these production wells is currently used only as nonpotable process water and the upper bound estimates for the resultant exposure concentrations associated with this current groundwater use are approximately 10,000 fold below Occupational Safety and Health Administration (OSHA) Permissible Exposure Limits (PELs) for workers. The migration of PCE and TCE in groundwater from AOI 7 is predicted to cause concentrations in groundwater to exceed MCLs at the Dryden Road North well field under groundwater use scenarios with current interim measures and at the Dryden Road South well field for several groundwater use scenarios with and without capture zone interim measures. However, groundwater use at these well fields is very unlikely, and, therefore, potential exposure to these constituents from these well fields are likely overstated. However,

- The migration of constituents in groundwater from AOI 7 is not predicted to cause concentrations at current drinking water supplies (i.e., the West Carrollton well field) to exceed MCLs (or similar risk-based drinking water concentrations for constituents without MCLs) under any of the groundwater scenarios evaluated (with or without capture zone interim measures);

- The migration of constituents in groundwater from AOI 7 is not predicted to cause concentrations at the Miami Shores well field to exceed MCLs (or similar risk-based drinking water concentrations for constituents without MCLs) if it is used as an emergency drinking water supply (with or without capture zone interim measures); and

- The migration of constituents in groundwater from AOI 7 is not predicted to cause concentrations at the currently inactive Delphi Thermal Moraine industrial production wells to exceed MCLs (or similar risk-based drinking water concentrations for constituents without MCLs) if they were placed into service under the pumping scenarios evaluated.

1.6.2 RFI Conclusions

As concluded in the Baseline Risk Assessment, no unacceptable human exposures have been determined to be currently occurring, and no unacceptable exposures via direct contact or airborne transport from soil/waste are predicted to occur for reasonably expected future land use conditions. Therefore, no further remedial action is warranted for soil/waste. For the drainage ditch at the north end of Delphi Thermal Moraine, and an area west of the facility along the Great Miami River, there was no indication of adverse ecological impacts from the SWMUs, and therefore, there was no need for a more detailed ecological assessment. However, the potential exists for constituents in groundwater from to migrate to the extent that reasonably expected future uses of groundwater in the lower aquifer might be affected. Therefore, GM initiated interim measures to remediate the source area contamination, and established the following short-term and long-term goals for addressing groundwater at and downgradient of the AOI 7 source area:

Short-term Goal: Implementation of capture zone interim measures and interim measures to address the VOCs present in shallow groundwater at and downgradient of AOI 7. This work has been implemented.

Long-term Goal: Remediation of groundwater by implementing an effective strategy to reduce constituent concentrations within the plume migrating from AOI 7, in conjunction with a site-wide monitoring plan, allowing initial interim measures implemented at the downgradient site boundary (i.e., groundwater extraction from TW-2 in the upper aquifer and DN-13 in the lower aquifer) to be shut-off after the remediation of constituents from AOI 7 is proven to be effective. A site-wide groundwater monitoring program has been developed which will provide data necessary to assess the timing for shutting off the initial interim measures wells (TW-2 and DN-13), as well as providing for long-term site-wide monitoring of SWMUs with in-place wastes (i.e., the landfills and lagoons) and the Waste Pile/Staging Area (ARCADIS Geraghty & Miller, Inc., 2000d). The intent of the long-term monitoring of SWMUs with waste in-place is to identify any significant contributions to groundwater from these units that would inhibit GM's ability to meet its corrective action objectives in a timely manner.

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2. Corrective Action Completion Strategy

As stated in Section 1.1, GM's long-term goal under its corrective action program is to reduce existing on-site and off-site groundwater concentrations to levels that are protective of reasonably expected future uses of groundwater. GM's strategy for achieving this goal will be met through a combination of corrective measures that ~~achieve~~ maintain plume migration control, reduce existing plume concentrations, and monitor performance of these measures. Data will be acquired during the implementation of corrective measures to evaluate progress towards achieving this goal. Once on-site groundwater concentrations are reduced sufficiently by active corrective measures to ensure continued protection of reasonably expected groundwater uses, the active measures will be shut-off. Groundwater monitoring would continue to verify that groundwater conditions remain acceptable.

D R A F T

As discussed in Section 1.6, the RFI Baseline Risk Assessments determined that no unacceptable human exposures are currently occurring. However, constituents in groundwater at AOI 7 were determined to have a potential to migrate to an extent that reasonably expected future uses of groundwater might be affected. As described in detail in Section 3.0, at the request of U.S. EPA, GM implemented interim measures pumping of groundwater at the downgradient property boundary at wells TW-2 and DN-13 to control migration of groundwater constituents. GM has also implemented in-situ remediation in AOI 7 and at three on-site locations downgradient of AOI 7. In addition, GM has initiated a site-wide groundwater monitoring program to collect and evaluate data for its ongoing assessment of the effectiveness of these remedial measures in meeting the objectives stated in Section 1.1. The monitoring program includes monitoring for some period following termination of these remedial measures to ensure that groundwater quality remains acceptable. In addition, the monitoring program includes provisions for identifying potentially significant contributions from the land-based units (i.e., landfills and lagoons), if any, relative to the existing site-wide groundwater quality, to ensure continuation of corrective action as necessary to address these units.

The need for continued operation of the remedial measures will be determined based on achieving and maintaining the following conditions:

1. Upper Aquifer: Consistent with the criterion stated in the RCRA Corrective Action Environmental Indicator Determination – Migration of Contaminated Groundwater Under Control (CA 750), the condition to be met in the upper aquifer is no migration of VOCs at concentrations exceeding appropriately protective levels (i.e., appropriate for the protection of the groundwater resource and its beneficial

uses as characterized in the RFI) beyond the existing area of contaminated groundwater. Based on the groundwater conditions established during the September 1999 baseline sampling event, GM proposes to use existing well GM-26 as the POC for ensuring that this condition is maintained.

2. Lower Aquifer: Consistent with the goal to maintain a usable aquifer, including off-site drinking water use, the condition to be met in the lower aquifer is no VOC concentrations exceeding MCLs or equivalent risk-based drinking water concentrations in the lower aquifer beyond the existing area of contaminated groundwater. Based on the groundwater conditions established during the September 1999 baseline sampling event, GM proposes to use existing wells GM-15, GM-11, and GM-20D as the POC for ensuring that this condition is achieved and maintained.

Progress towards achieving these conditions will be evaluated by comparing groundwater quality data from on-site monitoring wells to performance-based remediation target levels (RTLs) that ensure compliance with these conditions without active corrective measures. Monitoring wells located at and downgradient of the remedial measures (i.e., capture zone pumping wells and in-situ remediation zones) are included in GM's site-wide groundwater monitoring program to provide data for determining whether active measures are performing as expected, have reduced groundwater concentrations to RTLs, or have reached the feasible limits of the technology. These annual evaluations will provide the basis for modifications to the remedial measures, including terminating some or all of these actions in the future. In addition, these evaluations will determine if the land-based units contribute to the existing groundwater concentrations which would prevent meeting RTLs downgradient of AOI 7 (e.g., concentrations are reduced immediately downgradient of AOI 7 to meet the RTLs, but higher concentrations continue to be observed downgradient of a land-based unit at levels above the RTLs). In this case, appropriate corrective measures will continue until the RTLs are achieved at the POC.

2.1 Development of Remediation Target Levels

Similar to the assessment of potential exposures to groundwater under current and reasonably expected future groundwater uses at and surrounding the Delphi Thermal Moraine, Moraine Engine, and Moraine Assembly facilities that was conducted in the RFI Baseline Risk Assessments, GM is using mathematical models to estimate on-site groundwater concentrations that will be protective of future groundwater uses. Specifically, the MODFLOW groundwater flow model (Geraghty & Miller, Inc.

1994a) developed for Delphi Thermal Moraine and the surrounding region (including Moraine Engine and Moraine Assembly) is being used to support the estimation of RTLs equal to concentrations in on-site groundwater at locations downgradient of AOI 7 that would not be expected to result in exceedances of the MCL at the designated points of compliance.

2.1.1 Baseline Risk Assessment Modeling

The MODFLOW model (Geraghty & Miller, Inc. 1994a) developed to evaluate groundwater flow at and surrounding the three facilities under various pumping conditions was used in the RFI Baseline Risk Assessment as the basis for approximating the transport of waste constituents from the SWMUs and AOIs to potential points of groundwater use. Specifically, the groundwater flow model facilitated the approximation of constituent transport in groundwater by allowing the calculation of source reduction factors that account for the natural dilution of constituents as they move in groundwater from under the facilities to potential exposure points. The source reduction factors were calculated by using the MODFLOW model in combination with MODALL (Potter 1995), a complete-mix model designed to work with MODFLOW. The MODALL model uses the cell-by-cell flow terms computed by MODFLOW to calculate source reduction factors for a specified source within each downgradient cell or block in the finite difference domain of the MODFLOW model. The source reduction factors were computed for steady-state transport (without dispersion) with the following conservative assumptions:

- The contaminant source provides a continuous, steady-state flux of constituents into the upper aquifer.
- No degradation of constituents occurs during transport.
- No dispersion of constituents occurs during transport.

A source reduction factor was computed by setting the concentration of the groundwater beneath the source to a constant, unit concentration (or dimensionless concentration C/C_0), such that the calculated concentration at an exposure point ranges from zero to one. The concentration estimated at the potential exposure point for a unit source concentration was the source reduction factor for that source and exposure point combination. The estimated exposure concentration of a constituent at an exposure point resulting from a specific source was then obtained by multiplying the groundwater concentration at the source with the source reduction factor.

2.1.2 Model Application

For the purpose of developing RTLs for assessing the performance of remedial measures, the groundwater modeling scenario that best represents current groundwater use conditions in the absence of interim measures pumping at TW-2 and DN-13 is used. Currently, this scenario, which accounts for current operations of on-site industrial wells and off-site industrial and municipal well fields, is best represented by groundwater model Scenario 1 evaluated in the Supplemental RFI Baseline Risk Assessment.

Under this current pumping scenario, source reduction factors are estimated for several monitoring locations or zones[1] between the AOI 7 groundwater source area and the downgradient POCs. First, a source reduction factor between the source area and the POC is estimated using the methods employed in the Supplemental Baseline Risk Assessment, as summarized above. Then, normalized RTL values are calculated for specific monitoring zones between the source and the POC by dividing the source reduction factor for each monitoring zone by the source reduction factor for the POC. A constituent-specific RTL for each monitoring zone is then calculated by multiplying the allowable POC concentration of the constituent (e.g., the MCL or equivalent risk-based drinking water concentration) with this normalized RTL value.

2.2 Preliminary Remediation Target Levels

Using the approach discussed above and considering the scope of the proposed annual groundwater monitoring program, GM has developed preliminary RTLs for both the upper and lower aquifer at the following locations:

- Upper Aquifer
  - The AOI 7 source area (includes wells GM-30, GM-29, and GM-23),

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[1] In cases where multiple monitoring wells are located between or downgradient of remedial measures locations, then the performance of the remedial measures located upgradient of these wells may be assessed based on the average concentration from all of the wells rather than on a well-by-well basis.

  - Monitoring zone 1 (S1), immediately downgradient of RZ-1 (includes well GM-28),

  - Monitoring zone 2 (S2), midway between RZ-1 and RZ-3 (includes wells GM-28, ME-6, and other monitoring wells to be identified as a replacement for the ME series wells in the central portion of the site, as discussed in Section 5.0),

  - Monitoring zone 3 (S3), immediately downgradient of RZ-3 (includes wells GM-32 and GM-21).

- Lower Aquifer

  - Monitoring zone 1 (D1), encompassing Well 32 and GM-19D,

  - Monitoring zone 2 (D2), between GM-19D and GM-11, GM-15 and GM-20D encompassing GM-3 and GM-1.

The preliminary RTLs for these monitoring zones and between these monitoring zones for the five primary constituents of concern in AOI 7 (i.e., constituents currently exceeding MCLs in the source area) are presented on Table B-1 (Appendix B) for the upper and lower aquifers. As indicated on Table B-1 for the AOI 7 area, the RTLs developed for the lower aquifer would be the limiting values for AOI 7 under current groundwater pumping conditions.

The RTLs shown in this table are considered preliminary because they are based on current groundwater pumping conditions at and around AOI 7. As remediation progresses, changes to groundwater pumping conditions and their effects on RTLs, if any, will be assessed on an annual basis. The preliminary RTLs shown on Table B-1 will be revised as appropriate to reflect knowledge of groundwater pumping conditions at the time of each annual evaluation. Any changes to the RTLs or the methodology for deriving the RTLs will be reviewed with USEPA prior to making a decision regarding termination of one or more remedial measures.

2.3 Shut-Down of Remediation Components

As part of the annual remediation performance monitoring evaluation, data collected from on-site and off-site monitoring wells will be compared to RTLs as a measure of the performance of each remedial measure; i.e., to determine the extent to which each remedial measure is contributing to achievement of the specific conditions outlined above for the upper and lower aquifers. In addition, as part of the annual performance monitoring evaluation, GM will review the groundwater pumping conditions at the facility and surrounding area to confirm that the basis for the RTLs remain valid. In the event that pumping conditions at or surrounding the facility changed during the monitoring period, then GM will update the RTLs prior to conducting the performance evaluation. Further, because the models used to develop the RTLs do not take into consideration attenuation of constituents during transport in the groundwater (e.g., retardation, degradation), and one of the primary components of the remedial measures is enhanced in-situ biodegradation, GM will also assess the extent to which these processes should be accounted for in applying the RTLs during the performance evaluation. Any changes to the methodology for deriving the RTLs will be reviewed with U.S. EPA prior to making a decision regarding termination of one or more remedial measures.

GM's long-term goal is to reduce existing on-site and off-site groundwater concentrations within the existing plume boundary to levels that are protective of reasonably expected future uses of groundwater. Achievement of this goal will be determined by comparing groundwater quality data from monitoring wells to RTLs that are designed to ensure residual on-site concentrations will not result in off-site concentrations exceeding acceptable levels. For example, achieving the RTLs in areas downgradient of AOI 7 (e.g., downgradient of RZ-3) would indicate that the downgradient control measures (e.g., pumping TW-2) would no longer be necessary to meet the allowable POC concentration. However, in this example, if concentrations upgradient of RZ-3 remain above the target levels, the active measures at RZ-1 and/or RZ-3 would need to be maintained until upgradient concentrations are further reduced. Achieving RTLs in all of the on-site monitoring zones would indicate that the allowable POC concentrations would not be exceeded if all active measures were shut-off.

Once on-site groundwater concentrations are reduced sufficiently by active measures to be protective of reasonably expected future uses, some or all of these active measures will be shut-off. Following shutdown of any active measures, GM will continue its groundwater monitoring program to confirm that the conditions in the upper and lower aquifer continue to be met without these active measures. In addition, the monitoring program will continue to evaluate potentially significant contributions from the land-based units (i.e., landfills and lagoons), if any, relative to the existing site-wide groundwater quality, to ensure that the groundwater conditions achieved by the remedial measures continue to be met.

3. Identification and Screening of Corrective Measures Technologies

The identification and screening process for potentially applicable corrective measures technologies for implementation at the GM facilities is presented in this section. This technology identification and screening process was completed in the past to identify the current groundwater interim measures (capture zone interim measures and AOI 7 interim measures). Implementation of the interim measures has resulted in knowledge gained regarding the effectiveness of these technologies within site conditions (presented below). This knowledge was then used to re-evaluate the technology screening process as part of this Corrective Measures study. A summary of this screening is presented below. The objective of this section is to identify and screen technologies, taking the current interim measures into consideration, and eliminate those technologies that are not effective or implementable within site conditions. The retained list of technologies is assembled into the final corrective measure alternative for the site, as discussed in Section 5.0.

3.1 Capture Zone Interim Measures

As discussed in Section 1.5, the initial phase of RFI field activities began in October 1992 and was completed in February 1993. Delphi Thermal Moraine submitted an Interim RFI Report to the U.S. EPA, summarizing the RFI field activities and analytical results, in July 1993 (Geraghty & Miller, Inc. 1993b). The U.S. EPA submitted a comment letter to Delphi Thermal Moraine on this Interim RFI Report in October 1993. The U.S. EPA informed Delphi Thermal Moraine in this correspondence that interim measures needed to be implemented to control the migration of groundwater which contains VOCs, until a final remedy was implemented at the facility. GM agreed to perform interim measures that consisted of hydraulic control for both the upper and lower aquifers to control off-site migration of groundwater containing VOCs.

Because the objective of interim measures was to maintain effective hydraulic control of both the upper and lower aquifers in a timely manner, groundwater extraction was the technology chosen over other hydraulic containment technologies and in-situ groundwater treatment. Montgomery County had already been operating a Pump-to-Waste Program in the lower aquifer since March 1990 by pumping DN-13 (Figure 1-3) at a rate of approximately 2.6 mgd, upgradient of their Miami Shores well field. This effort resulted in hydraulic control of the lower aquifer immediately downgradient of the site. GM incorporated the pumping of DN-13 into their capture zone interim measures. GM covers the cost of operation and maintenance of the well, as well as monthly monitoring. An existing upper aquifer test well, TW-2 located in the southwest corner of Landfill L1, was used as part of these initial interim measures. Capture zones were modeled using the RFI groundwater flow model in order to predict whether DN-13 and TW-2 would be adequate for attaining hydraulic control of both aquifers.

Recovered groundwater from TW-2 required treatment prior to discharge; therefore, ex-situ treatment technologies were evaluated to address VOC concentrations (e.g., air stripper, carbon adsorption). Treatment through an air stripper tower (countercurrent packed aeration tower) was selected because it could be easily implemented, it was effective for stripping VOCs from the groundwater to the extent necessary to meet effluent limits, and it was a cost-effective technology. The remediation system for the upper aquifer consisted of pumping groundwater from TW-2, at a rate that would ensure adequate capture of groundwater to meet the interim measures objectives, treatment through an air stripper tower, and discharge through an NPDES permitted outfall to the Miami River.

A Preliminary Interim Measures Work Plan was submitted to the U.S. EPA in May 1994 (Geraghty & Miller, Inc., 1994b). This work plan contained the design basis, process descriptions, permit requirements, the monitoring program, and a schedule. The Final Interim Measures Design Plans and Specifications report was submitted to the U.S. EPA in April 1995 (Geraghty & Miller, Inc., 1995). The interim measures groundwater recovery and treatment system designed for the upper aquifer began operation on January 31, 1996.

Monthly influent samples are collected from the air stripper tower to meet the air permit requirements and monthly effluent samples are collected from the air stripper tower to meet the NPDES permit requirements. Select upper and lower aquifer wells in the vicinity of TW-2 are sampled for VOCs on an annual basis, and water-level measurements are collected on a quarterly basis. Annual interim measures capture zone reports are submitted to the U.S. EPA to demonstrate that the required control has been maintained. Recent groundwater flow maps depicting the capture zones for TW-2 in the upper aquifer and for DN-13 in the lower aquifer are shown on Figures 1-2 and 1-3, respectively. GM samples DN-13 on a monthly basis for analysis of VOCs. The results are submitted to the U.S. EPA in the Monthly Technical Progress Reports. The DN-13 monthly sampling results are also submitted to Montgomery County.

3.2 Former Oil House Area Interim Measures

The RFI identified that the primary source of VOCs in upper aquifer groundwater at the three facilities is located at AOI 7 – Former Oil House Area. As stated in the RFI report conclusions, interim measures were recommended for groundwater at AOI 7, because of its potential for VOCs in groundwater to continue to impact site-wide groundwater.

The objectives of the AOI 7 interim measures are as follows:

1. To reduce VOC mass in the upper aquifer groundwater above the upper clay till in the primary source area;

2. To limit future migration from the source area to downgradient portions of the upper aquifer and into the lower aquifer; and

3. To actively address VOCs that have already migrated downgradient from the source area in order to expedite remediation of the downgradient plume.

These objectives are currently being met by using a combination of in-situ technologies that were selected for the site. The source area is being addressed using an in-situ oxidation technology and the downgradient plume is being addressed using enhanced in-situ reductive dechlorination. Descriptions of these technologies and the interim measures system design were presented in the Primary Groundwater Source Area (AOI 7) Interim Measures Work Plan and submitted to the U.S. EPA in June 1999 (ARCADIS Geraghty & Miller, Inc. 1999). Additional background information on AOI 7 is presented below and in Appendix A, in order to support the technology selection process.

3.2.1 Former Oil House Area Background

The Former Oil House Building 7 was located north of the Moraine Engine Plant and was built at least as early as 1949. The Former Oil House Area consisted of the Oil House Building and an outdoor area that contained underground storage tanks (USTs), aboveground storage tanks (ASTs), and a drum storage area. The Oil House Building and associated outside structures covered a total area of approximately 48,000 square ft. Virgin paints and chemicals necessary for production were stored and mixed in the Oil House and pumped or transferred to various production areas. Materials were stored in both drums and tanks. Virgin chemicals, including oils, paints, thinners, solvents, acids, toluene diisocyanate (TDI) and resins, were stored inside the Oil House. Alcohols were reclaimed and solvent blending activities were conducted at the Oil House. The outdoor area just north of the Oil House had seventeen 8,000 to 15,000-gallon ASTs used to store oil, solvents, acids and other production materials, and three 15,000-gallon USTs used to store oil. These tanks were located in a tank farm which had dikes (concrete or earthen) for spill containment and a gravel floor. A drum storage area was also located just north of the Oil House and was used to store drummed waste oils, thinners, alcohols, and still bottoms from the Oil House and sludges containing chromium, nickel, and phosphorus. This AOI was removed from service in 1979 when at least three buildings were demolished and all tanks were removed. Based on data collected during the RFI, AOI 7 was evaluated in the Baseline Risk Assessment as an approximately 275,000 sq ft area encompassing these areas.

Currently, AOI 7 is primarily covered with asphalt, concrete, and the Moraine Engine Tank Farm. This AST farm and pump house were constructed in 1980 over the footprint of the former Oil House tank farm. Figure 3 from the AOI 7 interim measures work plan presents photographs of the conditions at AOI 7 in 1999 (also presented in Appendix A). This tank farm is currently being decommissioned.

3.2.2 Former Oil House Area Investigation Results

The hydrogeologic units beneath AOI 7 consist of the upper aquifer, the regional confining unit, and the lower aquifer. In addition, the upper aquifer beneath the AOI 7 area is divided into an upper and lower portion by the presence of an upper clay till. The upper clay till is continuous beneath the AOI 7 area at a depth to top of till ranging from approximately 25 ft to over 40 ft bls. The water table is located approximately 4 to 12 ft above the top of the upper clay till due to the undulating nature of the top of the till.

The average hydraulic conductivity of the upper aquifer across the site, based on pumping test data collected in 1985 and in 1989, is approximately 1,650 ft/day. The flow velocity in the upper aquifer ranged from approximately 2.2 to 5.1 ft/day in 1999 (ARCADIS Geraghty & Miller, 2000e). However, based on slug test data collected in 1998, the hydraulic conductivities of the upper and lower portions of the upper aquifer in AOI 7 are much lower than the site-wide hydraulic conductivities at approximately 43 ft/day and 54 ft/day, respectively, and lower flow velocities would be expected in this area. The groundwater flow velocity in the lower aquifer across the site, ranged from approximately 0.7 to 1.4 ft/day in 1999 (ARCADIS Geraghty & Miller 2000e).

The highest concentrations of VOCs in groundwater across the three facilities are present at AOI 7 in monitoring well GM-23. At this location, total VOC concentrations were 19,706 micrograms per liter (ug/L) in March 1998, with estimated concentrations of PCE at 11,200J ug/L, TCE at 3,870J ug/L, cis-1,2-DCE at 3,870J ug/L, and vinyl chloride at 766J ug/L. The highest total VOC concentrations in a hydropunch sample collected above the upper clay till within AOI 7 were in OH-BH2A where 18,441 ug/L was detected in November 1998, with cis-1,2-DCE at 11,000 ug/L, vinyl chloride at 4,770J, PCE at 1,180J ug/L, TCE at 1,260J ug/L, and 1,1-dichloroethane (1,1-DCA) at 231 ug/L. In general, the area of highest VOC concentrations is centered around GM-23, as shown on Figure 5 in the AOI 7 interim measures work plan, which has been included in Appendix A. This area is estimated to be approximately 750 ft long in the north/south direction and 350 ft across in the east/west direction. Figure 5 (Appendix A) presents the distribution of total VOC concentrations in this area. Hydrophobic dye testing of saturated soil samples in the AOI 7 area indicated the potential presence of a dense nonaqueous phase liquid (DNAPL). The dye test results are presented on Figure 4, which has been included in Appendix A. The calculated total mass of dissolved VOCs within the 1,000 ug/L contour boundary identified on Figure 5 (Appendix A) is approximately 95 pounds (or 7 gallons) based on a saturated thickness of 9 ft and a porosity of 0.3.

The concentrations of VOCs in groundwater within AOI 7 are much higher in the portion of the upper aquifer above the upper clay till. VOC concentrations are almost two orders of magnitude lower in upper aquifer groundwater below the upper clay till in hydropunch samples collected during installation of GM-27: 11,525.3 ug/L total VOCs were detected just above the upper clay till compared with 101.5 ug/L just below the upper clay till. As a result, the interim measure within AOI 7 focused on the upper portion of the upper aquifer. Downgradient from AOI 7 where the upper clay till is not present, interim measures focused on both the upper and lower portions of the upper aquifer, as VOCs have dispersed both horizontally and vertically in the upper aquifer as they have migrated downgradient from AOI 7.

3.2.3 Technology Selection

Based on a review of potential remedial technologies which could be applied at the GM site to address VOCs in groundwater at and emanating from AOI 7, two remediation technologies were selected as the most likely to achieve the interim measures objectives. One of these is a chemical (non-biological) oxidation of the contaminants using hydrogen peroxide and the creation of Fenton's reagent; the other is enhanced bioremediation, primarily via the reductive dechlorination process. The chemical oxidation technology was selected for the AOI 7 primary source area which contains the highest VOC concentrations because this technology provides the greatest potential for rapidly reducing high VOC concentrations. The enhanced bioremediation technology was selected for downgradient areas affected by lower concentrations of VOCs from the AOI 7 source area because this technology is effective for reducing these VOC concentrations detected at the site. These technologies were tested at the site in order to evaluate their potential to become a component of the site-wide remedy. A description of these technologies is presented below and implementation results are presented in Sections 4.2 and 4.3.

3.2.3.1 Chemical Oxidation

Chemical oxidation as a remedial alternative is based on the introduction of an oxidant, such as hydrogen peroxide (H_2O_2), into the subsurface. The resulting hydroxyl radicals (OH^-), a strong chemical oxidizer, can create an environment which oxidizes organic compounds such as PCE and TCE (and their degradation daughter products 1,2-DCE and vinyl chloride). The reaction is a nearly instantaneous oxidation of these compounds upon contact with the hydroxyl radicals.

Fenton's reagent, a combination of hydrogen peroxide and ferrous salts, can be used to cost-effectively create hydroxyl radicals. The general chemistry for the creation of hydroxyl radicals with Fenton's reagent is shown in the following reaction (Suthersan, 1997):

$$Fe^{2+} + H_2O_2 \text{—>} Fe^{3+} + OH^- + OH$$

The ultimate breakdown products of this reaction are water, oxygen, and iron. Fenton's reagent can be created immediately prior to injection into the subsurface or within the subsurface using successive injections of hydrogen peroxide and ferrous salts to maximize remedial effectiveness. In aquifers with high iron content, Fenton's reagent may be created naturally with the injection of hydrogen peroxide.

The oxidation of a PCE molecule occurs as the hydroxyl free radical (OH) breaks the chemical bonds between the carbon and chlorine atoms. The oxidation of PCE is shown below.

$$\begin{gathered} C_2Cl_4 \text{ (PCE)} + OH \text{—>} \\ Cl^- + \text{mineralized end products (e.g., } CO_2\text{)} + H_2O \end{gathered}$$

This oxidation reaction is similar for TCE, 1,2-DCE, and vinyl chloride. Chloride ions, carbon dioxide, and water are the major end products of the complete oxidation process.

The use of this remedial technology as part of the AOI 7 interim measure was proposed for areas within AOI 7 above the upper clay till with the most elevated concentrations of VOCs: 1) the areas around GM-23, OH-BH7, and OH-BH13 (Oxidation Area 1 [OA-1]) and 2) west, north and southeast of the Moraine Engine tank farm (OA-2). These areas are shown on Figure 7 of the Interim Measures Work Plan, which has been included in Appendix A. The proposed interim measure involved the injection of hydrogen peroxide (with or without a ferrous salt catalyst) to facilitate the oxidation of the chlorinated VOCs. Because the iron concentrations in the upper aquifer above the upper clay till at AOI 7 (3.41 to 15.0 mg/L at GM-23) may not be high enough to support creation of Fenton's reagent without the introduction of a ferrous salt catalyst, this was further evaluated during implementation of this technology. Field data collected to verify the completeness of these reactions within the AOI 7 source area is presented in Section 4.3.

3.2.3.2 Enhanced Reductive Dechlorination

Enhanced anaerobic biodegradation is a remedial alternative which modifies the subsurface environment to provide conditions which accelerate the natural biodegradation of the chlorinated VOCs. This technology is recommended because site data indicates that natural degradation of the PCE to daughter products is already occurring at varying degrees, as discussed in Section 4.6.2 of the Supplemental RFI Report.

Naturally occurring bacteria use available carbon that exists in their environment for energy. During utilization of the available carbon, biodegradation of chlorinated VOCs can occur through various degradation pathways. The most important microbial pathway for degradation of the higher chlorinated VOC compounds (i.e., PCE and TCE) is reductive dechlorination (Wiedemeier, et al 1998). During reductive dechlorination, the chlorinated VOC is degraded via co-metabolism, whereby bacteria utilize another primary carbon substrate as a source of energy. This primary utilization produces enzymes and co-factors that can result in a chlorine atom on the VOC compound being subsequently replaced with a hydrogen atom. Thus, biodegradation through reductive dechlorination results in a step-wise dechlorination from PCE to TCE to cis-1,2-DCE to vinyl chloride to ethene or ethane. Importantly, however, there must be an appropriate carbon source available for this degradation pathway to proceed. It is accepted that reductive dechlorination occurs under anaerobic conditions.

During co-metabolism, the microbial populations are able to metabolize chlorinated compounds even though they do not gain any significant energy from them, since the primary carbon source satisfies this need. Thus, co-metabolism (and degradation of contaminants) can occur at very low concentrations of chlorinated compounds, and the reactions tend to be stable as long as a primary carbon source is available.

Recent studies have also indicated that the chlorinated VOCs themselves can be used as an electron acceptor by bacteria. Thus, the bacteria can use the chlorinated VOCs as a means of "breathing" or metabolizing, just as they use nitrate, sulfate, iron, manganese and carbon dioxide for metabolizing carbon when oxygen is not present. This process is called dehalorespiration and results in the degradation of more chlorinated VOCs, such as TCE, proceeding directly to ethene, without the production of intermediates such as cis-1,2-DCE and vinyl chloride. Other dehalorespiration reactions are most likely possible, and these reactions are currently being studied in laboratory environments. The important point to note is that dehalorespiring reactions are most prevalent in the reducing environments in groundwater that also support reductive dechlorination. Therefore, many complimentary dechlorination processes are most likely on-going at any site impacted with chlorinated VOCs where natural degradation is occurring.

Enhanced bioremediation, as implemented for the AOI 7 interim measures, increases the rate of intrinsic remediation by introducing a carbon source directly into the impacted areas of the saturated zone. This creates a chemically enhanced anaerobic and reducing environment which follows groundwater movement (mobile reactive zone) where chlorinated VOCs can be degraded to innocuous end products consisting of chloride ions, carbon dioxide, and water. As the indigenous bacteria utilize the carbon source for energy, the available dissolved oxygen and other electron acceptors are depleted, and the subsurface environment is driven toward more anaerobic (reducing) conditions. Degradation of the chlorinated VOCs can then proceed by reductive dechlorination. The use of the carbon source within a mobile reactive zone provides a fundamental advantage over most treatment technologies in that it is not a diffusion-limited process which relies on the VOC desorption rate. The effects of bacteria can often act as a natural surfactant and desorb some VOCs that are attached to the aquifer matrix, thereby increasing the amount of mass which can be degraded through natural biological processes. Through the mobile reactive zone, the carbon source can become available to all portions of the aquifer through which water flows.

In addition, due to the concentration gradient that develops across the mobile reactive zone, the carbon source is driven throughout the aquifer. Thus, the carbon source can access interstitial pore spaces and influence degradation of contaminants in areas generally not accessible through groundwater extraction techniques.

The use of this remedial technology as part of the AOI 7 interim measure was implemented in three areas: 1) at the southern boundary of AOI 7 (Reactive Zone 1 [RZ-1]), 2) at an intermediate downgradient barrier curtain south of AOI 7 in the ME well series area (RZ-2) because existing wells were available for carbon introduction, and 3) at a downgradient barrier curtain south of the Moraine Engine and the Delphi Thermal Moraine plants (RZ-3). The technology involved the introduction of a carbon source in the form of simple carbohydrates to allow the microbial population to develop the reducing conditions necessary to support the enhanced anaerobic biodegradation of the chlorinated VOCs. Field data collected during interim measures was used to verify reducing conditions necessary to support dechlorination were developed within these areas of the site which are downgradient of the AOI 7 source area and contain elevated concentrations of chlorinated VOCs, as discussed in Section 4.2.

3.3 Corrective Measures Technologies Screening Process

This section presents an evaluation of groundwater corrective measure technologies (capture zone and AOI 7) and those technologies that are appropriate to address the land-based units if required in the future (i.e., landfills and lagoons), against the screening criteria. The list of focused technologies presented on Table 3-1 has been developed based on a review of groundwater corrective measures that address chlorinated VOCs and ARCADIS Geraghty & Miller's experience with implementing the innovative technologies described in Section 3.2 at the GM facilities. The technologies listed on Table 3-1 were screened on a preliminary basis on their applicability to site conditions. Those technologies that were retained because of their applicability to site conditions, were further screened using the following criteria: effectiveness, implementability, and relative cost. This screening process is presented on Table 3-2. Corrective measures technologies retained after this second screening process will be further evaluated when assembling the final site-wide remedy.

3.3.1 Screening Criteria

The detailed screening process consists of evaluating corrective measure technologies for these categories: effectiveness, implementability, and relative cost. These screening criteria are defined below.

Effectiveness: This criterion focuses on the degree to which a corrective measure is protective of human health and the environment; reduces toxicity, mobility, or volume of waste through treatment; affords long-term protection; and minimizes short-term impacts. Corrective measures providing significantly less effectiveness than other technologies are eliminated from further consideration. Additionally, technologies are evaluated as to how effectively the risk of exposure would be reduced through the elimination of exposure pathways. The time frame to achieve protection has been divided into three general periods: short-term (1 to 3 years), mid-term (4 to 7 years), and long-term (greater than 7 years).

Implementability: The implementability criterion is used to evaluate both technical and administrative feasibility of constructing, maintaining, and operating the corrective measure. Technical feasibility is evaluated by considering the potential construction, maintenance, and operation difficulties which could arise from implementing the technology. This criterion also addresses the need and ability to monitor the actions conducted both during and after corrective measures are complete. Administrative feasibility refers to the likelihood of obtaining approvals from regulatory agencies and the availability of the components which are necessary to successfully conduct the remediation. Consideration of the availability of required components includes examination of the availability and capacity of treatment, storage, or disposal facilities, and the availability of equipment, materials, and specialists necessary to implement and complete the proposed work. The time frame required to implement the technology is defined as short-term (1 to 3 years), mid-term (4 to 7 years), and long-term (greater than 7 years). Even though they are the same numbers, the implementation time frame differs from the effectiveness time frame in that the former describes the time required to initiate the measure and the latter describes the time required to achieve the goal of protection.

Relative Cost: The costs to implement, operate, and maintain the corrective measure are considered under this criterion. Costs that are excessive compared to the overall effectiveness of the technology represent one of several factors used to eliminate technologies from further consideration. Technologies providing effectiveness and implementability similar to that of another technology by employing a similar method of treatment or engineering control, but at greater cost may be eliminated. This evaluation takes into account both capital and operation and maintenance costs. Capital costs include equipment, buildings, construction, land and site development, and initial purchased services, such as transportation or chemicals. Operation and maintenance costs include operating labor, maintenance, materials, energy, and on-going services, such as continued monitoring and purchase of chemicals.

3.3.2 Groundwater

The corrective measures technologies retained for groundwater from the screening process on Table 3-2 were considered when assembling the final site-wide alternative. These technologies include the following:

- Institutional Actions – deed restrictions, groundwater monitoring.
- Collection – groundwater extraction wells.
- Ex-situ Treatment – air stripping, adsorption media.
- Discharge – off-site discharge to surface water.
- In-situ Treatment – monitored natural attenuation, enhanced reductive dechlorination, oxidation.

4. Summary of AOI 7 Interim Measures Investigations and Results

As discussed in Section 3.2, after reviewing potential technologies that could be applied at the GM site to address VOCs in groundwater at and emanating from AOI 7, two in-situ technologies were selected. A work plan to implement these technologies, enhanced reductive dechlorination and in-situ oxidation, was approved by the U.S. EPA in July 1999. Field activities began in August 1999 and technology testing was completed in May 2000. Prior to implementing the AOI 7 interim measures, baseline conditions were determined through completion of a site-wide groundwater sampling event. As discussed below, the Baseline data was compared to samples collected after technology implementation to determine the effectiveness of the technologies. Based on the results presented in the following sections, enhanced reductive dechlorination and in-situ oxidation are successful technologies for addressing the chlorinated VOCs in the upper aquifer at the site.

4.1 Baseline, 3-Month, 6-Month, and First Annual Sampling Events

As described in the AOI 7 Interim Measures Work Plan, four shallow monitoring wells, 51 reactive zone introduction wells, and six oxidation injection wells were installed as part of the interim measures. This program began at the end of August 1999 and was completed by early October 1999. The database of groundwater analytical and quality assurance/quality control (QA/QC) results from the Baseline sampling event is presented in Appendix C.

Two new shallow monitoring wells (GM-29 and GM-30) were installed within the AOI 7 area as shown on Figure 4-1 to serve as an upgradient monitoring point for RZ-1 (GM-29) and to monitor effectiveness of the oxidation system (GM-30). These wells were drilled down to the upper clay till. New shallow monitoring wells were also installed in the RZ-2 area (GM-31) and south of RZ-3 west (GM-32), as shown on Figure 4-1, to monitor effectiveness of interim measures in those areas. These wells were drilled down to the regional clay till. All wells were drilled, constructed, and developed per procedures defined in the approved Supplemental RFI Work Plan (Geraghty & Miller, Inc., 1997b). The monitor well construction logs and soil boring logs are presented in Appendix D.

Prior to implementing the proposed interim measures, baseline conditions were determined through the completion of a site-wide groundwater sampling event in the upper and lower aquifers. Baseline groundwater conditions were assessed by collecting groundwater samples for laboratory analysis and field measurements from

43 existing upper aquifer monitoring wells, 4 newly installed upper aquifer monitoring wells, 18 lower aquifer monitoring wells, 6 oxidation injection wells, and 9 reactive zone introduction wells, as detailed on Table 4-1. Monitoring well locations are shown on Figures 1-2 and 1-3.

Prior to sampling, depth-to-water measurements were obtained from all wells. The depth-to-water measurements were presented on Table 1-1. Field parameters including pH, conductivity, temperature, oxidation/reduction potential (ORP) and dissolved oxygen were measured during purging of each upper aquifer well using a multi-parameter flow-through cell. In addition to indicating proper purging, these field parameters were used to evaluate measurements periodically collected to assess the interim measures activities. All groundwater samples were collected, managed under strict chain-of-custody procedures, and validated in accordance with procedures defined in the approved Supplemental RFI Work Plan (Geraghty & Miller, Inc., 1997b).

Groundwater samples were collected using low-flow sampling procedures from the upper aquifer monitoring wells and injection/introduction wells presented on Table 4-1. The groundwater samples were submitted to TestAmerica, Inc. of Dayton, Ohio for analysis of Appendix IX VOCs and cis-1,2-DCE by Method 8260 and biogeochemical indicator parameters, except for the analysis of dissolved gases which was performed by Microseeps, Ltd. of Pittsburgh, Pennsylvania. Groundwater samples collected from the lower aquifer monitoring wells were analyzed for Appendix IX VOCs and cis-1,2-DCE by Method 8260. Table 4-2 lists specific field and laboratory parameters, analytical methods and laboratories.

Data from the site-wide Baseline sampling was evaluated to assess the current VOC concentrations in light of the technologies proposed to be implemented as interim measures to address VOCs from AOI 7. With respect to chemical oxidation, the evaluation was used to assist in determining the presence and quantity of non-target compounds susceptible to oxidation, the anticipated quantity and spatial distribution of oxidizing agent to be injected and the anticipated quantity of additional compounds (i.e., iron salts) to be injected at the site. With respect to enhanced bioremediation, the baseline data was used to compare the conditions before and after introduction of the carbon source. Discussions of the Baseline results compared to the 3-month (February 2000), 6-month (May/June 2000), and first annual (September 2000) sampling events are presented in Sections 4.2 and 4.3 in terms of technology results and conclusions.

The Baseline VOC results were also evaluated to establish a site-specific parameter list for all future groundwater sampling events, specifically the Site-Wide Groundwater Monitoring Plan (ARCADIS Geraghty & Miller, Inc., 2000d). The results of the VOC analyses, biogeochemical analysis and field data are presented on Tables 4-3 through 4-11. Tables 4-3 and 4-4 also contain total VOC results from the RFI and Supplemental RFI that can be used to evaluate trends. VOC concentrations at each well sampled during the Baseline event in the upper and lower aquifers are posted on Figures 4-2 and 4-3, respectively. Groundwater sampling logs from the Baseline sampling event are presented in Appendix D.

Samples from the 3-month (February 2000) and 6-month (May/June 2000) sampling events were collected, managed under strict chain-of-custody procedures, and validated in accordance with procedures defined in the approved Supplemental RFI Work Plan (Geraghty & Miller, Inc. 1997b). Groundwater samples were collected using low-flow sampling procedures from the upper aquifer monitoring wells and injection/introduction wells presented on Table 4-1. The groundwater samples were submitted to TestAmerica, Inc. of Dayton, Ohio for analysis of Appendix IX VOCs and cis-1,2-DCE by Method 8260 and biogeochemical indicator parameters, except for the analysis of dissolved gases which was performed by Microseeps, Ltd. of Pittsburgh, Pennsylvania. Table 4-2 lists specific field and laboratory parameters, analytical methods and laboratories. The results of the VOC analyses, biogeochemical analysis and field data are presented on Tables 4-12 through 4-27. VOC concentrations at each well sampled during the 3-month and 6-month events are posted on Figures 4-4 and 4-5, respectively. Groundwater sampling logs from the 3-month and 6-month sampling events are presented in Appendix D.

Samples from the first annual (September 2000) sampling event were collected, managed under strict chain-of-custody procedures, and validated in accordance with procedures defined in the approved Supplemental RFI Work Plan (Geraghty & Miller, Inc. 1997b). Groundwater samples were collected using low-flow sampling procedures from 38 selected upper aquifer monitoring wells. Groundwater samples were also collected from 13 selected lower aquifer wells. The laboratory parameters and analytical methods are presented on Table 5-1. The groundwater samples were submitted to TestAmerica, Inc. of Dayton, Ohio for analysis of Appendix IX VOCs and cis-1,2-DCE by Method 8260 and biogeochemical indicator parameters, except for the analysis of dissolved gases which was performed by Microseeps, Ltd. of Pittsburgh, Pennsylvania. In addition, U.S. EPA requested and GM agreed to modify the parameter list only for the first annual sampling event; therefore, groundwater samples were also analyzed for semi-volatile organic compounds (SVOCs) and metals.

The results of the VOC, SVOC, and metals analyses from the first annual event are presented in Tables 4-28 and 4-29. The biogeochemical analysis and field data were only collected from wells upgradient and downgradient from the Reactive Zones, these results are presented and discussed in Section 4.2. VOC concentrations at each well sampled during the first annual event in the upper and lower aquifers are posted on Figures 4-6 and 4-7, respectively. Groundwater sampling logs from the first annual sampling event are presented in Appendix D.

4.2 Reactive Zones Implementation and Results

Enhanced reductive dechlorination was implemented as a component of AOI 7 interim measures at three areas: 1) at the southern boundary of AOI 7 (RZ-1), 2) at an intermediate downgradient barrier curtain south of AOI 7 in the ME well series area (RZ-2) because the wells were available, and 3) at a downgradient barrier curtain south of the Delphi Thermal Moraine (RZ-3 west) and the Moraine Engine (RZ-3 east) plants. The reactive zone locations are shown on Figure 4-1. This technology was implemented for a period of six months and involved the introduction of a carbon source in the form of simple carbohydrates (food grade molasses) to allow the microbial population to develop the reducing conditions necessary to support the enhanced anaerobic biodegradation of the chlorinated VOCs. Groundwater samples were collected throughout this six-month period, as recommended in the AOI 7 interim measures work plan. This field data included field parameters, bioattenuation parameters and VOCs. The carbon source solution concentration, feed rate, introduction frequency to achieve the desired strongly reducing conditions in groundwater was continuously evaluated as the field data was collected. As a result, some adjustments were made to the process. Due to the success of the first six months of implementing this technology, carbon source introduction activities continued in October, November, and December 2000. The following sections present a summary of the reactive zone installation, operation, monitoring, results and conclusions.

4.2.1 Reactive Zone Installation

The bioremediation delivery network consisted of newly installed introduction points for RZ-1 and RZ-3, and existing on-site monitoring wells in RZ-2 (Figures 4-8, 4-9, and 4-10). Carbon source introduction points were installed in areas RZ-1 and RZ-3 as a barrier (row of points) generally running west to east, with a separation distance of approximately 25 ft. Installation was conducted during September and October 1999.

At RZ-1, the carbon source solution was introduced within the upper aquifer above the upper clay till using nine introduction points (Figure 4-8). The carbon injection level was set by screening the injection wells in the lower 10 ft of the upper aquifer, which is 4 ft to 12 ft thick in area of RZ-1.

At RZ-2, six existing monitoring wells located along the western edge of the Moraine Engine Plant 3 building were used for carbon source introduction points (Figure 4-9). The existing wells provided complete coverage of the planned injection barrier, so no new introduction points were necessary at RZ-2. The RZ-2 wells were screened within the upper 3 ft of the upper aquifer.

At RZ-3, carbon was introduced using 42 introduction points (Figure 4-10). The upper clay till was not present in the area of RZ-3, and the carbon injection wells were screened from the aquifer surface to a depth of 46 ft to 68 ft to allow carbon introduction through the entire thickness of the upper aquifer.

According to the AOI 7 interim measures work plan, four additional introduction points were to be installed (three in RZ-1 and one in RZ-3 east). However, interference from aboveground features and underground utilities precluded drilling in these areas.

Carbon injection wells were drilled through the upper aquifer, using the hollow stem auger drilling method, and were terminated at a depth of 0.5 ft into the upper clay till formation in RZ-1 and at a depth of 0.5 ft into the regional clay till at RZ-3 when it was encountered. At all other locations in RZ-3 west and east, the presence of heaving sands prevented setting the introduction point into the regional clay till, so the point was set as deep as possible. Boring logs and well construction logs from wells selected for lithologic characterization are presented in Appendix D. Soil samples were not collected during drilling for laboratory analysis; however, as described in the AOI 7 interim measures work plan, a saturated soil sample was collected from above the upper clay till within each boring at RZ-1 and was field-screened using the hydrophobic-dye test to assess the potential presence of DNAPL within AOI 7. The dye test results are presented on Table 4-30. The possible presence of DNAPL is noted on this table.

Each boring was completed as a carbon source introduction point by installing a 3-inch diameter Schedule 80 polyvinyl chloride casing. Each casing was equipped with a screened section spanning a portion of the upper aquifer and the uppermost 6 inches of the underlying clay till layer, if encountered. A 6-inch bottom sump was installed in each injection point, to facilitate identification of a DNAPL, if present. A 10-foot long screen section was used for all introduction points in RZ-1 and boring depths ranged from 26 ft to 33 ft bls. Introduction points installed within RZ-3 were equipped with 20 ft to 40 ft of screen. Boring depths ranged from 46 ft to 68 ft below land surface. An example introduction point construction detail is presented in Appendix E (Figure E-1).

4.2.2 Reactive Zone Operation

As discussed in Section 3.2, the reductive dechlorination of VOCs can be enhanced by the introduction of a carbon source that stimulates activity of indigenous microorganisms. The high carbon loading triggers a succession of microbial species, as the available "aerobic" electron acceptors (such as oxygen and nitrate) are consumed. The microbial succession leads to a consortium of species that survive by sulfate reduction and methanogenisis and other low-ORP metabolic pathways, supporting the highly reducing conditions necessary for the dechlorination of PCE, TCE, and cis-1,2-DCE.

To sustain the necessary changes in aquifer conditions within the reactive zones, periodic introductions of a carbon source solution were conducted during a 6-month period between December 1999 and May 2000, according to the procedures detailed in the AOI 7 interim measures work plan (Appendix E). The carbon source solution consisted of a 10 to 1 mixture of potable water to feed-grade molasses that was pumped into each RZ well. The contractor, Monarch Water Systems, Inc. of Xenia, Ohio, maintained dedicated mix tanks at their Xenia facility and transported the pre-mixed solution in a dedicated tanker truck to the GM site. The initial event, conducted in December 1999, consisted of two consecutive rounds of carbon source introductions in each RZ well. After the initial introduction event, the carbon source solution introductions were scheduled twice per month through May 2000. Modifications were made to the scheduled introductions throughout the six-month period based on continuing review of the field data. Details regarding the frequency and strength of carbon source introductions are provided in Appendix E (Table E-2). Carbon introductions were re-initiated in October through December 2000, after completion of the first annual sampling event.

4.2.3 Reactive Zone Monitoring

Development of the reactive zones was monitored through the collection of samples for field parameters measurement (monthly), and laboratory analysis of biogeochemical indicator parameters and VOCs during the 3-month (February 2000) and 6-month

(May/June 2000) sampling events. Field parameter measurements included: pH, dissolved oxygen (DO), ORP, temperature, and specific conductivity. Biogeochemical parameters included: nitrate/nitrite, nitrogen (ammonia), manganese (total and dissolved), iron (total, dissolved, and ferrous), sulfate/sulfide, total organic carbon (TOC), chlorides, the light hydrocarbon scan (ethane and ethene), and dissolved permanent gases (carbon dioxide, oxygen, nitrogen, methane, and carbon monoxide). Tables containing the field parameter results are included in Appendix E (Table E-3) and the bioattenuation results and VOC results (compounds above detection) for all wells sampled are presented on Tables 4-12 through 4-14, 4-16 through 4-18, 4-20 through 4-22, and 4-24 through 4-26. The full list of VOC and QA/QC results is presented in Appendix C for the 3-month and 6-month sampling events. An evaluation of the pertinent monitoring data is presented in the following sections.

At RZ-1, GM-29 was used as an upgradient monitoring well and GM-28 was used as a downgradient monitoring well. ME-6 was used as an upgradient monitoring well for RZ-2 and for carbon source solution introductions. During the six-month implementation period, carbon source solution introductions in ME-3 were stopped so that this well could serve as a downgradient monitoring well for RZ-2. For RZ-3 west, upgradient wells EAST, WEST, and GM-19S were used as monitoring points and GM-32 was used as a downgradient monitoring point. During the six-month implementation period, carbon source solution introductions in RZ-3L were stopped so that this well could serve as a side-gradient monitoring well to evaluate the radius of influence within RZ-3 west. For RZ-3 east, GM-22 served as the upgradient monitoring well and GM-21 served as the downgradient monitoring well. During the six-month implementation period, carbon source solution introductions in RZ-3KK were stopped so that this well could serve as a side-gradient monitoring well to evaluate the radius of influence within RZ-3 east. Locations of these wells are shown on Figures 4-8 through 4-10.

4.2.4 Analysis of Field Parameters

Field parameter data collected as part of the Baseline, 3-month, 6-month, and first annual sampling events are provided in Tables 4-31, 4-32, 4-33, and 4-34 for RZ-1, RZ-2, RZ-3 west, and RZ-3 east, respectively. These tables are organized such that upgradient and downgradient changes can be easily identified. Field parameters collected periodically to monitor introduction events are provided in Appendix E (Table E-3).

4.2.4.1 pH

The ideal pH range for reductive dechlorination is 6 to 8, optimum conditions were present within the three reactive zones to support this process. pH values below 6.0 were noted in the carbon source introduction wells used for monitoring within RZ-1, RZ-2, and RZ-3. The carbon source solution has a lower pH than groundwater at the site: 5 to 6 for cane sugar molasses, versus 6.5 to 8 for groundwater. Also, the formation of acetic acid during the breakdown of sugars may further reduce groundwater pH. It is recognized that while pH values less than 5 may be outside of the optimal range for reductive dechlorination under natural attenuation, it is suspected that lower pH values being measured during some of the periodic monitoring events (Appendix E) was titrated to a more neutral pH by the high-carbonate aquifer formation and, therefore, the observed low-pH value was localized in comparison to the overall volume of the aquifer. Additionally, the biogeochemical indicator data discussed later in this section and VOC results discussed in Section 4.2.6, indicated that the periodic episodes of localized low pH associated with carbon source introduction did not adversely affect reductive dechlorination processes within the three reactive zones.

4.2.4.2 Dissolved Oxygen

Anaerobic bacteria generally cannot function at DO concentrations greater than about 0.5 mg/L and, hence, reductive dechlorination will not occur (Wiedemeier, et al, 1998). Field-measured DO readings collected during much of the six-month period indicate that DO levels within the three reactive zones were relatively low before, during, and at the end of carbon source introductions. However, DO values measured during some events show relatively elevated values when compared to other measurement events and compared to what would be expected considering the low ORP measurements noted in the same monitoring wells. Such values of DO are likely caused by interference or fouling of the DO probe by the carbon source solution during purging of the well and, therefore, have not been used in this assessment. Future sampling events will attempt to eliminate these measurement problems by recommending more frequent field calibration of the DO probe during measurement events and more frequent maintenance of the DO probe when questionable data is identified (physical replacement of the DO membrane on the probe). Based on a review of other field and bioattenuation parameters, reductive dechlorination was occurring: therefore, the DO readings may not always be reliable.

4.2.4.3 Oxidation/Reduction Potential

The ORP of groundwater is a measure of electron activity and is an indicator of the relative tendency of a solution to accept or transfer electrons. ORP reactions in groundwater containing organic compounds are usually biologically mediated and, therefore, the ORP of a groundwater system is dependent on and influences biodegradation (Wiedemeier et al, 1998). ORP measurements below 0 millivolts (mV) (i.e. negative measurements) are indicative of reducing conditions in the groundwater. The ORP readings measured during the 3-month and 6-month groundwater sampling events and the periodic measurement of field parameters (Appendix E) indicate that more reducing conditions have been generated within the three reactive zones by the introduction of the carbon source. For instance, after 6-months of carbon introduction, the ORP in introduction wells within RZ-1 went from an average value of approximately 170 mV to an average of approximately -67 mV. Additionally, a transition from 90.5 mV to -93.7 mV was noted in downgradient monitoring well GM-28, indicating that the reducing conditions are moving outward from the introduction wells. By September 2000 residual influence of dechlorination was still noted because the ORP in GM-28 was further reduced to -200.1 mV and carbon solutions had not been introduced in RZ-1 since May 2000. Similar reductions in ORP were noted in RZ-2, where the average baseline ORP of approximately 100 mV has been reduced after 6-months to an average of -143 mV. Finally, for portions of the RZ-3 areas where ORP values in introduction wells prior to implementation of the carbon source introductions were positive, a transition to negative, more reducing ORP conditions were noted.

4.2.4.4 Temperature

Temperature increases may also serve as an indicator of increased biological activity within an aquifer. This phenomenon was noted in RZ-1, where upgradient and downgradient monitoring wells were available for direct comparison. However, the fact that carbon source was introduced directly to all monitoring wells in RZ-2 prevented observation of temperature changes. Also, natural conditions upgradient and within RZ-3 were too variable to observe temperature increases due to microbial respiration.

4.2.4.5 Specific Conductivity

The specific conductivity increased in each of the three reactive zones, indicating that total dissolved solids concentrations increased. This resulted in an increase in electron activity which can positively influence the rate of reductive dechlorination.

4.2.5 Analysis of Bioattenuation Indicator Parameters

Bioattenuation indicator parameters collected as part of the Baseline, 3-month, 6-month, and first annual sampling events are provided in Tables 4-31, 4-32, 4-33, and 4-34 for RZ-1, RZ-2, RZ-3 west, and RZ-3 east, respectively. These tables are organized such that upgradient-to-downgradient changes can be easily identified.

4.2.5.1 Dissolved Manganese and Iron

Manganese can be used as an alternate electron acceptor during anaerobic degradation of VOCs and is reduced in the process. The reduced form of manganese is more soluble and, therefore, an increase in dissolved manganese is an indicator of changes in biogeochemistry favorable of reducing conditions within, and downgradient of the reactive zones. The distribution of dissolved manganese at the site prior to injecting the carbon source solution was fairly low, as indicated by the results of the baseline groundwater sampling event in September 1999, ranging from <0.010 mg/L to a maximum of 0.942 mg/L. Increases in the concentration of dissolved manganese during the 3-month and 6-month sampling events relative to the baseline data, provided a good indication of increased anaerobic and reducing conditions in groundwater at the site. The 3-month and 6-month sampling results indicated substantial increases in the concentrations of dissolved manganese within the reactive zones. In RZ-1, dissolved manganese increased within introduction wells RZ-1A and RZ-1G from 0.203 mg/L to 13.2 mg/L and 0.198 mg/L to 19.9 mg/L, respectively, in the first 3 months. Downgradient of RZ-1, increased concentrations of dissolved manganese from 0.068 mg/L to 6.71 mg/L noted in GM-28 (located 80 ft downgradient of introduction wells) by 6 months provides strong indication that the effects of carbon source introduction are moving downgradient away from the introduction points. RZ-2 showed an increase in dissolved manganese within introduction wells ME-6, ME-1 and ME-3 from <0.01 mg/L to 3.6 mg/L, 0.493 mg/L to 1.93 mg/L and <0.01 mg/L to 0.702 mg/L, respectively, in the first 3 months. Similar increases in all RZ-3 introduction points can also be seen after the first 3 months of operation. Dissolved manganese concentrations remained relatively the same, although there were some increases and decreases noted in September 2000.

Ferric iron may also be used as an electron acceptor in reductive dechlorination reactions after the depletion of available oxygen, nitrate and manganese from the local groundwater environment, and is converted to a more soluble ferrous or "dissolved" iron in the process. Like dissolved manganese, this phenomenon is indicated by the presence of dissolved iron in the groundwater samples. This process, termed iron reduction, is therefore an indicator of a more reduced environment which should facilitate reductive dechlorination.

The 3-month and 6-month results for dissolved iron showed good evidence that more strongly reducing conditions developed at all introduction wells that were used for monitoring in RZ-1, RZ-2, and RZ-3. Additionally, the increased concentration of dissolved iron in GM-28 indicated that these reducing conditions migrated over 80 ft downgradient within the first 6 months of introductions. Dissolved iron concentrations continued to increase or remained the same by September 2000.

These dissolved metals data provide strong evidence that the effects of carbon source introductions changed the groundwater geochemistry and promoted reducing conditions in the targeted portions of the upper aquifer at the site. The less distinct effects noted within the RZ-3 areas are likely due to the larger area of the aquifer being targeted for remediation (depth of aquifer up to 40 ft thick) that will require a period longer than 6 months to provide the necessary carbon loading to obtain reducing conditions similar to those seen in RZ-1 and RZ-2 (where the aquifer thickness was between 10 and 15 ft).

4.2.5.2 Sulfate

Under more strongly reducing conditions, sulfate can be used as an alternate electron acceptor, and in the process reduced to elemental sulfur or sulfide. The phenomenon of sulfate reduction can be masked in some cases by the introduction of sulfur present in the carbon source solution (molasses). This can be seen in introduction wells RZ-1A, RZ-1G, RZ-3E and RZ-3T where increases in sulfate concentrations are seen in the 3-month sampling data (and 6-month data in the case of RZ-3T); however, the strongly reducing conditions developed by the carbon source introductions ultimately led to a decrease in sulfate concentrations in the majority of introduction wells by the 6-month sampling event. Additionally, a decrease in sulfate concentration within GM-28, to non-detectable levels, provided evidence that the affects of RZ-1 migrated at least 80 ft downgradient in the first 6 months. Sulfate concentrations were still at non-detectable levels in GM-28 in September 2000, 5 months after carbon introductions were halted.

Under some aquifer conditions, concentrations of sulfate greater than 20 mg/L may compete with the dechlorination processes under unenhanced natural attenuation. This competition may occur if sulfate acts as a preferred electron acceptor over the chlorinated compounds. However, in many plumes with high concentrations of sulfate, reductive dechlorination still occurs (Weidemeier et al, 1998). If conditions are reducing enough for sulfate reduction to occur, then reductive dechlorination is likely occurring. This appears to be the case at this site as indicated by the VOC results discussed in Section 4.2.6. A review of the site-specific list of VOCs and supporting biogeochemical data provides indication that degradation occurred in all three reactive zones even though sulfate concentrations above 20 mg/L exist.

4.2.5.3 Carbon Dioxide

Carbon dioxide is the ultimate degradation end product in the dechlorination of PCE and TCE and their associated daughter products, and is an indicator of increased biological activity. Carbon dioxide can be produced during the oxidation of vinyl chloride aerobically or via iron reduction (Wiedemeier et al, 1998) and can also be produced during microbial respiration and oxidation of most organic materials. Carbon dioxide data is presented in Tables 4-31 through 4-34, for the introduction/monitor wells and upgradient and downgradient monitoring wells. A dramatic increase in carbon dioxide is evident in all reactive zone introduction wells compared to the baseline results. These results reinforce the observation from other indicator parameters that the carbon introductions have generated aquifer conditions that support enhanced biological activity.

4.2.5.4 Chloride

Elevated concentrations of chloride above baseline results were identified in groundwater samples obtained from introduction monitoring wells during both the 3-month and 6-month sampling events (Tables 4-31 through 4-34). The elevated chloride concentrations are likely due to the enhancement of biodegradation processes by introduction of the carbon source in the reactive zones. The presence of elevated concentrations of chloride in the introduction wells suggests that during the enhanced biodegradation of the chlorinated hydrocarbons at the site, chloride has been released into groundwater as a metabolic byproduct (Wiedemeier et al, 1998). The presence of elevated chloride compared to historical results is thus another indication that conditions for biodegradation are being enhanced.

4.2.5.5 Methane

Methane concentrations can increase during methanogenesis when acetate (a product of sugar fermentation) is split to form carbon dioxide and methane, or when carbon dioxide is utilized as an electron acceptor under extreme reducing conditions, producing methane (Wiedemeier, et al, 1998). The presence of increased methane concentrations in the 3-month and 6-month groundwater data is further evidence that strongly reducing conditions have been developed and a sign that methanogenesis is occurring. Overall, methane concentrations were continuing to increase in September 2000.

4.2.5.6 Oxygen

Low levels or lack of oxygen within the vicinity of the reactive zones was another indicator that reducing conditions were developed, likely by increased biological activity that used available oxygen during respiration processes. Dissolved oxygen is a difficult field parameter to measure in introduction wells due to interference and fouling problems with the DO probe, as discussed in Section 4.2.4. However, the laboratory analytical results provided a better indication of oxygen concentrations within the aquifer. Specifically, site-wide upgradient and downgradient DO levels increased, or remained relatively unchanged at the site, while DO levels in the introduction wells generally decreased.

4.2.5.7 Bioattenuation Indicator Parameter Radial Diagrams

SEQUENCE is a visual aid used to illustrate spatial and temporal trends for multiple chemicals on one map (Conestoga-Rovers & Associates, 1998). This technique has been used to present biogeochemical indicator parameters for RZ-1, RZ-2 and RZ-3, as a means of demonstrating the interaction of the bioattenuation indicator parameters discussed above, as they relate to demonstrating that changes in the biogeochemistry of the upper aquifer at the Moraine facilities have been altered to be more reducing conditions, and thereby, more conducive to enhanced reductive dechlorination. The radial diagrams have been developed to include dissolved manganese, dissolved iron, sulfate, DO, and methane. The axis of the diagrams have been oriented such that conditions indicative of enhanced reducing conditions are directed to the center of the radial diagram (i.e., dissolved manganese, dissolved iron, and methane increase toward the center, while sulfate and DO decrease toward the center). In this way, a reduction in size of the area within the SEQUENCE-radial diagram provides an indication of increased reducing conditions more conducive to enhanced reductive dechlorination.

As can be seen in the radial diagrams presented for the RZ-1 baseline sampling event (Figure 4-11) conditions upgradient, within and downgradient of the RZ-1 introduction wells are generally similar in nature. As the same parameters are plotted for the 3-month, 6-month, and first annual sampling events, the shape of the radial diagrams for the two introduction wells within RZ-1indicate that manganese and iron reduction begin to occur prior to 3-months, and that evidence of sulfate reduction and methanogenesis are evident in the 6-month data. Additionally, the radial diagram for downgradient monitor well GM-28 indicates that limited evidence of changes in geochemistry are noted at 3-months (limited manganese and iron reduction); however, a more pronounced conversion to reducing conditions is evident in the 6-month and first annual (excluding DO which is not available) data providing strong indication that the reducing zone developed through carbon introductions is expanding downgradient.

D

The radial diagrams for RZ-2 are presented in Figure 4-12. Baseline groundwater conditions at upgradient well ME-6 and downgradient well ME-3 are very similar, while the radial diagram for ME-1 indicates that some manganese reduction is likely occurring through this area prior to carbon introductions. This is consistent with the biogeochemical assessment of this area conducted during the Supplemental RFI, where evidence of natural attenuation was noted through this area of the facility. The radial diagrams for the 3-month, 6-month, and first annual data demonstrate that more reducing conditions have been developed throughout the area. It should be noted, that since carbon source introductions were halted in ME-3 during the fifth month to allow this well to serve as a downgradient monitoring point, the radial diagram does not continue to reduce in size as seen for ME-6 and ME-1, but does continue to show a reduction compared to the baseline data due to the affects of the initial carbon introductions and the treated groundwater moving into this area from upgradient.

R

A

The radial diagrams for RZ-3 west are presented in Figure 4-13. Baseline groundwater conditions at upgradient wells GM-19S, WEST, and EAST (not shown on Figure 4-13) and downgradient well GM-32 are very similar. Conditions remain relatively constant for the 3-month and 6-month sampling events. The 3-month and 6-month radial diagrams for RZ-3E and RZ-3Z demonstrate that more reducing conditions developed within the reactive zone. It should be noted, that carbon source introductions were halted in RZ-3L during the fifth month to allow this well to serve as a side-gradient monitoring point. Conditions at GM-32 indicate that reducing conditions evident within RZ-3 west have reached this downgradient monitoring point, but with continued carbon source introductions the effects will be more distinctive. The radial diagram for the first annual data appears to be similar to the 6-month data, with the exception of increases in methane and iron at GM-32.

F

T

The radial diagrams for RZ-3 east are presented in Figure 4-14. Baseline groundwater conditions at upgradient well GM-22 and downgradient well GM-21 are very similar and remain relatively constant for the 3-month, 6-month, and first annual sampling events. The 3-month and 6-month radial diagrams for RZ-3FF and RZ-3KK demonstrate that more reducing conditions developed within the reactive zone. It should be noted, that since carbon source introductions were halted in RZ-3KK during the fifth month to allow this well to serve as a side-gradient monitoring point, the radial diagram continues to reduce in size due to continued carbon source solution introductions in wells adjacent to RZ-3KK. Conditions at GM-21 indicated that reducing conditions evident within RZ-3 east have not yet reached this downgradient monitoring point. The less distinct effects noted at GM-21 are likely due to it being located further downgradient (approximately 160 ft) than other wells used to monitor downgradient conditions and the larger area of the aquifer being targeted for remediation (depth of aquifer up to 30 ft thick). For these reasons, a period longer than 6 months will be required to provide the necessary carbon loading to obtain reducing conditions that propagate that far downgradient.

4.2.6 Analysis of VOC Analytical Results

The groundwater analytical data for the site-specific list of VOCs for the baseline, 3-month, 6-month, and first annual sampling events are presented in Table 4-35 for RZ-1, Table 4-36 for RZ-2, Table 4-37 for RZ-3 east and Table 4-38 for RZ-3 west. Additionally, the ratios of PCE and TCE (parent compounds) to cis-1,2-DCE and vinyl chloride (daughter products) are provided for the introduction and monitoring wells in RZ-1, RZ-2, RZ-3 east and RZ-3 west on Figures 4-15, 4-16, 4-17, and 4-18, respectively.

The following bullets summarize the observations and trends evident among the three reactive zones at the Moraine facilities which indicate that enhanced reduction of the target chlorinated VOCs was achieved through the carbon introduction process:

- The parent to daughter (PCE+TCE)/(cis-1,2-DCE+vinyl chloride) ratio decreased at RZ-1 introduction wells from a baseline average of 7.4 to 0.11 after six months of carbon introduction;

- The concentrations of PCE and TCE in GM-28, located 80 ft downgradient of the RZ-1 introduction zone, decreased by 90 percent and 98 percent, respectively, during the first six months and the parent to daughter ratio in GM-28 decreased from a baseline value of 6.25 to 1.83 after three months and to 0.02 after six months. By the first annual event, concentrations of both PCE and TCE in GM-28 decreased by greater than 99 percent. The parent to daughter ratio in GM-28 was 0.08 after one year;

- The concentrations of PCE and TCE in the three RZ-2 wells being monitored decreased by an average of approximately 95 percent after six months of carbon introduction. By one year, the PCE and TCE concentrations decreased by 100 percent and by 85 percent, respectively;

- Monitoring well GM-32, located immediately downgradient of RZ-3 west showed an increased concentration of cis-1,2-DCE (as well as some moderate changes in other biogeochemical markers) after three months of carbon introductions, indicating enhanced reduction of chlorinated VOCs is likely occurring in this area. However, detection limits in the May 2000 sampling event were above pre-treatment target contaminant levels, therefore, a determination of PCE/TCE reduction could not be made. By the first annual sampling event, both PCE and TCE were nondetect; and

- The concentration of PCE is below detectable concentrations within introduction wells monitored in RZ-3 east, and a measurable concentration of TCE is only present in one well at an estimated concentration of 1.4J ug/L. VOC concentrations at downgradient well GM-21 have remained relatively unchanged, however, this well lies at a greater distance from the reactive zone than is the case for the other reactive zones, and sufficient time has not passed to allow observation of the treatment affects.

4.2.7 Conclusions

After nine months of implementing enhanced reductive dechlorination through the introduction of a carbon source solution, the following observations can be made:

- Existing aquifer conditions can be converted to more reducing conditions through the introduction of a carbon source as evidenced by the changes in field and bioattenuation parameters; and

- The target compounds (PCE and TCE) can be effectively reduced to daughter products (cis-1,2-DCE and vinyl chloride) and ultimately ethane and ethene based on a review of the VOC results.

- A non-target compound, 2-butanone, was generated within the reactive zones because the soluble and colloidal carbon injected to enhance reductive dechlorination was metabolized by aquifer microbial communities in a sequence of processes that included fermentation reactions. These anaerobic processes preceded the development of sulfate reduction and methanogenesis, the principal working mechanisms of reductive dechlorination that caused the dramatic reductions of chlorinated solvents noted in RZ-1. Fermentation reactions occur when hydrocarbons are metabolized under anoxic conditions. For example, acetone and 2-butanone form at fuel spill sites and can be used as indicators of active biodegradation. When carbon is injected at the rates required to enhance reductive dechlorination, combined concentrations of acetone and 2-butanone can rise to levels of 1,000 ug/L or more. These compounds are associated with a much larger group of fermentation products, including alcohols and organic acids. The fermentation products, collectively, were instrumental in disrupting sorbed-phase solvent masses in the aquifer that would have resisted other remedial measures.

- ERD results at RZ-1 demonstrated several important points regarding application of the technology at this site:

  1. Conditions were sufficiently reducing to fully dechlorinate cis-1,2-DCE, without production of vinyl chloride;

  2. Collateral effects of the carbon injections caused desorption of large quantities of chlorinated solvents that would have been unaffected by other remedial measures. Among these effects were:

     a. Solvent effects of fermentation products including alcohols, ketones and organic acids;

     b. Effects of microbial surfactants that are released into the formation; and

     c. Equilibration of solvents between the pre-existing carbon mass and the much larger injected carbon mass.

3. Degradation of cis-1,2-DCE accelerated after dissolved organic carbon (DOC) concentrations exceeded 700 mg/L;

4. DOC traveled at a Darcian velocity roughly one-third of the groundwater flow velocity.

- Contaminant reductions and the sequential nature of the degradation processes are summarized in figures presented in Appendix E. PCE and TCE degradation effects begin quickly, yielding a buildup of cis-1,2-DCE. Degradation of cis-1,2-DCE proceeded rapidly when DOC levels peaked at 750 mg/L. The increase in total alkenes is a result of enhanced reductive dechlorination-induced desorption processes that draw PCE, TCE and cis-1,2-DCE from sorption sites in the aquifer. The half lives of PCE and TCE are quite low when this occurs and their presence is not observed in aqueous-phase analyses. Their degradation by-products, cis-1,2-DCE and ethene, have longer half-lives at low ORPs so they linger in aqueous phase. It is also very important to note that degradation of cis-1,2-DCE did not result in a buildup of vinyl chloride, while the more degraded product, ethene was observed to accumulate. This is a very positive result of the interim measures.

Enhanced reductive dechlorination can be considered a viable technology at this site and continued implementation should result in the desired reduction of VOC concentrations.

4.3 Oxidation Area Implementation and Results

In-situ oxidation was selected as a corrective measures technology for testing in the primary source area at AOI 7, to reduce VOC mass in the upper aquifer above the upper clay till in a relatively short period of time. The oxidation testing at AOI 7 was designed to provide the information necessary to support full-scale implementation of the oxidation technology, while reducing the mass of VOCs in the source area. This section provides an overview of testing activities, a presentation of the data, and an evaluation of results.

4.3.1 Oxidation Testing Well Network

In August 1999, six stainless steel wells intended for oxidation testing were installed. Three oxidation wells (OW-1, OW-2, and OW-3) were installed in oxidation area 1 (OA-1), at the location of the former oil house (south of the existing pump house). An additional three wells, OW-4, OW-5, and OW-6, were installed in oxidation area 2 (OA-2), in the vicinity of the existing Moraine Engine tank farm. An example introduction point construction detail is presented in Appendix F (Figure F-1). Refer to Figure 4-4 for the location of the oxidation areas and Figure 4-1 for the location of the wells within OA-1. Two cross-sections showing site lithology were developed to provide additional detail within OA-1 using recent and historical soil boring information. Figure 4-19 shows the lines of the cross-sections and Figures 4-20 and 4-21 present the localized cross-sections for the injection area.

After reviewing the laboratory analytical results for groundwater samples collected at OA-2 during the September 1999 baseline event, it was determined that oxidation testing would be delayed in this area for several reasons. First, the baseline groundwater analytical results obtained from OW-4, OW-5 and OW-6 indicated concentrations that differed from the hydropunch groundwater data collected for this area during the RFI investigation. The concentration of chlorinated VOCs (PCE, TCE) was lower than anticipated, and a significant source of non-chlorinated VOCs (benzene, toluene, ethylbenzene, and xylenes [BTEX]) was encountered. These findings were inconsistent with the conceptual model previously developed for this area, and therefore, it was decided that the remedial strategy for OA-2 needed to be reevaluated. During this re-evaluation, oxidation testing began on OA-1 and GM announced its decision to close the Moraine Engine plant in 2000. Upon closure of the Moraine Engine plant, the existing tank farm and pump house will be dismantled. The Moraine Engine plant closure is currently underway with structure demolition to be complete in the spring of 2001. However, GM also announced the re-development of this area for new car storage and loading, including the installation of new railroad tracks for storage and loading/unloading.

The oxidation testing was conducted at OW-1, OW-2, and OW-3, within OA-1 area. Oxidation test groundwater monitoring was conducted at the oxidation wells and monitoring well GM-23, which is located in the center of the test area. The oxidation wells have five foot submerged screens, completed approximately 6-inches into the upper clay till (Figure F-1 in Appendix F). GM-23 was constructed with a 10-foot screen spanning from the top of the upper clay till, the water table (under normal conditions) and the capillary fringe. Monitoring was not performed at GM-27, since this well is screened below the upper clay till. The following section describes the progression of the testing that was performed in a step-by-step approach so that safety and oxidation efficiency concerns could be addressed.

4.3.2 Progression of Oxidation Testing

The oxidation testing was conducted in three parts; Preliminary Test 1, Preliminary Test 2, and a phased-oxidation test (PhaseOx test). The three tests are summarized below and detailed descriptions of the test procedures including equipment layout figures are provided in Appendix F. Table 4-39 presents a summary of the volume of injected chemicals. Figures 4-22 and 4-23 present the oxidation test conceptual model and the total injected chemical volumes on a site cross-section for the Phase-Ox test (hydrogen peroxide injection and Fenton's reagent injection, respectively).

Procedures were modified as the testing progressed, in response to observed oxygen and temperature levels, and rates of contaminant reduction. These modifications were undertaken to maximize project safety and to improve effectiveness of the technology application.

4.3.2.1 Preliminary Test 1 (September 8, 9, and 10, 1999)

Test 1 was comprised of alternating injections of ferrous sulfate and hydrogen peroxide solutions using injection equipment per Figure F-2 in Appendix F. Ferrous sulfate was injected at 50 percent saturation, and hydrogen peroxide was injected at successively increasing concentrations (at 5, 10, and 20 percent) into OW-1. A total of 750 pounds (lbs) of ferrous sulfate and 200 gallons of hydrogen peroxide (corrected to 100% H_2O_2) were injected (Table 4-39) into OW-1 on three consecutive days. The chemicals were injected separately rather than simultaneously to address safety concerns associated with aboveground mixing of chemicals or the potential for a run-away reaction beneath the surface of this active area of the facility. In addition, the hydrogen peroxide was first injected at low concentrations until the safety hazards (i.e. high temperatures, pressures, and oxygen levels) were better understood.

The Fenton's reaction is typically run at solution pH levels between 3 and 5. This maximizes regeneration of iron, which is an essential participant in the reaction sequence. Recent literature reports indicate that the Fenton's reaction can proceed effectively at higher pH levels, in the presence of sufficient iron in the soil. Because the high-carbonate aquifer formation at the Moraine site rapidly titrates any injected reaction mixture to pH levels above the 3 to 5 range, an objective of the first test was to determine the effectiveness of the oxidation at this site without pH adjustment. Iron was pre-placed in the formation by pumping in the ferrous sulfate solution, which was followed by hydrogen peroxide injection. Before and after each day of Preliminary Test 1, groundwater samples were collected from the injection well and nearby wells for analysis of VOCs. Field parameters (pH, ORP, temperature, conductivity, and DO), water level measurements, photoionization (PID) readings, and field test kit data were collected from the surrounding wells throughout the testing.

4.3.2.2 Preliminary Oxidation Test 2 (December 2, 1999)

Preliminary Test 2 consisted of the simultaneous injection of a ferrous sulfate solution and a pH-adjusted hydrogen peroxide solution into OW-3 using injection equipment per Figure F-3 in Appendix F. A total of 340 lbs of ferrous sulfate and 51.8 gallons of hydrogen peroxide were injected (Table 4-39). Because the aquifer soils rapidly titrate acidified solutions to higher pH, a reagent mix injected in the pH 3 to 5 would be pushed above that range within a very short distance from the point of injection. Instead, the hydrogen peroxide component of the reagents was acidified with a 10% sulfuric acid solution, to bring the final, combined reagent mixture to a pH of 1. As the solution was pushed through the formation, it was titrated into the effective range for the Fenton's reaction, and the effective radius of the chemical reaction was extended.

Another effect of the low-pH reagent mixture was displacement of the most aggressive oxidation away from the injection hardware. This reduced the reaction backpressure exerted on the well system, improving system safety.

Before and after Preliminary Test 2, groundwater samples were collected from the injection well and nearby wells for analysis of VOCs. In addition, the same field water quality parameters, water level measurements, PID readings, and field test kit data were collected from the surrounding wells throughout the test.

4.3.2.3 PhaseOx Testing (April and May 2000)

Phased oxidation testing (PhaseOx) was conducted in April and May of 2000 at OW-1, OW-2 and OW-3. Because oxidant reactions with oils and other non-chlorinated compounds occur very rapidly relative to reaction rates for oxidation of chlorinated alkenes, the non-target organics are almost entirely oxidized before target compounds such as PCE and TCE come under oxidant attack. Phased oxidation attacks oils and other non-target organic compounds with low-cost oxidant mixtures, to improve the efficiency of the more costly Fenton's reagent mixture.

Part 1 of the PhaseOx approach involved the introduction of 196, 552, and 316 gallons of hydrogen peroxide (a moderate strength oxidant) into the aquifer via oxidation wells OW-1, OW-2, and OW-3, respectively. The hydrogen peroxide was diluted with potable water to a 17.5 percent solution prior to injecting. The objective of Part 1 was to oxidize non-target compounds and thereby overcome the aquifer's reductive poise.

Part 2 of the Phase Ox testing consisted of the injection of ferrous sulfate and pH adjusted hydrogen peroxide (Fenton's reagent) simultaneously. The objective of Part 2 was to create the hydroxyl radical (a high strength oxidant) to oxidize the target VOCs (specifically PCE and TCE). During Part 2, approximately 210 and 175 gallons of hydrogen peroxide, and 1,378 and 1,125 pounds of ferrous sulfate (diluted with potable water) were injected into OW-1 and OW-2, respectively (Table 4-39). The simultaneous injection of chemicals using the acidified hydrogen peroxide procedure used in Preliminary Test 2 was also used for Part 2 of the PhaseOx testing (Figure F-3 in Appendix F).

Before PhaseOx Part 1, between PhaseOx Part 1 and PhaseOx Part 2, and after PhaseOx Part 2, groundwater samples were collected from the injection well(s) and nearby wells for analysis of VOCs. Field water quality parameters and water level measurements were collected from the monitoring wells throughout the testing.

Prior to PhaseOx Part 1, five vadose zone points (VP-1 through VP-5) were installed (Figure 4-19) to a depth of 15 or 20 ft bls and at a distance of 5 or 10 ft from the injection wells. The purpose of these vadose points is to provide subsurface pressure and temperature relief by allowing gas to flow from the point of the reaction through the vadose point to the atmosphere.

During the installation of three vadose points (VP-1, VP-3, and VP-5), soil samples for TOC analysis were collected from both the saturated sand and gravel and the upper clay till (Table 4-40). In addition, two borings (VP-3A and VP-5A) were installed adjacent to VP-3 and VP-5 to collect soil samples for TOC analysis following PhaseOx Part 1. The purpose for the initial TOC sampling was to provide data to determine the reductive poise and adsorption capacity of the aquifer. The purpose of the follow-up TOC sampling after PhaseOx Phase 1 was to determine if a reduction of TOC due to hydrogen peroxide oxidation had occurred.

During the first week of PhaseOx Part 1, the off-gas was monitored using a Landtech gas meter. The meter is capable of measuring the percent of oxygen, carbon dioxide, and methane in a gas. The data from the first week of hydrogen peroxide addition indicated that the off-gas consisted of 95 to 100 percent oxygen. It was determined that if the high concentration of oxygen remained in the subsurface, the potential for a hazardous situation could occur during future construction at the site. Therefore, to address this concern, an explosion proof, 1.5 horsepower, blower was installed at VP-4 (centrally located among the oxidation wells). The blower was operated for the remainder of PhaseOx Parts 1 and 2. Blower influent air (consisting of reaction gas diluted with soil gas) was monitored using the gas meter. In addition, the gas emissions from the oxidation wells and GM-23 (which have submerged screens during oxidation testing) were monitored to provide data representative of reaction gas only.

4.3.3 Summary of Test Results

A summary of the results from the oxidation testing is presented in the following sections and on Tables 4-41 and 4-42, and on Figures 4-24 through 4-28. Additional raw data is presented in Appendix F.

4.3.3.1 VOC Laboratory Analytical Data

The VOC analytical results are included in Table 4-42 and presented in Figures 4-24 through 4-27. The following generalizations can be made based on the laboratory analytical data.

- VOC concentrations in the oxidation wells OW-1 and OW-3 decreased (after 1 day) then rebounded (after 2 weeks) following Preliminary Test 1 and Preliminary Test 2 (Figures 4-24 and 4-26). The resultant rebound concentration was greater than the pretest concentration. The initial decrease is thought to be a result of dilution and oxidation, while the rebound effect is a result of two processes: (1) groundwater was entering the area from upgradient and (2) non-target organic carbon was being destroyed via oxidation resulting in a transfer of contaminants from the sorbed phase to the aqueous phase.

- Minimal rebound of VOC concentrations was observed two weeks (at OW-1, OW-2, OW-3 and GM-23) and 4 months (at GM-23) following the PhaseOx testing, likely indicating that the majority of the VOC mass (dissolved and adsorbed) was oxidized.

- Minimal changes in PCE and TCE were observed at GM-23 during and two weeks following the three oxidation tests (Figure 4-27). The persistence of PCE and TCE may be a result of the high adsorptive capacity of the silty/clayey sand observed during the installation of GM-23 (Figures 4-20 and 4-21). A second possible reason may be due to the difference in monitoring depth versus injection depth since GM-23 is screened throughout the saturated zone while the oxidation wells are screened only in the bottom 4 to 4.5 ft.

- PCE and TCE concentrations at GM-23 decreased 40 to 60 percent, four months following the oxidation testing compared to previous data (Figure 4-27). This change was likely due to the aquifer returning to equilibrium conditions as a portion of the remaining PCE and TCE reabsorbed into the soil structure. The reduced equilibrium concentrations indicate a net reduction of PCE and TCE mass (in soil and groundwater) in the vicinity of GM-23.

4.3.3.2 TOC Laboratory Analytical Data

The results of the initial TOC data, indicated relatively high concentrations of TOC in the saturated sand and gravel and very high concentrations of TOC in the upper clay till. The TOC data was used to estimate the aquifer's reductive poise or capacity to reduce an oxidizing agent. A sample calculation for determining the aquifer's reductive poise and the volume of hydrogen peroxide required to overcome the reductive poise is included in Appendix F.

The results of the follow up TOC data indicated that much of the TOC still existed within the both the saturated sand and gravel and the upper clay till, despite the quantity of hydrogen peroxide injected during PhaseOx Part 1 (Table 4-40).

4.3.3.3 Geochemical Laboratory Analytical Data

The geochemical analytical results are included in Table 4-41 and presented in Figure 4-28. The following generalizations can be made based on the laboratory analytical data.

- Sulfate increased in all the wells indicating a reasonable injection radius of influence by the injection of ferrous sulfate.

- Total iron decreased in wells where oxidation was not conducted (GM-23 and OW-2 prior to PhaseOx). This indicated that hydrogen peroxide likely reacted with the natural iron present at these wells resulting in some gratuitous production of hydroxyl radical and ferric iron which becomes less mobile. Total iron increased in wells used for oxidation via Fenton's reagent, as expected.

- Dissolved TOC decreased significantly following Preliminary Test 1, indicating that the TOC in groundwater was oxidized first.

- Carbon dioxide, a product of the oxidation of organic compounds, generally increased in all the wells.

4.3.3.4 Field Water Quality Parameters and Groundwater Elevation Data

Data trends based on the water quality parameters collected in the field are presented in Figures F-5 through F-8 in Appendix F. The following generalizations can be made based on the data.

4.2.7.1.1 pH

The pH in all the wells decreased (to approximately 5.5 to 6.5) during injection of pH adjusted hydrogen peroxide to create Fenton's reagent (Figure F-5 in Appendix F). The pH was approximately 7 during baseline sampling and the injection of hydrogen peroxide alone (PhaseOx, Part1).

4.2.7.1.2 Specific Conductivity

Specific conductivity increased dramatically in the oxidation wells during PhaseOx Part 2 as expected due to the injection of ferrous sulfate (Figure F-6 in Appendix F). Specific conductivity doubled in monitoring well GM-23 indicating a reasonable injection radius of influence.

4.2.7.1.3 Redox Potential

Baseline redox potential at the oxidation wells (screened immediately above the upper clay till only) ranged from -500 to -100 indicating highly reducing conditions (Figure F-7 in Appendix F). Baseline redox potential at GM-23 was notably higher, at +120, which indicated different aquifer conditions. A geologic cross section of the test area depicting why these conditions may differ is given in Figure 4-20.

Redox potential generally increased to an approximate range of 200 to 400 mV and then decreased slightly during PhaseOx, Part 2. The increase in redox potential indicates that the hydrogen peroxide was gradually overcoming the reductive poise of the aquifer.

4.2.7.1.4 Dissolved Oxygen

An obvious increase in DO can be interpreted from the data especially in the beginning of the testing, but due to the multiple interferences that the dissolved oxygen probe may detect in a chemically rich environment, no evaluation will be completed for DO (Figure F-8 in Appendix F).

4.2.7.1.5 Groundwater Elevation Data

A substantial increase in the groundwater elevation was observed during the injection of both hydrogen peroxide and Fenton's Reagent. The rise in the water table is a result of the reaction producing gas that displaces the groundwater. An injection radius of influence greater than 25 ft was observed based on the groundwater elevation data. The greatest rise was observed during PhaseOx Part 1. Figures 4-22 and 4-23 present the rise of the water table on the site cross-section for Phase Ox Part 1 and 2, respectively.

4.3.3.5 Field Off-Gas Monitoring Parameters

The results of the off-gas monitoring data are presented in Figure 4-22 for PhaseOx Part 1 and Figure 4-23 for PhaseOx Part 2. These figures present a conceptual model of the off-gas recovery system that was used during the Phase Ox test. In addition, Figures F-9, F-10, and F-11 in Appendix F present plots of the available oxygen injected compared to the oxygen and carbon dioxide emitted for one day during PhaseOx Part 1 and two days during PhaseOx Part 2.

Reaction gas diluted with soil gas was extracted and monitored at VP-4. Oxygen in the off-gas ranged from 33 to 56 percent during PhaseOx Part 1 and 20 to 29 percent during PhaseOx Part 2. Carbon dioxide in the off-gas ranged from 0 to 1.7 percent during PhaseOx Part 1 and 0 to 8 percent during PhaseOx Part 2. Reaction gas produced and capture below the displaced water table was monitored in GM-23 and the oxidation wells. Oxygen at GM-23 ranged from 95 to 100 percent during PhaseOx Part 1 and 50 to 75 percent during PhaseOx Part 2. Carbon dioxide at GM-23 ranged from 0 to 5 percent during PhaseOx Part 1 and 25 to 43 percent during PhaseOx Part 2. The oxygen and carbon dioxide concentrations were generally less in the oxidation wells but this may be due to atmospheric dilution since it appeared that less gas flow was emitted from these wells.

The off-gas oxygen concentrations were higher during PhaseOx, Part 1, than in Part 2. This suggests that a large portion of the injected hydrogen peroxide was lost to the disproportion reaction. However, evaluation of the target compound reductions indicated that PhaseOx Part 1 was, itself, very effective in attacking target compounds. Because OW-2 did not receive iron injections during Preliminary Tests 1 and 2, it can be conclude that there was sufficient iron in the aquifer formation to promote high-pH development of the hydroxyl radical from injected hydrogen peroxide.

4.2.8 Conclusions

In-situ oxidation substantially reduced all chlorinated alkene concentrations in the lower portion of the upper aquifer in AOI 7, Oxidation Area 1, represented by oxidation wells OW-1, OW-2 and, OW-3.

Total chlorinated alkenes were reduced only 40 percent in nearby monitoring well GM-23, and general chemical parameters indicated that the oxidant had a limited effect on this well, despite the well's proximity to the oxidant injections.

PhaseOx Part 1 results indicate that injection of hydrogen peroxide, alone, can achieve remedial objectives, simplifying the reagent handling process. Full Fenton's reagent may be required in some areas, and should be maintained as a spot-treatment contingency.

Observations of well hydraulics and pre-treatment oxidation levels suggest that GM-23 is most representative of a conductive aquifer stratum at the top of the upper aquifer, and little water is entering the well from the deeper portion of the screened interval. The upper aquifer can be treated by in-situ oxidation to achieve remedial objectives in the AOI 7 area, although injections should be directed into both the top and the bottom of the formation.

The total oxidant injected to achieve the observed reductions in target compounds matched the amount needed to quench the reductive poise generated by 3,000 mg/kg TOC.

In-situ oxidation can be considered a viable technology at this site and continued implementation should result in the desired reduction of VOC concentrations; however, special considerations of safety concerns associated with technology implementation will be required.

5. Recommended Final Corrective Measure Alternative

The primary purpose of this IM/CM report is to present a summary of the RFI results, a summary of existing interim measures, and an evaluation of corrective measures technologies that would be applicable for the site. GM believes that the ongoing capture zone interim measures and the AOI 7 interim measures previously described are capable of effectively addressing the VOCs in groundwater at the Moraine Facilities. Therefore, GM recommends that the capture zones and in-situ remediation of groundwater combined with institutional actions will be the final corrective measure alternative for the Moraine site. This site-wide alternative is protective of human health and the environment by reducing the toxicity, mobility, and volume of waste through treatment; will address the short-term and long-term goals for the site (Section 1.6.2); will meet the interim measures/corrective measures objectives (Section 1.1); and will be cost effective.

The components of the final corrective measure alternative are as follows:

- Capture Zone Corrective Measures: GM will continue to operate TW-2 and DN-13.

RZ-2 and

- Reactive Zone Corrective Measures: GM will continue to operate and expand RZ-1, and continue to operate RZ-3. ~~Within RZ-2, future railroad expansion and construction will eliminate access to the ME series wells; therefore, GM recommends halting carbon source solution introductions and abandoning wells ME-1 through ME-6 when access is no longer available. Once construction is complete, GM will install appropriate replacement monitoring wells.~~

- Site-Wide Groundwater Monitoring: GM will continue to monitor groundwater quality in order to monitor effectiveness of the capture zones and reactive zones and determine when active corrective measures have met the RTLs within the monitoring zones defined in Section 2.0.

- Institutional Actions: GM will implement deed restrictions to prevent inappropriate use of the site and monitor use of groundwater by the GM facilities and implement access restrictions to the site property.

Capture Zone Corrective Measures

The existing capture zones include a combination of groundwater extraction from TW-2 in the upper aquifer and DN-13 in the lower aquifer and treatment of VOCs in upper aquifer groundwater through an air stripper tower and discharge through an NPDES permit to the Great Miami River (Section 3.1). These systems are already in place and will remain in operation until the appropriate RTLs and corrective measures objectives have been met and the site-wide monitoring confirms that corrective measures objectives have been met.

Reactive Zone Corrective Measures

As discussed in Section 4.0, both enhanced reductive dechlorination and in-situ oxidation (creation of Fenton's reagent) were successfully implemented at the site and are effective at remediating chlorinated VOCs. Due to ongoing redevelopment of the Moraine Engine property, in-situ oxidation would not be a viable option. Therefore, GM recommends the selection of enhanced reductive dechlorination with some modifications to the existing reactive zones as a component of the final site-wide remedy to address the chlorinated VOCs in the groundwater plume emanating from AOI 7.

- Within RZ-1, GM will expand the aerial coverage of the zone through the additional installation of RZ wells along the western side of AOI 7, parallel to the railroad tracks. Groundwater flows to the southwest and the upper clay till pinches out west of AOI 7; therefore, this modification will allow RZ-1 to more effectively remediate groundwater emanating from AOI 7. GM will install between 8 to 12 RZ wells, depending on accessibility to the area. Once installed, the carbon source solution (molasses and potable water) introductions will continue within the expanded RZ-1 area. Solution volumes and concentrations and introduction frequencies will be evaluated and adjusted as necessary.
- Within RZ-3, GM recommends continuing introduction of the carbon source solutions into the existing wells at RZ-3West (north of Landfill L1) and RZ-3East (in the overflow parking lot). Solution volumes and concentrations and introduction frequencies will be evaluated and adjusted as necessary.

Site-Wide Groundwater Monitoring

A key component of the final remedy will be the site-wide groundwater monitoring program. The objectives of this program will be to:

- Monitor groundwater quality upgradient and downgradient of Landfills L1, L2, and L3; the North and South Settling Lagoons; and the Waste Pile/Staging Area;
- Monitor groundwater in the upper and lower aquifers at the southern, downgradient property boundary to assess the need for continued operation of TW-2 and DN-13; and
- Monitor the effectiveness of enhanced reductive dechlorination downgradient of the reactive zones and across the site.

The upper and lower aquifer wells to be included in the site-wide groundwater monitoring program, the sampling frequency, and the list of parameters to be analyzed are presented in Table 5-1. As discussed in the Site-Wide Groundwater Monitoring Plan, an annual report will be prepared and submitted to the U.S. EPA. The annual report will include a discussion of field activities (groundwater sampling, corrective measures, water-level measurements) and a presentation of analytical results (ARCADIS Geraghty & Miller, Inc. 2000d). Data evaluation and any recommendations for changes to the corrective measures, RTLs, or site-wide groundwater monitoring plan will be included in this annual report. This report will replace the annual capture zone monitoring report which is currently required to be submitted by GM (corrective measures at TW-2 and DN-13).

Institutional Actions

Institutional actions are an important component of the final remedy to ensure long-term protection of human health and environment under the current industrial land use. Property deed restrictions placed on the land-based units, landfills and lagoons, will prevent non-industrial use of this land and prevent exposure for long-term management of these units. Property deed restrictions placed on groundwater at the site will prevent its use as a potable water supply for the facilities. These controls are in addition to existing state regulations governing development and use of groundwater for a potable water supply and local zoning of the land use at and surrounding the facilities. Deed restrictions are administratively implementable and require the filing of notices with the Moraine Office of the Recorder. Access restrictions will also be maintained to limit the potential for direct human contact. The access restrictions already in place at the facility include the site-wide perimeter fence and 24-hour security.

6. References

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Table 1-1. Water-Level Measurements During September 1999, General Motors Corporation, Moraine, Ohio.

Well	Measuring Point Elevation	Depth-to-Water (feet)	Water-Level Elevation
Shallow Aquifer Wells			
W-1-N	739.02	34.03	704.99
W-2-N	731.68	27.47	704.21
W-3-N	733.66	29.58	704.08
W-4-N	731.63	27.54	704.09
HR-1	732.71	30.44	702.27
HR-2	734.75	30.61	704.14
HR-3	736.75	32.65	704.10
HR-4	742.6	37.80	704.80
HR-5	734.27	30.65	703.62
HR-6	732.66	29.91	702.75
HR-7	731.73	28.10	703.63
HR-8	743.42	38.22	705.20
HR-9	743.51	37.77	705.74
HR-11	743.33	37.62	705.71
HR-16	727.01	25.32	701.69
HR-17	726.43	24.50	701.93
W-1-S	729.29	27.26	702.03
W-2-S	726.64	25.64	701.00
W-3-S	733.42	32.46	700.96
W-4-S	727.68	26.69	700.99
GM-2	735.81	34.90	700.91
4S	731.36	30.75	700.61
GM-6	730.27	30.10	700.17
GM-8	735.17	34.63	700.54
GM-10	723.9	23.99	699.91
GM-16	725.3	25.04	700.26
GM-17	723.84	23.56	700.28
GM-18	723.8	23.60	700.20
GM-19S	730.85	29.90	700.95
EAST	730.98	29.12	701.86
WEST	731.08	29.36	701.72
WSU-24	725.1	24.32	700.78
TW-2 (1)	733.38	36.52	696.86
GM-21	724.2	23.75	701.26

Table 1-1. Water-Level Measurements During September 1999, General Motors Corporation, Moraine, Ohio.

Well	Measuring Point Elevation	Depth-to-Water (feet)	Water-Level Elevation
GM-22	728.28	26.21	702.07
GM-23	730.99	26.50	704.49
GM-24	747.29	40.92	706.37
GM-25	746.17	41.89	704.28
GM-26	722.29	22.84	699.45
GM-27	730.59	26.21	704.38
GM-28	729.19	25.39	703.80
GM-29	730.78	26.56	704.22
GM-30	732.33	27.60	704.73
GM-31	728.20	26.00	702.20
GM-32	NM	NM	NM
ME-1	728.06	25.80	702.26
ME-2	728.4	26.16	702.24
ME-3	728.09	25.90	702.19
ME-4	728.31	26.19	702.12
ME-5	728.29	26.52	701.77
ME-6	728.34	26.10	702.46
Deep Aquifer Wells			
GM-1	735.74	35.14	700.60
GM-3	730.44	30.41	700.03
GM-4	731.46	31.45	700.01
GM-5	731.29	31.05	700.24
GM-7R	735.61	35.06	700.55
GM-9	724.07	24.60	699.47
GM-11	723.71	24.40	699.31
GM-13	723.82	25.08	698.74
GM-14	723.5	24.90	698.60
GM-15	725.23	26.60	698.63
GM-19D	730.25	29.45	700.80
GM-20D	727.26	26.66	700.60
HR-10	742.81	37.08	705.73
HR-12	742.64	36.92	705.72
HR-13	735.03	31.00	704.03
HR-14	731.63	27.68	703.95

Table 1-1. Water-Level Measurements During September 1999, General Motors Corporation, Moraine, Ohio.

Well	Measuring Point Elevation	Depth-to-Water (feet)	Water-Level Elevation
HR-15	733.74	29.90	703.84
M73C	716.55	17.17	699.38
MT68	746.45	43.18	703.27
MT69	722.71	23.43	699.28
MT576M	751.46	46.05	705.41
MT596M*	757.73	50.96	706.77
Production and Fire Wells			
11A	744.93	NA	NA
12A	742.35	NA	NA
15	731.44	NM	NM
28	733.67	NA	NA
31	734.05	NA	NA
32	732.10	NA	NA
35	733.96	32.30	701.66
37	731.24	NA (bolted shut)	NA
39	732.07	NA	NA
42	731.62	NA	NA
44	734.62	NA	NA
45	731.03	30.25	700.78
46	733.34	32.46	700.88
A	739.00	34.55	704.45
FW-1A	739.89	NM	NM
FW-2	737.48	34.00	703.48
FW-3	739.26	35.90	703.36
FW-4	731.62	30.10	701.52

Water-level elevations are reported in feet above mean sea level (msl).

Depth-to-water elevations were measured on September13, 1999 using an electronic water level indicator.

Depth-to-water measurements are reported in feet below the measuring point.

1. TW-2 is an active recovery well.

NA - Not accessible.

NM - Not measured.

*Measuring point is top of cement housing.

Table 1-2. Summary of Delphi Thermal Moraine RFI Sampling Programs, General Motors Corporation, Moraine, Ohio.

DRAFT

SWMU	Groundwater Samples	Analyses	Soil Samples	Analyses	Surface Water/ Sediment Samples	Analyses	Waste Samples	Analyses
PHASE I								
West Tank Farm (Jan. 93 groundwater) (Nov. 92 soil)	HR-1 W-1-S DUP-13	APP. IX VOCs APP. IX Metals APP. IX PCBs	4	TCL VOCs TCL PCBs TCL Pest. TAL Tot. Metals	NA	NA	NA	NA
T5/T6 (Dec. 92 soil)	NA	NA	3	TCL VOCs TCL SVOCs TCL PCBs TAL Tot. Metals	NA	NA	NA	NA
T4 (Oct. 92 soil)	NA	NA	1	TCL VOCs TAL Tot. Metals	NA	NA	NA	NA
T11 (Jan. 93 groundwater) (Dec. 92 soil)	GM-19S GM-19D DUP-16	APP. IX VOCs APP. IX SVOCs APP. IX PCBs APP. IX Pest. APP. IX Herb. APP. IX Cyanide APP. IX Tot. & Diss. Metals	7	TCL VOCs TCL SVOCs TCL PCBs TCL Pest. TAL Tot. Metals TAL Cyanide	NA	NA	NA	NA
T12 (Jan. 93 groundwater) (Oct. 92 soil)	HR-6	APP. IX VOCs APP. IX Tot. & Diss. Metals	3	TCL VOCs TAL Tot. Metals	NA	NA	NA	NA
Off-Site Upgradient (Jan. 93 groundwater) (Jan. 93 surface water/sediment)	HR-8 HR-9 HR-10 HR-11 HR-12 W-1-N DUP-20	APP. IX VOCs APP. IX SVOCs APP. IX PCBs APP. IX Pest. APP. IX Herb. APP. IX Cyanide APP. IX Tot. & Diss. Metals	NA	NA	3	APP. IX VOCs APP. IX SVOCs APP. IX PCBs APP. IX Pest. APP. IX Herb. APP. IX Cyanide APP. IX Tot. Metals	NA	NA

Table 1-2. Summary of Delphi Thermal Moraine RFI Sampling Programs. General Motors Corporation, Moraine, Ohio.

DRAFT

SWMU	Groundwater Samples	Analyses	Soil Samples	Analyses	Surface Water/ Sediment Samples	Analyses	Waste Samples	Analyses
Off-Site Downgradient (Jan. 93 groundwater) (Jan. 93 surface water/sediment)	GM-9 GM-10 GM-11 GM-13 GM-15 GM-16 GM-17 GM-18 DUP-21 DUP-22	APP. IX VOCs APP. IX SVOCs APP. IX PCBs APP. IX Pest. APP. IX Herb. APP. IX Cyanide APP. IX Tot. & Diss. Metals	NA	NA	3	APP. IX VOCs APP. IX SVOCs APP. IX PCBs APP. IX Pest. APP. IX Herb. APP. IX Cyanide APP. IX Tot. Metals	NA	NA
Landfill L1 (Jan. 93 groundwater) (Oct. 92 waste)	East 4S GM-1 GM-2 GM-5 GM-7R GM-8 DUP-17 DUP-18	APP. IX VOCs APP. IX SVOCs APP. IX PCBs APP. IX Pest. APP. IX Herb. APP. IX Cyanide APP. IX Tot. & Diss. Metals	NA	NA	NA	NA	6	TCL VOCs TCL SVOCs TCL PCBs TCL Pest. TAL Tot. Metals TAL Cyanide
Landfill L2 (Jan. 93 groundwater) (Dec. 92 waste)	HR-3 HR-13	APP. IX VOCs APP. IX SVOCs APP. IX PCBs APP. IX Pest. APP. IX Herb. APP. IX Cyanide APP. IX Tot. & Diss. Metals	NA	NA	NA	NA	4	TCL VOCs TCL SVOCs TCL PCBs TCL Pest. TAL Tot. Metals TAL Cyanide

Table 1-2. Summary of Delphi Thermal Moraine RFI Sampling Programs, General Motors Corporation, Moraine, Ohio.

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SWMU	Groundwater Samples	Analyses	Soil Samples	Analyses	Surface Water/ Sediment Samples	Analyses	Waste Samples	Analyses
Landfill L3 (Jan. 93 groundwater) (Dec. 92 and Feb. 93 waste)	HR-4 DUP-15	APP. IX VOCs APP. IX SVOCs APP. IX PCBs APP. IX Pest. APP. IX Herb. APP. IX Cyanide APP. IX Tot. & Diss. Metals	NA	NA	NA	NA	3	TCL VOCs TCL SVOCs TCL PCBs TCL Pest. TAL Tot. Metals TAL Cyanide
North Lagoon (Jan. 93 groundwater)	W-3-N W-4-N HR-14 HR-15 DUP-14	APP. IX VOCs APP. IX SVOCs APP. IX PCBs APP. IX Pest. APP. IX Herb. APP. IX Cyanide APP. IX Tot. & Diss. Metals	NA	NA	NA	NA	NA	NA
South Lagoon (Jan. 93 groundwater)	W-2-S W-4-S HR-17 DUP-19	APP. IX VOCs APP. IX SVOCs APP. IX PCBs APP. IX Pest. APP. IX Herb. APP. IX Cyanide APP. IX Tot. & Diss. Metals	NA	NA	NA	NA	NA	NA

Table 1-2. Summary of Delphi Thermal Moraine RFI Sampling Programs, General Motors Corporation, Moraine, Ohio.

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SWMU	Groundwater Samples	Analyses	Soil Samples	Analyses	Surface Water/ Sediment Samples	Analyses	Waste Samples	Analyses
Waste Pile/ Staging Area (Jan. 93 groundwater) (Dec. 92 soil)	GM-19S GM-19D DUP-16	APP. IX VOCs APP. IX SVOCs APP. IX PCBs APP. IX Pest. APP. IX Herb. APP. IX Cyanide APP. IX Tot. & Diss. Metals	7	TCL VOCs TCL SVOCs TCL PCBs TAL Tot. Metals	NA	NA	NA	NA
South Tank Farm (Jan. 93 groundwater) (Nov. 92 soil)	GM-19S GM-19D DUP-16	APP. IX VOCs APP. IX SVOCs APP. IX PCBs APP. IX Pest. APP. IX Herb. APP. IX Cyanide APP. IX Tot. & Diss. Metals	3	TCL VOCs TCL PCBs TCL Pest. TAL Tot. Metals	NA	NA	NA	NA
Background (Nov. 92 soil)	NA	NA	27	TCL VOCs TCL SVOCs TCL PCBs TCL Pest. TAL Tot. Metals TAL Cyanide	NA	NA	NA	NA
PHASE II								
West Tank Farm (Oct. 94 groundwater)	HR-1 W-1-S	VOCs 8015	NA	NA	NA	NA	NA	NA
T10 (Sept. 94 soil)	NA	NA	2	TCL VOCs	NA	NA	NA	NA
T11 (Oct. 94 groundwater)	GM-19S GM-19D	APP. IX VOCs	NA	NA	NA	NA	NA	NA

Table 1-2. Summary of Delphi Thermal Moraine RFI Sampling Programs, General Motors Corporation, Moraine, Ohio.

DRAFT

SWMU	Groundwater Samples	Analyses	Soil Samples	Analyses	Surface Water/ Sediment Samples	Analyses	Waste Samples	Analyses
T12 (Nov. 94 groundwater)	HR-6	VOCs 8015	NA	NA	NA	NA	NA	NA
Off-Site Upgradient (Oct. and Nov. 94 groundwater) (Oct. 94 surface water/ sediment)	HR-8 HR-9 HR-10 HR-11 HR-12 W-1-N DUP-29 DUP-36	VOCs 8015	NA	NA	1	VOCs 8015	NA	NA
Off-Site Upgradient (Oct. and Nov. 94 groundwater)	HR-10 HR-12 DUP-29 DUP-26	Total and Diss. Antimony						
Off-Site Downgradient (Oct. 94 groundwater) (Oct. 94 soil) (Oct. 94 surface water/ sediment)	GM-9 GM-10 GM-11 GM-13 GM-15 GM-16 GM-17 GM-18 DUP-32	VOCs 8015	3	TCL VOCs TCL PCB/Pest. TAL Metals & Cyanide	2	VOCs 8015	NA	NA
Off-Site Downgradient (Oct. and Nov. 94 groundwater)	MT-69 WSU-24 DUP-33 GM-20D	APP. IX VOCs APP. IX PCBs APP. IX Pest. APP. IX Herb. APP. IX Cyanide APP. IX Total & Diss. Metals						

Table 1-2. Summary of Delphi Thermal Moraine RFI Sampling Programs, General Motors Corporation, Moraine, Ohio.

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SWMU	Groundwater Samples	Analyses	Soil Samples	Analyses	Surface Water/ Sediment Samples	Analyses	Waste Samples	Analyses
L1 (Oct. and Nov. 94 groundwater)	4S GM-1 GM-2 GM-5 GM-8 DUP-37	VOCs 8015	NA	NA	NA	NA	NA	NA
L1 (Oct. 94 groundwater)	East GM-3 GM-6 GM-7R DUP-29 DUP-34	APP. IX VOCs	NA	NA	NA	NA	NA	NA
L2 (Nov. 94 groundwater)	HR-3 HR-13	VOCs 8015	NA	NA	NA	NA	NA	NA
L3 (Nov. 94 groundwater)	HR-4	VOCs 8015	NA	NA	NA	NA	NA	NA
North Lagoon (Nov. 94 groundwater)	HR-14 HR-15 W-3-N W-4-N DUP-38	VOCs 8015	NA	NA	NA	NA	NA	NA
South Lagoon (Oct. 94 groundwater)	HR-17 W-2-S W-4-S DUP-35	APP. IX VOCs	NA	NA	NA	NA	NA	NA
Waste Pile/ Staging Area (Oct. 94 groundwater) (Sept. 94 soil)	GM-19S GM-19D	APP. IX VOCs	13	TCL VOCs TCL SVOCs TCL PCBs TCL Pest. TAL Metals	NA	NA	NA	NA

Table 1-2. Summary of Delphi Thermal Moraine RFI Sampling Programs, General Motors Corporation, Moraine, Ohio.

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SWMU	Groundwater Samples	Analyses	Soil Samples	Analyses	Surface Water/ Sediment Samples	Analyses	Waste Samples	Analyses
South Tank Farm (Oct. 94 groundwater)	GM-19S GM-19D	APP. IX VOCs	NA	NA	NA	NA	NA	NA
Liquid Waste Burner (Oct. 94 groundwater) (Sept. 94 soil)	West	APP. IX VOCs	3	TCL VOCs TCL SVOCs TCL PCBs TCL Pest. TAL Metals	NA	NA	NA	NA
Fill Area (Sept. 94 soil)	NA	NA	4	TCL VOCs TCL SVOCs TCL PCBs TCL Pest. TAL Metals	NA	NA	NA	NA
Background (Sept. 94 soil)	NA	NA	6 1	Acetone Cyanide	NA	NA	NA	NA

VOC Volatile Organic Compounds
SVOC Semivolatile Organic Compounds
PCB Polychlorinated Biphenyls
TAL Target Analyted Listed
TCL Target Compound List
Herb. Herbicides
APP Appendix
Diss. Dissolved
Tot. Total

Table 1-3. Summary of Moraine Engine and Moraine Assembly Supplemental RFI Sampling Programs, General Motors Corporation, Moraine, Ohio. **DRAFT**

AOI	Soil Samples	# of Soil Samples*	Analyses	Groundwater Samples	# of Groundwater Samples*	Analyses
AOI 7 - Former Oil House Area (February 1998)	OH-BH1 to OH-BH4	11	TCL VOC 8240B TCL SVOC 8270B TCL PCB 8080A TAL Metals[1]	GM-23 and HR-11 (Low-flow)	2	App. IX VOC 8240B and cis-1,2-DCE App. IX SVOC 8270B App. IX PCB 8080A App. IX Total Metals 6020[2] App. IX Diss. Metals 6020[2] Biogeochemical Parameters[3]
AOI 7 - Former Oil House Area (August 1998)	OH-BH5 to OH-BH10 GM-27 borehole GM-28 borehole	21	TCL VOC 8240B short list[4]	OH-BH5 to OH-BH10 GM-27 and GM-28 (Hydropunch)	11	App. IX VOC 8240B short list[4]
				GM-27, GM-28, ME-6, HR-1, HR-3, and GM-26	6	App. IX VOC 8240B short list[4]
				GM-23, GM-27, and GM-28 (Low-flow)	3	App. IX VOC 8240B short list[4] Biogeochemical Parameters[3]
AOI 7 - Former Oil House Area (November 1998)	OH-BH11 to OH-BH20 OH-BH2A OH-BH3A GM-23A	31	TCL VOC 8260B short list[4]	OH-BH11 to OH-BH20 OH-BH2A OH-BH3A (Hydropunch)	14	App. IX VOC 8260 short list[4]
AOI 13 - Buildings 4, 6, and 13 (February 1998)	BDG-DP1 to BDG-DP19 (direct-push)	20	VOC and PCB Field Screening	GM-21, GM-22, and EAST (Low-flow)	3	App. IX VOC 8240B and cis-1,2-DCE App. IX SVOC 8270B App. IX PCB 8080A App. IX Total Metals 6020[2] App. IX Diss. Metals 6020[2] Biogeochemical Parameters[3]
	BDG-DP1	1	TCL PCB 8080A			
	BDG-DP13	1	TAL Metals[1]			
AOI 17 - Building 15 (February 1998)	BD15-DP1 to BD15-DP3	3	VOC and PCB Field Screening	GM-21 and GM-22 (Low-flow)	NA	App. IX VOC 8240B and cis-1,2-DCE App. IX SVOC 8270B App. IX PCB 8080A App. IX Total Metals 6020[2] App. IX Diss. Metals 6020[2] Biogeochemical Parameters[3]

Table 1-3. Summary of Moraine Engine and Moraine Assembly Supplemental RFI Sampling Programs, General Motors Corporation, Moraine, Ohio. **DRAFT**

AOI	Soil Samples	# of Soil Samples*	Analyses	Groundwater Samples	# of Groundwater Samples*	Analyses
AOI 34 - Excavation Area 1 (August 1997)	EA1-BH01	2	TCL VOC 8240B TCL SVOC 8270B TCL PCB 8080A TAL Metals[1]	NA		
AOI 35 - Excavation Area 2 (August 1997)	EA2-BH01	2	TCL VOC 8240B TCL SVOC 8270B TCL PCB 8080A TAL Metals[1]	NA		
AOI 36 - Former Southwest ASTs (February 1998)	AST-BH1 to AST-BH2	4	TCL VOC 8240B TCL SVOC 8270B TCL PCB 8080A TAL Metals[1]	GM-2 and GM-21 (Low-flow)	1	App. IX VOC 8240B and cis-1,2-DCE App. IX SVOC 8270B App. IX PCB 8080A App. IX Total Metals 6020[2] App. IX Diss. Metals 6020[2] Biogeochemical Parameters[3]
AOI 36 - Former Southwest ASTs (June 1998)	Composite A to Composite G	7	Arsenic 7060A	NA		
Site-Wide Groundwater (March 1998)	NA			HR-9, GM-24, W-3-N, GM-25, HR-1, W-1-S, ME-6, ME-3, HR-17, GM-8, GM-6 WSU-24, GM-10, GM-26 (Low flow)	14	App. IX VOC 8240B and cis-1,2-DCE Biogeochemical Parameters[3]
				HR-12, HR-13, GM-1, GM-20D, GM-9, MT-69	6	App. IX VOC 8240B and cis-1,2-DCE

[1] List excluded aluminum, calcium, iron, magnesium, potassium, and sodium. Method numbers included 6010A for antimony, barium, beryllium, cadium, chromium, cobalt, manganese, nickel, silver, vanadium and zinc; Method 7060A for arsenic; Method 7421 for lead; Method 7471A for mercury; Method 7740 for selenium; Method 7841 for thallium.

[2] Appendix IX metals analyzed using Method 6020 except for mercury by Method 7470A, selenium by Method 7741A, tin by Method 6010A, and vanadium by Method 200.8.

[3] Biogeochemical parameters included Nitrogen - Ammonia 350.1, Total Fe & Mn 6010A, Diss. Fe & Mn 6010A, Sulfide 376.1, Sulfate 375.4, Chloride 325.3, Total Organic Carbon (TOC) SM5310B, Light Hydrocarbon Scan AM18G, Permanent Gases AM-15.01G, Nitrate Test Kit, Nitrite Test Kit and Ferrous Iron Test Kit.

[4] Short List of VOCs included 1,1-Dichloroethane, 1,1-Dichloroethene, trans-1,2-Dichloroethene, cis-1,2-Dichloroethene, Tetrachloroethene, 1,1,1-Trichloroethane, Trichloroethene and Vinyl Chloride.

*Number of samples does not include QA/QC samples. Refer to Appendix A for QA/QC data.

AOI - Area of Interest.
OH - Oil House.
EA - Excavation Area.
DP - Direct Push.
BD - Building.
BH - Borehole.
BDG - Building.
VOC- Volatile organic compounds.
SVOC - Semi-volatile organic compounds.
PCB - Polychlorinated biphenyls.
AST - Aboveground Storage Tank.
NA - Not applicable.

Table 3-1. Groundwater Corrective Measures Technologies, General Motors Corporation, Moraine, Ohio.

Corrective Measures Technologies	Technology Description	Screening Comments
No Action	No action is the absence of active measures to address groundwater.	Not retained for further evaluation because it cannot meet the corrective measures objectives.
Institutional Actions		
Deed Restrictions	Deed restrictions are institutional controls for groundwater beneath the affected property to restrict use until clean up goals are met.	Applicable for the GM Moraine site.
Alternate Water Supply	Providing a supply of drinking water from a suitable, non-contaminated source to affected users.	Not retained for further evaluation because groundwater in the upper aquifer is not used as a drinking water supply and conditions at the facilities will not affect downgradient users in the lower aquifer (West Carrollton, Miami Shores). Drinking water is supplied to local users by the city of Dayton.
Groundwater Monitoring	The scheduled, periodic sampling and analysis of affected groundwater.	Applicable for the GM Moraine site to monitor effectiveness of corrective measures.
Containment		
Physical Barriers	Injection of grout in a series of wells spaced to create overlapping grouted areas, or installation of a trench filled with cement/bentonite slurry, to form a low permeability barrier to preclude migration of the plume of VOCs. To ensure the barrier's performance, these methods would have to be anchored into the upper clay till or regional clay till present beneath the site at depths ranging from approximately 25 ft to 40 ft bls at AOI 7 and 50 ft to 60 ft bls where the upper clay till is not present. Special consideration for quality control of installation would be necessary to accommodate the range of heterogeneous materials present beneath the site. Groundwater mounding on the upgradient side of the barrier must also be addressed, usually through some form of groundwater extraction.	Not retained for further evaluation due to practicability issues and groundwater mounding. Potentially implementable within site conditions but would not effectively achieve corrective measures objectives.

Table 3-1. Groundwater Corrective Measures Technologies, General Motors Corporation, Moraine, Ohio.

Corrective Measures Technologies	Technology Description	Screening Comments
Collection		
Groundwater Extraction Wells	Extraction and collection of impacted groundwater for ex-situ treatment (if required) and discharge.	Applicable for the GM Moraine site. Implementable under site conditions. Extraction technologies currently in use at the site for the upper aquifer (TW-2) and the lower aquifer (DN-13). Extracted groundwater is discharged to the Great Miami River.
Groundwater/Vacuum Enhanced Recovery	Removal of groundwater using a vacuum placed on the well to enhance groundwater recovery rates in low transmissivity aquifers. This extraction process option may also remove VOCs adsorbed to soil in the vadose zone or dewatered portion of the aquifer. Ex-situ treatment is typically required for the recovered groundwater and soil vapors.	Not retained for further evaluation because existing groundwater recovery rates and aquifer transmissivity values are sufficiently high without the expense of vacuum enhancement. Although VOCs were detected in vadose zone soil, they were not at concentrations high enough to pose a risk and therefore, they do not require remediation.

Table 3-1. Groundwater Corrective Measures Technologies, General Motors Corporation, Moraine, Ohio.

Corrective Measures Technologies	Technology Description	Screening Comments
Ex-situ Treatment		
Biological	Aerobic/anaerobic biodegradation of organic wastes in an engineered bioreactor.	Not retained for further evaluation due to identification of more applicable and cost-effective technologies (e.g., air stripping is already being successfully implemented at the site).
Chemical Oxidation	Reaction of organic contaminants with ozone and/or hydrogen peroxide in an engineered reactor to chemically degrade compounds to carbon dioxide and water.	Not retained for further evaluation due to identification of more applicable and cost-effective technologies (e.g., air stripping is already being successfully implemented at the site).
Physical/Air Stripping	Volatilization of VOCs in groundwater through introduction of air in a packed column receiving impacted groundwater. Treated groundwater would require off-site discharge. Both effluent streams require permitting.	Applicable at the GM Moraine site. An air stripper tower is currently used to treat extracted groundwater from recovery well TW-2.
Physical/Adsorption Media	Transfer of dissolved-phase contaminants, or contaminants in a vapor stream, to adsorbed-phase through contact with adsorption media. Requires off-site recycling or disposal of adsorption media.	Potentially applicable for VOCs in extracted groundwater at the GM Moraine site.
Discharge		
Off-site Discharge/Surface Water	Discharge of extracted groundwater to the Great Miami River under a National Pollutant Discharge Elimination System permit.	Applicable for the GM Moraine site. Implementable under site conditions.

Table 3-1. Groundwater Corrective Measures Technologies, General Motors Corporation, Moraine, Ohio.

Corrective Measures Technologies	Technology Description	Screening Comments
In-situ Treatment		
Biological Treatment/Monitored Natural Attenuation	Biodegradation of VOCs by indigenous microorganisms has been documented to play a significant role in natural attenuation and hydraulic control of a VOC plume, in addition to other attenuation mechanisms (dispersion, dilution, adsorption). Monitoring this attenuation would allow implementation of additional corrective measures if the VOC plume does not continue to attenuate or if significant plume migration is detected.	Potentially applicable for the GM Moraine site as a component of the corrective measures.
Biological Treatment/Enhanced Reductive Dechlorination	Augmentation of natural biodegradation processes by the injection of a carbon source to the subsurface environment which will promote reductive dechlorination of the chlorinated VOCs. The carbon source is injected into the groundwater through multiple injection points and is carried by groundwater flow across the site. This technique is referred to as a mobile reactive zone. This remedial technique can improve clean-up times because the reactive zone developed by the carbon source injection moves with the groundwater through areas beneath the site which otherwise would be limited to the rate of VOC diffusion into groundwater and then the travel time required to reach extraction-based or stationary reactive wall process options.	Applicable for the GM Moraine site. This technology has been successfully implemented as part of AOI 7 interim measures.
Chemical Treatment/Oxidation	Introduction of oxidant into the subsurface and creation of hydroxyl radicals to oxidize the chlorinated VOCs in groundwater. The oxidant consists of Fenton's reagent (hydrogen peroxide, ferrous salts, pH adjustment). Chloride ions, carbon dioxide, and water are the major end products of the complete oxidation process.	Applicable for the GM Moraine site. This technology has been successfully implemented as part of AOI 7 interim measures.

Table 3-1. Groundwater Corrective Measures Technologies, General Motors Corporation, Moraine, Ohio.

Corrective Measures Technologies	Technology Description	Screening Comments
In-situ Treatment (continued)		
Physical Treatment/Air Sparging	Volatilization of VOCs in groundwater through high-pressure subsurface air injection. Stripped VOCs would then be collected by an in-situ soil vapor extraction (ISVE) system installed in the vadose zone. This technology requires uniform permeability conditions to ensure VOCs stripped by air sparging move vertically to the vadose zone and can be captured by the ISVE system. Variations in permeability could lead to stripped VOCs moving horizontally beyond the area of ISVE influence.	Not retained for further evaluation due to the heterogeneous, low permeability soils (interspersed with sand/gravel) present in the AOI 7 source area and the presence of numerous underground utilities. This technology is not potentially applicable as stripped VOCs have the potential to move laterally and not be captured.
Physical Treatment/In-well Sparging	Volatilization and capture of VOCs through injection of air into dual-screened, double-cased wells equipped with a vapor collection system. The treatment well(s) act as groundwater lift pumps and VOCs are stripped from the water being lifted within the well casing and collected for ex-situ treatment. The treatment well(s) discharges the lifted water back into the formation at the water table, and this mounding causes a groundwater circulation to develop around the well which enhances the movement of groundwater to the treatment well(s).	Potentially applicable for site conditions; however, for this technology to be effective a cost-prohibitive number of treatment wells would need to be installed to meet the corrective measures objectives. This technology will not be retained for further evaluation due to identification of more applicable and cost-effective technologies.

Table 3-1. Groundwater Corrective Measures Technologies, General Motors Corporation, Moraine, Ohio.

Corrective Measures Technologies	Technology Description	Screening Comments
In-situ Treatment (continued)		
Physical/Chemical Treatment Reactive Walls	Interception and in-situ treatment of groundwater. Groundwater flow is rerouted using an in-situ low permeability containment/barrier system through a more permeable treatment zone(s). Treatment zone(s) may contain an in-situ treatment medium (i.e., activated carbon, iron filings) or treatment system (i.e., ISVE/air sparging). To be applicable at the site, a low permeability barrier would be installed at several locations along the plume and anchored into the upper clay till or regional clay till. The treatment zones would have to be designed to allow sufficient groundwater flow to pass through so the water table beneath the site is not elevated to the point that it would impact facility operations or land-based units, while controlling the rate of groundwater flow to allow for proper residence time within the treatment zone.	Not retained for further evaluation due to practicability issues and potential for groundwater mounding beneath the land-based units. Potentially implementable within site conditions but would not effectively achieve corrective measures objectives.

Table 3-2. Groundwater Corrective Measures Technology Screening, General Motors Corporation, Moraine, Ohio.

Corrective Measures Technologies	Effectiveness	Implementability	Relative Cost	Conclusions
Institutional Actions				
Deed Restrictions[1]	Effective in protecting human health and the environment by reducing potential for on-site exposure to impacted groundwater. Does not reduce toxicity, mobility, or volume of contaminants. Effectiveness achieved in short term.	Deed restrictions are easily implemented in the short term.	Low costs for implementation.	Retained for incorporation into site-wide remedy.
Groundwater Monitoring	Effective in protecting human health and the environment by periodically monitoring groundwater quality. Does not reduce toxicity, mobility, or volume of contaminants. Effectiveness achieved in short term.	Groundwater monitoring is easily implementable because the monitoring well network is already in place. Implementation completed in the short term.	Low to moderate costs to complete periodic groundwater monitoring and data evaluation. Maintenance costs would be low for monitoring well repairs, as required.	Retained for incorporation into site-wide remedy. This technology is a component of the interim measures already in place at the site.

Table 3-2. Groundwater Corrective Measures Technology Screening, General Motors Corporation, Moraine, Ohio.

Corrective Measures Technologies	Effectiveness	Implementability	Relative Cost	Conclusions
Collection				
Groundwater Extraction Wells	The site already has extraction wells in place for the upper aquifer (TW-2) and the deep aquifer (DN-13). These wells have been successfully maintaining capture to prevent the further off-site migration of VOCs. This technology can effectively protect human health and the environment by preventing downgradient exposure to impacted groundwater. Does not reduce toxicity of contaminants as a stand alone technology. Effectiveness in regards to preventing exposure is likely achieved in the short to mid term, however, effectiveness at meeting corrective measures objectives is likely achieved in the very long term.	Groundwater extraction wells are easily implemented and operated at the site. Implementation has been ongoing as part of the capture zone interim measures. Once groundwater is extracted, discharging and permitting the groundwater stream must be addressed.	No capital costs because the extraction wells are already in operation. Low O&M costs for periodic well repairs, cleaning the well screen, or pump replacement.	Retained for incorporation into site-wide remedy. This technology is a component of the capture zone interim measures.

Table 3-2. Groundwater Corrective Measures Technology Screening, General Motors Corporation, Moraine, Ohio.

Corrective Measures Technologies	Effectiveness	Implementability	Relative Cost	Conclusions
Ex-situ Treatment				
Physical/Air Stripping	Effective in protecting human health and the environment by reducing volume of contaminants in extracted groundwater. Does not reduce toxicity of contaminants but causes transfer from dissolved-phase to vapor phase. Effectiveness likely achieved in short-term time frame.	An air stripper tower is already in place to treat extracted groundwater from TW-2. Implementation has been ongoing as part of the capture zone interim measures. Permitting for effluent discharge of groundwater and off-gas has already been addressed.	No capital costs because the air stripper tower is already in operation. Moderate O&M costs for electricity, pre-treatment chemicals, periodic repairs, cleaning the influent line and tower packing, or equipment replacement	Retained for incorporation into site-wide remedy. This technology is a component of the capture zone interim measures.
Physical/Adsorption Media	Effective in protecting human health and the environment by reducing volume of contaminant in extracted groundwater and or vapors. Does not reduce toxicity of contaminants but causes transfer from dissolved-phase (or vapor-phase) to adsorbed-phase. Does not influence mobility of contaminants remaining within groundwater or vapor treatment stream. Special considerations may be required to address adsorption of vinyl chloride. Effectiveness likely achieved in short-term time frame.	Potentially implementable, may require permitting for effluent discharge. Implementation completed in short-term time frame.	Moderate capital costs and moderate to high O&M costs.	Retained for further evaluation.

Table 3-2. Groundwater Corrective Measures Technology Screening, General Motors Corporation, Moraine, Ohio.

Corrective Measures Technologies	Effectiveness	Implementability	Relative Cost	Conclusions
Discharge				
Off-site Discharge/Surface Water	Pre-treatment requirements of discharge will dictate effectiveness in protecting human health and the environment, reducing exposure to treated extracted groundwater, and reducing toxicity, mobility, and volume of contaminants. Effectiveness achieved in short-term.	Easily implemented, discharge lines and NPDES permit already in place to the Great Miami River.	No capital costs because the discharge system is already in place. O&M costs for periodic repairs, monitoring, and permitting are low. Treatment for VOCs not included in this cost, but included under treatment options.	Retained for incorporation into site-wide remedy. This technology is a component of the capture zone interim measures.
In-situ Treatment				
Biological Treatment/ Monitored Natural Attenuation	On-going natural attenuation (biodegradation, dispersion, dilution and adsorption) is potentially effective in protecting human health and the environment by reducing toxicity, mobility, and/or volume of residual contaminants, once corrective measures objectives have been met.	Potentially implementable. Implementation can be completed in short-term time frame.	No capital costs because the monitoring well network is already in place and low O&M costs for sampling and data evaluation.	Retained for further evaluation.
Biological Treatment/ Enhanced Reductive Dechlorination	Site-specific evaluation has demonstrated effectiveness of enhanced reductive dechlorination to be potentially effective in protecting human health and the environment by reducing toxicity, mobility, and/or volume of contaminants. Effectiveness likely achieved in short- to mid-term time frame.	Easily implemented within site conditions. Reactive zone introduction wells are already in place at the site. Implementation completed in short-term time frame. Underground injection control permit (UIC) exemption and reporting required in place.	No capital costs because introduction wells are already in place at the site, unless additional wells are installed. Moderate O&M costs to continue carbon source introduction, monitoring UIC permit reporting and periodic well repairs.	Retained for incorporation into site-wide remedy. This technology is a component of AOI 7 interim measures.

Table 3-2. Groundwater Corrective Measures Technology Screening, General Motors Corporation, Moraine, Ohio.

Corrective Measures Technologies	Effectiveness	Implementability	Relative Cost	Conclusions
In-situ Treatment				
Chemical Treatment/ Oxidation	Site-specific evaluation has demonstrated that of in-situ oxidation in the AOI 7 source area to be potentially effective in protecting human health and the environment by reducing toxicity, mobility, and/or volume of contaminants. Effectiveness likely achieved in short- to mid-term time frame.	Implementable within site conditions. Some oxidation wells are already in place at the site, though a large number of additional wells will likely be required. Health and safety concerns associated with handling chemicals may be significant. Implementation completed in short-term time frame. Underground injection control permit exemption and reporting required.	Moderate capital costs required if additional stainless steel oxidation wells are installed. Moderate to high O&M cost to continue injecting Fenton's reagent (purchase of chemicals) and periodic well repairs.	Retained for incorporation into site-wide remedy. This technology is a component of AOI 7 interim measures.

(1) Regulatory Controls (refer to Section 3.1.3.2 of the Baseline Risk Assessment [ENVIRON Corporation 2000b]) – Development of public water supplies using groundwater as a source is goverened by Ohio Revised Code 6109 and regulations adopted there under (OAC 3745-1 to-82). Development of private wells is governed by the Department of Health (OAC 3701-28).

Table 4-1. List of Wells Sampled for the Baseline, 3-Month, and 6-Month Sampling Events, General Motors Corporation, Moraine, Ohio.

Site-wide Baseline Groundwater Sampling

Appendix IX VOCs and cis-1,2-DCE and field parameters will be analyzed during the baseline sampling event from the following list of upper aquifer monitoring wells while biogeochemical parameters (Table 4-2) will be analyzed at wells denoted with an asterisk(*):

W-1-N
W-2-N
W-3-N
W-4-N
HR-1*
HR-2
HR-3*
HR-4
HR-5
HR-6
HR-7
HR-8
HR-9
HR-11
HR-16
HR-17
W-1-S*
W-2-S
W-3-S
W-4-S
GM-2*
4S*
GM-6*
GM-8*
GM-10*
GM-16*
GM-17*
GM-18
GM-19S*
EAST*
WEST*
WSU-24
ME-1*
ME-3*
ME-6*
GM-21*
GM-22*
GM-23*
GM-24
GM-25
GM-26
GM-27*
GM-28*
GM-29*
GM-30*
GM-31*
GM-32*

Appendix IX VOCs and cis-1,2-DCE and field parameters will be analyzed during the baseline sampling event from the following list of lower aquifer monitoring wells:

HR-10
HR-12
HR-13
HR-14
HR-15
GM-1
GM-3
GM-4
GM-5
GM-7R
GM-9
GM-11
GM-13
GM-14
GM-15
GM-19D
GM-20D
MT69

Appendix IX VOCs and cis-1,2-DCE, field parameters and biogeochemical parameters (Table 4-2) will be analyzed during the baseline sampling event from the following list of injection/introduction wells:

OA-1	**OA-2**	**RZ-1**	**RZ-3**		
OW-1	OW-4	RZ-1A	RZ-3E	RZ-3Z	RZ-3PP
OW-2	OW-5	RZ-1G	RZ-3L	RZ-3FF	
OW-3	OW-6		RZ-3T	RZ-3KK	

Table 4-1. List of Wells Sampled for the Baseline, 3-Month, and 6-Month Sampling Events, General Motors Corporation, Moraine, Ohio.

3-Month and 6-Month Groundwater Sampling

Appendix IX VOCs and cis-1,2-DCE, field parameters, and biogeochemical parameters (Table 4-2) will be analyzed during the 3-month and 6-month sampling events from the following upper aquifer monitoring wells:

HR-1
HR-3
GM-2
GM-6
GM-8
GM-10
GM-16
GM-17
GM-19S
GM-21
GM-22
GM-23
GM-27
GM-28
GM-29
GM-30
GM-31
GM-32
EAST
WEST
4S
W-1-S
ME-1
ME-3
ME-6

Only the Appendix IX VOCs and cis-1,2-DCE, field parameters and biogeochemical parameters (Table 4-2) will be analyzed during the 3-month and 6-month sampling events from the following list of injection/introduction wells:

OA-1	**OA-2**	**RZ-1**	**RZ-3**		
OW-1	OW-4	RZ-1A	RZ-3E	RZ-3Z	RZ-3PP
OW-2	OW-5	RZ-1G	RZ-3L	RZ-3FF	
OW-3	OW-6		RZ-3T	RZ-3KK	

Table 4-2. Field and Laboratory Analytical Procedures for Groundwater, General Motors Corporation, Moraine, Ohio.

Parameters	Method Number	Procedure
Appendix IX VOCs and cis 1,2-DCE	Method 8260	Laboratory(3)
Dissolved Oxygen	(1)	Field
Reduction/Oxidation Potential	(1)	Field
pH	(1)	Field
Specific Conductance	(1)	Field
Nitrate	Test Kit	Field
Nitrite	Test Kit	Field
Nitrogen, Ammonia	SM350.1	Laboratory(3)
Manganese (Total)	Method 6010A	Laboratory(3)
Manganese (Dissolved)	Method 6010A	Laboratory(3)
Iron (Total)	Method 6010A	Laboratory(3)
Iron (Dissolved)	Method 6010A	Laboratory(3)
Iron (Ferrous)	Test Kit	Field
Sulfate	SM 375.4	Laboratory(3)
Sulfide	SM 376.1	Laboratory(3)
Total Organic Carbon	SM 5310B	Laboratory(3)
Chlorides	SM 325.3	Laboratory(3)
Light Hydrocarbon Scan (Ethane, Ethene)	Method AM18G(2)	Laboratory(4)
Permanent Gases (Carbon Dioxide, Oxygen, Nitrogen, Methane and Carbon Monoxide)	Method AM15.01G(2)	Laboratory(4)

Method	Refers to U.S. Environmental Protection Agency SW 846.
SM	Standard Methods for the Evaluation of Water and Wastewater, 18th Edition, 1992.
(1)	Field parameters to be collected using a down-well or a flow-through meter.
(2)	Method numbers are laboratory-specific and developed for monitoring natural attenuation projects.
(3)	TestAmerica, Inc. - Dayton Division.
(4)	Microseeps, Pittsburgh, Pennsylvania.
cis-1,2-DCE	cis-1,2-Dichloroethene.
VOCs	Volatile organic compounds.

Table 4-3. Summary of Baseline Groundwater Results from Site-Wide Upper Aquifer Monitoring Wells, General Motors Corporation, Moraine, Ohio.

Constituents	Units	HR-9 9/16/99	HR-11 9/14/99	GM-24 9/23/99	HR-8 9/16/99	W-1-N 9/17/99	HR-4 9/14/99	W-2-N 9/14/99	W-3-N 9/17/99
Volatile Organic Compounds									
Acetone	ug/L	<20.0	<20.0	<20.0	<20.0	<20.0	<20.0	<20.0	<20.0
Benzene	ug/L	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Chloroethane	ug/L	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0
Chloroform	ug/L	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Dichlorodifluoromethane	ug/L	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
1,1-Dichloroethane	ug/L	52.2	13.5	<1.0	26.4	<1.0	<1.0	<1.0	<1.0
1,2-Dichloroethane	ug/L	1.9	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
1,1-Dichloroethene	ug/L	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
cis-1,2-Dichloroethene	ug/L	20.3	3.3	<1.0	4.4	<1.0	<1.0	1.6	291
trans-1,2-Dichloroethene	ug/L	3.2	<1.0	<1.0	1.5	<1.0	<1.0	<1.0	2.6
Ethylbenzene	ug/L	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
1,1,1,2-Tetrachloroethane	ug/L	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Tetrachloroethene	ug/L	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Toluene	ug/L	<1.0	<1.0	<1.0	<1.0	<1.0	1.2	<1.0	2.5
1,1,1-Trichloroethane	ug/L	20.3	<1.0	2.7	10.6	<1.0	<1.0	<1.0	<1.0
1,1,2-Trichloroethane	ug/L	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Trichloroethene	ug/L	18.1	<1.0	<1.0	1.6	<1.0	1.4	1.7	<1.0
Trichlorofluoromethane	ug/L	<1.0	<1.0	<1.0J	<1.0	<1.0	<1.0	<1.0	<1.0
Vinyl chloride	ug/L	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	12.8
Xylenes	ug/L	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Total VOCs	**ug/L**	**116**	**16.8**	**2.7**	**44.5**	**ND**	**2.6**	**3.3**	**308.9**
Total VOCs, Historical RFI Groundwater Quality Data									
September 1998	ug/L	--	--	--	--	--	--	--	--
March 1998	ug/L	110.7	8.2	19.6	--	--	--	--	315.6
October/November 1994	ug/L	--	--	--	--	--	--	--	--
January 1993	ug/L	64.5	10.7	--	41.1	ND	3.3	--	50.7

ug/L - Micrograms per liter.

ND - Not detected.

"--" - Indicates historical RFI groundwater quality data not available for this event.

J - Estimated value.

Table 4-3. Summary of Baseline Groundwater Results from Site-Wide Upper Aquifer Monitoring Wells, General Motors Corporation, Moraine, Ohio.

Constituents	Units	W-4-N 9/17/99	HR-2 9/16/99	HR-3 9/16/99	HR-7 9/17/99	HR-5 9/16/99	GM-30 9/2/99	GM-23 9/1/99	GM-27 9/1/99
Volatile Organic Compounds									
Acetone	ug/L	<20.0	<20.0	<20.0	<20.0	<20.0	R	20.6J	R
Benzene	ug/L	<1.0	<1.0	<1.0	<1.0	<1.0	<10	1.9	<1.0
Chloroethane	ug/L	<5.0	<5.0	<5.0	<5.0	<5.0	<50	<5.0	<5.0
Chloroform	ug/L	<1.0	<1.0	<1.0	<1.0	<1.0	<10	<1.0	<1.0
Dichlorodifluoromethane	ug/L	<1.0	<1.0	<1.0	<1.0	<1.0	<10	6.9	<1.0J
1,1-Dichloroethane	ug/L	1.3	3.9	6.2	<1.0	<1.0	53.8J	32.5	2.4
1,2-Dichloroethane	ug/L	<1.0	<1.0	<1.0	<1.0	<1.0	<10	<1.0	<1.0
1,1-Dichloroethene	ug/L	<1.0	<1.0	<1.0	<1.0	<1.0	<10	17.2	<1.0
cis-1,2-Dichloroethene	ug/L	2.2	9.6	6.1	<1.0	10.5	<10	7,530	20.6
trans-1,2-Dichloroethene	ug/L	<1.0	1.5	<1.0	<1.0	1.1	<10	54.5	<1.0
Ethylbenzene	ug/L	<1.0	<1.0	<1.0	<1.0	<1.0	7030J	<1.0	<1.0
1,1,1,2-Tetrachloroethane	ug/L	<1.0	<1.0	<1.0	<1.0	<1.0	<10	2.5	<1.0
Tetrachloroethene	ug/L	2.1	<1.0	<1.0	<1.0	<1.0	<10	6,250	1.7
Toluene	ug/L	<1.0	<1.0	<1.0	<1.0	<1.0	6950J	<1.0	<1.0
1,1,1-Trichloroethane	ug/L	<1.0	<1.0	<1.0	<1.0	<1.0	<10	7.2	<1.0
1,1,2-Trichloroethane	ug/L	<1.0	<1.0	<1.0	<1.0	<1.0	<10	3.5	<1.0
Trichloroethene	ug/L	9.8	<1.0	<1.0	9.8	12.0	<10	1,460	121
Trichlorofluoromethane	ug/L	<1.0	<1.0	<1.0	<1.0	<1.0	<10	8.5	<1.0
Vinyl chloride	ug/L	<1.0	<1.0	<1.0	<1.0	<1.0	<10	2,500	<1.0
Xylenes	ug/L	<1.0	<1.0	<1.0	<1.0	<1.0	23300J	<1.0	<1.0
Total VOCs	**ug/L**	**15.4**	**15**	**12.3**	**9.8**	**23.6**	**37,333.8**	**17,895.3**	**145.7**
Total VOCs, Historical RFI Groundwater Quality Data									
August 1998	ug/L	--	--	8.7	--	--	--	14,655.5	173.6
March 1998	ug/L	--	--	--	--	--	--	19,706	--
October/November 1994	ug/L	--	--	--	--	--	--	--	--
January 1993	ug/L	10.7	--	ND	--	--	--	--	--

ND - Not detected.

"--" - Indicates historical RFI groundwater quality data not available for this event.

J - Estimated value.

R - Rejected value.

Table 4-3. Summary of Baseline Groundwater Results from Site-Wide Upper Aquifer Monitoring Wells, General Motors Corporation, Moraine, Ohio.

Constituents	Units	GM-29 9/1/99	GM-28 9/1/99	HR-6 9/16/99	HR-1 9/16/99	DUP-75 9/16/99	W-1-S 9/22/99	DUP-77 9/22/99	ME-6 8/31/99
Volatile Organic Compounds									
Acetone	ug/L	R	R	<20.0	<20.0	<20.0	R	R	R
Benzene	ug/L	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Chloroethane	ug/L	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0
Chloroform	ug/L	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	1.5
Dichlorodifluoromethane	ug/L	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
1,1-Dichloroethane	ug/L	4.3	3.3	<1.0	2.4	2.5	<1.0	<1.0	<1.0
1,2-Dichloroethane	ug/L	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
1,1-Dichloroethene	ug/L	1.3	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
cis-1,2-Dichloroethene	ug/L	320	175	<1.0	5.8	6.1	8.0	7.8	255
trans-1,2-Dichloroethene	ug/L	11.1	9.2	<1.0	3.9	4.0	1.1	1.1	<1.0
Ethylbenzene	ug/L	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
1,1,1,2-Tetrachloroethane	ug/L	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Tetrachloroethene	ug/L	<20	316	<1.0	44.3	40.5	30.9	28.4	213
Toluene	ug/L	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
1,1,1-Trichloroethane	ug/L	37.8	17.7	<1.0	1.6	1.5	<1.0	<1.0	2.9
1,1,2-Trichloroethane	ug/L	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Trichloroethene	ug/L	878	768	2.0	56.0	53.5	11.6	11.6	474
Trichlorofluoromethane	ug/L	221	85.0	<1.0	4.5	4.5	5.9	6J	<1.0
Vinyl chloride	ug/L	3.8	3.2	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Xylenes	ug/L	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Total VOCs	**ug/L**	**1,477.3**	**1,377.4**	**2.0**	**118.5**	**112.6**	**57.5**	**54.9**	**946.4**
Total VOCs, Historical RFI Groundwater Quality Data									
August 1998	ug/L	--	1,119	--	105.6	--	--	--	472.7
March 1998	ug/L	--	--	--	138.6	--	48.3	--	667.7
October/November 1994	ug/L	--	--	--	--	--	--	--	--
January 1993	ug/L	--	--	4.4	93.4	--	69.8	--	--

DUP-75 is a duplicate sample of HR-1.

DUP-77 is a duplicate sample of W-1-S.

"--" - Indicates historical RFI groundwater quality data not available for this event.

J - Estimated value; R - Rejected value.

Table 4-3. Summary of Baseline Groundwater Results from Site-Wide Upper Aquifer Monitoring Wells, General Motors Corporation, Moraine, Ohio.

Constituents	Units	ME-1 8/31/99	GM-31 9/1/99	ME-3 8/31/99	DUP-72 8/31/99	GM-25 9/22/99	HR-16 9/23/99	HR-17 9/23/99	W-2-S 9/23/99
Volatile Organic Compounds									
Acetone	ug/L	R	R	R	R	R	<20.0	<20.0	<20.0
Benzene	ug/L	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Chloroethane	ug/L	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0
Chloroform	ug/L	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Dichlorodifluoromethane	ug/L	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
1,1-Dichloroethane	ug/L	2.4	1.3	6.1	6.1	<1.0	<1.0	<1.0	<1.0
1,2-Dichloroethane	ug/L	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
1,1-Dichloroethene	ug/L	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
cis-1,2-Dichloroethene	ug/L	38.2	7.80	5.7	5.6	<1.0	<1.0	6.2	<1.0
trans-1,2-Dichloroethene	ug/L	1.5	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Ethylbenzene	ug/L	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
1,1,1,2-Tetrachloroethane	ug/L	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Tetrachloroethene	ug/L	83.6	1.3	57.9	60.4	<1.0	<1.0	15.5	<1.0
Toluene	ug/L	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
1,1,1-Trichloroethane	ug/L	13.5	<1.0	42.5	38.3	<1.0	<1.0	<1.0	1.9J
1,1,2-Trichloroethane	ug/L	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Trichloroethene	ug/L	292	27.2	47.5	45.0	<1.0	2.7	7.4	6.1
Trichlorofluoromethane	ug/L	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0J	1.0J	<1.0
Vinyl chloride	ug/L	36	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Xylenes	ug/L	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Total VOCs	**ug/L**	**467.2**	**37.6**	**159.7**	**155.4**	**ND**	**2.7**	**30.1**	**8**
Total VOCs, Historical RFI Groundwater Quality Data									
August 1998	ug/L	--	--	--	--	--	--	--	--
March 1998	ug/L	--	--	232.1	--	ND	--	13.1	--
October/November 1994	ug/L	--	--	--	--	--	--	28.7	5.1
January 1993	ug/L	--	--	--	--	--	--	17.9	4.6

ND - Not detected.

DUP-72 is a duplicate sample of ME-3.

"--" - Indicates historical RFI groundwater quality data not available for this event.

J - Estimated value; R - Rejected value.

Table 4-3. Summary of Baseline Groundwater Results from Site-Wide Upper Aquifer Monitoring Wells, General Motors Corporation, Moraine, Ohio.

Constituents	Units	W-3-S 9/23/99	W-4-S 9/23/99	DUP-78 9/23/99	WEST 9/21/99	EAST 9/21/99	GM-19S 9/20/99	GM-32 9/22/99	GM-22 9/1/99
Volatile Organic Compounds									
Acetone	ug/L	<20.0	<20.0	<20.0	<20.0J	<20.0J	<20.0J	R	R
Benzene	ug/L	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Chloroethane	ug/L	<5.0	<5.0	<5.0	2.9	<5.0	<5.0	<5.0	<5.0
Chloroform	ug/L	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Dichlorodifluoromethane	ug/L	<1.0	<1.0	<1.0	2.5	<1.0	<1.0	<1.0	<1.0
1,1-Dichloroethane	ug/L	<1.0	1.2	1.2	25.6	5.4	7.7	3.3	<1.0J
1,2-Dichloroethane	ug/L	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
1,1-Dichloroethene	ug/L	<1.0	<1.0	<1.0	<1.0	<1.0	1.0	<1.0	<1.0
cis-1,2-Dichloroethene	ug/L	<1.0	4.4	4.3	125	9.1	34.6	2.6	<1.0
trans-1,2-Dichloroethene	ug/L	<1.0	<1.0	<1.0	<1.0	<1.0	2.3	4.2	<1.0
Ethylbenzene	ug/L	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
1,1,1,2-Tetrachloroethane	ug/L	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Tetrachloroethene	ug/L	1.1	30.5J	29.6	41.3	61.0	46.0	1.2	3.6
Toluene	ug/L	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	1.0	<1.0
1,1,1-Trichloroethane	ug/L	3.9	3.3	3.4	24.8	21.0	16.0	<1.0	<1.0
1,1,2-Trichloroethane	ug/L	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Trichloroethene	ug/L	2.6	14.7J	14.6	37.3	56.1	71.1	3.2	4.0
Trichlorofluoromethane	ug/L	<1.0J	7.2J	7.5J	<1.0	<1.0	<1.0	<1.0	<1.0
Vinyl chloride	ug/L	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Xylenes	ug/L	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	3.0	<1.0
Total VOCs	**ug/L**	**7.6**	**61.3**	**60.6**	**259.4**	**152.6**	**178.7**	**18.5**	**7.6**
Total VOCs, Historical RFI Groundwater Quality Data									
August 1998	ug/L	--	--	--	--	--	--	--	--
March 1998	ug/L	--	--	--	--	175.7	--	--	12.5
October/November 1994	ug/L	--	60.3	--	498.8	160.3	242.4	--	--
January 1993	ug/L	--	193.5	--	--	189.7	290.6	--	--

DUP-78 is a duplicate sample of W-4-S.

"--" - Indicates historical RFI groundwater quality data not available for this event.

J - Estimated value.

R - Rejected value.

Table 4-3. Summary of Baseline Groundwater Results from Site-Wide Upper Aquifer Monitoring Wells, General Motors Corporation, Moraine, Ohio.

Constituents	Units	GM-21 9/22/99	GM-8 9/20/99	GM-6 9/20/99	4S 9/20/99	GM-2 9/20/99	GM-16 9/21/99	GM-17 9/21/99	GM-18 9/22/99
Volatile Organic Compounds									
Acetone	ug/L	R	<20.0J	<20.0J	<20.0J	<20.0J	<20.0J	<20.0J	R
Benzene	ug/L	<1.0	3.4	<1.0	1.6	<1.0	<1.0	<1.0	<1.0
Chloroethane	ug/L	<5.0	5.0	3.6	54.2	<5.0	<5.0	3.2	1.5
Chloroform	ug/L	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Dichlorodifluoromethane	ug/L	1.3	6.3	4.6	<1.0	<1.0	<1.0	<1.0	2.7
1,1-Dichloroethane	ug/L	9.0	30.2	33.2	1.6	1.4	<1.0	26.4	22.6
1,2-Dichloroethane	ug/L	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
1,1-Dichloroethene	ug/L	3.9	<1.0	1.2	<1.0	<1.0	<1.0	<1.0	1.3
cis-1,2-Dichloroethene	ug/L	66.4	26.2	52.9	<1.0	8.4	1.7	30.0	35.3
trans-1,2-Dichloroethene	ug/L	7.8	12.0	2.0	<1.0	<1.0	<1.0	2.6	2.2
Ethylbenzene	ug/L	<1.0	20.7	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
1,1,1,2-Tetrachloroethane	ug/L	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Tetrachloroethene	ug/L	<1.0	14.8	81.4	<1.0	6.0	44.1	<1.0	4.9
Toluene	ug/L	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
1,1,1-Trichloroethane	ug/L	53.1	1.9	24.6	<1.0	5.5	2.2	6.4	42.6
1,1,2-Trichloroethane	ug/L	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Trichloroethene	ug/L	28.7	30.4	78.2	<1.0	61.6	8.5	28.7	131
Trichlorofluoromethane	ug/L	4.9	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Vinyl chloride	ug/L	<1.0	8.4	1.6	<1.0	<1.0	<1.0	1.4	<1.0
Xylenes	ug/L	<1.0	2.3	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Total VOCs	**ug/L**	**175.1**	**161.6**	**283.3**	**57.4**	**82.9**	**56.5**	**98.7**	**244.1**
Total VOCs, Historical RFI Groundwater Quality Data									
August 1998	ug/L	--	--	--	--	--	--	--	--
March 1998	ug/L	506.1	306.2	371.6	--	101.7	--	--	--
October/November 1994	ug/L	--	--	1,286.50	--	--	--	--	--
January 1993	ug/L	--	456.7	--	147.7	132.4	89.7	181.3	269.2

ug/L - Micrograms per liter.

"--" - Indicates historical RFI groundwater quality data not available for this event.

J - Estimated value.

R - Rejected value.

Table 4-3. Summary of Baseline Groundwater Results from Site-Wide Upper Aquifer Monitoring Wells, General Motors Corporation, Moraine, Ohio.

Constituents	Units	WSU-24 9/23/99	GM-10 9/21/99	DUP-76 9/21/99	GM-26 9/22/99
Volatile Organic Compounds					
Acetone	ug/L	<20.0	<20.0J	<20.0J	R
Benzene	ug/L	<1.0	<1.0	<1.0	<1.0
Chloroethane	ug/L	<5.0	<5.0	<5.0	<5.0
Chloroform	ug/L	1.4	<1.0	<1.0	<1.0
Dichlorodifluoromethane	ug/L	<1.0	<1.0	<1.0	<1.0
1,1-Dichloroethane	ug/L	<1.0	<1.0	<1.0	<1.0
1,2-Dichloroethane	ug/L	<1.0	<1.0	<1.0	<1.0
1,1-Dichloroethene	ug/L	<1.0	<1.0	<1.0	<1.0
cis-1,2-Dichloroethene	ug/L	<1.0	<1.0	<1.0	<1.0
trans-1,2-Dichloroethene	ug/L	<1.0	<1.0	<1.0	<1.0
Ethylbenzene	ug/L	<1.0	<1.0	<1.0	<1.0
1,1,1,2-Tetrachloroethane	ug/L	<1.0	<1.0	<1.0	<1.0
Tetrachloroethene	ug/L	1.9	<1.0	<1.0	<1.0
Toluene	ug/L	<1.0	<1.0	<1.0	<1.0
1,1,1-Trichloroethane	ug/L	2.4	1.7	1.6	<1.0
1,1,2-Trichloroethane	ug/L	<1.0	<1.0	<1.0	<1.0
Trichloroethene	ug/L	17.0	14.8	13.8	<1.0
Trichlorofluoromethane	ug/L	<1.0J	<1.0	<1.0	<1.0
Vinyl chloride	ug/L	<1.0	<1.0	<1.0	<1.0
Xylenes	ug/L	<1.0	<1.0	<1.0	<1.0
Total VOCs	**ug/L**	**22.7**	**16.5**	**15.4**	**ND**
Total VOCs, Historical RFI Groundwater Quality Data					
August 1998	ug/L	--	--	--	1.2
March 1998	ug/L	17.2	36.9	--	ND
October/November 1994	ug/L	26.1	--	--	--
January 1993	ug/L	--	109.5	--	--

ND - Not detected.

DUP-76 is a duplicate sample of GM-10.

"--" - Indicates historical RFI groundwater quality data not available for this event.

J - Estimated value; R - Rejected value.

Table 4-4. Summary of Baseline Groundwater Results from Site-Wide Lower Aquifer Monitoring Wells, General Motors Corporation, Moraine, Ohio.

DRAFT

Constituents	**Units**	**HR-10** **9/15/99**	**HR-12** **9/14/99**	**HR-13** **9/15/99**	**DUP-74** **9/15/99**	**HR-14** **9/15/99**	**HR-15** **9/15/99**	**GM-19D** **9/28/99**	**GM-7R** **9/28/99**	**DUP-79** **9/28/99**
Volatile Organic Compounds										
Benzene	ug/L	<1.0	1.2	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
1,1-Dichloroethane	ug/L	<1.0	2.7	41.4	42.8	<1.0	<1.0	<1.0	<1.0	1.1
cis-1,2-Dichloroethene	ug/L	<1.0	1.8	20.8	21.2	7.9	2.5	1.2	2.1	2.3
trans-1,2-Dichloroethene	ug/L	<1.0	<1.0	3.1	3.3	<1.0	<1.0	<1.0	<1.0	<1.0
Tetrachloroethene	ug/L	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Toluene	ug/L	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
1,1,1-Trichloroethane	ug/L	<1.0	<1.0J	1.6	1.6	<1.0	<1.0	<1.0	4.2	4.8
Trichloroethene	ug/L	<1.0	<1.0	3.4	3.3	3.4	<1.0	13.5	76.1	76.8
Vinyl chloride	ug/L	<1.0	1.7	<1.0	<1.0	11.5	11.0	1.5	<1.0	<1.0
Total VOCs	**ug/L**	**ND**	**7.4**	**70.3**	**72.2**	**22.8**	**13.5**	**16.2**	**82.4**	**85**
Total VOCs, Historical RFI Groundwater Quality Data										
March 1998	ug/L	--	7.6	79	--	--	--	--	--	--
October/November 1994	ug/L	--	--	--	--	--	--	97.2	145.5	--
January 1993	ug/L	3	12.1	51	--	12.3	ND	119	199.3	--

ug/L - Micrograms per liter.

DUP-74 is a duplicate sample of HR-13.

DUP-79 is a duplicate sample of GM-7R.

ND - Not detected.

"--" - Indicates historical RFI groundwater quality data not available for this event.

J - Estimated value.

DRAFT

Table 4-4. Summary of Baseline Groundwater Results from Site-Wide Lower Aquifer Monitoring Wells, General Motors Corporation, Moraine, Ohio.

Constituents	**Units**	**GM-1 9/28/99**	**GM-3 9/28/99**	**GM-4 9/28/99**	**GM-5 9/28/99**	**GM-11 9/24/99**	**GM-13 9/24/99**	**GM-14 9/24/99**	**GM-15 9/24/99**
Volatile Organic Compounds									
Benzene	ug/L	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
1,1-Dichloroethane	ug/L	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	2.4
cis-1,2-Dichloroethene	ug/L	<1.0	1.1	2.3	<1.0	<1.0	<1.0	<1.0	4.3
trans-1,2-Dichloroethene	ug/L	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Tetrachloroethene	ug/L	2.0	1.2	<1.0	<1.0	1.5	3.6	<1.0	<1.0
Toluene	ug/L	5.2	<1.0	<1.0	3.9	<1.0	<1.0	<1.0	<1.0
1,1,1-Trichloroethane	ug/L	1.1	1.7	<1.0	<1.0	<1.0	1.9	<1.0	<1.0
Trichloroethene	ug/L	30.6	7.5	13.4	1.3	14.5	31.0	<1.0	4.1
Vinyl chloride	ug/L	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Total VOCs	**ug/L**	**38.9**	**11.5**	**15.7**	**5.2**	**16**	**36.5**	**ND**	**10.8**
Total VOCs, Historical RFI Groundwater Quality Data									
March 1998	ug/L	58.2	--	--	--	--	--	--	--
October/November 1994	ug/L	--	8.8	--	--	--	--	--	--
January 1993	ug/L	55.1	--	--	ND	43.2	26.2	--	6.1

ug/L - Micrograms per liter.

ND - Not detected.

"--" - Indicates historical RFI groundwater quality data not available for this event.

Table 4-4. Summary of Baseline Groundwater Results from Site-Wide Lower Aquifer Monitoring Wells, General Motors Corporation, Moraine, Ohio.

Constituents	Units	GM-20D 9/24/99	GM-9 9/24/99	MT69 9/24/99
Volatile Organic Compounds				
Benzene	ug/L	<1.0	<1.0	<1.0
1,1-Dichloroethane	ug/L	<1.0	<1.0	<1.0
cis-1,2-Dichloroethene	ug/L	<1.0	1.0	<1.0
trans-1,2-Dichloroethene	ug/L	<1.0	<1.0	<1.0
Tetrachloroethene	ug/L	<1.0	<1.0	<1.0
Toluene	ug/L	<1.0	<1.0	<1.0
1,1,1-Trichloroethane	ug/L	<1.0	1.0	<1.0
Trichloroethene	ug/L	<1.0	13.8	<1.0
Vinyl chloride	ug/L	<1.0	<1.0	<1.0
Total VOCs	**ug/L**	**ND**	**15.8**	**ND**
Total VOCs, Historical RFI Groundwater Quality Data				
March 1998	ug/L	ND	11	ND
October/November 1994	ug/L	7.9	--	ND
January 1993	ug/L	--	23.5	--

ug/L - Micrograms per liter.

ND - Not detected.

"--" - Indicates historical RFI groundwater quality data not available for this event.

Table 4-5. Summary of Baseline Groundwater Results from Reactive Zone 1 Wells, General Motors Corporation, Moraine, Ohio.

Constituents	Units	RZ-1A 9/29/99	RZ-1G 9/29/99	DUP-80 9/29/99
Volatile Organic Compounds				
1,1-Dichloroethane	ug/L	1.8	<1.0	<1.0
1,1-Dichloroethene	ug/L	<1.0	<1.0	<1.0
cis-1,2-Dichloroethene	ug/L	68.6	14.8	14.2
trans-1,2-Dichloroethene	ug/L	3.6	<1.0	<1.0
Tetrachloroethene	ug/L	252	91.5	93.9
1,1,1-Trichloroethane	ug/L	5.7	<1.0	<1.0
Trichloroethene	ug/L	158	44.1	44.5
Trichlorofluoromethane	ug/L	13.0	<1.0	<1.0
Vinyl chloride	ug/L	3.3	<1.0	<1.0
Total VOCs	**ug/L**	**506**	**150.4**	**152.6**

ug/L - Micrograms per liter.
DUP-80 is a duplicate sample of RZ-1G.

Table 4-6. Summary of Baseline Groundwater Results from Reactive Zone 3 Wells, General Motors Corporation, Moraine, Ohio.

Constituents	**Units**	**RZ-3E 9/30/99**	**RZ-3L 9/30/99**	**RZ-3T 9/30/99**	**RZ-3Z 9/29/99**	**RZ-3FF 10/7/99**	**RZ-3KK 10/7/99**	**RZ-3PP 10/8/99**
Volatile Organic Compounds								
Acetone	ug/L	<20.0J	108	<20.0J	<20.0	<20.0	<20.0	<20.0
Benzene	ug/L	<1.0	8.2	<1.0	<1.0	<1.0	<1.0	<1.0
Chloroethane	ug/L	<5.0	13.9	<5.0	<5.0	<5.0	<5.0	<5.0
Dichlorodifluoromethane	ug/L	6.4	16.8	<1.0	<1.0	<1.0	<1.0	<1.0
1,1-Dichloroethane	ug/L	20.9	59.7	4.9	1.5	2.8J	<1.0	<1.0
1,1-Dichloroethene	ug/L	1.6	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
cis-1,2-Dichloroethene	ug/L	112	96.6	23.8	3.2	9.3J	<1.0	<1.0
trans-1,2-Dichloroethene	ug/L	2.0	2.0	<1.0	<1.0	<1.0	<1.0	<1.0
Ethylbenzene	ug/L	<1.0	22.1	<1.0	<1.0	400J	<1.0	<1.0
4-Methyl-2-pentanone	ug/L	<12.5	53.7	<12.5	<12.5	<12.5	<12.5	<12.5
Tetrachloroethene	ug/L	58.2	<1.0	19.8	20.6	6.6J	8.0	2.0
Toluene	ug/L	<1.0	124	<1.0	<1.0	42.9J	<1.0	1.3
1,1,1-Trichloroethane	ug/L	28.4	2.4	7.2	3.8	3.2J	3.6	<1.0
Trichloroethene	ug/L	124	18.2	97.3	33.9	36.8J	38.9	14.7
Trichlorofluoromethane	ug/L	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Vinyl chloride	ug/L	2.7	14.1	<1.0	<1.0	6.6J	<1.0	<1.0
Xylenes	ug/L	<1.0	182.4	<1.0	<1.0	2210J	<1.0	<1.0
Total VOCs	**ug/L**	**356.2**	**722.1**	**153**	**63**	**2,718.2**	**50.5**	**18**

ug/L - Micrograms per liter.
J - Estimated value.

Table 4-7. Summary of Baseline Groundwater Results from the Oxidation Wells, General Motors Corporation, Moraine, Ohio.

Constituents	Units	OW-1 9/2/99	DUP-73 9/2/99	OW-2 9/2/99	OW-3 9/3/99	OW-4 9/3/99	OW-5 9/3/99	OW-6 9/3/99
Volatile Organic Compounds								
Acetone	ug/L	R	40.8J	R	25.0J	27.8J	R	20.8J
Benzene	ug/L	<10	<10	<10	1.2	1.4	2.7	<1.0
Bromoform	ug/L	<10	<10	<10	<1.0	1.4	<1.0	<1.0
Dichlorodifluoromethane	ug/L	25.0	26.7	72.9	<1.0	<1.0	<1.0	<1.0
1,1-Dichloroethane	ug/L	80.6	96.6	129	15.5	3.8	74.5	11.1
1,1-Dichloroethene	ug/L	<10	42.5J	71.9	2.1	<1.0	<1.0	1.0
cis-1,2-Dichloroethene	ug/L	1,640	10,200	32,200	3,360	581	29.9	982
trans-1,2-Dichloroethene	ug/L	94.2J	128J	149	17.8	2.0	1.0	3.1
Ethylbenzene	ug/L	<10	<10	18.0	<1.0	14.6	332	<1.0
Tetrachloroethene	ug/L	273J	562J	280	116	48.6	13.8	796
Toluene	ug/L	<10	<10	29.9	2.2	1303J	622	2.8
1,1,1-Trichloroethane	ug/L	<10	15.2	20.7	<1.0	<1.0	<1.0	2.2
1,1,2-Trichloroethane	ug/L	<10	<10	<10	1.1	<1.0	<1.0	3.1
Trichloroethene	ug/L	1,240	1,310	503	<1.0	8.9	5.1	1,420
Trichlorofluoromethane	ug/L	<10	13.5	25.3	<1.0	<1.0	<1.0	<1.0
Vinyl chloride	ug/L	6800J	6,250	7,760	<1.0	61.8	23.3	1.3
Xylenes	ug/L	<10	<10	10.8	<1.0	44.9	285	<1.0
Total VOCs	**ug/L**	**10,152.8**	**18,644.5**	**41,270.5**	**3,540.9**	**2,099.2**	**1,389.3**	**3,243.4**

ug/L - Micrograms per liter.
DUP-73 is a duplicate sample of OW-1.
R - Rejected value.
J - Estimated value.

Table 4-8. Baseline Bioattenuation Parameter Groundwater Results from Upper Aquifer Monitoring Wells, General Motors Corporation, Moraine, Ohio.

Constituents	Units	HR-3 9/16/99	GM-30 9/2/99	GM-23 9/1/99	GM-27 9/1/99	GM-29 9/1/99	GM-28 9/1/99	HR-1 9/16/99	DUP-75 9/16/99
Inorganics & TOC									
Nitrate	mg/l	0	0	0.08	0	0	0.08	0	0
Nitrite	mg/l	0	0.02	3.83	0.1	0	0.06	0	0
Nitrogen, Ammonia	mg/l	<0.30	1.76	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30
Manganese (Total)	mg/l	0.215	1.86	4.71	0.248	0.552	3.2	<0.010	<0.010
Manganese (Dissolved)	mg/l	0.211	0.088	0.346	0.171	0.13	0.068	<0.010	<0.010
Iron (Total)	mg/l	<0.10	99.1	13.6	3.65	18	106	<0.10	<0.10
Iron (Dissolved)	mg/l	<0.10	6.84	<0.10	<0.10	0.24	<0.10	<0.10	<0.10
Iron (Ferrous)	mg/l	0	2.5	4	0	0.02	0	0	0
Sulfate	mg/l	49	<5	72	75	90	89	71	63
Sulfide	mg/l	<1	<4	<4	<2	<4	<4	<1	<1
Total Organic Carbon	mg/l	5	76	19	7	18	15	4	3
Chloride	mg/l	28	42	118	138	254	208	90	91
Permanent Gases									
Carbon Dioxide	mg/l	77.93	98.94	88.47	71.41	46.52	41.52	54.94	53.43
Oxygen	mg/l	1.22	0.75	0.96	1.21	1.02	2.32	1.74	1.98
Nitrogen	mg/l	24.50	12.92	20.22	24.11	20.29	19.42	18.62	18.84
Methane	mg/l	0.38	9.23	0.1248	0.002007	0.01152	0.002487	0.000523	0.000624
Carbon Monoxide	mg/l	NA	<0.40	<0.40	<0.40	<0.40	<0.40	NA	NA
Light Hydrocarbon Scan									
Ethane	ng/l	196	16598	6,878	108	5641	750	20	18
Ethene	ng/l	12	1930451	580916	33	9769	48	<5	<5
Field Parameters									
pH	S.U.	6.96	6.66	6.80	6.91	6.99	7.02	7.13	7.13
Specific Conductivity	umhos/cm	854	1002	1160	1230	1502	1359	999	999
Dissolved Oxygen	mg/l	0.26	0.50	0.65	0.3	0.35	0.95	0.91	0.91
Redox Potential	mV	199.1	-108.1	122.2	71.4	-526.6	90.5	204.5	204.5
Temperature	°C	15.22	16.46	17.89	16.66	17.80	16.40	19.58	19.58

mg/l - milligrams per liter.
ng/l - nanograms per liter.
S.U. - Standard Units.

mV - Millivolts.
°C - Degrees Celsius.
umhos/cm - Micromohs/centimeter.

NA - Data not available, insufficient sample volume.

Table 4-8. Baseline Bioattenuation Parameter Groundwater Results from Upper Aquifer Monitoring Wells, General Motors Corporation, Moraine, Ohio.

Constituents	Units	W-1-S 9/22/99	DUP-77 9/22/99	ME-6 8/31/99	ME-1 8/31/99	GM-31 9/1/99	ME-3 8/31/99	DUP-72 8/31/99	WEST 9/21/99
Inorganics & TOC									
Nitrate	mg/l	0	0	0.08	13.2	0	22	22	0
Nitrite	mg/l	0	0	0.06	0.333	0	0.1665	0.1665	17.6
Nitrogen, Ammonia	mg/l	<0.30	<0.30	<0.30	0.62	0.41	<0.30	<0.30	<0.30
Manganese (Total)	mg/l	0.521	0.506	0.502	0.5	7.45	0.016	0.012	0.391
Manganese (Dissolved)	mg/l	0.081	0.081	<0.010	0.493	0.293	<0.010	<0.010	0.383
Iron (Total)	mg/l	<0.10	<0.10	8.17	<0.10	288	<0.10	<0.10	0.27
Iron (Dissolved)	mg/l	<0.10	<0.10	<0.10	<0.10	0.27	<0.10	<0.10	<0.10
Iron (Ferrous)	mg/l	0	0	0.02	0	0	0	0	0
Sulfate	mg/l	100	98	139	143	118	152	158	73
Sulfide	mg/l	<1	<1	<2	<1	<4	<1	<1	<1
Total Organic Carbon	mg/l	2	2	9	2	176	1	<1	2
Chloride	mg/l	152	144	182	177	240	336	328	260
Permanent Gases									
Carbon Dioxide	mg/l	36.98	39.97	51.08	49.95	32.12	57.26	58.28	50.41
Oxygen	mg/l	1.55	1.57	0.84	1.27	0.60	1.72	1.70	1.30
Nitrogen	mg/l	17.18	17.94	18.57	19.14	16.05	16.44	16.64	13.24
Methane	mg/l	0.000535	0.001462	0.002063	0.000627	0.01240	0.000129	0.000108	0.001409
Carbon Monoxide	mg/l	<0.40	<0.40	<0.40	<0.40	<0.40	<0.40	<0.40	<0.40
Light Hydrocarbon Scan									
Ethane	ng/l	34	40	134	32	2472	10	10	37
Ethene	ng/l	20	73	134	40	2295	<5	<5	100
Field Parameters									
pH	S.U.	7.00	7.00	7.02	7.03	7.25	6.96	6.96	6.89
Specific Conductivity	umhos/cm	1263	1263	1424	1385	1514	1889	1889	1759
Dissolved Oxygen	mg/l	0.45	0.45	0.66	0.52	1.61	2.01	2.01	0.41
Redox Potential	mV	140.4	140.4	109.1	108.4	-328.2	80.9	80.9	106.2
Temperature	°C	18.36	18.36	27.51	25.46	28.93	22.86	22.86	21.44

mg/l - milligrams per liter.

ng/l - nanograms per liter.

S.U. - Standard Units.

mV - Millivolts.

°C - Degrees Celsius.

umhos/cm - Micromohs/centimeter.

NA - Data not available, insufficient sample volume.

Table 4-8. Baseline Bioattenuation Parameter Groundwater Results from Upper Aquifer Monitoring Wells, General Motors Corporation, Moraine, Ohio.

Constituents	Units	EAST 9/21/99	GM-19S 9/20/99	GM-32 9/22/99	GM-22 9/1/99	GM-21 9/22/99	GM-8 9/20/99	GM-6 9/20/99	4S 9/20/99
Inorganics & TOC									
Nitrate	mg/l	0	11	0	0	0	0	0	0
Nitrite	mg/l	0	0	0	0	0	0	0	0
Nitrogen, Ammonia	mg/l	<0.30	<0.30	2.29	<0.30	<0.30	1.95	<0.30	1.82
Manganese (Total)	mg/l	0.627	0.726	0.147	0.089	0.321	0.125	1.11	0.024
Manganese (Dissolved)	mg/l	0.098	0.185	0.052	0.096	0.273	0.125	0.958	0.027
Iron (Total)	mg/l	4.82	16.90	8.14	<0.10	2.58	0.27	0.27	1.28
Iron (Dissolved)	mg/l	<0.10	<0.10	3.53	<0.10	<0.10	0.26	<0.10	1.21
Iron (Ferrous)	mg/l	0	0	1.8	0.6	0.4	0	NA	0.4
Sulfate	mg/l	75	127	30	49	103	54	83	14
Sulfide	mg/l	<1	<1	<1	<1	<1	<1	<1	<1
Total Organic Carbon	mg/l	3	2	68	6	1	8	4	95
Chloride	mg/l	283	247	317	246	136	216	247	345
Permanent Gases									
Carbon Dioxide	mg/l	34.69	41.85	39.79	40.15	37.04	9.91	48.44	20.55
Oxygen	mg/l	1.88	4.43	1.67	1.05	1.41	0.92	2.23	1.03
Nitrogen	mg/l	17.88	20.87	14.93	23.38	23.40	25.42	21.77	23.60
Methane	mg/l	0.000571	0.009863	2.73	0.05818	0.037440	2.47	0.006916	7.82
Carbon Monoxide	mg/l	<0.40	<0.40	<0.40	<0.40	<0.40	<0.40	<0.40	<0.40
Light Hydrocarbon Scan									
Ethane	ng/l	32	71	1649	42	72	1134	67	6723
Ethene	ng/l	18	55	86509	67	169	39617	97	4788
Field Parameters									
pH	S.U.	6.99	7.05	7.54	7.12	6.99	7.98	7.05	8.02
Specific Conductivity	umhos/cm	1777	1500	2750	1373	1188	1584	1493	2802
Dissolved Oxygen	mg/l	0.30	0.92	0.09	0.32	0.66	0.28	0.48	0.30
Redox Potential	mV	14.9	31.3	-226.4	62.2	-26.9	-49.8	26.5	-101.1
Temperature	°C	21.21	20.85	19.27	19.41	20.43	19.09	21.07	18.05

mg/l - milligrams per liter.
ng/l - nanograms per liter.
S.U. - Standard Units.
mV - Millivolts.
°C - Degrees Celsius.
umhos/cm - Micromohs/centimeter.
NA - Data not available, insufficient sample volume.

Table 4-8. Baseline Bioattenuation Parameter Groundwater Results from Upper Aquifer Monitoring Wells, General Motors Corporation, Moraine, Ohio.

Constituents	Units	GM-2 9/20/99	GM-16 9/21/99	GM-17 9/21/99	GM-10 9/21/99	DUP-76 9/21/99
Inorganics & TOC						
Nitrate	mg/l	17.6	8.8	0	15.4	15.4
Nitrite	mg/l	0	0	0	0	0
Nitrogen, Ammonia	mg/l	<0.30	<0.30	<0.30	<0.30	<0.30
Manganese (Total)	mg/l	<0.010	<0.010	0.347	0.028	0.026
Manganese (Dissolved)	mg/l	<0.010	<0.010	0.29	0.021	0.02
Iron (Total)	mg/l	<0.10	<0.10	<0.10	<0.10	<0.10
Iron (Dissolved)	mg/l	<0.10	<0.10	<0.10	<0.10	<0.10
Iron (Ferrous)	mg/l	0	0	0	0	0
Sulfate	mg/l	43	80	82	40	36
Sulfide	mg/l	<1	<1	<1	<1	<1
Total Organic Carbon	mg/l	1	3	3	2	10
Chloride	mg/l	219	203	227	164	170
Permanent Gases						
Carbon Dioxide	mg/l	39.55	36.55	31.67	47.50	49.76
Oxygen	mg/l	3.10	2.48	1.35	4.10	4.30
Nitrogen	mg/l	21.90	22.75	27.62	20.24	21.60
Methane	mg/l	0.003147	0.005521	0.089542	0.003788	0.0012
Carbon Monoxide	mg/l	<0.40	<0.40	<0.40	<0.40	<0.40
Light Hydrocarbon Scan						
Ethane	ng/l	9	10	891	10	11
Ethene	ng/l	<5	123	289	63	25
Field Parameters						
pH	S.U.	7.03	7.10	7.33	7.05	7.05
Specific Conductivity	umhos/cm	1264	1463	1640	1337	1337
Dissolved Oxygen	mg/l	1.47	0.68	0.26	3.05	3.05
Redox Potential	mV	125.9	129.9	91.4	131.4	131.4
Temperature	°C	17.43	16.83	20.35	18.39	18.39

mg/l - milligrams per liter.
ng/l - nanograms per liter.
S.U. - Standard Units.
mV - Millivolts.
°C - Degrees Celsius.
umhos/cm - Micromohs/centimeter.
NA - Data not available, insufficient sample volume.

Table 4-9. Baseline Bioattenuation Parameter Groundwater Results from Reactive Zone 1, General Motors Corporation, Moraine, Ohio.

Constituents	Units	RZ-1A 9/29/99	RZ-1G 9/29/99	DUP-80 9/29/99
Inorganics & TOC				
Nitrate	mg/l	0	0	0
Nitrite	mg/l	0	0	0
Nitrogen, Ammonia	mg/l	<0.30	<0.30	<0.30
Manganese (Total)	mg/l	0.422	0.227	0.215
Manganese (Dissolved)	mg/l	0.203	0.198	0.199
Iron (Total)	mg/l	6.78	<0.10	<0.10
Iron (Dissolved)	mg/l	<0.10	<0.10	<0.10
Iron (Ferrous)	mg/l	0	0	0
Sulfate	mg/l	61	65	60
Sulfide	mg/l	<1	<1	<1
Total Organic Carbon	mg/l	6	12	12
Chloride	mg/l	397	483	777
Permanent Gases				
Carbon Dioxide	mg/l	16.96	42.51	35.14
Oxygen	mg/l	8.23	5.03	4.52
Nitrogen	mg/l	14.51	13.85	11.75
Methane	mg/l	0.004308	0.001898	0.001918
Carbon Monoxide	mg/l	NA	NA	NA
Light Hydrocarbon Scan				
Ethane	ng/l	1218	967	940
Ethene	ng/l	2458	1783	1726
Field Parameters				
pH	S.U.	7.24	6.78	6.78
Specific Conductivity	umhos/cm	2033	3191	3191
Dissolved Oxygen	mg/l	0.82	0.12	0.12
Redox Potential	mV	175.0	164.9	164.9
Temperature	°C	18.33	18.09	18.09

mg/l - milligrams per liter.
ng/l - nanograms per liter.
S.U. - Standard Units.
mV - Millivolts.
°C - Degrees Celsius.
umhos/cm - Micromohs/centimeter.
NA - Not available.

Table 4-10. Baseline Bioattenuation Parameter Groundwater Results from Reactive Zone 3, General Motors Corporation, Moraine, Ohio.

Constituents	Units	RZ-3E 9/30/99	RZ-3L 9/30/99	RZ-3T 9/30/99	RZ-3Z 9/29/99	RZ-3FF 10/7/99	RZ-3KK 10/7/99	RZ-3PP 10/8/99
Inorganics & TOC								
Nitrate	mg/l	NA	NA	NA	0	0	13.2	0
Nitrite	mg/l	NA	NA	NA	0	0	0	0
Nitrogen, Ammonia	mg/l	<0.30	2.22	<0.30	<0.30	<0.30	<0.30	<0.30
Manganese (Total)	mg/l	2.4	0.333	1.54	1.04	0.991	0.622	0.93
Manganese (Dissolved)	mg/l	0.942	0.25	0.799	0.276	0.579	0.176	0.222
Iron (Total)	mg/l	32.4	4.9	10.2	33.1	21.3	19.6	29.3
Iron (Dissolved)	mg/l	<0.10	0.23	0.14	0.18	0.1	<0.10	0.41
Iron (Ferrous)	mg/l	NA	NA	NA	0	0	0	0
Sulfate	mg/l	83	46	73	55	45	38	40
Sulfide	mg/l	<4	<1	<1	<4	<1	<1	<1
Total Organic Carbon	mg/l	8	55	5	8	4	3	4
Chloride	mg/l	262	262	231	231	203	229	184
Permanent Gases								
Carbon Dioxide	mg/l	22.61	0.83	13.98	19.08	34.37	29.45	23.06
Oxygen	mg/l	7.23	0.61	8.17	7.90	0.62	1.38	2.06
Nitrogen	mg/l	15.83	15.35	13.90	14.45	20.34	13.31	10.25
Methane	mg/l	0.009056	1.29	0.002506	0.000424	0.014674	0.010751	0.024394
Carbon Monoxide	mg/l	NA	NA	NA	NA	<0.40	<0.40	<0.40
Light Hydrocarbon Scan								
Ethane	ng/l	1975	2797	674	64	2546	3584	7341
Ethene	ng/l	2225	27685	1373	46	6250	1175	1834
Field Parameters								
pH	S.U.	7.16	9.45	7.36	7.09	7.22	7.24	7.35
Specific Conductivity	umhos/cm	1503	2902	1445	1400	1345	1352	1251
Dissolved Oxygen	mg/l	0.06	0.30	0.09	4.30	0.32	1.23	0.12
Redox Potential	mV	144.8	-27.6	-109.2	271.0	116.1	-61.6	-105.5
Temperature	°C	18.20	18.75	18.04	17.51	17.88	17.93	18.07

mg/l - milligrams per liter.
ng/l - nanograms per liter.
S.U. - Standard Units.
mV - Millivolts.
°C - Degrees Celsius.
umhos/cm - Micromohs/centimeter.
NA - Not available.

Table 4-11. Baseline Bioattenuation Parameter Groundwater Results from the Oxidation Wells, General Motors Corporation, Moraine, Ohio.

Constituents	Units	OW-1 9/2/99	DUP-73 9/2/99	OW-2 9/2/99	OW-3 9/3/99	OW-4 9/3/99	OW-5 9/3/99	OW-6 9/3/99
Inorganics & TOC								
Nitrate	mg/l	0	0	0	NA	0	0	0
Nitrite	mg/l	0	0	0	NA	0	0	0
Nitrogen, Ammonia	mg/l	0.64	0.66	0.44	0.87	2.41	1.68	2.92
Manganese (Total)	mg/l	2.68	1.36	1.98	NA	3.09	10.4	54.5
Manganese (Dissolved)	mg/l	0.401	0.393	0.164	NA	0.12	1.81	2.59
Iron (Total)	mg/l	130	43.3	119	NA	122	525	1470
Iron (Dissolved)	mg/l	2.21	2.46	4.23	NA	<0.10	3.53	2.67
Iron (Ferrous)	mg/l	2	2	3.6	NA	0	0.6	0.02
Sulfate	mg/l	8	9	27	NA	<5	<5	53
Sulfide	mg/l	<4	<4	<4	<4	NA	<4	<4
Total Organic Carbon	mg/l	174	129	171	380	64	354	188
Chloride	mg/l	221	196	109	NA	214	73	109
Permanent Gases								
Carbon Dioxide	mg/l	85.76	83.09	96.88	NA	11.13	62.68	24.64
Oxygen	mg/l	0.89	0.72	0.99	NA	0.89	1.10	1.16
Nitrogen	mg/l	18.90	18.47	21.21	NA	21.23	21.60	16.46
Methane	mg/l	0.30	0.25	1.33	NA	0.000900	0.24	0.000952
Carbon Monoxide	mg/l	<0.40	<0.40	<0.40	NA	<0.40	<0.40	<0.40
Light Hydrocarbon Scan								
Ethane	ng/l	57032	71412	59933	NA	125	1291	560
Ethene	ng/l	1205597	1164223	373161	NA	9464	1203499	2197
Field Parameters								
pH	S.U.	6.62	6.62	6.50	7.32	7.76	6.81	7.57
Specific Conductivity	umhos/cm	1444	1444	1093	1369	807	998	1078
Dissolved Oxygen	mg/l	0.56	0.56	0.45	5.21	8.95	1.88	6.81
Redox Potential	mV	-509.9	-509.9	-101.8	-129.1	-11.3	-46.5	6.8
Temperature	°C	16.17	16.17	18.69	22.58	19.17	19.05	21.04

mg/l - milligrams per liter.
ng/l - nanograms per liter.
S.U. - Standard Units.
mV - Millivolts.
°C - Degrees Celsius.
umhos/cm - Micromohs/centimeter.
NA - Data not available, insufficient sample volume.

Table 4-12. Summary of 3-Month Groundwater Results from Select Upper Aquifer Monitoring Wells, General Motors Corporation, Moraine, Ohio.

Constituents	**Units**	**HR-3** **2/24/00**	**GM-30** **2/22/00**	**GM-23** **2/21/00**	**GM-27** **2/25/00**	**GM-29** **2/22/00**	**DUP-82** **2/22/00**	**GM-28** **2/23/00**	**HR-1** **2/24/00**
Volatile Organic Compounds									
Acetone	ug/L	R	R	R	<20.0	R	R	<20.0	R
Benzene	ug/L	<1.0	<50	<50	<1.0	<1.0	<1.0	<1.0	<1.0
2-Butanone	ug/L	R	R	R	R	R	R	R	R
Chlorobenzene	ug/L	<1.0	<50	<50	<1.0	<1.0	<1.0	<1.0	<1.0
Chloroethane	ug/L	<5.0	<250	<250	<5.0	<5.0	<5.0	<5.0	<5.0
Dichlorodifluoromethane	ug/L	<1.0	<50	<50	<1.0	<1.0	<1.0	<1.0	<1.0
1,1-Dichloroethane	ug/L	6.8	70.0	<50	2.4	4.1	3.2	4.20	3.1
1,2-Dichloroethane	ug/L	<1.0	<50	34J	<1.0	<1.0	<1.0	<1.0	<1.0
1,1-Dichloroethene	ug/L	<1.0	<50	<50	<1.0	1.1	<1.0	<1.0	<1.0
cis-1,2-Dichloroethene	ug/L	6.0	<50	10400D	14.4	223DJ	348DJ	503D	8.0
trans-1,2-Dichloroethene	ug/L	<1.0	<50	118J	<1.0	9.1	8.8	9.70	4.5
Ethylbenzene	ug/L	<1.0	7270D	<50	<1.0	1.4	1.0	<1.0	<1.0
4-Methyl-2-pentanone	ug/L	<12.5	<625	<625	<12.5	<12.5	<12.5	<12.5	<12.5
Tetrachloroethene	ug/L	<1.0	89.0	7280J	1.8	38.7	37.9	88.4	43.0
Toluene	ug/L	<1.0	6,480	<50	<1.0	<1.0	<1.0	<1.0	<1.0
1,1,1-Trichloroethane	ug/L	<1.0	<50	<50	<1.0	36.0	35.0	23.2	2.5
Trichloroethene	ug/L	1.1	<50	1350D	104	758DJ	1190DJ	833D	103
Trichlorofluoromethane	ug/L	<1.0	<50	29.5J	<1.0	149DJ	233DJ	95.0	5.4
Vinyl chloride	ug/L	<1.0	<50	2420J	<1.0	1.0	<1.0	<1.0	<1.0
Xylenes	ug/L	<1.0	27800D	<50	<1.0	6J	3.6J	<1.0	<1.0
Total VOCs	**ug/L**	**13.9**	**41,709.0**	**21,631.5**	**122.6**	**1,227.4**	**1,860.5**	**1,556.5**	**169.5**

ug/L - Micrograms per liter.
R - Rejected data.
D - Result obtained via sample dilution.
J - Estimated result.
DUP-82 is a duplicate of GM-29.

Table 4-12. Summary of 3-Month Groundwater Results from Select Upper Aquifer Monitoring Wells, General Motors Corporation, Moraine, Ohio.

Constituents	Units	W-1-S 2/24/00	ME-6 2/22/00	ME-1 2/22/00	GM-31 2/23/00	ME-3 2/22/00	WEST 2/23/00	EAST 2/23/00
Volatile Organic Compounds								
Acetone	ug/L	R	208	<200	<20.0	<200	R	R
Benzene	ug/L	<1.0	<10	<10	<1.0	<10	<1.0	<1.0
2-Butanone	ug/L	R	1650J	1410J	R	R	R	R
Chlorobenzene	ug/L	<1.0	<10	<10	<1.0	<10	<1.0	<1.0
Chloroethane	ug/L	<5.0	<50	<50	<5.0	<50	<5.0	<5.0
Dichlorodifluoromethane	ug/L	<1.0	<10	<10	<1.0	<10	<1.0	<1.0
1,1-Dichloroethane	ug/L	<1.0	<10	<10	1.4	12.4	24.5	7.3
1,2-Dichloroethane	ug/L	<1.0	<10	<10	<1.0	<10	<1.0	<1.0
1,1-Dichloroethene	ug/L	<1.0	<10	<10	<1.0	<10	<1.0	<1.0
cis-1,2-Dichloroethene	ug/L	4.7	541	459	27.8	105	34.5	24.0
trans-1,2-Dichloroethene	ug/L	<1.0	<10	<10	<1.0	<10	1.7	2.0
Ethylbenzene	ug/L	<1.0	<10	<10	<1.0	<10	<1.0	<1.0
4-Methyl-2-pentanone	ug/L	<12.5	<125	<125	<12.5	<125	<12.5	<12.5
Tetrachloroethene	ug/L	50.3	18.3	<10	<1.0	<10	53.9	77.1
Toluene	ug/L	<1.0	<10	<10	<1.0	<10	<1.0	<1.0
1,1,1-Trichloroethane	ug/L	<1.0	<10	<10	<1.0	16.0	25.1	20.6
Trichloroethene	ug/L	9.1	39.0	<10	13.6	<10	108	90.1
Trichlorofluoromethane	ug/L	<1.0	<10	<10	<1.0	<10	<1.0	<1.0
Vinyl chloride	ug/L	<1.0	<10	<10	<1.0	<10	<1.0	5.3
Xylenes	ug/L	<1.0	<10	<10	1.1	<10	<1.0	<1.0
Total VOCs	**ug/L**	**64.1**	**2,456.3**	**1,869.0**	**43.9**	**133.4**	**247.7**	**226.4**

ug/L - Micrograms per liter.
R - Rejected data.
D - Result obtained via sample dilution.
J - Estimated result.

Table 4-12. Summary of 3-Month Groundwater Results from Select Upper Aquifer Monitoring Wells, General Motors Corporation, Moraine, Ohio.

Constituents	Units	GM-19S 2/23/00	DUP-83 2/23/00	GM-32 2/28/00	GM-22 2/23/00	GM-21 2/23/00	GM-8 2/25/00	GM-6 2/25/00
Volatile Organic Compounds								
Acetone	ug/L	<20.0	<20.0	380	<20.0	<20.0	<20.0	<20.0
Benzene	ug/L	<1.0	<1.0	8.7J	<1.0	<1.0	3.0	<1.0
2-Butanone	ug/L	R	R	440J	R	R	R	R
Chlorobenzene	ug/L	<1.0	<1.0	<10	<1.0	<1.0	<1.0	<1.0
Chloroethane	ug/L	<5.0	<5.0	<50	<5.0	<5.0	16.1	7.6
Dichlorodifluoromethane	ug/L	<1.0	1.0	<10	<1.0	<1.0	28.4	10.5
1,1-Dichloroethane	ug/L	7.3	7.5	101	2.2	5.8	46.3	29.0
1,2-Dichloroethane	ug/L	<1.0	<1.0	<10	<1.0	<1.0	<1.0	<1.0
1,1-Dichloroethene	ug/L	1.0	1.1	<10	<1.0	1.6	<1.0	1.2
cis-1,2-Dichloroethene	ug/L	38.8	39.2	<10	3.1	35.9	71.0	129
trans-1,2-Dichloroethene	ug/L	2.3	2.4	111	<1.0	9.3	13.7	3.5
Ethylbenzene	ug/L	<1.0	<1.0	<10	<1.0	<1.0	22.6	<1.0
4-Methyl-2-pentanone	ug/L	<12.5	<12.5	48.1J	<12.5	<12.5	<12.5	<12.5
Tetrachloroethene	ug/L	71.3	64.2	<10	2.8	<1.0	<1.0	77.0
Toluene	ug/L	<1.0	<1.0	20.6	<1.0	<1.0	<1.0	<1.0
1,1,1-Trichloroethane	ug/L	16.9	15.9	<10	<1.0	15.4	<1.0	20.6
Trichloroethene	ug/L	101	93.2	<10	2.5	283D	4.7	113
Trichlorofluoromethane	ug/L	<1.0	<1.0	<10	<1.0	1.3	<1.0	<1.0
Vinyl chloride	ug/L	1.7	1.9	<10	<1.0	<1.0	39.5	13.8
Xylenes	ug/L	<1.0	<1.0	<10	1.2	2.3	1.8	<1.0
Total VOCs	**ug/L**	**240.3**	**226.4**	**1,109.4**	**11.8**	**354.6**	**247.1**	**405.2**

ug/L - Micrograms per liter.
R - Rejected data.
D - Result obtained via sample dilution.
J - Estimated result.
DUP-83 is a duplicate of GM-19S.

Table 4-12. Summary of 3-Month Groundwater Results from Select Upper Aquifer Monitoring Wells, General Motors Corporation, Moraine, Ohio.

Constituents	Units	4S 2/25/00	DUP-84 2/25/00	GM-2 2/25/00	GM-16 2/24/00	GM-17 2/25/00	GM-10 2/24/00
Volatile Organic Compounds							
Acetone	ug/L	R	<20.0	<20.0	<20.0	<20.0	<20.0
Benzene	ug/L	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
2-Butanone	ug/L	R	R	R	R	R	R
Chlorobenzene	ug/L	<1.0	<1.0	<1.0	<1.0	1.0	<1.0
Chloroethane	ug/L	15.0	15.7	<5.0	<5.0	<5.0	<5.0
Dichlorodifluoromethane	ug/L	<1.0	<1.0	<1.0	<1.0	1.2	<1.0
1,1-Dichloroethane	ug/L	3.9	3.8	2.6	<1.0	20.8	1.5
1,2-Dichloroethane	ug/L	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
1,1-Dichloroethene	ug/L	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
cis-1,2-Dichloroethene	ug/L	<1.0	<1.0	16.7	<1.0	29.2	3.7
trans-1,2-Dichloroethene	ug/L	<1.0	<1.0	1.1	<1.0	2.2	<1.0
Ethylbenzene	ug/L	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
4-Methyl-2-pentanone	ug/L	<12.5	<12.5	<12.5	<12.5	<12.5	<12.5
Tetrachloroethene	ug/L	<1.0	<1.0	7.9	27.1	27.0	1.4
Toluene	ug/L	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
1,1,1-Trichloroethane	ug/L	<1.0	<1.0	6.4	2.6	14.1	2.5
Trichloroethene	ug/L	<1.0	<1.0	80.8	5.2	74.0	27.0
Trichlorofluoromethane	ug/L	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Vinyl chloride	ug/L	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Xylenes	ug/L	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Total VOCs	**ug/L**	**18.9**	**19.5**	**115.5**	**34.9**	**169.5**	**36.1**

ug/L - Micrograms per liter.
R - Rejected data.
D - Result obtained via sample dilution.
J - Estimated result.
DUP-84 is a duplicate of 4S.

Table 4-13. Summary of 3-Month Groundwater Results from Reactive Zone 1 Wells, General Motors Corporation, Moraine, Ohio.

Constituents	Units	RZ-1A 2/22/00	RZ-1G 2/22/00
Volatile Organic Compounds			
Acetone	ug/L	63.3J	<1,000
2-Butanone	ug/L	4890J	4360J
cis-1,2-Dichloroethene	ug/L	294	306
4-Methyl-2-pentanone	ug/L	287J	<625
Tetrachloroethene	ug/L	<50	50.5
Trichloroethene	ug/L	88.5	<50
Xylenes	ug/L	43J	<50
Total VOCs	**ug/L**	**5,665.8**	**4,716.5**

ug/L - Micrograms per liter.
J - Estimated result.

Table 4-14. Summary of 3-Month Groundwater Results from Reactive Zone 3 Wells, General Motors Corporation, Moraine, Ohio.

Constituents	**Units**	**RZ-3E 2/28/00**	**RZ-3L 2/28/00**	**RZ-3T 2/28/00**	**RZ-3Z 2/28/00**	**RZ-3FF 2/24/00**	**RZ-3KK 2/24/00**	**RZ-3PP 2/24/00**
Volatile Organic Compounds								
Acetone	ug/L	<200	<200	<200	<200	128J	<200	<200
Benzene	ug/L	<10	35.4	<10	<10	<10	<10	<10
2-Butanone	ug/L	6100DJ	496J	15300DJ	258J	1850J	2310J	672J
Chloroethane	ug/L	<50	15.2J	<50	<50	<50	<50	<50
1,1-Dichloroethane	ug/L	49.7	583	<10	<10	<10	<10	<10
cis-1,2-Dichloroethene	ug/L	320	260	213	130	50.4	40.7	33.7
Ethylbenzene	ug/L	<10	111	<10	<10	30.4	<10	<10
4-Methyl-2-pentanone	ug/L	<125	180J	<125	<125	<125	<125	<125
Tetrachloroethene	ug/L	23.6	<10	16.5	<10	6.5J	<10	<10
Toluene	ug/L	<10	416	<10	<10	<10	<10	<10
Trichloroethene	ug/L	34.1	<10	17.1	<10	20.3	5.4J	<10
Vinyl chloride	ug/L	<10	43.7	<10	<10	<10	<10	<10
Xylenes	ug/L	77.2	606	7.2J	6.6J	147	<10	<10
Total VOCs	**ug/L**	**6,604.6**	**2,746.3**	**15,553.8**	**394.6**	**2,232.6**	**2,356.1**	**705.7**

ug/L - Micrograms per liter.
J - Estimated result.
D - Result obtained via diluted sample.

Table 4-15. Summary of 3-Month Groundwater Results from the Oxidation Wells, General Motors Corporation, Moraine, Ohio.

Constituents	Units	OW-1 2/21/00	OW-2 2/21/00	OW-3 2/21/00	OW-4 2/22/00	OW-5 2/22/00	OW-6 2/21/00
Volatile Organic Compounds							
Acetone	ug/L	R	R	<200	R	R	41.4J
Benzene	ug/L	<50	<50	<10	71.0	<10	<1.0
1,1-Dichloroethane	ug/L	<50	<50	<10	128	78.2	23.2
1,1-Dichloroethene	ug/L	<50	<50	<10	<1.0	<10	6.0
cis-1,2-Dichloroethene	ug/L	3,080	8830D	2830D	965D	<10	3610D
trans-1,2-Dichloroethene	ug/L	<50	40J	12.5	27.5J	<10	13.1
Ethylbenzene	ug/L	<50	<50	<10	84.0	771	<1.0
Tetrachloroethene	ug/L	1,380	4,210	314	239	<10	2250D
Toluene	ug/L	<50	<50	<10	11700D	32.9	<1.0
1,1,1-Trichloroethane	ug/L	<50	<50	<10	<1.0	<10	18.3
1,1,2-Trichloroethane	ug/L	<50	<50	<10	<1.0	<10	2.7
Trichloroethene	ug/L	690	1,620	150	<1.0	<10	2680D
Vinyl chloride	ug/L	34J	657	<10	1,220	<10	12.2J
Xylenes	ug/L	<50	<50	<10	199	2,010	<1.0
Total VOCs	**ug/L**	**5,184.0**	**15,357.0**	**3,306.5**	**14,633.5**	**2,892.1**	**8,656.9**

ug/L - Micrograms per liter.

R - Rejected data.

J - Estimated quantity.

D - Result obtained via sample dilution.

Table 4-16. 3-Month Bioattenuation Parameter Groundwater Results from Upper Aquifer Monitoring Wells, General Motors Corporation, Moraine, Ohio.

Constituents	Units	GM-30 2/22/00	GM-23 2/21/00	DUP-81 2/21/00	GM-27 2/25/00	GM-29 2/22/00	DUP-82 2/22/00	GM-28 2/23/00	HR-3 2/24/00	HR-1 2/24/00
Inorganics & TOC										
Nitrate	mg/l	0	0	0	0	0	0	0	0	0
Nitrite	mg/l	0	0	0	0	0	0	0	0	0
Nitrogen, Ammonia	mg/l	1.93	0.94	0.92	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3
Manganese (Total)	mg/l	0.648	0.887	0.947	0.177	0.136	0.139	1.15	0.22	<0.010
Manganese (Dissolved)	mg/l	0.063	0.841	0.819	0.16	0.101	0.099	0.449	0.239	<0.010
Iron (Total)	mg/l	41.9	0.53	<0.10	1.77	1.43	1.54	25.3	<0.10	<0.10
Iron (Dissolved)	mg/l	8.88	<0.10	<0.10	<0.10	0.13	0.12	0.59	<0.10	<0.10
Iron (Ferrous)	mg/l	2.3	0	0	0	0	0	0.03	0	0
Sulfate	mg/l	<5	650	1000	81	126	89	43	57	80
Sulfide	mg/l	<1	<1	<1	<1	<1	<1	<1	<1	<1
Total Organic Carbon	mg/l	52	25	21	7	11	10	24	7	5
Chloride	mg/l	54	143	150	127	426	436	664	54	114
Permanent Gases										
Carbon Dioxide	mg/l	106.3	264.8	254.7	66.7	49.87	48.20	63.57	68.85	56.87
Oxygen	mg/l	0.57	1.56	2.40	1.12	0.66	0.95	0.59	0.58	0.98
Nitrogen	mg/l	12.0	13.75	15.07	21.26	18.7	19.8	16.39	19.64	16.63
Methane	mg/l	0.00856	0.72	0.57	0.002706	0.007699	6.074	0.001832	0.1159	<0.000015
Carbon Monoxide	mg/l	<0.40	<0.40	<0.40	<0.40	<0.40	<0.40	<0.40	<0.40	<0.40
Light Hydrocarbon Scan										
Ethane	ng/l	218908	14,644	12,875	64	1861	1746	493	181	<5
Ethene	ng/l	1598981	439458	401272	66	1275	1037	98	<5	<5
Field Parameters										
pH	S.U.	6.88	6.62	6.62	6.94	7.02	7.02	6.92	6.93	6.99
Specific Conductivity	umhos/cm	1393	2856	2856	1768	3044	3044	3124	1406	1649
Dissolved Oxygen	mg/l	0.79	0.78	0.78	0.55	0.51	0.51	1.45	0.51	0.94
Redox Potential	mV	-115.4	158.7	158.7	31.4	19.6	19.6	56.0	156.7	182.1
Temperature	°C	17.29	17.60	17.60	16.27	16.90	16.90	18.48	15.72	19.52

mg/l - milligrams per liter.

ng/l - nanograms per liter.

S.U. - Standard Units.

mV - Millivolts.

°C - Degrees Celsius.

umhos/cm - Micromohs/centimeter.

Table 4-16. 3-Month Bioattenuation Parameter Groundwater Results from Upper Aquifer Monitoring Wells, General Motors Corporation, Moraine, Ohio.

Constituents	Units	W-1-S 2/24/00	ME-6 2/22/00	ME-1 2/22/00	GM-31 2/23/00	ME-3 2/22/00	WEST 2/23/00	EAST 2/23/00	GM-19S 2/23/00	DUP-83 2/23/00
Inorganics & TOC										
Nitrate	mg/l	0	NA	NA	0	NA	0	0	0	0
Nitrite	mg/l	0	NA	NA	0	NA	0	0	0	0
Nitrogen, Ammonia	mg/l	<0.3	10.9	3.70	<0.3	3.10	<0.3	<0.3	<0.3	<0.3
Manganese (Total)	mg/l	0.17	4.19	2.40	0.53	0.870	0.038	0.474	1.09	1.16
Manganese (Dissolved)	mg/l	<0.010	3.60	1.93	0.208	0.702	<0.010	0.157	0.205	0.202
Iron (Total)	mg/l	<0.10	67.1	96.6	17.4	20.5	0.40	5.55	39.4	42.3
Iron (Dissolved)	mg/l	<0.10	46.5	63.4	1.87	15.3	<0.10	<0.10	<0.10	<0.10
Iron (Ferrous)	mg/l	0	NA	NA	1.6	NA	0	0	0	0
Sulfate	mg/l	113	111	41	105	60	129	130	131	142
Sulfide	mg/l	<1	2.00	<1	<1	1.39	<1	<1	<1	<1
Total Organic Carbon	mg/l	3	1,560	985	4	162	7	10	7	6
Chloride	mg/l	176	350	467	249	208	166	254	197	210
Permanent Gases										
Carbon Dioxide	mg/l	46.40	173.39	350.8	49.58	183.76	67.57	58.08	57.12	56.09
Oxygen	mg/l	1.42	0.45	0.40	0.61	0.47	1.50	0.97	1.01	1.63
Nitrogen	mg/l	15.40	12.44	10.6	19.79	13.39	13.74	17.50	17.07	18.61
Methane	mg/l	0.000062	0.56	1.11	0.03339	0.01088	0.000217	0.003269	0.002712	0.002803
Carbon Monoxide	mg/l	<0.40	<0.40	<0.40	<0.40	<0.40	<0.40	<0.40	<0.40	<0.40
Light Hydrocarbon Scan										
Ethane	ng/l	<5	97	164	4550	73	33	39	104	118
Ethene	ng/l	<5	164	293	1283	109	17	107	45	41
Field Parameters										
pH	S.U.	6.99	6.64	6.19	7.19	6.75	6.97	7.04	7.05	7.05
Specific Conductivity	umhos/cm	1930	4645	5030	1786	2305	1640	1955	1784	1784
Dissolved Oxygen	mg/l	1.72	7.12	7.00	0.39	4.06	1.73	0.37	0.30	0.30
Redox Potential	mV	196.5	-85.8	-81.7	-61.9	-96.8	139.1	122.9	149.6	149.6
Temperature	°C	18.37	18.59	19.25	20.75	19.28	19.90	19.38	18.69	18.69

mg/l - milligrams per liter.
ng/l - nanograms per liter.
S.U. - Standard Units.
mV - Millivolts.
°C - Degrees Celsius.
umhos/cm - Micromohs/centimeter.
NA - Not Available.

Table 4-16. 3-Month Bioattenuation Parameter Groundwater Results from Upper Aquifer Monitoring Wells, General Motors Corporation, Moraine, Ohio.

Constituents	Units	GM-32 2/28/00	GM-22 2/23/00	GM-21 2/23/00	GM-8 2/25/00	GM-6 2/25/00	4S 2/25/00	DUP-84 2/25/00	GM-2 2/25/00
Inorganics & TOC									
Nitrate	mg/l	0	0	0	0	0	0	0	0
Nitrite	mg/l	0	0	0	0	0	0	0	0
Nitrogen, Ammonia	mg/l	2.00	<0.3	<0.3	1.65	<0.3	0.77	0.80	<0.3
Manganese (Total)	mg/l	0.516	0.273	0.233	0.09	0.837	0.052	0.054	0.027
Manganese (Dissolved)	mg/l	0.061	0.263	0.225	0.097	0.721	0.056	0.055	<0.010
Iron (Total)	mg/l	42.4	0.16	0.30	1.54	0.38	2.77	2.98	<0.10
Iron (Dissolved)	mg/l	0.59	<0.10	<0.10	1.68	<0.10	3.1	0.19	<0.10
Iron (Ferrous)	mg/l	2.2	0	0	0	0	0	0	0
Sulfate	mg/l	<5	125	102	<5	66	77	79	71
Sulfide	mg/l	<10	<1	<1	<1	<1	<1	<1	<1
Total Organic Carbon	mg/l	1,200	4	3	26	6	14	13	3
Chloride	mg/l	638	270	145	285	249	244	249	223
Permanent Gases									
Carbon Dioxide	mg/l	8.94	43.99	37.40	10.9	11.3	21	21.6	46.8
Oxygen	mg/l	0.85	0.86	0.99	0.65	1.07	0.80	0.67	1.52
Nitrogen	mg/l	15.23	19.43	21.67	19.17	21.64	22.28	21.17	18.14
Methane	mg/l	7.06	0.23	0.01769	1.78	2.01	1.31	1.18	0.000839
Carbon Monoxide	mg/l	<0.40	<0.40	<0.40	<0.40	<0.40	<0.40	<0.40	<0.40
Light Hydrocarbon Scan									
Ethane	ng/l	9965	91	67	518	555	807	709	23
Ethene	ng/l	163855	32	38	39880	41653	4712	4100	34
Field Parameters									
pH	S.U.	8.59	7.15	7.22	7.98	7.08	7.93	7.93	6.99
Specific Conductivity	umhos/cm	9030	1975	1299	2592	2371	2986	2986	2142
Dissolved Oxygen	mg/l	0.23	0.46	0.60	0.45	0.40	0.33	0.33	0.92
Redox Potential	mV	-279.1	70.2	113.3	-157.2	98.3	-160.7	-160.7	174.5
Temperature	°C	19.72	18.87	18.43	17.41	19.21	16.51	16.51	18.27

mg/l - milligrams per liter.
ng/l - nanograms per liter.
S.U. - Standard Units.
mV - Millivolts.
°C - Degrees Celsius.
umhos/cm - Micromohs/centimeter.

Table 4-16. 3-Month Bioattenuation Parameter Groundwater Results from Upper Aquifer Monitoring Wells, General Motors Corporation, Moraine, Ohio.

Constituents	Units	GM-16 2/24/00	GM-17 2/25/00	GM-10 2/24/00
Inorganics & TOC				
Nitrate	mg/l	0	0	0
Nitrite	mg/l	0	0	0
Nitrogen, Ammonia	mg/l	<0.3	<0.3	<0.3
Manganese (Total)	mg/l	<0.010	0.311	0.027
Manganese (Dissolved)	mg/l	<0.010	0.265	0.023
Iron (Total)	mg/l	0.14	<0.10	<0.10
Iron (Dissolved)	mg/l	<0.10	<0.10	<0.10
Iron (Ferrous)	mg/l	0	0	0
Sulfate	mg/l	90	118	51
Sulfide	mg/l	<1	<1	<1
Total Organic Carbon	mg/l	4	5	3
Chloride	mg/l	270	200	187
Permanent Gases				
Carbon Dioxide	mg/l	36.11	37.4	47.65
Oxygen	mg/l	1.20	1.47	1.43
Nitrogen	mg/l	18.10	21.02	18.52
Methane	mg/l	0.079	0.04784	0.003706
Carbon Monoxide	mg/l	<0.40	<0.40	<0.40
Light Hydrocarbon Scan				
Ethane	ng/l	<5	385	<5
Ethene	ng/l	<5	157	<5
Field Parameters				
pH	S.U.	7.15	7.21	7.09
Specific Conductivity	umhos/cm	2222	2190	1905
Dissolved Oxygen	mg/l	1.32	0.32	1.66
Redox Potential	mV	158.1	109.3	82.9
Temperature	°C	17.59	18.20	16.68

mg/l - milligrams per liter.
ng/l - nanograms per liter.
S.U. - Standard Units.
mV - Millivolts.
°C - Degrees Celsius.
umhos/cm - Micromohs/centimeter.

Table 4-17. 3-Month Bioattenuation Parameter Groundwater Results from Reactive Zone 1, General Motors Corporation, Moraine, Ohio.

Constituents	Units	RZ-1A 2/22/00	RZ-1G 2/22/00
Inorganics & TOC			
Nitrate	mg/l	NA	NA
Nitrite	mg/l	NA	NA
Nitrogen, Ammonia	mg/l	39.0	28.1
Manganese (Total)	mg/l	18.7	23
Manganese (Dissolved)	mg/l	13.2	19.9
Iron (Total)	mg/l	566	276
Iron (Dissolved)	mg/l	366	234
Iron (Ferrous)	mg/l	NA	NA
Sulfate	mg/l	508	199
Sulfide	mg/l	<10	<10
Total Organic Carbon	mg/l	14,100	7,640
Chloride	mg/l	1,560	2,540
Permanent Gases			
Carbon Dioxide	mg/l	999.4	1096
Oxygen	mg/l	0.20	0.26
Nitrogen	mg/l	7.13	5.82
Methane	mg/l	0.02551	0.02337
Carbon Monoxide	mg/l	<0.40	<0.40
Light Hydrocarbon Scan			
Ethane	ng/l	1495	142
Ethene	ng/l	1980	674
Field Parameters			
pH	S.U.	5.76	5.45
Specific Conductivity	umhos/cm	28360	21151
Dissolved Oxygen	mg/l	2.84	3.64
Redox Potential	mV	-118.4	-85.5
Temperature	°C	20.24	19.96

mg/l - milligrams per liter.
ng/l - nanograms per liter.
S.U. - Standard Units.
mV - Millivolts.
°C - Degrees Celsius.
umhos/cm - Micromohs/centimeter.
NA - Not Available.

Table 4-18. 3-Month Bioattenuation Parameter Groundwater Results from Reactive Zone 3, General Motors Corporation, Moraine, Ohio.

Constituents	Units	RZ-3E 2/28/00	RZ-3L 2/28/00	RZ-3T 2/28/00	RZ-3Z 2/28/00	RZ-3FF 2/24/00	RZ-3KK 2/24/00	RZ-3PP 2/24/00
Inorganics & TOC								
Nitrate	mg/l	NA	NA	NA	NA	0	0	0
Nitrite	mg/l	NA	NA	NA	NA	0	0	0
Nitrogen, Ammonia	mg/l	0.88	2.00	2.48	1.20	4.5	6.00	36.4
Manganese (Total)	mg/l	18.9	0.939	15	1.49	1.26	2.45	1.64
Manganese (Dissolved)	mg/l	16.8	0.861	13.2	1.24	1.27	2.18	1.63
Iron (Total)	mg/l	199	26.1	282	76.8	65.5	158	61.5
Iron (Dissolved)	mg/l	179	23.4	220	22.4	67.2	150	62
Iron (Ferrous)	mg/l	NA	NA	NA	NA	0	0	0
Sulfate	mg/l	114	<10	76	<10	23	<20	5
Sulfide	mg/l	<10	<10	<10	<10	<1	1.1	<1
Total Organic Carbon	mg/l	2,670	1,040	3,050	434	514	1,050	394
Chloride	mg/l	695	249	405	311	296	353	260
Permanent Gases								
Carbon Dioxide	mg/l	10.62	545.7	238.3	10.33	252.34	305.57	156.80
Oxygen	mg/l	0.51	0.67	0.63	0.38	0.22	0.24	0.31
Nitrogen	mg/l	12.20	12.7	18.34	7.88	15.68	14.65	17.95
Methane	mg/l	8.92	0.03261	0.1037	22.3	0.01111	0.3552	0.2308
Carbon Monoxide	mg/l	<0.40	<0.40	<0.40	<0.40	<0.40	<0.40	<0.40
Light Hydrocarbon Scan								
Ethane	ng/l	11704	208	118	553	148	154	54
Ethene	ng/l	175096	529	270	1072138	785	255	126
Field Parameters								
pH	S.U.	5.76	8.76	6.15	6.41	6.24	6.09	6.48
Specific Conductivity	umhos/cm	8926	8372	10043	3513	3576	6396	3161
Dissolved Oxygen	mg/l	1.65	0.21	1.27	0.89	1.11	1.43	0.79
Redox Potential	mV	-36.2	-352.0	-103.2	-99.0	-84.7	-108.6	-131.3
Temperature	°C	19.70	19.33	19.24	18.96	18.80	19.85	18.72

mg/l - milligrams per liter.

ng/l - nanograms per liter.

S.U. - Standard Units.

mV - Millivolts.

°C - Degrees Celsius.

umhos/cm - Micromohs/centimeter.

NA - Not available.

Table 4-19. 3-Month Bioattenuation Parameter Groundwater Results from the Oxidation Wells, General Motors Corporation, Moraine, Ohio.

Constituents	Units	OW-1 2/21/00	OW-2 2/21/00	OW-3 2/21/00	OW-4 2/22/00	OW-5 2/22/00	OW-6 2/21/00
Inorganics & TOC							
Nitrate	mg/l	NA	0	0	NA	NA	0
Nitrite	mg/l	NA	0	0	NA	NA	0
Nitrogen, Ammonia	mg/l	1.16	0.71	0.93	1.13	2.13	0.65
Manganese (Total)	mg/l	2.15	2.21	0.583	0.563	9.8610	5.65
Manganese (Dissolved)	mg/l	0.528	1.11	0.66	0.147	0.062	0.287
Iron (Total)	mg/l	406	3.45	1.59	21.10	500	181
Iron (Dissolved)	mg/l	0.66	2.1	<0.10	<0.10	0.41	<0.10
Iron (Ferrous)	mg/l	NA	2	0	NA	NA	1
Sulfate	mg/l	1850	600	1525	<5	<5	24
Sulfide	mg/l	1.20	<1	<1	<1	<1	<1
Total Organic Carbon	mg/l	24	20	15	54	161	35
Chloride	mg/l	73	131	119	353	<50	145
Permanent Gases							
Carbon Dioxide	mg/l	193.2	81.41	82.08	21.74	74.15	64.96
Oxygen	mg/l	6.36	8.26	8.70	5.18	0.50	1.26
Nitrogen	mg/l	11.68	14.69	14.60	14.6	14.1	17.15
Methane	mg/l	0.002824	0.02262	0.001662	0.27	0.00036	0.001990
Carbon Monoxide	mg/l	<0.40	<0.40	<0.40	<0.40	<0.40	<0.40
Light Hydrocarbon Scan							
Ethane	ng/l	1086	2406	102	38124	382	509
Ethene	ng/l	1581	26719	460	1915746	1616870	812
Field Parameters							
pH	S.U.	6.14	6.80	6.61	6.69	6.90	7.39
Specific Conductivity	umhos/cm	3227	148.0	3075	2260	1418	1381
Dissolved Oxygen	mg/l	9.58	7.09	11.00	10.63	2.45	8.57
Redox Potential	mV	183.0	125.3	155.0	-22.2	-65.7	23.1
Temperature	°C	16.14	17.61	17.66	14.96	15.41	13.98

mg/l - milligrams per liter.
ng/l - nanograms per liter.
S.U. - Standard Units.
mV - Millivolts.
°C - Degrees Celsius.
umhos/cm - Micromohs/centimeter.
NA - Not Available.

Table 4-20. Summary of 6-Month Groundwater Results from Select Upper Aquifer Monitoring Wells, General Motors Corporation, Moraine, Ohio.

Constituents	**Units**	**HR-3** **5/23/00**	**GM-30** **5/31/00**	**GM-23** **5/31/00**	**DUP-88** **5/31/00**	**GM-27** **5/31/00**	**GM-29** **5/26/00**	**DUP-87** **5/26/00**	**GM-28** **5/26/00**
<u>Volatile Organic Compounds</u>									
Acetone	ug/L	<20.0	<20.0	<400	<400	<20.0	<20.0	<20.0	<20.0
Benzene	ug/L	<1.0	3.0	<20	<20	<1.0	<1.0	<1.0	<1.0
2-Butanone	ug/L	R	R	R	R	R	35.2J	35.8J	3,070J
Chloroethane	ug/L	<5.0	<5.0	<100	<100	<5.0	<5.0	<5.0	<5.0
Chloroform	ug/L	<1.0	<1.0	<20	<20	<1.0	<1.0	<1.0	<1.0
Dichlorodifluoromethane	ug/L	<1.0	<1.0	<20	<20	<1.0	<1.0	<1.0	<1.0
1,1-Dichloroethane	ug/L	4.0	60.0	12.8J	14.4J	2.2	6.3	6.5	11.8
1,1-Dichloroethene	ug/L	<1.0	<1.0	6.6J	7.4J	<1.0	1.6	1.7	3.8
cis-1,2-Dichloroethene	ug/L	4.2	<1.0	4,080J	3,690J	12.7	1,190J	924J	2,700
trans-1,2-Dichloroethene	ug/L	<1.0	<1.0	39.8J	47.6J	<1.0	8.9	8.8	36.5
Ethylbenzene	ug/L	<1.0	1,760	<20	<20	<1.0	<1.0	<1.0	<1.0
Tetrachloroethene	ug/L	<1.0	<1.0	6,200J	5,780J	2.5	24.6	24.1	30.2
Toluene	ug/L	<1.0	98.0	<20	<20	<1.0	<1.0	<1.0	<1.0
1,1,1-Trichloroethane	ug/L	<1.0	<1.0	<20	<20	<1.0	32.5	32.7	18.1
Trichloroethene	ug/L	<1.0	<1.0	1,480J	1,620J	111	649J	483J	14.8
Trichlorofluoromethane	ug/L	<1.0	<1.0	<20	<20	<1.0	140	140	54.4
Vinyl chloride	ug/L	<1.0	<1.0	140J	165J	1.7	1.7	1.8	1.9
Xylenes	ug/L	<1.0	5,460	<20	<20	<1.0	<1.0	<1.0	<1.0
Total VOCs	**ug/L**	**8.2**	**7,381**	**11,959.2**	**11,324.4**	**130.1**	**2,089.8**	**1,658.4**	**5,941.5**

ug/L - Micrograms per liter.
J - Estimated.
R - Rejected.
DUP-87 is a duplicate of GM-29.
DUP-88 is a duplicate of GM-23.

Table 4-20. Summary of 6-Month Groundwater Results from Select Upper Aquifer Monitoring Wells, General Motors Corporation, Moraine, Ohio.

Constituents	Units	HR-1 5/23/00	DUP-85 5/23/00	W-1-S 5/30/00	ME-6 5/25/00	ME-1 5/25/00	GM-31 5/31/00	ME-3 5/25/00	WEST 5/25/00
Volatile Organic Compounds									
Acetone	ug/L	<20.0	<20.0	<20.0	73.4J	85.7J	<20.0	<20.0	<20.0
Benzene	ug/L	<1.0	<1.0	<1.0	<5.0	<5.0	<1.0	<1.0	<1.0
2-Butanone	ug/L	R	R	R	1,040J	596J	R	84.9J	R
Chloroethane	ug/L	<5.0	<5.0	<5.0	<25	<25	<5.0	2.6	<5.0
Chloroform	ug/L	<1.0	<1.0	<1.0	<5.0	<5.0	<1.0	<1.0	<1.0
Dichlorodifluoromethane	ug/L	<1.0	<1.0	<1.0	<5.0	<5.0J	<1.0	<1.0J	<1.0J
1,1-Dichloroethane	ug/L	2.3	2.2	<1.0	1.4J	<5.0	1.8	4.7	32.5
1,1-Dichloroethene	ug/L	<1.0	<1.0	<1.0	<5.0	<5.0	<1.0	<1.0	<1.0
cis-1,2-Dichloroethene	ug/L	12.2	12.2	1.5	712	537	48.1	100	29.0
trans-1,2-Dichloroethene	ug/L	2.8	2.8	<1.0	6.1	4.2J	<1.0	7.5	1.3
Ethylbenzene	ug/L	<1.0	<1.0	<1.0	<5.0	1.5J	<1.0	<1.0	<1.0
Tetrachloroethene	ug/L	34.9	34.9	21.8	16.2	1.8J	<1.0	<1.0	37.7
Toluene	ug/L	<1.0	<1.0	<1.0	<5.0	1.4J	<1.5	<1.0	<1.0
1,1,1-Trichloroethane	ug/L	1.8	1.8	<1.0	<5.0	<5.0	<1.0	4.8	27.4
Trichloroethene	ug/L	76.5	76.1	5.2	28.0	5.8	8.4	4.3	103.0
Trichlorofluoromethane	ug/L	2.9	3.0	<1.0	<5.0	<5.0	<1.0	<1.0	<1.0
Vinyl chloride	ug/L	<1.0	<1.0	<1.0	10.8	9.1	<1.0	54.7	<1.0
Xylenes	ug/L	<1.0	<1.0	<1.0	<5.0	<5.0	<1.6	<1.0	<1.0
Total VOCs	**ug/L**	**133.4**	**133**	**28.5**	**1,887.9**	**1,244**	**61.4**	**263.5**	**230.9**

ug/L - Micrograms per liter.
J - Estimated.
R - Rejected.
DUP-85 is a duplicate of HR-1.

Table 4-20. Summary of 6-Month Groundwater Results from Select Upper Aquifer Monitoring Wells, General Motors Corporation, Moraine, Ohio.

Constituents	**Units**	**EAST** **5/25/00**	**DUP-86** **5/25/00**	**GM-19S** **5/24/00**	**GM-32** **5/30/00**	**GM-22** **5/25/00**	**GM-21** **5/26/00**	**GM-8** **5/24/00**	**GM-6** **5/24/00**
Volatile Organic Compounds									
Acetone	ug/L	<20.0	<20.0	<20.0	<2,000	<20.0	<20.0	<20.0	<20.0
Benzene	ug/L	<1.0	<1.0	<1.0	<100	<1.0	<1.0	1.3	<1.0
2-Butanone	ug/L	R	R	R	R	R	R	20.5J	R
Chloroethane	ug/L	<5.0	<5.0	<5.0	<500	<5.0	<5.0	<5.0	5.1
Chloroform	ug/L	<1.0	<1.0	<1.0	<100	<1.0	<1.0	<1.0	<1.0
Dichlorodifluoromethane	ug/L	<1.0J	<1.0J	1.1	<100	<1.0	<1.0	1.9	5.4
1,1-Dichloroethane	ug/L	7.7	7.6	7.0	46.0J	2.8	6.8	45.9	39.1
1,1-Dichloroethene	ug/L	1.02J	<1.0	1.1	<100	<1.0	2.4	<1.0	<1.0
cis-1,2-Dichloroethene	ug/L	32.0	31.2	42.9	<100	4.0	47.8	29.8	234
trans-1,2-Dichloroethene	ug/L	1.5	1.4	2.7	41.0J	<1.0	7.4	7.1	8.1
Ethylbenzene	ug/L	<1.0	<1.0	<1.0	<100	<1.0	<1.0	29.0	<1.0
Tetrachloroethene	ug/L	54.6	54.5	57.1	<100	3.0	<1.0	1.3	40.7
Toluene	ug/L	<1.0	<1.0	<1.0	<100	<1.0	<1.0	<1.0	<1.0
1,1,1-Trichloroethane	ug/L	20.5	20.3	17.9	<100	<1.0	27.9	1.01	10.1
Trichloroethene	ug/L	81.3	79.8	104	<100	3.6	311	7.2	71.9
Trichlorofluoromethane	ug/L	<1.0	<1.0	<1.0	<100	<1.0	2.4	<1.0	<1.0
Vinyl chloride	ug/L	1.2	1.1	1.4	<100	<1.0	<1.0	31.4	23.5
Xylenes	ug/L	<1.0	<1.0	<1.0	<100	<1.0	<1.0	4.8	<1.0
Total VOCs	**ug/L**	**199.82**	**195.9**	**235.2**	**87**	**13.4**	**405.7**	**181.21**	**437.9**

ug/L - Micrograms per liter.
J - Estimated.
R - Rejected.
DUP-86 is a duplicate of EAST.

Table 4-20. Summary of 6-Month Groundwater Results from Select Upper Aquifer Monitoring Wells, General Motors Corporation, Moraine, Ohio.

Constituents	**Units**	**TW-2* 5/23/00**	**GM-2 5/23/00**	**GM-16 5/24/00**	**GM-17 5/24/00**	**GM-10 5/24/00**
Volatile Organic Compounds						
Acetone	ug/L	<20.0	<20.0	<20.0	<20.0	<20.0
Benzene	ug/L	1.2	<1.0	<1.0	<1.0	<1.0
2-Butanone	ug/L	R	R	R	R	R
Chloroethane	ug/L	7.8	<5.0	<5.0	<5.0	<5.0
Chloroform	ug/L	3.3	<1.0	<1.0	<1.0	<1.0
Dichlorodifluoromethane	ug/L	3.2	<1.0	<1.0	1.1	<1.0
1,1-Dichloroethane	ug/L	39.9	2.8	<1.0	17.0	1.4
1,1-Dichloroethene	ug/L	<1.0	<1.0	<1.0	<1.0	<1.0
cis-1,2-Dichloroethene	ug/L	150	28.3	<1.0	30.8	3.6
trans-1,2-Dichloroethene	ug/L	9.9	1.05	<1.0	2.3	<1.0
Ethylbenzene	ug/L	1.8	<1.0	<1.0	<1.0	<1.0
Tetrachloroethene	ug/L	26.0	7.2	21.8	37.9	1.2
Toluene	ug/L	<1.0	<1.0	<1.0	<1.0	<1.0
1,1,1-Trichloroethane	ug/L	6.5	6.5	2.9	15.7	2.4
Trichloroethene	ug/L	38.7	84.1	<1.0	82.0	22.4
Trichlorofluoromethane	ug/L	<1.0	<1.0	<1.0	<1.0	<1.0
Vinyl chloride	ug/L	31.2	<1.0	<1.0	<1.0	<1.0
Xylenes	ug/L	<1.0	<1.0	<1.0	<1.0	<1.0
Total VOCs	**ug/L**	**319.5**	**129.95**	**24.7**	**186.8**	**31**

ug/L - Micrograms per liter.

* TW-2 was sampled instead of 4S, because 4S was not accessible.

R - Rejected.

Table 4-21. Summary of 6-Month Groundwater Results from Reactive Zone 1 Wells, General Motors Corporation, Moraine, Ohio.

Constituents	**Units**	**RZ-1A 5/26/00**	**RZ-1G 5/26/00**
Volatile Organic Compounds			
2-Butanone	ug/L	6,070J	13,400J
cis-1,2-Dichloroethene	ug/L	688	161
trans-1,2-Dichloroethene	ug/L	5.0	<5.0
Ethylbenzene	ug/L	<5.0	2.0J
Tetrachloroethene	ug/L	45.4	17.5
Toluene	ug/L	2.1J	1.1J
Trichloroethene	ug/L	37.9	13.8
Vinyl chloride	ug/L	43.1	136
Total VOCs	**ug/L**	**6,891.5**	**13,731.4**

ug/L - Micrograms per liter.
J - Estimated.

Table 4-22. Summary of 6-Month Groundwater Results from Reactive Zone 3 Wells, General Motors Corporation, Moraine, Ohio.

Constituents	Units	RZ-3E 5/30/00	RZ-3L 5/30/00	RZ-3T 5/30/00	RZ-3Z 5/30/00	RZ-3FF 5/25/00	RZ-3KK 5/25/00	RZ-3PP 5/26/00
Volatile Organic Compounds								
Acetone	ug/L	<100	585	<100	<100	<100	67.7J	44.4J
Benzene	ug/L	<5.0	105	<5.0	<5.0	<5.0	<5.0	<5
2-Butanone	ug/L	2,980J	1,700J	1,690J	1,220J	1,640J	1,580J	1,830J
Chloroethane	ug/L	<25	29.8	<25	<25	<25	<25	<20
1,1-Dichloroethane	ug/L	27.1	638	4.9J	<5.0	<5.0	5.4	<5
1,2-Dichloroethane	ug/L	<5.0	15.8	<5.0	<5.0	<5.0	<5.0	<5
1,1-Dichloroethene	ug/L	<5.0	5.0	<5.0	<5.0	<5.0	<5.0	<5
cis-1,2-Dichloroethene	ug/L	144	566	139	99.3	91.5	148	40.8
trans-1,2-Dichloroethene	ug/L	2.7J	9.2	<5.0	<5.0	<5.0	<5.0	<5
Ethylbenzene	ug/L	2.4	308	<5.0	<5.0	79.3	<5.0	<5
Tetrachloroethene	ug/L	4.6J	<5.0	3.2J	<5.0	<5.0	<5.0	<5
Toluene	ug/L	2.2J	706	2.0J	2.2J	14.0	<5.0	<5
1,1,1-Trichloroethane	ug/L	<5.0	<5.0	1.2J	<5.0	<5.0	<5.0	<5
Trichloroethene	ug/L	4.7J	4.2J	5.0J	3.2J	1.4J	<5.0	<5
Trichlorofluoromethane	ug/L	<5.0	4.4J	<5.0	<5.0	<5.0	<5.0	<5
Vinyl chloride	ug/L	9.0	104	<5.0	8.6	3.8J	1.4J	<5
Xylenes	ug/L	39.7	1,190	1.8J	<5.0	467	<5.0	<5
Total VOCs	**ug/L**	**3,216.4**	**5,970.4**	**1,847.1**	**1,333.3**	**2,297**	**1,802.5**	**1,915.2**

ug/L - Micrograms per liter.
J - Estimated.

Table 4-23. Summary of 6-Month Groundwater Results from the Oxidation Wells, General Motors Corporation, Moraine, Ohio.

Constituents	Units	OW-1 5/31/00	OW-2 5/31/00	OW-3 6/1/00	OW-4 6/1/00	OW-5 6/1/00	OW-6 6/1/00
Volatile Organic Compounds							
Acetone	ug/L	194	<100	<200	<2000	<20.0	<200
Benzene	ug/L	1.6J	<5.0	<10	105	1.6	<10
Carbon disulfide	ug/L	2.2J	<5.0	<10	<100	<1.0	<10
Chloroform	ug/L	<6.8	<5.0	<10	<100	<1.0	<10
1,1-Dichloroethane	ug/L	<5.0	<5.0	<10	216	48.3	25.4
cis-1,2-Dichloroethene	ug/L	21.8	7.9	1,080	274	<1.0	2,150
trans-1,2-Dichloroethene	ug/L	<5.0	<5.0	<10	<100	<1.0	13.2
Ethylbenzene	ug/L	1.4J	<5.0	<10	151	262	<10
Tetrachloroethene	ug/L	37.2	56.3	153	45J	<1.0	5,220
Toluene	ug/L	<5.1	<5.0	<10	12,300	<21.0	<10
1,1,1-Trichloroethane	ug/L	<5.0	<5.0	<10	<100	<1.0	41.1
Trichloroethene	ug/L	11.8	4.8	92.3	<100	<1.0	3,460
Vinyl chloride	ug/L	<5.0	<5.0	97.8	654	<1.0	16.6
Xylenes	ug/L	<5.0	<5.0	<10	433	358	<10
Total VOCs	**ug/L**	**285.6**	**69**	**1,423.1**	**14,178**	**690.9**	**10,926.3**

ug/L - Micrograms per liter.
J - Estimated.

Table 4-24. 6-Month Bioattenuation Parameter Groundwater Results from Upper Aquifer Monitoring Wells, General Motors Corporation, Moraine, Ohio.

Constituents	Units	GM-30 5/31/00	GM-23 5/31/00	DUP-88 5/31/00	GM-27 5/31/00	GM-29 5/26/00	DUP-87 5/26/00	GM-28 5/26/00	HR-3 5/23/00
Inorganics & TOC									
Nitrate	mg/l	0	0	0	NA	0	0	0	0
Nitrite	mg/l	0	0	0	NA	0	0	0	0
Nitrogen, Ammonia	mg/l	<0.30	2.84	2.81	<0.30	<0.30	<0.30	0.68	<0.30
Manganese (Total)	mg/l	0.302	0.121	0.124	0.365	0.35	0.254	6.26	0.32
Manganese (Dissolved)	mg/l	0.047	0.101	0.093	0.171	0.177	0.172	6.71	0.327
Iron (Total)	mg/l	25.3	0.18	0.18	8.14	10.1	6.37	22.7	<0.10
Iron (Dissolved)	mg/l	10.2	<0.10	<0.10	<0.10	2.78	2.13	23.3	<0.10
Iron (Ferrous)	mg/l	3	0	0	NA	2.2	2.2	2.6	0
Sulfate	mg/l	<5	8,040	14,100	82	31	30	<5	57
Sulfide	mg/l	<1	<1	<1	<1	<1	<1	<1	<1
Total Organic Carbon	mg/l	15	19	21	7	22	22	742	6
Chloride	mg/l	76	85	92	105	508	513	805	88
Permanent Gases									
Carbon Dioxide	mg/l	96.93	323.79	316.66	80.26	44.05	45.01	16.51	63.25
Oxygen	mg/l	0.63	17.78	17.18	1.25	1.41	0.60	0.64	1.06
Nitrogen	mg/l	17.85	3.13	2.70	27.68	15.61	17.77	19.82	21.42
Methane	mg/l	5.91	0.02083	0.01707	0.004248	0.17	0.59	0.21	0.03308
Carbon Monoxide	mg/l	<0.40	<0.40	<0.40	<0.40	<0.40	<0.40	<0.40	<0.40
Light Hydrocarbon Scan									
Ethane	ng/l	699900	1,037	997	263	751	951	865	118
Ethene	ng/l	1829296	569	560	<5	12098	14135	646	16
Field Parameters									
pH	S.U.	6.75	6.31	6.31	6.87	6.86	6.86	7.01	7.11
Specific Conductivity	umhos/cm	1028	6720	6720	1134	2388	2388	4402	1096
Dissolved Oxygen	mg/l	0.53	10.48	10.48	0.60	0.45	0.45	2.52	1.03
Redox Potential	mV	-71.3	194.2	194.2	1.4	-105.4	-105.4	-93.7	137.8
Temperature	°C	16.83	26.45	26.45	17.21	17.97	17.97	19.24	17.00

mg/l - milligrams per liter.
ng/l - nanograms per liter.
S.U. - Standard Units.
mV - Millivolts.
°C - Degrees Celsius.
umhos/cm - Micromohs/centimeter.
NA - Not Analyzed.

Table 4-24. 6-Month Bioattenuation Parameter Groundwater Results from Upper Aquifer Monitoring Wells, General Motors Corporation, Moraine, Ohio.

Constituents	Units	HR-1 5/23/00	DUP-85 5/23/00	W-1-S 5/30/00	ME-6 5/25/00	ME-1 5/25/00	GM-31 5/31/00	ME-3 5/25/00	WEST 5/25/00
Inorganics & TOC									
Nitrate	mg/l	0	0	0.3	NA	NA	0	NA	0
Nitrite	mg/l	0	0	0	NA	NA	0	NA	0
Nitrogen, Ammonia	mg/l	0.64	<0.30	<0.30	23.4	27.8	<0.30	12.6	<0.30
Manganese (Total)	mg/l	<0.010	<0.010	0.453	1.44	1.06	0.899	0.421	0.029
Manganese (Dissolved)	mg/l	<0.010	<0.010	<0.010	1.34	1.1	0.189	0.417	<0.010
Iron (Total)	mg/l	<0.10	<0.10	0.25	46.3	34	34.9	11	0.37
Iron (Dissolved)	mg/l	<0.10	<0.10	<0.10	42.8	34.7	2.37	9.75	<0.10
Iron (Ferrous)	mg/l	0	0	0	NA	NA	1.6	NA	0
Sulfate	mg/l	82	86	84	34	16	131	34	155
Sulfide	mg/l	<1	<1	<1	1.11	1.52	1.06	1.32	<1
Total Organic Carbon	mg/l	6	4	2	374	219	12	69	3
Chloride	mg/l	110	114	205	302	324	259	235	164
Permanent Gases									
Carbon Dioxide	mg/l	47.24	46.34	29.58	156.4	247.8	38.89	85.52	61.09
Oxygen	mg/l	2.13	2.41	3.41	0.52	0.41	0.66	0.78	2.20
Nitrogen	mg/l	18.38	17.19	16.42	9.03	5.32	23.03	13.0	17.1
Methane	mg/l	0.000055	0.000053	0.003544	12.2	15.6	86.19000	9.68	0.002179
Carbon Monoxide	mg/l	<0.40	<0.40	<0.40	<0.40	<0.40	<0.40	<0.40	<0.40
Light Hydrocarbon Scan									
Ethane	ng/l	22	20	19	<5	<5	9895	138	57
Ethene	ng/l	<5	15	<5	3508	129	2439	96276	47
Field Parameters									
pH	S.U.	7.16	7.16	7.02	6.58	6.49	7.03	6.89	6.97
Specific Conductivity	umhos/cm	1157	1157	1515	3118	2580	1538	1752	1547
Dissolved Oxygen	mg/l	1.45	1.45	4.17	0.84	4.78	0.81	0.59	1.50
Redox Potential	mV	180.6	180.6	204.8	-133.8	-157.8	-73.7	-136.7	198.3
Temperature	°C	20.17	20.17	18.90	22.60	21.27	21.91	20.00	19.75

mg/l - milligrams per liter.

ng/l - nanograms per liter.

S.U. - Standard Units.

mV - Millivolts.

°C - Degrees Celsius.

umhos/cm - Micromohs/centimeter.

NA - Not Analyzed.

Table 4-24. 6-Month Bioattenuation Parameter Groundwater Results from Upper Aquifer Monitoring Wells, General Motors Corporation, Moraine, Ohio.

Constituents	Units	EAST 5/25/00	DUP-86 5/25/00	GM-19S 5/24/00	GM-32 5/30/00	GM-22 5/25/00	GM-21 5/26/00	GM-8 5/24/00	GM-6 5/24/00	TW-2* 5/23/00
Inorganics & TOC										
Nitrate	mg/l	0	0	0	NA	0	0	0	2.0	0
Nitrite	mg/l	0	0	0	NA	0	0	0	0	0
Nitrogen, Ammonia	mg/l	<0.30	<0.30	<0.30	19.3	<0.30	<0.30	1.04	<0.30	0.30
Manganese (Total)	mg/l	0.361	0.367	0.247	0.051	0.355	0.215	0.091	0.338	0.456
Manganese (Dissolved)	mg/l	0.116	0.115	0.200	0.048	0.328	0.212	0.098	0.373	0.481
Iron (Total)	mg/l	5.3	5.9	1.19	18.4	0.96	0.83	2.26	1.21	3.99
Iron (Dissolved)	mg/l	<0.10	<0.10	<0.10	17.1	<0.10	<0.10	2.51	1.25	3.65
Iron (Ferrous)	mg/l	0	0	0	NA	0	0	1.4	1.0	2.5
Sulfate	mg/l	117	116	131	<10	120	80	<5	28	9
Sulfide	mg/l	<1	<1	<1	<1	<1	<1	<1	<1	<1
Total Organic Carbon	mg/l	4	4	5	2020	4	2	34	15	10
Chloride	mg/l	194	194	168	740	279	126	216	238	250
Permanent Gases										
Carbon Dioxide	mg/l	52.02	50.78	50.12	24.32	40.20	18.70	13.90	34.46	33.10
Oxygen	mg/l	1.26	1.07	1.24	<0.15	1.28	1.89	0.93	0.69	0.75
Nitrogen	mg/l	19.1	17.4	17.13	2.40	21.3	23.64	19.70	20.38	19.24
Methane	mg/l	0.01158	0.003328	0.003325	14.91	0.18	0.01370	3.17	1.47	2.21
Carbon Monoxide	mg/l	<0.40	<0.40	<0.40	<0.40	<0.40	<0.40	<0.40	<0.40	<0.40
Light Hydrocarbon Scan										
Ethane	ng/l	118	60	139	1029	69	84	395	806	1590
Ethene	ng/l	57	50	43	472312	64	70	85907	42167	88313
Field Parameters										
pH	S.U.	7.00	7.00	7.00	7.64	7.08	7.06	8.05	7.45	7.56
Specific Conductivity	umhos/cm	1503	1503	1548	9195	1671	1048	1471	1377	1464
Dissolved Oxygen	mg/l	2.76	2.76	1.94	10.82	0.49	0.40	0.67	1.06	0.83
Redox Potential	mV	144.5	144.5	200.1	-213.6	26.1	167.1	NR	-96.2	-135.6
Temperature	°C	19.32	19.32	20.80	23.48	20.87	17.92	18.10	17.60	18.79

mg/l - milligrams per liter.

ng/l - nanograms per liter.

S.U. - Standard Units.

mV - Millivolts.

°C - Degrees Celsius.

umhos/cm - Micromohs/centimeter.

* TW-2 was sampled instead of 4S, because 4S was not accessible.

NA - Not Analyzed.

NR - Not recorded.

Table 4-24. 6-Month Bioattenuation Parameter Groundwater Results from Upper Aquifer Monitoring Wells, General Motors Corporation, Moraine, Ohio.

Constituents	Units	GM-2 5/23/00	GM-16 5/24/00	GM-17 5/24/00	GM-10 5/24/00
Inorganics & TOC					
Nitrate	mg/l	0	0	0	0
Nitrite	mg/l	0	0	0	0
Nitrogen, Ammonia	mg/l	<0.30	<0.30	<0.30	<0.30
Manganese (Total)	mg/l	0.049	<0.010	0.774	0.018
Manganese (Dissolved)	mg/l	<0.010	<0.010	0.395	0.011
Iron (Total)	mg/l	<0.10	<0.10	<0.10	<0.10
Iron (Dissolved)	mg/l	<0.10	<0.10	<0.10	<0.10
Iron (Ferrous)	mg/l	0	0	0	0
Sulfate	mg/l	56	102	108	61
Sulfide	mg/l	<1	<1	<1	<1
Total Organic Carbon	mg/l	4	5	6	5
Chloride	mg/l	227	210	216	266
Permanent Gases					
Carbon Dioxide	mg/l	52.63	31.40	38.12	42.73
Oxygen	mg/l	1.41	2.78	1.25	2.68
Nitrogen	mg/l	19.00	19.22	19.66	20.05
Methane	mg/l	0.000548	0.003576	0.02460	0.001792
Carbon Monoxide	mg/l	<0.40	<0.40	<0.40	<0.40
Light Hydrocarbon Scan					
Ethane	ng/l	21	9	257	36
Ethene	ng/l	66	81	326	65
Field Parameters					
pH	S.U.	7.14	7.35	7.11	7.02
Specific Conductivity	umhos/cm	1311	1282	1665	1758
Dissolved Oxygen	mg/l	1.37	1.22	0.49	1.03
Redox Potential	mV	132.3	-714.6	212.0	220.6
Temperature	°C	17.76	17.76	19.04	17.25

mg/l - milligrams per liter.
ng/l - nanograms per liter.
S.U. - Standard Units.
mV - Millivolts.
°C - Degrees Celsius.
umhos/cm - Micromohs/centimeter.
NR - Not Recorded.

Table 4-25. 6-Month Bioattenuation Parameter Groundwater Results from Reactive Zone 1, General Motors Corporation, Moraine, Ohio.

Constituents	Units	RZ-1A 5/26/00	RZ-1G 5/26/00
Inorganics & TOC			
Nitrate	mg/l	NA	NA
Nitrite	mg/l	NA	NA
Nitrogen, Ammonia	mg/l	37.9	26.1
Manganese (Total)	mg/l	9.78	15.0
Manganese (Dissolved)	mg/l	10.7	14.9
Iron (Total)	mg/l	374	332
Iron (Dissolved)	mg/l	417	311
Iron (Ferrous)	mg/l	NA	NA
Sulfate	mg/l	140	55
Sulfide	mg/l	5.18	2.33
Total Organic Carbon	mg/l	5550	3560
Chloride	mg/l	1080	702
Permanent Gases			
Carbon Dioxide	mg/l	918.87	643.31
Oxygen	mg/l	0.17	<0.15
Nitrogen	mg/l	6.19	4.33
Methane	mg/l	0.88	2.59
Carbon Monoxide	mg/l	<0.40	<0.40
Light Hydrocarbon Scan			
Ethane	ng/l	770	123
Ethene	ng/l	11737	325
Field Parameters			
pH	S.U.	5.48	5.55
Specific Conductivity	umhos/cm	11895	7990
Dissolved Oxygen	mg/l	4.32	6.45
Redox Potential	mV	-65.4	-68.1
Temperature	°C	21.74	20.50

mg/l - milligrams per liter.
ng/l - nanograms per liter.
S.U. - Standard Units.

mV - Millivolts.
°C - Degrees Celsius.
umhos/cm - Micromohs/centimeter.

NA - Not Analyzed.

Table 4-26. 6-Month Bioattenuation Parameter Groundwater Results from Reactive Zone 3, General Motors Corporation, Moraine, Ohio.

Constituents	Units	RZ-3E 5/30/00	RZ-3L 5/30/00	RZ-3T 5/30/00	RZ-3Z 5/30/00	RZ-3FF 5/25/00	RZ-3KK 5/25/00	RZ-3PP 5/26/00
Inorganics & TOC								
Nitrate	mg/l	NA	NA	NA	NA	NA	0	NA
Nitrite	mg/l	NA	NA	NA	NA	NA	0	NA
Nitrogen, Ammonia	mg/l	31.3	24.2	19.9	3.23	20.6	88.8	15.2
Manganese (Total)	mg/l	5.5	0.604	4.75	2.65	2.25	1.89	1.62
Manganese (Dissolved)	mg/l	6.46	0.528	4.91	2.82	2.23	2.09	1.76
Iron (Total)	mg/l	234	3.05	83.5	120	134	125	85.7
Iron (Dissolved)	mg/l	275	2.0	87.4	128	133	140	93
Iron (Ferrous)	mg/l	NA	NA	NA	NA	NA	0	NA
Sulfate	mg/l	<10	<10	127	<20	<10	66	<10
Sulfide	mg/l	<1	<1	1.11	1.72	<1	2.74	2.33
Total Organic Carbon	mg/l	1610	1430	2410	1490	814	505	394
Chloride	mg/l	286	221	470	362	335	270	302
Permanent Gases								
Carbon Dioxide	mg/l	475.70	1.89	546.58	450.25	489.4	340.2	264.33
Oxygen	mg/l	0.35	0.20	0.26	<0.15	0.47	<0.15	0.18
Nitrogen	mg/l	11.67	8.35	7.85	2.29	4.69	2.40	4.80
Methane	mg/l	4.09	11.13	3.25	12.81	13.4	19.4	14.52
Carbon Monoxide	mg/l	<0.40	<0.40	<0.40	<0.40	<0.40	<0.40	<0.40
Light Hydrocarbon Scan								
Ethane	ng/l	887	2327	162	33	<5	<5	<5
Ethene	ng/l	13452	137794	1643	3120	8562	387	<5
Field Parameters								
pH	S.U.	5.98	8.98	5.82	6.05	6.07	6.33	6.27
Specific Conductivity	umhos/cm	4477	8714	4793	4369	3430	3219	2613
Dissolved Oxygen	mg/l	0.58	1.59	4.17	10.64	1.21	2.42	1.03
Redox Potential	mV	-94.4	-110.3	-54.2	-109.8	-121.6	-61.9	-58.8
Temperature	°C	20.47	20.05	18.32	19.92	19.22	18.54	19.43

mg/l - milligrams per liter.

ng/l - nanograms per liter.

S.U. - Standard Units.

mV - Millivolts.

°C - Degrees Celsius.

umhos/cm - Micromohs/centimeter.

NA - Not Analyzed.

Table 4-27. 6-Month Bioattenuation Parameter Groundwater Results from the Oxidation Wells, General Motors Corporation, Moraine, Ohio.

Constituents	Units	OW-1 5/31/00	OW-2 5/31/00	OW-3 6/1/00	OW-4 6/1/00	OW-5 6/1/00	OW-6 6/1/00
Inorganics & TOC							
Nitrate	mg/l	NA	NA	0	0	0	NA
Nitrite	mg/l	NA	NA	0	0	0	NA
Nitrogen, Ammonia	mg/l	<0.30	4.04	4.08	0.90	6.30	0.39
Manganese (Total)	mg/l	44.9	5.66	5.24	0.316	9.0	0.834
Manganese (Dissolved)	mg/l	43	5.55	4.32	0.218	0.137	0.381
Iron (Total)	mg/l	1,240	30.4	45.2	20.6	478	18.1
Iron (Dissolved)	mg/l	1,180	1.05	<0.20	<0.10	0.36	<0.10
Iron (Ferrous)	mg/l	NA	NA	0	1.1	NA	NA
Sulfate	mg/l	16,300	10,000	12,800	5	<10	28
Sulfide	mg/l	<1	<1	1.11	<1	2.33	<1
Total Organic Carbon	mg/l	23	16	28	26	155	12
Chloride	mg/l	270	71	82	301	124	53
Permanent Gases							
Carbon Dioxide	mg/l	968.13	340.72	354.64	81.50	82.96	97.43
Oxygen	mg/l	1.99	6.52	11.69	0.62	0.58	0.70
Nitrogen	mg/l	3.35	4.91	4.50	16.25	19.86	21.23
Methane	mg/l	0.006488	0.006579	0.03464	1.06	0.4319	0.004285
Carbon Monoxide	mg/l	<0.40	<0.40	<0.40	<0.40	<0.40	<0.40
Light Hydrocarbon Scan							
Ethane	ng/l	1473	1241	973	141104	744	768
Ethene	ng/l	2329	285	11089	11411690	2165024	27334
Field Parameters							
pH	S.U.	2.41	6.46	6.45	6.67	6.96	6.97
Specific Conductivity	umhos/cm	14386	10991	9071	1516	1013	934
Dissolved Oxygen	mg/l	9.89	13.03	33.41	10.62	10.11	9.20
Redox Potential	mV	498.7	133.7	237.5	-66.9	-64.7	-14.8
Temperature	°C	25.31	27.89	25.57	16.10	16.17	16.43

mg/l - milligrams per liter.
ng/l - nanograms per liter.
S.U. - Standard Units.

mV - Millivolts.
°C - Degrees Celsius.
umhos/cm - Micromohs/centimeter.

NA - Not Analyzed.

Table 4-30. Hydrophobic Dye Test Results, General Motors Corporation, Moraine, Ohio.

Boring	Depth Interval (ft bls)	Date	Appearance of Soil After Test	NAPL Presence/Absence
OW-1	31 to 32	8/23/99	Separation of soil grain sizes. Heavy sheen with red particals on top of water.	Possible presence
OW-2	34-35	8/23/99	Separation of soil grain sizes. Heavy sheen and red line on top of water. Odor noted.	Possible presence
OW-3	31-32	8/30/99	Separation of soil grain sizes. Slight sheen with some red specs.	Possible presence
OW-4	36-37	8/31/99	Separation of soil grain sizes. No visible sheen. Few red particles on top of water observed. Sample appeared clean otherwise.	No evidence
OW-5	35-36	8/30/99	Separation of soil grain sizes. Sheen with red specs on top of water observed.	Possible presence
OW-6	37-38.5	8/30/99	Separation of soil grain sizes. No visible sheen. Few red specs observed on top of water. Sample appeared clean otherwise.	No evidence
GM-29	36-38	8/25/99	Separation of soil grain sizes. No red lines, specs, or sheen observed.	No evidence
GM-30	30-32	8/25/99	Separaion of soil grain sizes. Heavy sheen and red line on top of water. Odor noted. No free product apparent.	Possible presence
GM-30	36-38	8/25/99	Separaion of soil grain sizes. Heavy sheen and red line on top of water. Odor noted. No free product apparent.	Possible presence
GM-31	58-60	8/26/99	Separation of soil grain sizes. No red lines, specs, or sheen observed.	No evidence
GM-32	58-60	8/31/99	Separation of soil grain sizes. Very slight sheen. No red particles observed.	No evidence
RZ-1A	32-39	9/1/99	Separation of soil grain sizes. Slight sheen with few red specs.	Possible presence
RZ-1B	31-32	9/3/99	Separation of soil grain sizes. No sheen, red specs, or lines visible.	No evidence
RZ-1C	31-33	9/1/99	Separation of soil grain sizes. Slight sheen with a few red specs visible.	Possible presence
RZ-1D	27-28.5	9/2/99	Separation of soil grain sizes. No sheen, red specs, or lines visible.	No evidence
RZ-1E	24-25.8	9/9/99	Separation of soil grain sizes. No sheen, red specs, or lines visible.	No evidence
RZ-1F	24-25.5	9/7/99	Separation of soil grain sizes. No sheen, red specs, or lines visible.	No evidence
RZ-1G	26-26.5	9/8/99	Separation of soil grain sizes. No sheen, red specs, or lines visible.	No evidence
RZ-1H	27-28	9/2/99	Separation of soil grain sizes. No sheen, red specs, or lines visible.	No evidence
RZ-1I	26-26.25	9/7/99	Separation of soil grain sizes. No sheen, red specs, or lines visible.	No evidence

ft - feet
bls - below land surface.
NAPL - nonaqueous phase liquid

Table 4-31. Bioattenuation Parameter Results for Groundwater Samples Collected in Reactive Zone 1, General Motors Corporation, Moraine, Ohio.

Constituents	Units	Upgradient Well GM-29				Introduction Well RZ-1A			Introduction Well RZ-1G			Downgradient Well GM-28			
		9/1/99	2/22/00	5/26/00	9/21/00	9/29/99	2/22/00	5/26/00	9/29/99	2/22/00	5/26/00	9/1/99	2/23/00	5/26/00	9/21/00
Inorganics & TOC															
Nitrate	mg/l	0	0	0	NA	0	NA	NA	0	NA	NA	0.08	0	0	NA
Nitrite	mg/l	0	0	0	NA	0	NA	NA	0	NA	NA	0.06	0	0	NA
Nitrogen, Ammonia	mg/l	<0.30	<0.30	<0.30	NA	<0.30	39.0	37.9	<0.30	28.1	26.1	<0.30	<0.30	0.68	NA
Manganese (Total)	mg/l	0.552	0.136	0.35	0.248	0.422	18.7	9.78	0.227	23	15.0	3.2	1.15	6.26	4.1
Manganese (Dissolved)	mg/l	0.13	0.101	0.177	0.125	0.203	13.2	10.7	0.198	19.9	14.9	0.068	0.449	6.71	3.94
Iron (Total)	mg/l	18	1.43	10.1	8.48	6.78	566	374	<0.10	276	332	106	25.3	22.7	58.9
Iron (Dissolved)	mg/l	0.24	0.13	2.78	3.09	<0.10	366	417	<0.10	234	311	<0.10	0.59	23.3	48.3
Iron (Ferrous)	mg/l	0.02	0	2.2	NA	0	NA	NA	0	NA	NA	0	0.03	2.6	NA
Sulfate	mg/l	90	126	31	29	61	508	140	65	199	55	89	43	<5	<5
Sulfide	mg/l	<4	<1	<1	<1	<1	<10	5.18	<1	<10	2.33	<4	<1	<1	<1
Total Organic Carbon	mg/l	18	11	22	<1	6	14,100	5550	12	7,640	3560	15	24	742	571
Chloride	mg/l	254	426	508	373	397	1,560	1080	483	2,540	702	208	664	805	782
Permanent Gases															
Carbon Dioxide	mg/l	46.52	49.87	44.05	NA	16.96	999.4	918.87	42.51	1096	643.31	41.52	63.57	16.51	NA
Oxygen	mg/l	1.02	0.66	1.41	NA	8.23	0.20	0.17	5.03	0.26	<0.15	2.32	0.59	0.64	NA
Nitrogen	mg/l	20.29	18.7	15.61	NA	14.51	7.13	6.19	13.85	5.82	4.33	19.42	16.39	19.82	NA
Methane	mg/l	0.01152	0.007699	0.00017	1.62	0.004308	0.02551	0.88	0.001898	0.02337	2.59	0.002487	0.001832	0.21	1.70
Carbon Monoxide	mg/l	<0.40	<0.40	<0.40	NA	NA	<0.40	<0.40	NA	<0.40	<0.40	<0.40	<0.40	<0.40	NA
Light Hydrocarbon Scan															
Ethane	ng/l	5641	1861	751	639	1218	1495	770	967	142	123	750	493	865	1198
Ethene	ng/l	9769	1275	12098	441796	2458	1980	11737	1783	674	325	48	98	646	1794606
Field Parameters															
pH	S.U.	6.99	7.02	6.86	7.24	7.24	5.76	5.48	6.78	5.45	5.55	7.02	6.92	7.01	7.18
Specific Conductivity	umhos/cm	1502	3044	2388	1942	2033	28360	11895	3191	21151	7990	1359	3124	4402	4538
Dissolved Oxygen	mg/l	0.35	0.51	0.45	3.44	0.82	2.84	4.32	0.12	3.64	6.45	0.95	1.45	2.52	6.78
Redox Potential	mV	-526.6	19.6	-105.4	-35.0	175	-118.4	-65.4	164.9	-18.5	-68.1	90.5	56.0	-93.7	-200.1
Temperature	°C	17.8	16.9	17.97	17.64	18.33	20.24	21.74	18.09	19.96	20.50	16.4	18.48	19.24	20.21

mg/l - milligrams per liter.
mV - Millivolts.
NA - Data not available, insufficient sample volume.
S.U. - Standard Units.
°C - Degrees Celsius.
umhos/cm - Micromohs/centimeter.
ng/l - nanograms per liter.

Samples collected in September 1999 represent baseline conditions.
Samples collected in February 2000 represent conditions after three months of carbon source introductions.
Samples collected in May 2000 represent conditions after six months of carbon source introductions.
Samples collected in September 2000 represent first annual conditions.

Table 4-32. Bioattenuation Parameter Results for Groundwater Samples Collected in Reactive Zone 2, General Motors Corporation, Moraine, Ohio.

		Introduction Well ME-6				Introduction Well ME-1			Introduction Well ME-3				Below Introduction Zone GM-31			
Constituents	**Units**	**8/31/99**	**2/22/00**	**5/25/00**	**9/21/00**	**8/31/99**	**2/22/00**	**5/25/00**	**8/31/99**	**2/22/00**	**5/25/00**	**9/21/00**	**9/1/99**	**2/23/00**	**5/31/00**	**9/21/00**
Inorganics & TOC																
Nitrate	mg/l	0.08	NA	NA	NA	13.2	NA	NA	22	NA	NA	NA	0	0	0	NA
Nitrite	mg/l	0.06	NA	NA	NA	0.333	NA	NA	0.1665	NA	NA	NA	0	0	0	NA
Nitrogen, Ammonia	mg/l	<0.30	10.9	23.4	NA	0.62	3.70	27.8	<0.30	3.10	12.6	NA	0.41	<0.3	<0.30	NA
Manganese (Total)	mg/l	0.502	4.19	1.44	0.46	0.5	2.40	2.23	0.016	0.870	1.16	0.556	7.45	0.53	0.899	0.605
Manganese (Dissolved)	mg/l	<0.010	3.60	1.34	0.456	0.493	1.93	1.06	<0.010	0.702	0.436	0.543	0.293	0.208	0.189	0.163
Iron (Total)	mg/l	8.17	67.1	46.3	6.4	<0.10	96.6	134	<0.10	20.5	38.2	4.9	288	17.4	34.9	18.7
Iron (Dissolved)	mg/l	<0.10	46.5	42.8	6.66	<0.10	63.4	20.4	<0.10	15.3	10.3	4.45	0.27	1.87	2.37	2.51
Iron (Ferrous)	mg/l	0.02	NA	NA	NA	0	NA	NA	0	NA	NA	NA	0	1.6	1.6	NA
Sulfate	mg/l	139	111	34	91	143	41	16	152	60	34	87	118	105	131	105
Sulfide	mg/l	<2	2.00	1.11	1.58	<1	<1	1.52	<1	1.39	1.32	<1	<4	<1	1.06	<1
Total Organic Carbon	mg/l	9	1,560	374	35	2	985	219	1	162	69	4	176	4	12	<1
Chloride	mg/l	182	350	302	196	177	467	324	336	208	235	184	240	249	259	221
Permanent Gases																
Carbon Dioxide	mg/l	51.08	173.39	156.4	NA	49.95	350.8	247.8	57.26	183.76	85.52	NA	32.12	49.58	38.89	NA
Oxygen	mg/l	0.84	0.45	0.52	NA	1.27	0.40	0.41	1.72	0.47	0.78	NA	0.60	0.61	0.66	NA
Nitrogen	mg/l	18.57	12.44	9.03	NA	19.14	10.6	5.32	16.44	13.39	13.0	NA	16.05	19.79	23.03	NA
Methane	mg/l	0.002063	0.56	12.2	0.33	0.000627	1.11	15.6	0.000129	0.01088	9.68	0.001226	0.0124	0.03339	0.08616	0.04758
Carbon Monoxide	mg/l	<0.40	<0.40	<0.40	NA	<0.40	<0.40	<0.40	<0.40	<0.40	<0.40	NA	<0.40	<0.40	<0.40	NA
Light Hydrocarbon Scan																
Ethane	ng/l	134	97	<5	134	32	164	<5	10	73	138	47	2472	4550	9895	2507
Ethene	ng/l	134	164	3508	3316	40	293	129	<5	109	96276	218	2295	1283	2439	413
Field Parameters																
pH	S.U.	7.02	6.64	6.58	7.00	7.03	6.19	6.49	6.96	6.75	6.89	7.15	7.25	7.19	7.03	7.30
Specific Conductivity	umhos/cm	1424	4645	3118	1864	1385	5030	2580	1889	2305	1752	1509	1514	1786	1538	1580
Dissolved Oxygen	mg/l	0.66	7.12	0.84	1.19	0.52	7.00	4.78	2.01	4.06	0.59	1.11	1.61	0.39	0.81	1.71
Redox Potential	mV	109.1	-85.8	-133.8	-200.6	108.4	-81.7	-157.8	80.9	-96.8	-136.7	-193.2	-328.2	-61.9	-73.7	-188.5
Temperature	°C	27.51	18.59	22.60	18.98	25.46	19.25	21.27	22.86	19.28	20.00	21.09	28.93	20.75	21.91	21.11

mg/l - milligrams per liter.
mV - Millivolts.
S.U. - Standard Units.
°C - Degrees Celsius.
NA - Data not available, insufficient sample volume.
umhos/cm - Micromohs/centimeter.
ng/l - nanograms per liter.

Samples collected in August and September 1999 represent baseline conditions.
Samples collected in February 2000 represent conditions after three months of carbon source introductions.
Samples collected in May 2000 represent conditions after six months of carbon source introductions.
Samples collected in September 2000 represent first annual conditions.

Table 4-33. Bioattenuation Parameter Results for Groundwater Samples Collected in Reactive Zone 3 West, General Motors Corporation, Moraine, Ohio.

RZ-3 West		**Upgradient Well EAST**				**Upgradient Well WEST**			**Upgradient Well GM-19S**				**Introduction Well RZ-3E**			**Introduction Well RZ-3L**		
Constituents	**Units**	**9/21/99**	**2/23/00**	**5/25/00**	**9/22/00**	**9/21/99**	**2/23/00**	**5/25/00**	**9/20/99**	**2/23/00**	**5/24/00**	**9/22/00**	**9/30/99**	**2/28/00**	**5/30/00**	**9/30/99**	**2/28/00**	**5/30/00**
Inorganics & TOC																		
Nitrate	mg/l	0	0	0	NA	0	0	0	11	0	0	NA	NA	NA	NA	NA	NA	NA
Nitrite	mg/l	0	0	0	NA	17.6	0	0	0	0	0	NA	NA	NA	NA	NA	NA	NA
Nitrogen, Ammonia	mg/l	<0.30	<0.30	<0.30	NA	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	NA	<0.30	0.88	31.3	2.22	2.00	24.2
Manganese (Total)	mg/l	0.627	0.474	0.361	0.227	0.391	0.038	0.029	0.726	1.09	0.247	0.238	2.4	18.9	5.5	0.333	0.939	0.604
Manganese (Dissolved)	mg/l	0.098	0.157	0.116	0.136	0.383	<0.010	<0.010	0.185	0.205	0.200	0.187	0.942	16.8	6.46	0.25	0.861	0.528
Iron (Total)	mg/l	4.82	5.55	5.3	2.26	0.27	0.40	0.37	16.9	39.4	1.19	0.40	32.4	199	234	4.9	26.1	3.05
Iron (Dissolved)	mg/l	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	179	275	0.23	23.4	2.0
Iron (Ferrous)	mg/l	0	0	0	NA	0	0	0	0	0	0	NA	NA	NA	NA	NA	NA	NA
Sulfate	mg/l	75	130	117	96	73	129	155	127	131	131	118	83	114	<10	46	<10	<10
Sulfide	mg/l	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<4	<10	<1	<1	<10	<1
Total Organic Carbon	mg/l	3	10	4	<1	2	7	3	2	7	5	<1	8	2670	1610	55	1040	1430
Chloride	mg/l	283	254	194	196	260	166	164	247	197	168	165	262	695	286	262	249	221
Permanent Gases																		
Carbon Dioxide	mg/l	34.69	58.08	52.02	NA	50.41	67.57	61.09	41.85	57.12	50.12	NA	22.61	10.62	475.70	0.83	545.7	1.89
Oxygen	mg/l	1.88	0.97	1.26	NA	1.30	1.50	2.20	4.43	1.01	1.24	NA	7.23	0.51	0.35	0.61	0.67	0.20
Nitrogen	mg/l	17.88	17.50	19.1	NA	13.24	13.74	17.1	20.87	17.07	17.13	NA	15.83	12.20	11.67	15.35	12.70	8.35
Methane	mg/l	0.000571	0.003269	0.01158	1.08	0.001409	0.000217	0.002179	0.009863	0.002712	0.003325	0.003706	0.009056	8.92	4.09	1.29	0.03261	11.13
Carbon Monoxide	mg/l	<0.40	<0.40	<0.40	NA	<0.40	<0.40	<0.40	<0.40	<0.40	<0.40	NA	NA	<0.40	<0.40	NA	<0.40	<0.40
Light Hydrocarbon Scan																		
Ethane	ng/l	32	39	118	126	37	33	57	71	104	139	184	1975	11704	887	2797	208	2327
Ethene	ng/l	18	107	57	73	100	17	47	55	45	43	36	2225	175096	13452	27685	529	137794
Field Parameters																		
pH	S.U.	6.99	7.04	7.00	7.11	6.89	6.97	6.97	7.05	7.05	7.00	7.19	7.16	5.76	5.98	9.45	8.76	8.98
Specific Conductivity	umhos/cm	1777	1955	1503	1133	1759	1640	1547	1500	1784	1548	1235	1503	8926	4477	2902	8372	8714
Dissolved Oxygen	mg/l	0.30	0.37	2.76	1.68	0.41	1.73	1.50	0.92	0.30	1.94	1.36	0.06	1.65	0.58	0.30	0.21	1.59
Redox Potential	mV	14.9	122.9	144.5	143.7	106.2	139.1	198.3	31.3	149.6	200.1	187.7	144.8	-36.2	-94.4	-27.6	-352.0	-110.3
Temperature	°C	21.21	19.38	19.32	20.30	21.44	19.90	19.75	20.85	18.69	20.80	20.09	18.20	19.70	20.47	18.75	19.33	20.05

mg/l - milligrams per liter.
mV - Millivolts.
S.U. - Standard Units.
°C - Degrees Celsius.
NA - Data not available, insufficient sample volume.
umhos/cm - Micromohs/centimeter.
ng/l - nanograms per liter.

Samples collected in September 1999 represent baseline conditions.
Samples collected in February 2000 represent conditions after three months of carbon source introductions.
Samples collected in May 2000 represent conditions after six months of carbon source introductions.
Samples collected in September 2000 represent first annual conditions.

Table 4-33. Bioattenuation Parameter Results for Groundwater Samples Collected in Reactive Zone 3 West, General Motors Corporation, Moraine, Ohio.

RZ-3 West, continued		**Introduction Well RZ-3T**			**Introduction Well RZ-3Z**			**Downgradient Well GM-32**			
Constituents	**Units**	**9/30/99**	**2/28/00**	**5/30/00**	**9/29/99**	**2/28/00**	**5/30/00**	**9/22/99**	**2/28/00**	**5/30/00**	**9/25/00**
Inorganics & TOC											
Nitrate	mg/l	NA	NA	NA	0	NA	NA	0	0	NA	NA
Nitrite	mg/l	NA	NA	NA	0	NA	NA	0	0	NA	NA
Nitrogen, Ammonia	mg/l	<0.30	2.48	19.9	<0.30	1.20	3.23	2.29	2.00	19.3	NA
Manganese (Total)	mg/l	1.54	15	4.75	1.04	1.49	2.65	0.147	0.516	0.051	0.30
Manganese (Dissolved)	mg/l	0.799	13.2	4.91	0.276	1.24	2.82	0.052	0.061	0.048	0.31
Iron (Total)	mg/l	10.2	282	83.5	33.1	76.8	120	8.14	42.4	18.4	81.0
Iron (Dissolved)	mg/l	0.14	220	87.4	0.18	22.4	128	3.53	0.59	17.1	81.6
Iron (Ferrous)	mg/l	NA	NA	NA	0	NA	NA	1.8	2.2	NA	NA
Sulfate	mg/l	73	76	127	55	<10	<20	30	<5	<10	<10
Sulfide	mg/l	<1	<10	1.11	<4	<10	1.72	<1	<10	<1	<1
Total Organic Carbon	mg/l	5	3050	2410	8	434	1490	68	1200	2020	2720
Chloride	mg/l	231	405	470	231	311	362	317	638	740	740
Permanent Gases											
Carbon Dioxide	mg/l	13.98	238.3	546.58	19.08	10.33	450.25	39.79	8.94	24.32	NA
Oxygen	mg/l	8.17	0.63	0.26	7.90	0.38	<0.15	1.67	0.85	<0.15	NA
Nitrogen	mg/l	13.90	18.34	7.85	14.45	7.88	2.29	14.93	15.23	2.40	NA
Methane	mg/l	0.002506	0.1037	3.25	0.000424	22.30	12.81	2.73	7.06	14.91	16.84
Carbon Monoxide	mg/l	NA	<0.40	<0.40	NA	<0.40	<0.40	<0.40	<0.40	<0.40	NA
Light Hydrocarbon Scan											
Ethane	ng/l	674	118	162	64	553	33	1649	9965	1029	189
Ethene	ng/l	1373	270	1643	46	1072138	3120	86509	163855	472312	510593
Field Parameters											
pH	S.U.	7.36	6.15	5.82	7.09	6.41	6.05	7.54	8.59	7.64	7.73
Specific Conductivity	umhos/cm	1445	10043	4793	1400	3513	4369	2750	9030	9195	9225
Dissolved Oxygen	mg/l	0.09	1.27	4.17	4.30	0.89	10.64	0.09	0.23	10.82	2.55
Redox Potential	mV	-109.2	-103.2	-54.2	271.0	-99.0	-109.8	-226.4	-279.1	-213.6	-353.8
Temperature	°C	18.04	19.24	18.32	17.51	18.96	19.92	19.27	19.72	23.48	19.27

mg/l - milligrams per liter.
mV - Millivolts.
NA - Data not available, insufficient sample volume.
S.U. - Standard Units.
°C - Degrees Celsius.
umhos/cm - Micromohs/centimeter.
ng/l - nanograms per liter.

Samples collected in September and October 1999 represent baseline conditions.
Samples collected in February 2000 represent conditions after three months of carbon source introductions.
Samples collected in May 2000 represent conditions after six months of carbon source introductions.
Samples collected in September 2000 represent first annual conditions.

Table 4-34. Bioattenuation Parameter Results for Groundwater Samples Collected in Reactive Zone 3 East, General Motors Corporation, Moraine, Ohio.

RZ-3 East		**Upgradient Well GM-22**				**Introduction Well RZ-3FF**			**Introduction Well RZ-3KK**			**Introduction Well RZ-3PP**			**Downgradient Well GM-21**			
Constituents	**Units**	**9/1/99**	**2/23/00**	**5/25/00**	**9/21/00**	**10/7/99**	**2/24/00**	**5/25/00**	**10/7/99**	**2/24/00**	**5/25/00**	**10/8/99**	**2/24/00**	**5/26/00**	**9/22/99**	**2/23/00**	**5/26/00**	**9/22/00**
Inorganics & TOC																		
Nitrate	mg/l	0	0	0	NA	0	0	NA	13.2	0	0	0	0	NA	0	0	0	NA
Nitrite	mg/l	0	0	0	NA	0	0	NA	0	0	0	0	0	NA	0	0	0	NA
Nitrogen, Ammonia	mg/l	<0.30	<0.30	<0.30	NA	<0.30	4.50	20.6	<0.30	6.00	88.8	<0.30	36.4	15.2	<0.30	<0.3	<0.30	NA
Manganese (Total)	mg/l	0.089	0.273	0.355	0.422	0.991	1.26	2.25	0.622	2.45	1.89	0.93	1.64	1.62	0.321	0.233	0.215	0.336
Manganese (Dissolved)	mg/l	0.096	0.263	0.328	0.403	0.579	1.27	2.23	0.176	2.18	2.09	0.222	1.63	1.76	0.273	0.225	0.212	0.312
Iron (Total)	mg/l	<0.10	0.16	0.96	0.94	21.3	65.5	134	19.6	158	125	29.3	61.5	85.7	2.58	0.30	0.83	0.63
Iron (Dissolved)	mg/l	<0.10	<0.10	<0.10	<0.10	0.1	67.2	133	<0.10	150	140	0.41	62	93	<0.10	<0.10	<0.10	<0.10
Iron (Ferrous)	mg/l	0.6	0	0	NA	0	0	NA	0	0	0	0	0	NA	0.4	0	0	NA
Sulfate	mg/l	49	125	120	117	45	23	<10	38	<20	66	40	5	<10	103	102	80	102
Sulfide	mg/l	<1	<1	<1	<1	<1	<1	<1	<1	1.1	2.74	<1	<1	2.33	<1	<1	<1	<1
Total Organic Carbon	mg/l	6	4	4	<1	4	514.0	814	3	1050	505	4	394	394	1	3	2	<1
Chloride	mg/l	246	270	279	248	203	296	335	229	353	270	184	260	302	136	145	126	129
Permanent Gases																		
Carbon Dioxide	mg/l	40.15	43.99	40.20	NA	34.37	252.34	489.4	29.45	305.57	340.2	23.06	156.80	264.33	37.04	37.40	18.70	NA
Oxygen	mg/l	1.05	0.86	1.28	NA	0.62	0.22	0.47	1.38	0.24	<0.15	2.06	0.31	0.18	1.41	0.99	1.89	NA
Nitrogen	mg/l	23.38	19.43	21.3	NA	20.34	15.68	4.69	13.31	14.65	2.40	10.25	17.95	4.80	23.40	21.67	23.64	NA
Methane	mg/l	0.05818	0.23	0.18	0.000967	0.014674	0.01111	13.4	0.010751	0.3552	19.4	0.024394	0.2308	14.52	0.03744	0.01769	0.01370	0.04218
Carbon Monoxide	mg/l	<0.40	<0.40	<0.40	NA	<0.40	<0.40	<0.40	<0.40	<0.40	<0.40	<0.40	<0.40	<0.40	<0.40	<0.40	<0.40	NA
Light Hydrocarbon Scan																		
Ethane	ng/l	42	91	69	29	2546	148	<5	3584	154	<5	7341	54	<5	72	67	84	72
Ethene	ng/l	67	32	64	111	6250	785	8562	1175	255	387	1834	126	<5	169	38	70	69
Field Parameters																		
pH	S.U.	7.12	7.15	7.08	7.17	7.22	6.24	6.07	7.24	6.09	6.33	7.35	6.48	6.27	6.99	7.22	7.06	7.21
Specific Conductivity	umhos/cm	1373	1975	1671	1684	1345	3576	3430	1352	6396	3219	1251	3161	2613	1188	1299	1048	1096
Dissolved Oxygen	mg/l	0.32	0.46	0.49	1.73	0.32	1.11	1.21	1.23	1.43	2.42	0.12	0.79	1.03	0.66	0.60	0.40	0.99
Redox Potential	mV	62.2	70.2	26.1	-80.8	116.1	-84.7	-121.6	-61.6	-108.6	-61.9	-105.5	-131.3	-58.8	-26.9	113.3	167.1	153.9
Temperature	°C	19.41	18.87	20.87	22.28	17.88	18.80	19.22	17.93	19.85	18.54	18.07	18.72	19.43	20.43	18.43	17.92	19.03

mg/l - milligrams per liter.
mV - Millivolts.
S.U. - Standard Units.
°C - Degrees Celsius.
Samples collected in September and October 1999 represent baseline conditions.
Samples collected in February 2000 represent conditions after three months of carbon source introductions.
Samples collected in May 2000 represent conditions after six months of carbon source introductions.
Samples collected in September 2000 represent first annual conditions.

NA - Data not available, insufficient sample volume.
umhos/cm - Micromohs/centimeter.
ng/l - nanograms per liter.

Table 4-35. Summary of Groundwater Analytical Results from Reactive Zone 1 Wells, General Motors Corporation, Moraine, Ohio.

		Upgradient Well GM-29				**Introduction Well RZ-1A**			**Introduction Well RZ-1G**			**Downgradient Well GM-28**			
Constituents	**Units**	**9/1/99**	**2/22/00**	**5/26/00**	**9/21/00**	**9/29/99**	**2/22/00**	**5/26/00**	**9/29/99**	**2/22/00**	**5/26/00**	**9/1/99**	**2/23/00**	**5/26/00**	**9/21/00**
Volatile Organic Compounds*															
Benzene	ug/L	<1.0	<1.0	<1.0	<1.0	<1.0	<50	<5.0	<1.0	<50	<5.0	<1.0	<1.0	<1.0	<1.0
1,1-Dichloroethane	ug/L	4.3	4.1	6.3	16.6	1.8	<50	<5.0	<1.0	<50	<5.0	3.3	4.2	11.8	9.9
1,1-Dichloroethene	ug/L	1.3	1.1	1.6	3.1	<1.0	<50	<5.0	<1.0	<50	<5.0	<1.0	<1.0	3.8	<1.0
cis-1,2-Dichloroethene	ug/L	320	223	1,190J	2,871	68.6	294	688	14.8	306	161	175	503	2,700	37.0
trans-1,2-Dichloroethene	ug/L	11.1	9.1	8.9	14.4	3.6	<50	5	<1.0	<50	<5.0	9.2	9.7	36.5	22.3
Ethylbenzene	ug/L	<1.0	1.4	<1.0	<1.0	<1.0	<50	<5.0	<1.0	<50	2.0	<1.0	<1.0	<1.0	<1.0
Tetrachloroethene	ug/L	<20	38.7	24.6	20.0	252	<50	45.4	91.5	50.5	17.5	316	88.4	30.2	2.3
Toluene	ug/L	<1.0	<1.0	<1.0	2.2	<1.0	<50	2.1J	<1.0	<50	1.1J	<1.0	<1.0	<1.0	<1.0
1,1,1-Trichloroethane	ug/L	37.8	36.0	32.5	24.5	5.7	<50	<5.0	<1.0	<50	<5.0	17.7	23.2	18.1	5.0
Trichloroethene	ug/L	878	758	649J	289	158	88.5	37.9	44.1	<50	13.8	768	833	14.8	1.6
Vinyl chloride	ug/L	3.8	1.0	1.7	788	3.3	<50	43.1	<1.0	<50	136.0	3.2	<1.0	1.9	12.4
Xylenes	ug/L	<1.0	6.0	<1.0	<1.0	<1.0	<50	<5.0	<1.0	<50	<5.0	<1.0	<1.0	<1.0	<1.0
Total VOCs	**ug/L**	**1,256.3**	**1,078.4**	**1,914.6**	**4,028.8**	**493**	**382.5**	**821.5**	**150.4**	**356.5**	**331.4**	**1,292.4**	**1,461.5**	**2,817.1**	**90.5**

* The site-specific parameter list is presented here, the complete set of VOC results is presented in Appendix C.
ug/L - Micrograms per liter.
J - Estimated.
Samples collected in September 1999 represent baseline conditions.
Samples collected in February 2000 represent conditions after three months of carbon source introductions.
Samples collected in May 2000 represent conditions after six months of carbon source introductions.
Samples collected in September 2000 represent first annual conditions.

Table 4-36. Summary of Groundwater Analytical Results from Reactive Zone 2 Wells, General Motors Corporation, Moraine, Ohio.

		Introduction Well ME-6				Introduction Well ME-1			Introduction Well ME-3				Below Introduction Zone GM-31			
Constituents	**Units**	**8/31/99**	**2/22/00**	**5/25/00**	**9/21/00**	**8/31/99**	**2/22/00**	**5/25/00**	**8/31/99**	**2/22/00**	**5/25/00**	**9/21/00**	**9/1/99**	**2/23/00**	**5/31/00**	**9/21/00**
Volatile Organic Compounds*																
Benzene	ug/L	<1.0	<10	<5.0	<1.0	<1.0	<10	<5.0	<1.0	<10	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
1,1-Dichloroethane	ug/L	<1.0	<10	1.4J	<1.0	2.4	<10	<5.0	6.1	12.4	4.7	3.4	1.3	1.4	1.8	1.1
1,1-Dichloroethene	ug/L	<1.0	<10	<5.0	<1.0	<1.0	<10	<5.0	<1.0	<10	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
cis-1,2-Dichloroethene	ug/L	255	541	712	98.8	38.2	459	537	5.7	105	100	2.9	7.80	27.8	48.1	40.2
trans-1,2-Dichloroethene	ug/L	<1.0	<10	6.1	2.5	1.5	<10	4.2J	<1.0	<10	7.5	2.9	<1.0	<1.0	<1.0	<1.0
Ethylbenzene	ug/L	<1.0	<10	<5.0	<1.0	<1.0	<10	1.5J	<1.0	<10	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Tetrachloroethene	ug/L	213	18.3	16.2	6.7	83.6	<10	1.8J	57.9	<10	<1.0	<1.0	1.3	<1.0	<1.0	<1.0
Toluene	ug/L	<1.0	<10	<5.0	1.9	<1.0	<10	1.4J	<1.0	<10	<1.0	1.4	<1.0	<1.0	1.5	<1.0
1,1,1-Trichloroethane	ug/L	2.9	<10	<5.0	<1.0	13.5	<10	<5.0	42.5	16.0	4.8	6.4	<1.0	<1.0	<1.0	<1.0
Trichloroethene	ug/L	474	39.0	28.0	19.0	292	<10	5.8	47.5	<10	4.3	<1.0	27.2	13.6	8.4	8.5
Vinyl chloride	ug/L	<1.0	<10	10.8	6.1	36	<10	9.1	<1.0	<10	54.7	2.1	<1.0	<1.0	<1.0	<1.0
Xylenes	ug/L	<1.0	<10	<5.0	<1.0	<1.0	<10	<5.0	<1.0	<10	<1.0	<1.0	<1.0	1.1	1.6	<1.0
Total VOCs	**ug/L**	**944.9**	**598.3**	**774.5**	**135**	**467.2**	**459**	**560.8**	**159.7**	**133.4**	**176**	**19.1**	**37.6**	**43.9**	**61.4**	**49.8**

* The site-specific parameter list is presented here, the complete set of VOC results is presented in Appendix C.
ug/L - Micrograms per liter.
J - Estimated.
Samples collected in August and September 1999 represent baseline conditions.
Samples collected in February 2000 represent conditions after three months of carbon source introductions.
Samples collected in May 2000 represent conditions after six months of carbon source introductions.
Samples collected in September 2000 represent first annual conditions.

Table 4-37. Summary of Groundwater Analytical Results from Reactive Zone 3 West Wells, General Motors Corporation, Moraine, Ohio.

RZ-3 West		Upgradient Well EAST				Upgradient Well WEST			Upgradient Well GM-19S				Introduction Well RZ-3E			Introduction Well RZ-3L		
Constituents	**Units**	**09/21/99**	**02/23/00**	**05/25/00**	**09/22/00**	**09/21/99**	**02/23/00**	**05/25/00**	**09/20/99**	**02/23/00**	**05/24/00**	**09/22/00**	**09/30/99**	**02/28/00**	**05/30/00**	**09/30/99**	**02/28/00**	**05/30/00**
Volatile Organic Compounds*																		
Benzene	ug/L	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<10	<5.0	8.2	35.4	105
1,1-Dichloroethane	ug/L	5.4	7.3	7.7	7.7	25.6	24.5	32.5	7.7	7.3	7.0	4.4	20.9	49.7	27.1	59.7	583	638
1,1-Dichloroethene	ug/L	<1.0	<1.0	1.02J	1.2	<1.0	<1.0	<1.0	1.0	1.0	1.1	<1.0	1.6	<10	<5.0	<1.0	<10	5.0
cis-1,2-Dichloroethene	ug/L	9.1	24.0	32.0	77.3	125	34.5	29.0	34.6	38.8	42.9	37.6	112	320	144	96.6	260	566
trans-1,2-Dichloroethene	ug/L	<1.0	2.0	1.5	1.8	<1.0	1.7	1.3	2.3	2.3	2.7	2.6	2.0	<10	2.7J	2.0	<10	9.2
Ethylbenzene	ug/L	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<10	2.4	22.1	111	308
Tetrachloroethene	ug/L	61.0	77.1	54.6	55.8	41.3	53.9	37.7	46.0	71.3	57.1	68.0	58.2	23.6	4.6J	<1.0	<10	<5.0
Toluene	ug/L	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<10	2.2J	124	416	706
1,1,1-Trichloroethane	ug/L	21.0	20.6	20.5	22.2	24.8	25.1	27.4	16.0	16.9	17.9	14.5	28.4	<10	<5.0	2.4	<10	<5.0
Trichloroethene	ug/L	56.1	90.1	81.3	97.2	37.3	108	103.0	71.1	101	104	104	124	34.1	4.7J	18.2	<10	4.2J
Vinyl chloride	ug/L	<1.0	5.3	1.2	3.0	<1.0	<1.0	<1.0	<1.0	1.7	1.4	<1.0	2.7	<10	9.0	14.1	43.7	104
Xylenes	ug/L	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	77.2	39.7	182.4	606	1,190
Total VOCs	**ug/L**	**152.6**	**226.4**	**199.8**	**266.2**	**254**	**247.7**	**230.9**	**178.7**	**240.3**	**234.1**	**231.1**	**349.8**	**504.6**	**236.4**	**529.7**	**2,055.1**	**3,635.4**

* The site-specific parameter list is presented here, the complete set of VOC results is presented in Appendix C.
J - Estimated data.
ug/L - Micrograms per liter.
Samples collected in September and October 1999 represent baseline conditions.
Samples collected in February 2000 represent conditions after three months of carbon source introductions.
Samples collected in May 2000 represent conditions after six months of carbon source introductions.
Samples collected in September 2000 represent first annual conditions.

Table 4-37. Summary of Groundwater Analytical Results from Reactive Zone 3 West Wells, General Motors Corporation, Moraine, Ohio.

RZ-3 West, continued		Introduction Well			Introduction Well			Downgradient Well			
		RZ-3T			RZ-3Z			GM-32			
Constituents	**Units**	**09/30/99**	**02/28/00**	**05/30/00**	**09/29/99**	**02/28/00**	**05/30/00**	**09/22/99**	**02/28/00**	**05/30/00**	**09/25/00**
Volatile Organic Compounds*											
Benzene	ug/L	<1.0	<10	<5.0	<1.0	<10	<5.0	<1.0	<10	<100	<1.0
1,1-Dichloroethane	ug/L	4.9	<10	4.9	1.5	<10	<5.0	3.3	101	46.0J	35.9
1,1-Dichloroethene	ug/L	<1.0	<10	<5.0	<1.0	<10	<5.0	<1.0	<10	<100	<1.0
cis-1,2-Dichloroethene	ug/L	23.8	213	139	3.2	130	99.3	2.6	<10	<100	<1.0
trans-1,2-Dichloroethene	ug/L	<1.0	<10	<5.0	<1.0	<10	<5.0	4.2	111	41.0J	20.3
Ethylbenzene	ug/L	<1.0	<10	<5.0	<1.0	<10	<5.0	<1.0	<10	<100	<1.0
Tetrachloroethene	ug/L	19.8	16.5	3.2J	20.6	<10	<5.0	1.2	<10	<100	<1.0
Toluene	ug/L	<1.0	<10	2.0J	<1.0	<10	2.2J	1.0	20.6	<100	10.4
1,1,1-Trichloroethane	ug/L	7.2	<10	1.2J	3.8	<10	<5.0	<1.0	<10	<100	<1.0
Trichloroethene	ug/L	97.3	17.1	5.0J	33.9	<10	3.2J	3.2	<10	<100	<1.0
Vinyl chloride	ug/L	<1.0	<10	<5.0	<1.0	<10	8.6	3.0	<10	<100	<1.0
Xylenes	ug/L	<1.0	<10	1.8J	<1.0	<10	<5.0	<1.0	<10	<100	<1.0
Total VOCs	**ug/L**	**153**	**246.6**	**157.1**	**63**	**130**	**113**	**18.5**	**232.6**	**87**	**66.6**

* The site-specific parameter list is presented here, the complete set of VOC results is presented in Appendix C.
J - Estimated data.
ug/L - Micrograms per liter.
Samples collected in September and October 1999 represent baseline conditions.
Samples collected in February 2000 represent conditions after three months of carbon source introductions.
Samples collected in May 2000 represent conditions after six months of carbon source introductions.
Samples collected in September 2000 represent first annual conditions.

Table 4-38. Summary of Groundwater Analytical Results from Reactive Zone 3 East Wells, General Motors Corporation, Moraine, Ohio.

RZ-3 East		**Upgradient Well GM-22**				**Introduction Well RZ-3FF**			**Introduction Well RZ-3KK**			**Introduction Well RZ-3PP**			**Downgradient Well GM-21**			
Constituents	**Units**	**09/01/99**	**02/23/00**	**05/25/00**	**09/21/00**	**10/07/99**	**02/24/00**	**05/25/00**	**10/07/99**	**02/24/00**	**05/25/00**	**10/08/99**	**02/24/00**	**05/26/00**	**09/22/99**	**02/23/00**	**05/26/00**	**09/22/00**
Volatile Organic Compounds*																		
Benzene	ug/L	<1.0	<1.0	<1.0	<1.0	<1.0	<10	<5.0	<1.0	<10	<5.0	<1.0	<10	<5	<1.0	<1.0	<1.0	<1.0
1,1-Dichloroethane	ug/L	<1.0	2.2	2.8	2.4	2.8J	<10	<5.0	<1.0	<10	5.4	<1.0	<10	<5	9.0	5.8	6.8	5.6
1,1-Dichloroethene	ug/L	<1.0	<1.0	<1.0	<1.0	<1.0	<10	<5.0	<1.0	<10	<5.0	<1.0	<10	<5	3.9	1.6	2.4	1.6
cis-1,2-Dichloroethene	ug/L	<1.0	3.1	4.0	1.9	9.3J	50.4	91.5	<1.0	40.7	148	<1.0	33.7	40.8	66.4	35.9	47.8	38.7
trans-1,2-Dichloroethene	ug/L	<1.0	<1.0	<1.0	<1.0	<1.0	<10	<5.0	<1.0	<10	<5.0	<1.0	<10	<5	7.8	9.3	7.4	12.9
Ethylbenzene	ug/L	<1.0	<1.0	<1.0	<1.0	400J	30.4	79.3	<1.0	<10	<5.0	<1.0	<10	<5	<1.0	<1.0	<1.0	<1.0
Tetrachloroethene	ug/L	3.6	2.8	3.0	1.6	6.6J	<10	<5.0	8.0	<10	<5.0	2.0	<10	<5	<1.0	<1.0	<1.0	<1.0
Toluene	ug/L	<1.0	<1.0	<1.0	<1.0	42.9J	<10	14.0	<1.0	<10	<5.0	1.3	<10	<5	<1.0	<1.0	<1.0	<1.0
1,1,1-Trichloroethane	ug/L	<1.0	<1.0	<1.0	<1.0	3.2J	<10	<5.0	3.6	<10	<5.0	<1.0	<10	<5	53.1	15.4	27.9	15.7
Trichloroethene	ug/L	4.0	2.5	3.6	<1.0	36.8J	20.3	1.4J	38.9	<10	<5.0	14.7	<10	<5	28.7	283	311	189
Vinyl chloride	ug/L	<1.0	<1.0	<1.0	<1.0	6.6J	<10	3.8J	<1.0	<10	1.4J	<1.0	<10	<5	<1.0	<1.0	<1.0	<1.0
Xylenes	ug/L	<1.0	1.2	<1.0	<1.0	2,210J	147	467	<1.0	<10	<5.0	<1.0	<10	<5	<1.0	2.3	<1.0	<1.0
Total VOCs	**ug/L**	**7.6**	**11.8**	**13.4**	**5.9**	**2,718.2**	**248.1**	**657**	**50.5**	**40.7**	**154.8**	**18**	**33.7**	**40.8**	**168.9**	**353.3**	**403.3**	**263.5**

* The site-specific parameter list is presented here, the complete set of VOC results is presented in Appendix C.
J - Estimated data.
ug/L - Micrograms per liter.
Samples collected in September and October 1999 represent baseline conditions.
Samples collected in February 2000 represent conditions after three months of carbon source introductions.
Samples collected in May 2000 represent conditions after six months of carbon source introductions.
Samples collected in September 2000 represent first annual conditions.

Table 4-39. Oxidation Testing Injection Fluids, General Motors Corporation, Moraine, Ohio.

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		Injection Well OW-1				Injection Well OW-2				Injection Well OW-3			
Test ID	Date	Hydrogen Peroxide gallons	Ferrous Sulfate pounds	Sulfuric Acid gallons	Potable Water gallons	Hydrogen Peroxide gallons	Ferrous Sulfate pounds	Sulfuric Acid gallons	Potable Water gallons	Hydrogen Peroxide gallons	Ferrous Sulfate pounds	Sulfuric Acid gallons	Potable Water gallons
Test 1	8-Sep-1999	20	200	--	620	--	--	--	--	--	--	--	--
	9-Sep-1999	40	200	--	600	--	--	--	--	--	--	--	--
	10-Sep-1999	140	350	--	980	--	--	--	--	--	--	--	--
	Subtotal	200	750	--	2200	--	--	--	--	--	--	--	--
Test 2	2-Dec-1999	--	--	--	--	--	--	--	--	52	338	24	924
Test 3, Phase 1													
	4-Apr-2000	56	--	--	154	43.8	--	--	156.2	--	--	--	--
	5-Apr-2000	70	--	--	280	61.3	--	--	238.7	--	--	--	--
	6-Apr-2000	70	--	--	330	52.5	--	--	247.5	--	--	--	--
	12-Apr-2000	--	--	--	--	70	--	--	330	--	--	--	--
	13-Apr-2000	--	--	--	--	105	--	--	495	70	--	--	330
	17-Apr-2000	--	--	--	--	70	--	--	330	70	--	--	330
	19-Apr-2000	--	--	--	--	65.6	--	--	334.4	70	--	--	330
	20-Apr-2000	--	--	--	--	83.8	--	--	366.2	65.6	--	--	334.4
	Subtotal	196	--	--	764	552	--	--	2,498	40	--	--	160
										316	--	--	1,484
Test 3, Phase 2	3-May-2000	50.3	366.7	23	943.4	--	--	--	--	--	--	--	--
	4-May-2000	54.7	308.3	25	917.6	--	--	--	--	--	--	--	--
	5-May-2000	--	--	--	--	35	225	16	619	--	--	--	--
	8-May-2000	--	--	--	--	70	450	32	1283	--	--	--	--
	9-May-2000*	8.7	83.3	--	151.3	--	--	--	--	--	--	--	--
	15-May-2000	70	450	32	1238	--	--	--	--	--	--	--	--
	16-May-2000	26.3	170	12	465.7	70	450	32	1238	--	--	--	--
	17-May-2000	--	--	--	--	35	225	16	1238	--	--	--	--
	Subtotal	210	1,378	92	3,716	175	1,125	80	3,140	--	--	--	--
	Total	606	2,128	92	6,680	727	1,125	80	5,638	368	338	24	2,408

* An attempt was made to add a chelator (sodium acid pyrophosphate) to enhance the oxidation reaction, but it turned into a milky solid that could not be pumped into OW-1. Approximately 38.7 pounds of this material was actually injected into the well.

-- No volume injected.

Table 4-40. Results of Soil TOC Sampling from Vapor Point Installation, General Motors Corporation, Moraine, Ohio.

TOC Results Pre-Phase-Ox

Vapor Point	Sample Interval (ft bls)	Date	Lithology	TOC (mg/Kg)
VP-1	28-30	3/22/00	sand & gravel	1,500
VP-1	31.8-32	3/22/00	UCT	5,500
VP-3	26-28	3/22/00	sand & gravel	2,400
VP-3	29.8-30	3/22/00	UCT	5,300
VP-5	30-32	3/22/00	sand & gravel	1,400
VP-5	37.5-38	3/22/00	UCT	5,600

TOC Results Post Phase-Ox Completed April 4 through 20, 2000

Vapor Point	Sample Interval (ft bls)	Date	Lithology	TOC (mg/Kg)
VP-3A	28-30	4/25/00	sand & gravel	5,600
VP-3A	30-30.5	4/25/00	UCT	5,100
VP-5A	30-32	4/25/00	sand & gravel	2,000
VP-5A	35-35.5	4/25/00	UCT	5,000

Samples analyzed via Walkley-Black method.
Practical Quantitation Limit = 250 mg/Kg.
ft - feet.
bls - below land surface.
UCT - Upper Clay Till.
TOC - Total Organic Carbon.
mg/Kg - milligrams per Kilogram.
VP-3A was drilled adjacent to VP-3.
VP-5A was drilled adjacent to VP-5.

Table 4-41. Bioattenuation Parameter Results for Groundwater Samples Collected in Oxidation Area 1, General Motors Corporation, Moraine, Ohio.

Constituents	Units	OW-1			OW-2			OW-3			GM-23			
		9/2/1999	2/21/2000	5/31/2000	9/2/1999	2/21/2000	5/31/2000	9/3/1999	2/21/2000	6/1/2000	9/1/1999	2/21/2000	5/30/2000	9/20/2000
Inorganics & TOC														
Nitrate	mg/l	0	NA	NA	0	0	NA	NA	0	0	0.08	0	0	NS
Nitrite	mg/l	0	NA	NA	0	0	NA	NA	0	0	3.83	0	0	NS
Nitrogen, Ammonia	mg/l	0.64	1.16	<0.30	0.44	0.71	4.04	0.87	0.93	4.08	<0.30	0.94	2.84	NS
Manganese (Total)	mg/l	2.68	2.15	44.9	1.98	2.21	5.66	NA	0.583	5.24	4.71	0.887	0.121	0.208
Manganese (Dissolved)	mg/l	0.401	0.528	43	0.164	1.11	5.55	NA	0.66	4.32	0.346	0.841	0.101	0.187
Iron (Total)	mg/l	130	406	1,240	119	3.45	30.4	NA	1.59	45.2	13.6	0.53	0.18	0.34
Iron (Dissolved)	mg/l	2.21	0.66	1,180	4.23	2.1	1.05	NA	<0.10	<0.20	<0.10	<0.10	<0.10	<0.10
Iron (Ferrous)	mg/l	2	NA	NA	3.6	2	NA	NA	0	0	4	0	0	NS
Sulfate	mg/l	8	1850	16,300	27	600	10,000	NA	1525	12,800	72	650	8,040	2,810
Sulfide	mg/l	<4	1.20	<1	<4	<1	<1	<4	<1	1.11	<4	<1	<1	<1
Total Organic Carbon	mg/l	174	24	23	171	20	16	380	15	28	19	25	19	6
Chloride	mg/l	221	73	270	109	131	71	NA	119	82	118	143	85	135
Permanent Gases														
Carbon Dioxide	mg/l	85.76	193.2	968.13	96.88	81.41	340.72	NA	82.08	354.64	88.47	264.8	323.79	NS
Oxygen	mg/l	0.89	6.36	1.99	0.99	8.26	6.52	NA	8.70	11.69	0.96	1.56	17.78	NS
Nitrogen	mg/l	18.90	11.68	3.35	21.21	14.69	4.91	NA	14.60	4.50	20.22	13.75	3.13	NS
Methane	mg/l	0.30	0.002824	0.006488	1.33	0.02262	0.006579	NA	0.001662	0.03464	0.1248	0.72	0.02083	NS
Carbon Monoxide	mg/l	<0.40	<0.40	<0.40	<0.40	<0.40	<0.40	NA	<0.40	<0.40	<0.40	<0.40	<0.40	NS
Light Hydrocarbon Scan														
Ethane	ng/l	57,032	1,086	1,473	59,933	2,406	1,241	NA	102	973	6,878	14,644	1,037	NS
Ethene	ng/l	1,205,597	1,581	2,329	373,161	26,719	285	NA	460	11,089	580,916	439,458	569	NS
Field Parameters														
pH	S.U.	6.62	6.14	2.41	6.50	6.80	6.46	7.32	6.61	6.45	6.80	6.62	6.31	6.56
Specific Conductivity	umhos/cm	1,444	3,227	14,386	1,093	148	10,991	1,369	3,075	9,071	1,160	2,856	6,720	5,238
Dissolved Oxygen	mg/l	0.56	9.58	9.89	0.45	7.09	13.03	5.21	11.00	33.41	0.65	0.78	10.48	7.78
Redox Potential	mV	-509.9	183.0	498.7	-101.8	125.3	133.7	-129.1	155.0	237.5	122.2	158.7	194.2	401.3
Temperature	°C	16.17	16.14	25.31	18.69	17.61	27.89	22.58	17.66	25.57	17.89	17.60	26.45	21.03

mg/l - milligrams per liter.
S.U. - Standard Units.
ng/l - nanograms per liter.
mV - Millivolts.
°C - Degrees Celsius.
NA - Data not available, insufficient sample volume.
umhos/cm - Micromohs/centimeter.
NS - Not sampled for these constituents.

Samples collected in September 1999 represent baseline conditions.
Samples collected in February 2000 represent conditions after two oxidation tests.
Samples collected in May 2000 represent conditions after three oxidation tests.

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Table 4. Bioattenuation Parameter Results for Groundwater Samples Collected in Oxidation Area 2, General Motors Corporation, Moraine, Ohio.

		OW-4			OW-5			OW-6			GM-30		
Constituents	**Units**	**9/3/1999**	**2/22/2000**	**6/1/2000**	**9/3/1999**	**2/22/2000**	**6/1/2000**	**9/3/1999**	**2/21/2000**	**6/1/2000**	**9/2/1999**	**2/22/2000**	**5/31/2000**
Inorganics & TOC													
Nitrate	mg/l	0	NA	0	0	NA	0	0	0	NA	0	0	0
Nitrite	mg/l	0	NA	0	0	NA	0	0	0	NA	0.02	0	0
Nitrogen, Ammonia	mg/l	2.41	1.13	0.90	1.68	2.13	6.30	2.92	0.65	0.39	1.76	1.93	<0.30
Manganese (Total)	mg/l	3.09	0.563	0.316	10.4	9.8610	9.0	54.5	5.65	0.834	1.86	0.648	0.302
Manganese (Dissolved)	mg/l	0.12	0.147	0.218	1.81	0.062	0.137	2.59	0.287	0.381	0.088	0.063	0.047
Iron (Total)	mg/l	122	21.10	20.6	525	500	478	1470	181	18.1	99.1	41.9	25.3
Iron (Dissolved)	mg/l	<0.10	<0.10	<0.10	3.53	0.41	0.36	2.67	<0.10	<0.10	6.84	8.88	10.2
Iron (Ferrous)	mg/l	0	NA	1.1	0.6	NA	NA	0.02	1	NA	2.5	2.3	3
Sulfate	mg/l	<5	<5	5	<5	<5	<10	53	24	28	<5	<5	<5
Sulfide	mg/l	NA	<1	<1	<4	<1	2.33	<4	<1	<1	<4	<1	<1
Total Organic Carbon	mg/l	64	54	26	354	161	155	188	35	12	76	52	15
Chloride	mg/l	214	353	301	73	<50	124	109	145	53	42	54	76
Permanent Gases													
Carbon Dioxide	mg/l	11.13	21.74	81.50	62.68	74.15	82.96	24.64	64.96	97.43	98.94	106.3	96.93
Oxygen	mg/l	0.89	5.18	0.62	1.10	0.50	0.58	1.16	1.26	0.70	0.75	0.57	0.63
Nitrogen	mg/l	21.23	14.6	16.25	21.60	14.1	19.86	16.46	17.15	21.23	12.92	12.0	17.85
Methane	mg/l	0.000900	0.27	1.06	0.24	0.00036	0.4319	0.000952	0.001990	0.004285	9.23	0.00856	5.91
Carbon Monoxide	mg/l	<0.40	<0.40	<0.40	<0.40	<0.40	<0.40	<0.40	<0.40	<0.40	<0.40	<0.40	<0.40
Light Hydrocarbon Scan													
Ethane	ng/l	125	38,124	141,104	1,291	382	744	560	509	768	16,598	218,908	699,900
Ethene	ng/l	9,464	1,915,746	11,411,690	1,203,499	1,616,870	2,165,024	2,197	812	27,334	1,930,451	1,598,981	1,829,296
Field Parameters													
pH	S.U.	7.76	6.69	6.67	6.81	6.90	6.96	7.57	7.39	6.97	6.66	6.88	6.75
Specific Conductivity	umhos/cm	807	2260	1516	998	1418	1013	1078	1381	934	1002	1393	1028
Dissolved Oxygen	mg/l	8.95	10.63	10.62	1.88	2.45	10.11	6.81	8.57	9.20	0.50	0.79	0.53
Redox Potential	mV	-11.3	-22.2	-66.9	-46.5	-65.7	-64.7	6.8	23.1	-14.8	-108.1	-115.4	-71.3
Temperature	°C	19.17	14.96	16.10	19.05	15.41	16.17	21.04	13.98	16.43	16.46	17.29	16.83

mg/l - milligrams per liter.
S.U. - Standard Units.
ng/l - nanograms per liter.
mV - Millivolts.
°C - Degrees Celsius.
NA - Data not available, insufficient sample volume.
umhos/cm - Micromohs/centimeter.
Samples collected in September 1999 represent baseline conditions.
Samples collected in February 2000 represent conditions after two oxidation tests.
Samples collected in May 2000 represent conditions after three oxidation tests.

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Table 4-42. Analytical Results for Groundwater Samples Collected During the Oxidation Tests, General Motors Corporation, Moraine, Ohio.

		OW-1											
		Baseline	**First Test**				**Second Test**				**Phase Ox Test**		
Constituents	**Units**	**9/2/99**	**9/9/99**	**9/10/99**	**9/13/99**	**10/20/99**	**12/1/99**	**12/2/99**	**12/3/99**	**12/17/99**	**4/28/00**	**5/18/00**	**5/31/00**
Volatile Organic Compounds*													
Benzene	ug/L	<10	NC	NC	<1.0	<10	<50	NC	<50	<50	<1.0	<1.0	1.6J
1,1-Dichloroethane	ug/L	80.6	NC	NC	<1.0	<10	<50	NC	<50	<50	2.9	<1.0	<5.0
1,1 Dichloroethene	ug/L	<10	NC	NC	<1.0	<10	<50	NC	<50	<50	1.0	<1.0	<5.0
cis-1,2-Dichloroethene	ug/L	1,640	NC	NC	56.0	677	3,810	NC	745	6,480	918	11.6	21.8
trans-1,2-Dichloroethene	ug/L	94.2J	NC	NC	1.1	<10	<50	NC	<50	<50	8.6	<1.0	<5.0
Ethylbenzene	ug/L	<10	NC	NC	<1.0	<10	<50	NC	<50	<50	<1.0	<1.0	1.4J
Tetrachloroethene	ug/L	273J	NC	NC	222	304	963	NC	836	1,300	208	6.5	37.2
Toluene	ug/L	<10	NC	NC	<1.0	<10	<50	NC	<50	<50	<1.0	1.1	<5.1
1,1,1-Trichloroethane	ug/L	<10	NC	NC	<1.0	<10	<50	NC	<50	<50	1.2	<1.0	<5.0
Trichloroethene	ug/L	1,240	NC	NC	48.2	108	452	NC	194	596	150	3.7	11.8
Vinyl chloride	ug/L	6,800J	NC	NC	4.7	114	304	NC	<100	705	31.1	<1.0	<5.0
Xylenes	ug/L	<10	NC	NC	<1.0	<10	<50	NC	<50	<50	<1.0	<1.0	<5.0
Total VOCs	ug/L	**10,127.8**			**332**	**1,203**	**5,529**		**1,775**	**9,081**	**1,320.8**	**22.9**	**73.8**
Chlorides	mg/L	NC	NC	NC	NC	NC	100	69	63	<5	64	918	270

*The site-specific parameter list is presented here, the complete set of VOC results is presented in Appendix C.
ug/L - Micrograms per liter.
mg/L - Milligrams per liter.
OW-3 recharges very poorly.
NC - Sample not collected.
J - Estimated.
Dates and volumes of injection fluids for OW-1, OW-2, and OW-3 are presented on Table 4-37.

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Table 4-42. Analytical Results for Groundwater Samples Collected During the Oxidation Tests, General Motors Corporation, Moraine, Ohio.

		OW-2											
		Baseline	First Test				Second Test				Phase Ox Test		
Constituents	**Units**	**9/2/99**	**9/9/99**	**9/10/99**	**9/13/99**	**10/20/99**	**12/1/99**	**12/2/99**	**12/3/99**	**12/17/99**	**4/28/00**	**5/18/00**	**5/31/00**
Volatile Organic Compounds*													
Benzene	ug/L	<10	NC	<100	<100	<100	<50	NC	<100	<50	<1.0	<1.0	<5.0
1,1-Dichloroethane	ug/L	129	NC	<100	<100	<100	<50	NC	<100	<50	<1.0	<1.0	<5.0
1,1 Dichloroethene	ug/L	71.9	NC	<100	<100	<100	<50	NC	<100	<50	2.6	<1.0	<5.0
cis-1,2-Dichloroethene	ug/L	32,200	NC	19,200	17,300	13,100	15,080	NC	12,400	13,200	778	2.3	7.9
trans-1,2-Dichloroethene	ug/L	149	NC	<100	<100	<100	68.0	NC	<100	<50	22.3	<1.0	<5.0
Ethylbenzene	ug/L	18.0	NC	<100	<100	<100	<50	NC	<100	<50	1.7	<1.0	<5.0
Tetrachloroethene	ug/L	280	NC	954	2,420	4,200	4,560	NC	4,800	5,570	86.1	14.2	56.3
Toluene	ug/L	29.9	NC	<100	<100	<100	<50	NC	<100	<50	3.5	1.4	<5.0
1,1,1-Trichloroethane	ug/L	20.7	NC	<100	<100	<100	<50	NC	<100	<50	<1.0	<1.0	<5.0
Trichloroethene	ug/L	503	NC	867	1,170	<100	1,280	NC	1,500	1,980	25.9	<1.0	4.8
Vinyl chloride	ug/L	7,760	NC	4,580	3,500	2,790	3,610	NC	2,660	3,700	24.1	<1.0	<5.0
Xylenes	ug/L	10.8	NC	<100	<100	<100	<50	NC	<100	<50	4.9	<1.0	<5.0
Total VOCs	ug/L	**41,172.3**		**25,601**	**24,390**	**20,090**	**24,598**		**21,360**	**24,450**	**949.1**	**17.9**	**69**
Chlorides	mg/L	NC	NC	NC	NC	NC	96	101	106	120	51	81	71

*The site-specific parameter list is presented here, the complete set of VOC results is presented in Appendix C.
ug/L - Micrograms per liter.
mg/L - Milligrams per liter.
OW-3 recharges very poorly.
NC - Sample not collected.
J - Estimated.
Dates and volumes of injection fluids for OW-1, OW-2, and OW-3 are presented on Table 4-37.

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Table 4-42. Analytical Results for Groundwater Samples Collected During the Oxidation Tests, General Motors Corporation, Moraine, Ohio.

		OW-3										
		Baseline	**First Test**				**Second Test**			**Phase Ox Test**		
Constituents	**Units**	**9/3/99**	**9/9/99**	**9/10/99**	**9/13/99**	**10/20/99**	**12/1/99**	**12/3/99**	**12/17/99**	**4/28/00**	**5/18/00**	**6/1/00**
Volatile Organic Compounds*												
Benzene	ug/L	1	1.2	<50	<100	<100	<100	<50	<50	<1.0	<1.0	<10
1,1-Dichloroethane	ug/L	15.5	19.2	<50	<100	<100	<100	<50	<50	<1.0	<1.0	<10
1,1 Dichloroethene	ug/L	2.1	2.5	<50	<100	<100	<100	<50	<50	<1.0	<1.0	<10
cis-1,2-Dichloroethene	ug/L	3,360	4,202	4,040	6,860	9,800	12,500	490	3,740	188	145	1,080
trans-1,2-Dichloroethene	ug/L	17.8	18.7	<50	<100	<100	<100	<50	<50	2.2	1.7	<10
Ethylbenzene	ug/L	<1.0	<1.0	<50	<100	<100	<100	<50	<50	<1.0	<1.0	<10
Tetrachloroethene	ug/L	116	194	178	203	<100	218	192	504	78.3	51.0	153
Toluene	ug/L	2.2	1.3	<50	<100	<100	<100	<50	<50	<1.0	<1.0	<10
1,1,1-Trichloroethane	ug/L	<1.0	<1.0	<50	<100	<100	<100	<50	<50	<1.0	<1.0	<10
Trichloroethene	ug/L	<1.0	782	742	1,670	2,670	2,540	227	793	33.3	<1.0	92.3
Vinyl chloride	ug/L	<1.0	360	504	1,150	<100	2,440	<100	310	18.8	15.7	97.8
Xylenes	ug/L	<1.0	<1.0	<50	<100	<100	<100	<50	<50	<1.0	<1.0	<10
Total VOCs	ug/L	**3,514.6**	**5,580.9**	**5,464**	**9,883**	**12,470**	**17,698**	**909**	**5,347**	**320.6**	**213.4**	**1,423.1**
Chlorides	mg/L	NC	NC	NC	NC	NC	159	58	86	32	53	82

*The site-specific parameter list is presented here, the complete set of VOC results is presented in Appendix C.
ug/L - Micrograms per liter.
mg/L - Milligrams per liter.
OW-3 recharges very poorly.
NC - Sample not collected.
J - Estimated.
Dates and volumes of injection fluids for OW-1, OW-2, and OW-3 are presented on Table 4-37.

Table 4-42. Analytical Results for Groundwater Samples Collected During the Oxidation Tests, General Motors Corporation, Moraine, Ohio.

Constituents	Units	GM-23												
		Baseline	First Test				Second Test				Phase Ox Test			
		9/2/99	9/9/99	9/10/99	9/13/99	10/20/99	12/1/99	12/2/99	12/3/99	12/17/99	4/28/00	5/18/00	5/31/00	9/20/00
Volatile Organic Compounds*														
Benzene	ug/L	1.9	2.7	<100	<100	<100	<50	NC	<100	<50	<50	<20	<20	<1.0
1,1-Dichloroethane	ug/L	32.5	31.1	<100	<100	<100	<50	NC	<100	<50	<50	7.0	12.8J	16.3
1,1 Dichloroethene	ug/L	17.2	18.5	<100	<100	<100	<50	NC	<100	<50	<50	<20	6.6J	5.1
cis-1,2-Dichloroethene	ug/L	7,530	8,950	9,730	9,710	7,000	7 ,380	NC	7,760	10,000	7,600	3,890	4,080J	5,620
trans-1,2-Dichloroethene	ug/L	54.5	50.9	<100	<100	<100	<50	NC	<100	<50	56.0	26.4	39.8J	33.2
Ethylbenzene	ug/L	<1.0	<1.0	<100	<100	<100	<50	NC	<100	<50	<50	<20	<20	<1.0
Tetrachloroethene	ug/L	6,250	7,120	7,030	6,710	5,200	5,650	NC	6,010	5,440	5,550	6,960	6,200J	3,470
Toluene	ug/L	<1.0	<1.0	<100	<100	<100	<50	NC	<100	<50	<50	<20	<20	<1.0
1,1,1-Trichloroethane	ug/L	7.2	9.1	<100	<100	<100	<50	NC	<100	<50	<50	<20	<20	2.0
Trichloroethene	ug/L	1,460	1,260	1,270	1,300	<100	1,370	NC	1,350	1,510	1,380	1,440	1,480J	609
Vinyl chloride	ug/L	2,500	2,470	2,600	2,310	<100	1,600	NC	1,460	2,050	506	<20	140J	801
Xylenes	ug/L	<1.0	<1.0	<100	<100	<100	<50	NC	<100	<50	<50	<20	<20	<1.0
Total VOCs	ug/L	**17,853.3**	**19,912.3**	**20,630**	**20,030**	**12,200**	**16,000**		**16,580**	**19,000**	**15,092**	**12,323.4**	**11,959.2**	**10,556.6**
Chlorides	mg/L	NC	NC	NC	NC	NC	148	133	184	136	118	93	85	135

*The site-specific parameter list is presented here, the complete set of VOC results is presented in Appendix C.
ug/L - Micrograms per liter.
mg/L - Milligrams per liter.
OW-3 recharges very poorly.
NC - Sample not collected.
J - Estimated.
Dates and volumes of injection fluids for OW-1, OW-2, and OW-3 are presented on Table 4-37.

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Table 5-1. Summary of Site-Wide Groundwater Monitoring Plan, General Motors Corporation, Moraine, Ohio.

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Monitoring Wells	Reason for Monitoring	Monitoring Frequency	Parameter List
Upper Aquifer Wells			
HR-9	Monitoring groundwater quality upgradient of the site.	Annual	1st Annual(1), VOCs(2)
HR-11	Monitoring groundwater quality upgradient of the site.	Annual	1st Annual(1), VOCs(2)
HR-8	Monitoring of groundwater quality upgradient of the North Settling Lagoon and Landfills L2 and L3.	Annual	1st Annual(1), VOCs(2)
HR-4	Monitoring of groundwater quality upgradient of the North Settling Lagoon and downgradient of Landfill L3.	Annual	1st Annual(1), VOCs(2)
W-2-N	Monitoring of groundwater quality downgradient of the North Settling Lagoon.	Annual	1st Annual(1), VOCs(2)
W-3-N	Monitoring of groundwater quality downgradient of the North Settling Lagoon.	Annual	1st Annual(1), VOCs(2)
W-4-N	Monitoring of groundwater quality downgradient of the North Settling Lagoon and Landfills L2 and L3.	Annual	1st Annual(1), VOCs(2)
HR-2	Monitoring groundwater quality downgradient of Landfills L2 and L3.	Annual.	1st Annual(1), VOCs(2)
HR-5	Monitoring of groundwater quality downgradient of the North Settling Lagoon.	Annual	1st Annual(1), VOCs(2)
HR-3	Monitoring groundwater quality in the central portion of the site.	Annual	1st Annual(1), VOCs(2)
HR-1	Monitoring groundwater quality in the central portion of the site.	Annual	1st Annual(1), VOCs(2)
GM-30	Monitoring effectiveness of interim measures at AOI 7.	Quarterly for 1st year, semi-annually for years 2 and 3, and annually thereafter.	1st Annual(1), VOCs(2) Biogeochemical(3)

Table 5-1. Summary of Site-Wide Groundwater Monitoring Plan, General Motors Corporation, Moraine, Ohio.

Monitoring Wells	Reason for Monitoring	Monitoring Frequency	Parameter List
Upper Aquifer Wells			
GM-23	Monitoring effectiveness of interim measures at AOI 7.	Quarterly for 1st year, semi-annually for years 2 and 3, and annually thereafter.	1st Annual(1), VOCs(2) Biogeochemical(3)
GM-27	Monitoring effectiveness of interim measures at AOI 7 in lower portion of the upper aquifer.	Annual	1st Annual(1), VOCs(2)
GM-29	Monitoring effectiveness of interim measures upgradient of RZ-1.	Quarterly for 1st year, semi-annually for years 2 and 3, and annually thereafter.	1st Annual(1), VOCs(2) Biogeochemical(3)
GM-28	Monitoring effectiveness of interim measures downgradient of RZ-1.	Quarterly for 1st year, semi-annually for years 2 and 3, and annually thereafter.	1st Annual(1), VOCs(2) Biogeochemical(3)
ME-6	Monitoring effectiveness of interim measures downgradient of RZ-1.	Quarterly for 1st year, semi-annually for years 2 and 3, and annually thereafter.	1st Annual(1), VOCs(2) Biogeochemical(3)
GM-31	Monitoring effectiveness of interim measures downgradient of RZ-1.	Annual	1st Annual(1), VOCs(2) Biogeochemical(3)
ME-3	Monitoring effectiveness of interim measures downgradient of RZ-1.	Quarterly for 1st year, semi-annually for years 2 and 3, and annually thereafter.	1st Annual(1), VOCs(2) Biogeochemical(3)
GM-22	Monitoring effectiveness of interim measures upgradient of RZ-3.	Quarterly for 1st year, semi-annually for years 2 and 3, and annually thereafter.	1st Annual(1), VOCs(2) Biogeochemical(3)

Table 5-1. Summary of Site-Wide Groundwater Monitoring Plan, General Motors Corporation, Moraine, Ohio.

Monitoring Wells	Reason for Monitoring	Monitoring Frequency	Parameter List
Upper Aquifer Wells			
19S	Monitoring effectiveness of interim measures upgradient of RZ-3 and groundwater quality upgradient of Landfill L1.	Quarterly for 1st year, semi-annually for years 2 and 3, and annually thereafter.	1st Annual(1), VOCs(2) Biogeochemical(3)
EAST	Monitoring effectiveness of interim measures upgradient of RZ-3 and groundwater quality upgradient of Landfill L1.	Quarterly for 1st year, semi-annually for years 2 and 3, and annually thereafter.	1st Annual(1), VOCs(2) Biogeochemical(3)
GM-32	Monitoring effectiveness of interim measures downgradient of RZ-3 and groundwater quality upgradient of Landfill L1.	Quarterly for 1st year, semi-annually for years 2 and 3, and annually thereafter.	1st Annual(1), VOCs(2) Biogeochemical(3)
GM-21	Monitoring effectiveness of interim measures downgradient of RZ-3.	Quarterly for 1st year, semi-annually for years 2 and 3, and annually thereafter.	1st Annual(1), VOCs(2) Biogeochemical(3)
HR-17	Monitoring of groundwater quality upgradient of the South Settling Lagoon.	Annual	1st Annual(1), VOCs(2)
W-2-S	Monitoring of groundwater quality downgradient of the South Settling Lagoon.	Annual	1st Annual(1), VOCs(2)
W-3-S	Monitoring of groundwater quality downgradient of the South Settling Lagoon.	Annual	1st Annual(1), VOCs(2)
W-4-S	Monitoring of groundwater quality downgradient of the South Settling Lagoon.	Annual	1st Annual(1), VOCs(2)
GM-8	Monitoring groundwater quality downgradient of the site and within Landfill L1.	Annual	1st Annual(1), VOCs(2)
GM-6	Monitoring groundwater quality downgradient of the site and Landfill L1.	Annual	1st Annual(1), VOCs(2)

Table 5-1. Summary of Site-Wide Groundwater Monitoring Plan, General Motors Corporation, Moraine, Ohio.

Monitoring Wells	Reason for Monitoring	Monitoring Frequency	Parameter List
Upper Aquifer Wells			
4S	Monitoring groundwater quality downgradient of the site and Landfill L1.	Annual	1st Annual(1), VOCs(2)
GM-2	Monitoring groundwater quality downgradient of the site.	Annual	1st Annual(1), VOCs(2)
GM-16	Monitoring groundwater quality downgradient of the site.	Annual	1st Annual(1), VOCs(2)
GM-17	Monitoring groundwater quality downgradient of the site.	Annual	1st Annual(1), VOCs(2)
GM-18	Monitoring groundwater quality downgradient of the site.	Annual	1st Annual(1), VOCs(2)
WSU-24	Monitoring groundwater quality downgradient of the site.	Annual	1st Annual(1), VOCs(2)
GM-10	Monitoring groundwater quality downgradient of the site.	Annual	1st Annual(1), VOCs(2)
GM-26	Monitoring groundwater quality downgradient of the site.	Annual	1st Annual(1), VOCs(2)
Lower Aquifer Wells			
HR-10	Monitoring groundwater quality upgradient of the site.	Annual	1st Annual(1), VOCs(2)
HR-12	Monitoring groundwater quality upgradient of the site.	Annual	1st Annual(1), VOCs(2)
HR-15	Monitoring groundwater quality in the central portion of the site.	Annual	1st Annual(1), VOCs(2)
HR-13	Monitoring groundwater quality in the central portion of the site.	Annual	1st Annual(1), VOCs(2)
31	Monitoring groundwater quality in the central portion of the site.	Annual	1st Annual(1), VOCs(2)
32	Monitoring groundwater quality in the central portion of the site.	Annual	1st Annual(1), VOCs(2)
28	Monitoring groundwater quality in the central portion of the site.	Annual	1st Annual(1), VOCs(2)

Table 5-1. Summary of Site-Wide Groundwater Monitoring Plan, General Motors Corporation, Moraine, Ohio.

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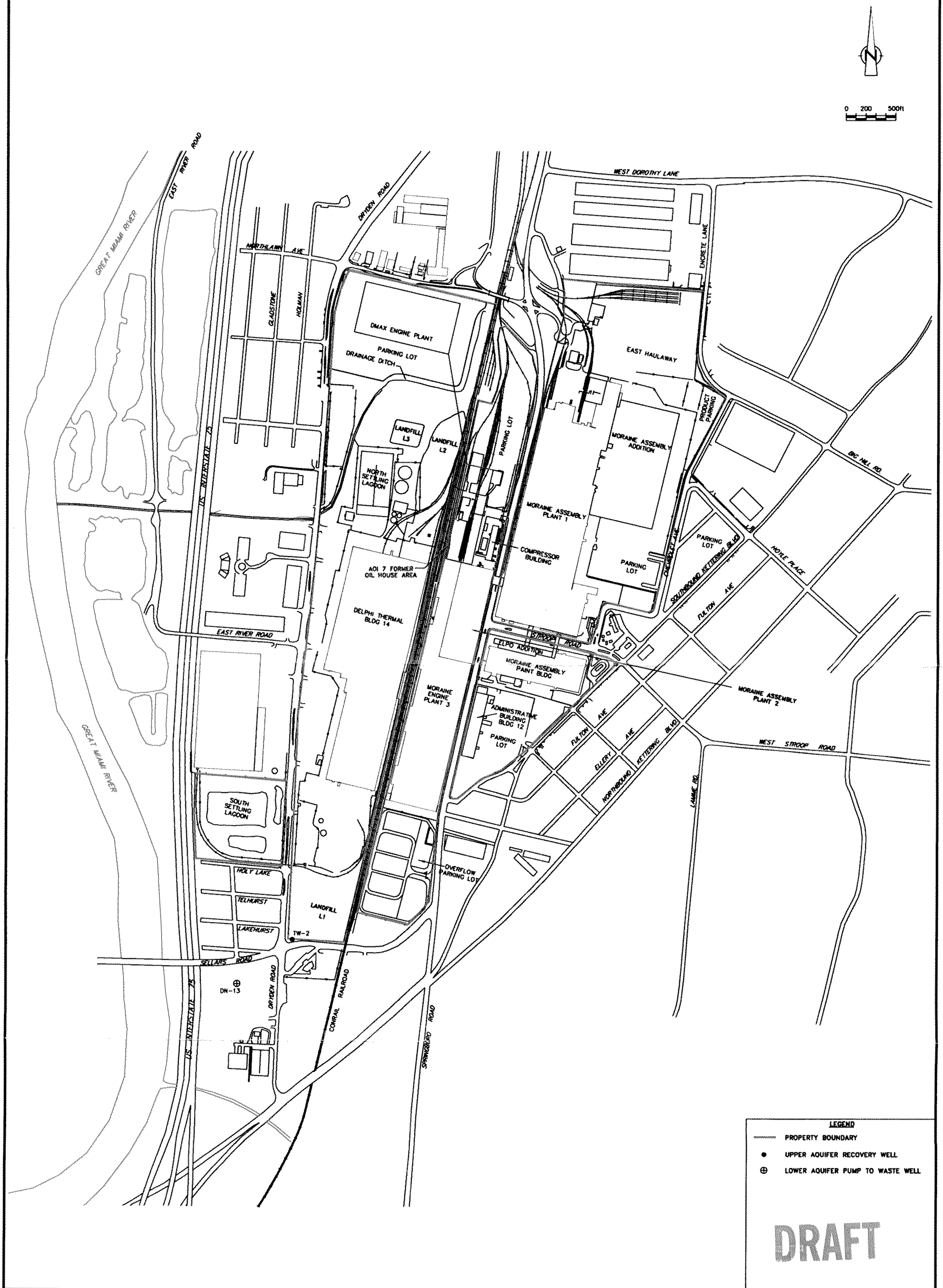
Monitoring Wells	Reason for Monitoring	Monitoring Frequency	Parameter List
Lower Aquifer Wells			
GM-19D	Monitoring groundwater quality downgradient of the site.	Annual	1st Annual(1), VOCs(2)
GM-3	Monitoring groundwater quality downgradient of the site.	Annual	1st Annual(1), VOCs(2)
GM-1	Monitoring groundwater quality downgradient of the site.	Annual	1st Annual(1), VOCs(2)
GM-15	Monitoring groundwater quality downgradient of the site.	Annual	1st Annual(1), VOCs(2)
GM-11	Monitoring groundwater quality downgradient of the site.	Annual	1st Annual(1), VOCs(2)
GM-20D	Monitoring groundwater quality downgradient of the site.	Annual	1st Annual(1), VOCs(2)
DN-13	Monitoring groundwater quality downgradient of the site.	Annual	1st Annual(1), VOCs(2)
GM-9	Monitoring groundwater quality downgradient of the site.	Annual	1st Annual(1), VOCs(2)
MT-69	Monitoring groundwater quality downgradient of the site.	Annual	1st Annual(1), VOCs(2)

VOCs - Volatile organic compounds.
SVOCs – Semi-volatile organic compounds.

(1) The following parameters will be analyzed for the 1st annual sampling event: Appendix IX VOCs and cis-1,2-dichloroethene, Appendix IX SVOCs, and Appendix IX total and dissolved metals.
(2) The parameters for the remaining annual sampling events will include the site-specific list of VOCs: benzene, 1,1,-dichloroethane, 1,1-dichloroethene, cis-1,2-dichloroethene, trans-1,2-dichloroethene, ethylbenzene, tetrachloroethene, toluene, 1,1,1-trichloroethane, trichloroethene, vinyl chloride, and xylenes.
(3) The biogeochemical list includes the field and laboratory parameters presented on Table 4-2.
Upper aquifer wells to be installed as part of the Waste Pile/Staging Area will be added to the annual sampling events.



LEGEND

- PROPERTY BOUNDARY
- ● UPPER AQUIFER RECOVERY WELL
- ⊕ LOWER AQUIFER PUMP TO WASTE WELL

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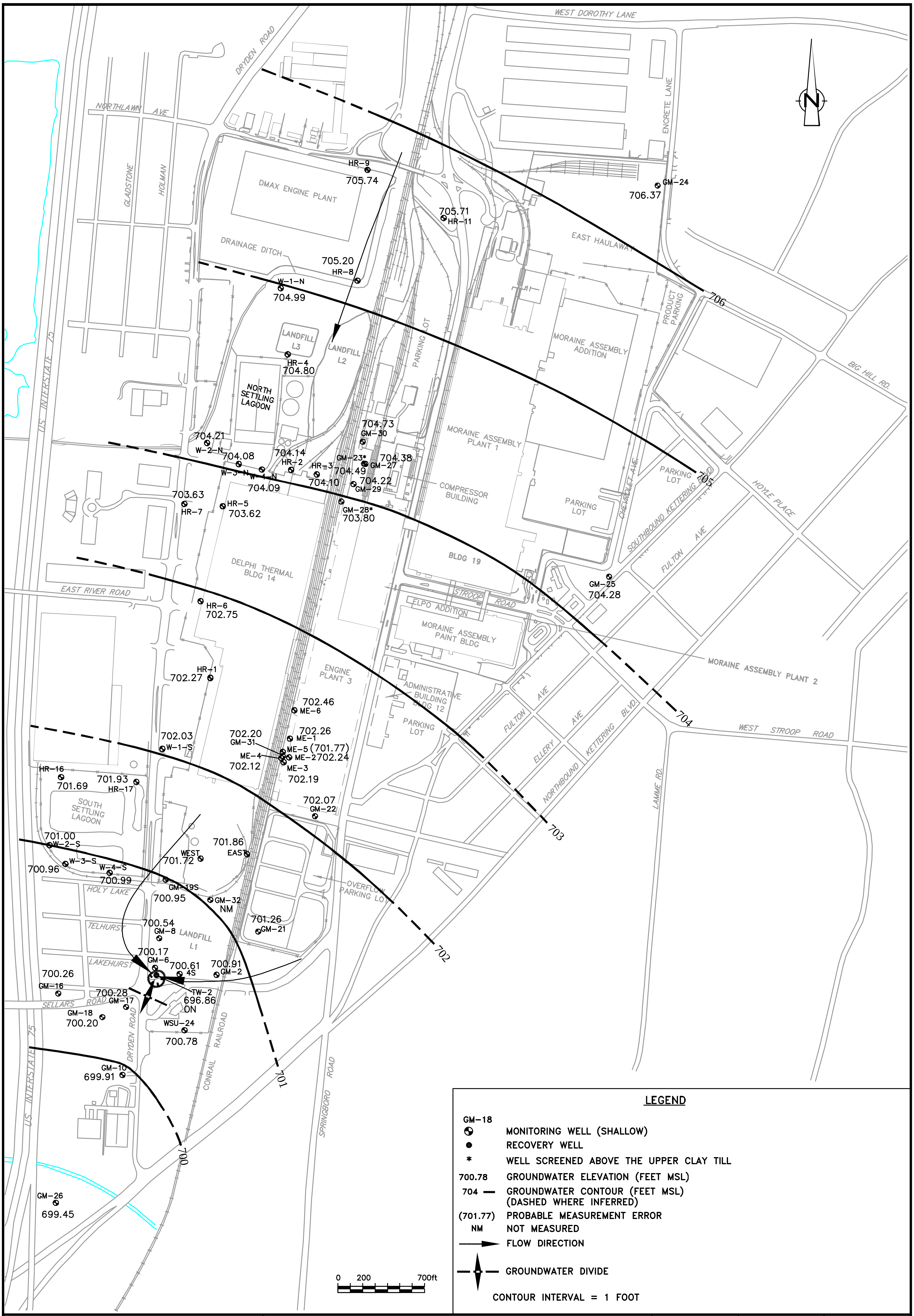
SITE LAYOUT
MORAINE ENGINE, MORAINE ASSEMBLY
AND DELPHI THERMAL FACILITIES
GENERAL MOTORS CORPORATION
MORAINE, OHIO

DATE 11AUG00	PROJECT MANAGER J. REID	DRAWING NAME \CRA\IMS-CMS\IMS-00
DRAWN R. SMITH	LEAD DESIGN PROF. J. REID	CHECKED N. GILLOTTI
PROJECT NUMBER 0H000294.0002.0007		FIGURE NUMBER 1-1



ARCADIS GERAGHTY&MILLER

6397 Emerald Parkway
Suite 150, Dublin, OH 43016
Tel: 614/764-2310 Fax: 614/764-1270

WATER TABLE SURFACE (UPPER AQUIFER)
ON SEPTEMBER 13, 1999
GENERAL MOTORS CORPORATION, MORAINE, OHIO

DATE 11AUG00	PROJECT MANAGER R. ASTLE	DRAWING NAME \CRA\IMS-CMS\IMS-01
DRAWN R. SMITH	LEAD DESIGN PROF.	CHECKED R. ASTLE
PROJECT NUMBER OH000294.0002.0007		FIGURE NUMBER 1-2

LEGEND

◒ GM-9	MONITORING WELL (DEEP)
⧖	FIRE WELLS
▲	INACTIVE PRODUCTION WELLS
⊘	ACTIVE PRODUCTION WELLS
⊕	PUMP TO WASTE WELL
⊗	SEALED WELL
699.47	GROUNDWATER ELEVATION (FEET MSL)
NM	NOT MEASURED
NA	NOT ACCESSIBLE
706 —	GROUNDWATER CONTOUR (FEET MSL) (DASHED WHERE INFERRED)
┬─┬	CONE OF DEPRESSION
──►	GROUNDWATER FLOW DIRECTION

CONTOUR INTERVAL = 1 FOOT

ARCADIS GERAGHTY & MILLER

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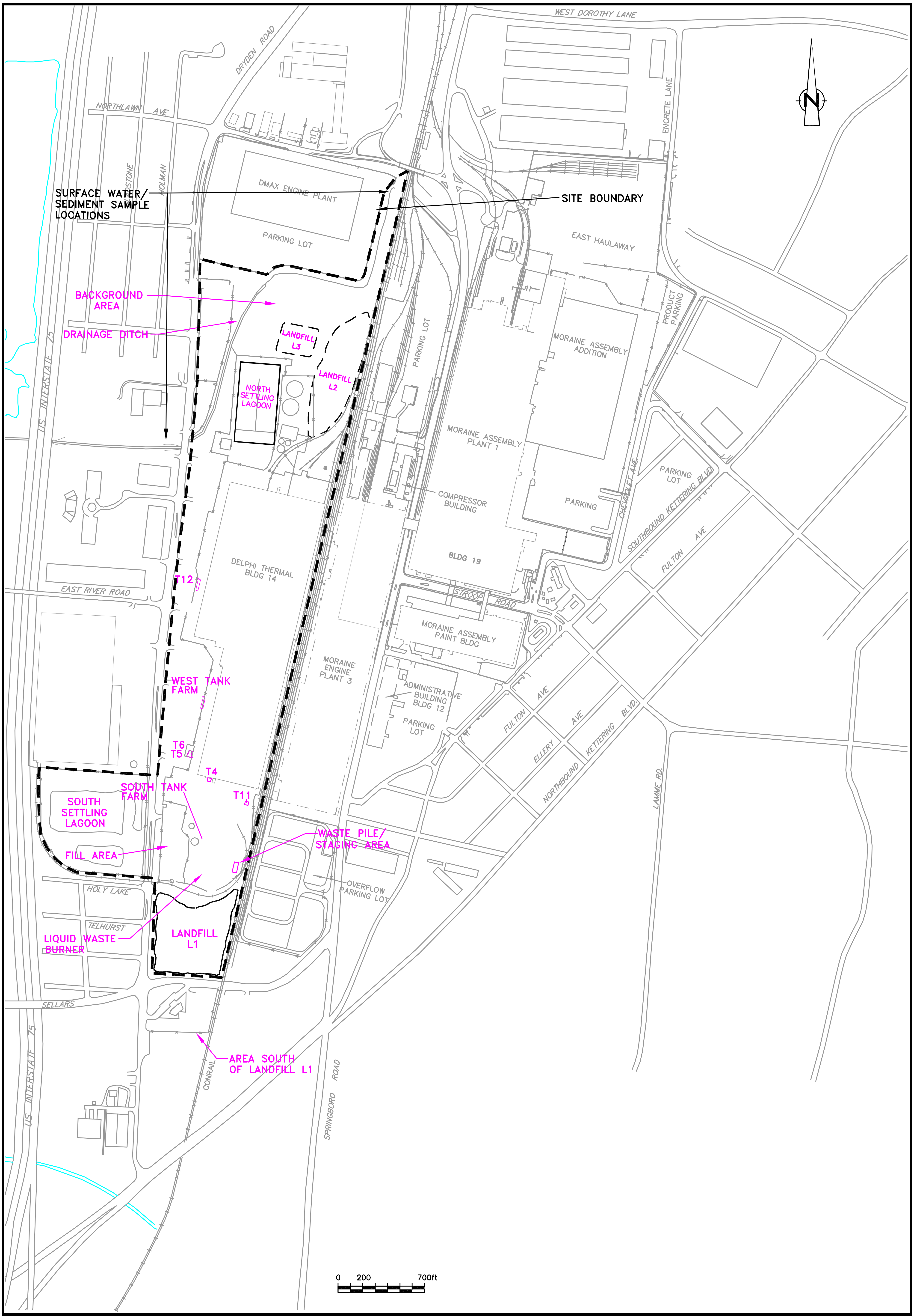
POTENTIOMETRIC SURFACE (LOWER AQUIFER)
ON SEPTEMBER 13, 1999
GENERAL MOTORS CORPORATION, MORAINE, OHIO

DATE 11AUG00	PROJECT MANAGER N. GILLOTTI	DRAWING NAME \CRA\IMS-CMS\IMS-02
DRAWN R. SMITH	LEAD DESIGN PROF.	CHECKED N. GILLOTTI
PROJECT NUMBER OH000294.0002.0007		FIGURE NUMBER 1-3

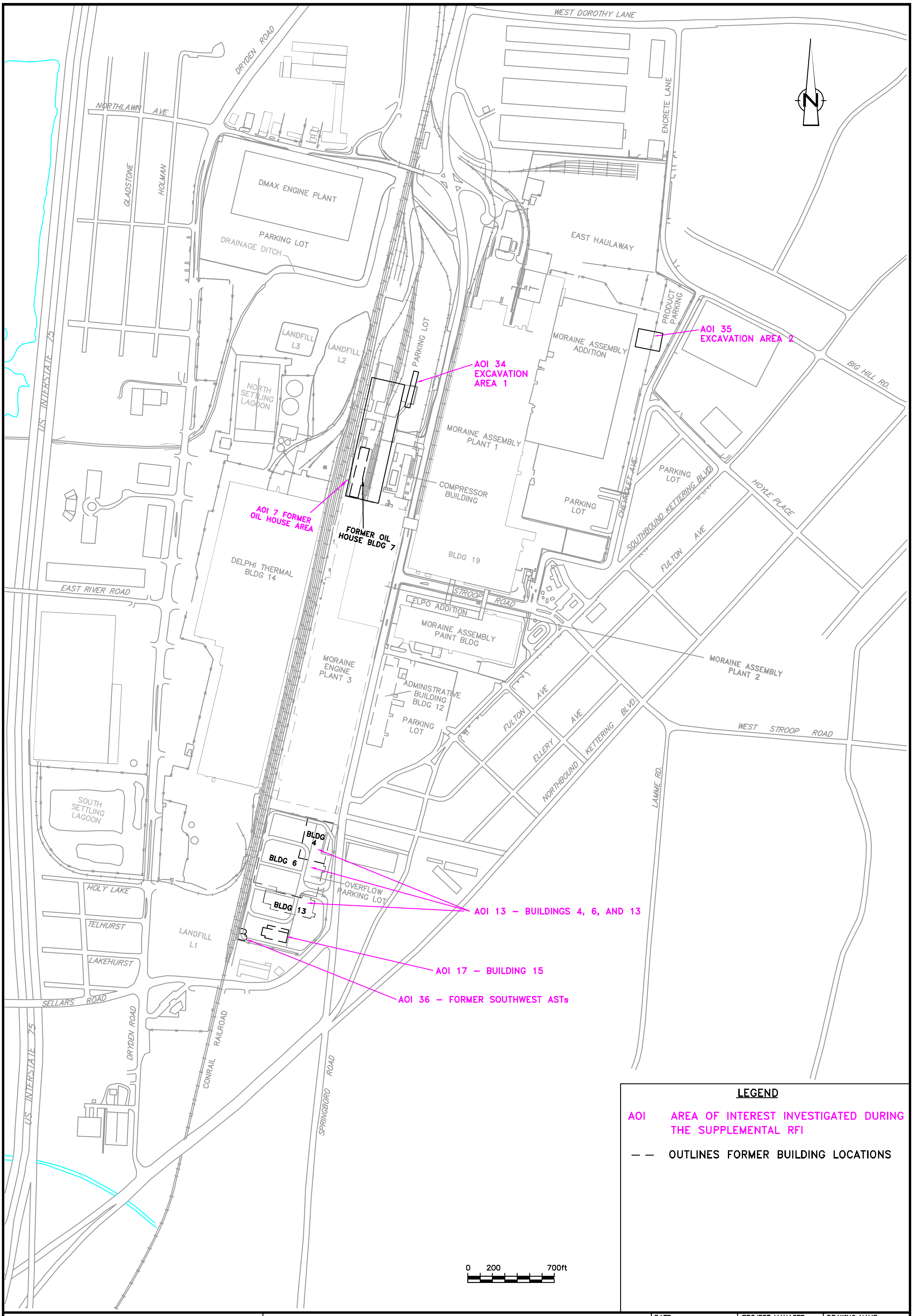


ARCADIS GERAGHTY & MILLER

6397 Emerald Parkway
Suite 150, Dublin, OH 43016
Tel: 614/764-2310 Fax: 614/764-1270

LOCATIONS OF SWMUs AT DELPHI THERMAL MORAINE GENERAL MOTORS CORPORATION MORAINE, OHIO

DATE 16AUG00	PROJECT MANAGER J. REID	DRAWING NAME CRA\IMS-CMS\IMS-08B
DRAWN R. SMITH	LEAD DESIGN PROF. J. REID	CHECKED N. GILLOTTI
PROJECT NUMBER OH000294.0002.0007		FIGURE NUMBER 1-4



LEGEND

AOI AREA OF INTEREST INVESTIGATED DURING THE SUPPLEMENTAL RFI

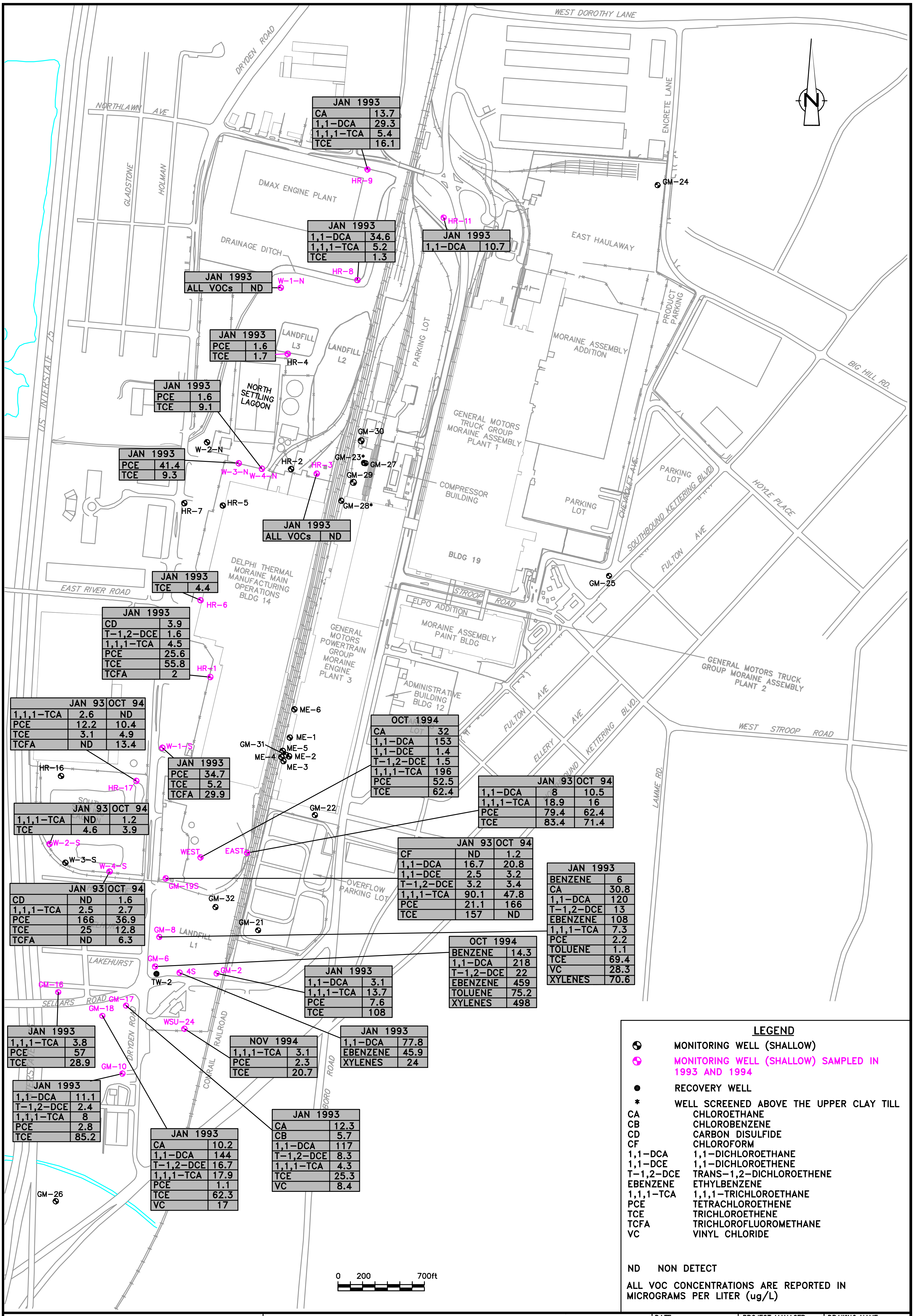
— — OUTLINES FORMER BUILDING LOCATIONS

ARCADIS GERAGHTY & MILLER

6397 Emerald Parkway
Suite 150, Dublin, OH 43016
Tel: 614/764–2310 Fax: 614/764–1270

LOCATIONS OF AOIs AT
MORAINE ENGINE AND MORAINE ASSEMBLY
GENERAL MOTORS CORPORATION
MORAINE, OHIO

DATE 11AUG00	PROJECT MANAGER J. REID	DRAWING NAME \CRA\IMS–CMS\IMS–03
DRAWN R. SMITH	LEAD DESIGN PROF.	CHECKED N. GILLOTTI
PROJECT NUMBER OH000294.0002.0007		FIGURE NUMBER 1–5



JAN 1993	
CA	13.7
1,1-DCA	29.3
1,1,1-TCA	5.4
TCE	16.1

JAN 1993	
1,1-DCA	34.6
1,1,1-TCA	5.2
TCE	1.3

JAN 1993	
1,1-DCA	10.7

JAN 1993	
ALL VOCs	ND

JAN 1993	
PCE	1.6
TCE	1.7

JAN 1993	
PCE	1.6
TCE	9.1

JAN 1993	
PCE	41.4
TCE	9.3

JAN 1993	
ALL VOCs	ND

JAN 1993	
TCE	4.4

JAN 1993	
CD	3.9
T-1,2-DCE	1.6
1,1,1-TCA	4.5
PCE	25.6
TCE	55.8
TCFA	2

	JAN 93	OCT 94
1,1,1-TCA	2.6	ND
PCE	12.2	10.4
TCE	3.1	4.9
TCFA	ND	13.4

OCT 1994	
CA	32
1,1-DCA	153
1,1-DCE	1.4
T-1,2-DCE	1.5
1,1,1-TCA	196
PCE	52.5
TCE	62.4

JAN 1993	
PCE	34.7
TCE	5.2
TCFA	29.9

	JAN 93	OCT 94
1,1-DCA	8	10.5
1,1,1-TCA	18.9	16
PCE	79.4	62.4
TCE	83.4	71.4

	JAN 93	OCT 94
1,1,1-TCA	ND	1.2
TCE	4.6	3.9

	JAN 93	OCT 94
CF	ND	1.2
1,1-DCA	16.7	20.8
1,1-DCE	2.5	3.2
T-1,2-DCE	3.2	3.4
1,1,1-TCA	90.1	47.8
PCE	21.1	166
TCE	157	ND

JAN 1993	
BENZENE	6
CA	30.8
1,1-DCA	120
T-1,2-DCE	13
EBENZENE	108
1,1,1-TCA	7.3
PCE	2.2
TOLUENE	1.1
TCE	69.4
VC	28.3
XYLENES	70.6

	JAN 93	OCT 94
CD	ND	1.6
1,1,1-TCA	2.5	2.7
PCE	166	36.9
TCE	25	12.8
TCFA	ND	6.3

OCT 1994	
BENZENE	14.3
1,1-DCA	218
T-1,2-DCE	22
EBENZENE	459
TOLUENE	75.2
XYLENES	498

JAN 1993	
1,1-DCA	3.1
1,1,1-TCA	13.7
PCE	7.6
TCE	108

JAN 1993	
1,1,1-TCA	3.8
PCE	57
TCE	28.9

NOV 1994	
1,1,1-TCA	3.1
PCE	2.3
TCE	20.7

JAN 1993	
1,1-DCA	77.8
EBENZENE	45.9
XYLENES	24

JAN 1993	
1,1-DCA	11.1
T-1,2-DCE	2.4
1,1,1-TCA	8
PCE	2.8
TCE	85.2

JAN 1993	
CA	12.3
CB	5.7
1,1-DCA	117
T-1,2-DCE	8.3
1,1,1-TCA	4.3
TCE	25.3
VC	8.4

JAN 1993	
CA	10.2
1,1-DCA	144
T-1,2-DCE	16.7
1,1,1-TCA	17.9
PCE	1.1
TCE	62.3
VC	17

LEGEND

⊕	MONITORING WELL (SHALLOW)
⊕	MONITORING WELL (SHALLOW) SAMPLED IN 1993 AND 1994
●	RECOVERY WELL
*	WELL SCREENED ABOVE THE UPPER CLAY TILL
CA	CHLOROETHANE
CB	CHLOROBENZENE
CD	CARBON DISULFIDE
CF	CHLOROFORM
1,1-DCA	1,1-DICHLOROETHANE
1,1-DCE	1,1-DICHLOROETHENE
T-1,2-DCE	TRANS-1,2-DICHLOROETHENE
EBENZENE	ETHYLBENZENE
1,1,1-TCA	1,1,1-TRICHLOROETHANE
PCE	TETRACHLOROETHENE
TCE	TRICHLOROETHENE
TCFA	TRICHLOROFLUOROMETHANE
VC	VINYL CHLORIDE
ND	NON DETECT

ALL VOC CONCENTRATIONS ARE REPORTED IN MICROGRAMS PER LITER (ug/L)

ARCADIS GERAGHTY&MILLER

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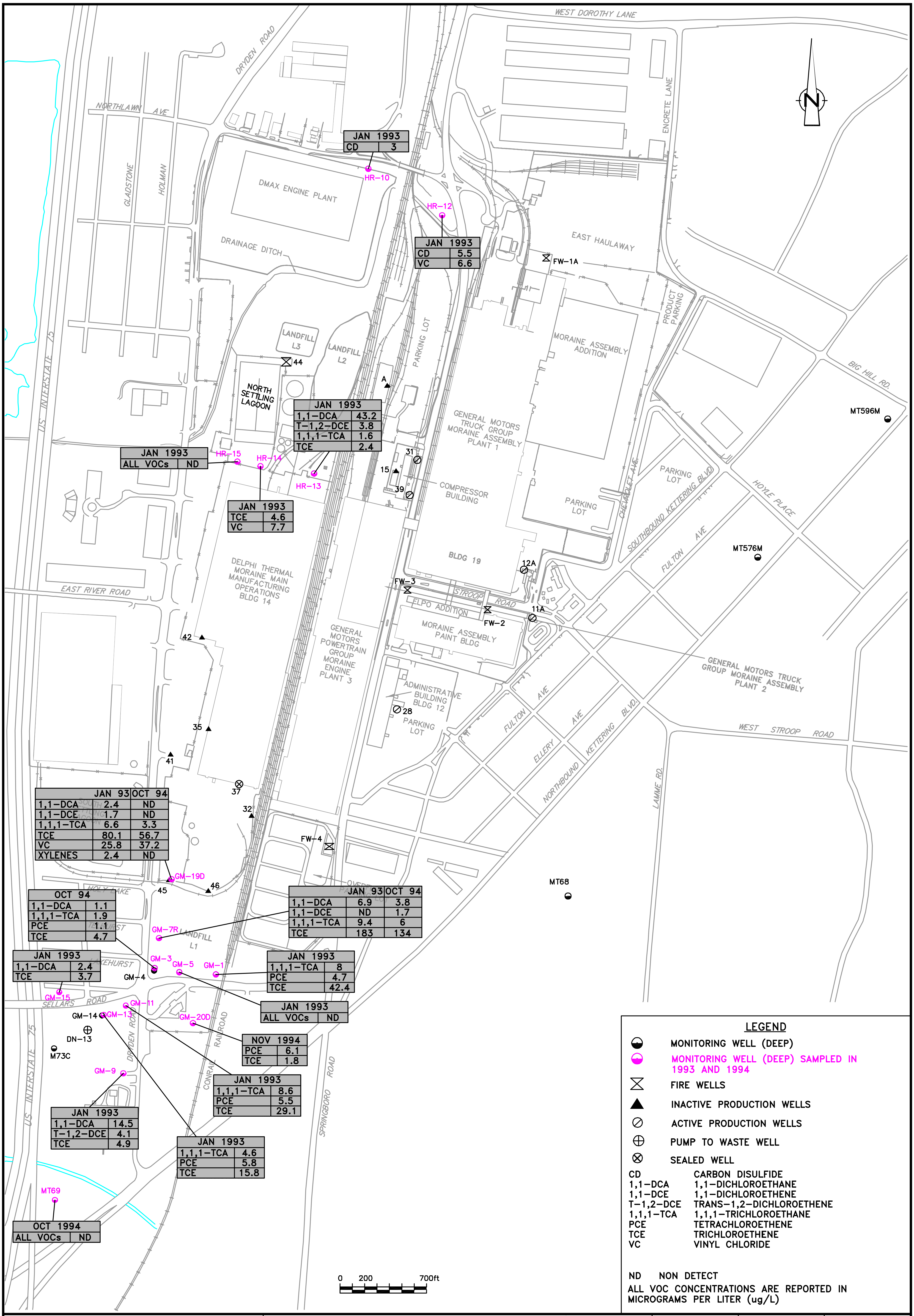
1993/1994 VOC CONCENTRATIONS IN UPPER AQUIFER MONITORING WELLS DELPHI THERMAL MORAINE RFI, GENERAL MOTORS CORPORATION, MORAINE, OHIO

DATE 11AUG00	PROJECT MANAGER N. GILLOTTI	DRAWING NAME \CRA\IMS-CMS\IMS-04
DRAWN R. SMITH	LEAD DESIGN PROF.	CHECKED N. GILLOTTI
PROJECT NUMBER 0H000294.0002.0007		FIGURE NUMBER 1-6



LEGEND

◒	MONITORING WELL (DEEP)
◒	MONITORING WELL (DEEP) SAMPLED IN 1993 AND 1994
⌛	FIRE WELLS
▲	INACTIVE PRODUCTION WELLS
⊘	ACTIVE PRODUCTION WELLS
⊕	PUMP TO WASTE WELL
⊗	SEALED WELL

CD	CARBON DISULFIDE
1,1-DCA	1,1-DICHLOROETHANE
1,1-DCE	1,1-DICHLOROETHENE
T-1,2-DCE	TRANS-1,2-DICHLOROETHENE
1,1,1-TCA	1,1,1-TRICHLOROETHANE
PCE	TETRACHLOROETHENE
TCE	TRICHLOROETHENE
VC	VINYL CHLORIDE

ND NON DETECT

ALL VOC CONCENTRATIONS ARE REPORTED IN MICROGRAMS PER LITER (ug/L)

ARCADIS GERAGHTY&MILLER
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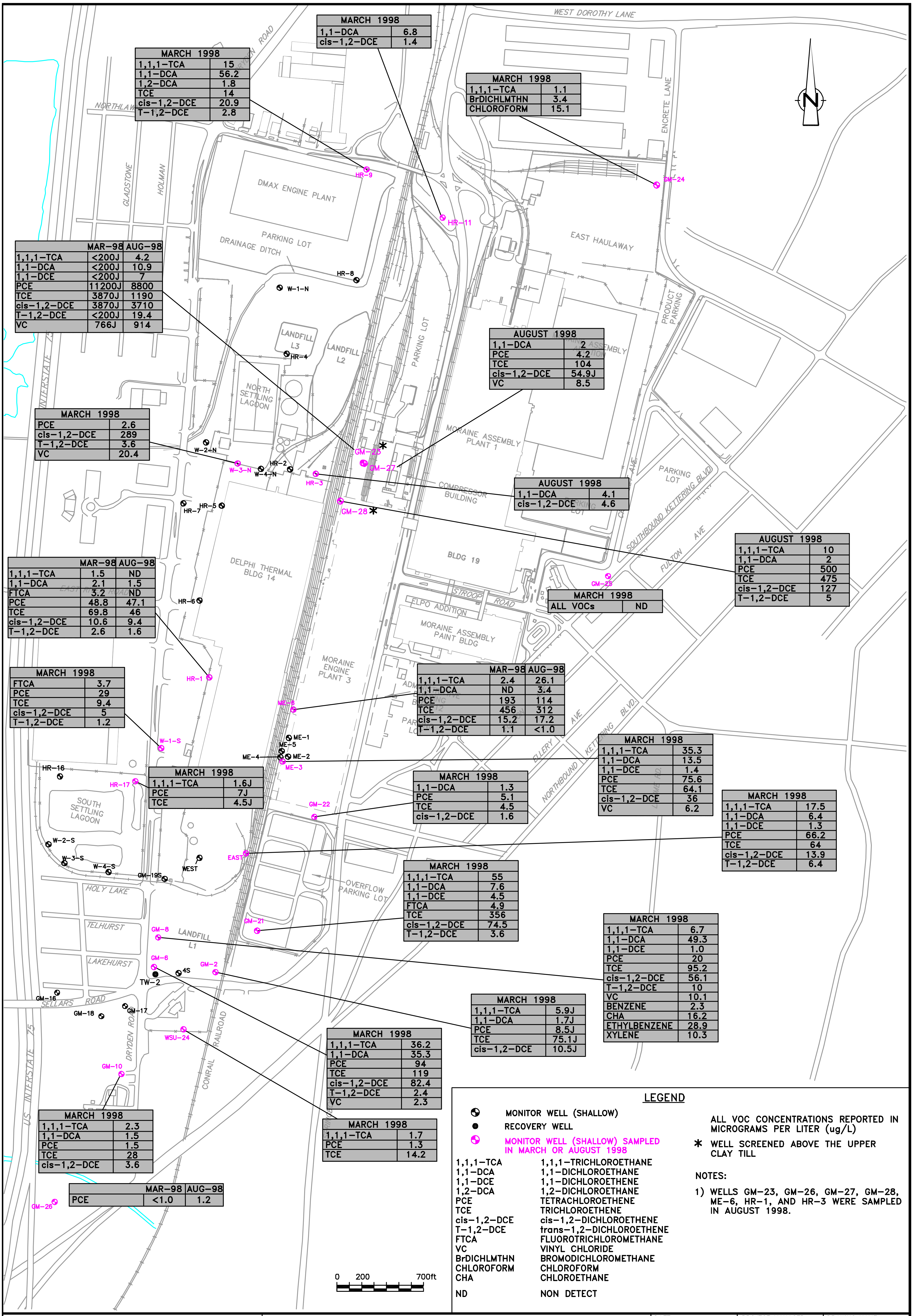
1993/1994 VOC CONCENTRATIONS IN LOWER AQUIFER MONITORING WELLS DELPHI THERMAL MORAINE RFI, GENERAL MOTORS CORPORATION, MORAINE, OHIO

DATE 11AUG00	PROJECT MANAGER N. GILLOTTI	DRAWING NAME CRA\IMS-CMS\IMS-05
DRAWN R. SMITH	LEAD DESIGN PROF.	CHECKED N. GILLOTTI
PROJECT NUMBER OH000294.0002.0007		FIGURE NUMBER 1-7



MARCH 1998	
1,1-DCA	6.8
cis-1,2-DCE	1.4

MARCH 1998	
1,1,1-TCA	15
1,1-DCA	56.2
1,2-DCA	1.8
TCE	14
cis-1,2-DCE	20.9
T-1,2-DCE	2.8

MARCH 1998	
1,1,1-TCA	1.1
BrDICHLMTHN	3.4
CHLOROFORM	15.1

	MAR-98	AUG-98
1,1,1-TCA	<200J	4.2
1,1-DCA	<200J	10.9
1,1-DCE	<200J	7
PCE	11200J	8800
TCE	3870J	1190
cis-1,2-DCE	3870J	3710
T-1,2-DCE	<200J	19.4
VC	766J	914

AUGUST 1998	
1,1-DCA	2
PCE	4.2
TCE	104
cis-1,2-DCE	54.9J
VC	8.5

MARCH 1998	
PCE	2.6
cis-1,2-DCE	289
T-1,2-DCE	3.6
VC	20.4

AUGUST 1998	
1,1-DCA	4.1
cis-1,2-DCE	4.6

AUGUST 1998	
1,1,1-TCA	10
1,1-DCA	2
PCE	500
TCE	475
cis-1,2-DCE	127
T-1,2-DCE	5

	MAR-98	AUG-98
1,1,1-TCA	1.5	ND
1,1-DCA	2.1	1.5
FTCA	3.2	ND
PCE	48.8	47.1
TCE	69.8	46
cis-1,2-DCE	10.6	9.4
T-1,2-DCE	2.6	1.6

MARCH 1998	
ALL VOCs	ND

MARCH 1998	
FTCA	3.7
PCE	29
TCE	9.4
cis-1,2-DCE	5
T-1,2-DCE	1.2

	MAR-98	AUG-98
1,1,1-TCA	2.4	26.1
1,1-DCA	ND	3.4
PCE	193	114
TCE	456	312
cis-1,2-DCE	15.2	17.2
T-1,2-DCE	1.1	<1.0

MARCH 1998	
1,1,1-TCA	35.3
1,1-DCA	13.5
1,1-DCE	1.4
PCE	75.6
TCE	64.1
cis-1,2-DCE	36
VC	6.2

MARCH 1998	
1,1,1-TCA	1.6J
PCE	7J
TCE	4.5J

MARCH 1998	
1,1-DCA	1.3
PCE	5.1
TCE	4.5
cis-1,2-DCE	1.6

MARCH 1998	
1,1,1-TCA	17.5
1,1-DCA	6.4
1,1-DCE	1.3
PCE	66.2
TCE	64
cis-1,2-DCE	13.9
T-1,2-DCE	6.4

MARCH 1998	
1,1,1-TCA	55
1,1-DCA	7.6
1,1-DCE	4.5
FTCA	4.9
TCE	356
cis-1,2-DCE	74.5
T-1,2-DCE	3.6

MARCH 1998	
1,1,1-TCA	6.7
1,1-DCA	49.3
1,1-DCE	1.0
PCE	20
TCE	95.2
cis-1,2-DCE	56.1
T-1,2-DCE	10
VC	10.1
BENZENE	2.3
CHA	16.2
ETHYLBENZENE	28.9
XYLENE	10.3

MARCH 1998	
1,1,1-TCA	5.9J
1,1-DCA	1.7J
PCE	8.5J
TCE	75.1J
cis-1,2-DCE	10.5J

MARCH 1998	
1,1,1-TCA	36.2
1,1-DCA	35.3
PCE	94
TCE	119
cis-1,2-DCE	82.4
T-1,2-DCE	2.4
VC	2.3

MARCH 1998	
1,1,1-TCA	2.3
1,1-DCA	1.5
PCE	1.5
TCE	28
cis-1,2-DCE	3.6

MARCH 1998	
1,1,1-TCA	1.7
PCE	1.3
TCE	14.2

	MAR-98	AUG-98
PCE	<1.0	1.2

LEGEND

⊕	MONITOR WELL (SHALLOW)
●	RECOVERY WELL
⊕	MONITOR WELL (SHALLOW) SAMPLED IN MARCH OR AUGUST 1998

1,1,1-TCA	1,1,1-TRICHLOROETHANE
1,1-DCA	1,1-DICHLOROETHANE
1,1-DCE	1,1-DICHLOROETHENE
1,2-DCA	1,2-DICHLOROETHANE
PCE	TETRACHLOROETHENE
TCE	TRICHLOROETHENE
cis-1,2-DCE	cis-1,2-DICHLOROETHENE
T-1,2-DCE	trans-1,2-DICHLOROETHENE
FTCA	FLUOROTRICHLOROMETHANE
VC	VINYL CHLORIDE
BrDICHLMTHN	BROMODICHLOROMETHANE
CHLOROFORM	CHLOROFORM
CHA	CHLOROETHANE
ND	NON DETECT

ALL VOC CONCENTRATIONS REPORTED IN MICROGRAMS PER LITER (ug/L)

* WELL SCREENED ABOVE THE UPPER CLAY TILL

NOTES:

1) WELLS GM-23, GM-26, GM-27, GM-28, ME-6, HR-1, AND HR-3 WERE SAMPLED IN AUGUST 1998.

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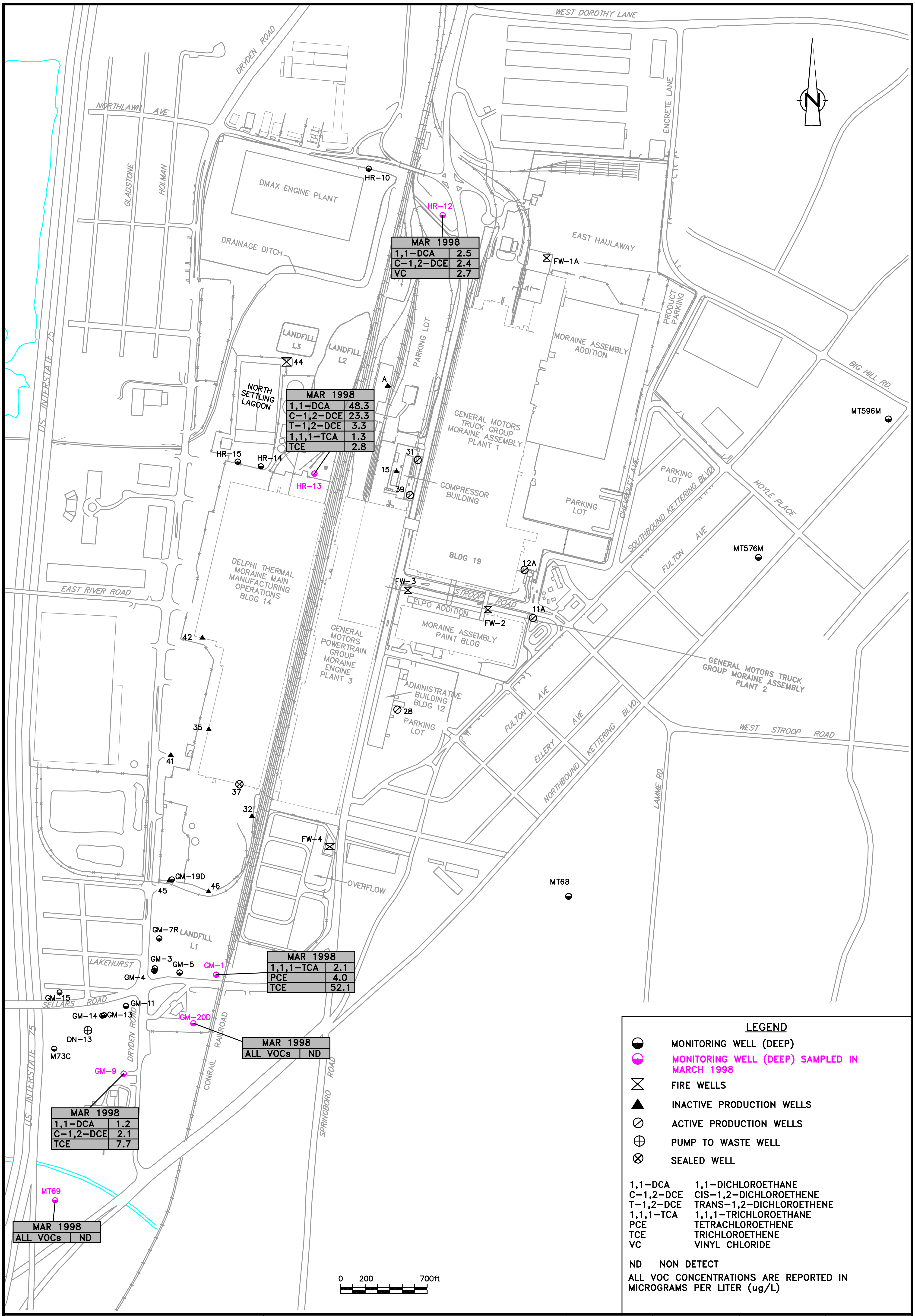
1998 VOC CONCENTRATIONS IN UPPER AQUIFER MONITORING WELLS SUPPLEMENTAL RFI GENERAL MOTORS CORPORATION, MORAINE, OHIO

DATE 11AUG00	PROJECT MANAGER N. GILLOTTI	DRAWING NAME \CRA\IMS-CMS\IMS-06
DRAWN R. SMITH	LEAD DESIGN PROF.	CHECKED N. GILLOTTI
PROJECT NUMBER OH000294.0002.0007		FIGURE NUMBER 1-8



MAR 1998	
1,1-DCA	2.5
C-1,2-DCE	2.4
VC	2.7

MAR 1998	
1,1-DCA	48.3
C-1,2-DCE	23.3
T-1,2-DCE	3.3
1,1,1-TCA	1.3
TCE	2.8

MAR 1998	
1,1,1-TCA	2.1
PCE	4.0
TCE	52.1

MAR 1998	
ALL VOCs	ND

MAR 1998	
1,1-DCA	1.2
C-1,2-DCE	2.1
TCE	7.7

MAR 1998	
ALL VOCs	ND

LEGEND

◒	MONITORING WELL (DEEP)
◒	MONITORING WELL (DEEP) SAMPLED IN MARCH 1998
⧖	FIRE WELLS
▲	INACTIVE PRODUCTION WELLS
⊘	ACTIVE PRODUCTION WELLS
⊕	PUMP TO WASTE WELL
⊗	SEALED WELL

1,1-DCA	1,1-DICHLOROETHANE
C-1,2-DCE	CIS-1,2-DICHLOROETHENE
T-1,2-DCE	TRANS-1,2-DICHLOROETHENE
1,1,1-TCA	1,1,1-TRICHLOROETHANE
PCE	TETRACHLOROETHENE
TCE	TRICHLOROETHENE
VC	VINYL CHLORIDE
ND	NON DETECT

ALL VOC CONCENTRATIONS ARE REPORTED IN MICROGRAMS PER LITER (ug/L)

ARCADIS GERAGHTY&MILLER

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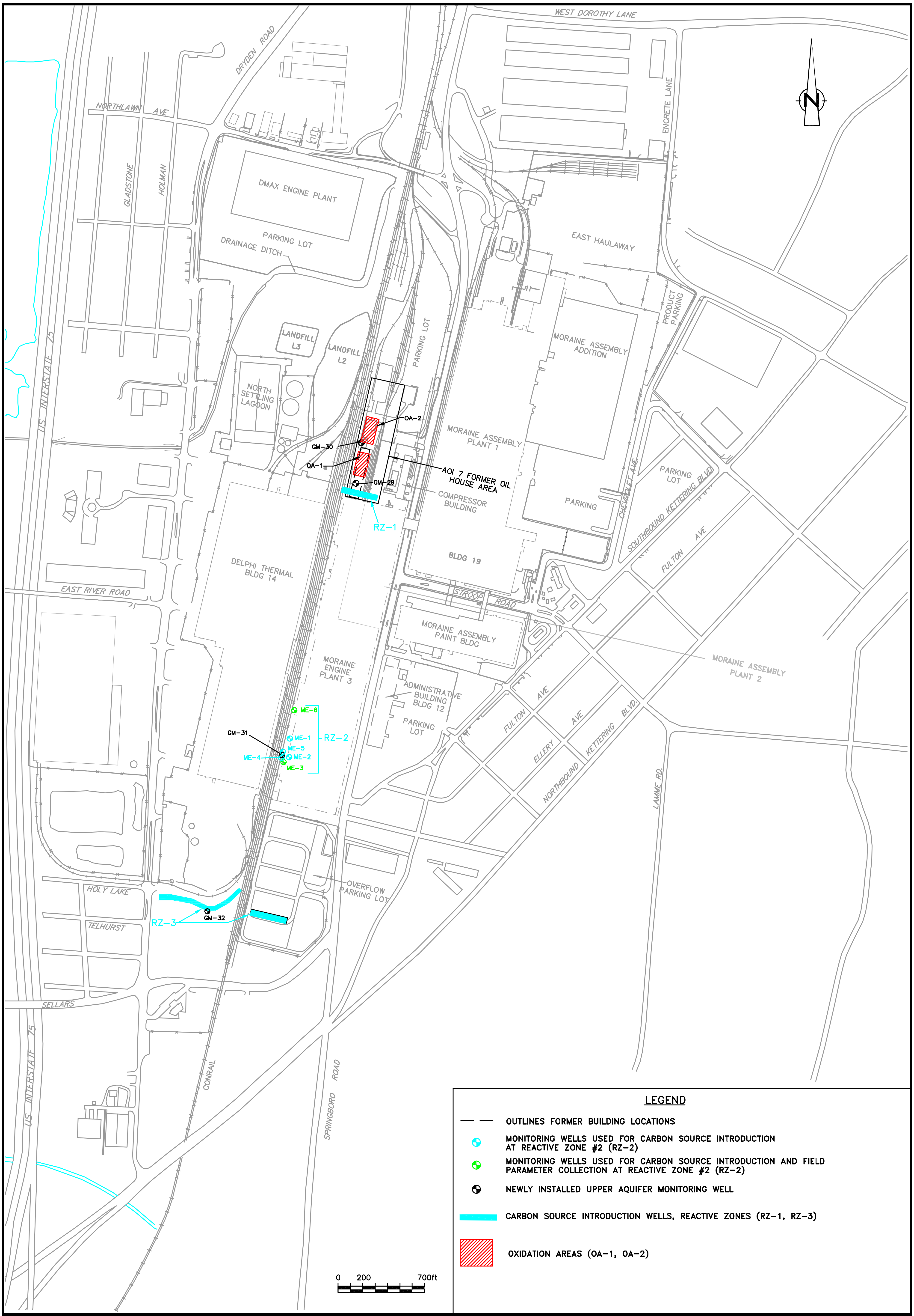
1998 VOC CONCENTRATIONS IN LOWER AQUIFER MONITORING WELLS SUPPLEMENTAL RFI, GENERAL MOTORS CORPORATION, MORAINE, OHIO

DATE 11AUG00	PROJECT MANAGER N. GILLOTTI	DRAWING NAME CRA\IMS-CMS\IMS-07
DRAWN R. SMITH	LEAD DESIGN PROF.	CHECKED N. GILLOTTI
PROJECT NUMBER OH000294.0002.0007		FIGURE NUMBER 1-9



LEGEND

— — OUTLINES FORMER BUILDING LOCATIONS

● MONITORING WELLS USED FOR CARBON SOURCE INTRODUCTION AT REACTIVE ZONE #2 (RZ-2)

● MONITORING WELLS USED FOR CARBON SOURCE INTRODUCTION AND FIELD PARAMETER COLLECTION AT REACTIVE ZONE #2 (RZ-2)

● NEWLY INSTALLED UPPER AQUIFER MONITORING WELL

▬ CARBON SOURCE INTRODUCTION WELLS, REACTIVE ZONES (RZ-1, RZ-3)

▨ OXIDATION AREAS (OA-1, OA-2)

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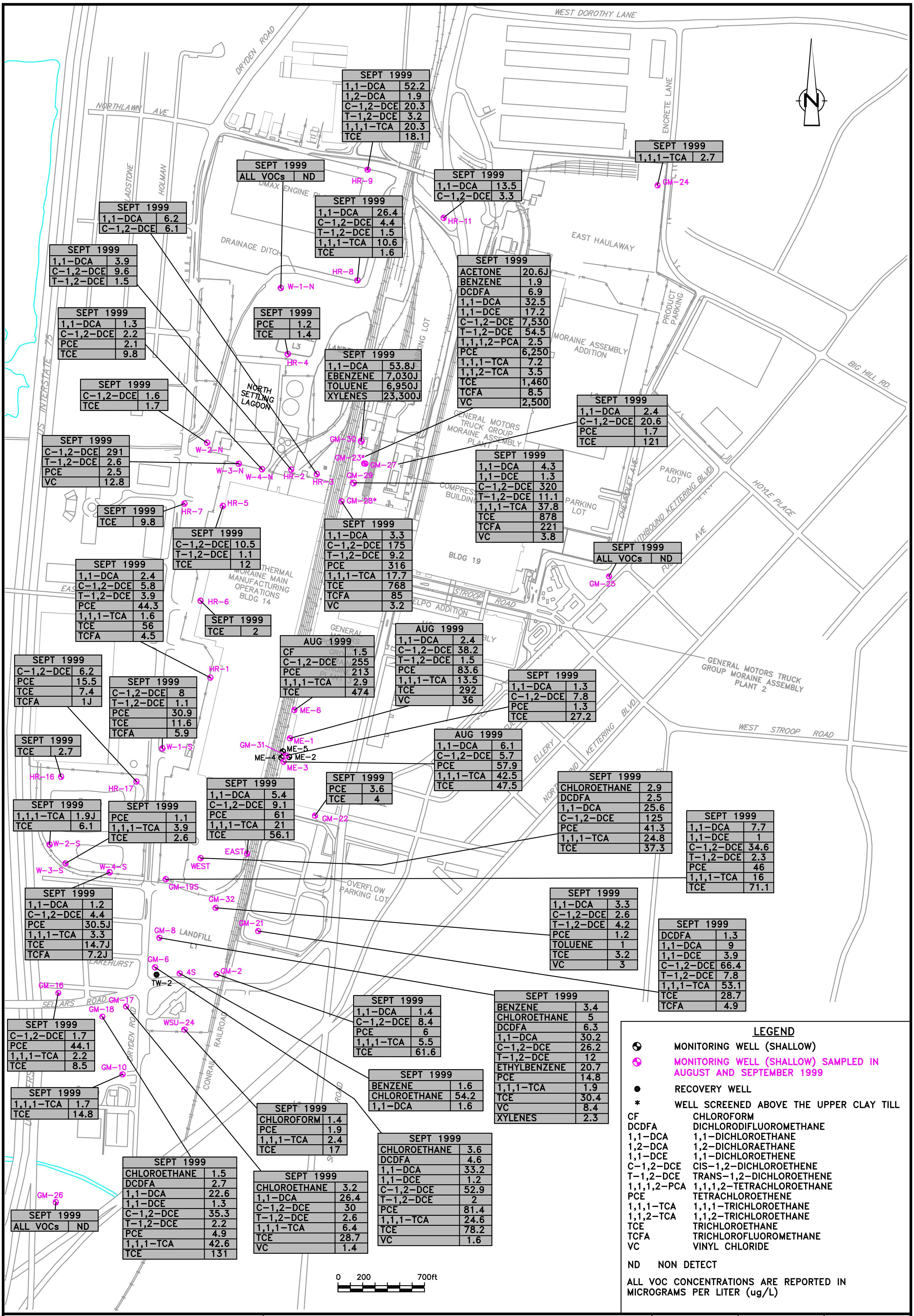
SITE LAYOUT FOR AOI 7 INTERIM MEASURES
GENERAL MOTORS CORPORATION
MORAINE, OHIO

DATE 16AUG00	PROJECT MANAGER J. REID	DRAWING NAME \CRA\IMS-CMS\IMS-09
DRAWN R. SMITH	LEAD DESIGN PROF. J. REID	CHECKED N. GILLOTTI
PROJECT NUMBER OH000294.0002.0007		FIGURE NUMBER 4-1



SEPT 1999	
1,1-DCA	52.2
1,2-DCA	1.9
C-1,2-DCE	20.3
T-1,2-DCE	3.2
1,1,1-TCA	20.3
TCE	18.1

SEPT 1999	
1,1,1-TCA	2.7

SEPT 1999	
ALL VOCs	ND

SEPT 1999	
1,1-DCA	13.5
C-1,2-DCE	3.3

SEPT 1999	
1,1-DCA	26.4
C-1,2-DCE	4.4
T-1,2-DCE	1.5
1,1,1-TCA	10.6
TCE	1.6

SEPT 1999	
1,1-DCA	6.2
C-1,2-DCE	6.1

SEPT 1999	
1,1-DCA	3.9
C-1,2-DCE	9.6
T-1,2-DCE	1.5

SEPT 1999	
ACETONE	20.6J
BENZENE	1.9
DCDFA	6.9
1,1-DCA	32.5
1,1-DCE	17.2
C-1,2-DCE	7,530
T-1,2-DCE	54.5
1,1,1,2-PCA	2.5
PCE	6,250
1,1,1-TCA	7.2
1,1,2-TCA	3.5
TCE	1,460
TCFA	8.5
VC	2,500

SEPT 1999	
1,1-DCA	1.3
C-1,2-DCE	2.2
PCE	2.1
TCE	9.8

SEPT 1999	
PCE	1.2
TCE	1.4

SEPT 1999	
1,1-DCA	53.8J
EBENZENE	7,030J
TOLUENE	6,950J
XYLENES	23,300J

SEPT 1999	
C-1,2-DCE	1.6
TCE	1.7

SEPT 1999	
1,1-DCA	2.4
C-1,2-DCE	20.6
PCE	1.7
TCE	121

SEPT 1999	
C-1,2-DCE	291
T-1,2-DCE	2.6
PCE	2.5
VC	12.8

SEPT 1999	
1,1-DCA	4.3
1,1-DCE	1.3
C-1,2-DCE	320
T-1,2-DCE	11.1
1,1,1-TCA	37.8
TCE	878
TCFA	221
VC	3.8

SEPT 1999	
TCE	9.8

SEPT 1999	
1,1-DCA	3.3
C-1,2-DCE	175
T-1,2-DCE	9.2
PCE	316
1,1,1-TCA	17.7
TCE	768
TCFA	85
VC	3.2

SEPT 1999	
C-1,2-DCE	10.5
T-1,2-DCE	1.1
TCE	12

SEPT 1999	
ALL VOCs	ND

SEPT 1999	
1,1-DCA	2.4
C-1,2-DCE	5.8
T-1,2-DCE	3.9
PCE	44.3
1,1,1-TCA	1.6
TCE	56
TCFA	4.5

SEPT 1999	
TCE	2

AUG 1999	
1,1-DCA	2.4
C-1,2-DCE	38.2
T-1,2-DCE	1.5
PCE	83.6
1,1,1-TCA	13.5
TCE	292
VC	36

AUG 1999	
CF	1.5
C-1,2-DCE	255
PCE	213
1,1,1-TCA	2.9
TCE	474

SEPT 1999	
C-1,2-DCE	6.2
PCE	15.5
TCE	7.4
TCFA	1J

SEPT 1999	
1,1-DCA	1.3
C-1,2-DCE	7.8
PCE	1.3
TCE	27.2

SEPT 1999	
C-1,2-DCE	8
T-1,2-DCE	1.1
PCE	30.9
TCE	11.6
TCFA	5.9

AUG 1999	
1,1-DCA	6.1
C-1,2-DCE	5.7
PCE	57.9
1,1,1-TCA	42.5
TCE	47.5

SEPT 1999	
TCE	2.7

SEPT 1999	
CHLOROETHANE	2.9
DCDFA	2.5
1,1-DCA	25.6
C-1,2-DCE	125
PCE	41.3
1,1,1-TCA	24.8
TCE	37.3

SEPT 1999	
PCE	3.6
TCE	4

SEPT 1999	
1,1-DCA	5.4
C-1,2-DCE	9.1
PCE	61
1,1,1-TCA	21
TCE	56.1

SEPT 1999	
1,1,1-TCA	1.9J
TCE	6.1

SEPT 1999	
PCE	1.1
1,1,1-TCA	3.9
TCE	2.6

SEPT 1999	
1,1-DCA	7.7
1,1-DCE	1
C-1,2-DCE	34.6
T-1,2-DCE	2.3
PCE	46
1,1,1-TCA	16
TCE	71.1

SEPT 1999	
1,1-DCA	1.2
C-1,2-DCE	4.4
PCE	30.5J
1,1,1-TCA	3.3
TCE	14.7J
TCFA	7.2J

SEPT 1999	
1,1-DCA	3.3
C-1,2-DCE	2.6
T-1,2-DCE	4.2
PCE	1.2
TOLUENE	1
TCE	3.2
VC	3

SEPT 1999	
DCDFA	1.3
1,1-DCA	9
1,1-DCE	3.9
C-1,2-DCE	66.4
T-1,2-DCE	7.8
1,1,1-TCA	53.1
TCE	28.7
TCFA	4.9

SEPT 1999	
BENZENE	3.4
CHLOROETHANE	5
DCDFA	6.3
1,1-DCA	30.2
C-1,2-DCE	26.2
T-1,2-DCE	12
ETHYLBENZENE	20.7
PCE	14.8
1,1,1-TCA	1.9
TCE	30.4
VC	8.4
XYLENES	2.3

SEPT 1999	
1,1-DCA	1.4
C-1,2-DCE	8.4
PCE	6
1,1,1-TCA	5.5
TCE	61.6

SEPT 1999	
C-1,2-DCE	1.7
PCE	44.1
1,1,1-TCA	2.2
TCE	8.5

SEPT 1999	
BENZENE	1.6
CHLOROETHANE	54.2
1,1-DCA	1.6

SEPT 1999	
1,1,1-TCA	1.7
TCE	14.8

SEPT 1999	
CHLOROFORM	1.4
PCE	1.9
1,1,1-TCA	2.4
TCE	17

SEPT 1999	
CHLOROETHANE	3.6
DCDFA	4.6
1,1-DCA	33.2
1,1-DCE	1.2
C-1,2-DCE	52.9
T-1,2-DCE	2
PCE	81.4
1,1,1-TCA	24.6
TCE	78.2
VC	1.6

SEPT 1999	
CHLOROETHANE	1.5
DCDFA	2.7
1,1-DCA	22.6
1,1-DCE	1.3
C-1,2-DCE	35.3
T-1,2-DCE	2.2
PCE	4.9
1,1,1-TCA	42.6
TCE	131

SEPT 1999	
CHLOROETHANE	3.2
1,1-DCA	26.4
C-1,2-DCE	30
T-1,2-DCE	2.6
1,1,1-TCA	6.4
TCE	28.7
VC	1.4

SEPT 1999	
ALL VOCs	ND

LEGEND

◐	MONITORING WELL (SHALLOW)
◐	MONITORING WELL (SHALLOW) SAMPLED IN AUGUST AND SEPTEMBER 1999
●	RECOVERY WELL
*	WELL SCREENED ABOVE THE UPPER CLAY TILL

CF	CHLOROFORM
DCDFA	DICHLORODIFLUOROMETHANE
1,1-DCA	1,1-DICHLOROETHANE
1,2-DCA	1,2-DICHLORAETHANE
1,1-DCE	1,1-DICHLOROETHENE
C-1,2-DCE	CIS-1,2-DICHLOROETHENE
T-1,2-DCE	TRANS-1,2-DICHLOROETHENE
1,1,1,2-PCA	1,1,1,2-TETRACHLOROETHANE
PCE	TETRACHLOROETHENE
1,1,1-TCA	1,1,1-TRICHLOROETHANE
1,1,2-TCA	1,1,2-TRICHLOROETHANE
TCE	TRICHLOROETHANE
TCFA	TRICHLOROFLUOROMETHANE
VC	VINYL CHLORIDE

ND NON DETECT

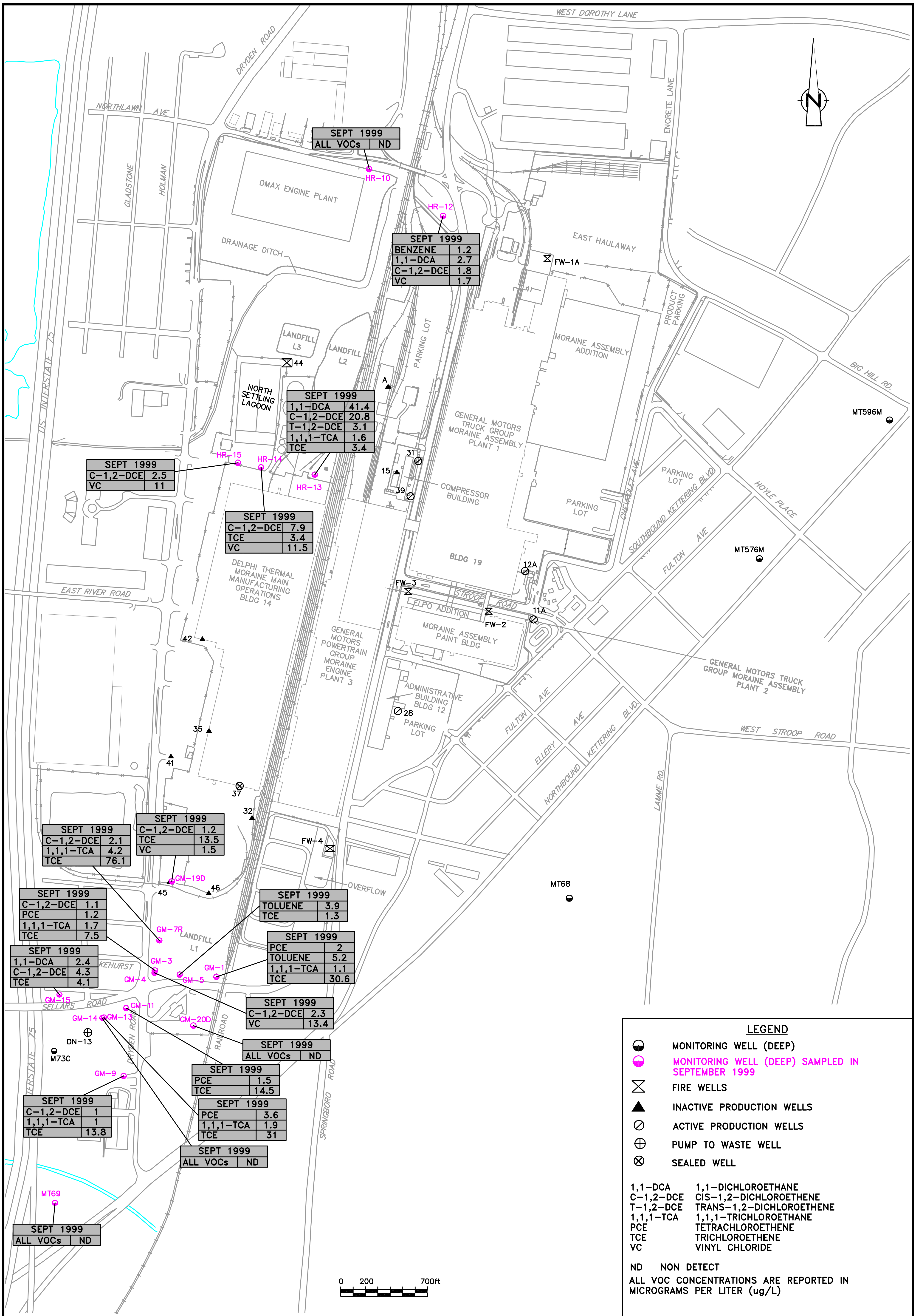
ALL VOC CONCENTRATIONS ARE REPORTED IN MICROGRAMS PER LITER (ug/L)

ARCADIS GERAGHTY&MILLER

6397 Emerald Parkway
Suite 150, Dublin, OH 43016
Tel: 614/764-2310 Fax: 614/764-1270

1999 VOC BASELINE CONCENTRATIONS IN UPPER AQUIFER MONITORING WELLS GENERAL MOTORS CORPORATION, MORAINE, OHIO

DATE 17AUG00	PROJECT MANAGER N. GILLOTTI	DRAWING NAME CRA\IMS-CMS\IMS-10
DRAWN R. SMITH	LEAD DESIGN PROF.	CHECKED N. GILLOTTI
PROJECT NUMBER OH000294.0002.0007		FIGURE NUMBER 4-2



SEPT 1999	
ALL VOCs	ND

SEPT 1999	
BENZENE	1.2
1,1-DCA	2.7
C-1,2-DCE	1.8
VC	1.7

SEPT 1999	
1,1-DCA	41.4
C-1,2-DCE	20.8
T-1,2-DCE	3.1
1,1,1-TCA	1.6
TCE	3.4

SEPT 1999	
C-1,2-DCE	2.5
VC	11

SEPT 1999	
C-1,2-DCE	7.9
TCE	3.4
VC	11.5

SEPT 1999	
C-1,2-DCE	1.2
TCE	13.5
VC	1.5

SEPT 1999	
C-1,2-DCE	2.1
1,1,1-TCA	4.2
TCE	76.1

SEPT 1999	
C-1,2-DCE	1.1
PCE	1.2
1,1,1-TCA	1.7
TCE	7.5

SEPT 1999	
TOLUENE	3.9
TCE	1.3

SEPT 1999	
PCE	2
TOLUENE	5.2
1,1,1-TCA	1.1
TCE	30.6

SEPT 1999	
1,1-DCA	2.4
C-1,2-DCE	4.3
TCE	4.1

SEPT 1999	
C-1,2-DCE	2.3
VC	13.4

SEPT 1999	
ALL VOCs	ND

SEPT 1999	
PCE	1.5
TCE	14.5

SEPT 1999	
C-1,2-DCE	1
1,1,1-TCA	1
TCE	13.8

SEPT 1999	
PCE	3.6
1,1,1-TCA	1.9
TCE	31

SEPT 1999	
ALL VOCs	ND

SEPT 1999	
ALL VOCs	ND

LEGEND

◒	MONITORING WELL (DEEP)
◒	MONITORING WELL (DEEP) SAMPLED IN SEPTEMBER 1999
⌛	FIRE WELLS
▲	INACTIVE PRODUCTION WELLS
⊘	ACTIVE PRODUCTION WELLS
⊕	PUMP TO WASTE WELL
⊗	SEALED WELL

1,1-DCA	1,1-DICHLOROETHANE
C-1,2-DCE	CIS-1,2-DICHLOROETHENE
T-1,2-DCE	TRANS-1,2-DICHLOROETHENE
1,1,1-TCA	1,1,1-TRICHLOROETHANE
PCE	TETRACHLOROETHENE
TCE	TRICHLOROETHENE
VC	VINYL CHLORIDE

ND NON DETECT

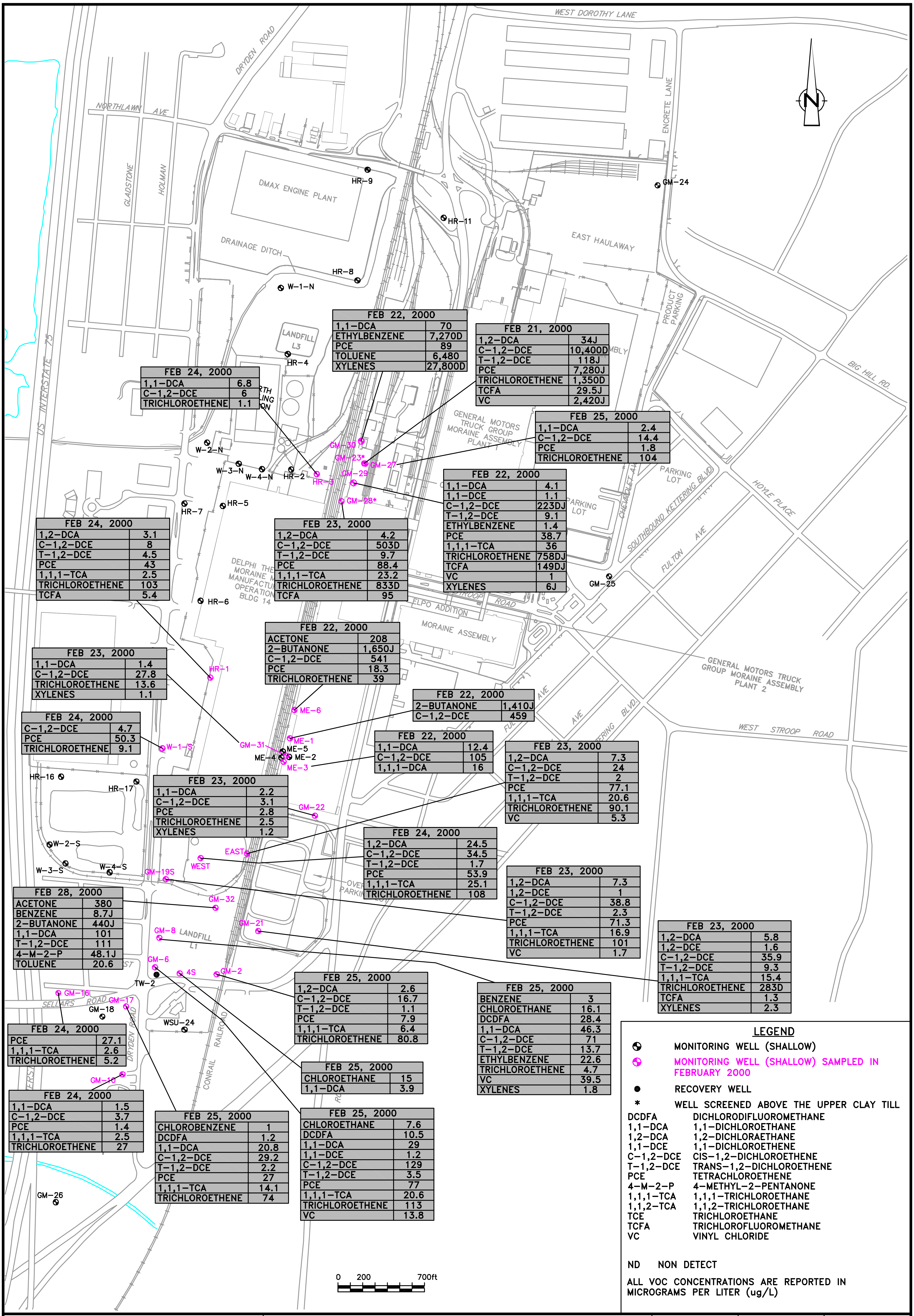
ALL VOC CONCENTRATIONS ARE REPORTED IN MICROGRAMS PER LITER (ug/L)

ARCADIS GERAGHTY&MILLER

6397 Emerald Parkway
Suite 150, Dublin, OH 43016
Tel: 614/764-2310 Fax: 614/764-1270

1999 VOC BASELINE CONCENTRATIONS IN LOWER AQUIFER MONITORING WELLS GENERAL MOTORS CORPORATION, MORAINE, OHIO

DATE 17AUG00	PROJECT MANAGER N. GILLOTTI	DRAWING NAME CRA\IMS-CMS\IMS-11
DRAWN R. SMITH	LEAD DESIGN PROF.	CHECKED N. GILLOTTI
PROJECT NUMBER OH000294.0002.0007		FIGURE NUMBER 4-3



FEB 22, 2000	
1,1-DCA	70
ETHYLBENZENE	7,270D
PCE	89
TOLUENE	6,480
XYLENES	27,800D

FEB 21, 2000	
1,2-DCA	34J
C-1,2-DCE	10,400D
T-1,2-DCE	118J
PCE	7,280J
TRICHLOROETHENE	1,350D
TCFA	29.5J
VC	2,420J

FEB 24, 2000	
1,1-DCA	6.8
C-1,2-DCE	6
TRICHLOROETHENE	1.1

FEB 25, 2000	
1,1-DCA	2.4
C-1,2-DCE	14.4
PCE	1.8
TRICHLOROETHENE	104

FEB 22, 2000	
1,1-DCA	4.1
1,1-DCE	1.1
C-1,2-DCE	223DJ
T-1,2-DCE	9.1
ETHYLBENZENE	1.4
PCE	38.7
1,1,1-TCA	36
TRICHLOROETHENE	758DJ
TCFA	149DJ
VC	1
XYLENES	6J

FEB 24, 2000	
1,2-DCA	3.1
C-1,2-DCE	8
T-1,2-DCE	4.5
PCE	43
1,1,1-TCA	2.5
TRICHLOROETHENE	103
TCFA	5.4

FEB 23, 2000	
1,2-DCA	4.2
C-1,2-DCE	503D
T-1,2-DCE	9.7
PCE	88.4
1,1,1-TCA	23.2
TRICHLOROETHENE	833D
TCFA	95

FEB 22, 2000	
ACETONE	208
2-BUTANONE	1,650J
C-1,2-DCE	541
PCE	18.3
TRICHLOROETHENE	39

FEB 23, 2000	
1,1-DCA	1.4
C-1,2-DCE	27.8
TRICHLOROETHENE	13.6
XYLENES	1.1

FEB 22, 2000	
2-BUTANONE	1,410J
C-1,2-DCE	459

FEB 24, 2000	
C-1,2-DCE	4.7
PCE	50.3
TRICHLOROETHENE	9.1

FEB 22, 2000	
1,1-DCA	12.4
C-1,2-DCE	105
1,1,1-DCA	16

FEB 23, 2000	
1,2-DCA	7.3
C-1,2-DCE	24
T-1,2-DCE	2
PCE	77.1
1,1,1-TCA	20.6
TRICHLOROETHENE	90.1
VC	5.3

FEB 23, 2000	
1,1-DCA	2.2
C-1,2-DCE	3.1
PCE	2.8
TRICHLOROETHENE	2.5
XYLENES	1.2

FEB 24, 2000	
1,2-DCA	24.5
C-1,2-DCE	34.5
T-1,2-DCE	1.7
PCE	53.9
1,1,1-TCA	25.1
TRICHLOROETHENE	108

FEB 23, 2000	
1,2-DCA	7.3
1,2-DCE	1
C-1,2-DCE	38.8
T-1,2-DCE	2.3
PCE	71.3
1,1,1-TCA	16.9
TRICHLOROETHENE	101
VC	1.7

FEB 28, 2000	
ACETONE	380
BENZENE	8.7J
2-BUTANONE	440J
1,1-DCA	101
T-1,2-DCE	111
4-M-2-P	48.1J
TOLUENE	20.6

FEB 23, 2000	
1,2-DCA	5.8
1,2-DCE	1.6
C-1,2-DCE	35.9
T-1,2-DCE	9.3
1,1,1-TCA	15.4
TRICHLOROETHENE	283D
TCFA	1.3
XYLENES	2.3

FEB 25, 2000	
1,2-DCA	2.6
C-1,2-DCE	16.7
T-1,2-DCE	1.1
PCE	7.9
1,1,1-TCA	6.4
TRICHLOROETHENE	80.8

FEB 25, 2000	
BENZENE	3
CHLOROETHANE	16.1
DCDFA	28.4
1,1-DCA	46.3
C-1,2-DCE	71
T-1,2-DCE	13.7
ETHYLBENZENE	22.6
TRICHLOROETHENE	4.7
VC	39.5
XYLENES	1.8

FEB 24, 2000	
PCE	27.1
1,1,1-TCA	2.6
TRICHLOROETHENE	5.2

FEB 25, 2000	
CHLOROETHANE	15
1,1-DCA	3.9

FEB 24, 2000	
1,1-DCA	1.5
C-1,2-DCE	3.7
PCE	1.4
1,1,1-TCA	2.5
TRICHLOROETHENE	27

FEB 25, 2000	
CHLOROBENZENE	1
DCDFA	1.2
1,1-DCA	20.8
C-1,2-DCE	29.2
T-1,2-DCE	2.2
PCE	27
1,1,1-TCA	14.1
TRICHLOROETHENE	74

FEB 25, 2000	
CHLOROETHANE	7.6
DCDFA	10.5
1,1-DCA	29
1,1-DCE	1.2
C-1,2-DCE	129
T-1,2-DCE	3.5
PCE	77
1,1,1-TCA	20.6
TRICHLOROETHENE	113
VC	13.8

LEGEND

⊕	MONITORING WELL (SHALLOW)
⊕	MONITORING WELL (SHALLOW) SAMPLED IN FEBRUARY 2000
●	RECOVERY WELL
*	WELL SCREENED ABOVE THE UPPER CLAY TILL

DCDFA	DICHLORODIFLUOROMETHANE
1,1-DCA	1,1-DICHLOROETHANE
1,2-DCA	1,2-DICHLORAETHANE
1,1-DCE	1,1-DICHLOROETHENE
C-1,2-DCE	CIS-1,2-DICHLOROETHENE
T-1,2-DCE	TRANS-1,2-DICHLOROETHENE
PCE	TETRACHLOROETHENE
4-M-2-P	4-METHYL-2-PENTANONE
1,1,1-TCA	1,1,1-TRICHLOROETHANE
1,1,2-TCA	1,1,2-TRICHLOROETHANE
TCE	TRICHLOROETHANE
TCFA	TRICHLOROFLUOROMETHANE
VC	VINYL CHLORIDE

ND NON DETECT

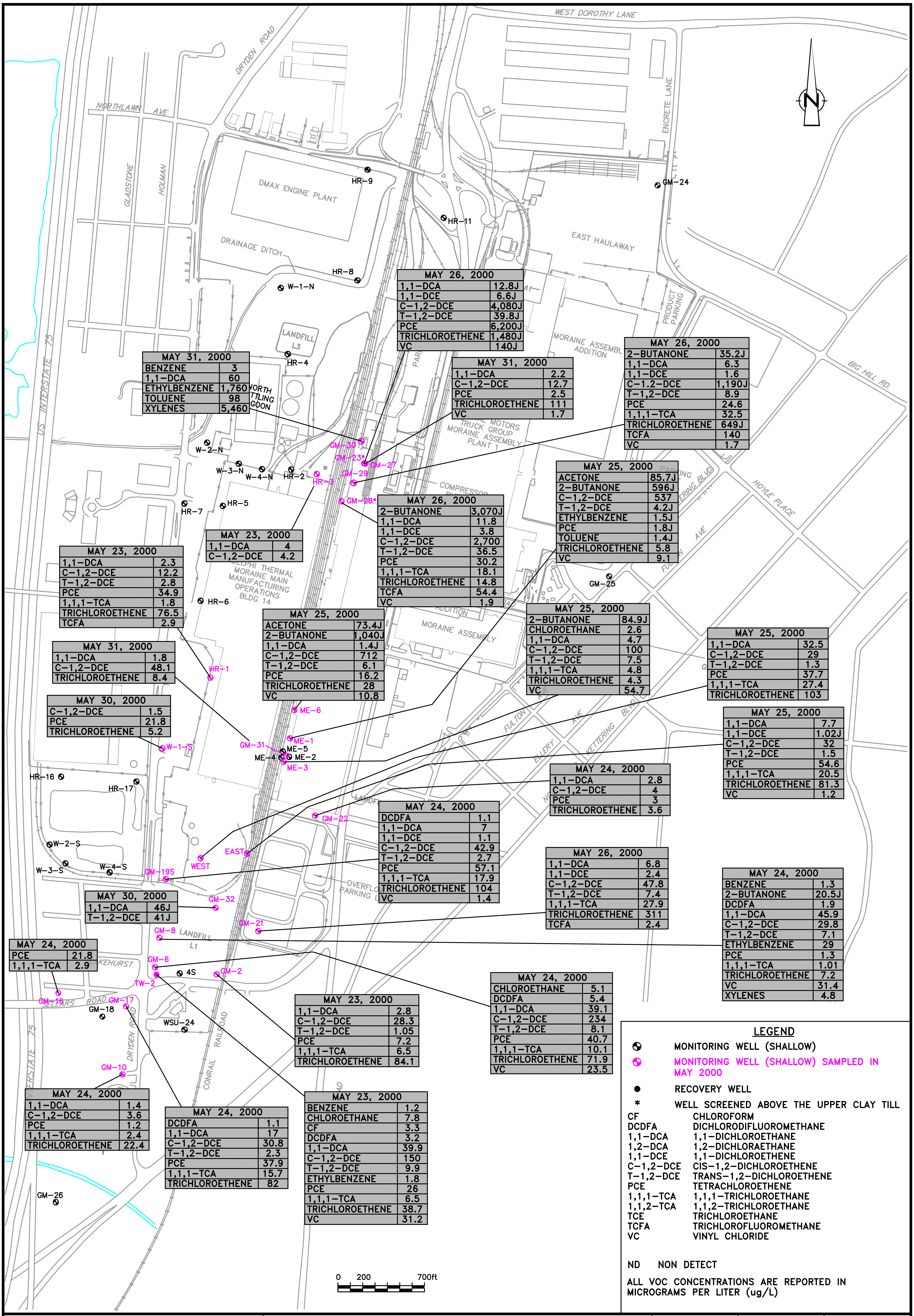
ALL VOC CONCENTRATIONS ARE REPORTED IN MICROGRAMS PER LITER (ug/L)

ARCADIS GERAGHTY&MILLER

6397 Emerald Parkway
Suite 150, Dublin, OH 43016
Tel: 614/764-2310 Fax: 614/764-1270

3-MONTH VOC CONCENTRATIONS IN UPPER AQUIFER MONITORING WELLS GENERAL MOTORS CORPORATION, MORAINE, OHIO

DATE 17AUG00	PROJECT MANAGER N. GILLOTTI	DRAWING NAME CRA\IMS-CMS\IMS-24
DRAWN R. SMITH	LEAD DESIGN PROF.	CHECKED N. GILLOTTI
PROJECT NUMBER OH000294.0002.0007		FIGURE NUMBER 4-4



MAY 26, 2000	
1,1-DCA	12.8J
1,1-DCE	6.6J
C-1,2-DCE	4,080J
T-1,2-DCE	39.8J
PCE	6,200J
TRICHLOROETHENE	1,480J
VC	140J

MAY 26, 2000	
2-BUTANONE	35.2J
1,1-DCA	6.3
1,1-DCE	1.6
C-1.2-DCE	1,190J
T-1,2-DCE	8.9
PCE	24.6
1,1,1-TCA	32.5
TRICHLOROETHENE	649J
TCFA	140
VC	1.7

MAY 31, 2000	
BENZENE	3
1,1-DCA	60
ETHYLBENZENE	1,760
TOLUENE	98
XYLENES	5,460

MAY 31, 2000	
1,1-DCA	2.2
C-1,2-DCE	12.7
PCE	2.5
TRICHLOROETHENE	111
VC	1.7

MAY 25, 2000	
ACETONE	85.7J
2-BUTANONE	596J
C-1,2-DCE	537
T-1,2-DCE	4.2J
ETHYLBENZENE	1.5J
PCE	1.8J
TOLUENE	1.4J
TRICHLOROETHENE	5.8
VC	9.1

MAY 26, 2000	
2-BUTANONE	3,070J
1,1-DCA	11.8
1,1-DCE	3.8
C-1,2-DCE	2,700
T-1,2-DCE	36.5
PCE	30.2
1,1,1-TCA	18.1
TRICHLOROETHENE	14.8
TCFA	54.4
VC	1.9

MAY 23, 2000	
1,1-DCA	4
C-1,2-DCE	4.2

MAY 23, 2000	
1,1-DCA	2.3
C-1,2-DCE	12.2
T-1,2-DCE	2.8
PCE	34.9
1,1,1-TCA	1.8
TRICHLOROETHENE	76.5
TCFA	2.9

MAY 25, 2000	
ACETONE	73.4J
2-BUTANONE	1,040J
1,1-DCA	1.4J
C-1,2-DCE	712
T-1,2-DCE	6.1
PCE	16.2
TRICHLOROETHENE	28
VC	10.8

MAY 25, 2000	
2-BUTANONE	84.9J
CHLOROETHANE	2.6
1,1-DCA	4.7
C-1,2-DCE	100
T-1,2-DCE	7.5
1,1,1-TCA	4.8
TRICHLOROETHENE	4.3
VC	54.7

MAY 25, 2000	
1,1-DCA	32.5
C-1,2-DCE	29
T-1,2-DCE	1.3
PCE	37.7
1,1,1-TCA	27.4
TRICHLOROETHENE	103

MAY 31, 2000	
1,1-DCA	1.8
C-1,2-DCE	48.1
TRICHLOROETHENE	8.4

MAY 30, 2000	
C-1,2-DCE	1.5
PCE	21.8
TRICHLOROETHENE	5.2

MAY 25, 2000	
1,1-DCA	7.7
1,1-DCE	1.02J
C-1,2-DCE	32
T-1,2-DCE	1.5
PCE	54.6
1,1,1-TCA	20.5
TRICHLOROETHENE	81.3
VC	1.2

MAY 24, 2000	
1,1-DCA	2.8
C-1,2-DCE	4
PCE	3
TRICHLOROETHENE	3.6

MAY 24, 2000	
DCDFA	1.1
1,1-DCA	7
1,1-DCE	1.1
C-1,2-DCE	42.9
T-1,2-DCE	2.7
PCE	57.1
1,1,1-TCA	17.9
TRICHLOROETHENE	104
VC	1.4

MAY 26, 2000	
1,1-DCA	6.8
1,1-DCE	2.4
C-1,2-DCE	47.8
T-1,2-DCE	7.4
1,1,1-TCA	27.9
TRICHLOROETHENE	311
TCFA	2.4

MAY 24, 2000	
BENZENE	1.3
2-BUTANONE	20.5J
DCDFA	1.9
1,1-DCA	45.9
C-1,2-DCE	29.8
T-1,2-DCE	7.1
ETHYLBENZENE	29
PCE	1.3
1,1,1-TCA	1.01
TRICHLOROETHENE	7.2
VC	31.4
XYLENES	4.8

MAY 30, 2000	
1,1-DCA	46J
T-1,2-DCE	41J

MAY 24, 2000	
PCE	21.8
1,1,1-TCA	2.9

MAY 24, 2000	
CHLOROETHANE	5.1
DCDFA	5.4
1,1-DCA	39.1
C-1,2-DCE	234
T-1,2-DCE	8.1
PCE	40.7
1,1,1-TCA	10.1
TRICHLOROETHENE	71.9
VC	23.5

MAY 23, 2000	
1,1-DCA	2.8
C-1,2-DCE	28.3
T-1,2-DCE	1.05
PCE	7.2
1,1,1-TCA	6.5
TRICHLOROETHENE	84.1

MAY 24, 2000	
1,1-DCA	1.4
C-1,2-DCE	3.6
PCE	1.2
1,1,1-TCA	2.4
TRICHLOROETHENE	22.4

MAY 24, 2000	
DCDFA	1.1
1,1-DCA	17
C-1,2-DCE	30.8
T-1,2-DCE	2.3
PCE	37.9
1,1,1-TCA	15.7
TRICHLOROETHENE	82

MAY 23, 2000	
BENZENE	1.2
CHLOROETHANE	7.8
CF	3.3
DCDFA	3.2
1,1-DCA	39.9
C-1,2-DCE	150
T-1,2-DCE	9.9
ETHYLBENZENE	1.8
PCE	26
1,1,1-TCA	6.5
TRICHLOROETHENE	38.7
VC	31.2

LEGEND

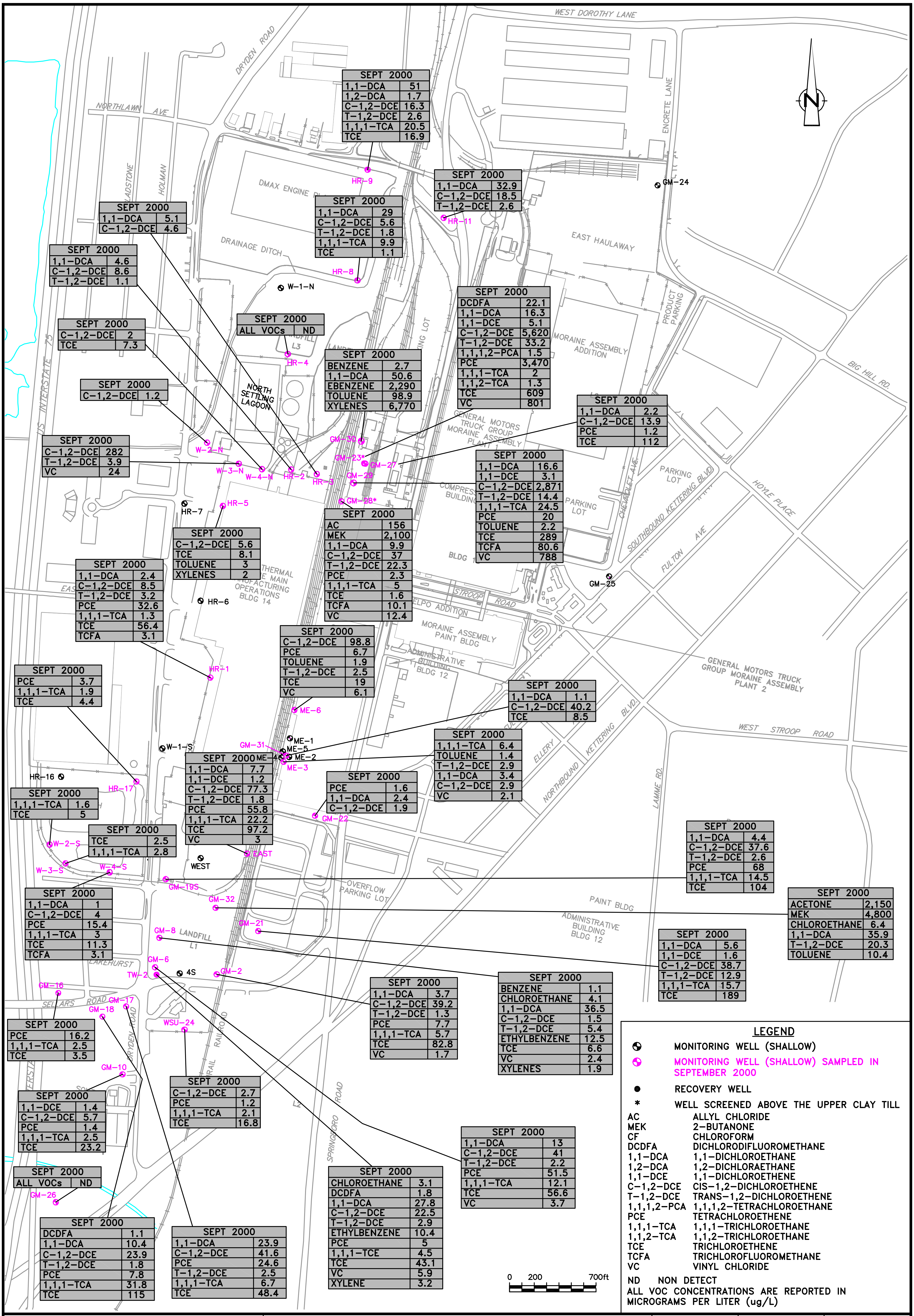
⊕	MONITORING WELL (SHALLOW)
⊕	MONITORING WELL (SHALLOW) SAMPLED IN MAY 2000
●	RECOVERY WELL
*	WELL SCREENED ABOVE THE UPPER CLAY TILL
CF	CHLOROFORM
DCDFA	DICHLORODIFLUOROMETHANE
1,1-DCA	1,1-DICHLOROETHANE
1,2-DCA	1,2-DICHLORAETHANE
1,1-DCE	1,1-DICHLOROETHENE
C-1,2-DCE	CIS-1,2-DICHLOROETHENE
T-1,2-DCE	TRANS-1,2-DICHLOROETHENE
PCE	TETRACHLOROETHENE
1,1,1-TCA	1,1,1-TRICHLOROETHANE
1,1,2-TCA	1,1,2-TRICHLOROETHANE
TCE	TRICHLOROETHANE
TCFA	TRICHLOROFLUOROMETHANE
VC	VINYL CHLORIDE
ND	NON DETECT

ALL VOC CONCENTRATIONS ARE REPORTED IN MICROGRAMS PER LITER (ug/L)

ARCADIS GERAGHTY&MILLER
6397 Emerald Parkway
Suite 150, Dublin, OH 43016
Tel: 614/764-2310 Fax: 614/764-1270

6-MONTH VOC CONCENTRATIONS IN UPPER AQUIFER MONITORING WELLS GENERAL MOTORS CORPORATION, MORAINE, OHIO

DATE 17AUG00	PROJECT MANAGER N. GILLOTTI	DRAWING NAME CRA\IMS-CMS\IMS-23
DRAWN R. SMITH	LEAD DESIGN PROF.	CHECKED N. GILLOTTI
PROJECT NUMBER OH000294.0002.0007		FIGURE NUMBER 4-5



SEPT 2000	
1,1-DCA	51
1,2-DCA	1.7
C-1,2-DCE	16.3
T-1,2-DCE	2.6
1,1,1-TCA	20.5
TCE	16.9

SEPT 2000	
1,1-DCA	32.9
C-1,2-DCE	18.5
T-1,2-DCE	2.6

SEPT 2000	
1,1-DCA	5.1
C-1,2-DCE	4.6

SEPT 2000	
1,1-DCA	29
C-1,2-DCE	5.6
T-1,2-DCE	1.8
1,1,1-TCA	9.9
TCE	1.1

SEPT 2000	
1,1-DCA	4.6
C-1,2-DCE	8.6
T-1,2-DCE	1.1

SEPT 2000	
DCDFA	22.1
1,1-DCA	16.3
1,1-DCE	5.1
C-1,2-DCE	5,620
T-1,2-DCE	33.2
1,1,1,2-PCA	1.5
PCE	3,470
1,1,1-TCA	2
1,1,2-TCA	1.3
TCE	609
VC	801

SEPT 2000	
C-1,2-DCE	2
TCE	7.3

SEPT 2000	
ALL VOCs	ND

SEPT 2000	
BENZENE	2.7
1,1-DCA	50.6
EBENZENE	2,290
TOLUENE	98.9
XYLENES	6,770

SEPT 2000	
C-1,2-DCE	1.2

SEPT 2000	
1,1-DCA	2.2
C-1,2-DCE	13.9
PCE	1.2
TCE	112

SEPT 2000	
C-1,2-DCE	282
T-1,2-DCE	3.9
VC	24

SEPT 2000	
1,1-DCA	16.6
1,1-DCE	3.1
C-1,2-DCE	2,871
T-1,2-DCE	14.4
1,1,1-TCA	24.5
PCE	20
TOLUENE	2.2
TCE	289
TCFA	80.6
VC	788

SEPT 2000	
AC	156
MEK	2,100
1,1-DCA	9.9
C-1,2-DCE	37
T-1,2-DCE	22.3
PCE	2.3
1,1,1-TCA	5
TCE	1.6
TCFA	10.1
VC	12.4

SEPT 2000	
C-1,2-DCE	5.6
TCE	8.1
TOLUENE	3
XYLENES	2

SEPT 2000	
1,1-DCA	2.4
C-1,2-DCE	8.5
T-1,2-DCE	3.2
PCE	32.6
1,1,1-TCA	1.3
TCE	56.4
TCFA	3.1

SEPT 2000	
C-1,2-DCE	98.8
PCE	6.7
TOLUENE	1.9
T-1,2-DCE	2.5
TCE	19
VC	6.1

SEPT 2000	
PCE	3.7
1,1,1-TCA	1.9
TCE	4.4

SEPT 2000	
1,1-DCA	1.1
C-1,2-DCE	40.2
TCE	8.5

SEPT 2000	
1,1,1-TCA	6.4
TOLUENE	1.4
T-1,2-DCE	2.9
1,1-DCA	3.4
C-1,2-DCE	2.9
VC	2.1

SEPT 2000	
1,1-DCA	7.7
1,1-DCE	1.2
C-1,2-DCE	77.3
T-1,2-DCE	1.8
PCE	55.8
1,1,1-TCA	22.2
TCE	97.2
VC	3

SEPT 2000	
PCE	1.6
1,1-DCA	2.4
C-1,2-DCE	1.9

SEPT 2000	
1,1,1-TCA	1.6
TCE	5

SEPT 2000	
1,1-DCA	4.4
C-1,2-DCE	37.6
T-1,2-DCE	2.6
PCE	68
1,1,1-TCA	14.5
TCE	104

SEPT 2000	
TCE	2.5
1,1,1-TCA	2.8

SEPT 2000	
ACETONE	2,150
MEK	4,800
CHLOROETHANE	6.4
1,1-DCA	35.9
T-1,2-DCE	20.3
TOLUENE	10.4

SEPT 2000	
1,1-DCA	1
C-1,2-DCE	4
PCE	15.4
1,1,1-TCA	3
TCE	11.3
TCFA	3.1

SEPT 2000	
1,1-DCA	5.6
1,1-DCE	1.6
C-1,2-DCE	38.7
T-1,2-DCE	12.9
1,1,1-TCA	15.7
TCE	189

SEPT 2000	
BENZENE	1.1
CHLOROETHANE	4.1
1,1-DCA	36.5
C-1,2-DCE	1.5
T-1,2-DCE	5.4
ETHYLBENZENE	12.5
TCE	6.6
VC	2.4
XYLENES	1.9

SEPT 2000	
1,1-DCA	3.7
C-1,2-DCE	39.2
T-1,2-DCE	1.3
PCE	7.7
1,1,1-TCA	5.7
TCE	82.8
VC	1.7

SEPT 2000	
PCE	16.2
1,1,1-TCA	2.5
TCE	3.5

SEPT 2000	
C-1,2-DCE	2.7
PCE	1.2
1,1,1-TCA	2.1
TCE	16.8

SEPT 2000	
1,1-DCE	1.4
C-1,2-DCE	5.7
PCE	1.4
1,1,1-TCA	2.5
TCE	23.2

SEPT 2000	
1,1-DCA	13
C-1,2-DCE	41
T-1,2-DCE	2.2
PCE	51.5
1,1,1-TCA	12.1
TCE	56.6
VC	3.7

SEPT 2000	
ALL VOCs	ND

SEPT 2000	
CHLOROETHANE	3.1
DCDFA	1.8
1,1-DCA	27.8
C-1,2-DCE	22.5
T-1,2-DCE	2.9
ETHYLBENZENE	10.4
PCE	5
1,1,1-TCE	4.5
TCE	43.1
VC	5.9
XYLENE	3.2

SEPT 2000	
DCDFA	1.1
1,1-DCA	10.4
C-1,2-DCE	23.9
T-1,2-DCE	1.8
PCE	7.8
1,1,1-TCA	31.8
TCE	115

SEPT 2000	
1,1-DCA	23.9
C-1,2-DCE	41.6
PCE	24.6
T-1,2-DCE	2.5
1,1,1-TCA	6.7
TCE	48.4

LEGEND

●	MONITORING WELL (SHALLOW)
●	MONITORING WELL (SHALLOW) SAMPLED IN SEPTEMBER 2000
●	RECOVERY WELL
*	WELL SCREENED ABOVE THE UPPER CLAY TILL
AC	ALLYL CHLORIDE
MEK	2-BUTANONE
CF	CHLOROFORM
DCDFA	DICHLORODIFLUOROMETHANE
1,1-DCA	1,1-DICHLOROETHANE
1,2-DCA	1,2-DICHLORAETHANE
1,1-DCE	1,1-DICHLOROETHENE
C-1,2-DCE	CIS-1,2-DICHLOROETHENE
T-1,2-DCE	TRANS-1,2-DICHLOROETHENE
1,1,1,2-PCA	1,1,1,2-TETRACHLOROETHANE
PCE	TETRACHLOROETHENE
1,1,1-TCA	1,1,1-TRICHLOROETHANE
1,1,2-TCA	1,1,2-TRICHLOROETHANE
TCE	TRICHLOROETHENE
TCFA	TRICHLOROFLUOROMETHANE
VC	VINYL CHLORIDE
ND	NON DETECT

ALL VOC CONCENTRATIONS ARE REPORTED IN MICROGRAMS PER LITER (ug/L)

ARCADIS GERAGHTY&MILLER

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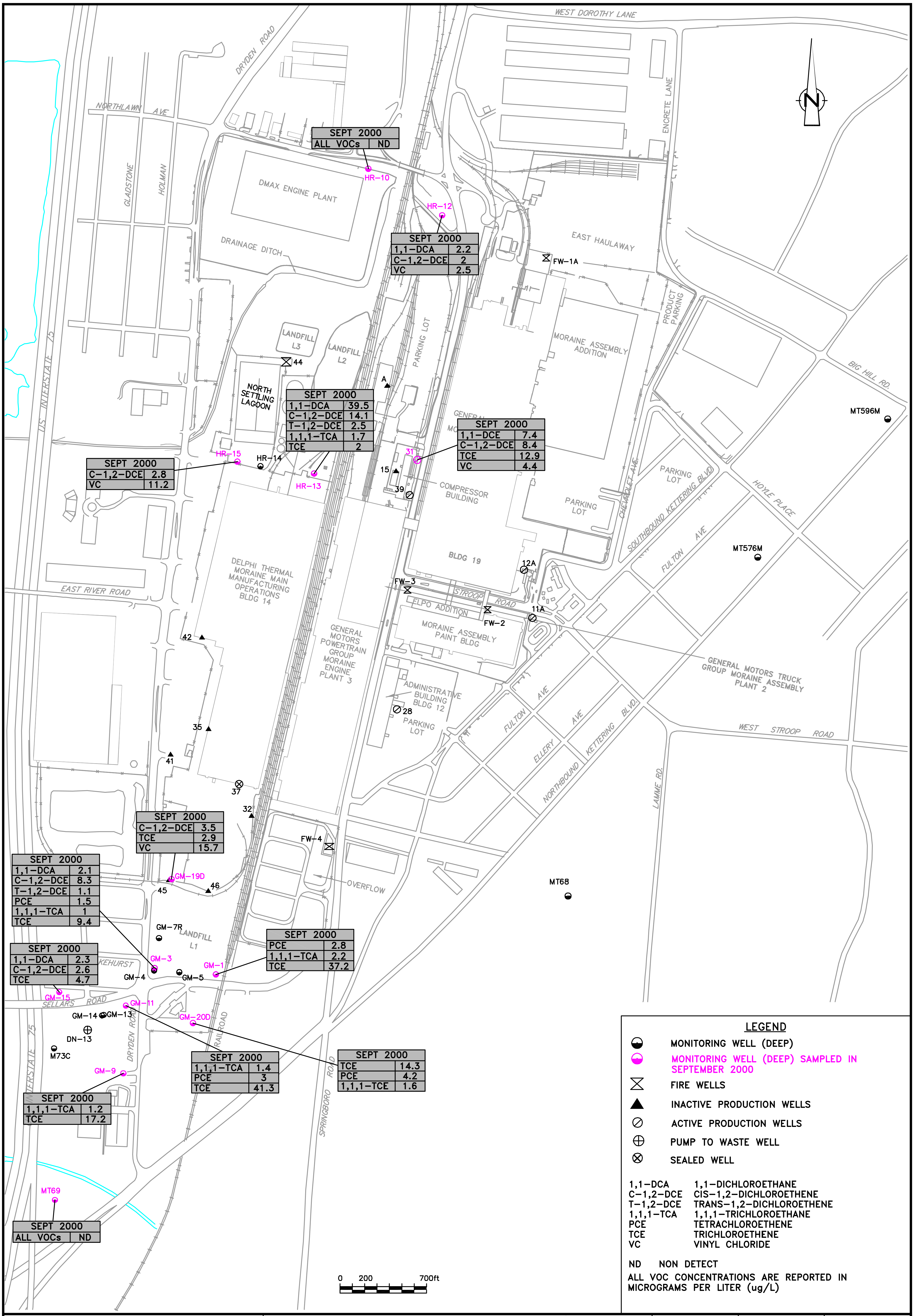
2000 VOC FIRST ANNUAL CONCENTRATIONS IN UPPER AQUIFER MONITORING WELLS GENERAL MOTORS CORPORATION, MORAINE, OHIO

DATE 17AUG00	PROJECT MANAGER N. GILLOTTI	DRAWING NAME CRA\IMS-CMS\2000-01
DRAWN R. SMITH	LEAD DESIGN PROF.	CHECKED N. GILLOTTI
PROJECT NUMBER OH000294.0002.0007		FIGURE NUMBER 4-6



LEGEND

◒	MONITORING WELL (DEEP)
◒	MONITORING WELL (DEEP) SAMPLED IN SEPTEMBER 2000
⧖	FIRE WELLS
▲	INACTIVE PRODUCTION WELLS
⊘	ACTIVE PRODUCTION WELLS
⊕	PUMP TO WASTE WELL
⊗	SEALED WELL

1,1-DCA	1,1-DICHLOROETHANE
C-1,2-DCE	CIS-1,2-DICHLOROETHENE
T-1,2-DCE	TRANS-1,2-DICHLOROETHENE
1,1,1-TCA	1,1,1-TRICHLOROETHANE
PCE	TETRACHLOROETHENE
TCE	TRICHLOROETHENE
VC	VINYL CHLORIDE
ND	NON DETECT

ALL VOC CONCENTRATIONS ARE REPORTED IN MICROGRAMS PER LITER (ug/L)

ARCADIS GERAGHTY&MILLER

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Suite 150, Dublin, OH 43016
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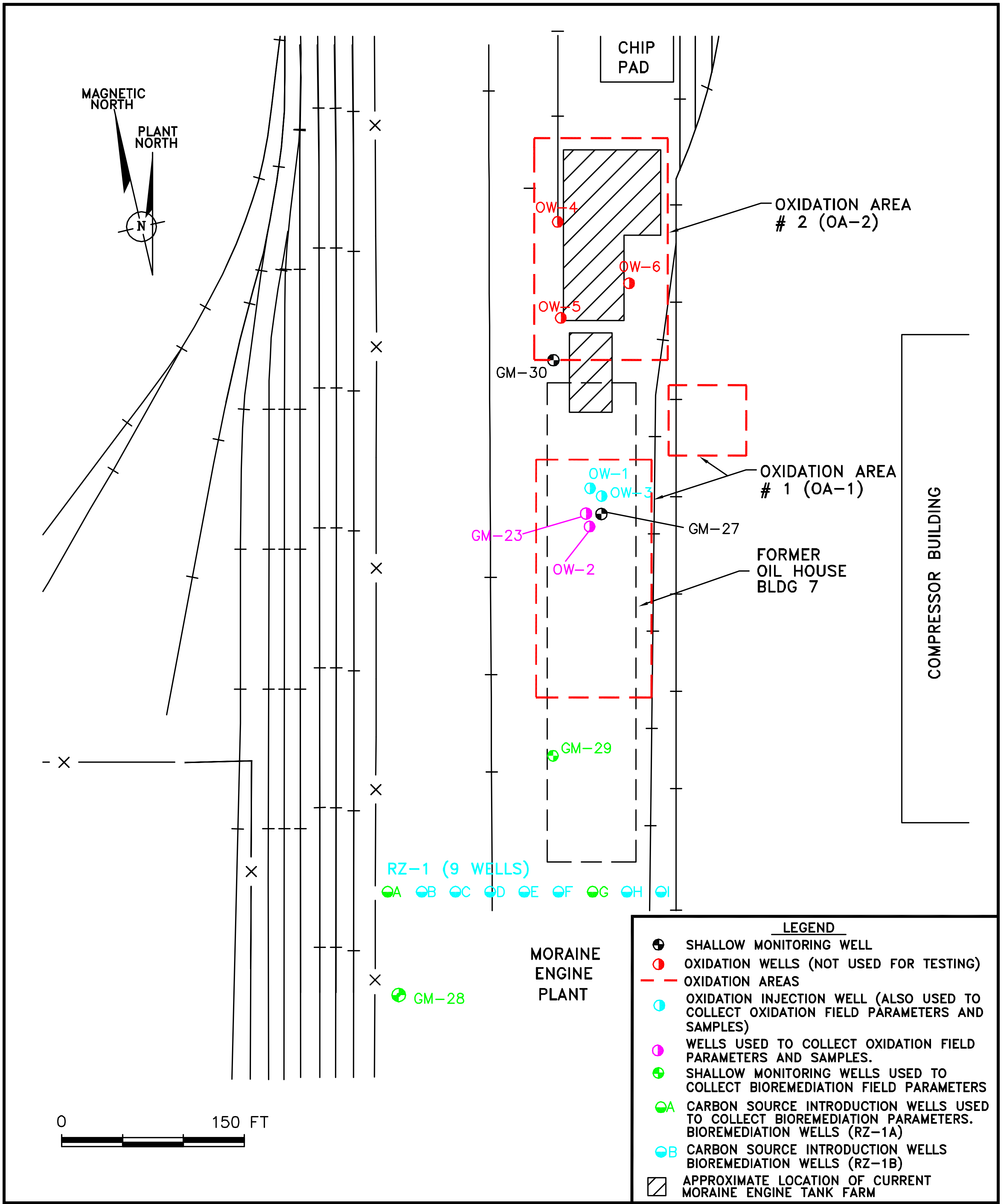
2000 VOC FIRST ANNUAL CONCENTRATIONS IN LOWER AQUIFER MONITORING WELLS GENERAL MOTORS CORPORATION, MORAINE, OHIO

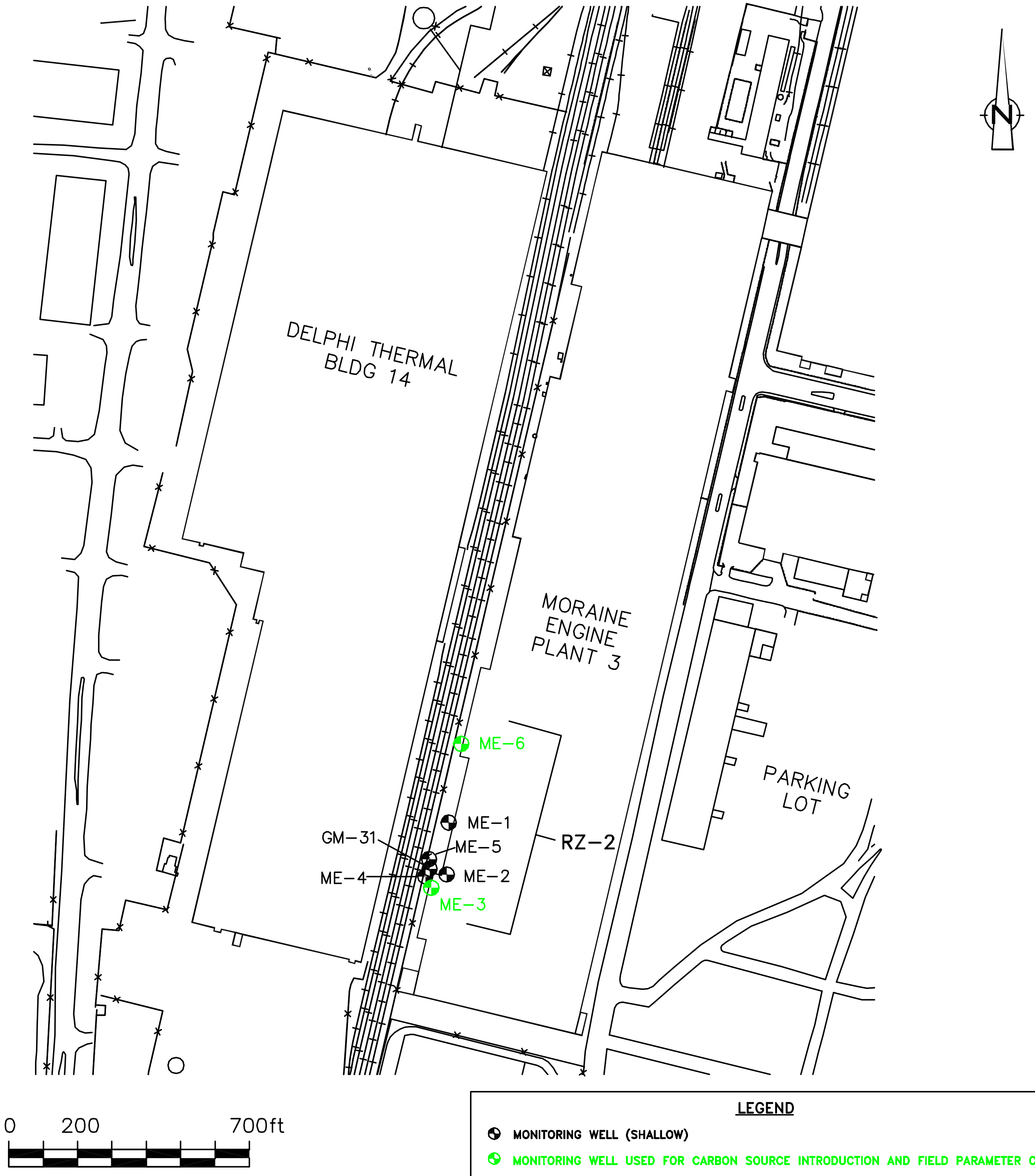
DATE 1/29/2001	PROJECT MANAGER N. GILLOTTI	DRAWING NAME CRA\IMS-CMS\2000-02
DRAWN R. SMITH	LEAD DESIGN PROF.	CHECKED N. GILLOTTI
PROJECT NUMBER OH000294.0002.0007		FIGURE NUMBER 4-7



ARCADIS GERAGHTY&MILLER
6397 Emerald Parkway
Suite 150, Dublin, OH 43016
Tel: 614/764-2310 Fax: 614/764-1270

BIOREMEDIATION REACTIVE ZONE #1 AND OXIDATION AREAS GENERAL MOTORS CORPORATION MORAINE, OHIO

DATE 17AUG00	PROJECT MANAGER GILLOTTI	DRAWING NAME \CRA\IMS-CMS\IMS-12
DRAWN R. SMITH	LEAD DESIGN PROF. JREID	CHECKED N. GILLOTTI
PROJECT NUMBER OH000294.002.007		FIGURE NUMBER 4-8



LEGEND

◐ MONITORING WELL (SHALLOW)

◐ MONITORING WELL USED FOR CARBON SOURCE INTRODUCTION AND FIELD PARAMETER COLLECTION

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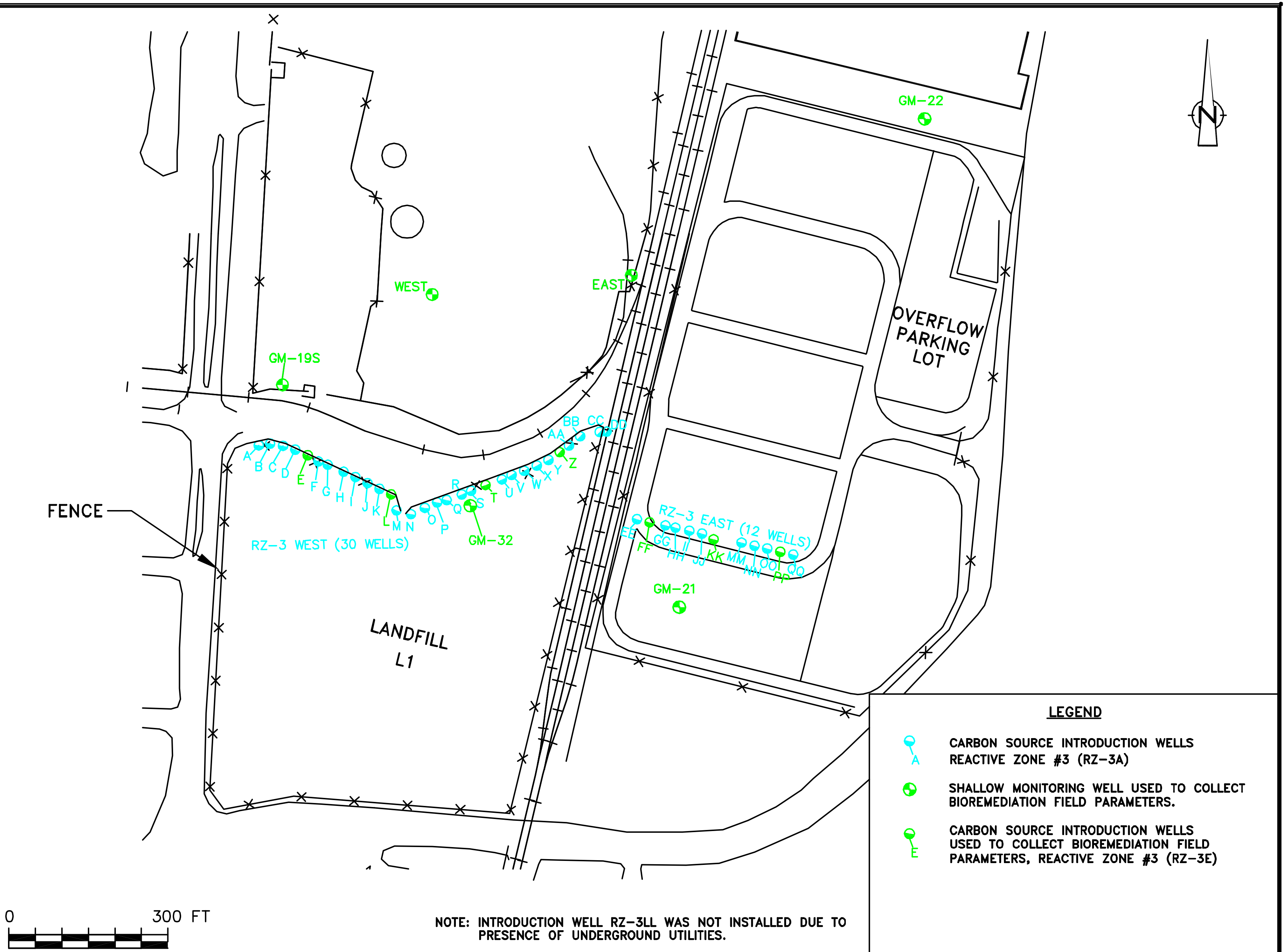
Tel: 614/764-2310 Fax: 614/764-1270

BIOREMEDIATION REACTIVE ZONE #2
GENERAL MOTORS CORPORATION
MORAINE, OHIO

DATE 17AUG00	PROJECT MANAGER N. GILLOTTI	DRAWING NAME CRA\IMS-CMS\IMS-13
DRAWN R. SMITH	LEAD DESIGN PROF. J. REID	CHECKED N. GILLOTTI
PROJECT NUMBER OH000294.0002.0007		FIGURE NUMBER 4-9



NOTE: INTRODUCTION WELL RZ-3LL WAS NOT INSTALLED DUE TO PRESENCE OF UNDERGROUND UTILITIES.

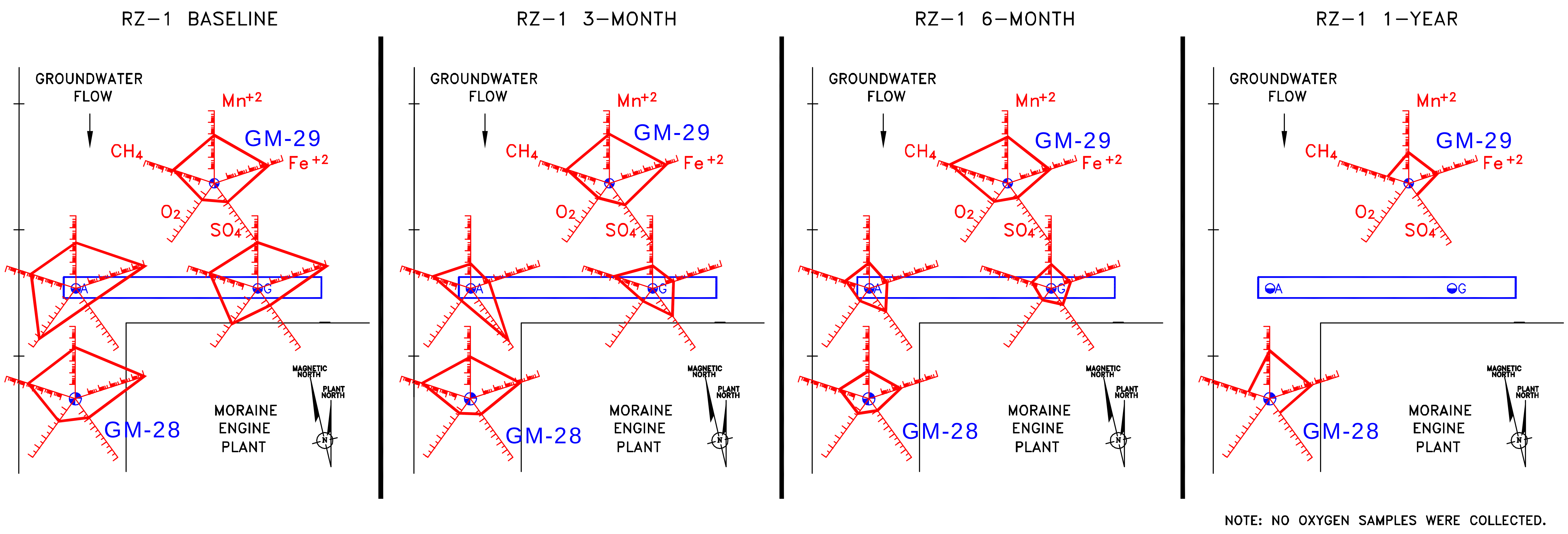
LEGEND

A	CARBON SOURCE INTRODUCTION WELLS REACTIVE ZONE #3 (RZ-3A)
●	SHALLOW MONITORING WELL USED TO COLLECT BIOREMEDIATION FIELD PARAMETERS.
E	CARBON SOURCE INTRODUCTION WELLS USED TO COLLECT BIOREMEDIATION FIELD PARAMETERS, REACTIVE ZONE #3 (RZ-3E)

ARCADIS GERAGHTY&MILLER

BIOREMEDIATION REACTIVE ZONE #3
GENERAL MOTORS CORPORATION
MORAINE, OHIO

DATE 17AUG00	PROJECT MANAGER J.REID	DRAWING NAME CRA\IMS-CMS\IMS-14
DRAWN R. SMITH	LEAD DESIGN PROF. J. REID	CHECKED N. GILLOTTI
PROJECT NUMBER OH000294.0002.0007		FIGURE NUMBER 4-10

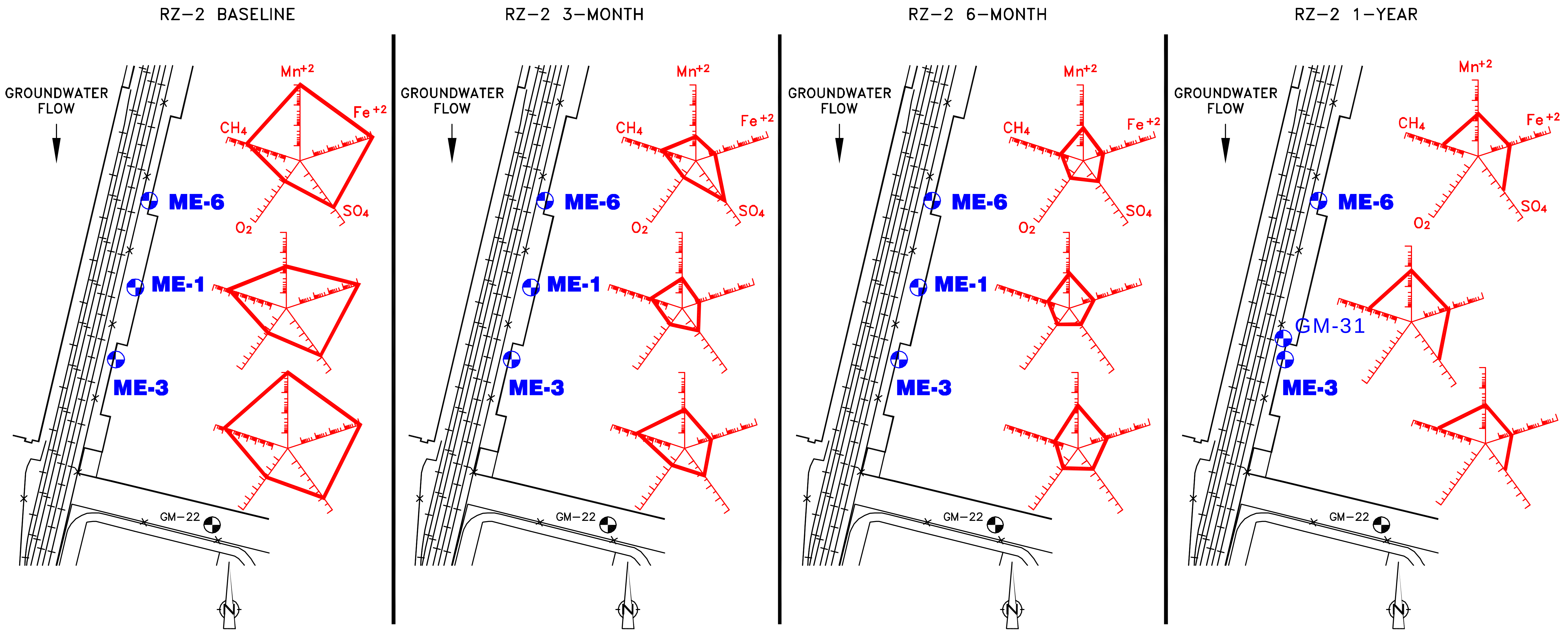


NOTE: NO OXYGEN SAMPLES WERE COLLECTED.

ARCADIS GERAGHTY&MILLER

RZ-1 RADIAL DIAGRAMS
GENERAL MOTORS CORPORATION
MORAINE, OHIO

DRAWN R. SMITH	DATE 1/29/2001	PROJECT MANAGER N. GILLOTTI	DRAWING NAME CRA\IMS–\RZ1–01
		LEAD DESIGN PROF. J. REID	CHECKED K. PATTON
		PROJECT NUMBER OH000294.02	FIGURE NUMBER 4–11



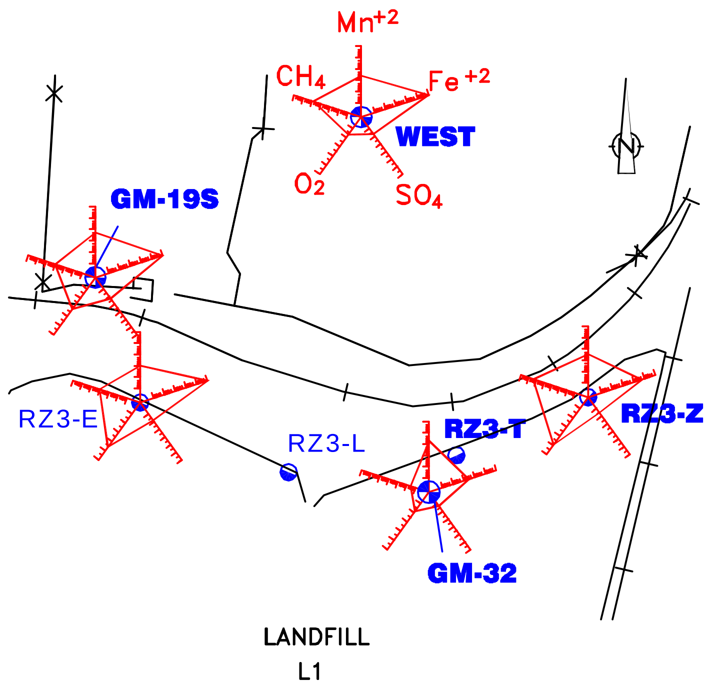
NOTE: NO OXYGEN SAMPLES WERE COLLECTED.

ARCADIS GERAGHTY&MILLER

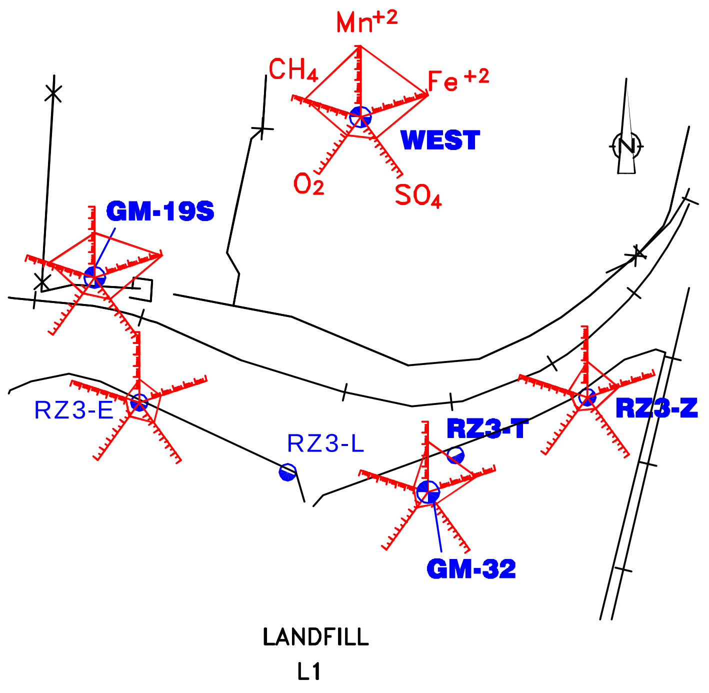
RZ-2 RADIAL DIAGRAMS
GENERAL MOTORS CORPORATION
MORAINE, OHIO

DRAWN R. SMITH
DATE 1/29/2001
PROJECT MANAGER N. GILLOTTI
DRAWING NAME CRA\IMS−\RZ2−01
LEAD DESIGN PROF. J. REID
CHECKED K. PATTON
PROJECT NUMBER OH000294.02
FIGURE NUMBER 4−12

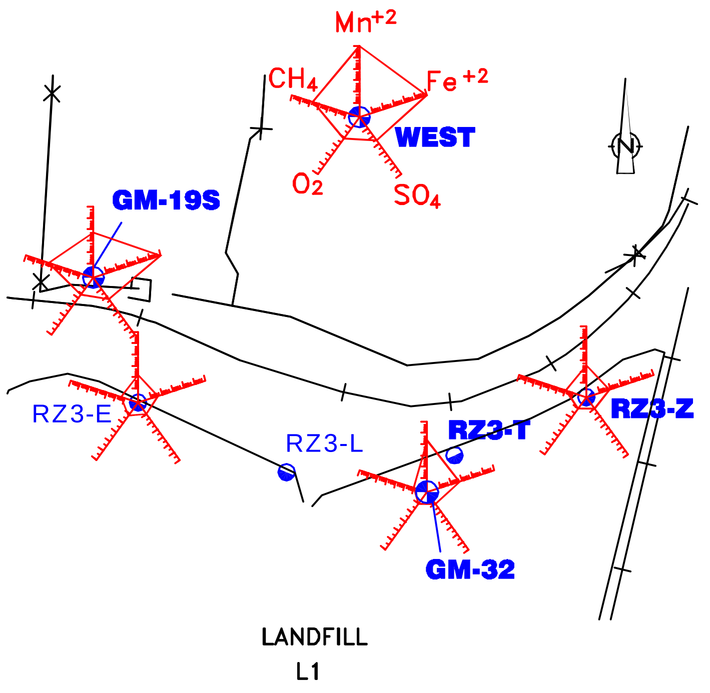
RZ–3 WEST BASELINE



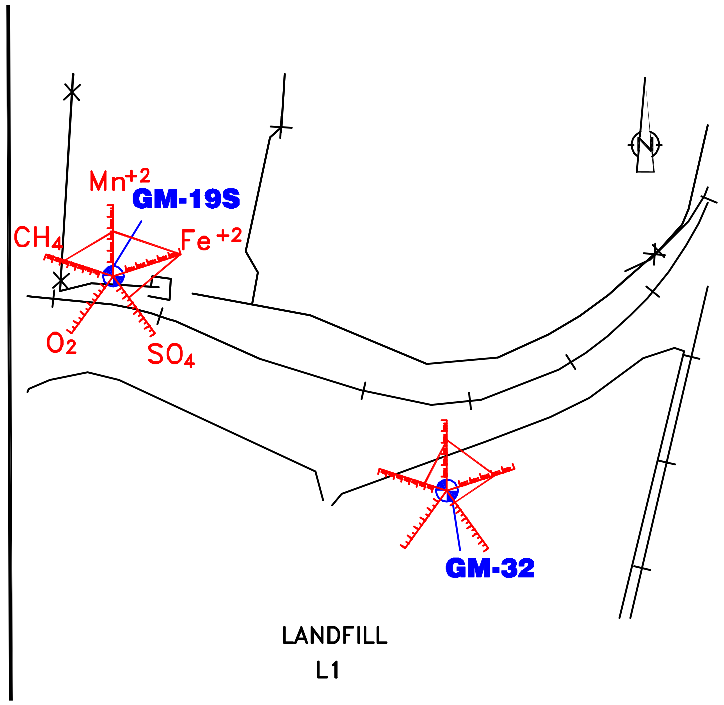
RZ–3 WEST 3–MONTH



RZ–3 WEST 6–MONTH



RZ–3 WEST 1–YEAR



NOTE: NO OXYGEN SAMPLES WERE COLLECTED.

ARCADIS GERAGHTY & MILLER

RZ-3 WEST RADIAL DIAGRAMS
GENERAL MOTOR CORPORATION
MORAINE, OHIO

DRAWN
R. SMITH

DATE
1/29/2001

PROJECT MANAGER
N. GILLOTTI

DRAWING NAME
CRA\IMS–\RZ3W–01

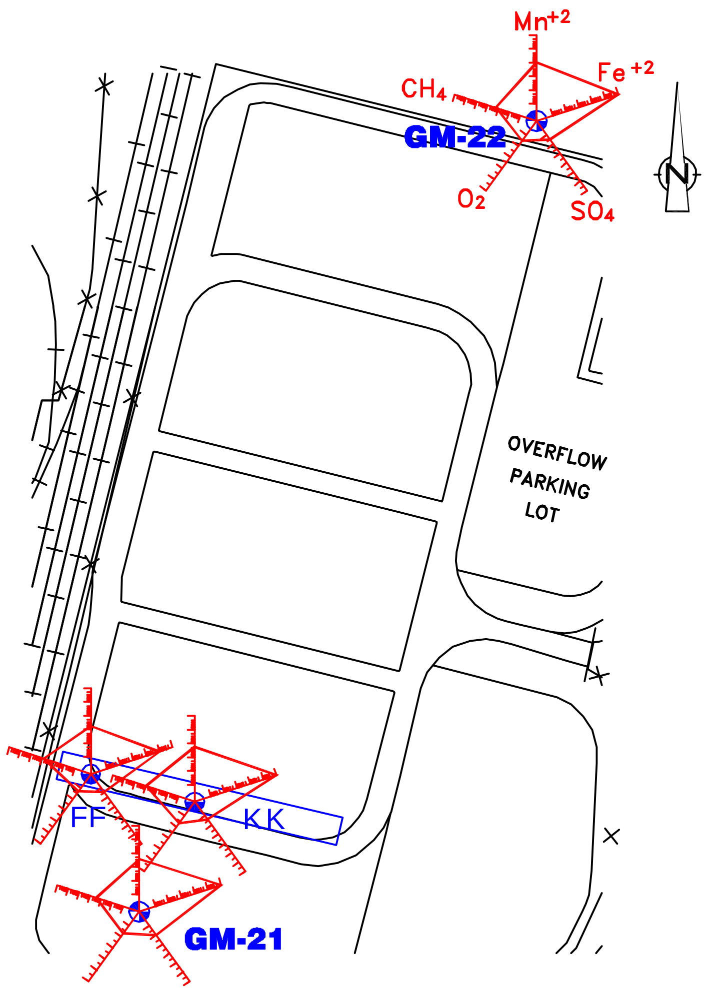
LEAD DESIGN PROF.
J. REID

CHECKED
K. PATTON

PROJECT NUMBER
OH000294.02

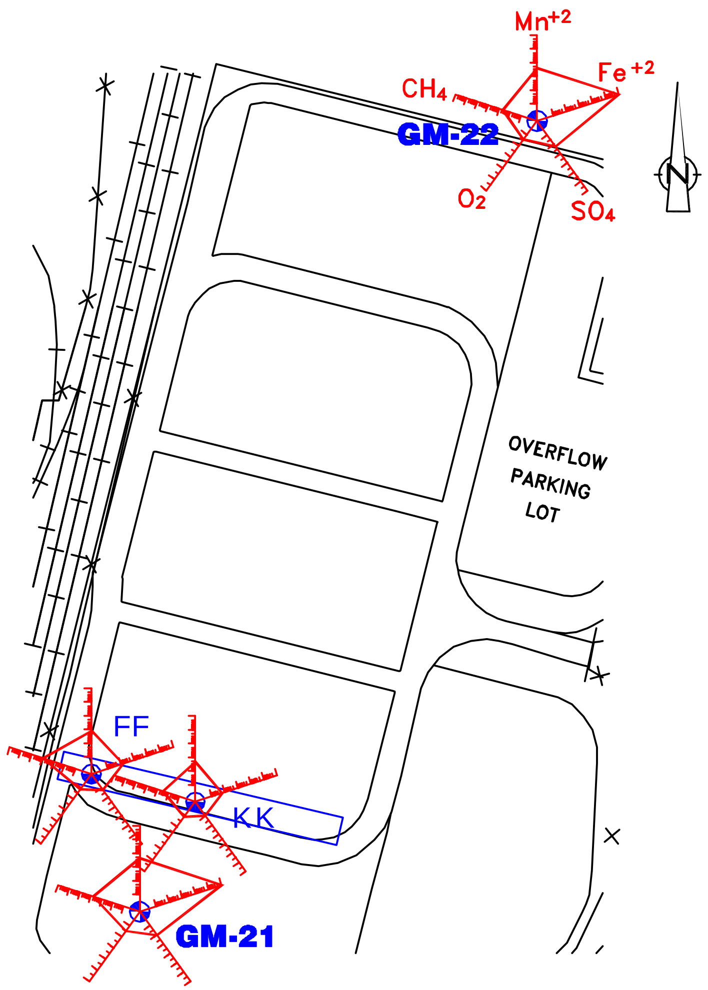
FIGURE NUMBER
4–13

RZ−3 EAST BASELINE



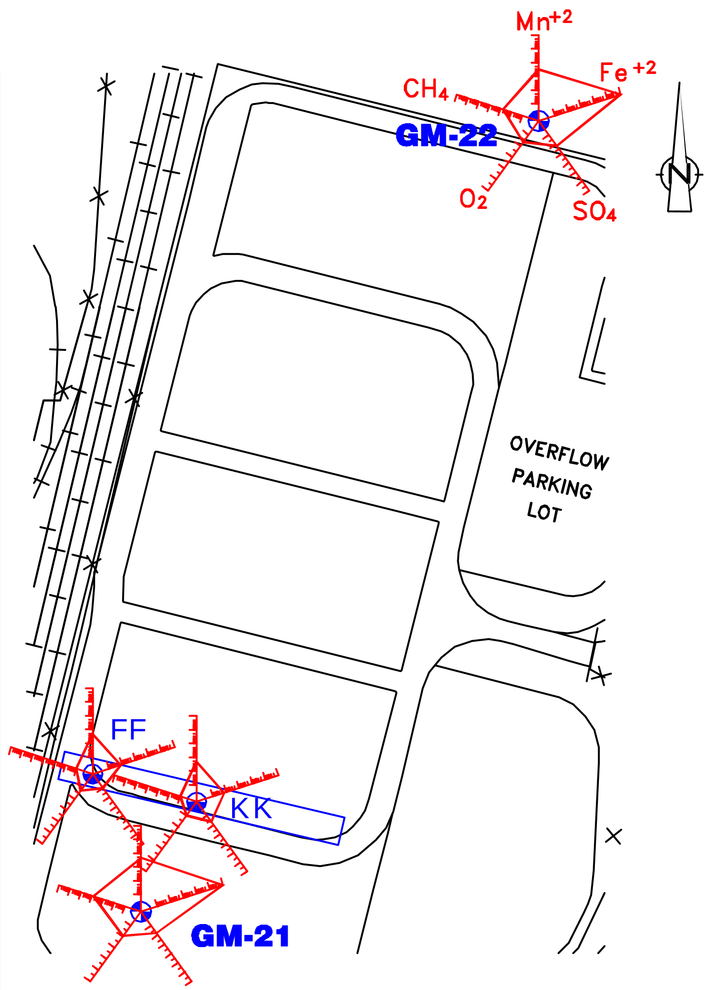
NOTE: INTRODUCTION WELL RZ−3LL WAS NOT INSTALLED DUE TO PRESENCE OF UNDERGROUND UTILITIES.

RZ−3 EAST 3−MONTH



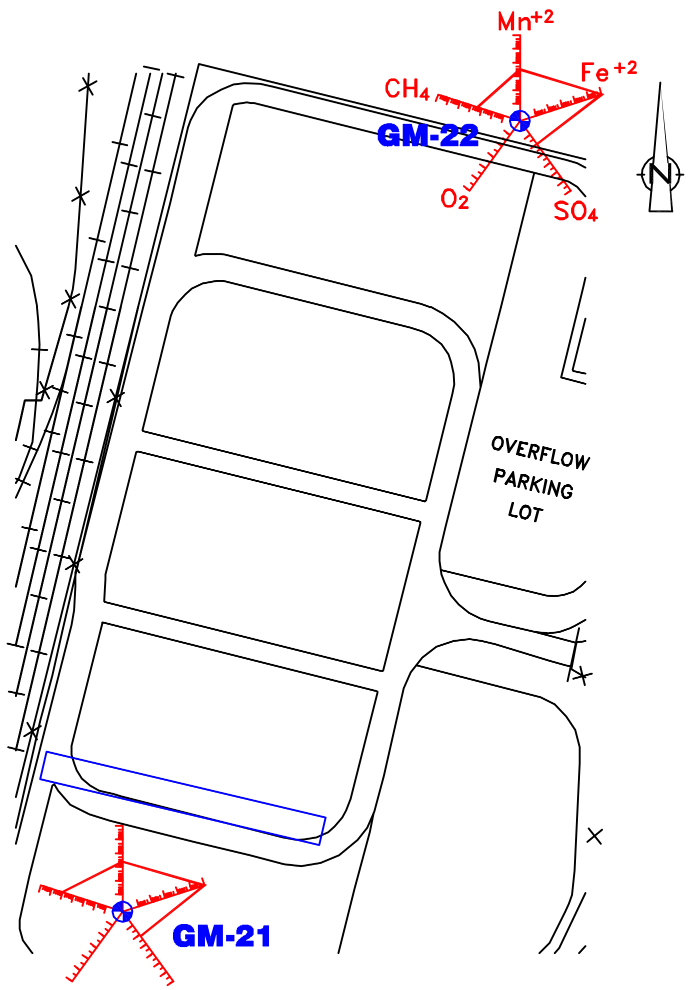
NOTE: INTRODUCTION WELL RZ−3LL WAS NOT INSTALLED DUE TO PRESENCE OF UNDERGROUND UTILITIES.

RZ−3 EAST 6−MONTH



NOTE: INTRODUCTION WELL RZ−3LL WAS NOT INSTALLED DUE TO PRESENCE OF UNDERGROUND UTILITIES.

RZ−3 EAST 1−YEAR



NOTE: 1. INTRODUCTION WELL RZ−3LL WAS NOT INSTALLED DUE TO PRESENCE OF UNDERGROUND UTILITIES.
2. NO OXYGEN SAMPLES WERE COLLECTED.

ARCADIS GERAGHTY&MILLER

RZ-3 EAST RADIAL DIAGRAMS
GENERAL MOTORS CORPORATION
MORAINE, OHIO

DRAWN
R. SMITH

DATE
1/30/2001

PROJECT MANAGER
N. GILLOTTI

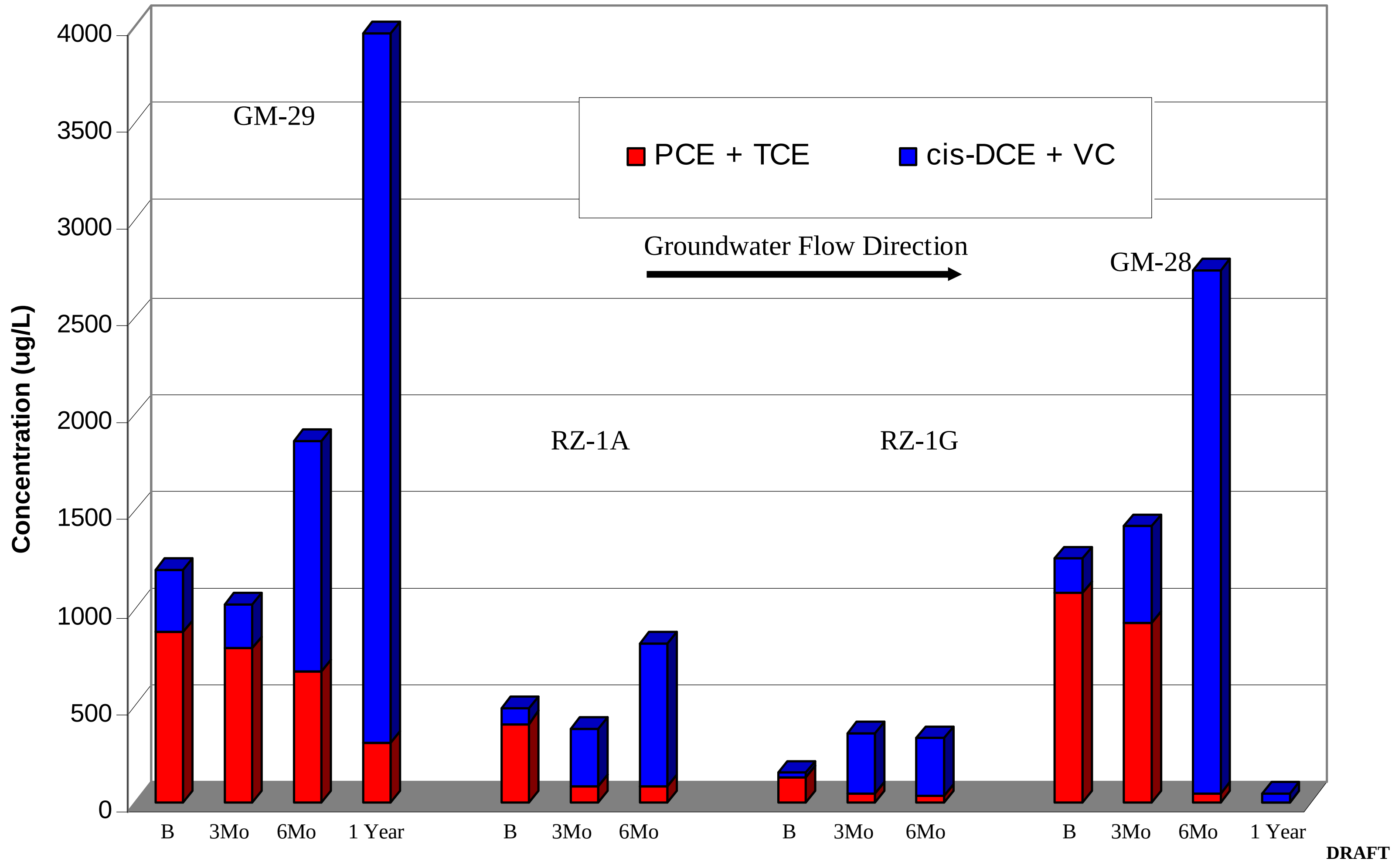
DRAWING NAME
CRA\MS−\RZ3E−01

LEAD DESIGN PROF.
J. REID

CHECKED
K. PATTON

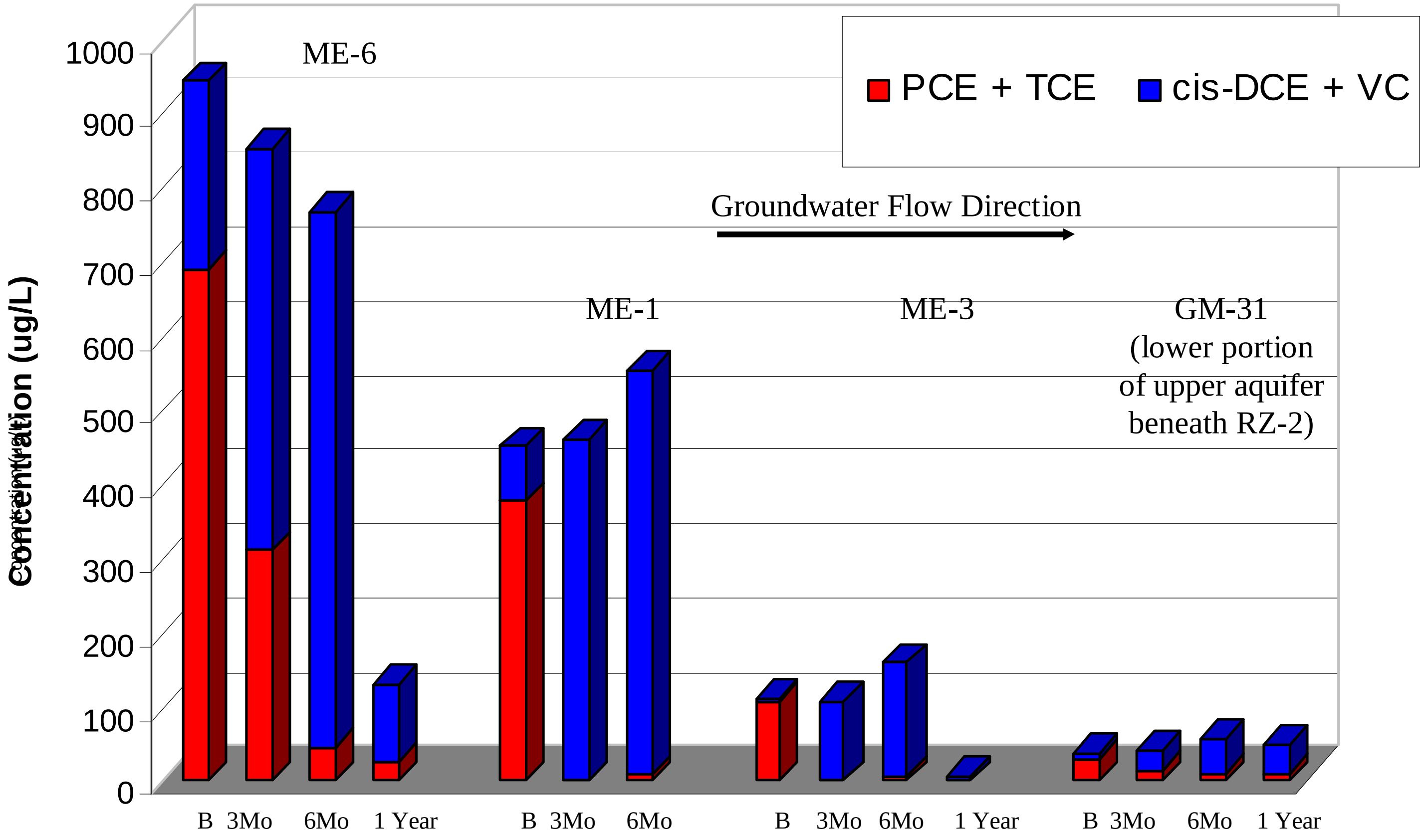
PROJECT NUMBER
OH000294.02

FIGURE NUMBER
4−14



ARCADIS Geraghty & Miller

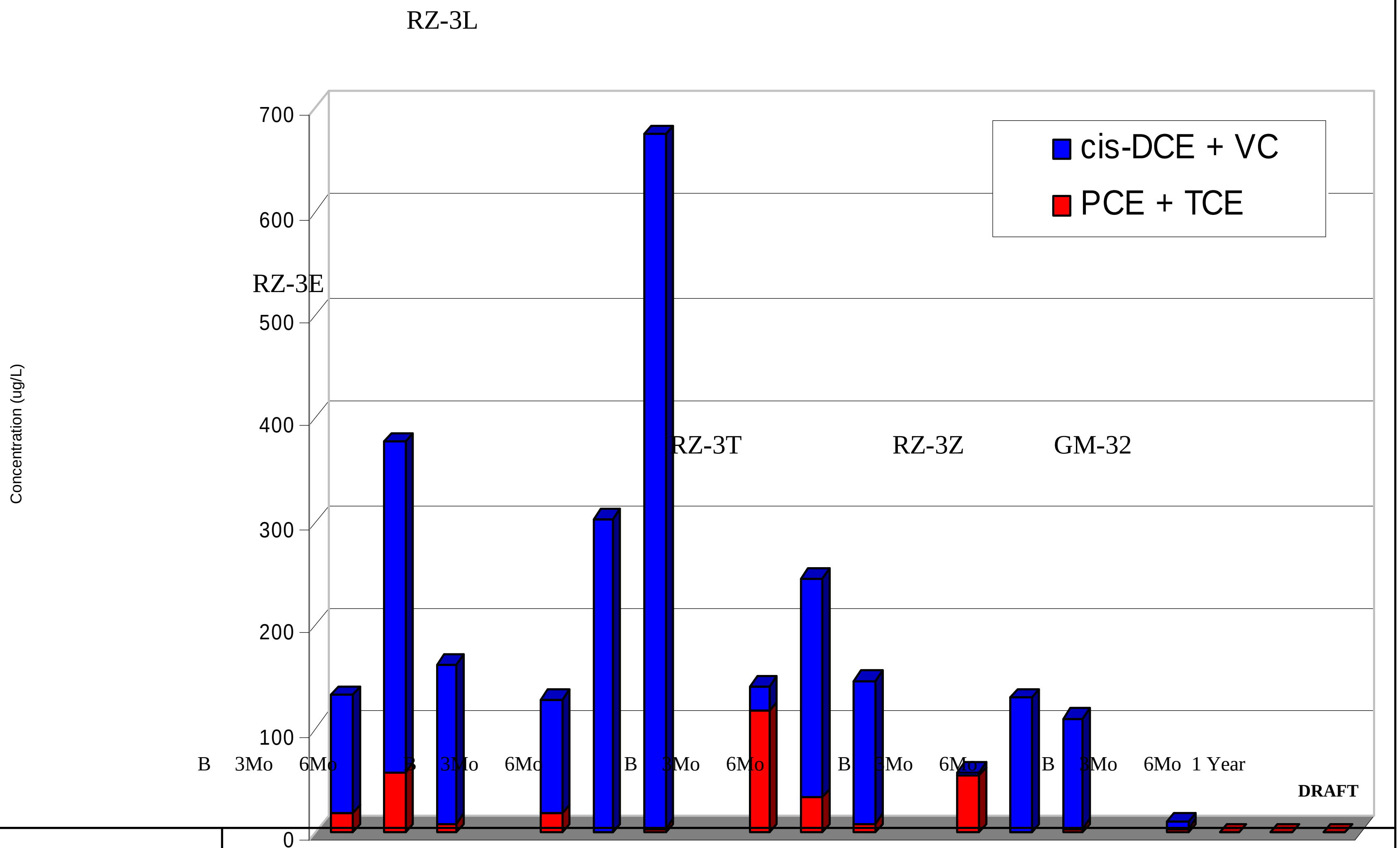
Figure 4-15. RZ-1 Parent to Daughter Ratios, General Motors Corporation, Moraine, Ohio.



DRAFT

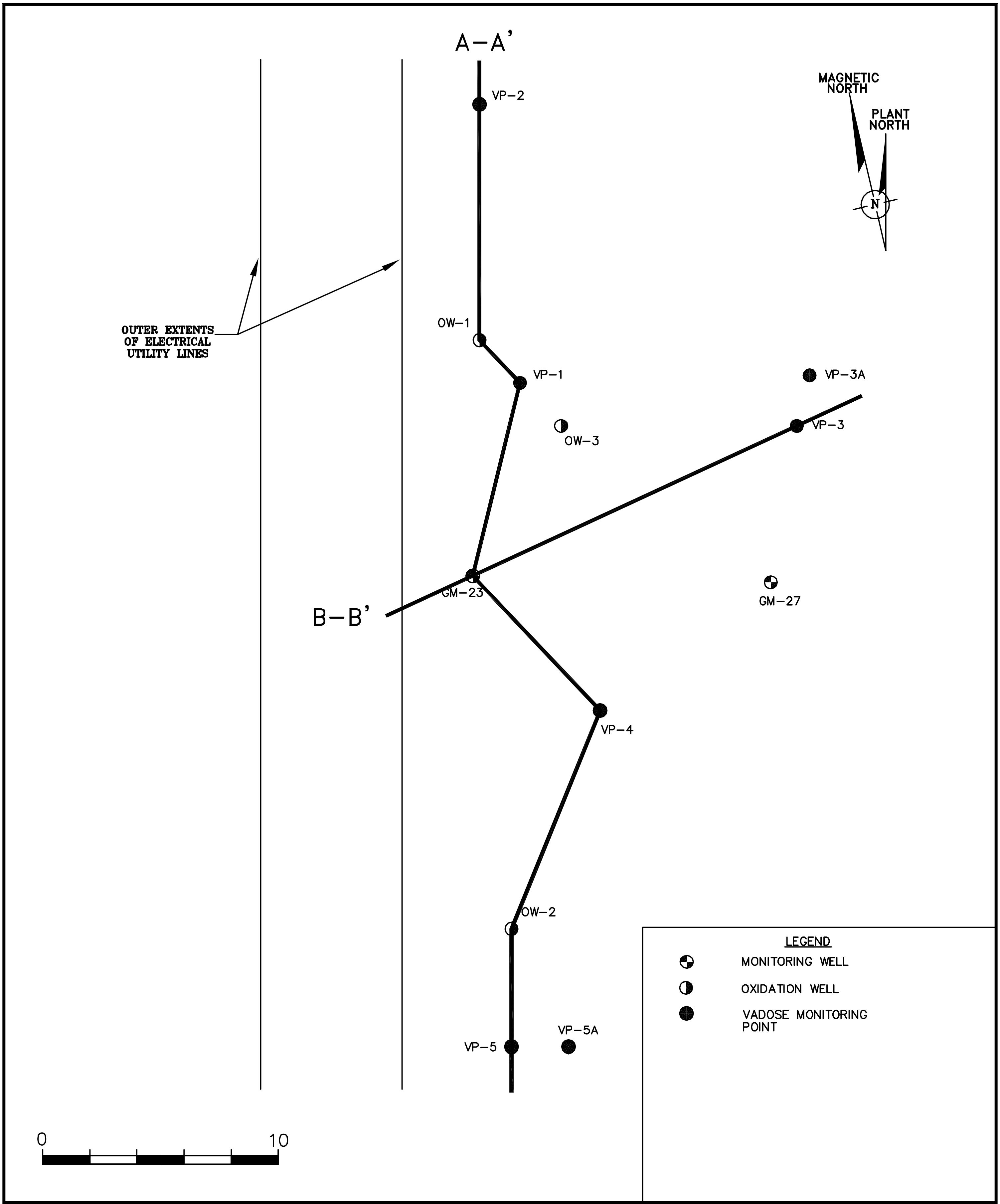
ARCADIS Geraghty & Miller

Figure 4-16. RZ-2 Parent to Daughter Ratios, General Motors Corporation, Moraine, Ohio.



ARCADIS Geraghty & Miller

Figure 4-17. RZ-3 West Parent to Daughter Ratios, General Motors Corporation, Moraine, Ohio.

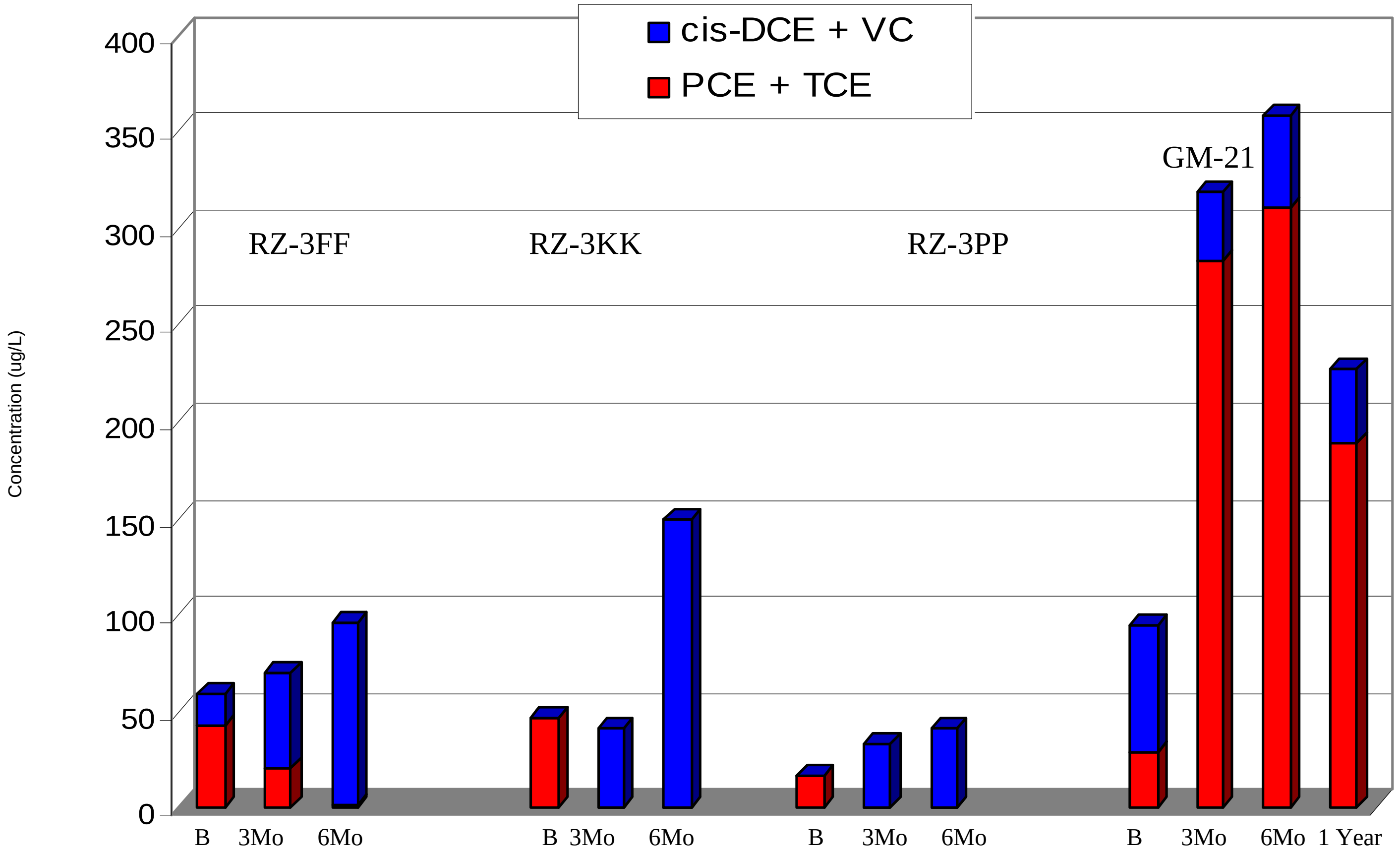


ARCADIS GERAGHTY&MILLER

[illegible]
[illegible] 46204
Tel: [illegible] Fax: [illegible]

LOCATION OF CROSS SECTIONS AT AOI 7
GENERAL MOTORS CORPORATION
MORAINE, OHIO

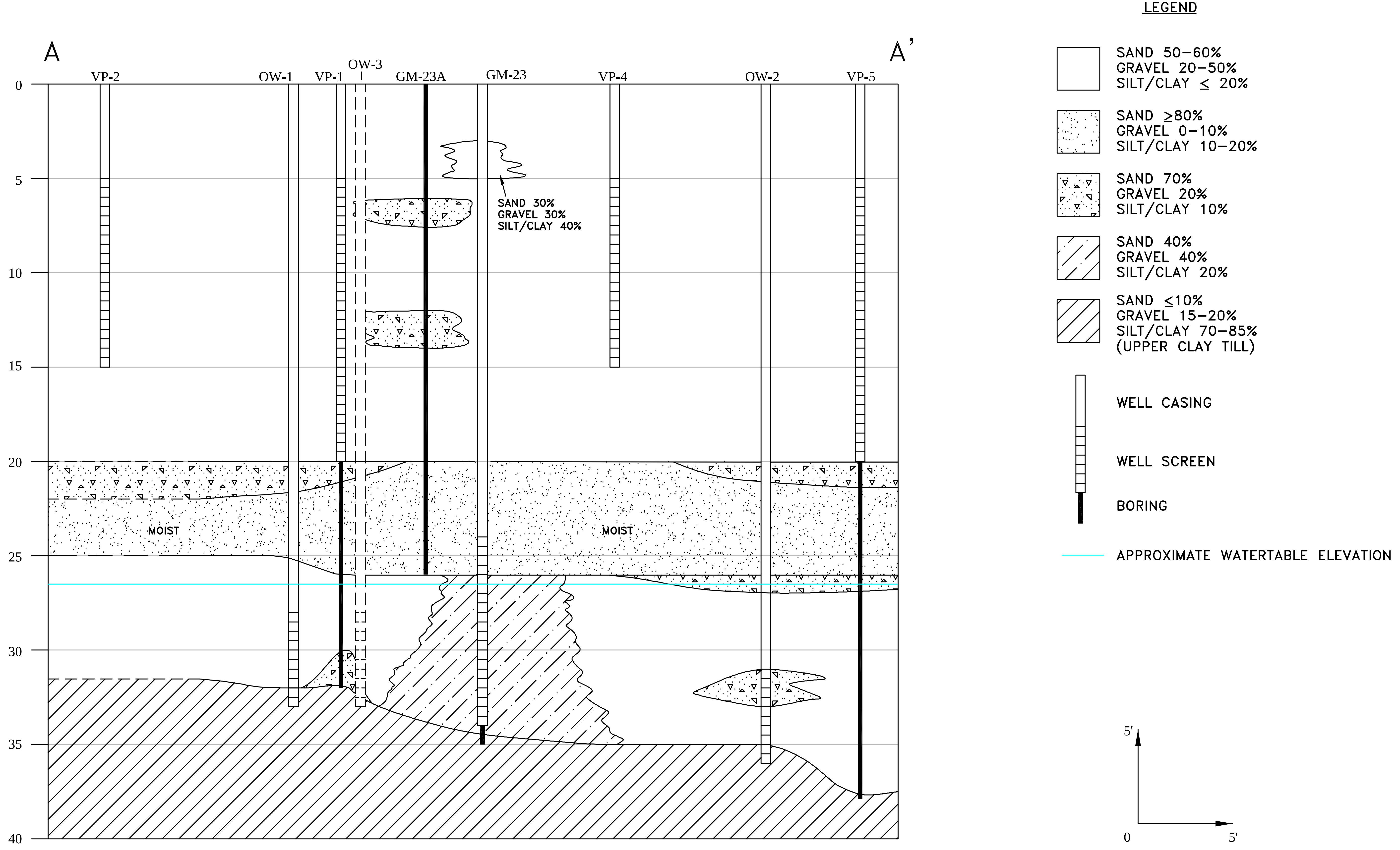
DATE 2/28/00	PROJECT MANAGER N.G.	DRAWING NAME CRA/CMS/OA–1
DRAWN B.G.	LEAD DESIGN PROF. J.R.	CHECKED B.G.
PROJECT NUMBER OH000294.0002.00007		FIGURE NUMBER 4–19



DRAFT

ARCADIS Geraghty & Miller

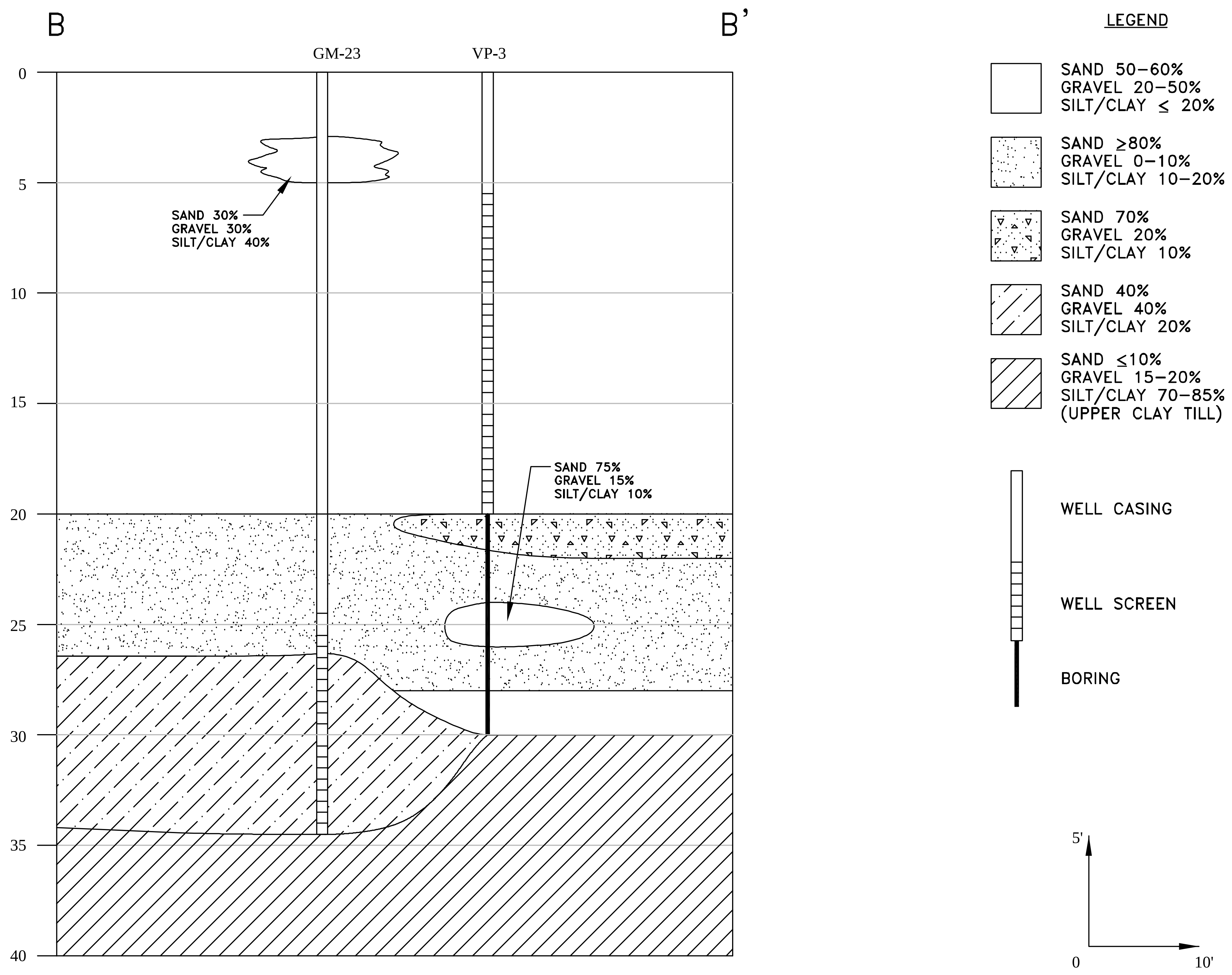
Figure 4-18. RZ-3 East Parent to Daughter Ratios, General Motors Corporation, Moraine, Ohio.



ARCADIS GERAGHTY&MILLER

CROSS SECTION A-A' AOI 7
GENERAL MOTORS CORPORATION
MORAINE, OHIO

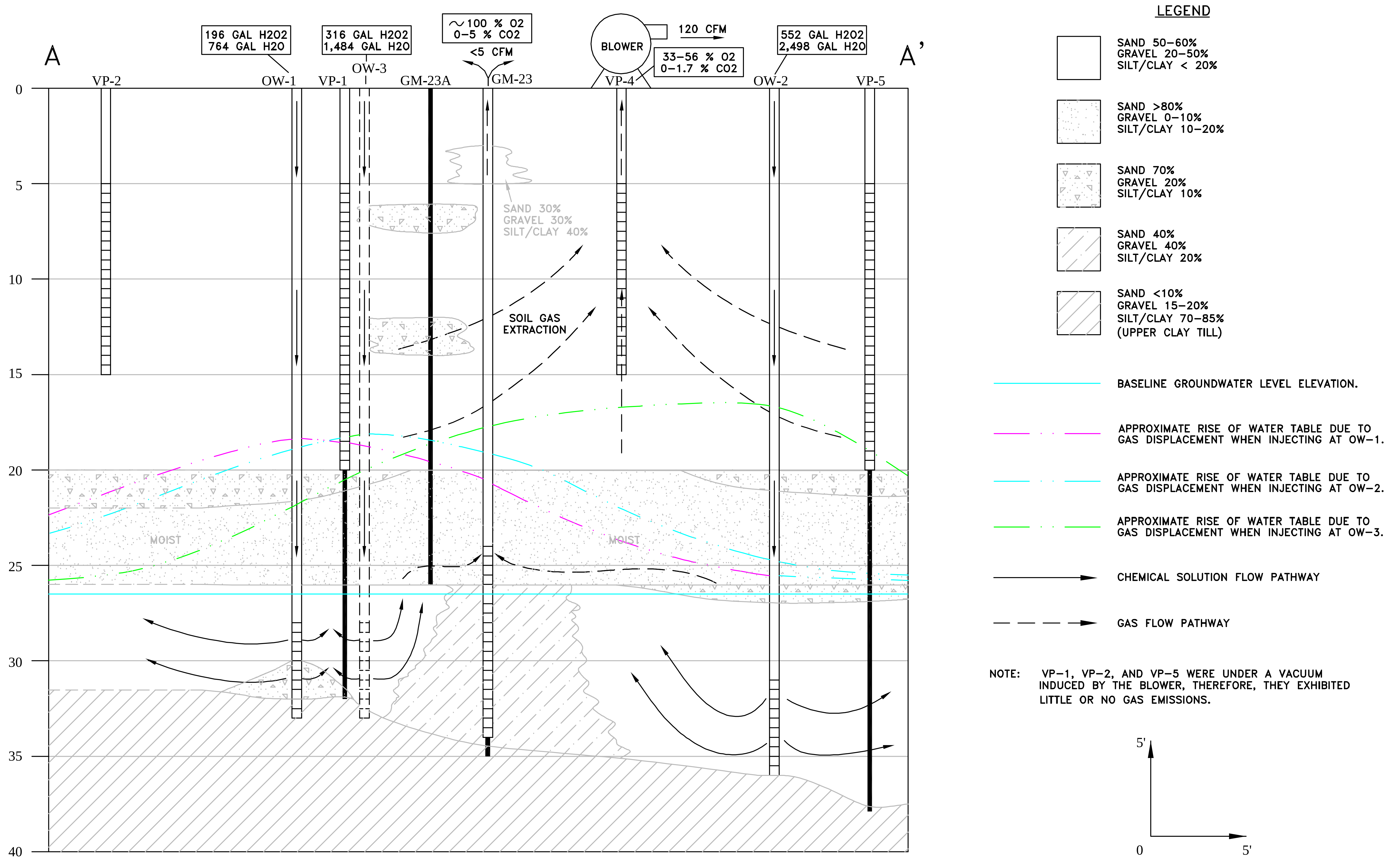
DRAWN R. SMITH	DATE 071300	PROJECT MANAGER N. GILLOTTI	DRAWING NAME CRA\IMS-CMS\OX-CSA
		LEAD DESIGN PROF. J. REID	CHECKED B. GOLLA
		PROJECT NUMBER OH000294.02	FIGURE NUMBER 4–20



ARCADIS GERAGHTY&MILLER

CROSS SECTION B-B', AOI 7
GENERAL MOTORS CORPORATION
MORAINE, OHIO

DRAWN R. SMITH	DATE 071300	PROJECT MANAGER N. GILLOTTI	DRAWING NAME CRA\CMS\OX-CSB
		LEAD DESIGN PROF. J. REID	CHECKED B. GOLLA
		PROJECT NUMBER OH000294.02	FIGURE NUMBER 4-21



LEGEND

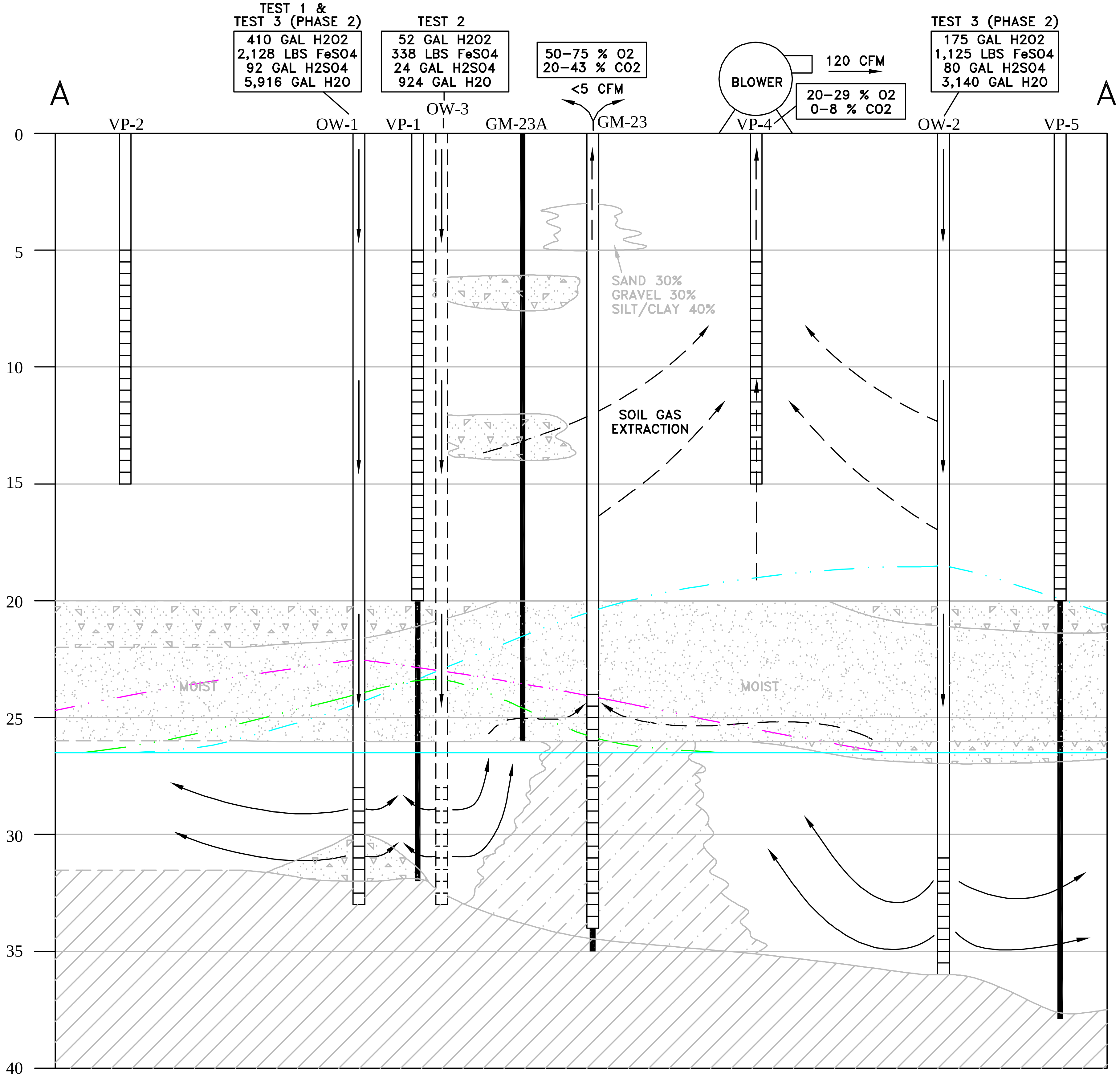
☐	SAND 50–60% GRAVEL 20–50% SILT/CLAY < 20%
▨	SAND >80% GRAVEL 0–10% SILT/CLAY 10–20%
▨	SAND 70% GRAVEL 20% SILT/CLAY 10%
▨	SAND 40% GRAVEL 40% SILT/CLAY 20%
▨	SAND <10% GRAVEL 15–20% SILT/CLAY 70–85% (UPPER CLAY TILL)
———	BASELINE GROUNDWATER LEVEL ELEVATION.
— · —	APPROXIMATE RISE OF WATER TABLE DUE TO GAS DISPLACEMENT WHEN INJECTING AT OW–1.
— · —	APPROXIMATE RISE OF WATER TABLE DUE TO GAS DISPLACEMENT WHEN INJECTING AT OW–2.
— · —	APPROXIMATE RISE OF WATER TABLE DUE TO GAS DISPLACEMENT WHEN INJECTING AT OW–3.
———→	CHEMICAL SOLUTION FLOW PATHWAY
— — →	GAS FLOW PATHWAY

NOTE: VP–1, VP–2, AND VP–5 WERE UNDER A VACUUM INDUCED BY THE BLOWER, THEREFORE, THEY EXHIBITED LITTLE OR NO GAS EMISSIONS.

ARCADIS GERAGHTY & MILLER

OXIDATION PHASE OX-PHASE 1, HYDROGEN PEROXIDE INJECTION
GENERAL MOTORS CORPORATION
MORAINE, OHIO

DRAWN R. SMITH	DATE 071300	PROJECT MANAGER N. GILLOTTI	DRAWING NAME CRA\IMS-CMS\OX-CSA
		LEAD DESIGN PROF. J. REID	CHECKED B. GOLLA
		PROJECT NUMBER OH000294.02	FIGURE NUMBER 4–22



LEGEND

▭ SAND 50–60%
GRAVEL 20–50%
SILT/CLAY ≤ 20%

▨ SAND >80%
GRAVEL 0–10%
SILT/CLAY 10–20%

▨ SAND 70%
GRAVEL 20%
SILT/CLAY 10%

▨ SAND 40%
GRAVEL 40%
SILT/CLAY 20%

▨ SAND <10%
GRAVEL 15–20%
SILT/CLAY 70–85%
(UPPER CLAY TILL)

BASELINE GROUNDWATER LEVEL ELEVATION.

APPROXIMATE RISE OF WATER TABLE DUE TO GAS DISPLACEMENT WHEN INJECTING AT OW–1.

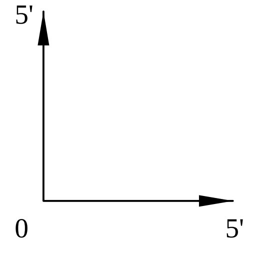
APPROXIMATE RISE OF WATER TABLE DUE TO GAS DISPLACEMENT WHEN INJECTING AT OW–2.

APPROXIMATE RISE OF WATER TABLE DUE TO GAS DISPLACEMENT WHEN INJECTING AT OW–3.

→ CHEMICAL SOLUTION FLOW PATHWAY

– – → GAS FLOW PATHWAY

NOTE: VP–1, VP–2, AND VP–5 WERE UNDER A VACUUM INDUCED BY THE BLOWER, THEREFORE, THEY EXHIBITED LITTLE OR NO GAS EMISSIONS.



ARCADIS GERAGHTY&MILLER

OXIDATION PHASE OX-PHASE 2, FENTON'S REAGENT INJECTION
GENERAL MOTORS CORPORATION
MORAINE, OHIO

DRAWN R. SMITH	DATE 071300	PROJECT MANAGER N. GILLOTTI	DRAWING NAME CRA\IMS-CMS\OX-CSA
		LEAD DESIGN PROF. J. REID	CHECKED B. GOLLA
		PROJECT NUMBER OH000294.02	FIGURE NUMBER 4-23

Figure 4-24. OW-1 Oxidation Data for Primary VOC Constituents, General Motors Corporation, Moraine, Ohio

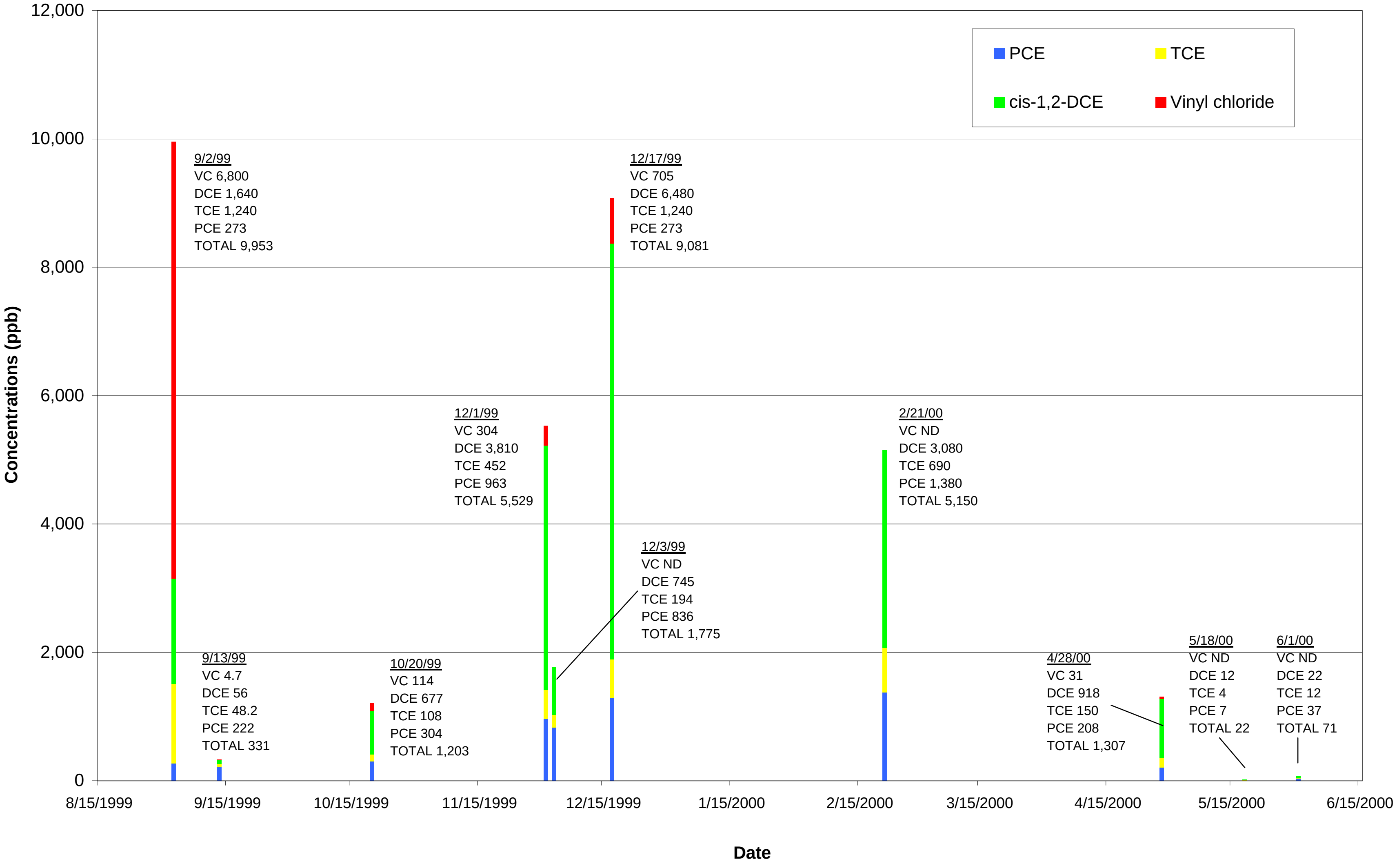


Figure 4-25. OW-2 Oxidation Data for Primary VOC Constituents, General Motors Corporation, Moraine, Ohio

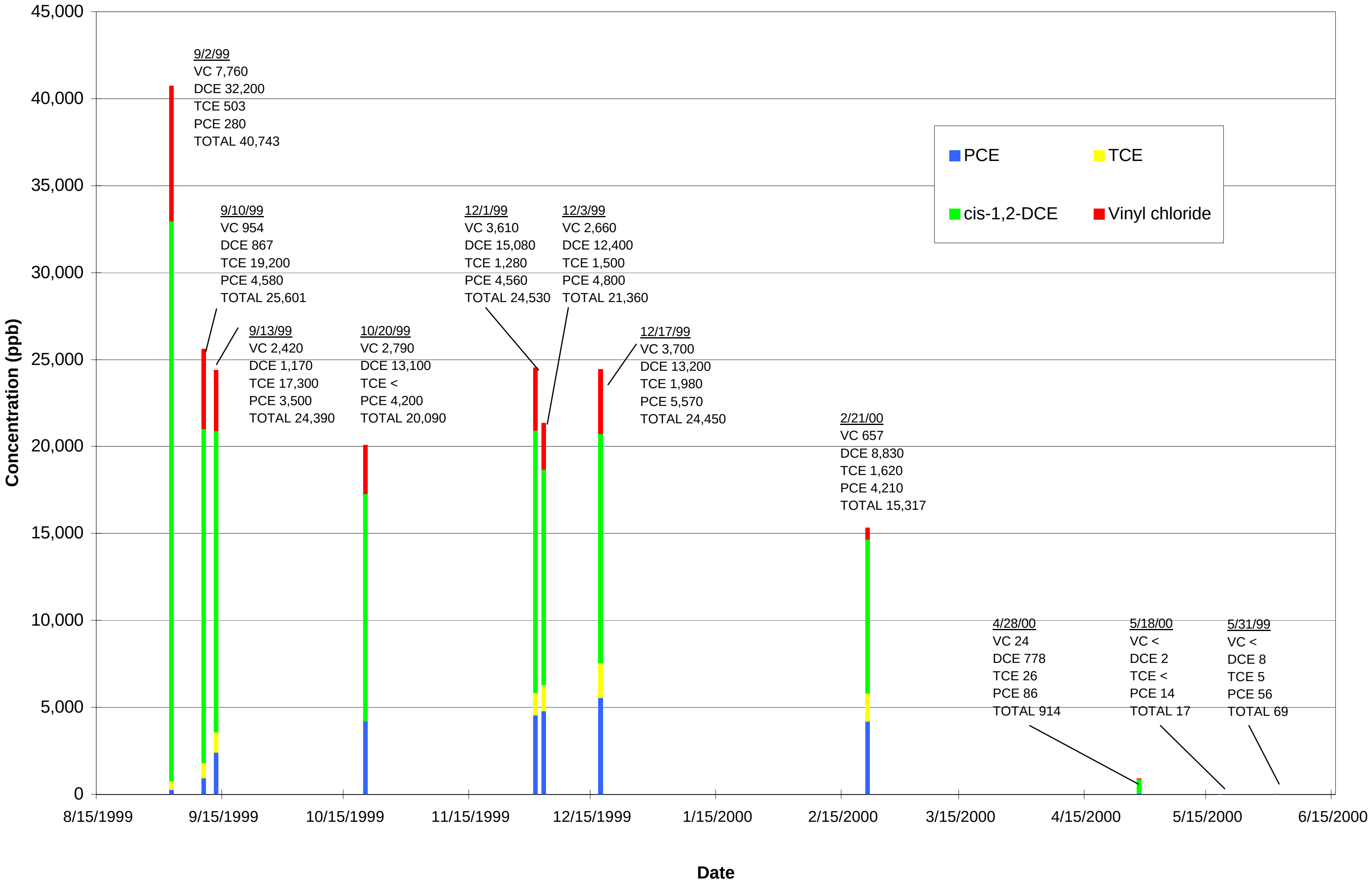


Figure 4-26. OW-3 Oxidation for Primary VOC Constituents,
General Motors Corporation, Moraine, Ohio

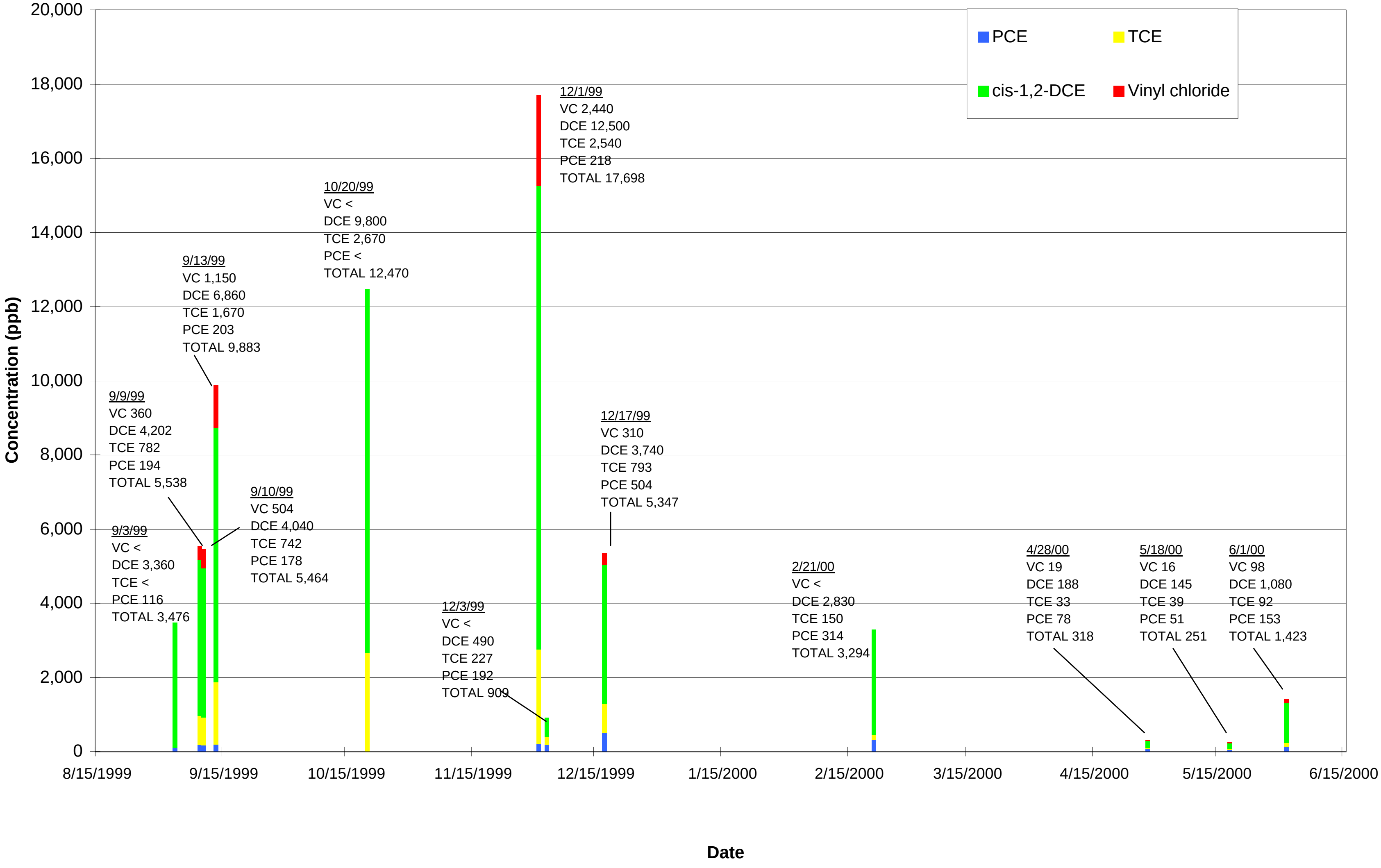


Figure 4-27. GM-23 Oxidation for Primary VOC Constituents, General Motors Corporation, Moraine, Ohio

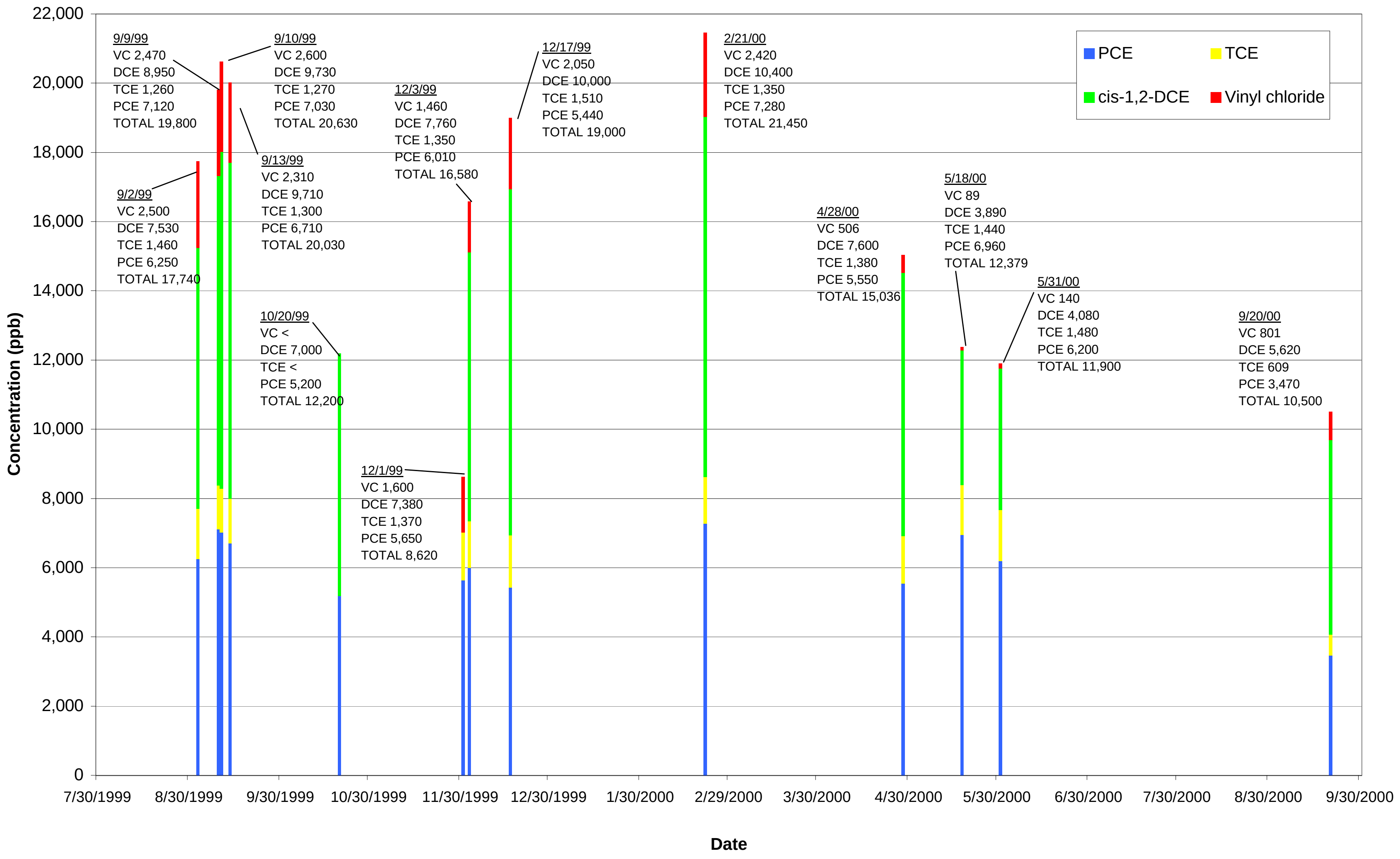
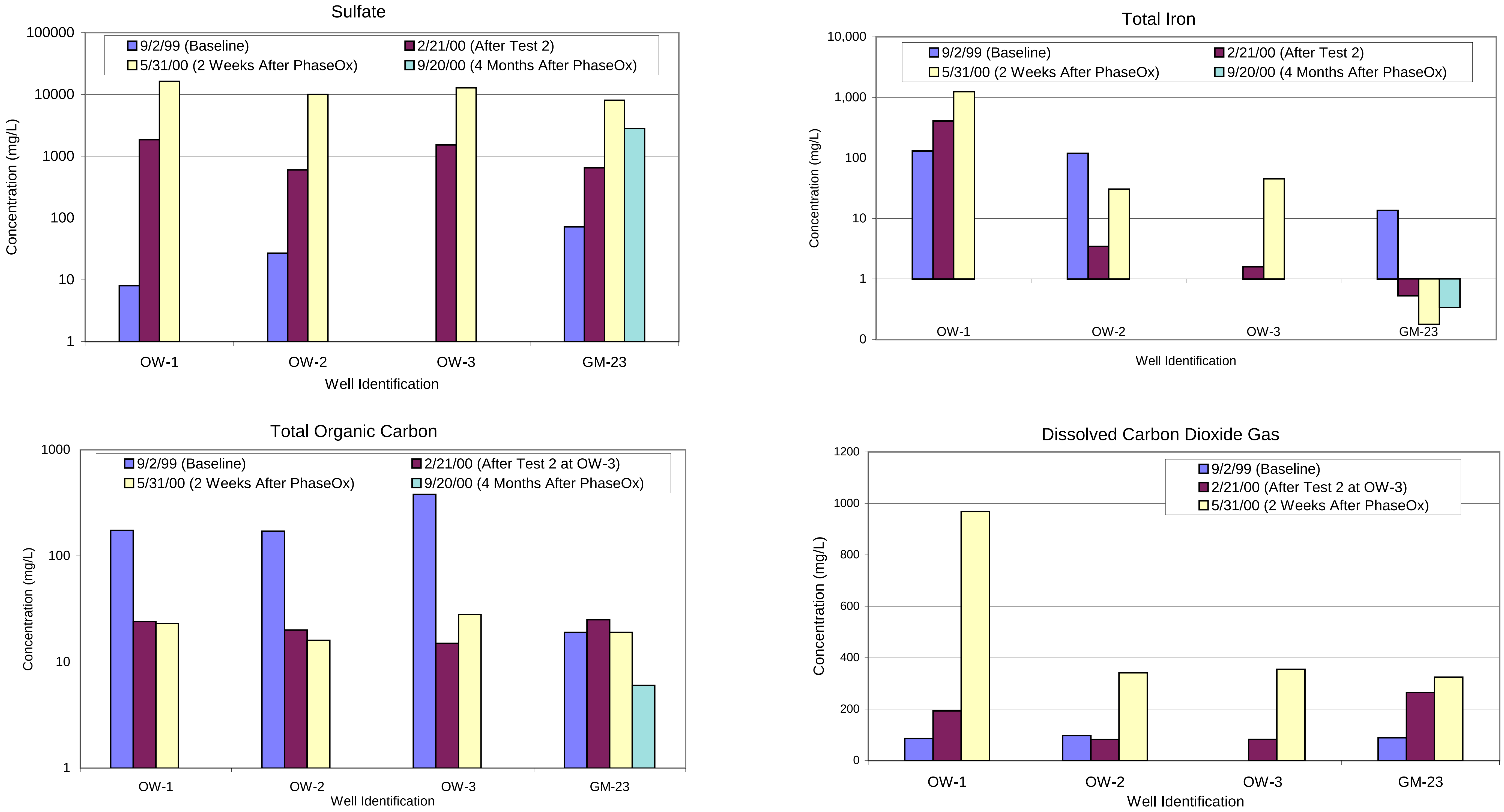


Figure 4-28. Groundwater Geochemical Laboratory Analytical Data, Oxidation Testing, General Motors Corporation, Moraine, Ohio.



DRAFT

Appendix A

RFI/Supplemental RFI Supporting Information

ARCADIS GERAGHTY&MILLER

Supporting Information:
RFI Report
Delphi Harrison Thermal Systems
April 2000

Solid Waste Management Units Description for Delphi Harrison Thermal Systems

Landfills

Three landfills (Landfill L1, L2, and L3) on the Delphi Thermal site were investigated during the RFI (Figure 1-4); these landfills are pre-RCRA, unlined, and uncapped disposal areas. Landfill L1 is located at the southern end of the facility and covers an area of approximately 7.8 acres; it was used for the collection and disposal of wastes generated by the previous plant operator, Frigidaire, for more than 20 years. Landfill L2 is located north of Building 14 and east of the wastewater treatment facility, and covers an area of approximately 3.7 acres; it was used for the collection and disposal of waste generated by Frigidaire from 1950 to 1975. Landfill L3 is located immediately northeast of the North Settling Lagoon and northwest of Landfill L2, and covers an area of approximately 1.6 acres; it was used for the collection and disposal of sludge from the adjacent North Settling Lagoon System. An estimated 25,000 cubic yards of sludge were placed in Landfill L3 from 1972 to 1979.

Surface Impoundments

Two surface impoundment SWMUs, the North and South Settling Lagoon systems (Figure 1-4), were investigated during the RFI. These SWMUs are also in the process of RCRA closure as required by the Ohio Environmental Protection Agency (Ohio EPA). The North Settling Lagoon is located east of Dryden Road, west of the wastewater treatment facility, north of Building 14, and south of Northlawn Avenue. The North Settling Lagoon covers approximately 4.6 acres. The South Settling Lagoon is located east of Interstate 75, west of Dryden Road, north of Sellars Road, and south of East River Road. This lagoon covers an estimated area of 7.9 acres. Details of the operating history for these two SWMUs are provided in the Description of Current Conditions (Geraghty & Miller, Inc. 1991).

Underground Storage Tanks

The Administrative Order listed 19 underground storage tanks (USTs) to be investigated under the RFI; 15 of the 19 USTs were removed before the RFI. Three of the four remaining USTs (T1 [10,000-gallon tank], T4 [10,000 gallon tank], and T12 [50,000-gallon tank]) were removed during the RFI. Only T11 is still in use. UST T11 is used as part of the oily waste collection system associated with the Waste Pile/Staging Area. USTs T1, T4, and T12 were used to hold a similar waste fluid consisting of wash water or spent detergent solution from a process that used polyester resins or potting compounds. RFI investigative activities were performed at the West Tank Farm, at the South Tank Farm, and at USTs T4, T5/T6, T11, and T12 (Figure 1-4).

Waste Pile/Staging Area

The Waste Pile/Staging Area (Figure 1-4) is located just north of Landfill L1 and east of Building 21. This SWMU consists of a three-sided sludge bunker (90 feet by 30 feet by 5 feet high), a concrete staging area, and drainage system associated with this area. The Waste Pile/Staging Area covers approximately 2 acres. The sludge bunker and staging area were originally constructed in 1976. This SWMU is used to manage grinding sludge from aluminum, steel, and cast iron machinery operations, steel and aluminum turnings and empty drums.

Liquid Waste Burner

The Liquid Waste Burner (LWB) (Figure 1-4) was in operation from approximately 1957 to 1970; its purpose was to incinerate spent solvents and oils. The liquids were transferred from on-site locations to the LWB in 55-gallon drums and emptied into two adjacent underground holding tanks for temporary storage. The liquids were then fed to the LWB and incinerated.

Fill Area

Before the south parking lot was constructed, fill material was used to bring the area up to grade level. The fill material consisted of approximately 75 percent bottom ash (clinkers) from two solid waste incinerators (burned combustible solid waste, such as wood, paper, and cardboard) and approximately 25 percent porcelain sludge from an on-site manufacturing process. Figure 1-4 shows the location and approximate aerial extent of the fill area (approximately 2.9 acres).

Additional Areas of Investigation

Soil samples were collected from 12 borings during Phase I in the Background Area to obtain data concerning background concentrations of metals in soils. Two additional borings were drilled during Phase II of the RFI to collect soil samples for analysis of acetone, which had been detected in the background soil samples collected during Phase I. Surface water/sediment samples were collected to support the risk assessment, to determine background conditions for surface water and sediment, and to determine if further sampling was required. The area south of Landfill L1 was investigated to further define the extent of groundwater contamination in that area by collecting groundwater samples from an existing upper aquifer monitor well, WSU-24, and from a lower aquifer monitor well, GM-20D, that was installed during Phase II of the RFI. Soil samples were collected during the installation of Well GM-20D to determine whether the soil contained hazardous constituents. Figure 1-4 shows the location of these additional areas of investigation.

Table 4-1. Upper Aquifer Monitor Well Water-Level Elevations Measured During Phase I, January 1993, Harrison RFI, Harrison Division - General Motors Corporation Moraine, Ohio

Well	MP (Top of __)	MP Elevation	Depth-to-Water from MP	Water-Level Elevation
W-1-N	PVC	739.02	31.67	707.35
W-2-N	PVC	731.68	24.89	706.79
W-3-N	PVC	733.66	27.05	706.61
W-4-N	PVC	731.63	25.05	706.58
HR-1	PVC	732.71	27.44	705.27
HR-2	PVC	734.75	28.18	706.57
HR-3	PVC	736.75	30.20	706.55
HR-4	PVC	742.60	35.43	707.17
HR-5	PVC	734.27	28.00	706.27
HR-6	PVC	732.66	27.00	705.66
HR-7	PVC	731.73	25.38	706.35
HR-8	PVC	743.42	35.97	707.45
HR-9	PVC	743.51	35.60	707.91
HR-11	PVC	743.33	35.52	707.81
HR-16	PVC	727.01	32.01*	695.00*
HR-17	PVC	726.43	21.30	705.13
W-1-S	PVC	729.29	24.10	705.19
W-2-S	PVC	726.64	22.13	704.51
W-3-S	PVC	733.42	28.96	704.46
W-4-S	PVC	727.68	23.20	704.48
GM-2	PVC	735.81	31.45	704.36
4S	PVC	731.36	27.18	704.18
GM-6	PVC	730.27	26.15	704.12
GM-8	PVC	735.17	30.96	704.21
GM-10	PVC	723.90	20.30	703.60
GM-16	PVC	725.30	21.36	703.94
GM-17	PVC	723.84	19.90	703.94
GM-18	PVC	723.80	19.94	703.86
GM-19S	PVC	730.85	26.14	704.71
EAST	PVC	730.98	26.02	704.96
WEST	PVC	730.90	25.93	704.97

PVC	Polyvinyl chloride.
MP	Measuring point.
*	Probable measurement error.

All elevations and water-level elevations reported in feet above mean sea level (msl).
Depth-to-water measurements reported in feet below MP.
All water-level measurements were collected on January 29, 1993, using an electronic water-level probe.

Table 4-2. Lower Aquifer Monitor Well Water-Level Elevations Measured During Phase I, January 1993, Harrison RFI, Harrison Division - General Motors Corporation, Moraine, Ohio.

Well	MP (Top of __)	MP Elevation	Depth-to-Water from MP	Water-Level Elevation
GM-1	PVC	735.74	31.95	703.79
GM-3	PVC	730.44	27.17	703.27
GM-4	PVC	731.46	28.20	703.26
GM-5	PVC	731.29	27.84	703.45
GM-7R	PVC	735.61	31.89	703.72
GM-9	PVC	724.07	21.02	703.05
GM-11	PVC	723.71	21.00	702.71
GM-13	PVC	723.82	21.64	702.18
GM-14	PVC	723.50	21.36	702.14
GM-15	PVC	725.23	23.24	701.99
GM-19D	PVC	730.25	26.49	703.76
HR-10	PVC	742.81	34.88	707.93
HR-12	PVC	742.64	34.81	707.83
HR-13	PVC	735.03	28.49	706.54
HR-14	PVC	731.63	25.16	706.47
HR-15	PVC	733.74	27.36	706.38

PCV	Polyvinyl chloride.
MP	Measuring point.

All elevations and water-level elevations reported in feet above mean sea level (msl).
Depth-to-water measurements reported in feet below MP.
All water-level measurements were collected on January 29, 1993 using an electronic water-level probe.

Table 4-3. Lower Aquifer Production Well Water-Level Elevations Measured During Phase I, January 1993, Harrison RFI, Harrison Division - General Motors Corporation, Moraine, Ohio

Well	MP (Top of __)	MP Elevation	Depth-to-Water from MP	Water-Level Elevation
32	Port Hole	732.10	28.20	703.90
35	Rim	733.96	29.72	704.24
37	W. Port Hole	731.24	NM (bolted shut)	NM
42	Rim	731.62	27.08	704.54
44	Port Hole	734.62	NM (inaccessible)	NM
45	Steel	731.03	27.28	703.75
46	Steel	733.34	29.56	703.78
"A"	Port Hole	739.00	32.10	706.90
FW-1	Airline Hole	740.90	33.60	707.30
FW-2	Airline Hole	737.48	32.70	704.78
FW-3	Airline Hole	739.26	NM (inaccessible)	NM
FW-4	Hole to West of Airline	731.62	26.90	704.72

MP Measuring point.
NM Not measured.
All elevations and water-level elevations reported in feet above mean sea level (msl).
Depth-to-water measurements reported in feet below MP.
All water-level measurements were collected on January 29, 1993 using an electronic water-level probe.

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Table 4-4. Upper Aquifer Monitor Well Water-Level Elevations Measured during Phase II, October 1994, Harrison RFI, Harrison Division - General Motors Corporation, Moraine, Ohio.

Well	MP (Top of __)	MP Elevation	Depth-to-Water from MP	Water-Level Elevation
W-1-N	PVC	739.02	33.82	705.20
W-2-N	PVC	731.68	27.21	704.47
W-3-N	PVC	733.66	29.36	704.30
W-4-N	PVC	731.63	27.34	704.29
HR-1	PVC	732.71	30.18	702.53
HR-2	PVC	734.75	30.44	704.31
HR-3	PVC	736.75	32.48	704.27
HR-4	PVC	742.60	37.62	704.98
HR-5	PVC	734.27	30.41	703.86
HR-6	PVC	732.66	29.68	702.98
HR-7	PVC	731.73	27.82	703.91
HR-8	PVC	743.42	38.07	705.35
HR-9	PVC	743.51	37.54	705.97
HR-11	PVC	743.33	37.40	705.93
HR-16	PVC	727.01	25.04	701.97
HR-17	PVC	726.43	24.23	702.20
W-1-S	PVC	729.29	26.97	702.32
W-2-S	PVC	726.64	25.31	701.33
W-3-S	PVC	733.42	32.15	701.27
W-4-S	PVC	727.68	26.34	701.34
GM-2	PVC	735.81	34.52	701.29
4S	PVC	731.36	30.49	700.87
GM-6	PVC	730.27	29.37	700.90
GM-8	PVC	735.17	34.18	700.99
GM-10	PVC	723.90	23.53	700.37
GM-16	PVC	725.30	24.65	700.65
GM-17	PVC	723.84	23.11	700.73
GM-18	PVC	723.80	23.19	700.61
GM-19S	PVC	730.85	29.15	701.70
EAST	PVC	730.98	28.85	702.13
WEST	PVC	730.90	28.87	702.03
TW-2	Steel Casing	NA	32.49	NA
WSU-24	PVC	725.10	23.87	701.23

PVC Polyvinyl chloride.
MP Measuring point.
All elevations and water-level elevations reported in feet above mean sea level (msl).
Depth-to-water measurements reported in feet below MP.
Water-level measurements were collected on October 20, 1994 using an electronic water-level probe.

Table 4-5. Additional Upper Aquifer Monitor Well Water-Level Elevations Measured During Phase II, October, 1994, Harrison Division - General Motors Corporation, Moraine, Ohio.

Well	MP (Top of __)	MP Elevation	Depth-to-Water from MP (ft)	Water-Level Elevation
ME-1	PVC	728.20	25.57	702.63
ME-2	PVC	728.60	25.95	702.65
ME-3	PVC	728.33	25.67	702.66
ME-4	PVC	728.56	25.97	702.59
ME-5	PVC	728.65	26.27	702.38
ME-6	PVC	728.60	25.93	702.67
GM-21	PVC	723.79	21.95	701.84
GM-22	PVC	728.67	25.93	702.74
GM-23	PVC	731.22	26.41	704.81
GM-24	PVC	747.61	40.74	706.87

PVC	Polyvinyl chloride.
MP	Measuring point.

All elevations are reported in feet above mean sea level (msl).
Depth-to-water measurements are reported in feet below MP.
Water-level measurements were collected on October 20, 1994, using an electronic water-level indicator.

Table 4-6. Lower Aquifer Monitor Well Water-Level Elevations Measured During Phase II, October 1994, Harrison RFI, Harrison Division - General Motors Corporation, Moraine, Ohio.

Well	MP (Top of __)	MP Elevation	Depth-to-Water from MP	Water-Level Elevation
GM-1	PVC	735.74	34.82	700.92
GM-3	PVC	730.44	30.10	700.34
GM-4	PVC	731.46	31.12	700.34
GM-5	PVC	731.29	30.75	700.54
GM-7R	PVC	735.61	34.76	700.85
GM-9	PVC	724.07	24.19	699.88
GM-11	PVC	723.71	24.03	699.68
GM-13	PVC	723.82	24.72	699.10
GM-14	PVC	723.50	24.47	699.03
GM-15	PVC	725.23	26.36	698.87
GM-19D	PVC	730.25	29.20	701.05
GM-20D(1)	PVC	727.26	26.26	701.00
MT-69	Steel	722.71	23.40	699.31(2)
HR-10	PVC	742.81	36.82	705.99
HR-12	PVC	742.64	36.69	705.95
HR-13	PVC	735.03	30.34	704.69
HR-14	PVC	731.63	27.64	703.99
HR-15	PVC	733.74	29.75	703.99

PVC Polyvinyl chloride.
MP Measuring point.
All elevations and water-level elevations reported in feet above mean sea level (msl).
Depth-to-water measurements reported in feet below MP.
Water-level measurements were collected on October 20, 1994, using an electronic water-level probe.

(1) Not available during Phase I.
(2) Measured on October 27, 1994.

Table 4-7. Lower Aquifer Production Well Water-Level Elevations Measured During Phase II, October 1994, Harrison RFI, Harrison Division - General Motors Corporation, Moraine, Ohio.

Well	MP (Top of ___)	MP Elevation	Depth-to-Water from MP	Water-Level Elevation
32	Port Hole	732.10	30.88	701.22
35	Rim	733.96	32.50	701.46
37	W. Port Hole	731.24	NM (sealed)	NM
42	Rim	731.62	30.00	701.62
44	Port Hole	734.62	NM	NM
45	Steel	731.03	30.02	701.01
46	Steel	733.34	32.16	701.18
"A"	Port Hole	739.00	34.75	704.25
FW-1	Airline Hole	740.90	35.88	705.02
FW-2	Airline Hole	737.48	35.58	701.90
FW-3	Airline Hole	739.26	36.79	702.47
FW-4	Hole to West of Airline	731.62	30.42	701.20

PVC	Polyvinyl choride.
MP	Measuring point.
NM	Not measured.

All elevations and water-level elevations reported in feet above mean sea level (msl).
Depth-to-water measurement reported in feet below MP.
Water-level measurements were collected on October 20, 1994, using an electronic water-level probe.

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Table 4-8. Detected Volatile Organic Compound Concentrations in the Upper and Lower Aquifers Upgradient from the Harrison Site During the RFI, Harrison Division - GMC.

Parameter	Concentration Units	UPPER AQUIFER				LOWER AQUIFER		
		HR-8 Phase I	HR-9 Phase I	HR-11 Phase I	W-1-N Phase I	HR-10 Phase I	DUP-20 Phase I	HR-12 Phase I
1,1,1-Trichloroethane	ug/L	5.2	5.4	--	--	--	--	--
1,1-Dichloroethane	ug/L	34.6	29.3	10.7	--	--	--	--
Carbon disulfide	ug/L	--	--	--	--	3	--	5.5
Chloroethane	ug/L	--	13.7	--	--	--	--	--
Trichloroethene	ug/L	1.3	16.1	--	--	--	--	--
Vinyl chloride	ug/L	--	--	--	--	--	--	6.6

64.5

-- Not detected.
ug/L Micrograms per liter.
DUP-20 is the duplicate sample of HR-10 during Phase I.

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Table 4-9. Detected Dissolved Metal Concentrations in the Upper and Lower Aquifer Upgradient from the Harrison Site During the RFI, Harrison Division - GMC.

		UPPER AQUIFER				LOWER AQUIFER					
Parameter	Concentration Units	HR-8 Phase I	HR-9 Phase I	HR-11 Phase I	W-1-N Phase I	HR-10 Phase I	DUP-20 Phase I	HR-10 Phase II	HR-12 Phase I	HR-12 Phase II	DUP-36 Phase II
Antimony, dissolved	ug/L	NA	55.3 J	NA	NA	NA	NA	NA	51.9	NA	NA
Barium, dissolved	ug/L	97.9	80.8 J	77.8	102	58	58.6	NA	97.7	NA	NA
Cobalt, dissolved	ug/L	--	11.9 J	9.8	6.1	5.6	8.6	NA	10.4	NA	NA
Selenium, dissolved	ug/L	NA	1 J	NA	NA	NA	NA	NA	NA	NA	NA

NA Not analyzed.
-- Not detected.
J Estimated.
ug/L Micrograms per liter.
DUP-20 is the duplicate sample of HR-10 during Phase I.
DUP-36 is the duplicate sample of HR-12 during Phase II.

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Table 4-10. Detected Volatile Organic Compound Concentrations in the Upper Aquifer Downgradient from the Harrison Facility RFI, Harrison Division - GMC

Parameter	Concentration Units	UPPER AQUIFER GM-10 Phase I	GM-16 Phase I	GM-17 Phase I	DUP-21 Phase I	GM-18 Phase I	DUP-22 Phase I	WSU-24 Phase II
1,1,1-Trichloroethane	ug/L	8	3.8	4.3	6.4	17.9	17.4	3.1
1,1-Dichloroethane	ug/L	11.1	--	117	115	144	152	--
Chlorobenzene	ug/L	--	--	5.7	2.5	--	--	--
Chloroethane	ug/L	--	--	12.3	--	10.2	11	--
Tetrachloroethene	ug/L	2.8	57	--	--	1.1	1.3	2.3
Trichloroethene	ug/L	85.2	28.9	25.3	43.3	62.3	63.5	20.7
Vinyl chloride	ug/L	--	--	8.4	6.5	17	17.5	--
trans-1,2-Dichloroethene	ug/L	2.4	--	8.3	9.2	16.7	17.2	--

-- Not detected.
ug/L Micrograms per liter.
DUP-21 is the duplicate sample of GM-17 during Phase I.
DUP-22 is the duplicate sample of GM-18 during Phase I.

i\harrison\95rfi\tables\tbl4-10 wb2

Table 4-11. Detected Volatile Organic Compound Concentrations in the Lower Aquifer Downgradient from the Harrison Facility RFI, Harrison Division - GMC

	LOWER AQUIFER						
Parameter	GM-9 Phase I	GM-11 Phase I	GM-13 Phase I	GM-15 Phase I	GM-20D Phase II	MT-69 Phase II	DUP-33 Phase II
1,1,1-Trichloroethane	--	8.6	4.6	--	--	--	--
1,1-Dichloroethane	14.5	--	--	2.4	--	--	--
Chlorobenzene	--	--	--	--	--	--	--
Chloroethane	--	--	--	--	--	--	--
Tetrachloroethene	--	5.5	5.8	--	6.1	--	--
Trichloroethene	4.9	29.1	15.8	3.7	1.8	--	--
Vinyl chloride	--	--	--	--	--	--	--
trans-1,2-Dichloroethene	4.1	--	--	--	--	--	--

-- Not detected.

DUP-33 is the duplicate sample of MT-69 during Phase II.

i\harrison\95rfi\tables\tbl4-11.wb2

Table 4-12. Detected Dissolved Metals and Cyanide Concentrations in the Upper Aquifer Downgradient from the Harrison Facility RFI, Harrison Division - GMC.

		UPPER AQUIFER						
Parameter	Concentration Units	GM-10 Phase I	GM-16 Phase I	GM-17 Phase I	DUP-21 Phase I	GM-18 Phase I	DUP-22 Phase I	WSU-24 Phase II
Cyanide	mg/L	--	--	--	--	0.021	--	--
Barium, dissolved	ug/L	180 J	142	78.7	80.8	48.8	47.7	115
Cobalt, dissolved	ug/L	7.3	5.4	13.4	14.8	--	--	NA
Copper, dissolved	ug/L	--	--	9.7	5.4	5.7	9.2	--
Selenium, dissolved	ug/L	NA	NA	NA	--	2.8	1.1 J	NA

-- Not detected.
mg/L Milligrams per liter.
ug/L Micrograms per liter.
J Estimated.
NA - Not analyzed.
DUP-21 is the duplicate sample of GM-17 during Phase I.
DUP-22 is the duplicate sample of GM-18 during Phase I.

i\harrison\95rfi\tables\tbl4-12.wb2

Table 4-13. Detected Dissolved Metals in the Lower Aquifer Downgradient from the Harrison Facility RFI, Harrison Division - GMC.

Parameter	Concentration Units	LOWER AQUIFER GM-9 Phase I	GM-11 Phase I	GM-13 Phase I	GM-15 Phase I	GM-20D Phase II	MT-69 Phase II	DUP-33 Phase II
Antimony, dissolved	ug/L	53.2 J	66.2 J	--	NA	NA	NA	NA
Barium, dissolved	ug/L	81.4	71.4	75.9	163 J	74.8	113	119
Cobalt, dissolved	ug/L	6.7	9.4	7.2	7.5	--	NA	NA
Copper, dissolved	ug/L	--	--	--	NA	--	--	--
Selenium, dissolved	ug/L	NA	NA	1 J	NA	NA	NA	NA
Zinc, dissolved	ug/L	--	--	--	--	--	17.5	NA

-- Not detected.
ug/L Micrograms per liter.
J Estimated.
NA Not analyzed.
DUP-33 is the duplicate sample of MT-69 during Phase II.

TABLE 4-14. SOIL BACKGROUND ANALYTICAL RESULTS
TOTAL ORGANIC CARBON AND CATION-EXCHANGE CAPACITIES
HARRISON DIVISION - GMC

Sample Name	UNITS	BKG BH03-02SL	BKG BH03-16SL	BKG BH07-02SL	BKG-BH07-16SL	BKG-BH10-02SL	BKG-BH10-16SL	DUP-05
Total Organic Carbon	MG/KG	12000	12000	13000	18000	4800	6500	12000
Cation-Exchange Capacity	UG/G N (Dry wt)	2000	990	2200	1300	2900	1900	2700

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Table 5-1. Detected Volatile Organic Compound Concentrations in the Upper Aquifer Upgradient and Downgradient from Landfill L1 RFI, Harrison Division - GMC.

Parameter	Concentration Units	UPGRADIENT GM-2 Phase I	DUP-17 Phase I	EAST- Phase I	EAST- Phase II	DUP-29 Phase II	DOWNGRADIENT 4S- Phase I	GM-6 Phase II	GM-8 Phase I
1,1,1-Trichloroethane	ug/L	13.7	12.6	18.9	16	16.1	--	--	7.3
1,1-Dichloroethane	ug/L	3.1	2.9	8	10.5	10.8	77.8	218	120
Benzene	ug/L	--	--	--	--	--	--	14.3	6
Chloroethane	ug/L	--	--	--	--	--	--	--	30.8
Ethylbenzene	ug/L	--	--	--	--	--	45.9	459	108
Tetrachloroethene	ug/L	7.6	7.2	79.4	62.4	61.2	--	--	2.2
Toluene	ug/L	--	--	--	--	--	--	75.2	1.1
Trichloroethene	ug/L	108	94.8	83.4	71.4	71.2	--	--	69.4
Vinyl chloride	ug/L	--	--	--	--	--	--	--	28.3
Xylenes, total	ug/L	--	--	--	--	--	24	498	70.6
trans-1,2-Dichloroethene	ug/L	--	--	--	--	--	--	22	13

-- Not detected.
ug/L Micrograms per liter.
DUP-17 is the duplicate sample of GM-2 during Phase I.
DUP-29 is the duplicate sample of East during Phase II.

Table 5-2. Detected Volatile Organic Compound Concentrations in the Lower Aquifer Upgradient and Downgradient from Landfill L1 RFI, Harrison Division - GMC.

Parameter	Concentration Units	UPGRADIENT	DOWNGRADIENT					
		GM-1 Phase I	GM-3 Phase II	GM-5 Phase I	DUP-18 Phase I	GM-7R Phase I	GM-7R Phase II	DUP-34 Phase II
1,1,1-Trichloroethane	ug/L	8	1.9	--	--	9.4	6	6.7
1,1-Dichloroethane	ug/L	--	1.1	--	2.5	6.9	3.8	4
1,1-Dichloroethene	ug/L	--	--	--	--	--	1.7	1.8
Tetrachloroethene	ug/L	4.7	1.1	--	--	--	--	--
Trichloroethene	ug/L	42.4	4.7	--	--	183	134	147

-- Not detected.
ug/L Micrograms per liter.
DUP-18 is the duplicate sample of GM-5 during Phase I.
DUP-34 is the duplicate sample of GM-7R during Phase II.

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Table 5-3. Detected Cyanide and Dissolved Metal Concentrations in the Upper Aquifer Upgradient and Downgradient from Landfill L1 RFI, Harrison Division - GMC.

Parameter	Concentration Units	UPGRADIENT			DOWNGRADIENT	
		GM-2 Phase I	DUP-17 Phase I	EAST- Phase I	4S- Phase I	GM-8 Phase I
Cyanide	mg/L	--	--	0.008	0.014	0.017
Antimony, dissolved	ug/L	NA	NA	56.2	NA	--
Arsenic, dissolved	ug/L		--	--	23.3	--
Barium, dissolved	ug/L	103	96	90.9	237	129
Cobalt, dissolved	ug/L	8.9	8.3	9.9	20.8	12.2
Copper, dissolved	ug/L	--	--	9.4	--	5.6
Nickel, dissolved	ug/L	--	--	15.8	--	NA
Zinc, dissolved	ug/L	--	--	11.7	--	--

NA Not analyzed.
-- Not detected.
mg/L Milligrans per liter.
ug/L Micrograms per liter.
DUP-17 is a duplicate sample of GM-2 during Phase I.

i:\harrison\95rfi\tables\tbl5-3 wb2

Table 5-4. Detected Dissolved Metal Concentrations in the Lower Aquifer Upgradient and Downgradient from Landfill L1 RFI, Harrison Division - GMC.

Parameter	Concentration Units	UPGRADIENT	DOWNGRADIENT		
		GM-1 Phase I	GM-5 Phase I	DUP-18 Phase I	GM-7R Phase I
Barium, dissolved	ug/L	79.2	84	84.6	80.6
Cobalt, dissolved	ug/L	8.6	9.1	13.1	10.7
Copper, dissolved	ug/L	--	10.2	--	--
Nickel, dissolved	ug/L	--	19.5	--	--

-- Not detected.
ug/L Micrograms per liter.
DUP-18 is the duplicate sample of GM-5 during Phase I.

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Table 5-5. Detected Volatile Organic Compound Concentrations in the Upper and Lower Aquifers Downgradient from Landfills L2 and L3 RFI, Harrison Division - GMC.

		LANDFILL - L2		LANDFILL- L3	
		Upper Aquifer	Lower Aquifer	Upper Aquifer	
Parameter	Concentration Units	HR-3 Phase I	HR-13 Phase I	HR-4 Phase I	DUP-15 Phase I
1,1,1-Trichloroethane	ug/L	--	1.6	--	--
1,1-Dichloroethane	ug/L	--	43.2	--	--
Tetrachloroethene	ug/L	--	--	1.6	2.5
Trichloroethene	ug/L	--	2.4	1.7	2.2
trans-1,2-Dichloroethene	ug/L	--	3.8	--	--

-- Not detected.
ug/L Micrograms per liter.
DUP-15 is the duplicate sample of HR-4 during Phase I

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Table 5-6. Detected Dissolved Metal Concentrations for Upper and Lower Aquifers Downgradient from Landfill L2 and Upper Aquifer Downgradient from Landfill L3 RFI, Harrison Division - GMC.

		LANDFILL - L2		LANDFILL - L3	
		Upper Aquifer	Lower Aquifer	Upper Aquifer	
Parameter	Concentration Units	HR-3 Phase I	HR-13 Phase I	HR-4 Phase I	DUP-15 Phase I
Barium, dissolved	ug/L	59.1	71.7	67.1	65.6
Cobalt, dissolved	ug/L	13.2	8.9	9.9	7.8
Lead, dissolved	ug/L	2.2 J	4.5 J	--	--

-- Not detected.
J Estimated.
ug/L Micrograms per liter.
DUP-15 is the duplicate sample of HR-4 during Phase I.

i:\harrison\95rfi\tables\tbl5-6 wb2

Table 5-7. Summary of North Settling Lagoon Analytical Results, Harrison Division - GMC.

Constituent[1]	Frequency of Detection[2]	Range of Detected Concentrations[3]	Median Concentrations	Location of Maximum[4]
Metals				
Antimony	15/18	8.93-54.8	18.2	NPI-COMPL
Arsenic	18/18	8.58-158.0	94.6	NPI-2/3M
Barium	18/18	330.0-2550.0	1190.0	NPI-COMPL
Cadmium	18/18	6.57-1430.0	265.0	NSI-10L
Chromium	18/18	244.0-3630.0	562.0	NSIII-5
Cobalt	9/9	72.7-1210.0	469.0	NPI-2/3M
Copper	18/18	54.2-969.0	221.0	NSI-COMPL
Lead	18/18	160.0-5970.0	881.0	NSI-10L
Mercury	18/18	0.270-1.87	0.864	NPI-COMPL
Nickel	18/18	218.0-3250.0	1575.0	NSIII-COMPU
Selenium	5/18	2.78-76.6	14.5	NSI-10L
Silver	17/18	0.492-2.12	0.824	NPI-2U
Tin	4/9	213.0-741.0	313.5	NSI-10U
Vanadium	5/9	19.1-30.7	24.4	NSII-3U
Zinc	18/18	920.0-10501.0	7830.0	NSI-COMPM
Volatile Organics				
1,2-Dichlorobenzene	2/18	0.57-1.52	1.05	NPI-2L
Ethylbenzene	7/18	0.153-3.4	1.3	NSI-10L
Tetrachloroethene	2/18	2.05-4.7	3.38	NSI-COMPM
Toluene	7/18	0.87-10.1	3.9	NPI-2/3M
Trichloroethylene	3/18	0.55-6.66	3.3	NPI-COMPL
Xylene	6/9	0.150-9.25	5.0	NSI-COMPL
Extractable Organics				
Bis(2-ethylhexyl)Phthalate	4/9	17.4-31.2	21.8	NSII-3U
Fluoranthene	5/9	6.18-104.0	10.3	NPI-2U
Fluorene	4/9	1.6-18.5	7.15	NSII-3L
2-Methylnaphthalene	6/9	1.2-9.54	5.36	NSII-3L
Phenanthrene	7/9	2.46-41.7	5.4	NPI-2U
Pyrene	5/9	5.58-81.5	8.86	NPI-2U

Table 5-7. Summary of North Settling Lagoon Analytical Results, Harrison Division - GMC.

Constituent[1]	Frequency of Detection[2]	Range of Detected Concentrations[3]	Median Concentrations	Location of Maximum[4]
<u>Miscellaneous</u>				
Cyanide	15/18	0.65-5.32	2.47	NSI-COMPL
PCB 1242	1/9	3.1-	3.1	NSI-10L
PCB 1260	6/9	5.1-27.4	7.7	NSIII-5
Sulfide	9/9	110.0-39000.0	1790.0	NSIII-5

Data from Description of Current Conditions (Geraghty & Miller, Inc. 1991a).

<u>Notes:</u>

[1] Included only detected constituents from the Primary and Secondary. and Sludge Basins which have been grouped together.

[2] Calculated by number of times constituent was detected divided by number of times constituent was tested for.

[3] Units in mg/kg (dry weight).

[4] NP --North Primary Basin.
NS--North Secondary Basin.

Table 5-8. Detected Volatile Organic Compound Concentrations in the Upper and Lower Aquifers Downgradient from the North Settling Lagoon RFI, Harrison Division - GMC.

Parameter	Concentration Units	UPPER AQUIFER W-3-N Phase I	UPPER AQUIFER W-4-N Phase I	LOWER AQUIFER HR-14 Phase I	LOWER AQUIFER HR-15 Phase I	LOWER AQUIFER DUP-14 Phase I
Carbon disulfide	ug/L	--	--	--	--	2.1
Tetrachloroethene	ug/L	41.4	1.6	--	--	--
Trichloroethene	ug/L	9.3	9.1	4.6	--	--
Vinyl chloride	ug/L	--	--	7.7	--	--

-- Not detected.
ug/L Micrograms per liter.
DUP-14 is the duplicate sample of HR-15 during Phase I.

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Table 5-9. Detected Dissolved Metal Concentrations in the Upper and Lower Aquifers Downgradient from the North Settling Lagoon RFI, Harrison Division - GMC.

Parameter	Concentration Units	UPPER AQUIFER W-3-N Phase I	 W-4-N Phase I	LOWER AQUIFER HR-14 Phase I	 HR-15 Phase I	 DUP-14 Phase I
Antimony, dissolved	ug/L	57.8 J	58.8	57.6	--	--
Barium, dissolved	ug/L	91.7	122	85.4	94.4	95.2
Cobalt, dissolved	ug/L	9.5	13.1	10.1	6.7	8
Lead, dissolved	ug/L	--	--	4.6	--	--
Nickel, dissolved	ug/L	NA	15.8	--	NA	NA

-- Not detected.
ug/L Micrograms per liter.
J Estimated.
NA - Not analyzed.
DUP-14 is the duplicate sample of HR-15 during Phase I.

i:\harrison\95rfi\tables\tbl5-9 wb2

Table 5-10. Summary of South Settling Lagoon Analytical Results, South Settling Lagoon, Harrison Division - GMC.

Constituent[1]	Frequency of Detection[2]	Range of Detected Concentrations[3]	Median Concentrations	Location of Maximum[4]
Metals				
Antimony	14/36	5.03-52.8	12.6	SSI-8L
Arsenic	36/36	3.4-157.0	33.3	SSII-7L
Barium	36/36	713.0-7310	2170.0	SSII-7L
Cadmium	36/36	0.721-26.9	12.2	SSIII-1U
Chromium	36/36	55.3-2020.0	1055.0	SSIII-5L
Cobalt	5/6	17.8-222.0	30.5	SSIII-5L
Copper	36/36	37.2-16900.0	480.0	SSIII-5L
Lead	36/36	87.1-398.0	252.0	SSI-8L
Mercury	34/36	0.081-4.03	0.41	SSII-8U
Nickel	36/36	26.3-1490.0	535.0	SSII-COMPL
Selenium	1/36	0.78-	0.78	SSII-COMPU
Silver	34/36	0.317-2.45	0.54	SSIII-5U
Tin	1/6	28.3-	28.3	SPI-1U
Zinc	36/36	157.0-2190.0	1351.0	SSIV-8U
Extractable Organics				
Bis(2-ethylhexyl)Phthalate	4/13	1.33-2.76	1.7	SPII-4L
Di-n-butyl phthalate	1/13	1.99-	1.99	SPI-1U
Miscellaneous				
Cyanide	36/36	0.562-18.9	7.0	SSIII-5L
PCB 1254	8/13	1.6-206.0	10.4	SSIII-5L
PCB 1260	2/13	1.5-4.6	3.0	SPI-1U

Data from the Description of Current Conditions (Geraghty & Miller, Inc. 1991a).

Notes:

1 Includes only detected constituents from the Primary and Secondary, and Sludge Basins which have been grouped together.
2 Calculated by number of times constituent was detected divided by number of times constituent was tested for.
3 Units in mg/kg (dry weight).
4 SP --South Primary Basin.
SS--South Secondary Basin.

Table 5-11. Detected Volatile Organic Compound Concentrations in the Upper Aquifer Upgradient and Downgradient from the South Settling Lagoon RFI, Harrison Division - GMC.

Parameter	Concentration Units	UPGRADIENT				DOWNGRADIENT			
		HR-17 Phase I	DUP-19 Phase I	HR-17 Phase II	DUP-35 Phase II	W-2-S Phase I	W-2-S Phase II	W-4-S Phase I	W-4-S Phase II
1,1,1-Trichloroethane	ug/L	2.6	--	--	--	--	1.2	2.5	2.7
Carbon disulfide	ug/L	--	--	--	1.7	--	--	--	1.6
Tetrachloroethene	ug/L	12.2	11.4	10.4	10.4	--	--	166	36.9
Trichloroethene	ug/L	3.1	3.1	4.9	4.9	4.6	3.9	25	12.8
Trichlorofluoromethane	ug/L	--	--	13.4	10.7	--	--	--	6.3

-- Not detected.

ug/L Micrograms per liter.

DUP-19 is the duplicate sample of HR-17 during Phase I.

DUP-35 is the duplicate sample of HR-17 during Phase II.

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Table 5-12. Detected Dissolved Metal Concentrations in the Upper Aquifer Upgradient and Downgradient from the South Settling Lagoon RFI, Harrison Division - GMC.

Parameter	Concentration Units	UPGRADIENT HR-17 Phase I	UPGRADIENT DUP-19 Phase I	DOWNGRADIENT W-2-S Phase I	DOWNGRADIENT W-4-S Phase I
Barium, dissolved	ug/L	118	116	176	74.1
Cobalt, dissolved	ug/L	--	5.6	7.7	7.6

-- Not detected.
ug/L Micrograms per liter.
DUP-19 is the duplicate sample of HR-17 during Phase I.

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Table 5-13. Detected Volatile Organic Compound Concentrations in Soil Samples Collected at the West Tank Farm RFI, Harrison Division - GMC

Parameters	Units	WTF-GS7-15SL Phase I	WTF-GS8-15SL Phase I	DUP-02 Phase I	WTF-GS10-15SL Phase I	T10-BH01-16SL Phase II	DUP-27 Phase II
1,2-Dichloroethene (Total)	ug/kg	--	--	--	--	1320	530
2-Butanone	ug/kg	--	--	--	--	9940	--
Tetrachloroethene	ug/kg	--	75	1500	--	6200	4,260
Trichloroethene	ug/kg	--	--	--	--	1390	510

-- Not detected.
ug/kg Micrograms per kilogram.

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Table 5-14. Detected Metals in Soil Samples Collected at the West Tank Farm RFI, Harrison Division - GMC.

Parameters	Units	WTF-GS7-15SL Phase I	WTF-GS8-15SL Phase I	DUP-02 Phase I	WTF-GS10-15SL Phase I
Aluminum	mg/kg	2720	2150	2690	3600
Arsenic	mg/kg	2.1 J	3.5 J	4 J	4.6 J
Barium	mg/kg	10.1	11.5	23.6	21.9
Cadmium	mg/kg	1.7 J	2.7 J	1.8 J	2.3 J
Calcium	mg/kg	118000 J	144000 J	125000 J	105000 J
Chromium	mg/kg	2.6 J	5.2 J	5.1 J	9 J
Cobalt	mg/kg	--	2.8	3.6	2.7
Copper	mg/kg	4.9	12.7	10.7	8.8
Iron	mg/kg	5870	8790	6340	6820
Lead	mg/kg	2.5 J	6 J	5.7 J	11.5 J
Magnesium	mg/kg	49100	42600	53000	49600
Manganese	mg/kg	169	175	298	234
Nickel	mg/kg	--	9.1	12.1	11.9
Potassium	mg/kg	418	490	404	601
Silver	mg/kg	1 J	0.65 J	--	--
Sodium	mg/kg	114	146	151	143
Vanadium	mg/kg	8	6.2	8.7	9.7
Zinc	mg/kg	18 J	30.9 J	40.6 J	32.9 J

-- Not detected.
J Estimated value.
mg\kg Milligrams per kilograms.

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Table 5-15. Detected Volatile Organic Compound Concentrations in the Upper Aquifer in the Vicinity of SWMU T12 and the West Tank Farm RFI, Harrison Division - GMC.

Parameter	Concentration Units	SWMU T12	WEST TANK FARM		
		DOWNGRADIENT	UPGRADIENT		DOWNGRADIENT
		HR-6 Phase I	HR-1 Phase I	DUP-13 Phase I	W-1-S Phase I
1,1,1-Trichloroethane	ug/L	--	4.5	7.7	--
Carbon Disulfide	ug/L	--	3.9	--	--
Tetrachloroethene	ug/L	--	25.6	46.3	34.7
Trichloroethene	ug/L	4.4	55.8	101	5.2
Trichlorofluoromethane	ug/L	--	2	5	29.9
trans-1,2-Dichloroethene	ug/L	--	1.6	2.8	--

-- Not detected.
ug/L Micrograms per liter.
DUP-13 is the duplicate sample of HR-1 during Phase I.

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Table 5-16. Detected Dissolved Metal Concentrations in the Upper Aquifer in the Vicinity of SWMU T12 and the West Tank Farm RFI, Harrison Division - GMC.

		SWMU T12	WEST TANK FARM		
		DOWNGRADIENT	UPGRADIENT		DOWNGRADIENT
Parameter	Concentration Units	HR-6 Phase I	HR-1 Phase I	DUP-13 Phase I	W-1-S Phase I
Antimony, dissolved	ug/L	NA	--	69 J	56.9 J
Barium, dissolved	ug/L	89.1	89.7	96.7	123 J
Cobalt, dissolved	ug/L	7.7	8.7	8	7.3 J
Copper, dissolved	ug/L	--	5.4	--	--
Lead, dissolved	ug/L	--	--	--	2J
Zinc, dissolved	ug/L	--	--	10.1	--

-- Not detected.
J Estimated.
NA - Not analyzed.
ug/L Micrograms per liter.
DUP-13 is the duplicate sample of HR-1 during Phase I.

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Table 5-17. Detected Volatile Organic Compound Concentrations in Soils at SWMU T12 RFI, Harrision Division - GMC.

Parameters	Units	T12-GS1-17SL Phase I	DUP-01 Phase I	T12-GS2-10SL Phase I
Ethylbenzene	ug/kg	6.1	8	--
Styrene	ug/kg	30	31	7.1

-- Not detected.
ug\kg Micrograms per kilograms.

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Table 5-18 . Detected Metals in Soils at SWMU T12 RFI
Harrision Division - GMC.

Parameters	Units	T12-GS1-17SL Phase I	DUP-01 Phase I	T12-GS2-10SL Phase I
Aluminum	mg/kg	1950 J	2000 J	8940 J
Antimony	mg/kg	48.4 J	56.3 J	32.5 J
Arsenic	mg/kg	1.5 J	1.8 J	4 J
Barium	mg/kg	9.6	9.1	139
Beryllium	mg/kg	0 .35 J	0.38 J	0.54
Cadmium	mg/kg	1.1 J	0.68 J	3.4
Calcium	mg/kg	174000	184000	71900
Chromium	mg/kg	--	--	11.2
Cobalt	mg/kg	18.5 J	20 J	23.3
Copper	mg/kg	5.1 J	6.4 J	22 J
Iron	mg/kg	4370 J	4400 J	14000 J
Lead	mg/kg	3.4 J	4 J	14.9 J
Magnesium	mg/kg	58700 J	85400 J	24400 J
Manganese	mg/kg	328 J	204 J	284 J
Sodium	mg/kg	202	254	282
Vanadium	mg/kg	6.2	7.8	25
Zinc	mg/kg	15.8	14.9	80.1

-- Not detected.
J Estimated value.
mg/kg Milligrams per kilogram.

i:\harrison\95rfi\tables\t12slmet wb2

Table 5-19. Detected Volatile Organic Compound Concentrations and Semivolatile Organic Compound Concentrations in Soil Samples Collected at SWMU T5/T6 RFI, Harrision Division - GMC.

Parameters	Units	T5/6-BH01-11SL Phase I	T5/6-BH01-12SL Phase I	DUP-06 Phase I	T5/6-BH02-12SL Phase I
VOCs			NA		
Acetone	ug/kg	280		--	110
Tetrachloroethene	ug/kg	33		55	32
SVOCs		NA			
bis(2-Ethylhexyl)phthalate	ug/kg		350	400	350

-- Not detected.
NA Not analyzed.
ug/kg Micrograms per kilograms.
VOCs Volatile Organic Compound Concentrations.
SVOCs Semivolatile Organic Compound Concentrations.

Table 5-20. Detected Metals in Soil Samples Collected at SWMU T5/T6 RFI,
Harrison Division - GMC.

Parameters	Units	T5/6-BH01-10SL Phase I	DUP-06 Phase I	T5/6-BH02-12SL Phase I
Aluminum	mg/kg	2930	6880	3210
Antimony	mg/kg	31.2	19.4	27.3
Arsenic	mg/kg	4.6	5	11
Barium	mg/kg	17.7	39.4	12.3
Beryllium	mg/kg	0.26 J	0.39	0.3 J
Cadmium	mg/kg	2.8 J	3.9	6.1 J
Calcium	mg/kg	123000	67900	131000
Chromium	mg/kg	6.9	10.9	8.8
Cobalt	mg/kg	10.3 J	9.8	10.6 J
Copper	mg/kg	7.3	17.3	7.4
Iron	mg/kg	7650 J	10800 J	16100 J
Lead	mg/kg	4.2 J	15.1 J	4.2 J
Magnesium	mg/kg	51300	28600	40000
Manganese	mg/kg	246 J	344 J	469 J
Nickel	mg/kg	7.9	13.2	8.4
Potassium	mg/kg	632	898	592
Sodium	mg/kg	207	268	173
Vanadium	mg/kg	9.1	18.3	13.7
Zinc	mg/kg	31.3	70.2	28.1

J Estimated value.
mg/kg Milligrams per kilogram.

Table 5-21. Detected Volatile Organic Compounds and Semivolatile Organic Compounds in Soils Collected at SWMU T11 RFI, Harrison Division - GMC.

Parameters	Units	T11-BH01-02SL Phase I	DUP-08 Phase I	T11-BH01-16S Phase I	T11-BH02-02SL Phase I	T11-BH02-16SL Phase I	T11-BH03-02SL Phase I	T11-BH03-16SL Phase I
VOCs								
Acetone	ug/kg	1800	1800	1400 J	--	1400 J	8900 J	710 J
Tetrachloroethene	ug/kg	66	120	41	--	--	110	38 J
Toluene	ug/kg	--	--	5.8	--	--	--	--
SVOCs								
2-Methylnaphthalene	ug/kg	--	--	--	7300	--	--	--
Bis(2-ethylhexyl)Phthalate	ug/kg	550	--	580	--	420	--	--
Naphthalene	ug/kg	--	--	--	7500	--	--	--

-- Not detected.
J Estimated value.
ug\kg Micrograms per kilogram.
VOCs Volatile Organic Compounds.
SVOCs Semivolatile Organic Compounds.

Table 5-22. Detected Volatile Organic Compound Concentrations in the Upper and Lower Aquifers in the Vicinity of the Fill Area, South Tank Farm, T11, and the Waste Pile/Staging Area SWMUs RFI, Harrison Division - GMC.

Parameter	Concentration Units	UPPER AQUIFER GM-19S Phase I	UPPER AQUIFER GM-19S Phase II	UPPER AQUIFER WEST Phase II	LOWER AQUIFER GM-19D Phase I	LOWER AQUIFER DUP-16 Phase I	LOWER AQUIFER GM-19D Phase II
1,1,1-Trichloroethane	ug/L	90.1	47.8	196	6.6	8	3.3
1,1-Dichloroethane	ug/L	16.7	20.8	153	2.4	--	--
1,1-Dichloroethene	ug/L	2.5	3.2	1.4	1.7	--	--
Chloroethane	ug/L	--	--	32	--	--	--
Chloroform	ug/L	--	1.2	--	--	--	--
Tetrachloroethene	ug/L	21.1	166	52.5	--	--	--
Trichloroethene	ug/L	157	--	62.4	80.1	91.6	56.7
Vinyl chloride	ug/L	--	--	--	25.8	25.3	37.2
Xylenes, total	ug/L	--	--	--	2.4	2.5	--
trans-1,2-Dichloroethene	ug/L	3.2	3.4	1.5	--	--	--

-- Not detected.
ug/L Micrograms per liter.
DUP-16 is the duplicate sample of GM-19D during Phase I.

i:\harrison\95rfi\tables\tbl5-22.wb2

Table 5-23. Detected Total and Dissolved Metals and Cyanide Concentrations in the Upper and Lower Aquifers in the Vicinity of the Fill Area, South Tank Farm, T11, and the Waste Pile/Staging Area SWMUs RFI, Harrison Division - GMC.

Parameter	Concentration Units	UPPER AQUIFER GM-19S Phase I	LOWER AQUIFER GM-19D Phase I	 DUP-16 Phase I
Cyanide	mg/L	0.008	--	--
Barium, dissolved	ug/L	87.7	113 J	129
Cobalt, dissolved	ug/L	--	11.1 J	12.1 J
Nickel, dissolved	ug/L	--	14.4 J	16

-- Not detected.
J Estimated.
DUP-16 is the duplicate sample of GM-19D during Phase I.
ug/L Micrograms per liter.
mg/L Milligrams per liter.

i:\harrison\95rfi\tables\tbl5-23.wb2

Table 5-24. Detected VOCs, SVOCs, and PCBs in Soils Collected at the Waste Pile/Staging Area, Harrison Divison - GMC.

Parameters	Units	WPSA-BH01-02SL Phase I	DUP-07 Phase I	WPSA-BH01-08SL Phase I	WPSA-BH02-02SL Phase I	WPSA-BH02-08SL Phase I
VOCs						
1,1,1-Trichloroethane	ug/kg	--	--	180	66	--
1,1-Dichloroethane	ug/kg	--	--	--	--	--
1,2-Dichloroethene (total)	ug/kg	--	--	--	--	--
2-Butanone	ug/kg	--	--	--	--	--
Acetone	ug/kg	--	--	3400 J	1900	--
Benzene	ug/kg	--	--	--	--	--
Carbon disulfide	ug/kg	--	--	--	--	--
Ethylbenzene	ug/kg	--	--	65	--	--
Tetrachloroethene	ug/kg	200	180	84	54	130
Toluene	ug/kg	--	36	52	--	--
Trichloroethene	ug/kg	--	--	--	--	--
Xylenes, total	ug/kg	--	--	130	--	--
SVOCs						
Benzo(a)pyrene	ug/kg	--	--	--	--	--
Benzo(b)fluoranthene(1)	ug/kg	--	--	--	--	--
bis(2-Ethylhexyl)phthalate	ug/kg	--	--	--	390	--
Butyl benzyl phthalate	ug/kg	28000	22000	--	--	--
Chrysene	ug/kg	--	--	--	--	--
Fluoranthene	ug/kg	--	--	--	--	--
Phenanthrene	ug/kg	--	--	--	--	--
Pyrene	ug/kg	--	--	--	--	--
PCBs						
Aroclor-1242	mg/kg	--	--	--	--	--
Aroclor-1260	mg/kg	--	--	--	--	--

VOCs	Volatile Organic Compounds.
SVOCs	Semivolatile Organic Compounds.
PCBs	Polychlorinated Biphenyls.
ug/kg	Micrograms per kilogram.
mg/kg	Milligrams per kilogram.

(1) Represents a total of benzo(b)fluoranthene and benzo(k)fluoranthene.

Table 5-24. Detected VOCs, SVOCs, and PCBs in Soils Collected at the Waste Pile/Staging Area, Harrison Divison - GMC.

Parameters	Units	WPSA-BH03-02SL Phase I	WPSA-BH03-08SL Phase I	WPSA-BH04-09SL Phase II	WPSA-BH04-21SL Phase II	WPSA-BH05-02SL Phase II
VOCs						
1,1,1-Trichloroethane	ug/kg	130	2100	--	--	--
1,1-Dichloroethane	ug/kg	3000 J	--	--	--	--
1,2-Dichloroethene (total)	ug/kg	--	--	--	--	--
2-Butanone	ug/kg	--	--	--	--	--
Acetone	ug/kg	12000 J	--	--	--	--
Benzene	ug/kg	25	--	--	--	--
Carbon disulfide	ug/kg	--	--	--	--	--
Ethylbenzene	ug/kg	46	1600	--	--	--
Tetrachloroethene	ug/kg	87	--	--	5.7	--
Toluene	ug/kg	520	16000	7.6	--	--
Trichloroethene	ug/kg	--	--	--	--	--
Xylenes, total	ug/kg	230	19000	--	--	--
SVOCs						
Benzo(a)pyrene	ug/kg	--	47000	--	--	--
Benzo(b)fluoranthene(1)	ug/kg	--	90000	--	--	--
bis(2-Ethylhexyl)phthalate	ug/kg	--	--	--	--	1900
Butyl benzyl phthalate	ug/kg	--	--	--	--	--
Chrysene	ug/kg	--	44000	--	--	--
Fluoranthene	ug/kg	--	86000	--	--	--
Phenanthrene	ug/kg	--	84000	--	--	--
Pyrene	ug/kg	--	83000	--	--	--
PCBs						
Aroclor-1242	mg/kg	2.5	--	--	--	--
Aroclor-1260	mg/kg	0.6	--	--	--	--

VOCs	Volatile Organic Compounds.
SVOCs	Semivolatile Organic Compounds.
PCBs	Polychlorinated Biphenyls.
ug/kg	Micrograms per kilogram.
mg/kg	Milligrams per kilogram.

(1) Represents a total of benzo(b)fluoranthene and benzo(k)fluoranthene.

Table 5-24. Detected VOCs, SVOCs, and PCBs in Soils Collected at the Waste Pile/Staging Area, Harrison Divison - GMC.

Parameters	Units	WPSA-BH05-10SL Phase II	WPSA-BH05-22SL Phase II	DUP-25 Phase II	WPSA-BH06-02SL Phase II	WPSA-BH06-06SL Phase II
VOCs						
1,1,1-Trichloroethane	ug/kg	--	--	--	--	--
1,1-Dichloroethane	ug/kg	--	--	--	--	--
1,2-Dichloroethene (total)	ug/kg	--	--	--	--	--
2-Butanone	ug/kg	--	--	--	--	--
Acetone	ug/kg	--	--	--	297	--
Benzene	ug/kg	--	--	--	12	--
Carbon disulfide	ug/kg	--	--	--	27.7	--
Ethylbenzene	ug/kg	--	--	--	--	--
Tetrachloroethene	ug/kg	--	--	--	--	--
Toluene	ug/kg	--	--	--	15.9	--
Trichloroethene	ug/kg	--	--	--	--	--
Xylenes, total	ug/kg	--	--	--	49.4	332
SVOCs						
Benzo(a)pyrene	ug/kg	--	--	--	--	--
Benzo(b)fluoranthene(1)	ug/kg	--	--	--	6920	--
bis(2-Ethylhexyl)phthalate	ug/kg	710	409	--	--	--
Butyl benzyl phthalate	ug/kg	--	--	--	--	--
Chrysene	ug/kg	--	--	--	--	--
Fluoranthene	ug/kg	--	--	--	5650	--
Phenanthrene	ug/kg	--	--	--	5450	8460
Pyrene	ug/kg	--	--	--	5180	--
PCBs						
Aroclor-1242	mg/kg	--	--	--	--	--
Aroclor-1260	mg/kg	--	--	--	--	--

VOCs Volatile Organic Compounds.
SVOCs Semivolatile Organic Compounds.
PCBs Polychlorinated Biphenyls.
ug/kg Micrograms per kilogram.
mg/kg Milligrams per kilogram.
(1) Represents a total of benzo(b)fluoranthene and benzo(k)fluoranthene.

Table 5-24. Detected VOCs, SVOCs, and PCBs in Soils Collected at the Waste Pile/Staging Area, Harrison Divison - GMC.

Parameters	Units	WPSA-BH06-14SL Phase II	WPSA-BH07-02SL Phase II	WPSA-BH07-06SL Phase II	DUP-26 Phase II	WPSA-BH07-22SL Phase II
VOCs						
1,1,1-Trichloroethane	ug/kg	--	--	549	1200	--
1,1-Dichloroethane	ug/kg	--	187	141	523	--
1,2-Dichloroethene (total)	ug/kg	--	1060	1090	4250	--
2-Butanone	ug/kg	--	--	2470 J	3430 J	--
Acetone	ug/kg	--	--	1950	3630	--
Benzene	ug/kg	--	--	--	--	--
Carbon disulfide	ug/kg	--	--	--	--	--
Ethylbenzene	ug/kg	--	148	543	930	--
Tetrachloroethene	ug/kg	--	237	209	395	--
Toluene	ug/kg	--	116	128	238	--
Trichloroethene	ug/kg	--	120	142	322	--
Xylenes, total	ug/kg	--	--	--	--	--
SVOCs						
Benzo(a)pyrene	ug/kg	--	--	--	--	--
Benzo(b)fluoranthene(1)	ug/kg	--	--	--	--	--
bis(2-Ethylhexyl)phthalate	ug/kg	--	--	--	--	--
Butyl benzyl phthalate	ug/kg	--	--	--	--	--
Chrysene	ug/kg	--	--	--	--	--
Fluoranthene	ug/kg	--	--	--	--	--
Phenanthrene	ug/kg	--	--	--	--	--
Pyrene	ug/kg	--	--	--	--	--
PCBs						
Aroclor-1242	mg/kg	--	--	--	--	--
Aroclor-1260	mg/kg	--	--	--	--	--

VOCs Volatile Organic Compounds.
SVOCs Semivolatile Organic Compounds.
PCBs Polychlorinated Biphenyls.
ug/kg Micrograms per kilogram.
mg/kg Milligrams per kilogram.
(1) Represents a total of benzo(b)fluoranthene and benzo(k)fluoranthene.

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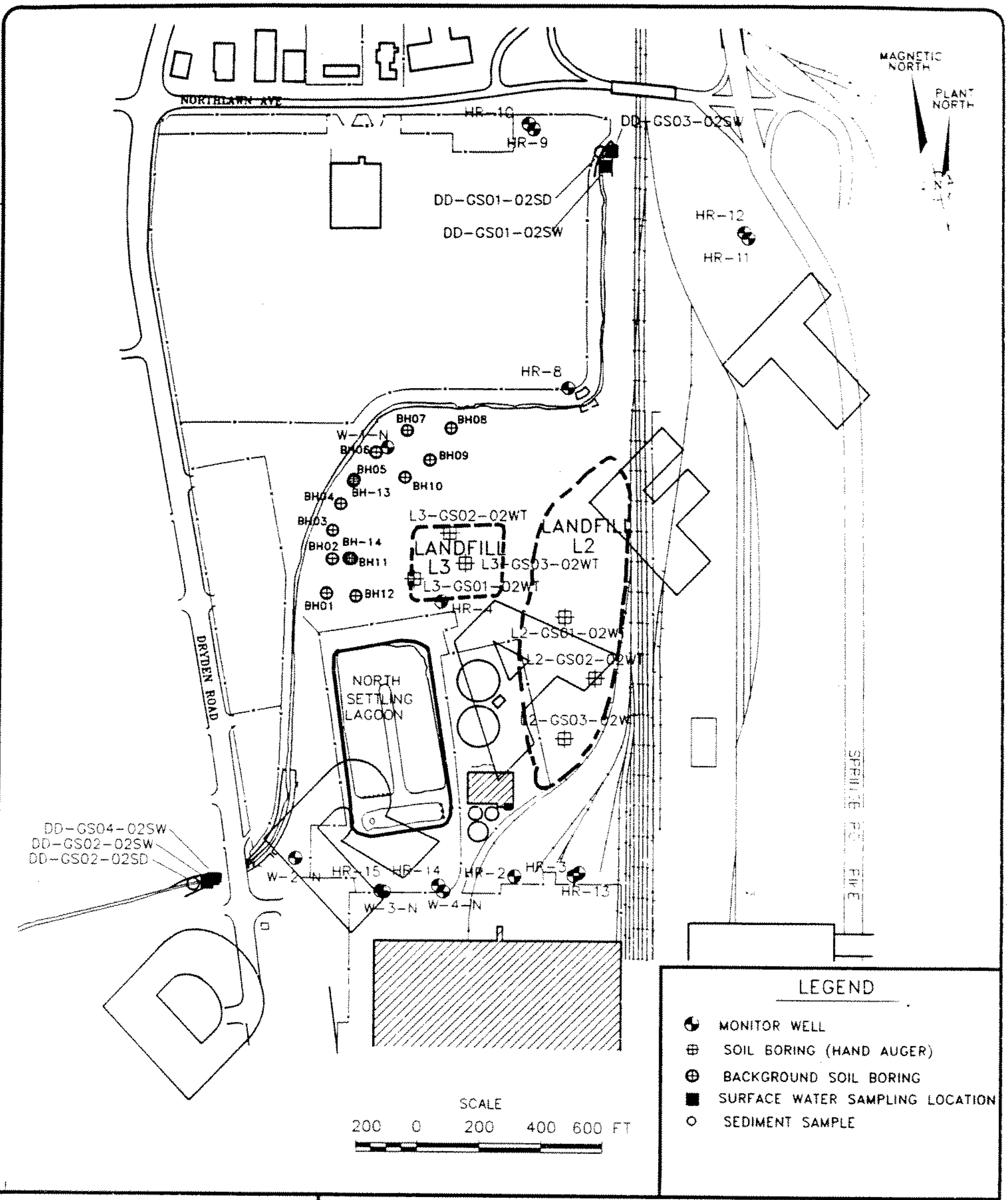
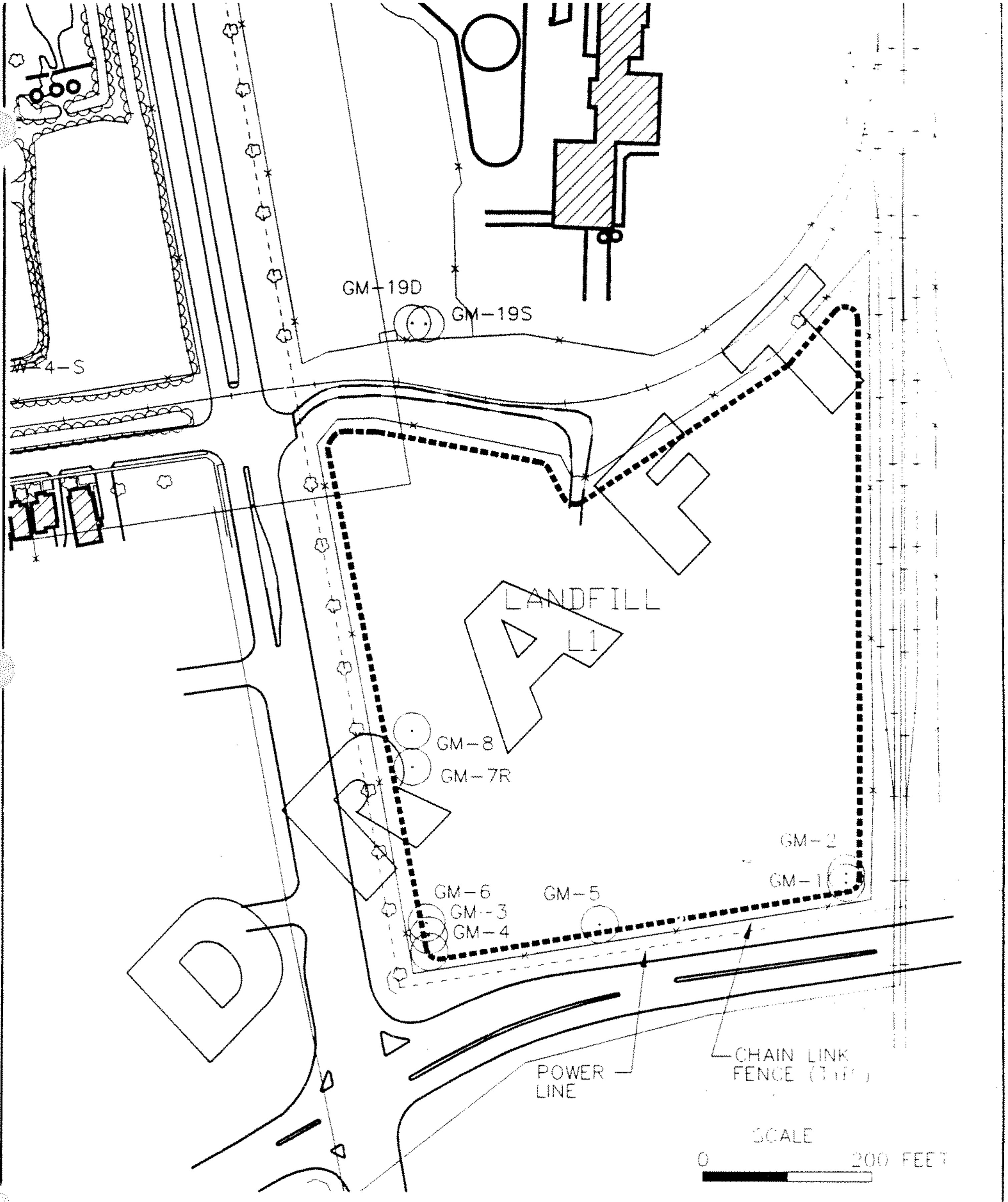


GERAGHTY & MILLER, INC.
Environmental Services

RFI SAMPLE LOCATIONS IN THE NORTH PART OF THE HARRISON SITE

DELPHI HARRISON THERMAL SYSTEMS, GENERAL MOTORS CORPORATION,
MORAINE, OHIO

FIGURE
4-5



GERAGHTY
& MILLER, INC.
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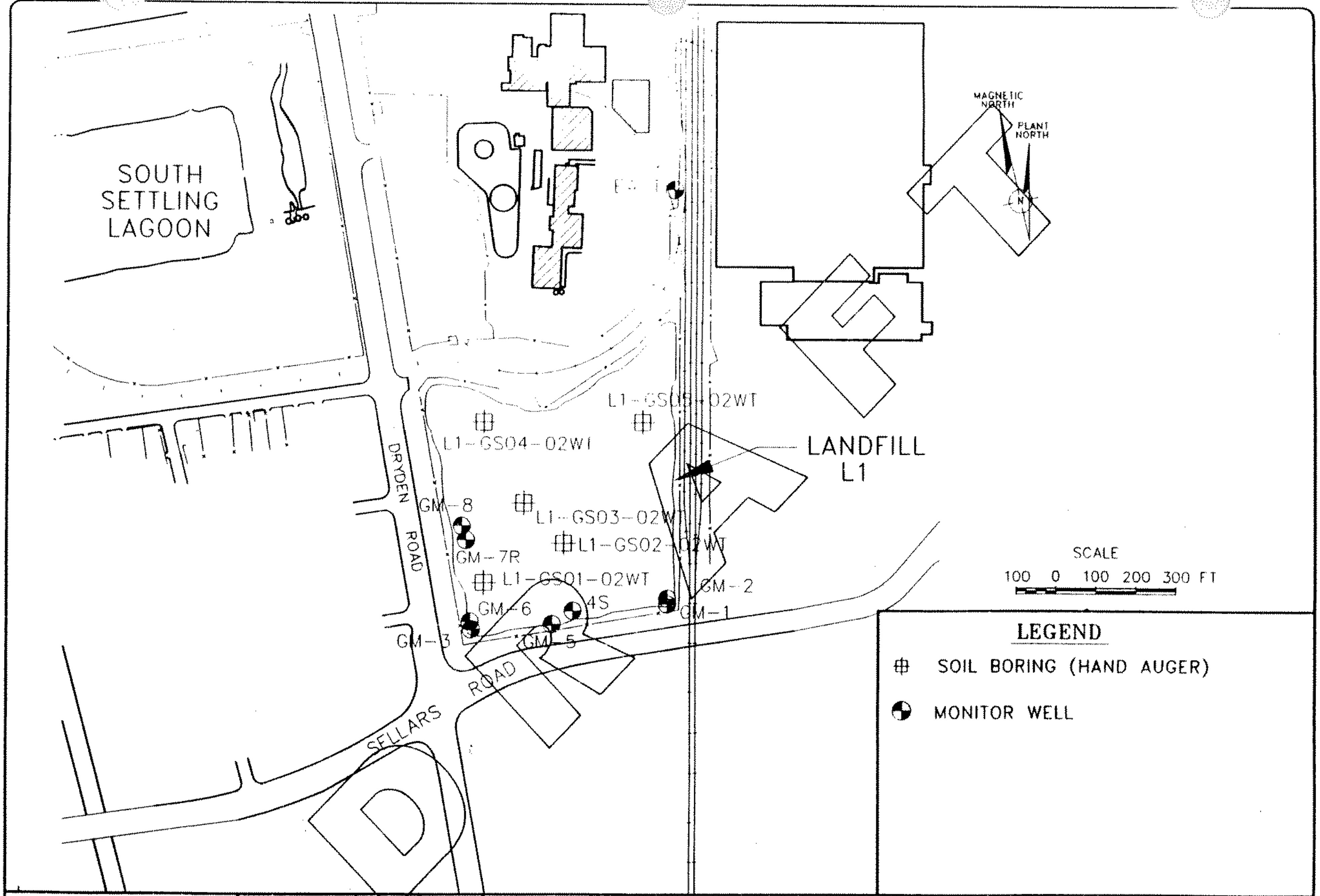
DRAWING:	L1	PLOT SIZE:	-
DRAFTED BY:	RTS	DATE:	-
CHECKED BY:	B.B.	DATE:	-
APPROVED BY:	B.B.	DATE:	-
DATE REVISED:			

EM31 SURVEY AT LANDFILL L1

DELPHI HARRISON THERMAL SYSTEMS, GENERAL MOTORS CORPORATION
MORAINE, OHIO

FIGURE
5-1



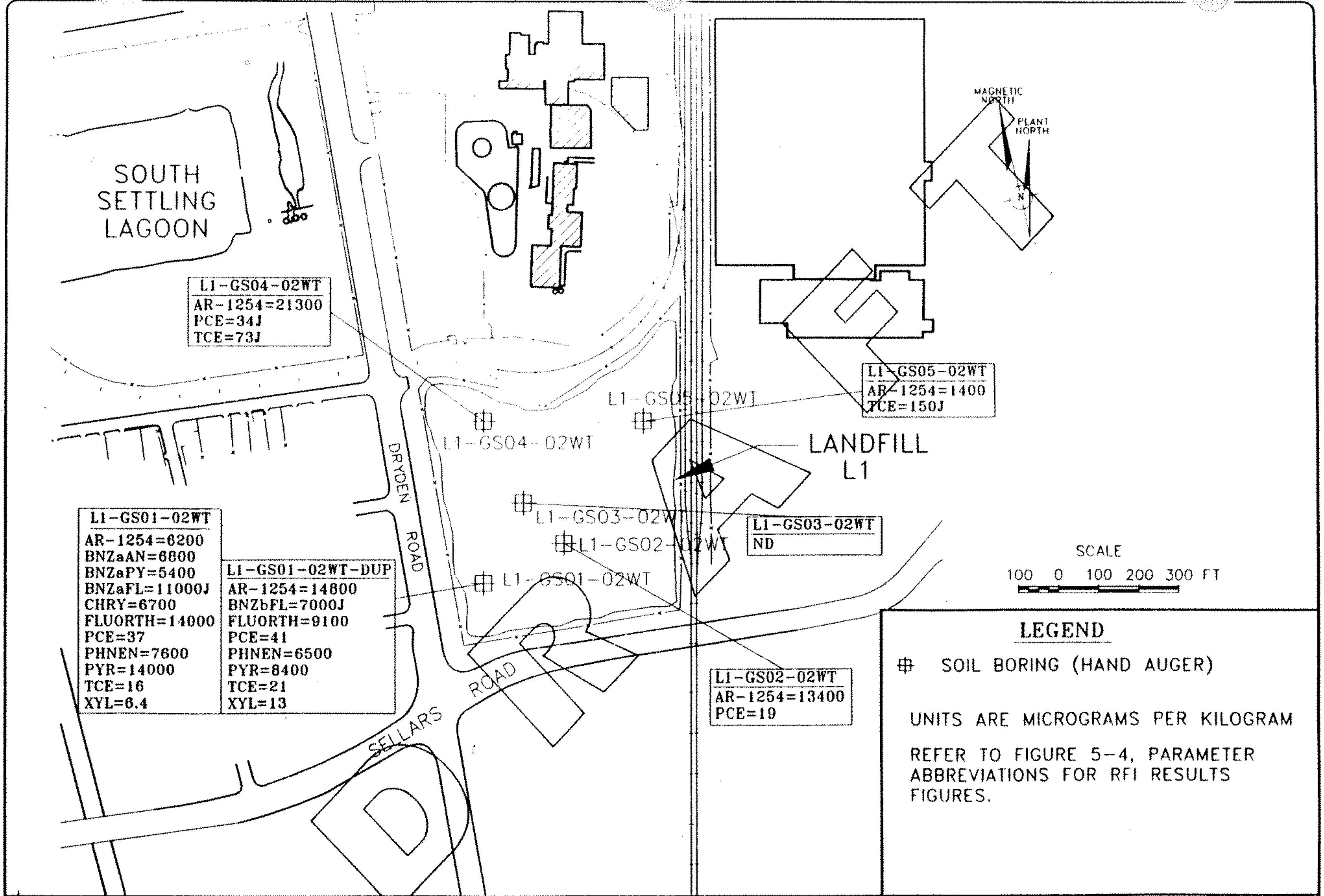
GERAGHTY & MILLER, INC.
Environmental Services

PROJECT NO.:	OH0015.021	FILE NO. HAR\AMP	
DRAWING:	L1-TV-2	PLOT SIZE: -	
DRAFTED BY:	RTS	DATE: 22DEC93	
CHECKED BY:	N.B.	DATE:	
APPROVED BY:	J.R.	DATE: -	

RFI SAMPLE LOCATIONS AT LANDFILL L1

DELPHI HARRISON THERMAL SYSTEMS, GENERAL MOTORS CORPORATION,
MORAINE, OHIO

FIGURE
5-2



LEGEND

⌗ SOIL BORING (HAND AUGER)

UNITS ARE MICROGRAMS PER KILOGRAM

REFER TO FIGURE 5-4, PARAMETER ABBREVIATIONS FOR RFI RESULTS FIGURES.

GERAGHTY & MILLER, INC.
Environmental Services

PROJECT NO.: OH0019.S21	FILE NO. HAR\MP
DRAWING: L1-TV-2	PLOT SIZE: -
DRAFTED BY: KTS	DATE: 22DEC93
CHECKED BY: N.R.	DATE:
APPROVED BY: J.R.	DATE: -

WASTE ORGANIC ANALYTICAL RESULTS FOR LANDFILL L1

DELPHI HARRISON THERMAL SYSTEMS, GENERAL MOTORS CORPORATION,
MORAINE, OHIO

FIGURE
5-3

DRAF S | APPROVED: J.R. | CHECKED: S.M. | DRAWING DER | FILE NO.: HAR\IMWP | PRJCT NO.: OH0019.018 | DWG

Semivolatile Organic Carbons (SVOCs) and Polychlorinated Biphenyls (PCBs)

AR-1242 = Aroclor-1242
AR-1254 = Aroclor-1254
AR-1260 = Aroclor-1260
b2EPHT = bis(2-Ethylhexyl)phthalate
BBZPHT = Butylbenzylphthalate
BNZaAN = Benzo(a)Anthracene
BNZaPY = Benzo(a)pyrene
BNZbFL = Benzo(b)fluoranthene (Represents total concentration of Benzo (b) fluoranthene and Benzo (k) fluoranthene)
CHRY = Chrysene
FLUORTH = Fluoranthene
2-MTNPEN = 2-Methylnaphthalene
PHNEN = Phenanthrene
PYR = Pyrene

Volatile Organic Carbons (VOCs)

ACE = Acetone
BNZ = Benzene
CA = Chloroethane
CB = Chlorobenzene
CD = Carbon disulfide
CFM = Chloroform
1,1-DCA = 1,1-Dichloroethane
1,2-DCE = 1,2-Dichloroethene (total)
1,1-DCE = 1,1-Dichloroethene
C1,2-DCE = cis-1,2-Dichloroethene
T1,2-DCE = trans-1,2-Dichloroethene
EBNZ = Ethylbenzene
MEK = 2-Butanone
PCE = Tetrachloroethene
STY = Styrene
TCA = 1,1,1-Trichloroethane
TCE = Trichloroethene
TCFM = Trichlorofluoromethane
TOL = Toluene
VC = Vinyl Chloride
XYL = Xylene (total)

Inorganics (Metals)

Sb = Antimony
As = Arsenic
Ba = Barium
Be = Beryllium
Cd = Cadmium
Cr = Chromium
Co = Cobalt
Cu = Copper
CN = Cyanide
Hg = Mercury
Pb = Lead
Ni = Nickel
Se = Selenium
Ag = Silver
Tl = Thallium
V = Vanadium
Zn = Zinc

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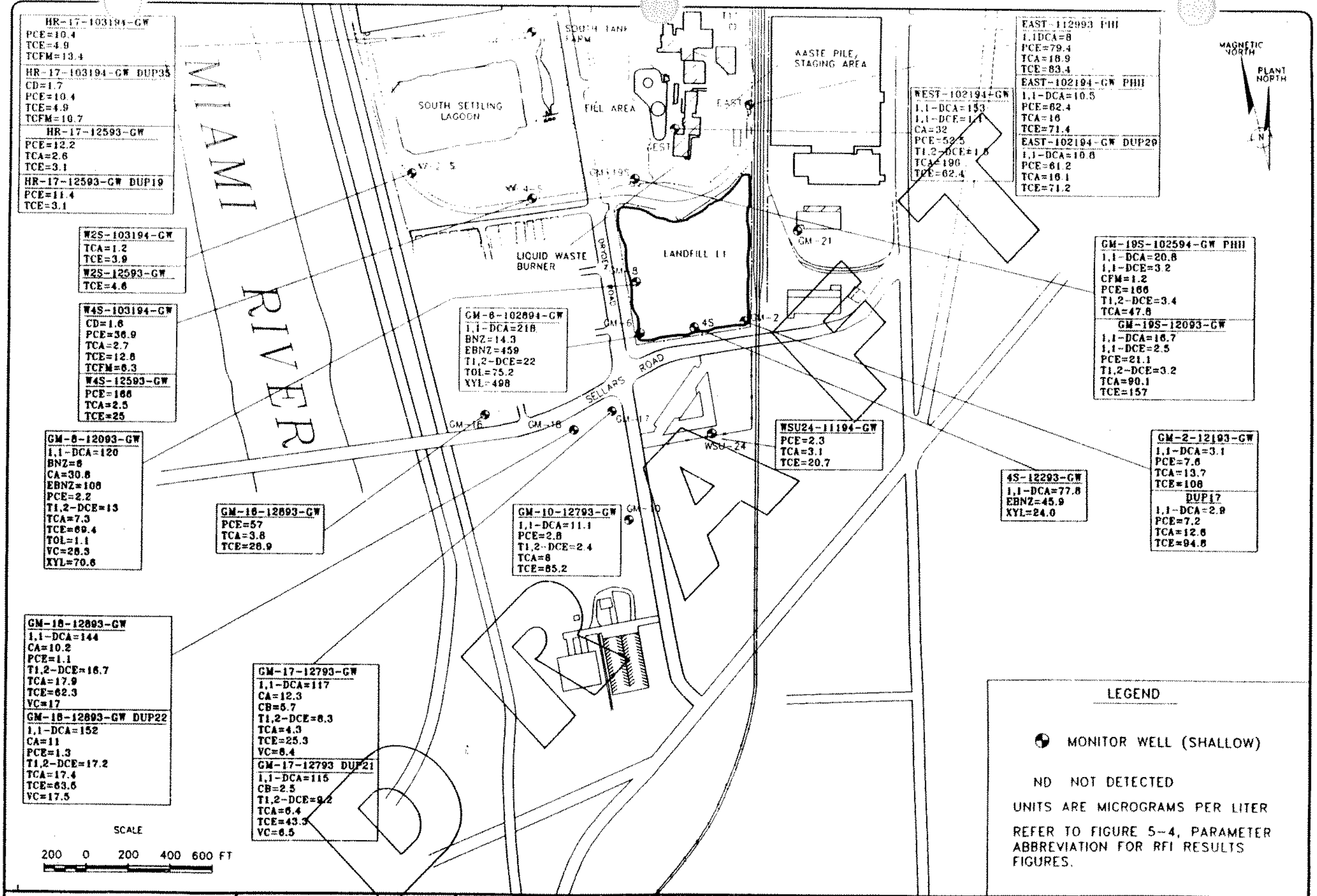
PARAMETER ABBREVIATIONS FOR RFI RESULTS FIGURES

DELPHI HARRISON THERMAL SYSTEMS, GENERAL MOTORS CORPORATION,
MORAINE, OHIO

FIGURE
5-4



LEGEND

● MONITOR WELL (SHALLOW)

ND NOT DETECTED

UNITS ARE MICROGRAMS PER LITER

REFER TO FIGURE 5-4, PARAMETER ABBREVIATION FOR RFI RESULTS FIGURES.

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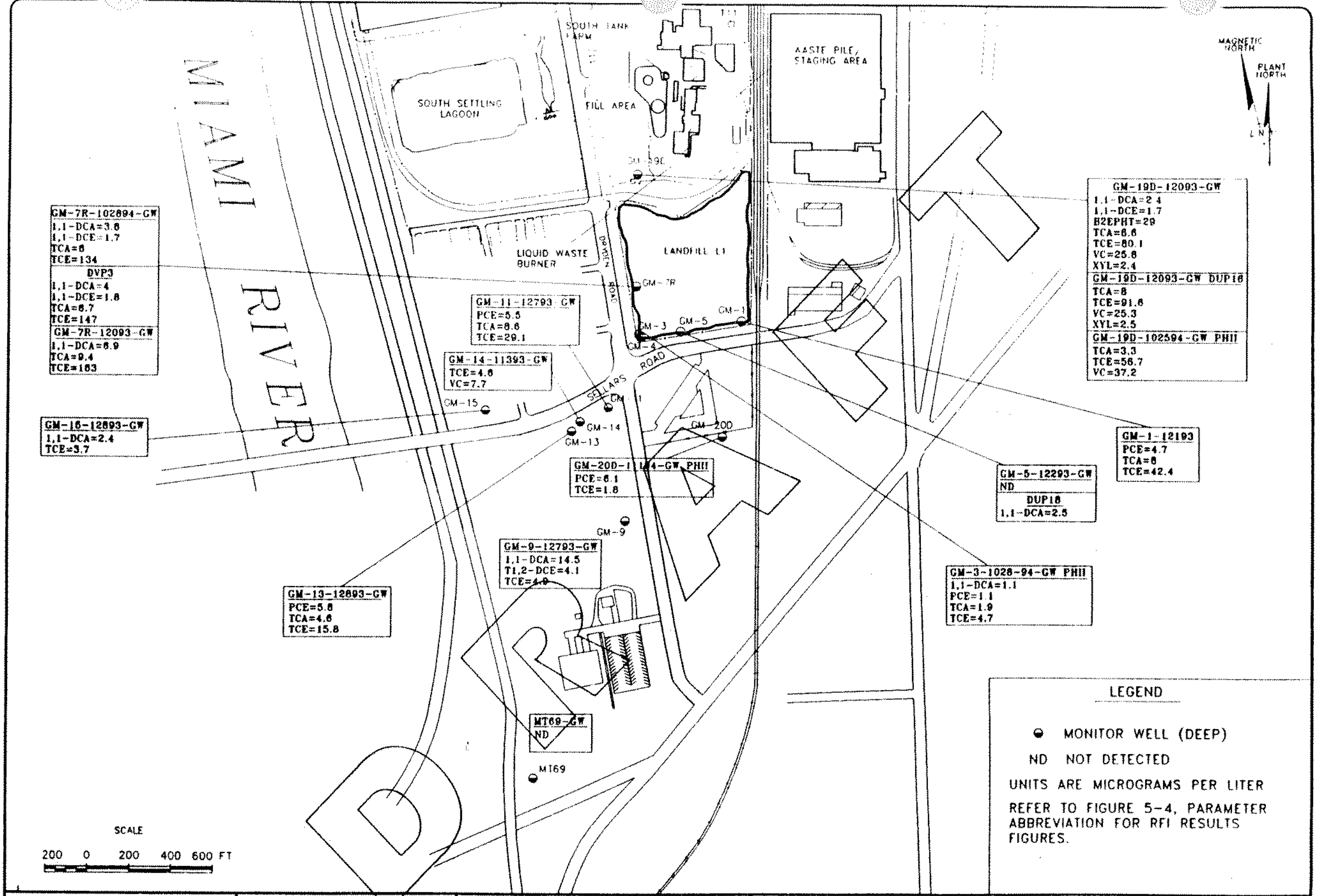
PROJECT NO.: DH0018018	FILE NO: HARRISON\NEWBASE\RFI\
DRAWING: RFISOUTH	PLOT SIZE: FIT
DRAFTED BY: MAJ	DATE: 11APR95
CHECKED BY: JR	DATE: 11APR95
APPROVED BY: JR	DATE: 12APR95

GROUNDWATER ORGANIC ANALYTICAL RESULTS FOR SHALLOW MONITOR WELLS LOCATED IN THE SOUTHERN PART OF THE HARRISON SITE AND AREA SOUTH OF SELLARS ROAD

DELPHI HARRISON THERMAL SYSTEMS, GENERAL MOTORS CORPORATION,
MORAINE, OHIO

FIGURE
5-5



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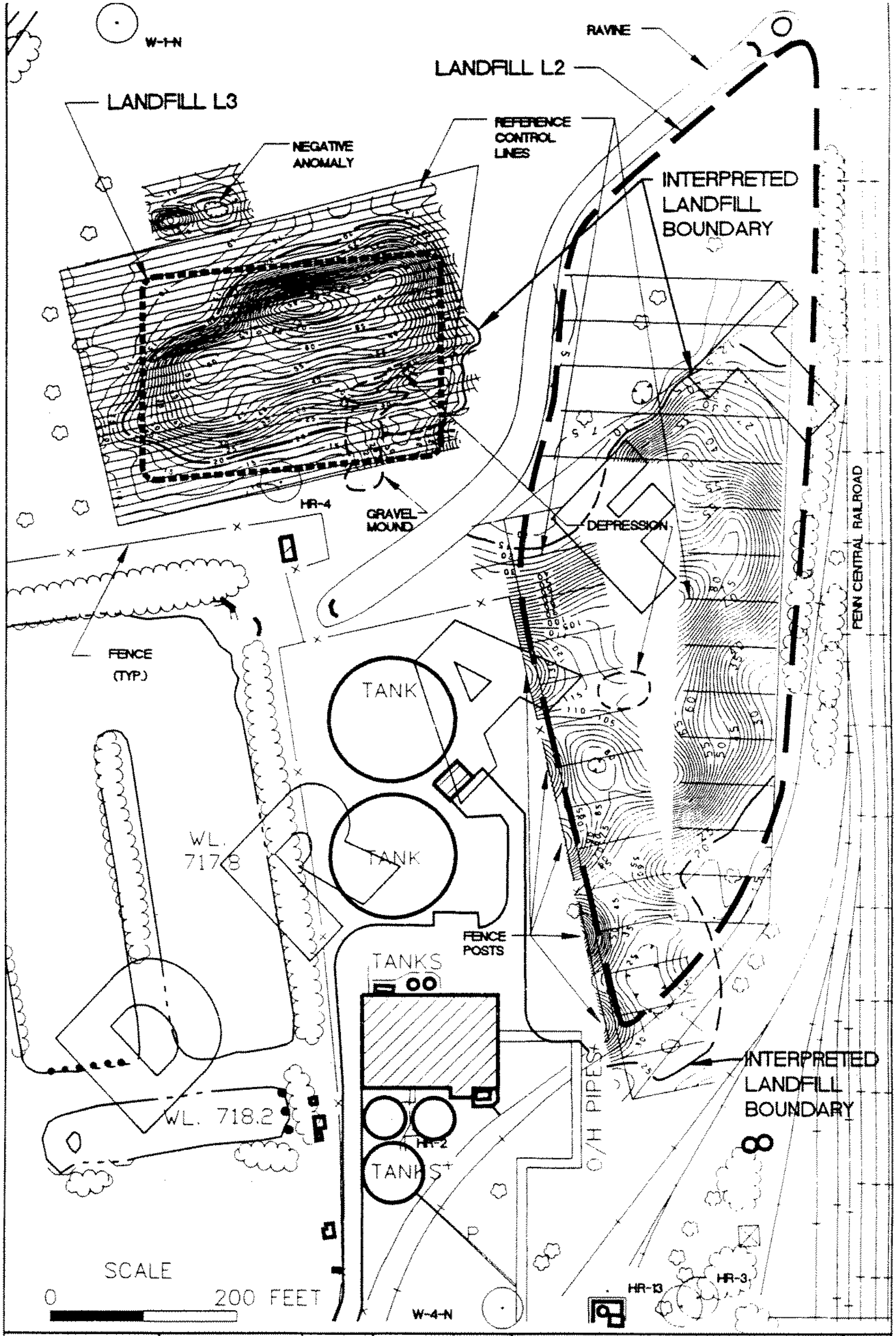
PROJECT NO.: OH0018018	FILE NO: HARRISON\NEWBASE\RF1\
DRAWING: RF1SOUTH	PLOT SIZE: FIT
DRAFTED BY: MAJ	DATE: 11APR95
CHECKED BY: J.R.	DATE: 11APR95
APPROVED BY: J.R.	DATE: 12APR95

GROUNDWATER ORGANIC ANALYTICAL RESULTS FOR DEEP MONITOR WELLS LOCATED IN THE SOUTHERN PART OF THE HARRISON SITE AND AREA SOUTH OF SELLARS ROAD

DELPHI HARRISON THERMAL SYSTE[illegible] GENERAL MOTORS CORPORATION,
MORA[illegible]IO

FIGURE
5-6



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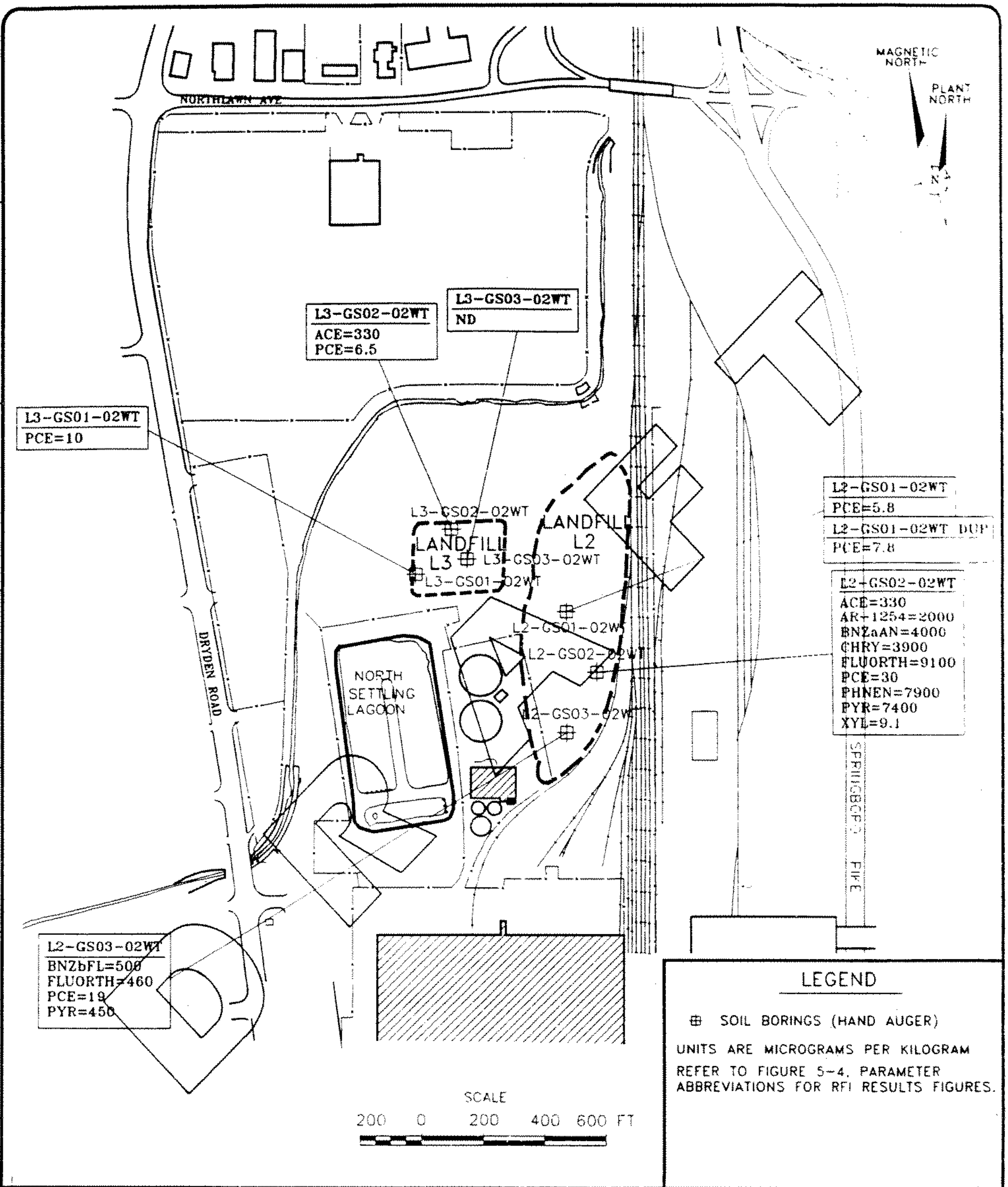
TERRAIN CONDUCTIVITY MAP,
LANDFILLS L2 AND L3

DELPHI HARRISON THERMAL SYSTEMS, GENERAL MOTORS CORPORATION
MORAINE, OHIO

FIGURE
5-7



LEGEND

⊞ SOIL BORINGS (HAND AUGER)

UNITS ARE MICROGRAMS PER KILOGRAM

REFER TO FIGURE 5-4, PARAMETER ABBREVIATIONS FOR RFI RESULTS FIGURES.

GERAGHTY & MILLER, INC.
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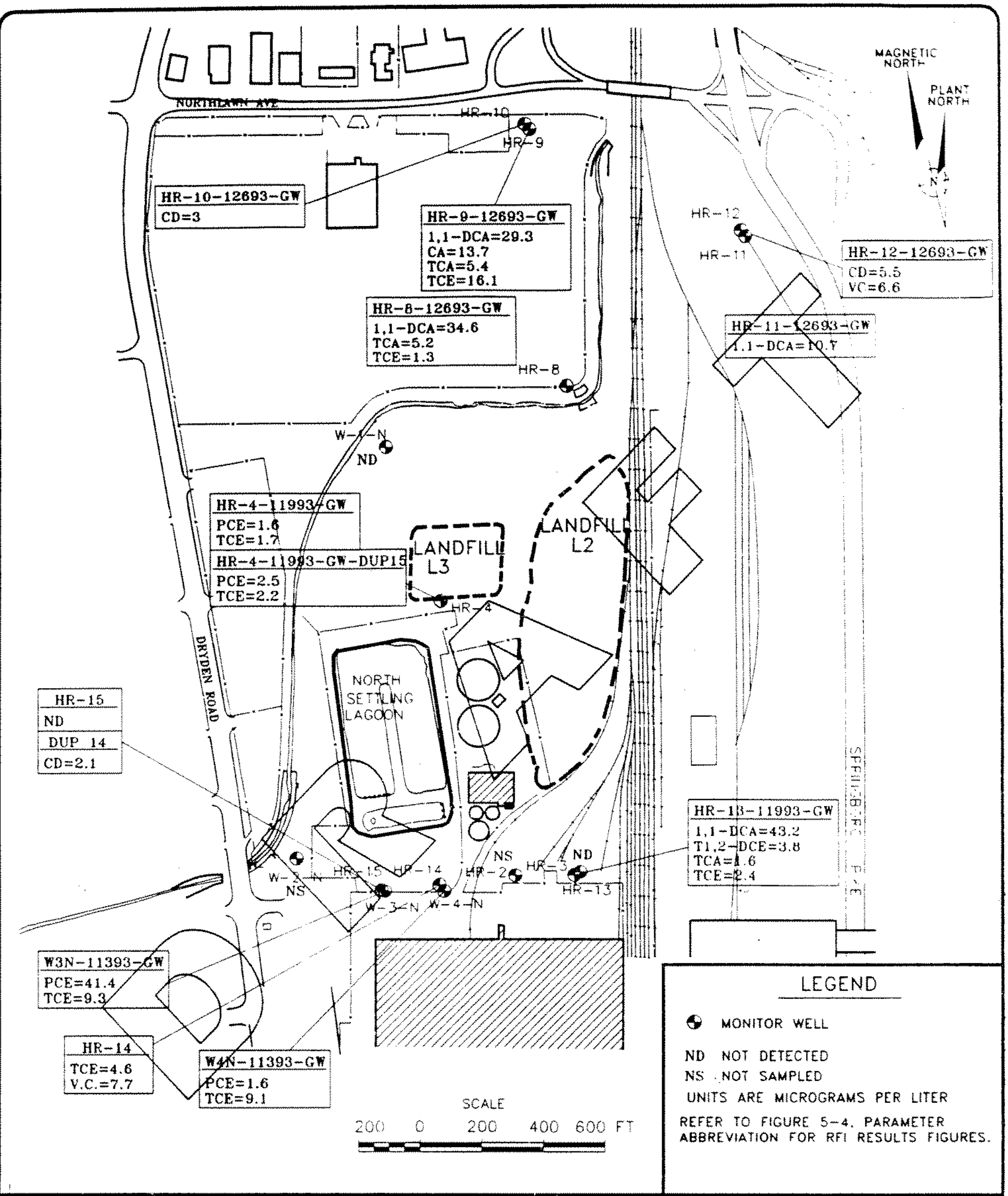
WASTE ORGANIC ANALYTICAL RESULTS FOR LANDFILLS L2 AND L3

DELPHI HARRISON THERMAL SYSTEMS, GENERAL MOTORS CORPORATION,
MORAINE, OHIO

FIGURE
5-8

DW... 25JAN93 | PRJCT NO. OH0191B | FILE NO: SITE-NCS | DRAWING ...RRISON | CHECKED: J.R. | APPROVED: J.R. | DRAF... S



DRAFTED: ...S
APPROVED: J.R.
CHECKED: J.R.
DRAWING: HARRISON
FILE NO. SITE-NCS
PRJCT NO. OH01918
DWG DATE: 25JAN93

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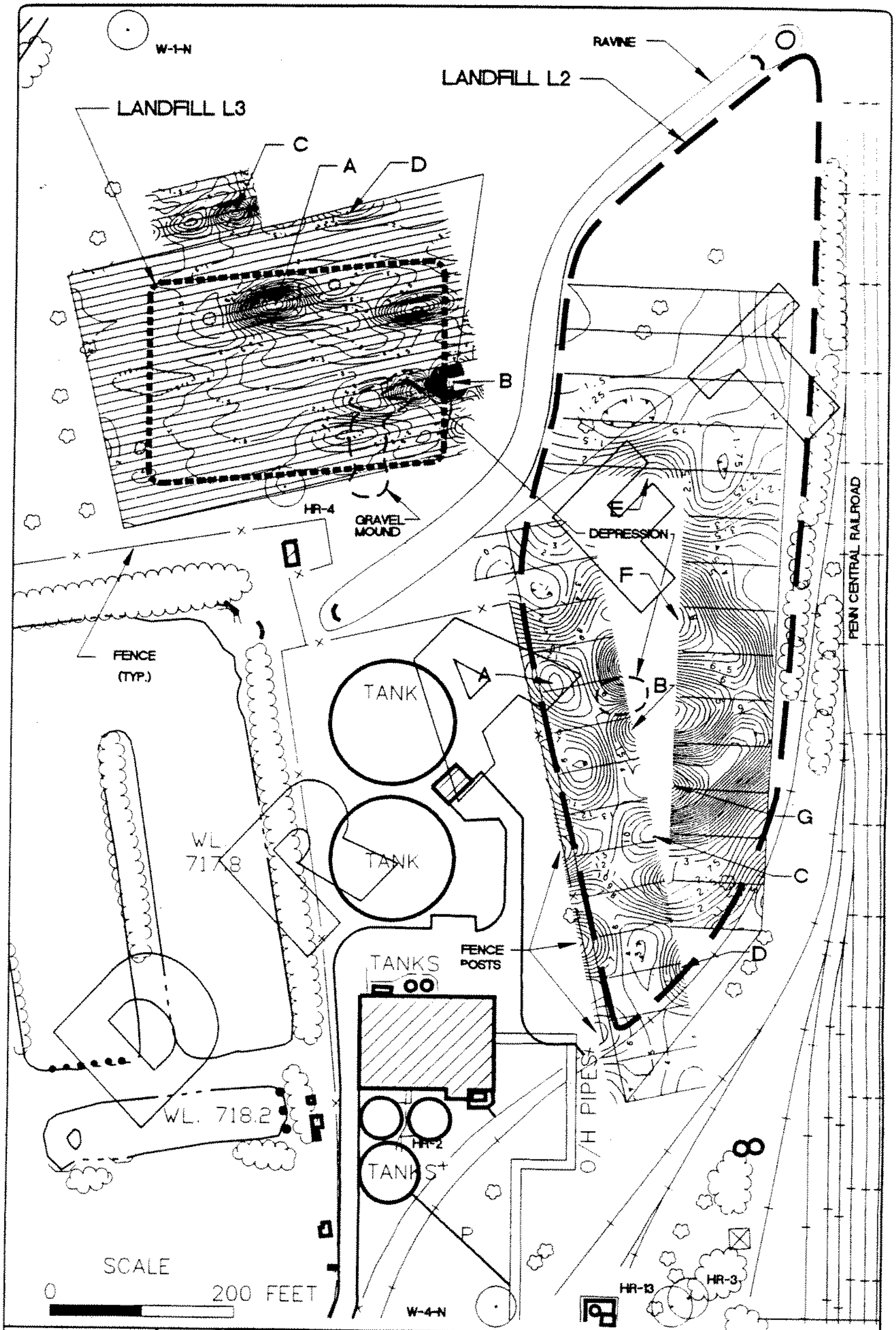
GROUNDWATER ORGANIC ANALYTICAL RESULTS FOR MONITOR WELLS LOCATED IN THE NORTHERN PART OF THE HARRISON SITE

DELPHI HARRISON THERMAL SYSTEMS, GENERAL MOTORS CORPORATION,
MORAINE, OHIO

FIGURE
5-9



GERAGHTY & MILLER, INC.
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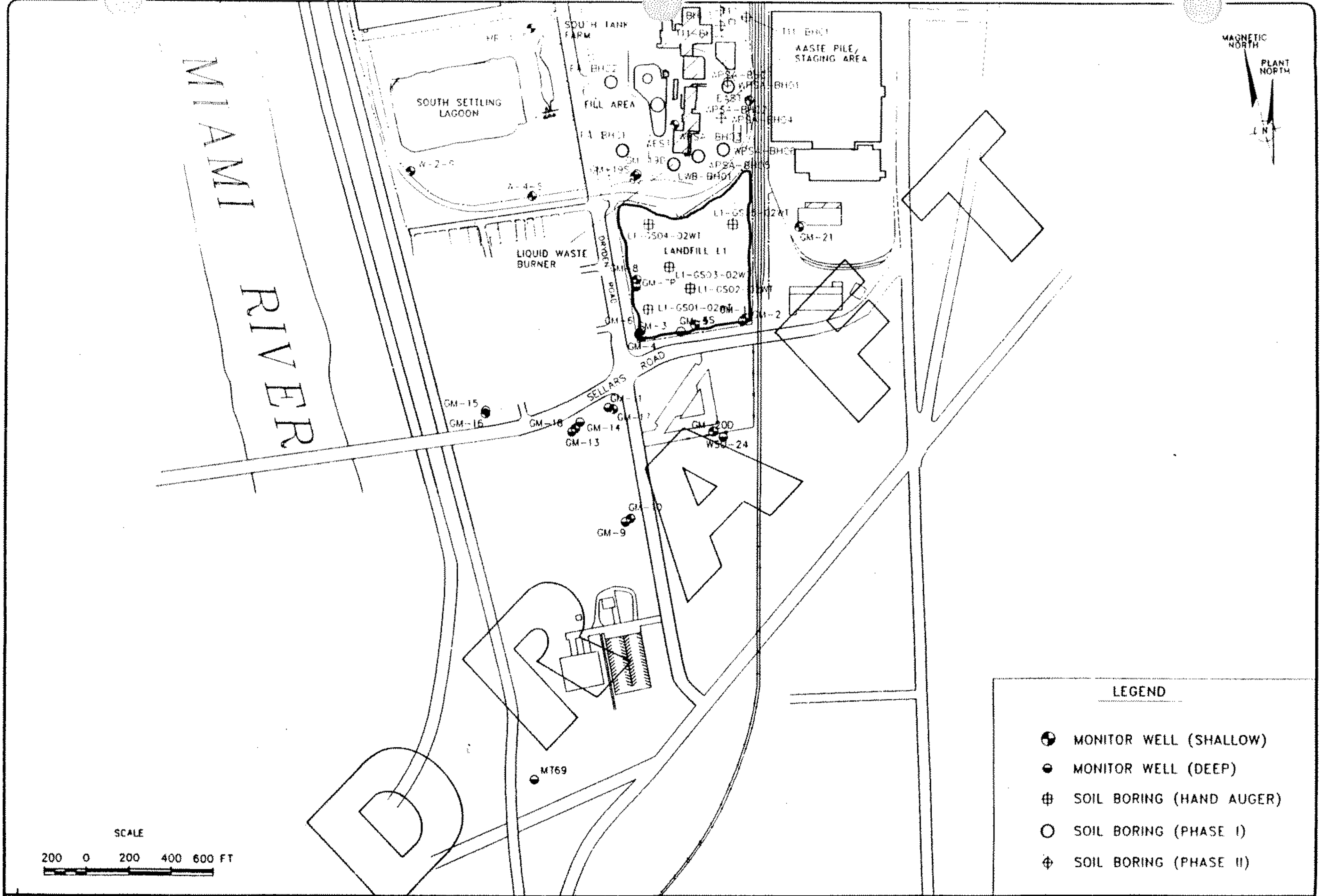
IN-PHASE COMPONENT MAP,
LANDFILLS L2 AND L3

DELPHI HARRISON THERMAL SYSTEMS, GENERAL MOTORS CORPORATION,
MORAINE, OHIO

FIGURE
5-10



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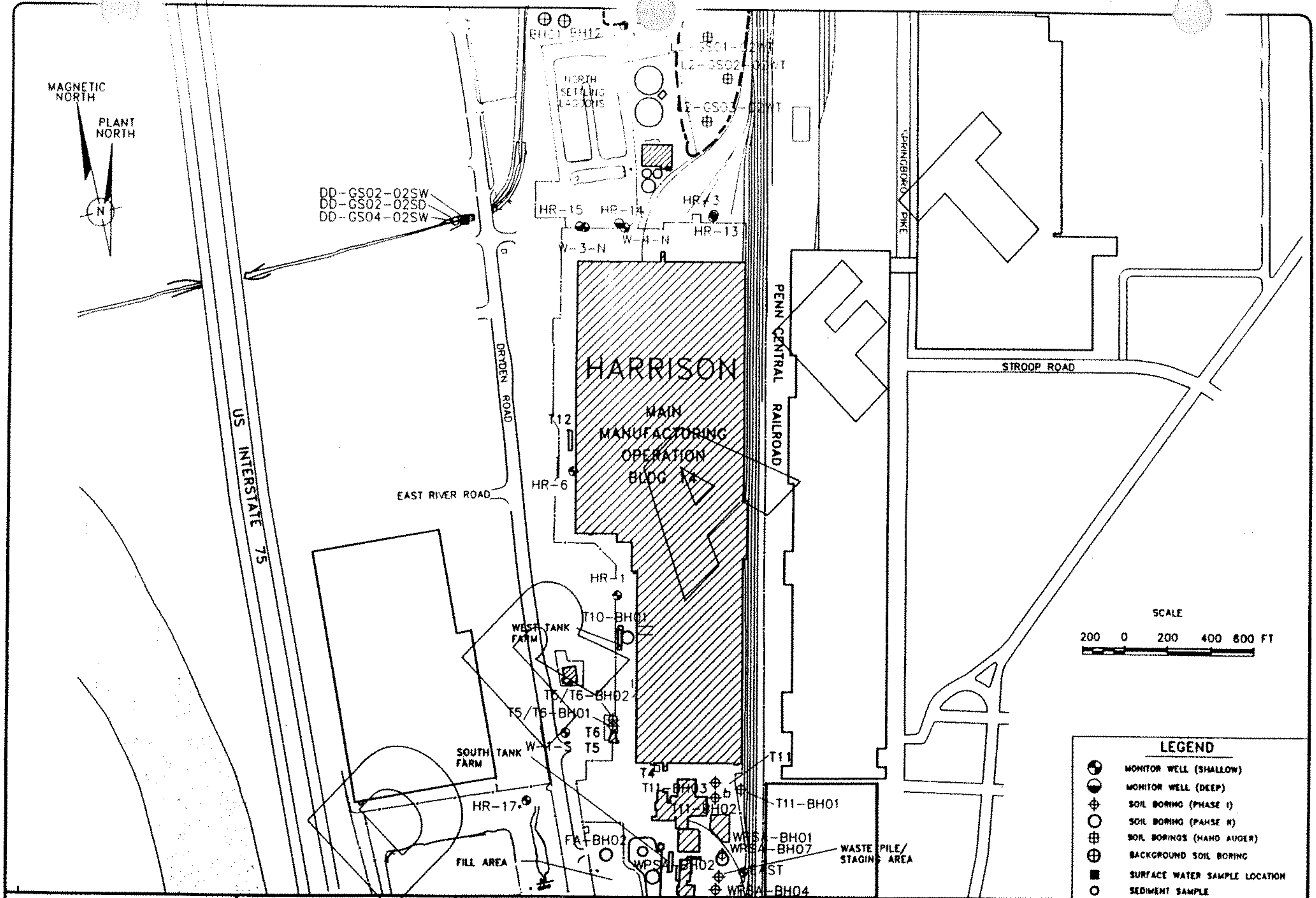
PROJECT NO.: OH0019018	FILE NO: HARRISON\JCMBASE\RFI\
DRAWING: RFISOUTH	PLOT SIZE: FIT
DRAFTED BY: MAJ	DATE: 11APR95
CHECKED BY: J.R.	DATE: 11APR95
APPROVED BY: J.R.	DATE: 12APR95

RFI SAMPLE LOCATIONS IN THE SOUTHERN PART OF THE HARRISON SITE

DELPHI HARRISON THERMAL SYSTEMS, GENERAL MOTORS CORPORATION,
MORAINE, OHIO

FIGURE
5-11



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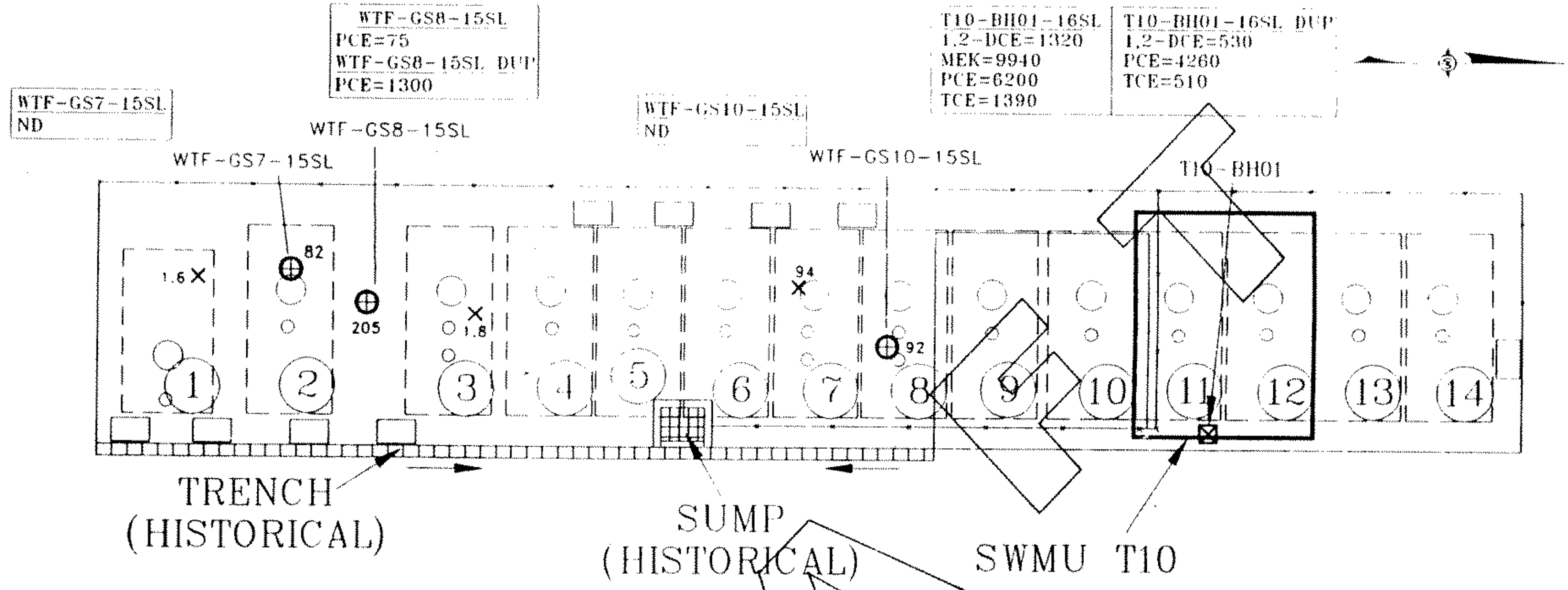
PROJECT NO.: BH0019.018	FILE NO. HARRISON\NEWBASE\RFI\
DRAWING: RFICENTRL	PLOT SIZE: FIT
DRAFTED BY: MAJ	DATE: 11APR95
CHECKED BY: J.R.	DATE: 11APR95
APPROVED BY: J.R.	DATE: 12APR95

RFI SAMPLE LOCATIONS IN THE CENTRAL PART OF THE HARRISON SITE

DELPHI HARRISON THERMAL SYSTEMS, GENERAL MOTORS CORPORATION,
MORAINE, OHIO

FIGURE
5-12



HISTORICAL TANK CONTENTS

1 NON-LEADED GASOLINE (REMOVED 1992)
2 DIESEL FUEL (REMOVED 1992)
3 CUTTING OIL (REMOVED 1992)
4 SWMU T8-PERCHLOROETHENE; (REMOVED 1988)
5 SWMU T8-PERCHLOROETHENE; (REMOVED 1988)
6 SWMU T7-OILY WASTE; (REMOVED 1988)
7 QUAKER 568 COOLANT; (REMOVED 1992)
8 CIMCOOL S-2 COOLANT; (REMOVED 1992)
9 SWMU T7-OILY WASTE; (REMOVED 1986)
10 SWMU T7-OILY WASTE; (REMOVED 1986)
11 SWMU T10-STODDARD SOLVENT; (REMOVED 1986)
12 SWMU T10-STODDARD SOLVENT; (REMOVED 1986)
13 SWMU T9-NAPTHALITE; (REMOVED 1986)
14 SWMU T9-NAPTHALITE; (REMOVED 1986)

LEGEND

☒	PHASE II BORING LOCATION
⊕	PHASE I RFI SOIL SAMPLE LOCATION
⑧	TANK NUMBER
×	HNU GRAB SAMPLE AND HNU READING (ppm HNU UNITS)
ppm	PARTS PER MILLION
ND	NOT DETECTED

UNITS ARE MICROGRAMS PER KILOGRAM

REFER TO FIGURE 5-4, PARAMETER ABBREVIATIONS FOR RFI RESULTS FIGURES.

GERAGHTY & MILLER, INC.
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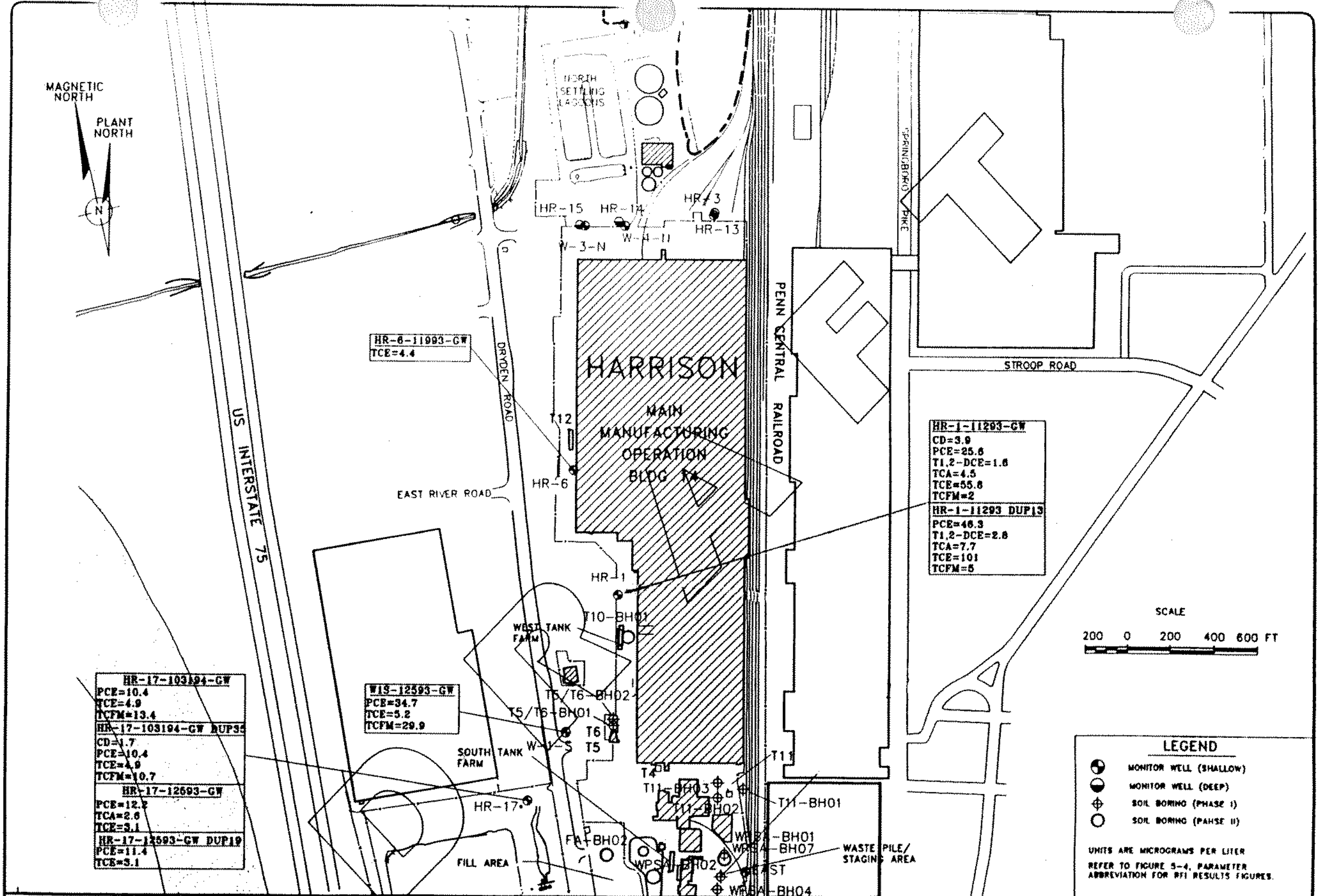
APPROXIMATE SCALE:

RFI SAMPLE LOCATIONS AND SOIL ORGANIC ANALYTICAL RESULTS FOR THE WEST TANK FARM

DELPHI HARRISON THERMAL SYSTEMS, GENERAL MOTORS CORPORATION,
MORAINE, OHIO

FIGURE
5-13



HR-6-11993-GW
TCE=4.4

HR-1-11293-GW
CD=3.9
PCE=25.6
T1,2-DCE=1.6
TCA=4.5
TCE=55.6
TCFM=2

HR-1-11293 DUP13
PCE=46.3
T1,2-DCE=2.8
TCA=7.7
TCE=101
TCFM=5

W1S-12593-GW
PCE=34.7
TCE=5.2
TCFM=29.9

HR-17-103194-GW
PCE=10.4
TCE=4.9
TCFM=13.4

HR-17-103194-GW DUP35
CD=1.7
PCE=10.4
TCE=4.9
TCFM=10.7

HR-17-12693-GW
PCE=12.2
TCA=2.6
TCE=3.1

HR-17-12593-GW DUP19
PCE=11.4
TCE=3.1

LEGEND

◕	MONITOR WELL (SHALLOW)
◒	MONITOR WELL (DEEP)
⊕	SOIL BORING (PHASE I)
○	SOIL BORING (PAHSE II)

UNITS ARE MICROGRAMS PER LITER

REFER TO FIGURE 5-4, PARAMETER ABBREVIATION FOR RFI RESULTS FIGURES.

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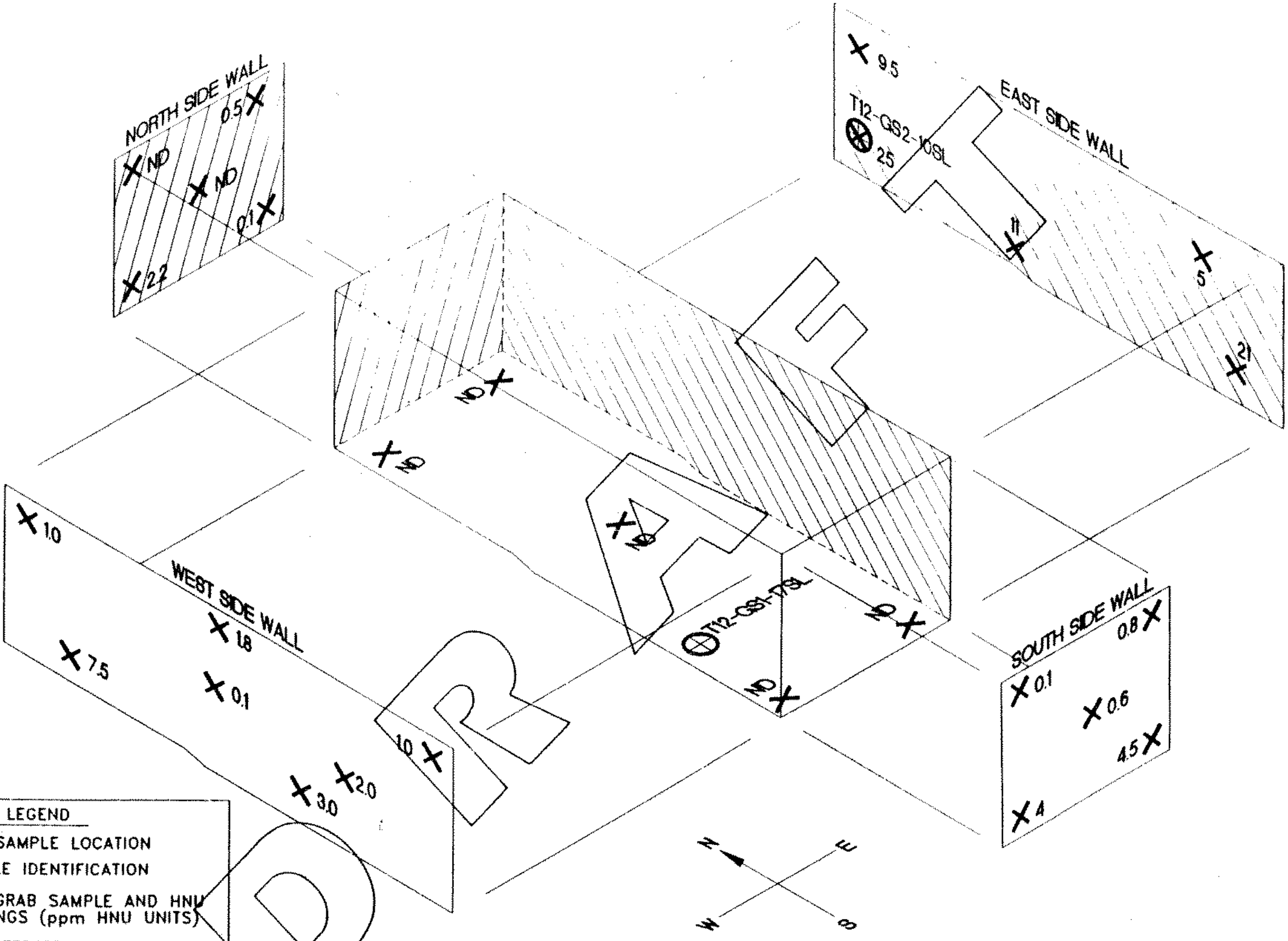
PROJECT NO.: DH0019.018	FILE NO. HARRISON\NEWBASE\RFI\
DRAWING: RFICENTRL	PLOT SIZE: FIT
DRAFTED BY: MAJ	DATE: 11APR95
CHECKED BY: J.R.	DATE: 11APR95
APPROVED BY: J.R.	DATE: 12APR95

GROUNDWATER ORGANIC ANALYTICAL RESULTS
FOR MONITOR WELLS LOCATED IN THE CENTRAL PART
OF THE HARRISON SITE

DELPHI HARRISON THERMAL SYSTEMS, GENERAL MOTORS CORPORATION,
MORAINE, OHIO

FIGURE
5-14



LEGEND

⊕	SOIL SAMPLE LOCATION
T12-GS1-17SL	SAMPLE IDENTIFICATION
×	HNU GRAB SAMPLE AND HNU READINGS (ppm HNU UNITS)
ND	NOT DETECTED
ppm	PARTS PER MILLION

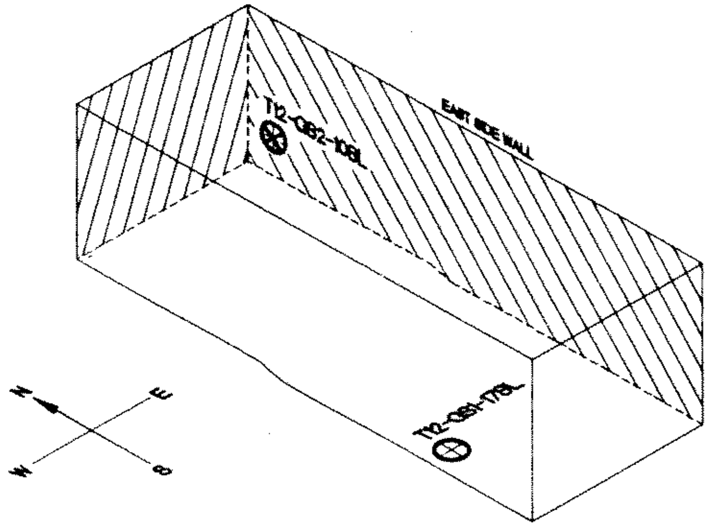
GERAGHTY & MILLER, INC.
Environmental Services

PROJECT NO.: OH01818	FILE NO: HAR(RFI)
DRAWING: T-12	PLOT SIZE:
DRAFTED BY: RTS	DATE: 11JUN93
CHECKED BY: J.R.	DATE: –
APPROVED BY: J.R.	DATE: –

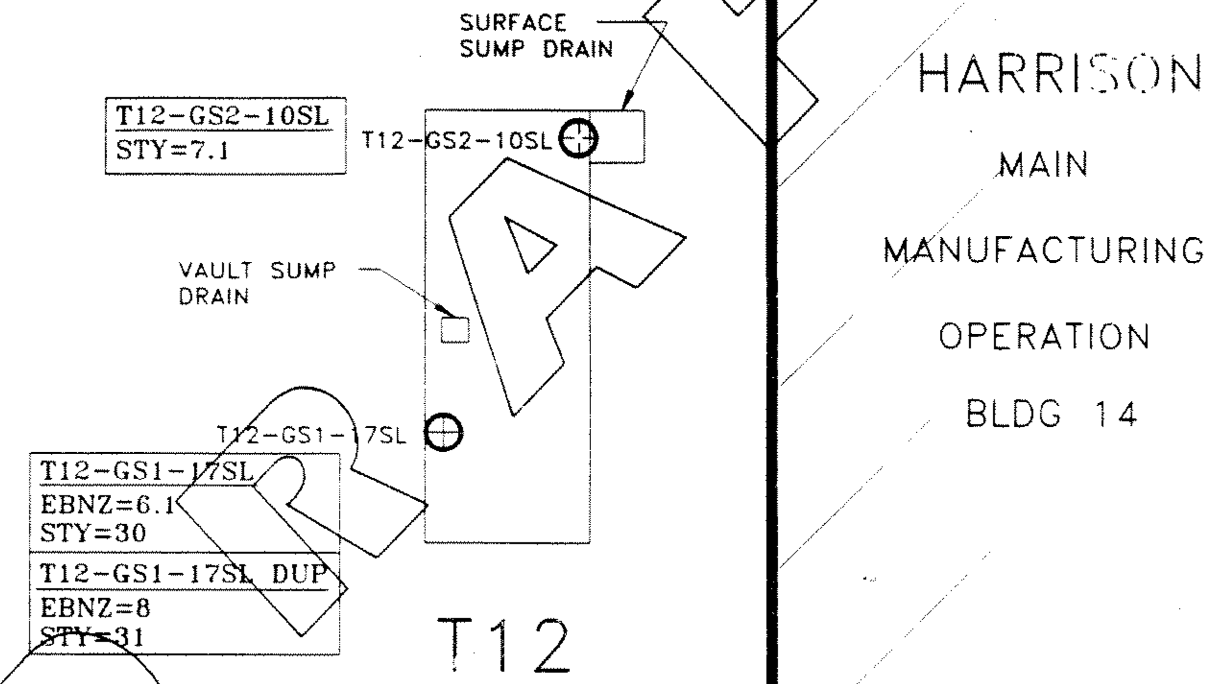
RFI GRAB-SAMPLE LOCATIONS AND HNU HEADSPACE READINGS AT SWMU T12

DELPHI HARRISON THERMAL SYSTEMS, GENERAL MOTORS CORPORATION
MORAINE, OHIO

FIGURE
5-15



ISOMETRIC VIEW OF T12



T12-GS2-10SL
STY=7.1

T12-GS1-17SL
EBNZ=6.1
STY=30

T12-GS1-17SL DUP
EBNZ=8
STY=31

LEGEND

⊕ SOIL SAMPLE LOCATION

T12-GS1-17SL SAMPLE IDENTIFICATION

UNITS ARE MICROGRAMS PER KILOGRAM

REFER TO FIGURE 5-4, PARAMETER ABBREVIATION FOR RFI RESULTS FIGURES.

SCALE
0 20 FT

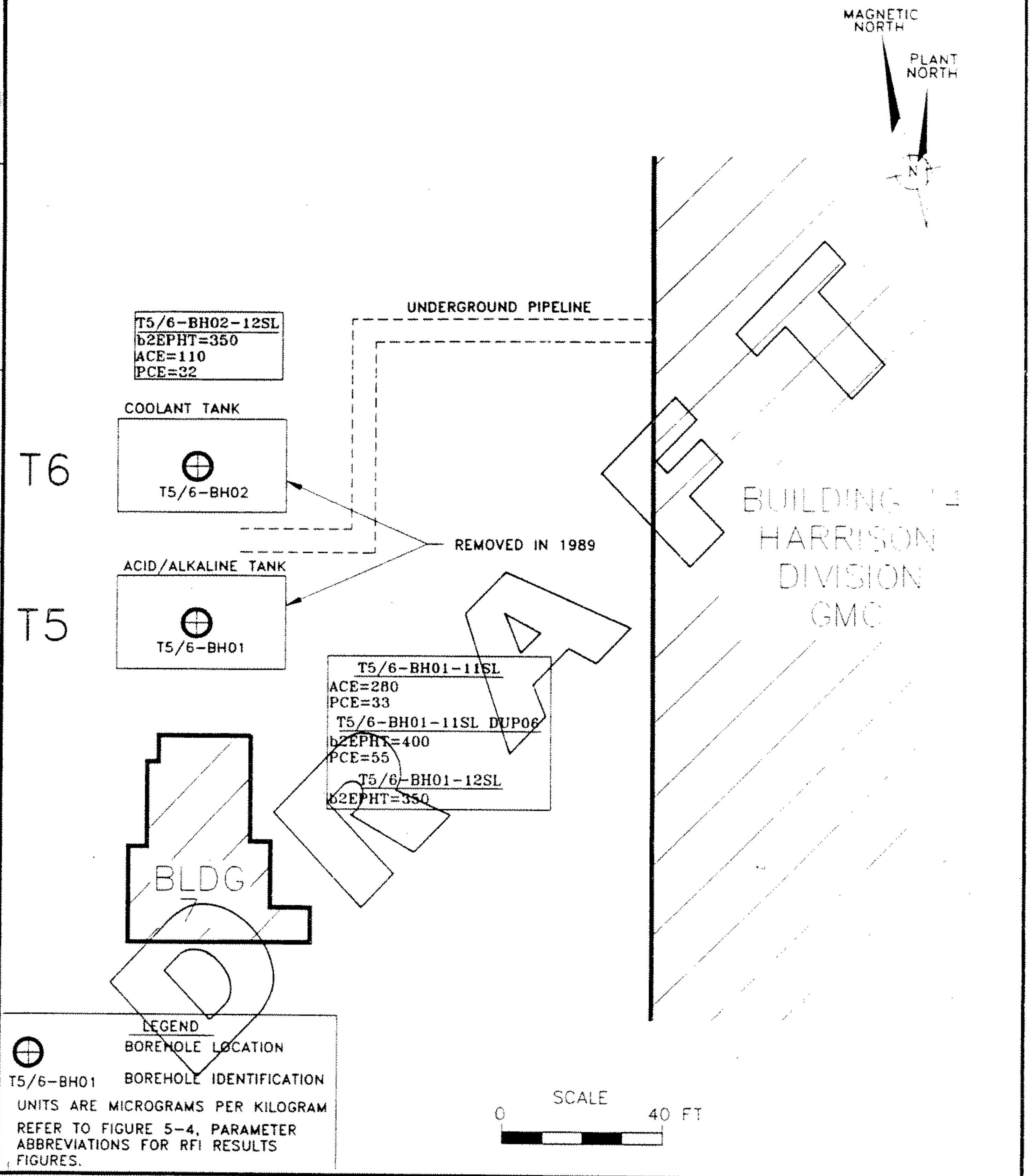
GERAGHTY & MILLER, INC.
Environmental Services

RFI SUBSURFACE SAMPLING LOCATIONS AND SOIL ORGANIC ANALYTICAL RESULTS FOR T12

DELPHI HARRISON THERMAL SYSTEMS, GENERAL MOTORS CORPORATION,
MORAINE, OHIO

FIGURE
5-16

DRAFTER: RTS
APPROVED: J.R.
CHECKED: R.A.
DRAWING: T12
FILE NO.: HAR\RFI
PRJCT NO.: OH01918
DWG DATE: 15APR93



LEGEND

⊕	BOREHOLE LOCATION
T5/6-BH01	BOREHOLE IDENTIFICATION

UNITS ARE MICROGRAMS PER KILOGRAM

REFER TO FIGURE 5-4, PARAMETER ABBREVIATIONS FOR RFI RESULTS FIGURES.

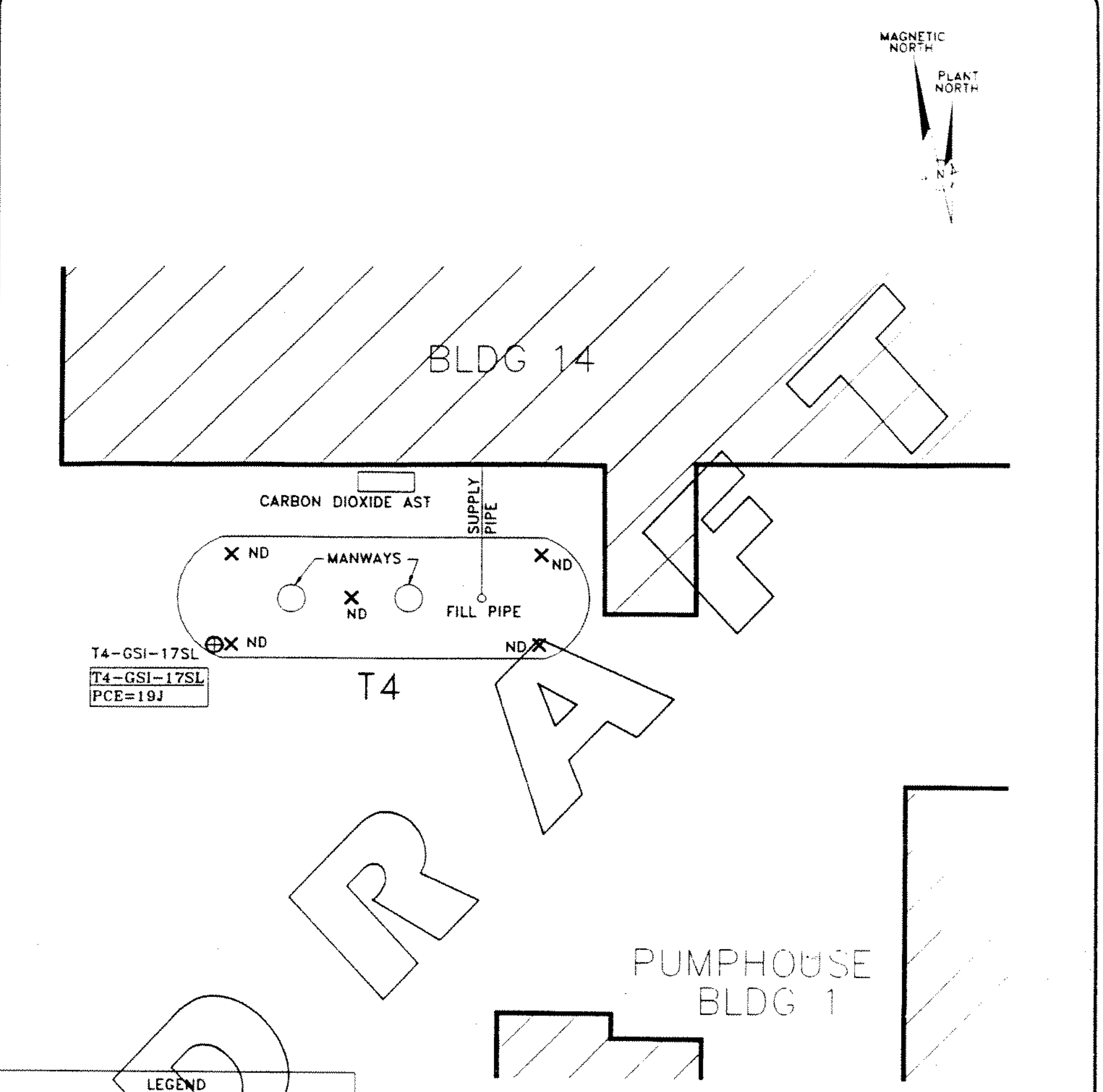
GERAGHTY & MILLER, INC.
Environmental Services

RFI SAMPLE LOCATIONS AND SOIL ORGANIC ANALYTICAL RESULTS FOR T5/T6

DELPHI HARRISON THERMAL SYSTEMS, GENERAL MOTORS CORPORATION, MORAINE, OHIO

FIGURE 5-17

DWG. 15APR93 | PRJCT NO.: OH01918 | FILE NO.: HAR\RFI | DRAWING: T6 | CHECKED: R.A. | APPROVED: J.R. | DRAWN: IS



LEGEND

⊕	SOIL SAMPLE LOCATION
×	HNU GRAB LOCATION AND FIELD HNU READING (ppm HNU UNITS)
ND	NOT DETECTED
ppm	PARTS PER MILLION

UNITS ARE MICROGRAMS PER KILOGRAM
REFER TO FIGURE 5-4, PARAMETER ABBREVIATIONS FOR RFI RESULTS FIGURES.

DRAI S
APPROVED: J.R.
CHECKED: J.R.
DRAWIN
FILE NO.: HAR\RFI
PRJCT NO.: OH0191B
15APR93
DW:

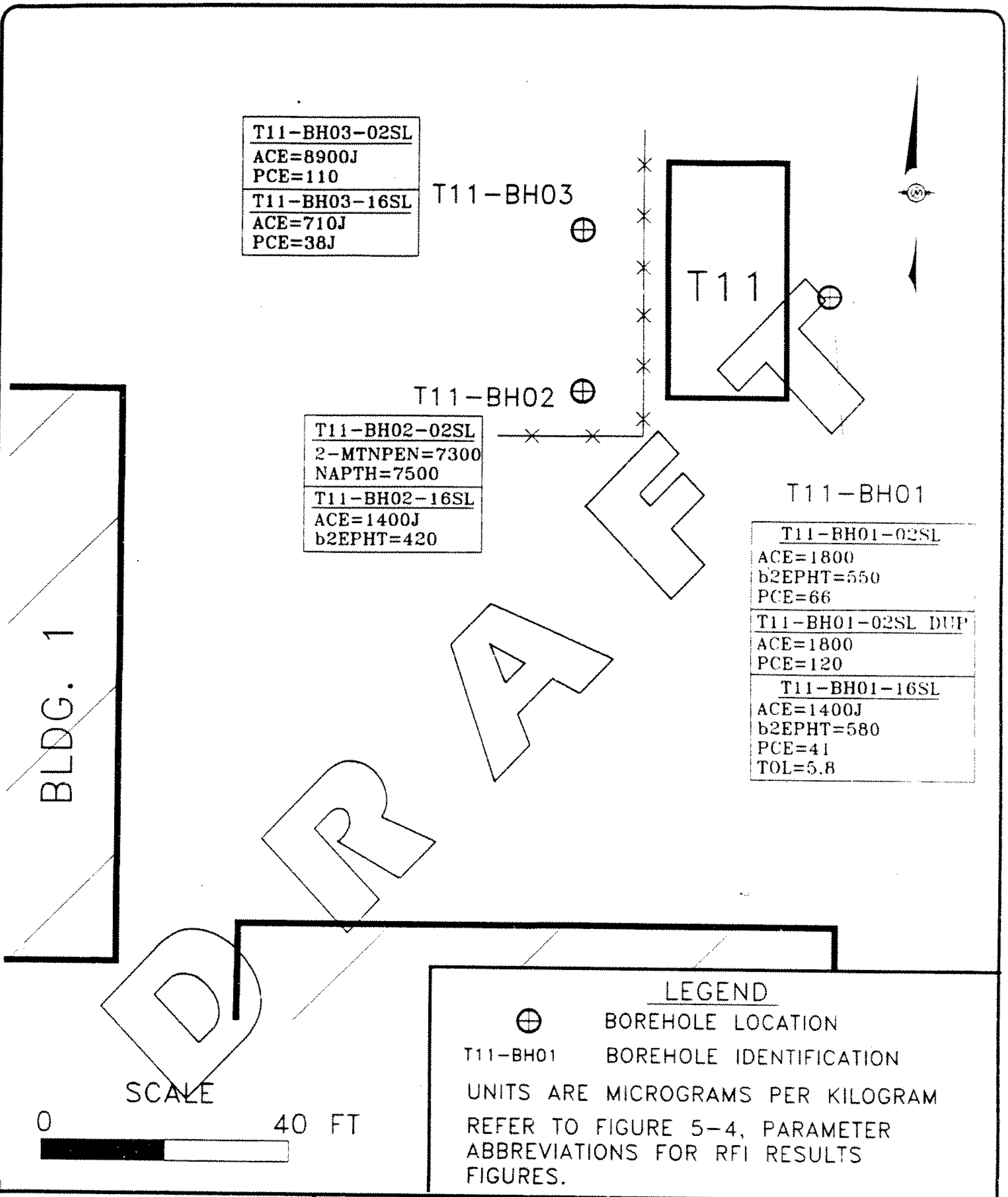
GERAGHTY
& MILLER, INC.
Environmental Services

NOT TO SCALE

RFI SAMPLE LOCATIONS AND SOIL ORGANIC ANALYTICAL RESULTS FOR T4

DELPHI HARRISON THERMAL SYSTEMS, GENERAL MOTORS CORPORATION,
MORAINE, OHIO

FIGURE
5-18



T11-BH03-02SL
ACE=8900J PCE=110
T11-BH03-16SL
ACE=710J PCE=38J

T11-BH02-02SL
2-MTNPEN=7300 NAPTH=7500
T11-BH02-16SL
ACE=1400J b2EPHT=420

T11-BH01-02SL
ACE=1800 b2EPHT=550 PCE=66
T11-BH01-02SL DUP
ACE=1800 PCE=120
T11-BH01-16SL
ACE=1400J b2EPHT=580 PCE=41 TOL=5.8

LEGEND

⊕	BOREHOLE LOCATION
T11-BH01	BOREHOLE IDENTIFICATION

UNITS ARE MICROGRAMS PER KILOGRAM

REFER TO FIGURE 5-4, PARAMETER ABBREVIATIONS FOR RFI RESULTS FIGURES.

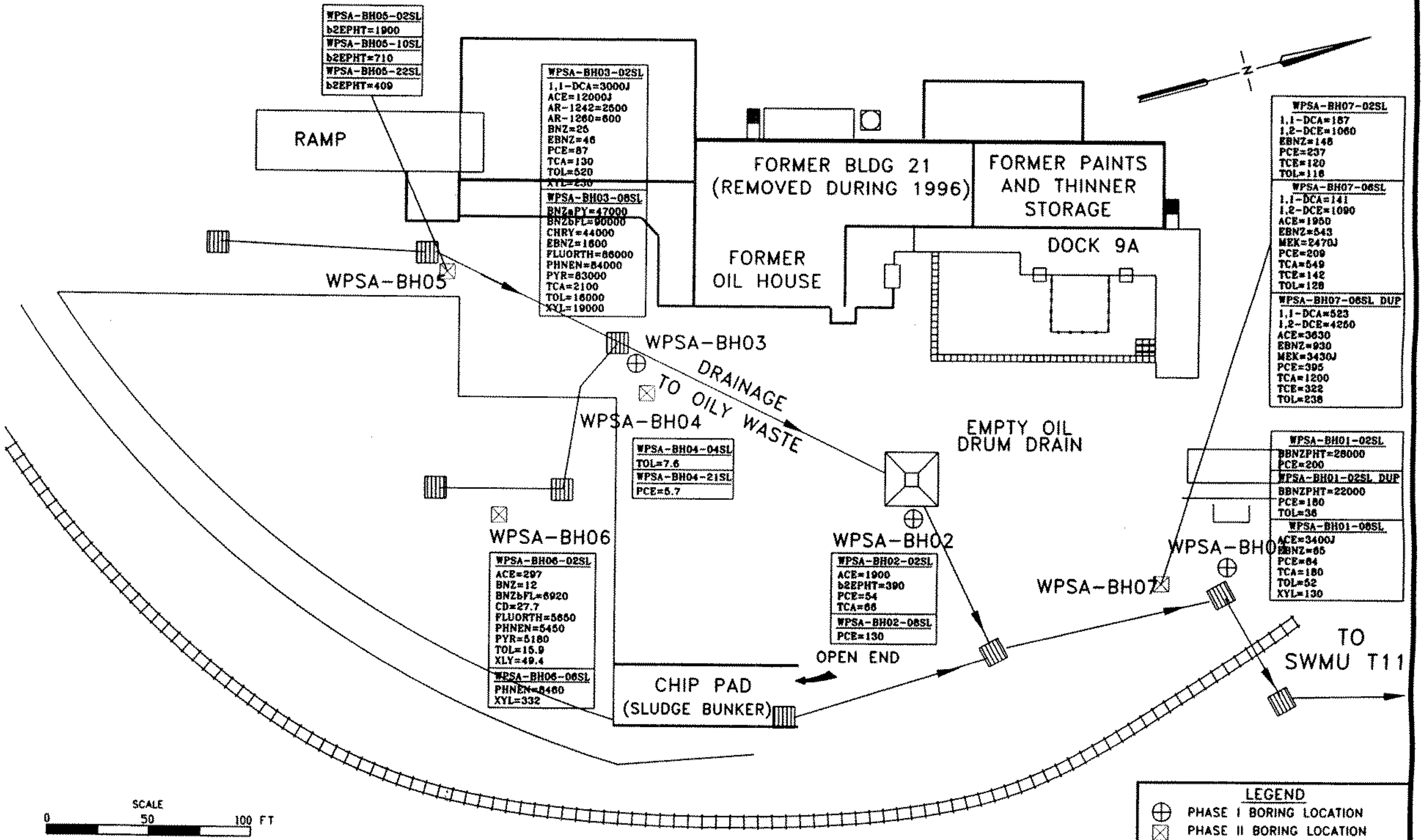
GERAGHTY & MILLER, INC.
Environmental Services

RFI SAMPLE LOCATIONS AND SOIL ORGANIC ANALYTICAL RESULTS FOR T11

DELPHI HARRISON THERMAL SYSTEMS, GENERAL MOTORS CORPORATION,
MORAINE, OHIO

FIGURE
5-19

DW 12NOV92
PRJCT NO.: OHO1312
FILE NO.: HARRI½RFI
DRAWIN .B
CHECKED: J.R.
APPROVED: J.R.
DRA TS



LEGEND

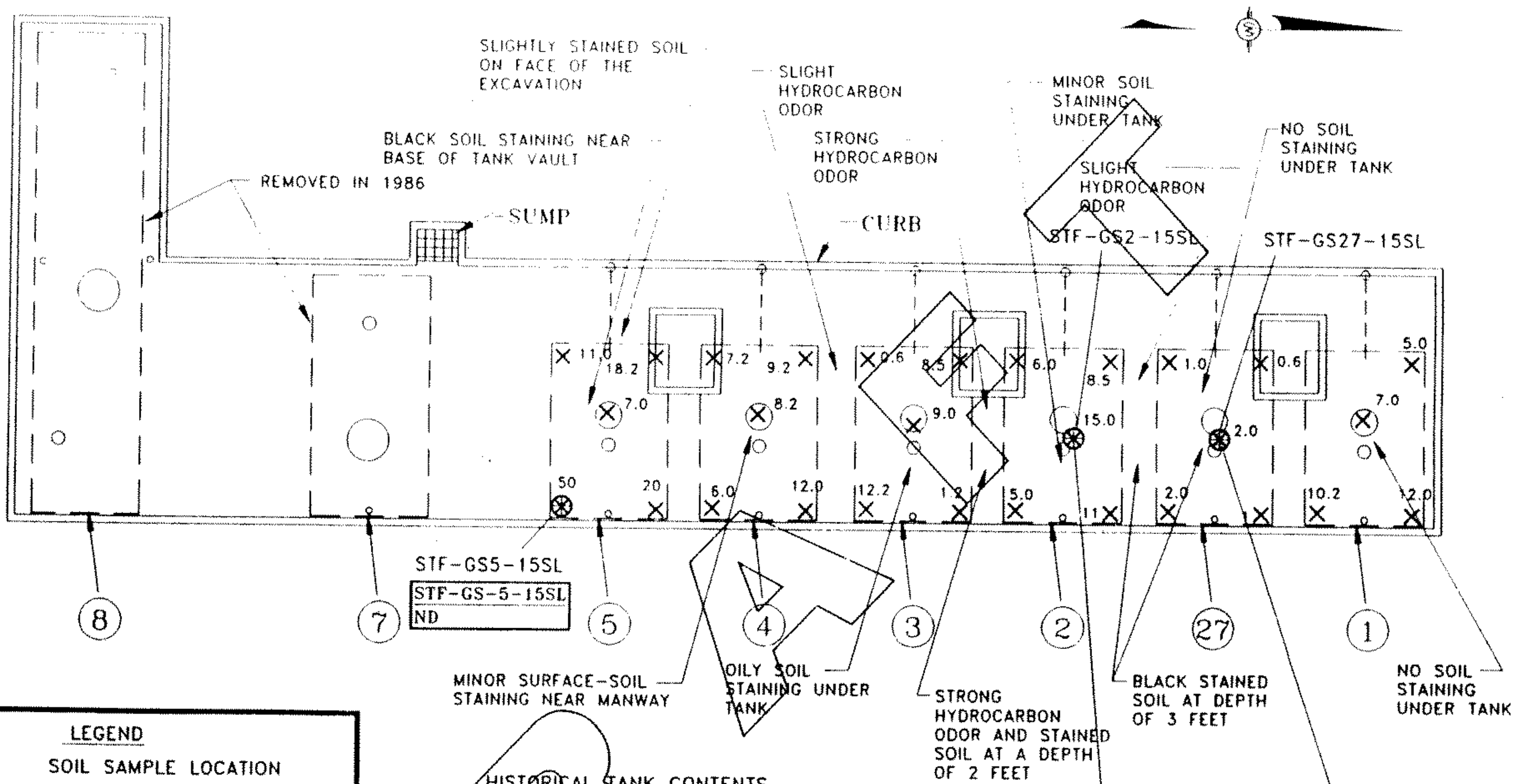
- ⊕ PHASE I BORING LOCATION
- ☒ PHASE II BORING LOCATION
- ▥ STORM DRAIN

UNITS ARE MICROGRAMS PER KILOGRAM
REFER TO FIGURE 5-4, PARAMETER ABBREVIATIONS FOR RFI RESULTS FIGURES.

ARCADIS GERAGHTY&MILLER

RFI SAMPLE LOCATIONS AND SOIL ORGANIC
ANALYTICAL RESULTS FOR THE WASTE
PILE/STAGING AREA
DELPHI HARRISON THERMAL SYSTEMS,
MORAINE, OHIO

DATE OCT91	PROJECT MANAGER R. ASTLE	DRAWING NAME HAR\RFI\STAGING
DRAWN R. SMITH	LEAD DESIGN PROF.	CHECKED R. ASTLE
PROJECT NUMBER OH000294.001.002		FIGURE NUMBER 5-20



LEGEND

⊕	SOIL SAMPLE LOCATION
STF-GS2-15SL	RFI SAMPLE IDENTIFICATION
(27)	TANK NUMBER
× 9.2	HNU GRAB SAMPLE AND HNU READINGS (ppm HNU UNITS)
ND	NOT DETECTED
ppm	PARTS PER MILLION

UNITS ARE MICROGRAMS PER KILOGRAM
REFER TO FIGURE 5-4, PARAMETER ABBREVIATIONS FOR RFI RESULTS FIGURES.

HISTORICAL TANK CONTENTS

1	WASHING OIL
2	LUB. GEAR OIL
3	BRUKO D-332
4	HYDRAULIC OIL - 215 SEC
5	CIMTECH 3900
7	SWMU T2 - DIRTY OILS
8	SWMU T3 - DIRTY OILS, VIRGIN MACHINE COOLANT
27	SWMU T1 - SPENT ALKALINE DETERGENT SOLUTION

APPROX SCALE
0 20 FT

GERAGHTY
& MILLER, INC.
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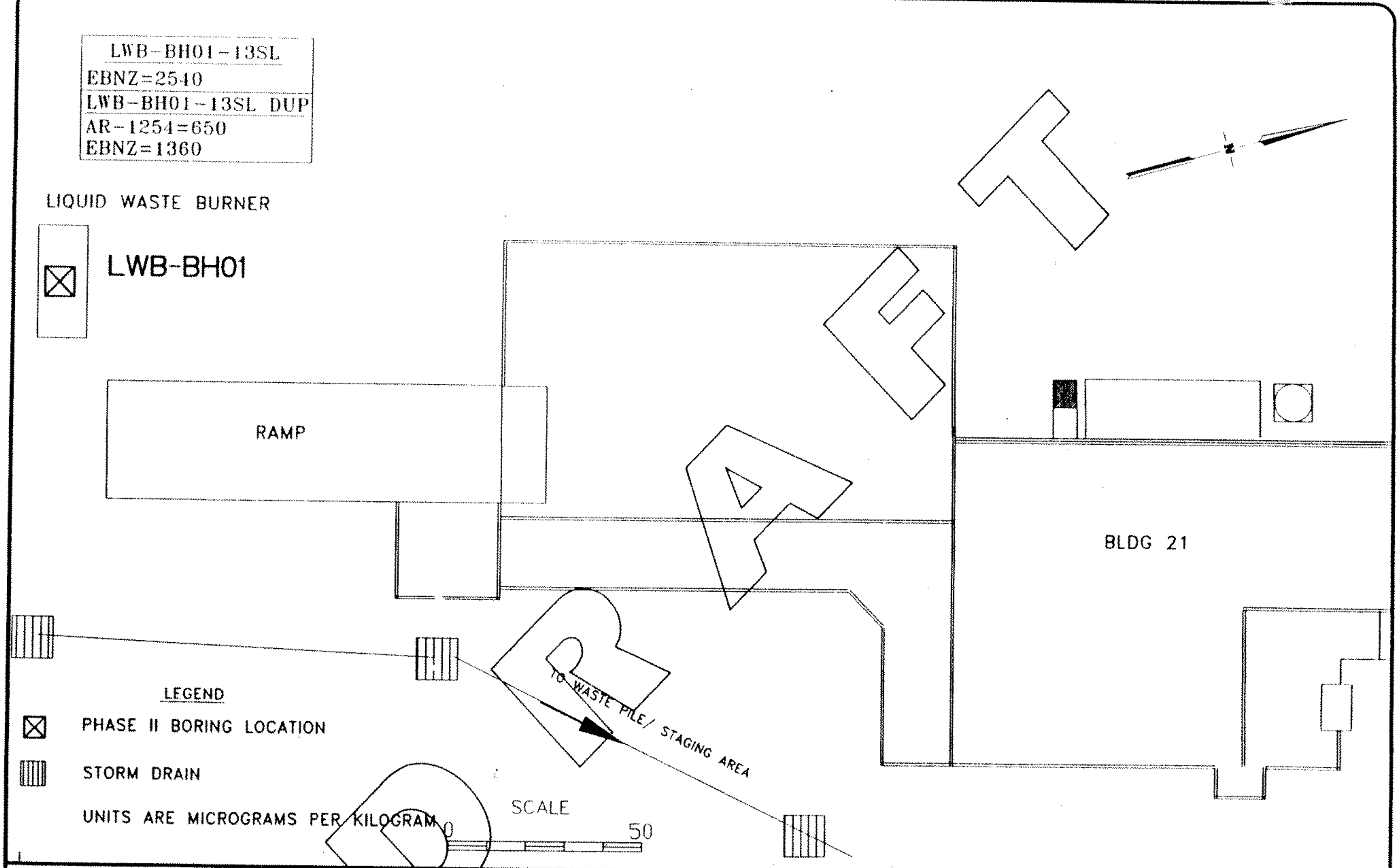
RFI SAMPLE LOCATIONS AND SOIL ORGANIC ANALYTICAL RESULTS FOR THE SOUTH TANK FARM

DELPHI HARRISON THERMAL SYSTEMS, GENERAL MOTORS CORPORATION,
MORAINE, OHIO

FIGURE
5-21

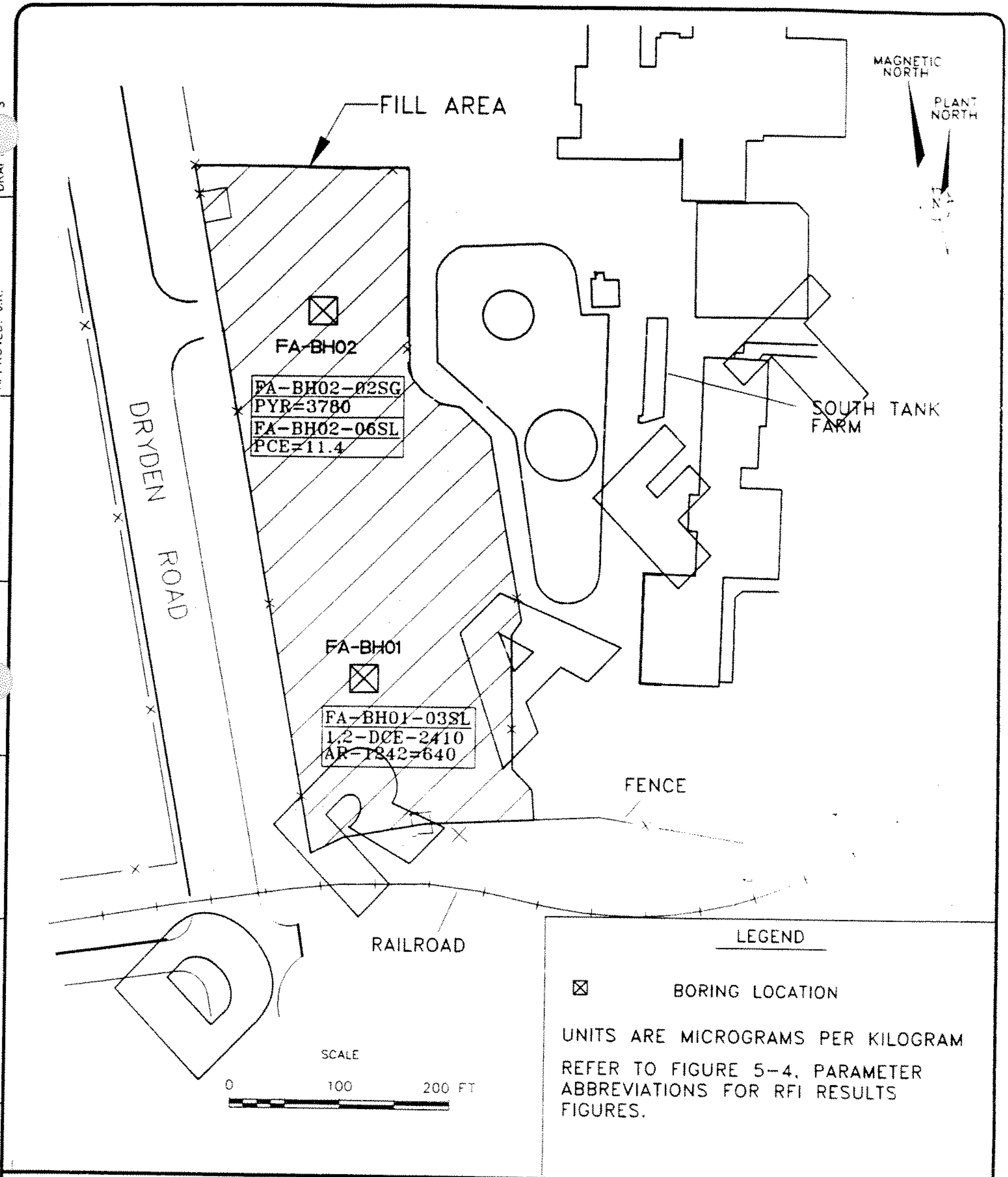


GERAGHTY & MILLER, INC.
Environmental Services

RFI SAMPLE LOCATION AND SOIL ORGANIC ANALYTICAL RESULTS FOR THE LIQUID WASTE BURNER

DELPHI HARRISON THERMAL SYSTEMS, GENERAL MOTORS CORPORATION,
MORAINE, OHIO

FIGURE
5-22



LEGEND

☒ BORING LOCATION

UNITS ARE MICROGRAMS PER KILOGRAM

REFER TO FIGURE 5-4, PARAMETER ABBREVIATIONS FOR RFI RESULTS FIGURES.

GERAGHTY
& MILLER, INC.
Environmental Services

RFI SAMPLE LOCATIONS AND SOIL ORGANIC ANALYTICAL RESULTS FOR THE FILL AREA

DELPHI HARRISON THERMAL SYSTEMS, GENERAL MOTORS CORPORATION,
MORAINE, OHIO

FIGURE
5-23

DWG
29JUN93
PRJCT NO.: OH0019.018
FILE NO.: HARR\NB
DRAWIN
L AREA
CHECKED: J.R.
APPROVED: J.R.
DRA
S

ARCADIS GERAGHTY&MILLER

Supporting Information:
Supplemental RFI Report
Moraine Engine and Moraine Assembly
April 2000

Areas of Interest Descriptions for Moraine Engine and Moraine Assembly

AOI 7 - Former Oil House Area

The Former Oil House (Building 7) was located north of the Moraine Engine Plant 3 (former Frigidaire Plant 2, Figure 1-5), and was built at least as early as 1949. The Former Oil House Area consisted of the Oil House (Building 7) and an outdoor area that contained underground storage tanks (USTs), ASTs, and a drum storage area. This AOI was removed from service in 1979 when at least three buildings were demolished and all tanks were removed and either replaced or reused. The Oil House Building 7 and associated outside structures covered a total area of approximately 48,000 square ft.

Virgin paints and chemicals necessary for production at the Frigidaire facilities were stored and mixed in the Oil House, and pumped or transferred to various production areas. Materials were stored in both drums and tanks. Materials were shipped to this area by railroad tank cars and tanker trucks. Virgin chemicals including oils, paints, thinners, solvents, acids, toluene diisocyanate (TDI) and resins were stored inside the Oil House. Alcohols were reclaimed and solvent blending activities were conducted at the Oil House. The outdoor area just north of the Oil House had seventeen 8,000 to 15,000-gallon ASTs used to store oil, solvents, acids and other production materials, and three 15,000-gallon USTs used to store oil. According to the 1976 Spill Prevention Control and Countermeasure (SPCC) Plan (General Motors Corporation 1976), these tanks had a gravel floor and concrete containment dikes for spill containment. A drummed waste storage area was also located just north of the Oil House and was used to store drummed waste oils, thinners, alcohols, still bottoms from the Oil House and sludges containing chromium, nickel, and phosphorus. Additionally, a May 1979 aerial photograph shows an area north of the Oil House was used for temporary storage of equipment, boxes, and drums during the conversion of Frigidaire Plant 2. As stated in the Supplemental DOCC, GM announced the shut down of all Frigidaire operations in January 1979. During 1980 and 1981, the majority of the former Frigidaire Plant 2 was converted to the Moraine Engine facility. A November 1979 aerial photograph showed that Building 7 had been demolished, and did not show evidence of the equipment, boxes, and drums seen in the May 1979 aerial photograph. Copies of both the aerial photographs were included in the October 16, 1998 letter from Delphi Thermal to U.S. EPA, which is presented in the Supplemental RFI Report.

AOI 7 is currently covered with asphalt, concrete, and the new Moraine Engine Tank Farm. This aboveground tank farm and pump house were constructed in 1980 over the footprint of the former Oil House tank farm. As concluded in the Supplemental DOCC, AOI 7 may be a potentially significant source for soil and groundwater contamination, and further investigation was warranted under the Supplemental RFI.

AOI 13 - Former Buildings 4, 6, And 13

Buildings 4, 6, and 13 of the Frigidaire facilities were located south of the Moraine Engine Plant 3 (Figure 1-5). Buildings 4 and 6 (also known as Moraine Engine Plant 4) consisted of approximately 300,000 square ft. Buildings 4 and 6 were constructed in 1917 and 1926, respectively, and the buildings had many previous uses including manufacturing of service parts, chemical storage, storage for oil recovery, and offices. Frigidaire discontinued operations in 1979, and by late 1981 these buildings were unoccupied without heat. In 1983, GM removed ten PCB-contaminated electrical transformers from Buildings 4 and 6 and disposed of them off site at a Toxic Substances Control Act (TSCA)-approved facility. Prior to 1985, GM removed asbestos from piping within Buildings 4 and 6 and disposed of this material in an approved off-site facility. In 1990, GM conducted a comprehensive study of the wood floor block in these buildings. The results indicated that PCB's were present in the floor block. The wood floor block was removed, the concrete floor beneath the wood floor block was cleaned and PCB sampling was conducted. Additionally, an area on the south side of Building 4, formerly used for plating, was impacted by metals (primarily cadmium). Decontamination activities began in 1995 and demolition of Buildings 4 and 6 took place in 1996. Building 13 (also known as Moraine Engine Plant 5) was built in 1916 by the Cleveland and Lake Erie Railroad Company (C&LE) and was used for railroad maintenance. It covered an area of approximately 60,000 square ft. GM acquired the building in 1941. From 1941 until 1979, the building was used for maintenance purposes and storage. After 1979, part of Building 13 was used as a Hazardous Waste Storage Pad. The concrete storage pad covered an area of 2,400 square ft and had the capacity to store 250 55-gallon drums. It was used for storage of drummed quantities of waste paint thinner and sludges, chlorinated solvents, and non-hazardous waste oil and process fluids prior to removal from the facility. The former Hazardous Waste Storage Pad was clean closed in 1993, and closure was approved by the Ohio Environmental Protection Agency (Ohio EPA). Cleaning and decontamination activities of the remainder of the building began in 1995, and demolition of Building 13 took place in 1996. During demolition, a portion of a UST was found. The partial tank was approximately 5,000 gallons in volume and was determined to previously have contained fuel oil used for heating purposes. The UST was taken out of service prior to 1970. Soil samples were collected from the cavity wall during demolition activities and the results were well below the applicable Bureau of Underground Storage Tank Regulations (BUSTR) standards.

AOI 13 is currently covered with an asphalt parking lot that was constructed in 1998. As concluded in the Supplemental DOCC, there was a potential for AOI 13 to have been a potentially significant source for soil and groundwater contamination, and further investigation was warranted under the Supplemental RFI.

AOI 17 - Building 15

AOI 17 includes Building 15 and a former Frigidaire Plant 2 used-oil UST (Figure 1-5). Building 15 covered an area of approximately 17,000 square ft, and based on a review of aerial photographs, it was constructed prior to 1949. The building was used for maintenance purposes and included a truck maintenance repair area, an equipment steam booth area and a maintenance spray booth area located in the center of the building. The 900-gallon steel UST located south of Building 13 and north of Building 15 was used to store used oil from garage operations. It is unknown when this tank began operation. The used oil present in the UST at closure contained VOCs (ethylbenzene, tetrachloroethene [PCE], toluene, and xylenes), but no VOCs were detected in the soil tested during closure activities. It was removed and clean closed under the BUSTR in 1994.

AOI 17 is currently covered with an asphalt parking lot that was constructed in 1998 (Building 15 was demolished and removed for off-site disposal as part of the parking lot construction). As concluded in the Supplemental DOCC, there was a potential for AOI 17 to have served as a historical source of chlorinated VOCs detected in monitoring well GM-21, and further investigation was warranted under the Supplemental RFI.

AOI 34 - Excavation Area 1

AOI 34 was located north of the Moraine Engine Plant 3 and west of Springboro Road (Figure 1-5), and was identified from a 1956 aerial photograph. The excavation area was approximately 300 ft long by 40 ft wide, with the southern end containing a depression that was possibly filled with liquid. This area was covered with grass at the time the Supplemental DOCC was completed and during the Supplemental RFI sampling (conducted in August 1997). No information was available regarding the types of materials which may have been handled in this area and their potential for releasing hazardous constituents. As concluded in the Supplemental DOCC, no specific basis existed for further investigation at AOI 34; however, a limited investigation to assess the potential presence of contamination was recommended. AOI 34 is currently covered with an asphalt parking lot that was constructed in 1998.

AOI 35 - Excavation Area 2

AOI 35 was located north of the Moraine Assembly Plant 1 and east of Springboro Road (Figure 1-5), and was identified from a 1956 aerial photograph. The excavation area was approximately 200 ft long by 150 ft wide. This area was covered by a parking lot at the time the Supplemental DOCC was completed and during the Supplemental RFI sampling (conducted in August 1997). No information was available regarding the types of materials which may have been handled in this area and their potential for releasing hazardous constituents. As concluded in the Supplemental DOCC, no specific basis existed for further investigation at AOI 35; however, a limited investigation to assess the potential presence of contamination was recommended. AOI 35 is currently covered by the parking lot associated with the new Moraine Assembly plant. Construction activities began in late 1997 and will be completed in 1999.

AOI 36 - Former Southwest Above Ground Storage Tanks

AOI 36 was located in the southwest corner of the Moraine Engine facility and consisted of four sets of concrete AST saddles (Figure 1-5). The two southern-most sets of saddles consisted of four larger saddles per tank and were contained in an earthen dike area approximately 50 ft by 70 ft. The two northern-most sets of saddles consisted of two saddles per tank and were contained in a separate 40 ft by 55 ft earthen dike area. These tank saddles and earthen berms were identified during a site walkover in June 1997. A review of aerial photographs indicated that the two southern-most tanks were installed prior to 1949. One tank was installed on the northern-most set of saddles between 1949 and 1956. These three tanks were present in the 1975 aerial photograph, but had been removed prior to the 1990 aerial photograph. There was no evidence that the fourth set of saddles was ever used. Use of these tanks was thought to have ceased prior to the early 1970's; however, the tank saddles and earthen berms were still present during the Supplemental RFI investigation. No information was available regarding the types of materials which may have been handled in this area and their potential for releasing hazardous constituents. AOI 36 is currently covered with an asphalt parking lot that was constructed in 1998. As concluded in the Supplemental DOCC, no specific basis existed for further investigation at AOI 36; however, given the probable use of the area for storage of liquid materials, a limited investigation to determine if a release had occurred was recommended under the Supplemental RFI.

Table 3-1. Analytical Results for Soil Samples, AOI - 34 Excavation Area 1 and AOI 35 - Excavation Area 2, General Motors Corporation, Moraine, Ohio.

		EA1-BH01			EA2-BH01	
Constituents	**Units**	**Fill 8/28/97 6 - 8 ft bgs**	**Fill 8/28/97 Dup-39**	**Native 8/28/97 12-14 ft bgs**	**Fill 8/28/97 6 - 8 ft bgs**	**Native 8/28/97 22-24 ft bgs**
VOCs	ug/Kg	ND	ND	ND	ND	ND
SVOCs						
Fluoranthene	ug/Kg	449	<330	<330	402	<330
Pyrene	ug/Kg	450	<330	<330	472	<330
PCBs	mg/Kg	ND	ND	ND	ND	ND
Metals						
Antimony	mg/Kg	<16	<16	<32	<33	<33
Arsenic	mg/Kg	46.5J	124J	3.18	3.16	3.24
Barium	mg/Kg	58.2J	66.9J	22J	53.8J	15J
Beryllium	mg/Kg	0.9	0.8	<2	<2	<2
Cadmium	mg/Kg	<3.9	<4.9	<9.6	<9.9	<9.9
Chromium	mg/Kg	12	15.1	<13	13	<13
Cobalt	mg/Kg	7.6	6.52	<6.4	<6.6	<6.6
Copper	mg/Kg	15.3	15.1	<6.4	<6.6	<6.6
Lead	mg/Kg	18	17.8	3.5	17.4	4.32
Manganese	mg/Kg	331	277	714	299	311
Mercury	mg/Kg	0.025	0.032	<0.01	0.012	<0.01
Nickel	mg/Kg	18.6	15.3	24	7.3	7.6
Selenium	mg/Kg	<1.63J	<1.64J	<1.66J	<1.64J	<1.64J
Silver	mg/Kg	<5.2	<1.3	<13	<13	<13
Thallium	mg/Kg	<0.5	<0.5	0.927	<0.5	0.683
Vanadium	mg/Kg	20.7J	24.9J	<16J	<16J	<17J
Zinc	mg/Kg	104J	141J	20J	49J	28J

EA - Excavation area.
ND - Not detected.
VOCs - Volatile organic compounds.
SVOCs - Semi-volatile organic compounds.
PCBs - Polychlorinated biphenyls.
< - Constituent not detected above laboratory detection limit shown.
mg/Kg - Milligram per kilogram.
ug/Kg - Microgram per kilogram.
ft bgs - Feet below ground surface.
DUP-39 = Duplicate of sample EA1-BH01(6-8).
J - Estimated Concentration.

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Table 3-2. Field Screening Results for Soil Samples, AOI 13 - Buildings 4, 6, and 13 and AOI 17 - Building 15, General Motors Corporation, Moraine, Ohio.

Sample Date	Sample Identification	Sample Interval (feet)	PCB Test Kit Results (ppm)	HNu Reading (ppm)	Field GC Results (ppm)		
					TCE	PCE	1,1,1-TCA
AOI 13							
2/17/98	BDG-DP3	4-8	<0.5	0	<0.001	<0.001	<0.001
2/17/98	BDG-DP4	4-8	<0.5	0	<0.001	<0.001	<0.001
2/17/98	BDG-DP6	4-8	<0.5	0	0.011	0.002	<0.001
2/17/98	BDG-DP7	4-8	<0.5	0	<0.001	<0.001	<0.001
2/17/98	BDG-DP10	4-8	<0.5	0	<0.001	<0.001	<0.001
2/17/98	BDG-DP11	4-8	<0.5	0	0.002	0.001	<0.001
2/17/98	BDG-DP12	4-8	<0.5	0	0.001	0.001	<0.001
2/18/98	BDG-DP2	4-8	0.5 - 1.0	0	<0.001	<0.001	<0.001
2/18/98	BDG-DP5	4-8	<0.5	0	0.001	0.001	<0.001
2/18/98	BDG-DP8	4-8	<0.5	0	0.03	0.001	<0.001
2/18/98	BDG-DP8 (DUP)	4-8	<0.5	0	NA	NA	NA
2/18/98	BDG-DP9	4-8	<0.5	0	<0.001	0.048	<0.001
2/18/98	BDG-DP14	4-8	<0.5	0	0.066	0.004	0.002
2/18/98	BDG-DP14 (DUP)	4-8	NA	0	0.07	0.004	0.003
2/18/98	BDG-DP17	4-8	<0.5	0	0.002	0.002	<0.001
2/18/98	BDG-DP18	4-8	<0.5	0	<0.001	<0.001	<0.001
2/18/98	BDG-DP18 (DUP)	4-8	<0.5	0	NA	NA	NA
2/18/98	BDG-DP19	4-8	<0.5	0	<0.001	<0.001	<0.001
2/19/98	BDG-DP1	4-8	>25	0	<0.001	<0.001	<0.001
2/19/98	BDG-DP1 (DUP)	4-8	1.1 - 4	0	NA	NA	NA
2/19/98	BDG-DP13 (0-4)	0-4	<0.5	0	0.003	<0.001	<0.001
2/19/98	BDG-DP13 (4-8)	4-8	<0.5	0	0.002	<0.001	<0.001
2/19/98	BDG-DP15	4-8	<0.5	0	0.028	<0.001	<0.001
2/19/98	BDG-DP16 (0-4)	0-4	<0.5	0	0.008	<0.001	<0.001
2/19/98	BDG-DP16 (4-8)	4-8	<0.5	0	0.001	<0.001	<0.001

Table 3-2. Field Screening Results for Soil Samples, AOI 13 - Buildings 4, 6, and 13 and AOI 17 - Building 15, General Motors Corporation, Moraine, Ohio.

Sample Date	Sample Identification	Sample Interval (feet)	PCB Test Kit Results (ppm)	HNu Reading (ppm)	Field GC Results (ppm)		
					TCE	PCE	1,1,1-TCA
AOI 17							
2/19/98	BD15-DP1	4-8	<0.5	0	0.006	0.065	<0.001
2/19/98	BD15-DP2	4-8	<0.5	0	0.004	0.065	<0.001
2/19/98	BD15-DP2 (DUP)	4-8	NA	0	0.005	0.064	<0.001
2/19/98	BD15-DP3	4-8	<0.5	0	0.009	0.036	<0.001
2/19/98	BD15-DP3 (DUP)	4-8	<0.5	0	NA	NA	NA

A split of BDG-DP1 (4-8) was submitted to NET for analysis of TCL PCBs by Method 8080A.
A split of BDG-DP13 (0-4) was submitted to NET for analysis of TAL Metals by Method 6010A.
PCB Test Kit Results were obtained by using the D-TECH #TK-1002-1, PCB Soil Extraction Pac D-TECH #TK-1002S-1, and the test kit results were interpreted using the DETECHTOR #TK-1001M-1.
Field gas chromatograph results were obtained from Microseeps mobile laboratory.
NA - Not analyzed.
PCB - Polychlorinated biphenyls.
TCE - Trichloroethene.
PCE - Tetrachloroethene.
1,1,1-TCA - 1,1,1-Trichloroethane
ppm - Parts per million.

Table 3-3. Analytical Results for Soil Samples, AOI 13-Buildings 4, 6, and 13, General Motors Corporation, Moraine, Ohio

Constituents	Units	Sample Description BDG-DP1 2/19/98 4-8 ft bls	Sample Description BDG-DP13 2/19/98 0-4 ft bls	Soil Background Level
Metals				
Antimony	mg/Kg	NA	<7.2UJ	NB
Arsenic	mg/Kg	NA	6.19	28.5
Barium	mg/Kg	NA	103J	229
Beryllium	mg/Kg	NA	0.6	2.41
Cadmium	mg/Kg	NA	<1.1	12.6
Chromium	mg/Kg	NA	9.7	47.4
Cobalt	mg/Kg	NA	4.16	26
Copper	mg/Kg	NA	13.1	41
Lead	mg/Kg	NA	23.1	49.1
Manganese	mg/Kg	NA	611	1,600
Mercury	mg/Kg	NA	0.182J	0.69
Nickel	mg/Kg	NA	10.9	63.7
Selenium	mg/Kg	NA	0.643J	1.5
Silver	mg/Kg	NA	<1.4	0.76
Thallium	mg/Kg	NA	<0.60	NB
Vanadium	mg/Kg	NA	16.5	84.4
Zinc	mg/Kg	NA	82.3J	152
PCBs				
Aroclor 1016	mg/Kg	<0.56	NA	
Aroclor 1221	mg/Kg	<0.56	NA	
Aroclor 1232	mg/Kg	<0.56	NA	
Aroclor 1242	mg/Kg	<0.56	NA	
Aroclor 1248	mg/Kg	<0.56	NA	
Aroclor 1254	mg/Kg	7.86J	NA	
Aroclor 1260	mg/Kg	<0.56	NA	

Background levels from the RFI Final Report Volume II, Baseline Risk Assessment (ENVIRON Corporation 1996).
PCB - Polychlorinated biphenyl.
< - Constituent not detected above laboratory detection limit shown.
mg/Kg - Milligram per kilogram.
NA - Not analyzed.
NB - No background levels were calculated.
J - Estimated value.
UJ - Constituent was not detected above the reporting limit, detection limit is estimated.
ft bls - Feet below land surface.

Table 3-5. VOC Analytical Results for Groundwater Samples Collected from Upper Aquifer Wells, March 1998, Supplemental RFI, General Motors Corporation, Moraine, Ohio.

Constituents	Units	HR-9 03/06/98	HR-11 03/09/98	GM-24 03/06/98	W-3-N 03/05/98	GM-23 03/09/98	GM-25 03/06/98	HR-1 03/05/98	W-1-S 03/05/98	ME-6 03/09/98	ME-3 03/09/98	HR-17 03/05/98
Volatile Organic Compounds												
1,1,1-Trichloroethane	ug/l	15.0	<1.0	1.1	<1.0	<200J	<1.0	1.5	<1.0	2.4	35.3	1.6J
1,1-Dichloroethane	ug/l	56.2	6.8	<1.0	<1.0	<200J	<1.0	2.1	<1.0	<1.0	13.5	<1.0J
1,1-Dichloroethene	ug/l	<1.0	<1.0	<1.0	<1.0	<200J	<1.0	<1.0	<1.0	<1.0	1.4	<1.0J
1,2-Dichloroethane	ug/l	1.8	<1.0	<1.0	<1.0	<200J	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0J
Benzene	ug/l	<1.0	<1.0	<1.0	<1.0	<200J	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0J
Bromodichloromethane	ug/l	<1.0	<1.0	3.4	<1.0	<200J	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0J
Chloroethane	ug/l	<10	<10	<10	<10	<2000J	<10	<10	<10	<10	<10	<10
Chloroform	ug/l	<1.0	<1.0	15.1	<1.0	<200J	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0J
Ethylbenzene	ug/l	<1.0	<1.0	<1.0	<1.0	<200J	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0J
Fluorotrichloromethane	ug/l	<1.0	<1.0	<1.0	<1.0	<200J	<1.0	3.2	3.7	<1.0	<1.0	<1.0J
Tetrachloroethene	ug/l	<1.0	<1.0	<1.0	2.6	11200J	<1.0	48.8	29.0	193	75.6	7.0J
Trichloroethene	ug/l	14.0	<1.0	<1.0	<1.0	3870J	<1.0	69.8	9.4	456	64.1	4.5J
Vinyl chloride	ug/l	<2.0	<2.0	<2.0	20.4	766J	<2.0	<2.0	<2.0	<2.0	6.2	<2.0J
Xylenes, total	ug/l	<1.0	<1.0	<1.0	<1.0	<200J	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0J
cis-1,2-Dichloroethene	ug/l	20.9	1.4	<1.0	289	3870J	<1.0	10.6	5.0	15.2	36.0	<1.0J
trans-1,2-Dichloroethene	ug/l	2.8	<1.0	<1.0	3.6	<200J	<1.0	2.6	1.2	1.1	<1.0	<1.0J
Total VOCs	ug/l	**110.7**	**8.2**	**19.6**	**315.6**	**19,706**	**0**	**138.6**	**48.3**	**667.7**	**232.1**	**13.1**

ug/l - Micrograms per liter.

J - Value is estimated.

UJ - Constituent was not detected above the reporting limit. Detection limit is estimated.

DUP-56 - Duplicate of GM-8.

DUP-57 - Duplicate of GM-22.

< - Constituent not detected above laboratory detection limit shown.

Table 3-4. Analytical Results for Selected Groundwater Samples Collected in March 1998, General Motors Corporation, Moraine, Ohio.

Constituents	Units	EAST 3/5/98	GM-2 3/4/98	GM-21 3/10/98	GM-22 3/10/98	DUP-57 3/10/98	GM-23 3/9/98	HR-11 3/9/98
Semi-Volatile Organic Compounds	ug/l	ND	ND	ND	ND	ND	ND	ND
Polychlorinated Biphenyls	ug/l	ND	ND	ND	ND	ND	ND	ND
Metals								
Antimony	mg/l	0.0161	<0.0010	<0.0010	0.0012	0.0012	<0.0050	<0.0050
Antimony, Dissolved	mg/l	0.0078	NA	NA	<0.0010	0.001	NA	NA
Arsenic	mg/l	<0.025	<0.0050	<0.0050	<0.0050	<0.0050	<0.025	<0.025
Barium	mg/l	0.117	0.104	0.0808	0.149	0.161	0.161	0.172
Barium, Dissolved	mg/l	0.086	0.0973	0.0634J	0.106J	0.120J	0.0908	0.0944
Beryllium	mg/l	<0.0050	<0.0010	<0.0010	<0.0010	<0.0010	<0.0050	<0.0050
Cadmium	mg/l	<0.0050	<0.0010	<0.0010	0.0012	0.0021	<0.0050	<0.0050
Cadmium, Dissolved	mg/l	NA	NA	NA	<0.0010	<0.0010	NA	NA
Chromium	mg/l	0.066	0.0027U	0.0069	<0.0020	0.0027U	0.018	0.0160U
Chromium, Dissolved	mg/l	<0.0020	<0.0020	<0.0020	NA	<0.0020	<0.0020	<0.0020
Cobalt	mg/l	<0.025	<0.0050	0.0094	<0.0050	<0.0050	<0.025	<0.025
Cobalt, Dissolved	mg/l	NA	NA	<0.0050	NA	NA	NA	NA
Copper	mg/l	<0.025	<0.0050	<0.0050	<0.0050	<0.0050	<0.025	<0.025
Iron	mg/l	7.77	<0.10	1.65	0.680J	0.910J	15.0	10.5
Iron, Dissolved	mg/l	<0.10	NA	<0.10	<0.10	<0.10	<0.10	<0.10
Lead	mg/l	0.0077	<0.0010	0.0011	0.0021	0.003	0.0129	0.0074
Lead, Dissolved	mg/l	<0.0010	NA	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010
Manganese	mg/l	1.00	0.048	0.719	0.143J	0.183J	2.63	0.369
Manganese, Dissolved	mg/l	0.122	<0.010	0.181	0.097	0.096	0.242	0.072
Mercury	mg/l	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002
Nickel	mg/l	0.0560J	0.0056J	0.0100J	0.0589J	0.0624J	0.029	0.027
Nickel, Dissolved	mg/l	0.0062	<0.0050	<0.0050	0.043	0.048	<0.0050	0.0064
Selenium	mg/l	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050
Silver	mg/l	<0.0020	<0.0005	<0.0005	<0.0005	<0.0005	<0.0020	<0.0020
Thallium	mg/l	<0.0050	<0.0010	<0.0010	<0.0010	<0.0010	<0.0050	<0.0050
Tin	mg/l	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0
Vanadium	mg/l	<0.025	<0.0050	<0.0050	<0.0050	<0.0050	<0.025	<0.025
Zinc	mg/l	<0.25	<0.050	<0.050	<0.050	<0.050	<0.25	<0.25

NA	Not analyzed.
ND	Not detected.
mg/l	Milligrams per liter.
ug/l	Micrograms per liter.
J	Value is estimated.
U	Sample result has been qualified as a non-detect due to blank contamination.
DUP-57	Duplicate of GM-22.
<	Constituent not detected above laboratory detection limit shown.

Table 3-5. VOC Analytical Results for Groundwater Samples Collected from Upper Aquifer Wells, March 1998, Supplemental RFI, General Motors Corporation, Moraine, Ohio.

Constituents	Units	EAST 03/05/98	GM-22 03/10/98	DUP-57 03/10/98	GM-21 03/10/98	GM-8 03/04/98	DUP-56 03/04/98	GM-6 03/04/98	GM-2 03/04/98	WSU-24 03/03/98	GM-10 03/03/98	GM-26 03/03/98
Volatile Organic Compounds												
1,1,1-Trichloroethane	ug/l	17.5	<1.0J	<1.0J	55.0	6.7	6.8	36.2	5.9J	1.7	2.3	<1.0
1,1-Dichloroethane	ug/l	6.4	1.3	1.3	7.6	49.3	52.6	35.3	1.7J	<1.0	1.5	<1.0
1,1-Dichloroethene	ug/l	1.3	<1.0J	<1.0J	4.5	1.0	1.1	<1.0	<1.0J	<1.0	<1.0	<1.0
1,2-Dichloroethane	ug/l	<1.0	<1.0J	<1.0J	<1.0J	<1.0	<1.0	<1.0	<1.0J	<1.0	<1.0	<1.0
Benzene	ug/l	<1.0	<1.0UJ	<1.0UJ	<1.0UJ	2.3	2.3	<1.0	<1.0UJ	<1.0	<1.0	<1.0
Bromodichloromethane	ug/l	<1.0	<1.0J	<1.0J	<1.0J	<1.0	<1.0	<1.0	<1.0J	<1.0	<1.0	<1.0
Chloroethane	ug/l	<10	<10UJ	<10UJ	<10UJ	16.2	16.8	<10	<10UJ	<10	<10	<10
Chloroform	ug/l	<1.0	<1.0J	<1.0J	<1.0J	<1.0	<1.0	<1.0	<1.0J	<1.0	<1.0	<1.0
Ethylbenzene	ug/l	<1.0	<1.0UJ	<1.0UJ	<1.0UJ	28.9	27.6	<1.0	<1.0UJ	<1.0	<1.0	<1.0
Fluorotrichloromethane	ug/l	<1.0	<1.0J	<1.0J	4.9	<1.0	<1.0	<1.0	<1.0J	<1.0	<1.0	<1.0
Tetrachloroethene	ug/l	66.2	5.1	5.0	<1.0J	20.0	19.7	94.0	8.5J	1.3	1.5	<1.0
Trichloroethene	ug/l	64.0	4.5	4.6	356	95.2	96.8	119	75.1J	14.2	28.0	<1.0
Vinyl chloride	ug/l	<2.0	<2.0J	<2.0J	<2.0J	10.1	10.7	2.3	<2.0J	<2.0	<2.0	<2.0
Xylenes, total	ug/l	<1.0	<1.0UJ	<1.0UJ	<1.0UJ	10.3	10.2	<1.0	<1.0UJ	<1.0	<1.0	<1.0
cis-1,2-Dichloroethene	ug/l	13.9	1.6	<1.0J	74.5	56.1	57.1	82.4	10.5J	<1.0	3.6	<1.0
trans-1,2-Dichloroethene	ug/l	6.4	<1.0J	<1.0J	3.6	10.1	10.6	2.4	<1.0J	<1.0	<1.0	<1.0
Total VOCs	ug/l	**175.7**	**12.5**	**10.9**	**506.1**	**306.2**	**312.3**	**371.6**	**101.7**	**17.2**	**36.9**	**0**

ug/l - Micrograms per liter.

J - Value is estimated.

UJ - Constituent was not detected above the reporting limit. Detection limit is estimated.

DUP-56 - Duplicate of GM-8.

DUP-57 - Duplicate of GM-22.

< - Constituent not detected above laboratory detection limit shown.

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Table 3-6. Analytical Results for Soil Samples, AOI 36-Former Southwest ASTs, February 1998, General Motors Corporation, Moraine, Ohio.

		AST-BH1		AST-BH2		
		2/19/98		2/19/98		
Constituents	Units	2 ft bls	22 ft bls	2 ft bls	24 ft bls	DUP-53
Volatile Organic Compounds						
Tetrachloroethene	ug/kg	<6.0	6	<6.1	<5.6	<5.5
Trichloroethene	ug/kg	<6.0	6.5	<6.1	<5.6	5.9
Semi-volatile Organic Compounds						
Bis(2-ethylhexyl)phthalate	ug/kg	<393	1,230	<403	<370	<360
Polychlorinated Biphenyls	mg/kg	ND	ND	ND	ND	ND
Metals						
Antimony	mg/kg	<19J	<17J	<19.8J	<15J	<16J
Arsenic	mg/kg	325	1.57	150	8.19J	0.639J
Barium	mg/kg	86J	11J	65.2J	11J	12J
Beryllium	mg/kg	0.8	<0.9	0.9	0.8	0.9
Cadmium	mg/kg	<1.2	<5.2	<1.2	<4.4	<4.9
Chromium	mg/kg	11	<6.9	11	<5.8	<6.5
Cobalt	mg/kg	7.9	<3.4	6.4	<2.9	<3.3
Copper	mg/kg	25.5	6.9	18.7	6.6	8.9
Lead	mg/kg	17.1	3.27	16.4	5.23	4.77
Manganese	mg/kg	619	123	494	152	192
Mercury	mg/kg	0.033J	<0.011J	0.032J	<0.011J	<0.011J
Nickel	mg/kg	17.4	4.3	13.1	4.4	5.3
Selenium	mg/kg	0.798J	<0.888J	0.808J	0.941J	<0.907J
Silver	mg/kg	<1.5	<6.9	<1.6	<5.8	<6.5
Thallium	mg/kg	<0.60	<0.54	<0.61	0.633	<0.55
Vanadium	mg/kg	20.1	<8.6	14.3	<7.3	<8.2
Zinc	mg/kg	67.9J	17.9J	63.6J	18.3J	20.5J

ug/kg - Micrograms per kilogram.
mg/kg - Milligrams per kilogram.
J - The reported value is estimated.
ND - Not detected.
DUP-53 - Duplicate of AST-BH2-24/SL.
< - Constituent not detected above laboratory detection limit shown.

ft bls - Feet below land surface.

Table 3-7. Analytical Results for Soil Samples Near AOI 36-Former Southwest ASTs, June 1998, General Motors Corporation, Moraine, Ohio.

Constituents	Units	Soil Area A Composite 6/10/98	Soil Area A DUP-59 6/10/98	Soil Area B Composite 6/10/98	Soil Area C Composite 6/10/98	Soil Area D Composite 6/11/98	Berm Area E Composite 6/10/98	Berm Area F Composite 6/10/98	Berm Area G Composite 6/10/98
Arsenic	mg/Kg	20.1J	41.6J	37.3	33.4	10	5.33	64.9	94.6

J - Value is estimated.
mg/Kg - Milligram per kilogram.
DUP-59 - Duplicate of composite sample A.
Soil Area A composite sample consists of A-GS1 through A-GS4.
Soil Area B composite sample consists of B-GS5 through B-GS8.
Soil Area C composite sample consists of C-GS9 through C-GS12.
Soil Area D composite sample consists of D-GS13 through D-GS16.
Berm Area E composite sample consists of E-GS17 through E-GS21.
Berm Area F composite sample consists of F-GS22 through F-GS26.
Berm Area G composite sample consists of G-GS27 through G-GS32.
Soil area samples were collected in the 0-2 foot interval within native soil and berm area samples were collected 1-1.5 feet into the berm.

Table 4-1. Water-Level Measurements During the Supplemental RFI, March 1998, General Motors Corporation, Moraine, Ohio.

Well	Measuring Point Elevation	Depth-to-Water (feet)	Water-Level Elevation
Shallow Aquifer Wells			
W-1-N	739.02	32.72	706.30
W-2-N	731.68	26.02	705.66
W-3-N	733.66	28.17	705.49
W-4-N	731.63	26.15	705.48
HR-1	732.71	28.77	703.94
HR-2	734.75	29.26	705.49
HR-3	736.75	31.29	705.46
HR-4	742.6	36.50	706.10
HR-5	734.27	29.21	705.06
HR-6	732.66	28.31	704.35
HR-7	731.73	26.55	705.18
HR-8	743.42	37.04	706.38
HR-9	743.51	36.58	706.93
HR-11	743.33	36.59	706.74
HR-16	727.01	23.48	703.53
HR-17	726.43	22.72	703.71
W-1-S	729.29	25.50	703.79
W-2-S	726.64	23.72	702.92
W-3-S	733.42	30.60	702.82
W-4-S	727.68	24.81	702.87
GM-2	735.81	33.01	702.80
4S	731.36	28.82	702.54
GM-6	730.27	28.13	702.14
GM-8	735.17	32.71	702.46
GM-10	723.9	21.99	701.91
GM-16	725.3	23.15	702.15
GM-17	723.84	21.62	702.22
GM-18	723.8	21.65	702.15
GM-19S	730.85	27.67	703.18
GM-26	722.29	20.70	701.59
EAST	730.98	27.42	703.56
WEST	731.08	27.62	703.46
WSU-24	725.1	22.35	702.75
TW-2 (1)	733.38	33.25	700.13
GM-21	724.2	20.49	703.71

Table 4-1. Water-Level Measurements During the Supplemental RFI, March 1998, General Motors Corporation, Moraine, Ohio.

Well	Measuring Point Elevation	Depth-to-Water (feet)	Water-Level Elevation
GM-22	728.28	24.57	703.71
GM-23	730.99	25.32	705.67
GM-24	747.29	40.06	707.23
GM-25	746.17	40.83	705.34
ME-1	728.06	24.17	703.89
ME-2	728.4	24.56	703.84
ME-3	728.09	24.28	703.81
ME-4	728.31	24.57	703.74
ME-5	728.29	24.87	703.42
ME-6	728.34	24.52	703.82
Deep Aquifer Wells			
GM-1	735.74	33.29	702.45
GM-3	730.44	28.58	701.86
GM-4	731.46	29.62	701.84
GM-5	731.29	29.20	702.09
GM-7R	735.61	33.22	702.39
GM-9	724.07	22.71	701.36
GM-11	723.71	22.61	701.10
GM-13	723.82	23.35	700.47
GM-14	723.5	23.15	700.35
GM-15	725.23	25.10	700.13
GM-19D	730.25	27.85	702.40
GM-20D	727.26	24.80	702.46
HR-10	742.81	35.87	706.94
HR-12	742.64	35.80	706.84
HR-13	735.03	29.58	705.45
HR-14	731.63	26.21	705.42
HR-15	733.74	28.44	705.30
M73C	716.55	16.13	700.43
MT68	746.45	41.80	704.65
MT69	722.71	21.34	701.37
MT576M	751.46	45.13	706.33
MT596M*	757.73	50.20	707.53

Table 4-1. Water-Level Measurements During the Supplemental RFI, March 1998, General Motors Corporation, Moraine, Ohio.

Well	Measuring Point Elevation	Depth-to-Water (feet)	Water-Level Elevation
Production and Fire Wells			
32	732.1	23.79	703.31
35	733.96	(29.54)	704.42
37	731.24	NA (bolted shut)	NA
42	731.62	27.92	703.70
44	734.62	28.57	706.05
45	731.03	28.50	702.53
46	733.34	30.67	702.67
A	739	32.63	706.38
12A	742.35	40.83	701.52
FW-1	740.9	34.42	706.48
FW-2	737.48	32.92	704.56
FW-3	739.26	NA	NA
FW-4	731.62	28.35	703.27

Measuring point is to top of the PVC Casing.

Water-level elevations are reported in feet above mean sea level (msl).

Depth-to-water elevations were measured on March 11 and 12, 1998 using an electronic water level indicator except for HR-9 which was collected on March 16, 1998.

Depth-to-water measurements are reported in feet below the measuring point.

1. TW-2 is an active recovery well.

NA - Not accessible.

( ) - Probable measurement error.

*Measuring point is top of cement housing.

Table 4-2. Vertical Gradients For Shallow/Deep Well Pairs, March 11-12 1998, General Motors Corporation, Moraine, Ohio

Shallow/Deep Wells Pairs	Vertical Gradient	
	Direction	Magnitude
Upgradient		
HR-9/HR-10	U[(1)]	0.01
HR-11/HR-12	U	0.10
On-Site		
W-3-N/HR-15	D	-0.19
W-4-N/HR-14	D	-0.06
HR-3/HR-13	D	-0.01
4S/GM-5	D	-0.45
GM-8/GM-7R	D	-0.07
GM-16/GM-15	D	-2.02
GM-2/GM-1	D	-0.35
GM-18/GM-13	D	-1.68
GM-17/GM-11	D	-1.12
GM-6/GM-3	U	2.72
Downgradient		
GM-10/GM-9	D	-0.55
GM-26/MT-69	D	-0.22

D Downward gradient (-).
U Upward gradient (+).

(1) Water-level measurement for HR-9 could not be collected on March 11-12, 1998 therefore, water-level measurements from March 16, 1998 sampling event was used to conduct this evaluation.

Table 4-3. VOC Analytical Results for Groundwater Samples Collected from Lower Aquifer Wells, March 1998, General Motors Corporation, Moraine, Ohio.

Constituents	Units	HR-12 03/09/98	DUP-58 03/09/98	HR-13 03/10/98	GM-1 03/04/98	GM-20D 03/02/98	GM-9 03/03/98	MT-69 03/02/98
Volatile Organic Compounds								
1,1,1-Trichloroethane	ug/l	<1.0	<1.0	1.3	2.1	<1.0	<1.0	<1.0
1,1-Dichloroethane	ug/l	2.5	2.5	48.3	<1.0	<1.0	1.2	<1.0
Tetrachloroethene	ug/l	<1.0	<1.0	<1.0UJ	4.0	<1.0	<1.0	<1.0
Trichloroethene	ug/l	<1.0	<1.0	2.8	52.1	<1.0	7.7	<1.0
Vinyl chloride	ug/l	2.7	2.7	<2.0UJ	<2.0	<2.0	<2.0	<2.0
cis-1,2-Dichloroethene	ug/l	2.4	2.4	23.3	<1.0	<1.0	2.1	<1.0
trans-1,2-Dichloroethene	ug/l	<1.0	<1.0	3.3	<1.0	<1.0	<1.0	<1.0
Total VOCs		7.6	7.6	79	58.2	0	11	0

ug/l - Micrograms per liter.

UJ - Constituent was not detected. Detection limit is estimated.

ND - Not detected.

DUP-58 - Duplicate of HR-12.

Table 4-4. Bioattenuation Parameter Results in Upper Aquifer Monitor Wells March 1998, General Motors Corporation, Moraine, Ohio.

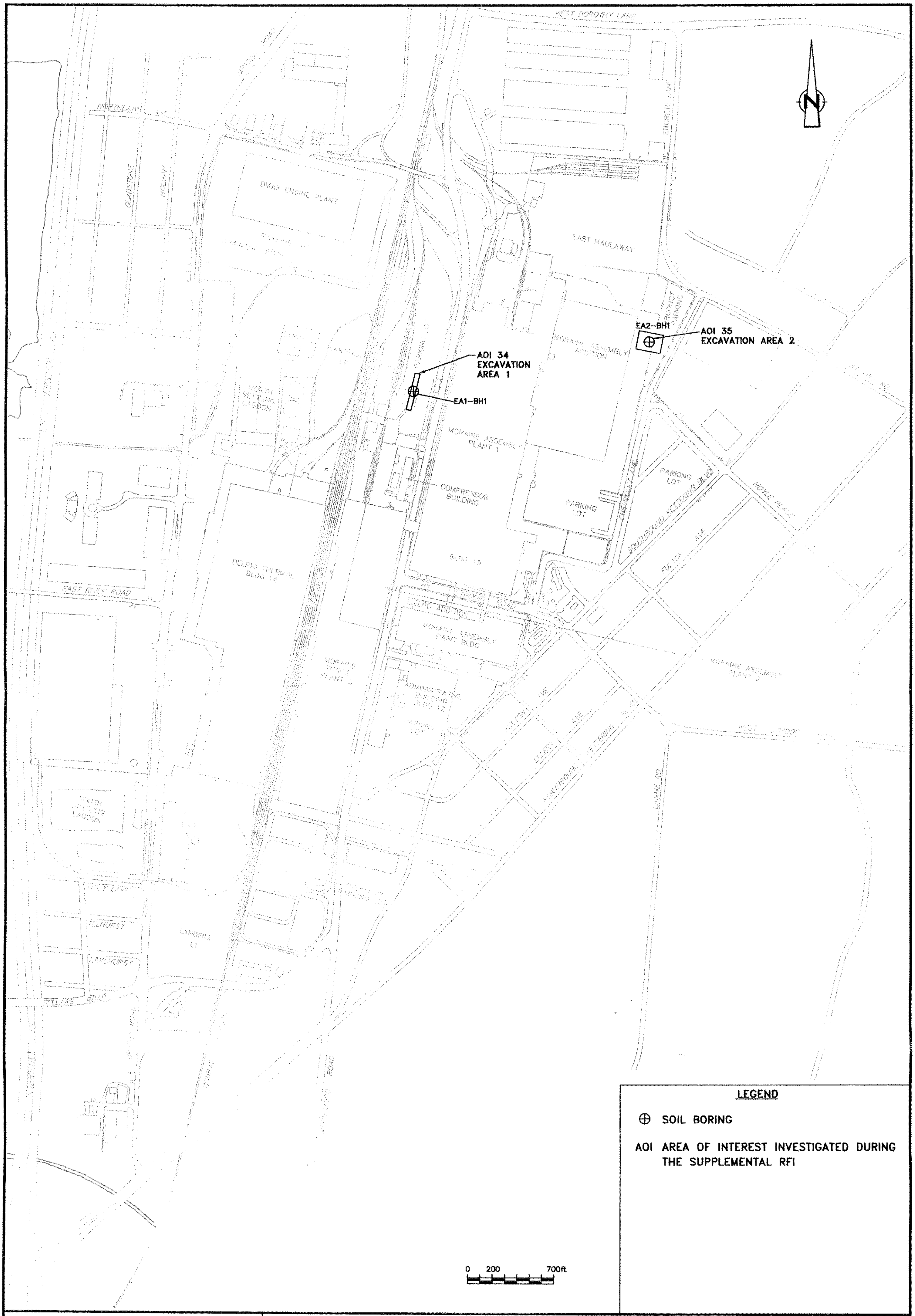
COMPOUND	UNITS	UPGRADIENT WELLS			SIDE-GRADIENT WELL	ON-SITE WELLS						
		HR-9 3/6/98	HR-11 3/9/98	GM-24 3/6/98	GM-25 3/6/98	W-3-N 3/5/98	GM-23 3/9/98	HR-1 3/5/98	ME-6 3/9/98	ME-3 3/9/98	W-1-S 3/5/98	HR-17 3/5/98
Inorganics & TOC												
Nitrate	mg/l	8.8	8.8	13.2	<4.4	<4.4	17.6	13.2	22.0	<4.4	13.2	13.2
Nitrite	mg/l	<0.033	<0.033	<0.033	<0.033	<0.033	<0.033	<0.033	<0.033	<0.033	<0.033	<0.033
Nitrogen, Ammonia	mg/l	<0.300	0.940	<0.300	<0.300	<0.300	<0.300	<0.300	<0.300	0.500	<0.300	<0.300
Manganese (Total)	mg/l	0.152	0.369	<0.01	0.310	0.089	2.63	<0.01	0.094	0.237	0.530	<0.01
Manganese (Dissolved)	mg/l	0.107	0.072	ns	0.058	0.083	0.242	ns	<0.01	0.050	0.011	ns
Iron (Total)	mg/l	1.37	10.5	<0.1	18.9	11.1	15.0	0.450	1.45	1.81	0.340	<0.1
Iron (Dissolved)	mg/l	<0.1	<0.1	ns	4.10	4.44	<0.1	<0.1	0.140	<0.1	<0.1	ns
Iron (Ferrous)	mg/l	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
Sulfate	mg/l	49.0	97.0	61.0	80.0	110	77.0	80.0	165	166	105	69.0
Sulfide	mg/l	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
Total Organic Carbon	mg/l	1.00	3.00	<1	<1	2.00	8.00	2.00	<1	6.00	2.00	1.00
Chloride	mg/l	103	101	111	82.0	99.0	51.0	104	211	271	164	309
Permanent Gases												
Carbon Dioxide	mg/l	64.1	122.6	5.6	45.4	47.2	72.0	58.9	58.5	72.3	48.0	34.3
Oxygen	mg/l	1.81	1.37	8.15	1.23	3.68	1.24	1.95	2.38	1.12	2.11	4.00
Nitrogen	mg/l	26.4	21.4	18.5	23.4	24.5	19.4	20.1	16.2	16.8	23.5	18.9
Methane	mg/l	0.162931	0.012077	0.000463	0.001478	0.082004	0.079487	0.000380	0.000367	0.151422	0.000793	0.00052
Carbon Monoxide	mg/l	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4
Light Hydrocarbon Scan												
Ethane	ug/l	22.014	0.750	0.030	0.067	0.073	2.932	0.033	0.011	0.091	0.019	0.007
Ethene	ug/l	<0.005	<0.005	0.006	0.014	0.199	84.070	0.006	0.009	0.030	0.010	0.005
Field Parameters												
pH	S.U.	6.84	6.77	7.52	7.05	7.07	6.98	6.98	6.99	6.93	6.95	7.05
ORP	mV	30.90	121.70	42.50	-198.90	-87.30	92.70	47.40	118.60	119.40	79.30	104.10
Temperature	°C	15.88	16.04	17.18	18.38	15.16	17.77	20.65	22.53	23.46	15.87	14.01
Dissolved Oxygen	mg/L	0.20	0.21	5.15	0.14	0.17	0.42	0.40	1.23	0.27	0.44	2.07
Specific Conductance	umhos/cm	1,281	1,664	851	1,219	1,274	1,069	1,263	1,976	2,244	1,453	1,777

Table 4-4. Bioattenuation Parameter Results in Upper Aquifer Monitor Wells March 1998, General Motors Corporation, Moraine, Ohio.

COMPOUND	UNITS	ON-SITE WELLS								DOWNGRADIENT WELLS		
		EAST 3/5/98	GM-22 3/10/98	DUP-57 3/10/98	GM-21 3/10/98	GM-8 3/4/98	DUP-56 3/4/98	GM-6 3/4/98	GM-2 3/4/98	GM-10 3/3/98	GM-26 3/3/98	WSU-24 3/3/98
Inorganics & TOC												
Nitrate	mg/l	17.6	<4.4	<4.4	17.6	<4.4	<4.4	<4.4	22.0	22.0	17.6	22.0
Nitrite	mg/l	0.066	<0.033	<0.033	0.066	<0.033	<0.033	<0.033	<0.033	<0.033	<0.033	<0.033
Nitrogen, Ammonia	mg/l	<0.300	<0.300	<0.300	<0.300	1.69	1.77	<0.300	<0.300	<0.300	<0.300	<0.300
Manganese (Total)	mg/l	1.00	0.143	0.183	0.719	0.204	0.214	1.07	0.048	0.033	0.056	<0.01
Manganese (Dissolved)	mg/l	0.122	0.097	0.096	0.181	0.229	0.218	1.00	<0.01	0.010	0.032	ns
Iron (Total)	mg/l	7.77	0.680	0.910	1.65	1.01	1.08	1.32	<0.1	<0.1	0.500	<0.1
Iron (Dissolved)	mg/l	<0.1	<0.1	<0.1	<0.1	1.22	1.18	<0.1	ns	ns	<0.1	ns
Iron (Ferrous)	mg/l	<0.2	<0.2	<0.2	<0.2	<0.2	0.8	<0.2	<0.2	<0.2	<0.2	<0.2
Sulfate	mg/l	80.0	84.0	92.0	123	59.0	52.0	93.0	54.0	48.0	44.0	49.0
Sulfide	mg/l	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
Total Organic Carbon	mg/l	2.00	3.00	3.00	2.00	7.00	8.00	3.00	<1	<1	<1	<1
Chloride	mg/l	267	296	280	119	248	246	227	200	140	92.0	106
Permanent Gases												
Carbon Dioxide	mg/l	50.5	41.8	45.6	41.2	15.8	15.9	47.4	41.0	38.2	24.9	38.6
Oxygen	mg/l	1.77	1.10	1.55	1.57	1.10	1.37	1.57	3.12	2.54	5.14	8.12
Nitrogen	mg/l	22.2	19.1	23.2	22.4	19.7	20.9	20.5	21.1	18.4	19.6	18.2
Methane	mg/l	0.007093	0.110000	0.090000	0.003020	1.480000	1.550000	0.008337	0.000255	0.001694	0.001746	0.000241
Carbon Monoxide	mg/l	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4
Light Hydrocarbon Scan												
Ethane	ug/l	0.027	0.115	0.115	0.054	0.370	0.423	0.047	0.009	0.008	0.017	<0.005
Ethene	ug/l	0.019	0.066	0.075	0.016	12.233	14.483	0.091	0.005	0.008	<0.005	<0.005
Field Parameters												
pH	S.U.	6.96	7.12	7.12	7.13	7.70	7.70	7.00	7.01	7.16	7.32	7.10
ORP	mV	-80.80	150.40	150.40	137.50	-145.00	-145.00	57.60	126.70	143.70	142.10	157.00
Temperature	°C	18.46	18.76	18.76	15.54	17.53	17.53	18.49	14.63	15.69	12.63	14.44
Dissolved Oxygen	mg/L	0.20	0.25	0.25	0.38	0.16	0.16	0.88	1.38	0.96	2.84	3.63
Specific Conductance	umhos/cm	1,777	2,721	2,721	1,884	1,539	1,539	1,422	1,191	1,424	1,144	1,303

ns	Not sampled.
mg/L	Milligrams per liter.
ug/L	Micrograms per liter.
S.U.	Standard units.
mV	Millivolts.
°C	Degrees Celsius.
umhos/cm	Micro-mohs/centimeter.

DUP-56 - Duplicate of GM-8.
DUP-57 - Duplicate of GM-22.
*HR-11 is upgradient and GM-23 is located within the suspected center of AOI-7 Former Oil House.
GM-22 is upgradient and, GM-21 and EAST are downgradient of AOI-13 Buildings 4, 6, and 13.
GM-22 is upgradient and GM-21 is downgradient of AOI-7 Building 15.
GM-21 is upgradient and GM-2 is downgradient of AOI-36 Former Southwest ASTs.



LEGEND

⊕ SOIL BORING

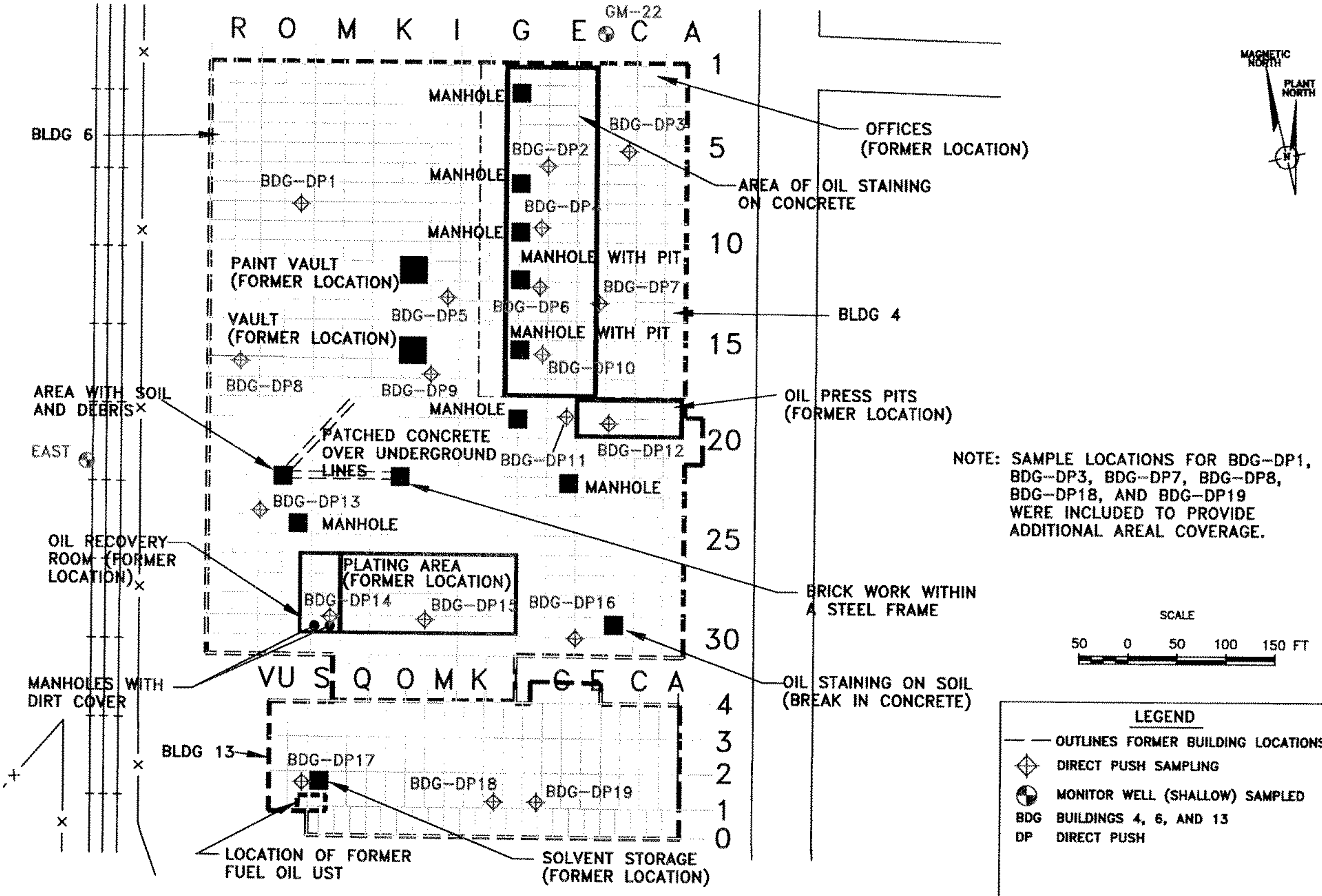
AOI AREA OF INTEREST INVESTIGATED DURING THE SUPPLEMENTAL RFI

ARCADIS GERAGHTY&MILLER

6397 Emerald Parkway
Suite 150, Dublin, OH 43016
Tel: 614/764-2310 Fax: 614/764-1270

BORING LOCATIONS FOR AOI 34-EXCAVATION AREA 1 AND AOI 35-EXCAVATION AREA 2
GENERAL MOTORS CORPORATION
MORAINE, OHIO

DATE 27APR99	PROJECT MANAGER J. REID	DRAWING NAME HAR\CRA\\OH294-04
DRAWN R. SMITH	LEAD DESIGN PROF.	CHECKED N. GILLOTTI
PROJECT NUMBER OH000294.0001.0002		FIGURE NUMBER 3-1



NOTE: SAMPLE LOCATIONS FOR BDG-DP1, BDG-DP3, BDG-DP7, BDG-DP8, BDG-DP18, AND BDG-DP19 WERE INCLUDED TO PROVIDE ADDITIONAL AREAL COVERAGE.

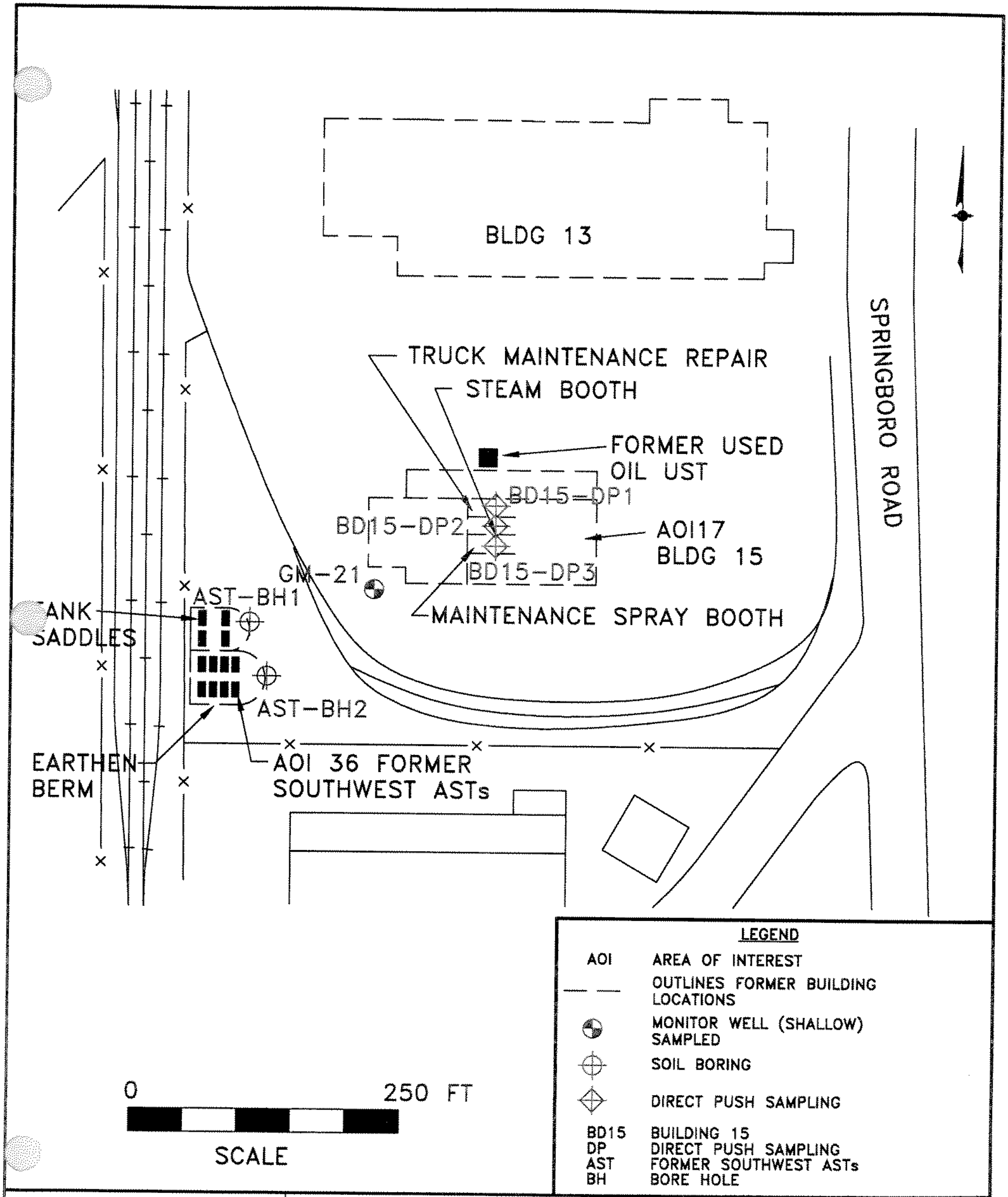
LEGEND

— —	OUTLINES FORMER BUILDING LOCATIONS
⌖	DIRECT PUSH SAMPLING
◉	MONITOR WELL (SHALLOW) SAMPLED
BDG	BUILDINGS 4, 6, AND 13
DP	DIRECT PUSH

ARCADIS GERAGHTY&MILLER

**DIRECT PUSH SOIL SAMPLE LOCATIONS FOR AOI 13. BUILDINGS 4, 6, AND 13
GENERAL MOTORS CORPORATION
MORAINE, OHIO**

DATE MAR99	PROJECT MANAGER N. GILLOTTI	DRAWING NAME NB\SUP\X3ARFI
DRAWN R. SMITH	LEAD DESIGN PROF. J. REID	CHECKED B. FERGUSON
PROJECT NUMBER 0H000294.0001.0002		FIGURE NUMBER 3-2

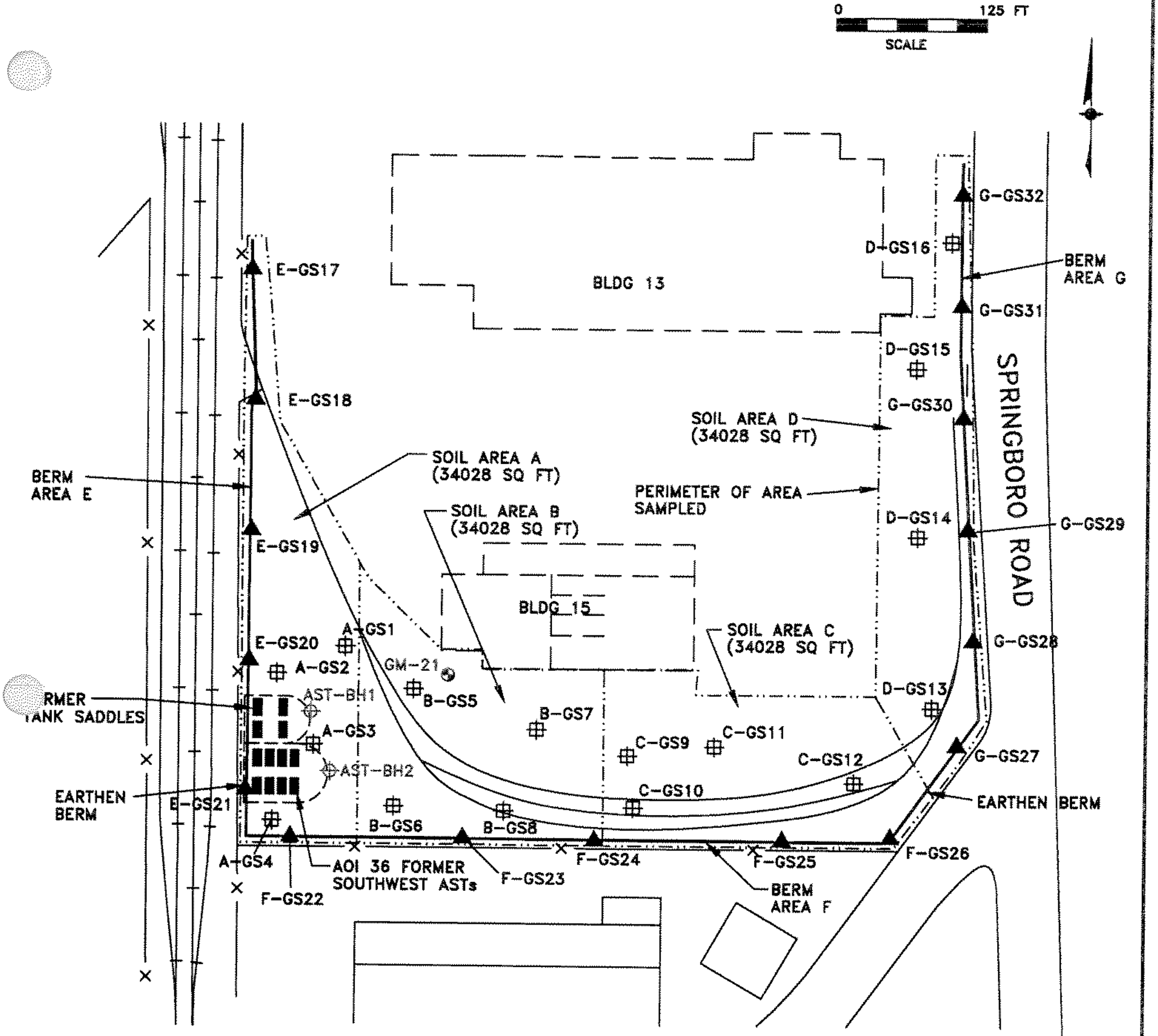


ARCADIS GERAGHTY&MILLER

4700 Lakehurst Court
Suite 100, Dublin, OH 43016
Tel: 614/764-2310 Fax: 614/764-1270

DIRECT PUSH SOIL SAMPLING LOCATIONS
FOR AOI 17 – BUILDING 15 AND SOIL BORING
LOCATIONS FOR AOI 36 – FORMER SOUTHWEST ASTs
GENERAL MOTORS CORPORATION
MORAINE, OHIO

DATE MAR99	PROJECT MANAGER N. GILLOTTI	DRAWING NAME NB\SUP\AOI36RF1
DRAWN R. SMITH	LEAD DESIGN PROF.	CHECKED N. GILLOTTI
PROJECT NUMBER 0H000294.0001.00002		FIGURE NUMBER 3-3



SOIL AREA A COMPOSITE SAMPLE CONSISTED OF A-GS1 THROUGH A-GS4.

SOIL AREA B COMPOSITE SAMPLE CONSISTED OF B-GS5 THROUGH B-GS8.

SOIL AREA C COMPOSITE SAMPLE CONSISTED OF C-GS9 THROUGH C-GS12.

SOIL AREA D COMPOSITE SAMPLE CONSISTED OF D-GS13 THROUGH D-GS16.

BERM AREA E COMPOSITE SAMPLE CONSISTED OF E-GS17 THROUGH E-GS21.

BERM AREA F COMPOSITE SAMPLE CONSISTED OF F-GS22 THROUGH F-GS26

ERM AREA G COMPOSITE SAMPLE CONSISTED OF G-GS27 THROUGH G-GS32

LEGEND

AOI	AREA OF INTEREST
— —	OUTLINES FORMER BUILDING LOCATIONS
⊛	MONITOR WELL (SHALLOW) SAMPLED
⌖	SUPPLEMENTAL RFI SOIL BORING
⊞	HAND AUGER SAMPLE LOCATION
▲	HAND AUGER BERM SAMPLE LOCATION
GS	GRAB SAMPLE
BH	BORE HOLE

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Suite 100, Dublin, OH 43016
Tel: 614/764-2310 Fax: 614/764-1270

HAND AUGER SOIL SAMPLING
LOCATIONS FOR AOI 36 - FORMER
SOUTHWEST ASTs
GENERAL MOTORS CORPORATION
MORAINE, OHIO

DATE MAR99	PROJECT MANAGER J. REID	DRAWING NAME AOI36-9
DRAWN R. SMITH	LEAD DESIGN PROF. J. REID	CHECKED N. GILLOTTI
PROJECT NUMBER OH000294.001.002		DRAWING NUMBER 3-4

ARCADIS GERAGHTY&MILLER

Supporting Information:
Supplemental RFI Report
AOI 7-Former Oil House Area
April 2000

Table 3-8. Analytical Results for Soil Samples, AOI 7-Former Oil House Area, February 1998, General Motors Corporation, Moraine, Ohio.

		OH-BH1/SL				OH-BH2/SL			OH-BH3/SL		
		2/23/98				2/20/98			2/23/98		
Constituents	**Units**	**2 ft bls**	**8 ft bls**	**30 ft bls**	**DUP-55**	**3 ft bls**	**31 ft bls**	**DUP-54**	**2 ft bls**	**16 ft bls**	**26 ft bls**
Volatile Organic Compounds											
Tetrachloroethene	ug/kg	53.7	125	505	377	56.4	7,690	9,290	41.4	29.3	247
Trichloroethene	ug/kg	<5.2	<5.2	<53	<53	<5.3	<530	<520	<5.4	<5.2	521
Semi-volatile Organic Compounds											
Fluoranthene	ug/kg	<342	<344	<350	<347	4,570	<347	<346	<357	<346	<363
Phenanthrene	ug/kg	<342	<344	<350	<347	3,770	<347	<346	<357	<346	<363
Polychlorinated Biphenyls	mg/kg	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Metals											
Antimony	mg/kg	<17J	<17J	<17J	<20J	<18	<16	<17	<16J	<17J	<14J
Arsenic	mg/kg	2.76J	1.93J	1.53J	3.01J	2.09J	1.49	0.561J	10.4J	3.88J	2.51J
Barium	mg/kg	11	8.3	8.1	11	30.2J	11J	9.6J	30.2	14	16
Beryllium	mg/kg	1	<0.8	0.8	<1	1.1	0.9	0.9	1	0.9	0.9
Cadmium	mg/kg	<5.1	<5.1	<5.0	<6.1	<5.3	<4.8	<4.9	<4.9	<5.1	<4.3
Chromium	mg/kg	8.6	<6.9	<6.7	<8.2	<7.0	<6.4	<6.6	<6.5	<6.8	<5.7
Cobalt	mg/kg	<3.4	<3.4	<3.4	<4.1	<3.5	<3.3	<3.2	3.9	4.1	<2.9
Copper	mg/kg	3.9	7	5.5	7.4	6	7.4	7.5	12	13	7.5
Lead	mg/kg	3.67	2.72	3.55J	6.39J	5.47	4.11	4.14	9.39	4.36	4.8
Manganese	mg/kg	142	220	161J	2.88J	227	184	188	302	331	190
Mercury	mg/kg	<0.010	0.012	<0.011	<0.011	0.029	<0.011	<0.010	0.052	0.014	0.014
Nickel	mg/kg	25.2	5.8	4	6	4.3	5.9	4.9	8.5	14	6.6
Selenium	mg/kg	<1.66	<1.62	<0.881	<1.67	<1.57J	<1.67J	<0.780J	<0.805	<0.819	<0.860
Silver	mg/kg	<6.7	<6.9	<6.7	<8.2	<7.0	<6.4	<6.6	<6.5	<6.8	<5.7
Thallium	mg/kg	<0.52	<0.52	<0.53	<0.53	<0.53	<0.53	<0.52	<0.54	<0.52	<0.55
Vanadium	mg/kg	<8.5	<8.5	<8.4	<10	<8.8	<8.0	<8.2	<8.1	<8.5	<7.1
Zinc	mg/kg	16J	17.6J	16J	19J	26.2J	19J	18.6J	42.6J	227J	22.6J

ug/kg - Micrograms per kilogram.
mg/kg - Milligrams per kilogram.
J - The reported value is estimated.
ND - Not detected.
DUP-55 - Duplicate of OH-BH1-30/SL.

DUP-54 - Duplicate of OH-BH2-31/SL.
SL - Soil.
< - Constituent not detected above laboratory detection limit shown.
ft bls - Feet below land surface.

Table 3-8. Analytical Results for Soil Samples, AOI 7-Former Oil House Area, February 1998, General Motors Corporation, Moraine, Ohio.

		OH-BH4/SL 2/23/98		
Constituents	**Units**	**2 ft bls**	**8 ft bls**	**24 ft bls**
Volatile Organic Compounds				
Tetrachloroethene	ug/kg	123	113	474
Trichloroethene	ug/kg	20.6	<5.5	<55
Semi-volatile Organic Compounds				
Fluoranthene	ug/kg	<350	<363	<363
Phenanthrene	ug/kg	<350	<363	<363
Polychlorinated Biphenyls	mg/kg	ND	ND	ND
Metals				
Antimony	mg/kg	<17J	<18J	<18J
Arsenic	mg/kg	3.54J	3.91J	2.59J
Barium	mg/kg	13	7.7	24.3
Beryllium	mg/kg	0.8	<0.9	<0.9
Cadmium	mg/kg	<5.0	<5.3	<5.3
Chromium	mg/kg	<6.6	<7.0	<7.0
Cobalt	mg/kg	<3.3	<3.5	<3.5
Copper	mg/kg	6.1	6.8	7
Lead	mg/kg	6.06	4.36	4.56
Manganese	mg/kg	159	151	178
Mercury	mg/kg	0.013	<0.011	0.014
Nickel	mg/kg	5.6	5.6	5.4
Selenium	mg/kg	<0.863	<0.890	<0.786
Silver	mg/kg	<6.6	<7.0	<7.0
Thallium	mg/kg	<0.53	<0.55	<0.55
Vanadium	mg/kg	<8.3	<8.8	<8.7
Zinc	mg/kg	22J	26J	27.8J

ug/kg - Micrograms per kilogram.
mg/kg - Milligrams per kilogram.
J - The reported value is estimated.
ND - Not detected.
DUP-55 - Duplicate of OH-BH1-30/SL.

DUP-54 - Duplicate of OH-BH2-31/SL.
SL - Soil.
< - Constituent not detected above laboratory detection limit shown.
ft bls - Feet below land surface.

Table 3-9. Analytical Results for Soil Samples, AOI 7-Former Oil House Area, August 1998, General Motors Corporation, Moraine, Ohio.

Constituents	Units	OH-BH5/SL 8/14/98			OH-BH6/SL 8/12/98				OH-BH7/SL 8/10/98			OH-BH8/SL 8/18/98		
		2 ft bls	20 ft bls	26 ft bls	2 ft bls	DUP-60	8 ft bls	24 ft bls	2 ft bls	20 ft bls	24 ft bls	2 ft bls	18 ft bls	28 ft bls
Volatile Organic Compounds														
1,1-Dichloroethane	ug/kg	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0
1,1-Dichloroethene	ug/kg	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0
trans-1,2-Dichloroethene	ug/kg	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0
cis-1,2-Dichloroethene	ug/kg	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0
Tetrachloroethene	ug/kg	<5.0	135	762J	554	500	38.9	119J	31.4	482	325	16.0	70.0	36.3
1,1,1-Trichloroethane	ug/kg	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	6,010
Trichloroethene	ug/kg	<5.0	6.1	22.5	12.7	8.3	<5.0	5.8J	<5.0	5.1	<5.0	<5.0	<5.0	<5.0
Vinyl Chloride	ug/kg	<10.0	<10.0	<10.0	<10.0	<10.0	<10.0	<10.0	<10.0	<10.0	<10.0	<10.0	<10.0	73.5
Total VOCs	ug/kg	0.0	141.1	784.5	566.7	508.3	38.9	124.8	31.4	487.1	325	16.0	70.0	6,119.8

ug/kg - Micrograms per kilogram.
SL - Soil.
J - The reported value is estimated.
DUP-60 - Duplicate of OH-BH6-2/SL.
DUP-62 - Duplicate of OH-BH9-30/SL.
< - Constituent not detected above laboratory detection limit shown.
ft bls - Feet below land surface.

Table 3-9. Analytical Results for Soil Samples, AOI 7-Former Oil House Area, August 1998, General Motors Corporation, Moraine, Ohio.

		OH-BH9/SL 8/19/98			OH-BH10/SL 8/18/98			GM-27/SL 8/4/98			GM-28/SL 8/5/98
Constituents	**Units**	**2 ft bls**	**30 ft bls**	**DUP-62**	**2 ft bls**	**16 ft bls**	**28 ft bls**	**2 ft bls**	**20 ft bls**	**24 ft bls**	**26 ft bls**
Volatile Organic Compounds											
1,1-Dichloroethane	ug/kg	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0
1,1-Dichloroethene	ug/kg	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0
trans-1,2-Dichloroethene	ug/kg	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0
cis-1,2-Dichloroethene	ug/kg	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	6.0	<5.0
Tetrachloroethene	ug/kg	280	462J	619	548	235J	995	40.3	743	1,510J	27.0J
1,1,1-Trichloroethane	ug/kg	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0
Trichloroethene	ug/kg	<5.0	<5.0	<5.0	24.7	<5.0	20.0	<5.0	6.9	16.4	<5.0J
Vinyl Chloride	ug/kg	<10.0	<10.0	<10.0	<10.0	<10.0	<10.0	<10.0J	<10.0	<10.0	<10.0
Total VOCs	ug/kg	280	462	619	572.7	235	1,015	40.3	749.9	1,532.4	27.0

ug/kg - Micrograms per kilogram.
SL - Soil.
J - The reported value is estimated.
DUP-60 - Duplicate of OH-BH6-2/SL.
DUP-62 - Duplicate of OH-BH9-30/SL.
< - Constituent not detected above laboratory detection limit shown.
ft bls - Feet below land surface.

Table 3-10. Hydrophobic Dye Test Results, AOI 7 - Former Oil House Area, General Motors Corporation, Moraine, Ohio.

Boring	Depth Interval (ft bls)	Date	Appearance of Soil After Test	DNAPL Presence/Absence
GM-27	31.5 to 33.5	8/7/98	Sample taken from second attempted borehole. Separation of soil grain sizes. Possible red specs among soil particles floating on water surface.	Possible presence
GM-27	33.5 to 34.5	8/7/98	Sample very silty. Clear sheen containing red specs completely covers water surface.	Possible presence
GM-27	38 to 39	8/13/98	Separation of soil grain sizes. Slightly colored sheen with red specs observed on water surface. Slight odor noted.	Possible presence
GM-27	54 to 55	8/13/98	Very small spot of sheen observed on water surface with few red specs. Sample appeared clean otherwise.	No evidence
GM-28	30 to 32	8/5/98	Separation of soil grain sizes. No sheen, red specs or layers visible.	No evidence
OH-BH5	36.5 to 37.5	8/14/98	Separation of soil grain sizes. No sheen, red specs or layers visible.	No evidence
OH-BH6	30 to 31.5	8/12/98	Separation of soil grain sizes. 2 mm film on water surface containing soil particles and many red specs. Odor noted.	Possible presence
OH-BH7	30 to 30.5	8/10/98	Separation of soil grain sizes. No sheen, red specs or layers visible.	No evidence
OH-BH8	22 to 24	8/18/98	Separation of soil grain sizes. No sheen, red specs or layers visible.	No evidence
OH-BH8	36 to 38	8/18/98	Separation of soil grain sizes. No sheen, red specs or layers visible.	No evidence
OH-BH9	36 to 38	8/19/98	Separation of soil grain sizes. No sheen, red specs or layers visible.	No evidence
OH-BH10	32 to 34	8/18/98	Separation of soil grain sizes. No sheen, red specs or layers visible.	No evidence
OH-BH11	32 to 33.5	11/3/98	Separation of soil grain sizes. No sheen, red specs or layers visible.	No evidence
OH-BH12	32 to 33.5	11/6/98	Separation of soil grain sizes. Very heavy sheen observed on water surface with many red specs. Strong odor noted.	Possible presence
OH-BH13	26 to 27	11/10/98	Separation of soil grain sizes. No sheen, red specs or layers visible.	No evidence
OH-BH14	32 to 32.5	11/10/98	Separation of soil grain sizes. Some specs observed on water surface. No sheen noted.	No evidence
OH-BH15	40 to 42	11/5/98	Separation of soil grain sizes. Slight sheen and few specs observed on water surface.	Possible presence
OH-BH16	60 to 61.75	11/12/98	Separation of soil grain sizes. No sheen, red specs or layers visible.	No evidence
OH-BH17	56 to 57	11/13/98	Separation of soil grain sizes. No sheen, red specs or layers visible.	No evidence
OH-BH18	34 to 35.5	11/4/98	Separation of soil grain sizes. No sheen, red specs or layers visible.	No evidence
OH-BH19	34 to 35	11/9/98	Separation of soil grain sizes. No sheen, red specs or layers visible.	No evidence
OH-BH20	36 to 38	11/11/98	Separation of soil grain sizes. No sheen, red specs or layers visible.	No evidence
OH-BH2A	36 to 37	11/2/98	Separation of soil grain sizes. Heavy sheen and red specs in sheen observed on water surface.	Possible presence
OH-BH3A	28 to 30	11/6/98	Separation of soil grain sizes. No sheen, red specs or layers visible.	No evidence

ft - feet.
bls - below land surface.
mm - Millimeter.

OH - Oil House.
BH - borehole.
DNAPL - Dense nonaqueous phase liquid.

Table 3-11. Analytical Results for Groundwater Samples Collected Using a Hydropunch, AOI 7-Former Oil House Area, August 1998, General Motors Corporation, Moraine, Ohio.

Constituents	**Units**	**OH-BH5/HP 37 ft bls 8/14/98**	**OH-BH6/HP 31.5 ft bls 8/12/98**	**OH-BH7/HP 30 ft bls 8/10/98**	**OH-BH8/HP 38 ft bls 8/18/98**	**OH-BH9/HP 38 ft bls 8/19/98**	**DUP-63 38 ft bls 8/19/98**
Volatile Organic Compounds							
1,1-Dichloroethane	ug/L	18.5	8.5	2.1	20.6	<1.0	<1.0
1,1-Dichloroethene	ug/L	84.1	8.8	<2.0	3.6	<1.0	<1.0
trans-1,2-Dichloroethene	ug/L	7.6	13.2	11.1	7.0	<1.0	<1.0
cis-1,2-Dichloroethene	ug/L	1,280	1,900	962	226	<1.0	<1.0
Tetrachloroethene	ug/L	1,550	28.5	2,950	77.6	520J	543
1,1,1-Trichloroethane	ug/L	<2.0	<1.0	3.2	<2.0	5.4	6.1
Trichloroethene	ug/L	1,330	52.4	728	246	6.6	7.1
Vinyl Chloride	ug/L	436	503	7.3	2,680	<2.0	<2.0
Total VOCs	ug/L	4,706.2	2,514.4	4,663.7	3,260.8	532	556.2

ug/L - Micrograms per liter.
ft bls - Feet below land surface.
HP - Hydropunch.
J - The reported value is estimated.
DUP-63 - Duplicate of OH-BH9-38/HP.
< - Consituent not detected above laboratory detection limit shown.
TW - Temporary well.

Table 3-11. Analytical Results for Groundwater Samples Collected Using a Hydropunch, AOI 7-Former Oil House Area, August 1998, General Motors Corporation, Moraine, Ohio.

Constituents	**Units**	**OH-BH10/HP 34 ft bls 8/18/98**	**GM-27/HP 32 ft bls 8/4/98**	**GM-27/HP 39 ft bls 8/13/98**	**GM-27/HP 50 ft bls 8/13/98**	**GM-27/TW 55 ft bls 8/19/98**	**GM-28/HP 32 ft bls 8/5/98**
Volatile Organic Compounds							
1,1-Dichloroethane	ug/L	2.5	54.6	3.0	<2.0	<5.0	2.4
1,1-Dichloroethene	ug/L	1.3	6.8	<2.0	<2.0	<5.0	<2
trans-1,2-Dichloroethene	ug/L	1.4	42.8	6.8	<2.0	<5.0	6.2
cis-1,2-Dichloroethene	ug/L	57.0	3,540	821	17.4	395	187
Tetrachloroethene	ug/L	1,810	484	14.3	3.2	14	242
1,1,1-Trichloroethane	ug/L	6.2	1.5	<2.0	<2.0	<5.0	10.5
Trichloroethene	ug/L	66.6	75.6	113	80.9	69.5	444
Vinyl Chloride	ug/L	3.7	7,320	231	<4.0	110	<4.0
Total VOCs	ug/L	1,948.7	11,525.3	1,189.1	101.5	588.5	892.1

ug/L - Micrograms per liter.
ft bls - Feet below land surface.
HP - Hydropunch.
J - The reported value is estimated.
DUP-63 - Duplicate of OH-BH9-38/HP.
< - Consituent not detected above laboratory detection limit shown.
TW - Temporary well.

Table 3-12. Analytical Results for Groundwater Samples Collected in August 1998, General Motors Corporation, Moraine, Ohio.

Constituents	Units	GM-28/GW 8/17/98	DUP-61 8/17/98	GM-27/GW 8/24/98	ME-6/GW 8/24/98	HR-1/GW 8/24/98	DUP-64 8/24/98	HR-3/GW 8/24/98
Volatile Organic Compounds								
1,1-Dichloroethane	ug/L	<1.0	<1.0	1.7	3.4	1.5	1.6	4.1
1,1-Dichloroethene	ug/L	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
trans-1,2-Dichloroethene	ug/L	1.3	1.2	<1.0	<1.0	1.6	1.6	<1.0
cis-1,2-Dichloroethene	ug/L	38.2	35.7	48.5	17.2	9.4	9.3	<1.0
Tetrachloroethene	ug/L	693	770	6.0	114	47.1	48.2	4.6
1,1,1-Trichloroethane	ug/L	1.8	1.6	<1.0	26.1	<1.0	<1.0	<1.0
Trichloroethene	ug/L	98.1J	96.0	89.5	312	46.0	47.3	<1.0
Vinyl Chloride	ug/L	<2.0	<2.0	6.9	<2.0	<2.0	<2.0	<2.0
Total VOCs	ug/L	832.4	904.5	152.6	472.7	105.6	108.0	8.7

ug/L - Micrograms per liter.
GW - Groundwater.
LF - Low Flow Groundwater Sample taken as Part of Bioattenuation Study.
J - The reported value is estimated.
DUP-61 - Duplicate of GM-28/GW.
DUP-64 - Duplicate of HR-1/GW.
DUP-65 - Duplicate of GM-27/LF.
< - Constituent not detected above laboratory detection limit shown.

Table 3-12. Analytical Results for Groundwater Samples Collected in August 1998, General Motors Corporation, Moraine, Ohio.

Constituents	**Units**	**GM-26/GW 8/24/98**	**GM-23/LF 8/26/98**	**GM-27/LF 8/26/98**	**DUP-65 8/26/98**	**GM-28/LF 8/26/98**
Volatile Organic Compounds						
1,1-Dichloroethane	ug/L	<1.0	10.9	2.0	2.1	2.0
1,1-Dichloroethene	ug/L	<1.0	7.0	<1.0	<1.0	<1.0
trans-1,2-Dichloroethene	ug/L	<1.0	19.4	<1.0	<1.0	5.0
cis-1,2-Dichloroethene	ug/L	<1.0	3,710	54.9J	60.3	127
Tetrachloroethene	ug/L	1.2	8,800	4.2	4.7	500
1,1,1-Trichloroethane	ug/L	<1.0	4.2	<1.0	<1.0	10.0
Trichloroethene	ug/L	<1.0	1,190	104	104	475
Vinyl Chloride	ug/L	<2.0	914	8.5	9.3	<2.0
Total VOCs	ug/L	1.2	14,655.5	173.6	180.4	1,119

ug/L - Micrograms per liter.
GW - Groundwater.
LF - Low Flow Groundwater Sample taken as Part of Bioattenuation Study.
J - The reported value is estimated.
DUP-61 - Duplicate of GM-28/GW.
DUP-64 - Duplicate of HR-1/GW.
DUP-65 - Duplicate of GM-27/LF.
< - Constituent not detected above laboratory detection limit shown.

Table 3-13. Analytical Results for Soil Samples Collected in November 1998, AOI 7-Former Oil House Area, General Motors Corporation, Moraine, Ohio.

		OH-BH2A/SL		OH-BH3A/SL	GM-23A/SL					OH-BH11/SL		
		11/2/98		11/6/98	11/5/98					11/3/98		
Constituents	**Units**	**14 ft bls**	**DUP-66**	**22 ft bls**	**2 ft bls**	**4 ft bls**	**5 ft bls**	**DUP-68**	**10 ft bls**	**2 ft bls**	**20 ft bls**	**28 ft bls**
Volatile Organic Compounds												
1,1-Dichloroethane	ug/kg	R	<50	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0
1,1-Dichloroethene	ug/kg	R	<50	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0
trans-1,2-Dichloroethene	ug/kg	R	<50	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0
cis-1,2-Dichloroethene	ug/kg	R	<50	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0
Tetrachloroethene	ug/kg	1,150J	2,540J	70.7	<5.0	9,440	908J	1,000	772	6.8	517	61.7
1,1,1-Trichloroethane	ug/kg	R	<50	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	4,880
Trichloroethene	ug/kg	53.9J	<50	14.2	<5.0	6.7J	<5.0	5.1	<5.0	<5.0	10.0	78.1
Vinyl Chloride	ug/kg	R	<20	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0
Total VOCs		1,203.9	2,540	84.9	0.0	9,446.7	908	1,005.1	772	6.8	527.0	5,019.8

ug/kg - Micrograms per kilogram.
SL - Soil.
< - Constituent not detected above laboratory detection limit shown.
J - The reported value is estimated.
R - The data is unusable and the presence or absence of the analyte cannot be verified.
DUP-66 - Duplicate of OH-BH2A-14/SL.
DUP-68 - Duplicate of GM-23A-5/SL.
DUP-69 - Duplicate of OH-BH13-22/SL.
DUP-71 - Duplicate of OH-BH17-2/SL.
ft bls - Feet below land surface.

Table 3-13. Analytical Results for Soil Samples Collected in November 1998, AOI 7-Former Oil House Area, General Motors Corporation, Moraine, Ohio.

		OH-BH12/SL 11/6/98			OH-BH13/SL 11/10/98				OH-BH14/SL 11/10/98		OH-BH15/SL 11/4/98			OH-BH16/SL 11/12/98	
Constituents	**Units**	**2 ft bls**	**14 ft bls**	**28 ft bls**	**2 ft bls**	**22 ft bls**	**DUP-69**	**25 ft bls**	**2 ft bls**	**24 ft bls**	**2 ft bls**	**18 ft bls**	**26 ft bls**	**2 ft bls**	**30 ft bls**
Volatile Organic Compounds															
1,1-Dichloroethane	ug/kg	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0
1,1-Dichloroethene	ug/kg	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0
trans-1,2-Dichloroethene	ug/kg	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0
cis-1,2-Dichloroethene	ug/kg	<5.0	<5.0	6.3	<5.0	<5.0	<5.0	5.4	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0
Tetrachloroethene	ug/kg	675	81.2	120	17.6	333J	48.2J	3,300	<5.0	108	<5.0	<5.0	<5.0	<5.0	<5.0
1,1,1-Trichloroethane	ug/kg	<5.0	<5.0J	<5.0J	<5.0	<5.0	<5.0	6.4J	<5.0J	<5.0	118	95.1	367	<5.0	18.2
Trichloroethene	ug/kg	35.8	13.8	25.3	10.0	60.4J	16.8J	1,780	5.2	8.4	<5.0	<5.0	<5.0	<5.0	<5.0
Vinyl Chloride	ug/kg	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2	<2.0	<2.0	30.3	<5.0	9.7	<5.0	<5.0
Total VOCs		710.8	95.0	151.6	27.6	393.4	65.0	5,091.8	5.2	116.4	148.3	95.1	376.7	0.0	18.2

ug/kg - Micrograms per kilogram.
SL - Soil.
< - Constituent not detected above laboratory detection limit shown.
J - The reported value is estimated.
R - The data is unusable and the presence or absence of the analyte cannot be verified.
DUP-66 - Duplicate of OH-BH2A-14/SL.
DUP-68 - Duplicate of GM-23A-5/SL.
DUP-69 - Duplicate of OH-BH13-22/SL.
DUP-71 - Duplicate of OH-BH17-2/SL.
ft bls - Feet below land surface.

Table 3-13. Analytical Results for Soil Samples Collected in November 1998, AOI 7-Former Oil House Area, General Motors Corporation, Moraine, Ohio.

Constituents	Units	OH-BH17/SL 11/13/98 2 ft bls	 DUP-71	 30 ft bls	OH-BH18/SL 11/4/98 2 ft bls	 6 ft bls	 31 ft bls	OH-BH19/SL 11/9/98 2 ft bls	 32 ft bls	OH-BH20/SL 11/11/98 2 ft bls	 35 ft bls
Volatile Organic Compounds											
1,1-Dichloroethane	ug/kg	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0
1,1-Dichloroethene	ug/kg	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0
trans-1,2-Dichloroethene	ug/kg	<5.0J	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0
cis-1,2-Dichloroethene	ug/kg	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0
Tetrachloroethene	ug/kg	<5.0J	<5.0	91.6	202	140	34.2J	<5.0	11.1	<5.0	<5.0
1,1,1-Trichloroethane	ug/kg	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0
Trichloroethene	ug/kg	<5.0J	6.8	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0
Vinyl Chloride	ug/kg	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	5.8	7.8	8.8	<5.0
								<2.0	<2.0	<2.0	<2.0
Total VOCs		0.0	6.8	91.6	202	140	34.2	5.8	18.9	8.8	0.0

ug/kg - Micrograms per kilogram.
SL - Soil.
< - Constituent not detected above laboratory detection limit shown.
J - The reported value is estimated.
R - The data is unusable and the presence or absence of the analyte cannot be verified.
DUP-66 - Duplicate of OH-BH2A-14/SL.
DUP-68 - Duplicate of GM-23A-5/SL.
DUP-69 - Duplicate of OH-BH13-22/SL.
DUP-71 - Duplicate of OH-BH17-2/SL.
ft bls - Feet below land surface.

Table 3-14. Analytical Results for Groundwater Samples Collected Using a Hydropunch, AOI 7-Former Oil House Area, November 1998, General Motors Corporation, Moraine, Ohio.

Constituents	Units	OH-BH2A/HP 37 ft bls 11/3/98	OH-BH2A/HP DUP-67 11/3/98	OH-BH3A/HP 30 ft bls 11/6/98	OH-BH11/HP 33 ft bls 11/3/98	OH-BH12/HP 33.5 ft bls 11/6/98	OH-BH13/HP 27 ft bls 11/10/98	OH-BH14/HP 32 ft bls 11/11/98	OH-BH14/HP DUP-70 11/11/98
Volatile Organic Compounds									
1,1-Dichloroethane	ug/L	231	213	4.3	18.2	29.3	3.6	2.3	2.3
1,1-Dichloroethene	ug/L	<100	<100	<2	6.6	<1	1.4	<2.0	<2.0
trans-1,2-Dichloroethene	ug/L	<100	<100	<2	23.0	3.2	2.7	<2.0	<2.0
cis-1,2-Dichloroethene	ug/L	11,000	10,500	34.1	1,490	131	130	33.9	36.6
Tetrachloroethene	ug/L	1,180J	1,470	238	2,060	254	136	114	112
1,1,1-Trichloroethane	ug/L	<100	<100	24.4	43.5	2.1	12.0	<2.0	<2.0
Trichloroethene	ug/L	1,260J	1,390	1,560	1,680	45.5	3,500	39.0	42.4
Vinyl Chloride	ug/L	4,770J	4,460	4.5	245	113	<2	<4.0	<4.0
Total VOCs		18,441	18,033	1,865.3	5,566.3	578.1	3,785.7	189.2	193.3

ug/L - Micrograms per liter.
ft bls - Feet below land surface.
HP - Hydropunch.
< - Constitutent not detected above laboratory detection limit shown.
J - The reported value is estimated.
DUP-67 - Duplicate of OH-BH2A-37/HP.
DUP-70 - Duplicate of OH-BH14-32/HP.

Table 3-14. Analytical Results for Groundwater Samples Collected Using a Hydropunch, AOI 7-Former Oil House Area, November 1998, General Motors Corporation, Moraine, Ohio.

Constituents	Units	OH-BH15/HP	OH-BH16/HP		OH-BH17/HP		OH-BH18/HP	OH-BH19/HP	OH-BH20/HP
		42 ft bls 11/5/98	33 ft bls 11/12/98	61 ft bls 11/12/98	40 ft bls 11/13/98	57 ft bls 11/13/98	35.5 ft bls 11/4/98	35 ft bls 11/11/98	38 ft bls 11/11/98
Volatile Organic Compounds									
1,1-Dichloroethane	ug/L	<2.0	<10.0	25.0	11.1	20.7	<2	<2.0	<2.0
1,1-Dichloroethene	ug/L	<2.0	<10.0	<1.0	<1.0	<2.0	<2	<2.0	<2.0
trans-1,2-Dichloroethene	ug/L	<2.0	<10.0	1.4	<1.0	<2.0	<2	<2.0	<2.0
cis-1,2-Dichloroethene	ug/L	281	<10.0	12.0	2.7	12.3	<2	<2.0	<2.0
Tetrachloroethene	ug/L	65.4	<10.0	2.0	82.6	10.0	712	27.3	<2.0
1,1,1-Trichloroethane	ug/L	18.3	<10.0	7.3	5.1	<2.0	88.8	6.3	<2.0
Trichloroethene	ug/L	981	<10.0	1.8	116	24.6	15.1	10.1	<2.0
Vinyl Chloride	ug/L	<4.0	<20.0	<2.0	<2.0	<4.0	<4	<4.0	<4.0
Total VOCs		1,345.7	0.0	49.5	217.5	67.6	815.9	43.7	0.0

ug/L - Micrograms per liter.
ft bls - Feet below land surface.
HP - Hydropunch.
< - Constitutent not detected above laboratory detection limit shown.
J - The reported value is estimated.
DUP-67 - Duplicate of OH-BH2A-37/HP.
DUP-70 - Duplicate of OH-BH14-32/HP.

Table 3-15. Toluene Analytical Results, AOI 7 - Former Oil House Area, General Motors Corporation, Moraine, Ohio.

Sample ID	Units	Analysis Date	Toluene
Groundwater Sample			
OH-BH5-37/HP	ug/L	8/14/98	<2
OH-BH6-31.5/HP	ug/L	8/12/98	11.6
OH-BH7-30/HP	ug/L	8/13/98	4.1
OH-BH8-38/HP	ug/L	8/19/98	6
OH-BH10-34/HP	ug/L	8/19/98	1
GM-27-32/HP	ug/L	8/12/98	17.1
GM-23/LF	ug/L	8/28/98	<1
GM-27/LF	ug/L	8/28/98	<1
GM-28/LF	ug/L	8/28/98	<1
OH-BH11-33/HP	ug/L	11/16/98	10.1
OH-BH12-33.5/HP	ug/L	11/18/98	19.9
OH-BH13-27/HP	ug/L	11/18/98	3.6
OH-BH14-32/HP	ug/L	11/20/98	<2
OH-BH15-42/HP	ug/L	11/17/98	2.6
OH-BH2A-37/HP	ug/L	11/13/98	>444*
DUP-67	ug/L	11/13/98	>465*
OH-BH3A-30/HP	ug/L	11/18/98	25.1
Soil Sample			
OH-BH5-2/SL	ug/Kg	8/17/98	<5
OH-BH5-20/SL	ug/Kg	8/17/98	<5
OH-BH5-26/SL	ug/Kg	8/17/98	<5
OH-BH6-2/SL	ug/Kg	8/17/98	<5
OH-BH6-8/SL	ug/Kg	8/17/98	<5
OH-BH6-24/SL	ug/Kg	8/17/98	<5
OH-BH7-2/SL	ug/Kg	8/17/98	<5
OH-BH7-20/SL	ug/Kg	8/17/98	<5
OH-BH7-24/SL	ug/Kg	8/17/98	<5
OH-BH8-2/SL	ug/Kg	8/20/98	<5
OH-BH8-18/SL	ug/Kg	8/20/98	<5
OH-BH8-28/SL	ug/Kg	8/20/98	29.3
OH-BH10-2/SL	ug/Kg	8/21/98	<5
OH-BH10-16/SL	ug/Kg	8/21/98	<5
OH-BH10-28/SL	ug/Kg	8/21/98	<5
GM-27-2/SL	ug/Kg	8/9/98	<5
GM-27-20/SL	ug/Kg	8/9/98	<5
GM-27-24/SL	ug/Kg	8/9/98	<5
OH-BH11-2/SL	ug/Kg	11/5/98	6.2
OH-BH11-20/SL	ug/Kg	11/4/98	5.7
OH-BH11-28/SL	ug/Kg	11/4/98	<5

Table 3-15. Toluene Analytical Results, AOI 7 - Former Oil House Area, General Motors Corporation, Moraine, Ohio.

Sample ID	Units	Analysis Date	Toluene
Soil Sample (continued)			
OH-BH12-2/SL	ug/Kg	11/16/98	<5
OH-BH12-14/SL	ug/Kg	11/16/98	<5
OH-BH12-28/SL	ug/Kg	11/16/98	<5
OH-BH13-2/SL	ug/Kg	11/17/98	<5
OH-BH13-22/SL	ug/Kg	11/18/98	<5
OH-BH13-25/SL	ug/Kg	11/17/98	<5
GM-23A-2/SL	ug/Kg	11/13/98	<5
GM-23A-4/SL	ug/Kg	11/13/98	13.9
GM-23A-5/SL	ug/Kg	11/13/98	<5
GM-23A-10/SL	ug/Kg	11/13/98	<5

ug/L - Microgram per liter.
ug/Kg - Microgram per kilogram.
SL - Soil.
HP - Hydropunch.
LF - Low flow.
DUP-67 - Duplicate of OH-BH2A-37/HP.
* Due to carryover, the calibration performed by NET on 11/13/98 did not pass the linearity criteria of Method 8260, the RSD exceeded the 30% limit. Results were also reported from a 100x dilution. At this dilution, NET estimated the toluene concentrations to be >24,800 ug/L for OH-BH2A-37/HP and >24,300 ug/L for DUP-67.

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Table 4-5. Bioattenuation Parameter Results in AOI 7 - Former Oil House Area, August 1998, General Motors Corporation, Moraine, Ohio.

COMPOUND	UNITS	GM-23 8/26/98	GM-27 8/26/98	GM-28 8/26/98
Inorganics & TOC				
Nitrate	mg/l	22	<4.4	<4.4
Nitrite	mg/l	0.17	0.5	<0.033
Nitrogen, Ammonia	mg/l	<0.3	<0.3	<0.3
Manganese (Total)	mg/l	0.343	0.425	0.486
Manganese (Dissolved)	mg/l	0.197	0.17	0.269
Iron (Total)	mg/l	3.41	16	6.16
Iron (Dissolved)	mg/l	<0.10	0.19	<0.10
Iron (Ferrous)	mg/l	<0.2	<0.2	<0.2
Sulfate	mg/l	50	90	144
Sulfide	mg/l	<1	<2	<1
Total Organic Carbon	mg/l	9	2	6
Chloride	mg/l	69	118	163
Permanent Gases				
Carbon Dioxide	mg/l	58.32	63.42	31.50
Oxygen	mg/l	1.65	1.84	2.13
Nitrogen	mg/l	17.27	22.92	17.23
Methane	mg/l	0.063452	0.010517	0.004460
Carbon Monoxide	mg/l	<0.40	<0.40	<0.40
Light Hydrocarbon Scan				
Ethane	ug/l	5.136	4.599	0.990
Ethene	ug/l	75.038	4.700	0.696
Field Parameters				
pH	S.U.	6.57	6.80	7.02
ORP	mV	287.1	191.6	274.7
Temperature	°C	18.31	20.27	19.24
Dissolved Oxygen	mg/L	2.66	1.34	1.25
Specific Conductance	umhos/cm	952	1,271	1,336

mg/L	Milligrams per liter.
ug/L	Micrograms per liter.
S.U.	Standard units.
mV	Millivolts.
°C	Degrees Celsius.
umhos/cm	Micro-mohs/centimeter.

1.

VIEW FACING SOUTH, WITH MORAINE ENGINE TANK FARM IN THE MIDDLE AND MORAINE ENGINE PLANT IN THE BACKGROUND.

2.

VIEW FACING SOUTH, WITH CHIP PAD IN THE FOREGROUND AND MORAINE ENGINE TANK FARM IN THE BACKGROUND.

3.

VIEW FACING NORTH, FROM DRIVEWAY WEST OF MORAINE ENGINE PLANT. MORAINE ENGINE TANK FARM PUMP HOUSE IN THE BACKGROUND.

4.

VIEW FACING NORTH, OF THE MORAINE ENGINE TANK FARM PUMP HOUSE.

ARCADIS GERAGHTY&MILLER

AOI 7 - FORMER OIL HOUSE AREA
CURRENT CONDITIONS
GENERAL MOTORS CORPORATION
MORAINE, OHIO

DRAWN
R. SMITH

DATE
22JUN99

PROJECT MANAGER
J.REID

DRAWING NAME
CRA\AOI7JPG

LEAD DESIGN PROF.
J. REID

CHECKED
N. GILLOTTI

PROJECT NUMBER
OH000294.01

FIGURE NUMBER
3

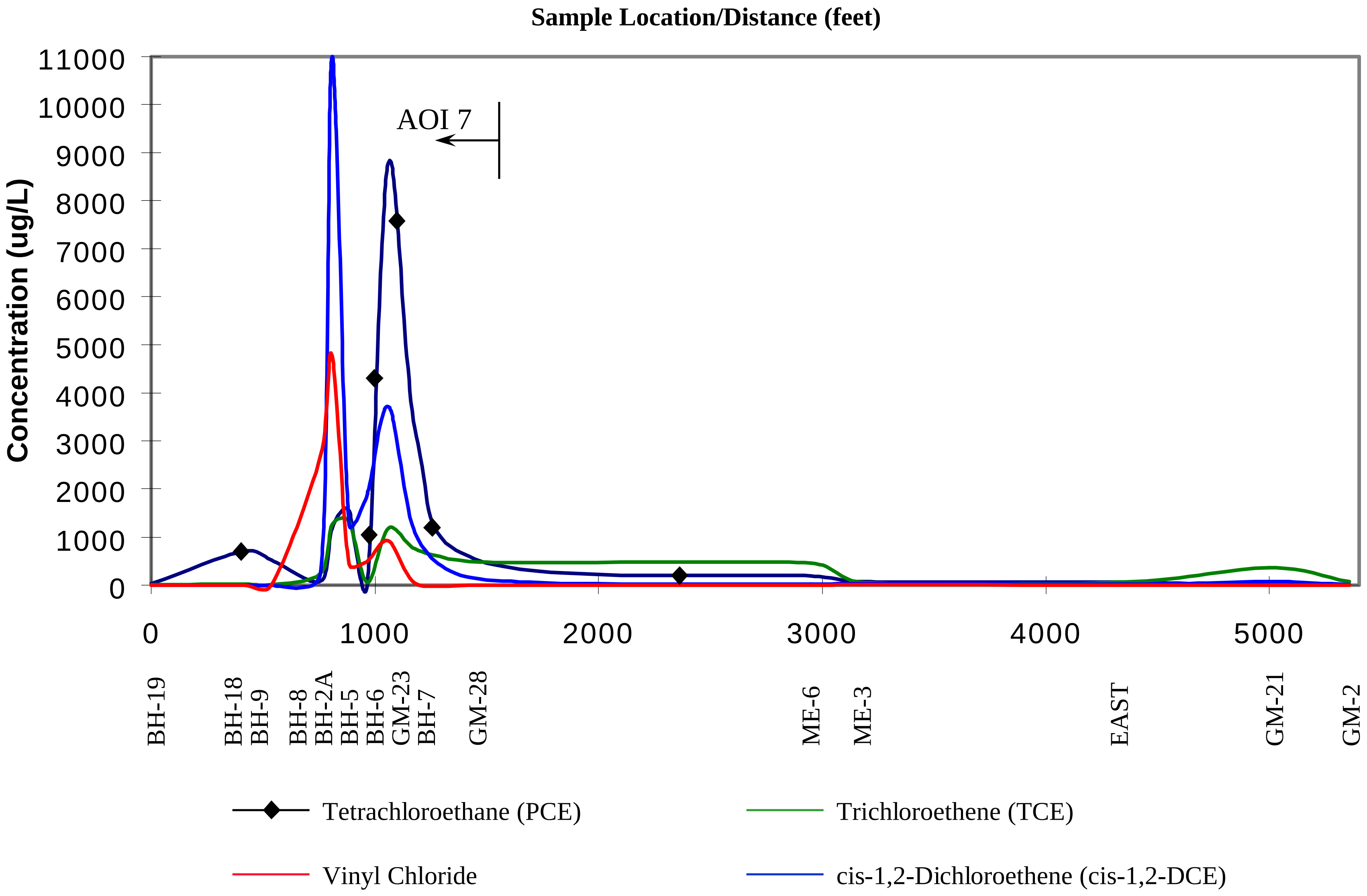

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Figure 4-4. PCE/TCE/cis-1,2-DCE/VC North South Groundwater Concentration Graph, General Motors Corporation, Moraine, Ohio.

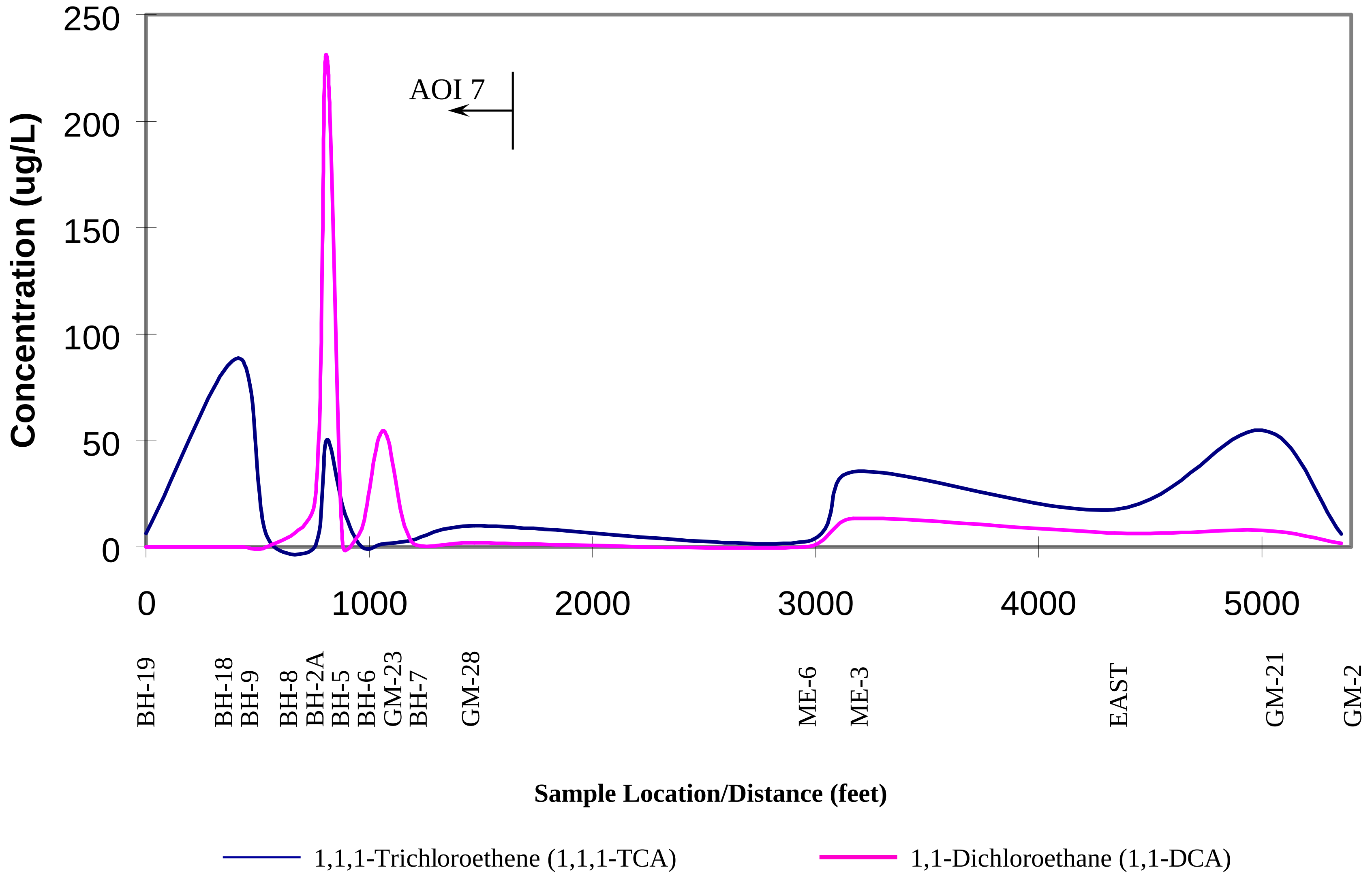

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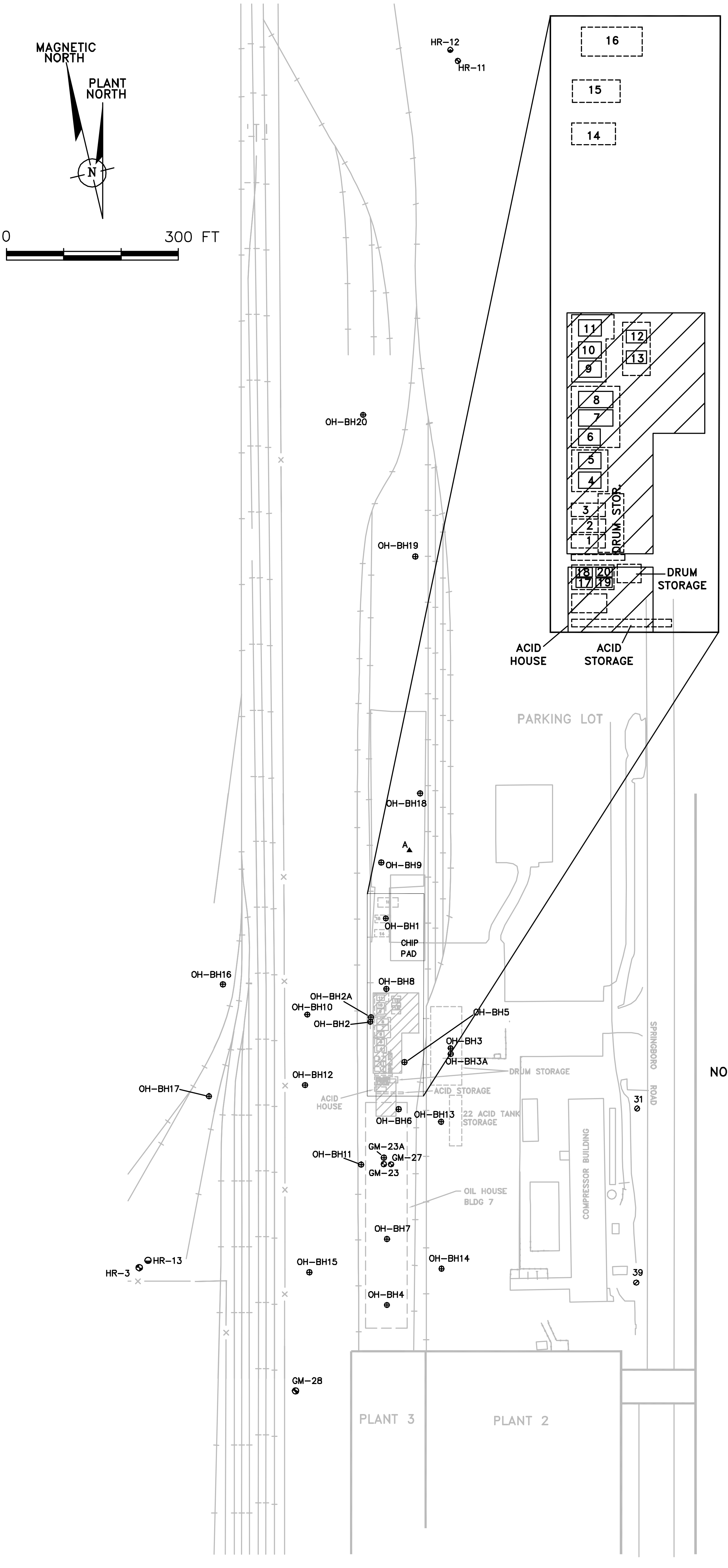
Figure 4-5. TCA/DCA North South Groundwater Concentration Graph, General Motors Corporation, Moraine, Ohio.



HISTORIC TANK No.	CONTENTS	CAPACITY
1	OIL	15,000 GALLONS
2	OIL	15,000 GALLONS
3	OIL	15,000 GALLONS
4	THINNER	8,000 GALLONS
5	REDUCER	8,000 GALLONS
6	ALCOHOL	8,000 GALLONS
7	KEROSENE	10,000 GALLONS
8	PERCHLOROETHENE	10,000 GALLONS
9	PERCHLOROETHENE	10,000 GALLONS
10	ALCOHOL	10,000 GALLONS
11	ALCOHOL	10,000 GALLONS
12	XYLOL	10,000 GALLONS
13	THINNER	10,000 GALLONS
14	FREON 12	160,000 LBS
15	FREON 12	160,000 LBS
16	OIL	30,000 GALLONS
17	ACID-HNO_3	11,000 GALLONS
18	ACID-HCI	10,000 GALLONS
19	ACID-H_2SO_4	13,000 GALLONS
20	ACID-H_3PO_4	11,000 GALLONS
21	DRUMS-OIL	300 BBL
22	ACID	-----

NOTE:

BORINGS OH-BH1 THROUGH OH-BH4 WERE INSTALLED IN FEBRUARY 1998. BORINGS OH-BH5 THROUGH OH-BH10 AND WELLS GM-27 AND GM-28 WERE INSTALLED IN AUGUST 1998. BORINGS OH-BH11 THROUGH OH-BH20, OH-BH2A, OH-BH3A, AND GM-23A WERE INSTALLED IN NOVEMBER 1998.

LEGEND

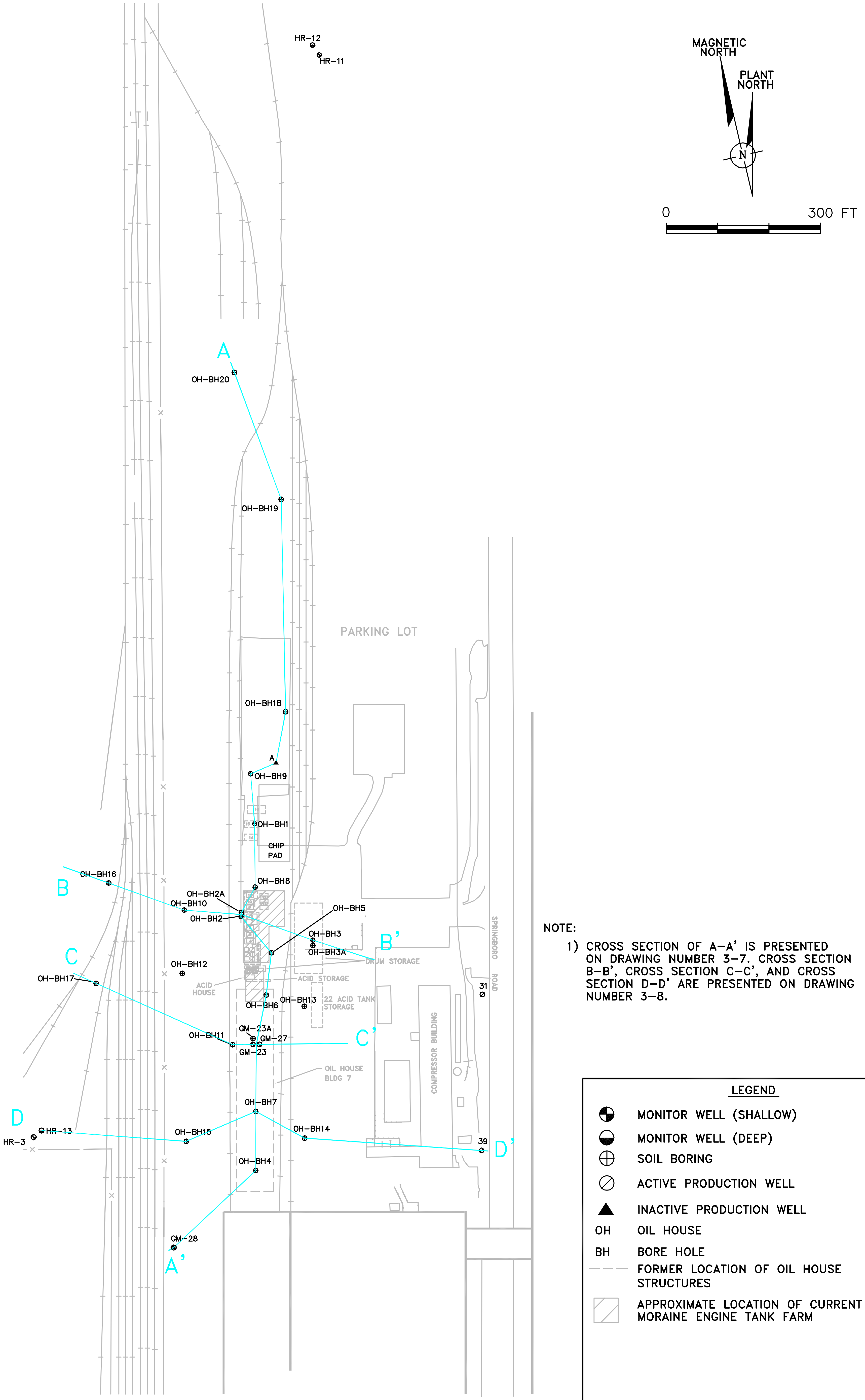
◕	MONITOR WELL (SHALLOW)
◒	MONITOR WELL (DEEP)
⊕	SOIL BORING
⊘	ACTIVE PRODUCTION WELL
▲	INACTIVE PRODUCTION WELL
OH	OIL HOUSE
BH	BORE HOLE
---	FORMER LOCATION OF OIL HOUSE STRUCTURES
▨	APPROXIMATE LOCATION OF CURRENT MORAINE ENGINE TANK FARM

ARCADIS GERAGHTY & MILLER
6397 Emerald Parkway
Suite 150, Dublin, OH 43016
Tel: 614/764-2310 Fax: 614/764-1270

SOIL BORING LOCATIONS FOR AOI 7 – FORMER OIL HOUSE AREA

GENERAL MOTORS CORPORATION
MORAINE, OHIO

DATE	PROJECT MANAGER	DRAWING NAME
MAR99	J. REID	HARR\N-B\RFISUP1D
DRAWN	LEAD DESIGN PROF.	CHECKED
R. SMITH	J. REID	N. GILLOTTI
PROJECT NUMBER		DRAWING NUMBER
OH000294.0001.0002		3-5



NOTE:

1) CROSS SECTION OF A-A' IS PRESENTED ON DRAWING NUMBER 3-7. CROSS SECTION B-B', CROSS SECTION C-C', AND CROSS SECTION D-D' ARE PRESENTED ON DRAWING NUMBER 3-8.

LEGEND

◕	MONITOR WELL (SHALLOW)
◒	MONITOR WELL (DEEP)
⊕	SOIL BORING
⊘	ACTIVE PRODUCTION WELL
▲	INACTIVE PRODUCTION WELL
OH	OIL HOUSE
BH	BORE HOLE
— —	FORMER LOCATION OF OIL HOUSE STRUCTURES
▨	APPROXIMATE LOCATION OF CURRENT MORAINE ENGINE TANK FARM

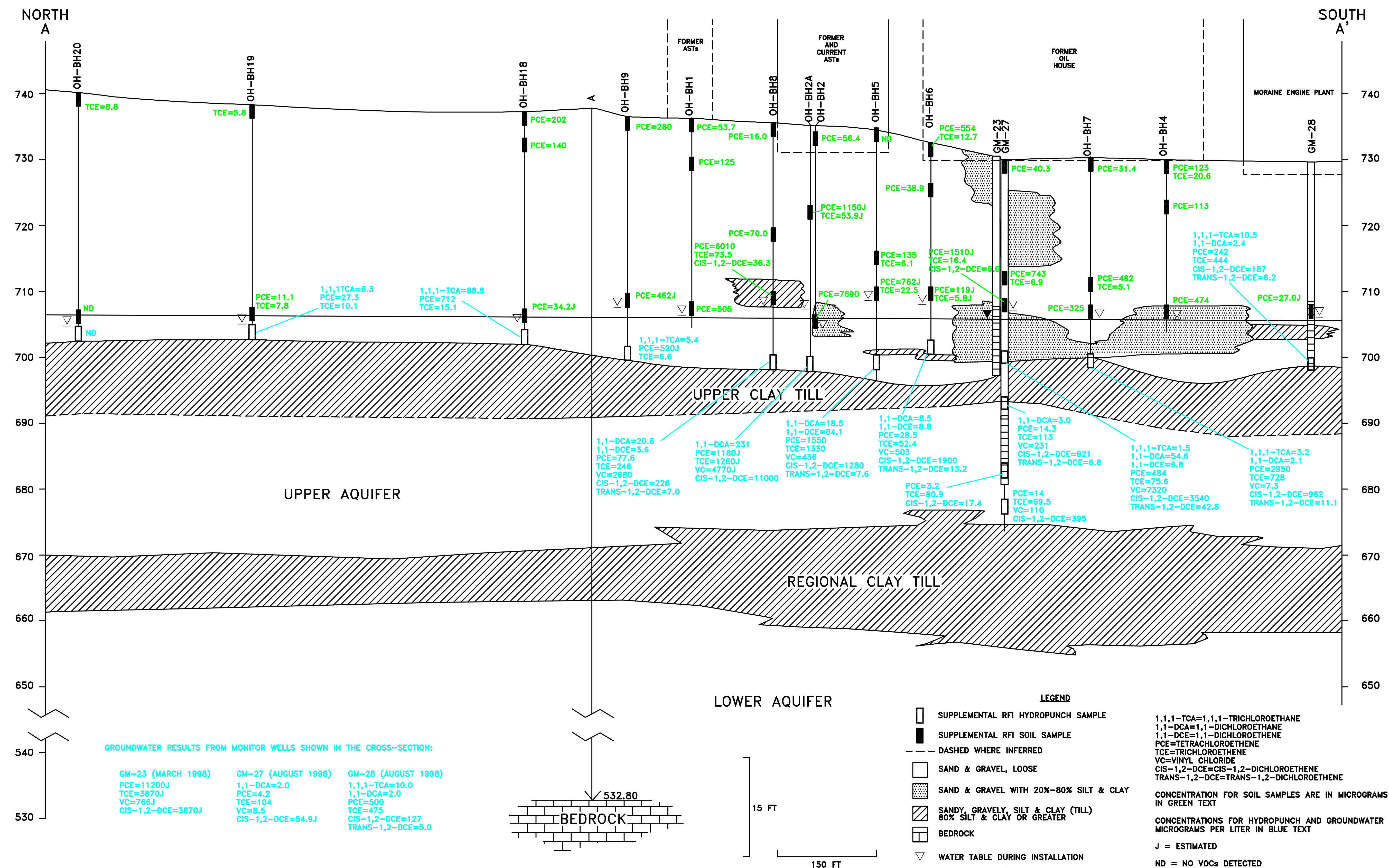
ARCADIS GERAGHTY&MILLER

6397 Emerald Parkway
Suite 150, Dublin, OH 43016
Tel: 614/764-2310 Fax: 614/764-1270

LINES OF CROSS SECTION FOR AOI 7 – FORMER OIL HOUSE AREA

GENERAL MOTORS CORPORATION
MORAINE, OHIO

DATE MAR99	PROJECT MANAGER J. REID	DRAWING NAME HARR\N-B\RFISUP1G
DRAWN R. SMITH	LEAD DESIGN PROF. J. REID	CHECKED N. GILLOTTI
PROJECT NUMBER OH000294.0001.0002		DRAWING NUMBER 3-6



GROUNDWATER RESULTS FROM MONITOR WELLS SHOWN IN THE CROSS-SECTION:

GM-23 (MARCH 1998)
PCE=11200J
TCE=3870J
VC=766J
CIS-1,2-DCE=3870J

GM-27 (AUGUST 1998)
1,1-DCA=2.0
PCE=4.2
TCE=104
VC=8.5
CIS-1,2-DCE=54.9J

GM-28 (AUGUST 1998)
1,1,1-TCA=10.0
1,1-DCA=2.0
PCE=500
TCE=475
CIS-1,2-DCE=127
TRANS-1,2-DCE=5.0

LEGEND

▯ SUPPLEMENTAL RFI HYDROPUNCH SAMPLE
▮ SUPPLEMENTAL RFI SOIL SAMPLE
– – – DASHED WHERE INFERRED
☐ SAND & GRAVEL, LOOSE
▩ SAND & GRAVEL WITH 20%-80% SILT & CLAY
▨ SANDY, GRAVELY, SILT & CLAY (TILL) 80% SILT & CLAY OR GREATER
⊞ BEDROCK
▽ WATER TABLE DURING INSTALLATION
▼ WATER TABLE 3/98

NOTE: LOCATION OF CROSS-SECTION A-A' SHOWN ON DRAWING NUMBER 3-6.

1,1,1-TCA=1,1,1-TRICHLOROETHANE
1,1-DCA=1,1-DICHLOROETHANE
1,1-DCE=1,1-DICHLOROETHENE
PCE=TETRACHLOROETHENE
TCE=TRICHLOROETHENE
VC=VINYL CHLORIDE
CIS-1,2-DCE=CIS-1,2-DICHLOROETHENE
TRANS-1,2-DCE=TRANS-1,2-DICHLOROETHENE

CONCENTRATION FOR SOIL SAMPLES ARE IN MICROGRAMS PER KILOGRAM IN GREEN TEXT

CONCENTRATIONS FOR HYDROPUNCH AND GROUNDWATER SAMPLES ARE IN MICROGRAMS PER LITER IN BLUE TEXT

J = ESTIMATED

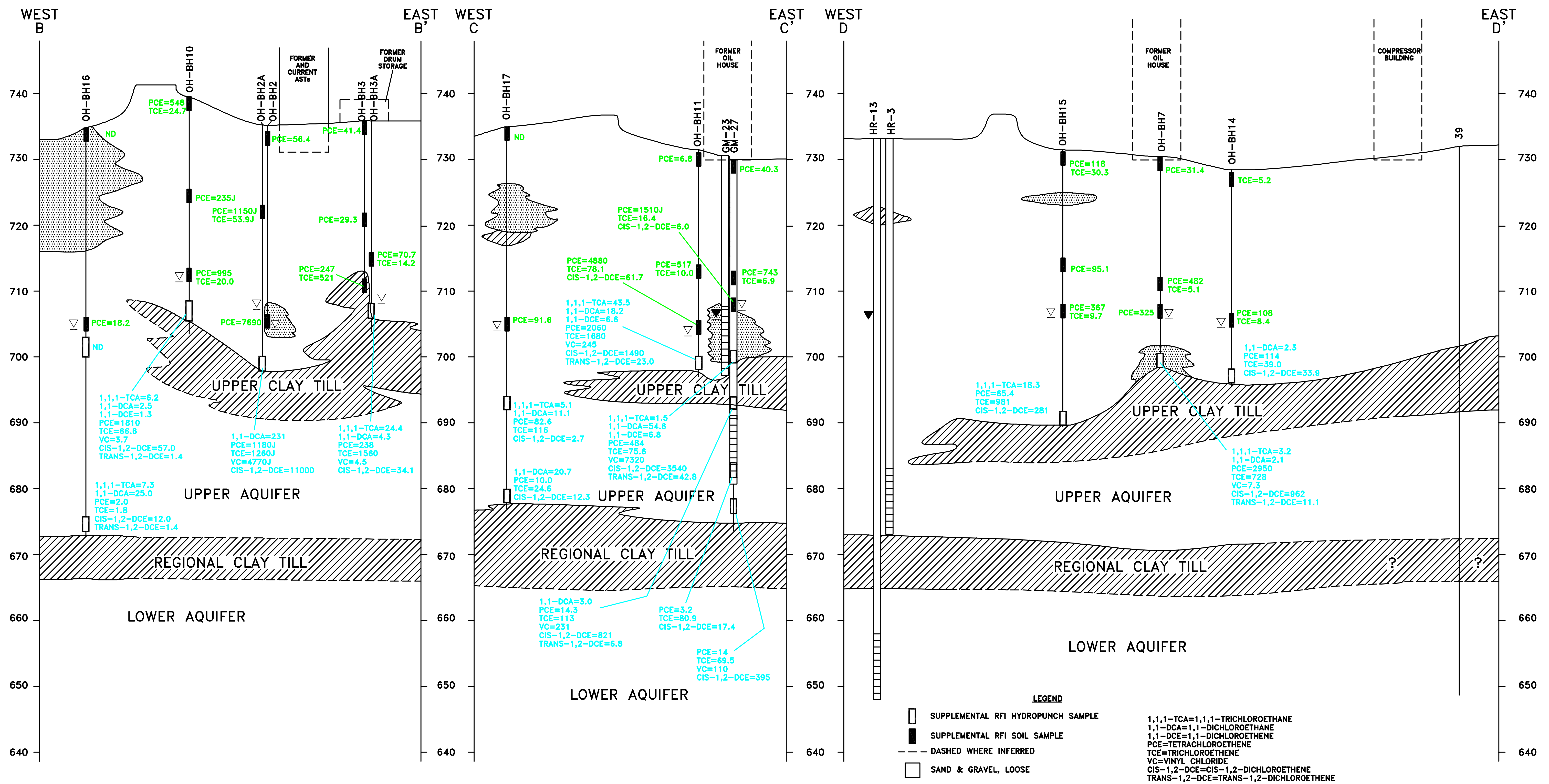
ND = NO VOCs DETECTED

ONLY DETECTED VOCs ARE POSTED ON THIS FIGURE

ARCADIS GERAGHTY&MILLER

CROSS SECTION A-A'
FOR AOI 7 – FORMER OIL HOUSE AREA
GENERAL MOTORS CORPORATION
MORAINE, OHIO

DRAWN	DATE	PROJECT MANAGER	DRAWING NAME
R. SMITH	27MAY99	J. REID	HAR\CRA\RFI\CS-01
		LEAD DESIGN PROF. J. REID	CHECKED N. GILLOTTI
		PROJECT NUMBER OH0294.01.02	FIGURE NUMBER 3-7



GROUNDWATER RESULTS FROM MONITOR WELLS SHOWN IN THE CROSS-SECTIONS:

GM-23 (MARCH 1998)
PCE=11200J
TCE=3870J
VC=766J
CIS-1,2-DCE=3870J

GM-27 (AUGUST 1998)
1,1-DCA=2.0
PCE=4.2
TCE=104
VC=8.5
CIS-1,2-DCE=54.9J

GM-28 (AUGUST 1998)
1,1,1-TCA=10.0
1,1-DCA=2.0
PCE=500
TCE=475
CIS-1,2-DCE=127
TRANS-1,2-DCE=5.0

HR-3 (AUGUST 1998)
1,1-DCA=4.1
CIS-1,2-DCE=4.6

HR-13 (MARCH 1998)
1,1,1-TCA=1.3
1,1-DCA=48.3
TCE=2.8
CIS-1,2-DCE=23.3
TRANS-1,2-DCE=3.3

LEGEND

▯ SUPPLEMENTAL RFI HYDROPUNCH SAMPLE
▮ SUPPLEMENTAL RFI SOIL SAMPLE
– – – DASHED WHERE INFERRED
☐ SAND & GRAVEL, LOOSE
▦ SAND & GRAVEL WITH 20%-80% SILT & CLAY
▨ SANDY, GRAVELY, SILT & CLAY (TILL) 80% SILT & CLAY OR GREATER
⊞ BEDROCK
▽ WATER TABLE DURING INSTALLATION
▼ WATER TABLE 3/98

NOTE: LOCATION OF CROSS-SECTION B-B', C-C', AND D-D' SHOWN ON DRAWING NUMBER 3-6.

1,1,1-TCA=1,1,1-TRICHLOROETHANE
1,1-DCA=1,1-DICHLOROETHANE
1,1-DCE=1,1-DICHLOROETHENE
PCE=TETRACHLOROETHENE
TCE=TRICHLOROETHENE
VC=VINYL CHLORIDE
CIS-1,2-DCE=CIS-1,2-DICHLOROETHENE
TRANS-1,2-DCE=TRANS-1,2-DICHLOROETHENE

CONCENTRATION FOR SOIL SAMPLES ARE IN MICROGRAMS PER KILOGRAM IN GREEN TEXT

CONCENTRATIONS FOR HYDROPUNCH AND GROUNDWATER SAMPLES ARE IN MICROGRAMS PER LITER IN BLUE TEXT

J = ESTIMATED

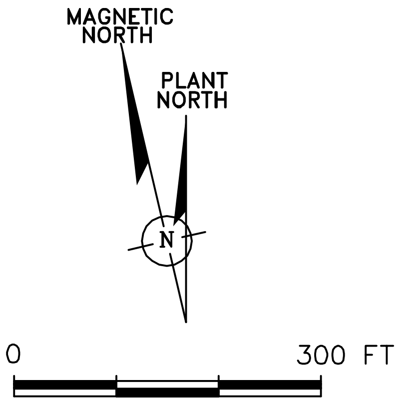
ND = NO VOCs DETECTED

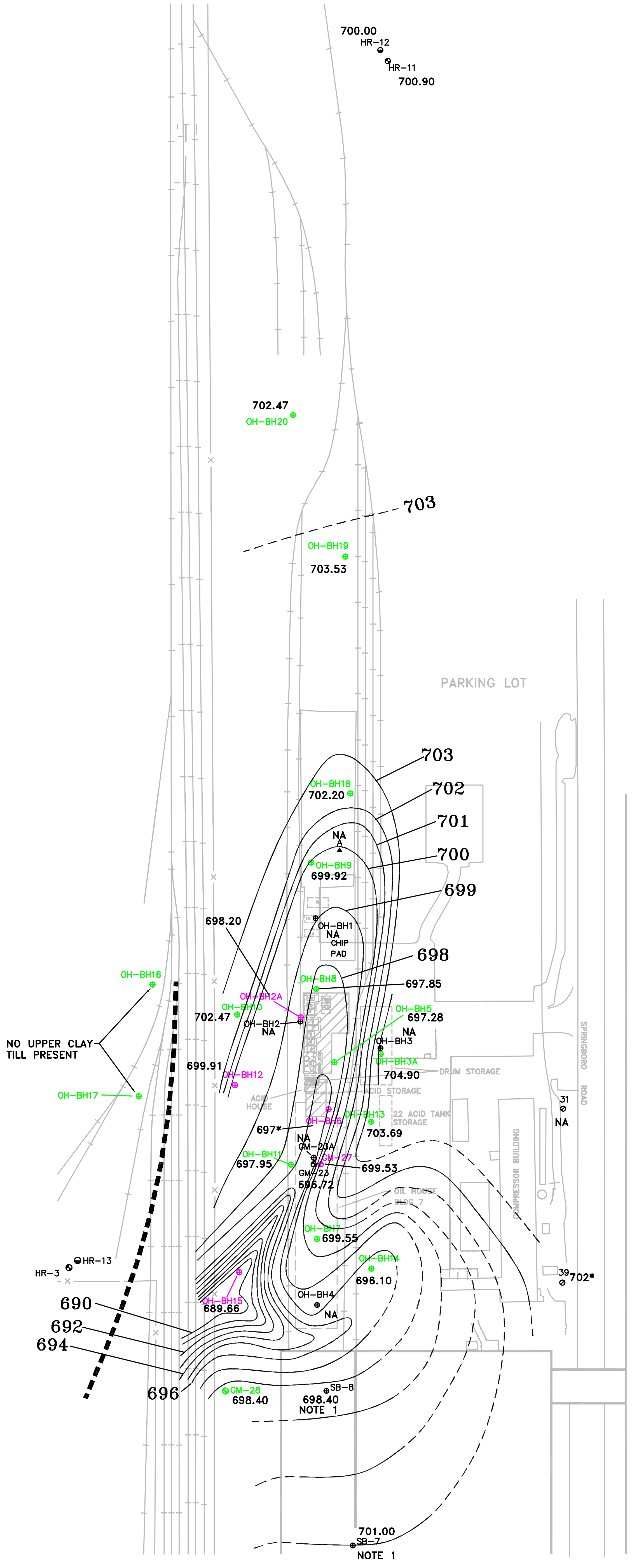
ONLY DETECTED VOCs ARE POSTED ON THIS FIGURE

ARCADIS GERAGHTY&MILLER

CROSS SECTIONS B-B', C-C', AND D-D'
FOR AOI 7 - FORMER OIL HOUSE AREA
GENERAL MOTORS CORPORATION
MORAINE, OHIO

DRAWN R. SMITH	DATE 27MAY99	PROJECT MANAGER J. REID	DRAWING NAME HAR\CRA\RFI\CS-01
		LEAD DESIGN PROF. J. REID	CHECKED N. GILLOTTI
		PROJECT NUMBER OH0294.01.02	FIGURE NUMBER 3-8





NOTE:

1) SOIL BORINGS SB-7 AND SB-8 WERE HISTORIC GEOTECHNICAL BORINGS AND NOT INSTALLED AS PART OF THE RFI THE LOGS WERE USED TO IDENTIFY THE UPPER CLAY TILL.

2) HYDROPHOBIC DYE TESTS WERE CONDUCTED ON SOIL SAMPLES TO EVALUATE THE PRESENCE OR ABSENCE OF DNAPL. THE DYE TESTS WERE PERFORMED ON A SATURATED SOIL SAMPLE COLLECTED FROM THE INTERVAL IMMEDIATELY ABOVE THE UPPER CLAY TILL.

LEGEND

◕	MONITOR WELL (SHALLOW)
◒	MONITOR WELL (DEEP)
⊕	SOIL BORING
⊕	SOIL BORING, DNAPL DYE TEST NEGATIVE
⊕	SOIL BORING, DNAPL DYE TEST POSITIVE
⊘	ACTIVE PRODUCTION WELL
▲	INACTIVE PRODUCTION WELL
OH	OIL HOUSE
BH	BORE HOLE
— —	FORMER LOCATION OF OIL HOUSE STRUCTURES
▨	APPROXIMATE LOCATION OF CURRENT MORAINE ENGINE TANK FARM
– – –	EDGE OF UPPER CLAY TILL
NA	NOT AVAILABLE
*	ESTIMATED ELEVATION

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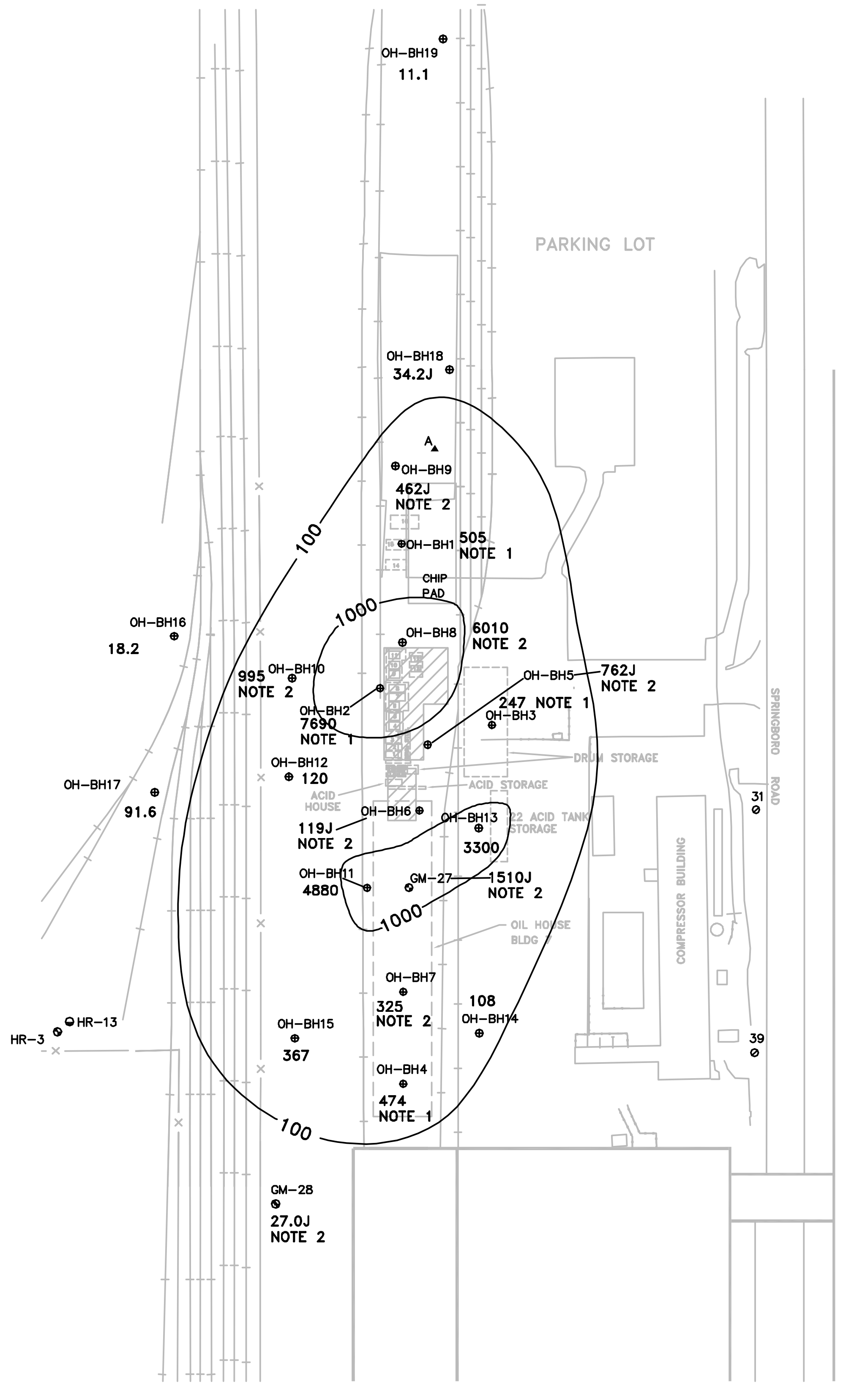
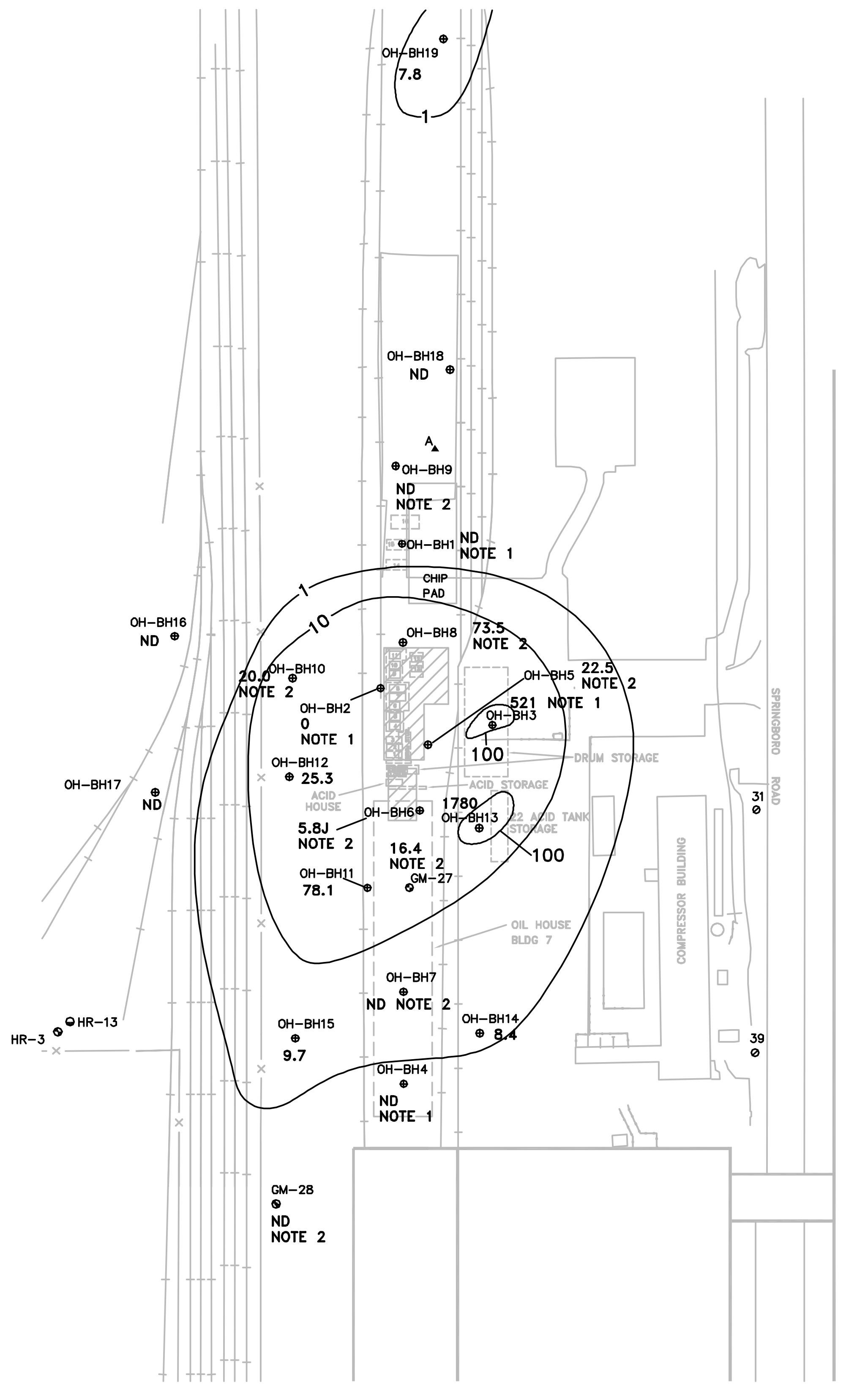
TOP OF UPPER CLAY TILL FOR AOI 7 – FORMER OIL HOUSE AREA

GENERAL MOTORS CORPORATION
MORAINE, OHIO

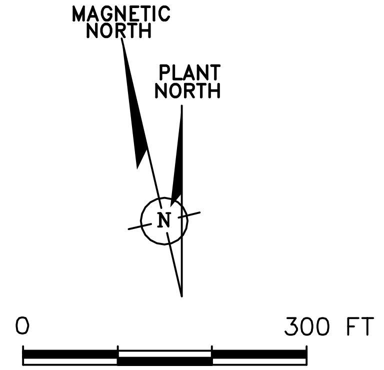
DATE MAR99	PROJECT MANAGER J. REID	DRAWING NAME HARR\N-B\RFISUP1E
DRAWN R. SMITH	LEAD DESIGN PROF. J. REID	CHECKED N. GILLOTTI
PROJECT NUMBER OH000294.0001.0002		DRAWING NUMBER 3-9



PCE CONCENTRATIONS



TCE CONCENTRATIONS



PCE/TCE CONTOURS HAVE BEEN DEVELOPED TO REPRESENT SOIL CONCENTRATIONS ABOVE THE WATER TABLE DURING NOVEMBER 1998, UNLESS OTHERWISE NOTED.

NOTES

1) DATA FROM MARCH 1998 SUPPLEMENTAL RFI SOIL SAMPLING.

2) DATA FROM AUGUST 1998 SUPPLEMENTAL RFI SOIL SAMPLING.

LEGEND

◕	MONITOR WELL (SHALLOW)
◒	MONITOR WELL (DEEP)
⊕	SOIL BORING
⊘	ACTIVE PRODUCTION WELL
▲	INACTIVE PRODUCTION WELL
OH	OIL HOUSE
BH	BORE HOLE
– – –	FORMER LOCATION OF OIL HOUSE STRUCTURES
▨	APPROXIMATE LOCATION OF CURRENT MORAINE ENGINE TANK FARM

TETRACHLOROETHENE (PCE) AND TRICHLOROETHENE (TCE) CONCENTRATIONS ARE REPRESENTED IN MICROGRAMS PER KILOGRAM

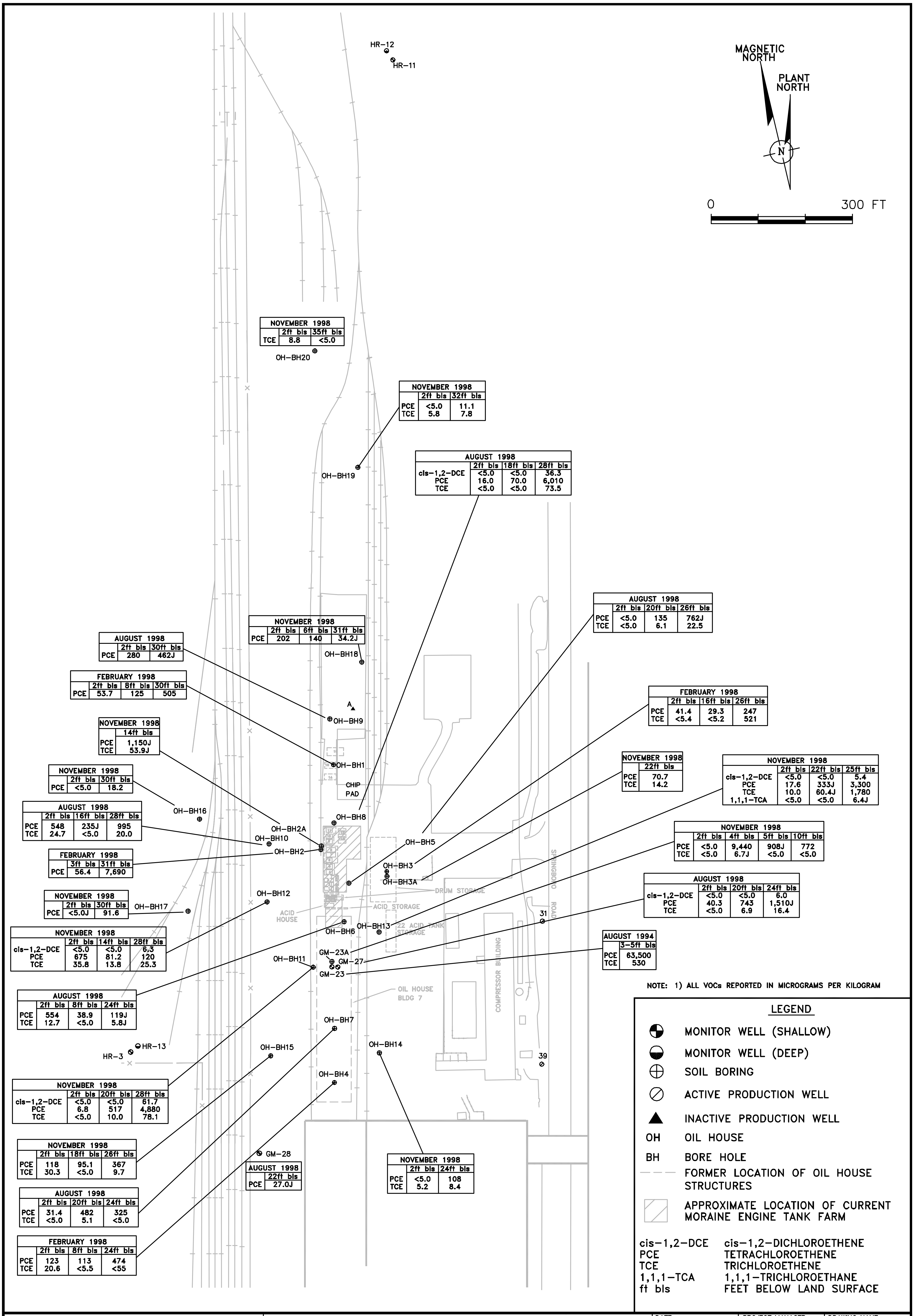
ND NOT DETECTED

ARCADIS GERAGHTY&MILLER

PCE/TCE CONCENTRATIONS IN SOIL ABOVE WATER TABLE FOR AOI 7 – FORMER OIL HOUSE AREA

GENERAL MOTORS CORPORATION
MORAINE, OHIO

DRAWN R. SMITH	DATE 27MAY99	PROJECT MANAGER J. REID	DRAWING NAME HAR\CRA\AOI7-03
		LEAD DESIGN PROF. J. REID	CHECKED N. GILLOTTI
		PROJECT NUMBER OH0294.01.02	FIGURE NUMBER 3-10



NOVEMBER 1998		
	2ft bls	35ft bls
TCE	8.8	<5.0

NOVEMBER 1998		
	2ft bls	32ft bls
PCE	<5.0	11.1
TCE	5.8	7.8

AUGUST 1998			
	2ft bls	18ft bls	28ft bls
cis-1,2-DCE	<5.0	<5.0	36.3
PCE	16.0	70.0	6,010
TCE	<5.0	<5.0	73.5

AUGUST 1998			
	2ft bls	20ft bls	26ft bls
PCE	<5.0	135	762J
TCE	<5.0	6.1	22.5

NOVEMBER 1998			
	2ft bls	6ft bls	31ft bls
PCE	202	140	34.2J

AUGUST 1998		
	2ft bls	30ft bls
PCE	280	462J

FEBRUARY 1998			
	2ft bls	8ft bls	30ft bls
PCE	53.7	125	505

FEBRUARY 1998			
	2ft bls	16ft bls	26ft bls
PCE	41.4	29.3	247
TCE	<5.4	<5.2	521

NOVEMBER 1998	
	14ft bls
PCE	1,150J
TCE	53.9J

NOVEMBER 1998	
	22ft bls
PCE	70.7
TCE	14.2

NOVEMBER 1998			
	2ft bls	22ft bls	25ft bls
cis-1,2-DCE	<5.0	<5.0	5.4
PCE	17.6	333J	3,300
TCE	10.0	60.4J	1,780
1,1,1-TCA	<5.0	<5.0	6.4J

NOVEMBER 1998		
	2ft bls	30ft bls
PCE	<5.0	18.2

AUGUST 1998			
	2ft bls	16ft bls	28ft bls
PCE	548	235J	995
TCE	24.7	<5.0	20.0

NOVEMBER 1998				
	2ft bls	4ft bls	5ft bls	10ft bls
PCE	<5.0	9,440	908J	772
TCE	<5.0	6.7J	<5.0	<5.0

FEBRUARY 1998		
	3ft bls	31ft bls
PCE	56.4	7,690

AUGUST 1998			
	2ft bls	20ft bls	24ft bls
cis-1,2-DCE	<5.0	<5.0	6.0
PCE	40.3	743	1,510J
TCE	<5.0	6.9	16.4

NOVEMBER 1998		
	2ft bls	30ft bls
PCE	<5.0J	91.6

NOVEMBER 1998			
	2ft bls	14ft bls	28ft bls
cis-1,2-DCE	<5.0	<5.0	6.3
PCE	675	81.2	120
TCE	35.8	13.8	25.3

AUGUST 1994	
	3-5ft bls
PCE	63,500
TCE	530

NOTE: 1) ALL VOCs REPORTED IN MICROGRAMS PER KILOGRAM

AUGUST 1998			
	2ft bls	8ft bls	24ft bls
PCE	554	38.9	119J
TCE	12.7	<5.0	5.8J

NOVEMBER 1998			
	2ft bls	20ft bls	28ft bls
cis-1,2-DCE	<5.0	<5.0	61.7
PCE	6.8	517	4,880
TCE	<5.0	10.0	78.1

NOVEMBER 1998			
	2ft bls	18ft bls	26ft bls
PCE	118	95.1	367
TCE	30.3	<5.0	9.7

AUGUST 1998	
	22ft bls
PCE	27.0J

NOVEMBER 1998		
	2ft bls	24ft bls
PCE	<5.0	108
TCE	5.2	8.4

AUGUST 1998			
	2ft bls	20ft bls	24ft bls
PCE	31.4	482	325
TCE	<5.0	5.1	<5.0

FEBRUARY 1998			
	2ft bls	8ft bls	24ft bls
PCE	123	113	474
TCE	20.6	<5.5	<55

LEGEND

◕	MONITOR WELL (SHALLOW)
◒	MONITOR WELL (DEEP)
⊕	SOIL BORING
⊘	ACTIVE PRODUCTION WELL
▲	INACTIVE PRODUCTION WELL
OH	OIL HOUSE
BH	BORE HOLE
— — —	FORMER LOCATION OF OIL HOUSE STRUCTURES
▨	APPROXIMATE LOCATION OF CURRENT MORAINE ENGINE TANK FARM

cis-1,2-DCE	cis-1,2-DICHLOROETHENE
PCE	TETRACHLOROETHENE
TCE	TRICHLOROETHENE
1,1,1-TCA	1,1,1-TRICHLOROETHANE
ft bls	FEET BELOW LAND SURFACE

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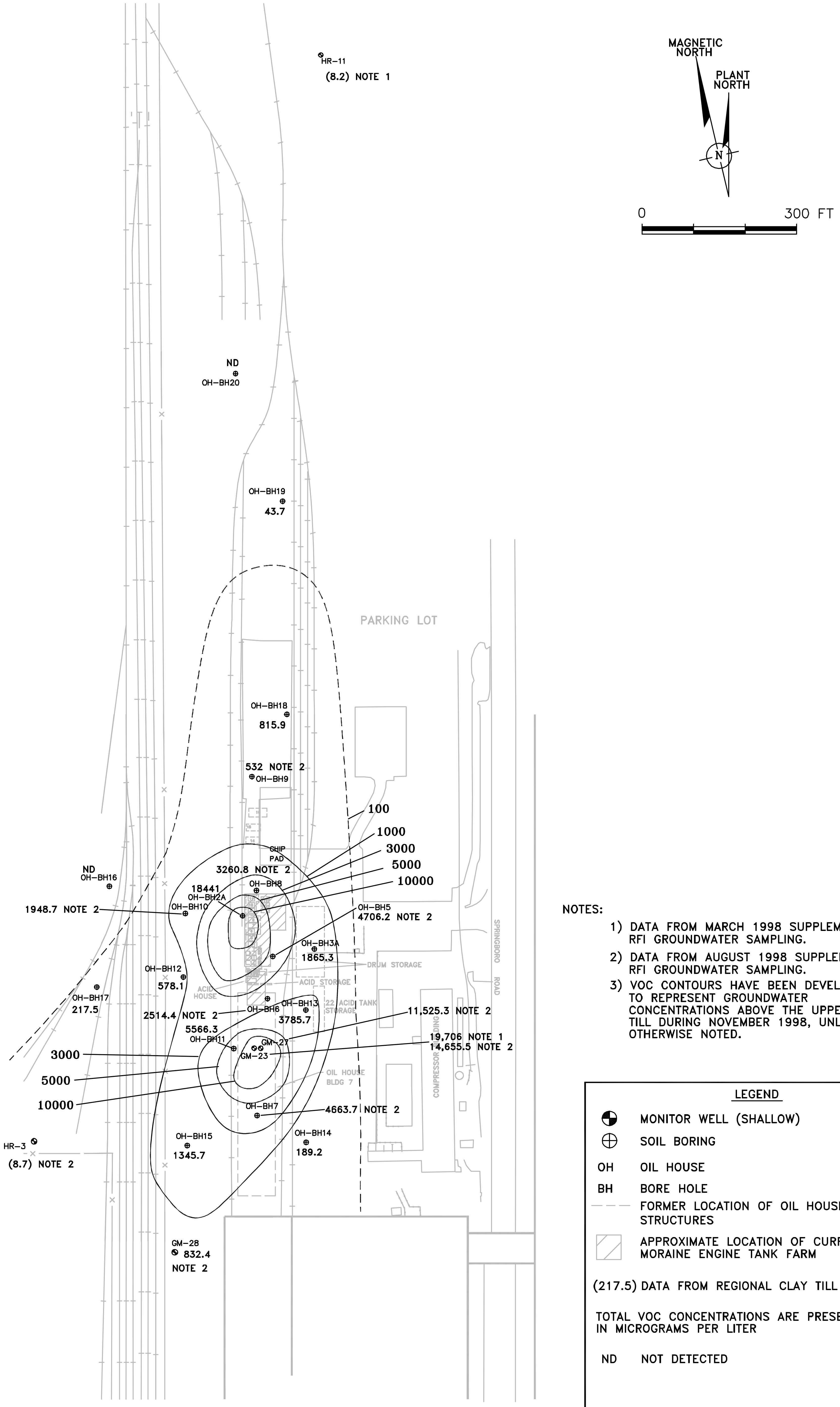
VOC CONCENTRATIONS IN SOIL
AOI 7 – FORMER OIL HOUSE AREA

GENERAL MOTORS CORPORATION
MORAINE, OHIO

DATE MAR99	PROJECT MANAGER J. REID	DRAWING NAME HAR\CRA\\OH294-03
DRAWN R. SMITH	LEAD DESIGN PROF. J. REID	CHECKED N. GILLOTTI
PROJECT NUMBER OH000294.0001.0002		DRAWING NUMBER 3-11



NOTES:

1) DATA FROM MARCH 1998 SUPPLEMENTAL RFI GROUNDWATER SAMPLING.
2) DATA FROM AUGUST 1998 SUPPLEMENTAL RFI GROUNDWATER SAMPLING.
3) VOC CONTOURS HAVE BEEN DEVELOPED TO REPRESENT GROUNDWATER CONCENTRATIONS ABOVE THE UPPER CLAY TILL DURING NOVEMBER 1998, UNLESS OTHERWISE NOTED.

LEGEND

◒	MONITOR WELL (SHALLOW)
⊕	SOIL BORING
OH	OIL HOUSE
BH	BORE HOLE
– – –	FORMER LOCATION OF OIL HOUSE STRUCTURES
▨	APPROXIMATE LOCATION OF CURRENT MORAINE ENGINE TANK FARM
(217.5)	DATA FROM REGIONAL CLAY TILL

TOTAL VOC CONCENTRATIONS ARE PRESENTED IN MICROGRAMS PER LITER

ND NOT DETECTED

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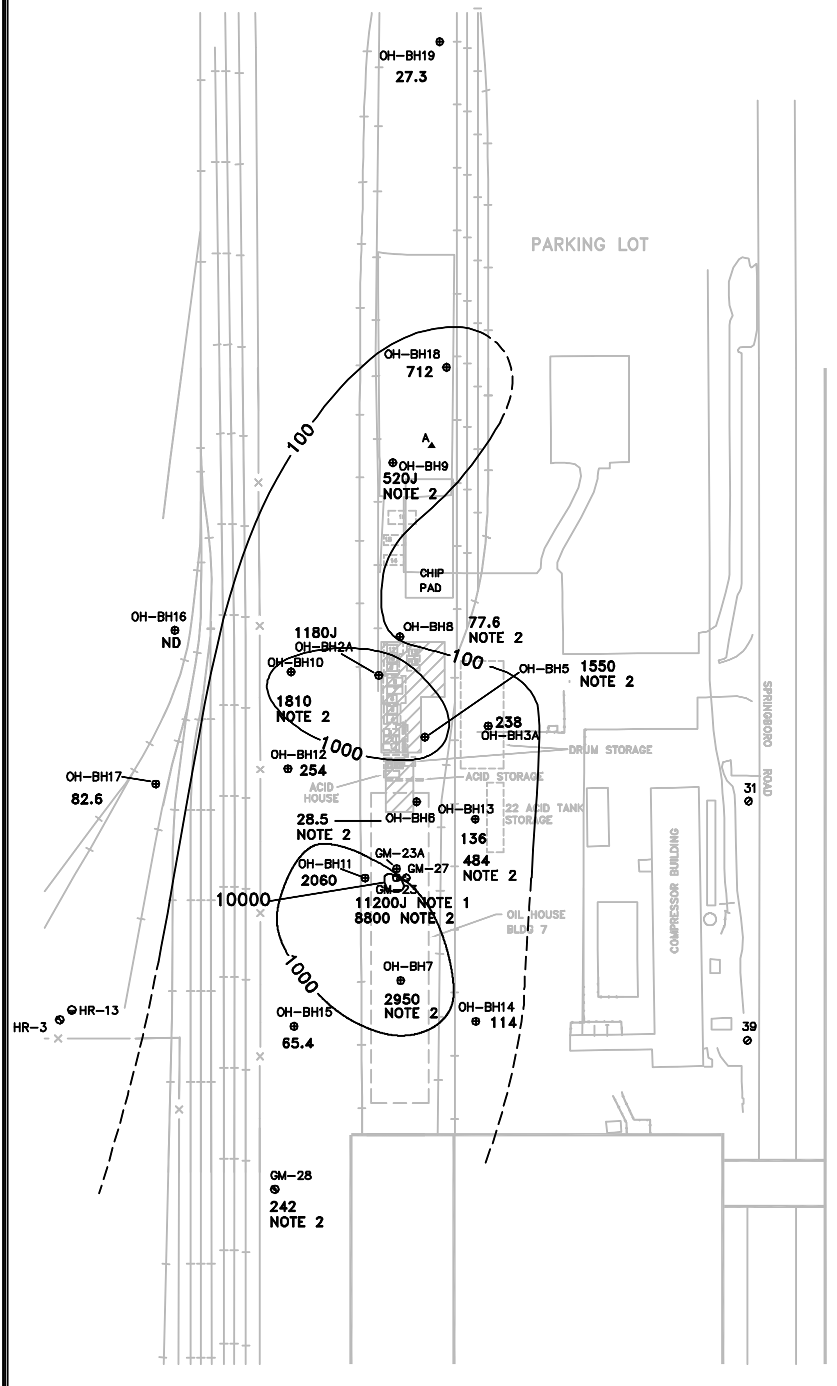
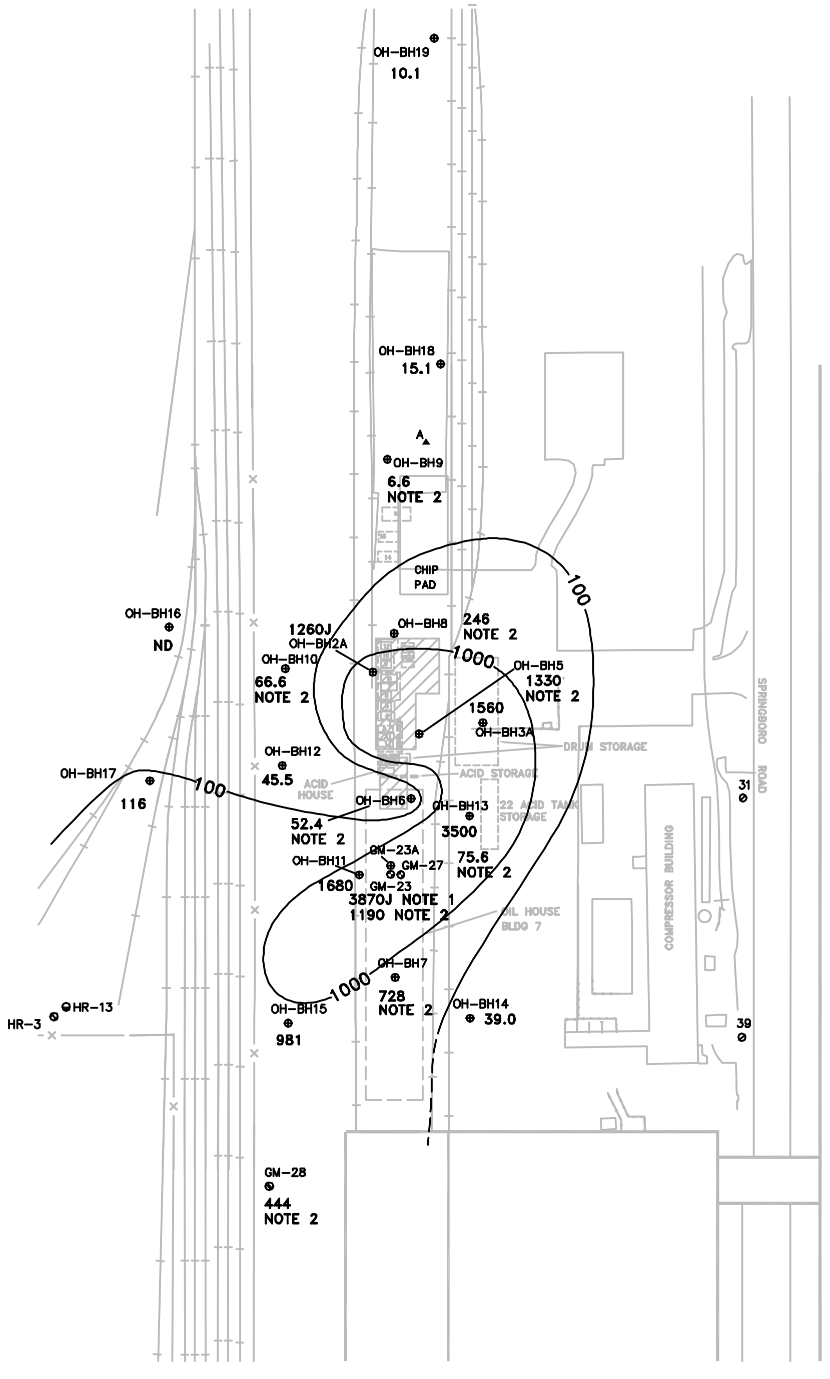
TOTAL VOC CONCENTRATIONS IN SHALLOW GROUNDWATER FOR AOI 7 – FORMER OIL HOUSE AREA

GENERAL MOTORS CORPORATION
MORAINE, OHIO

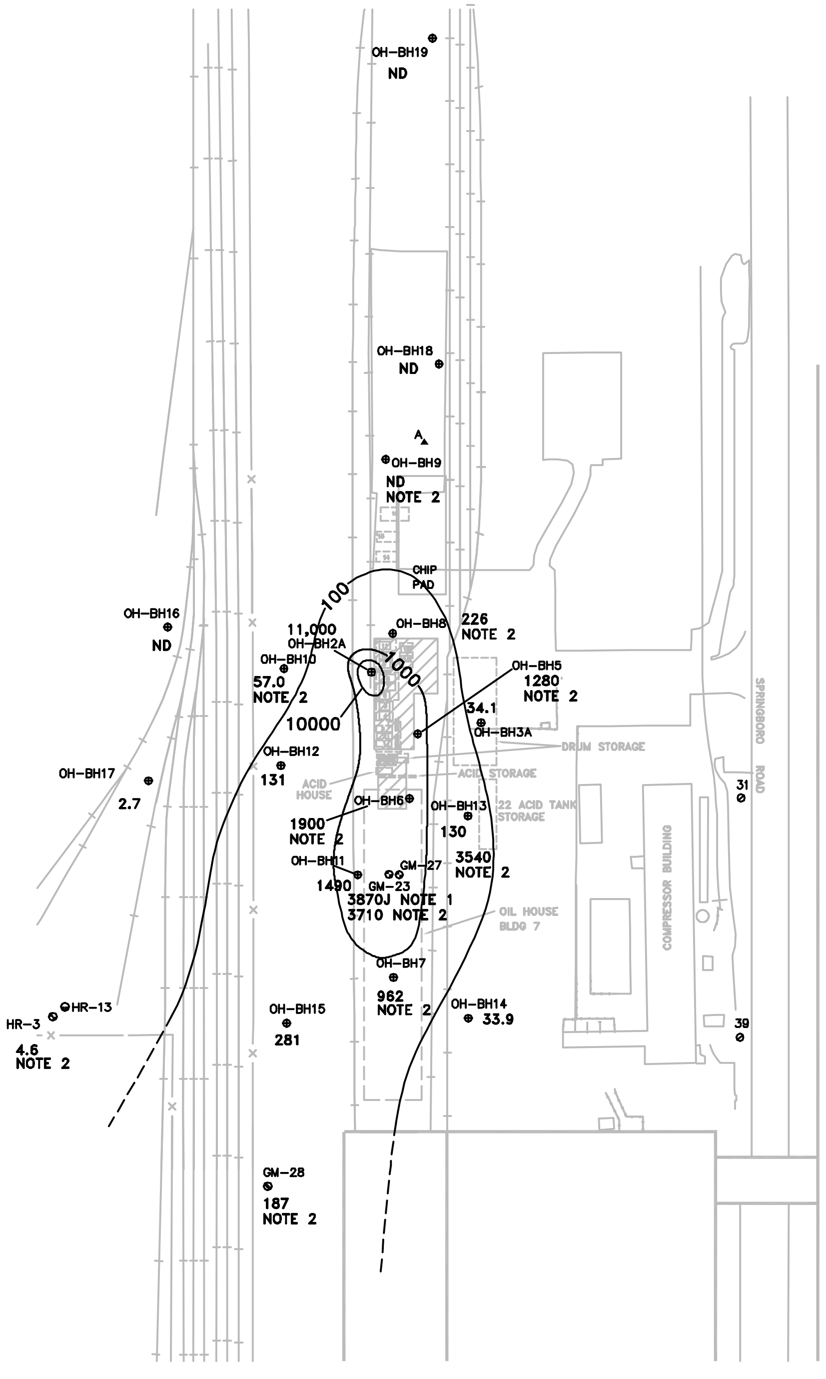
DATE MAR99	PROJECT MANAGER J. REID	DRAWING NAME HARR\N-B\RFISUP1F
DRAWN R. SMITH	LEAD DESIGN PROF. J. REID	CHECKED N. GILLOTTI
PROJECT NUMBER OH000294.0001.0002		DRAWING NUMBER 3-12



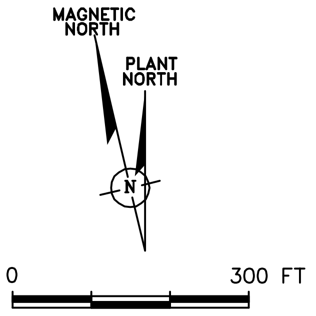
PCE CONCENTRATIONS



TCE CONCENTRATIONS



CIS-1,2-DCE CONCENTRATIONS



PCE/TCE CONTOURS HAVE BEEN DEVELOPED TO REPRESENT GROUNDWATER CONCENTRATIONS ABOVE THE UPPER CLAY TILL DURING NOVEMBER 1998, UNLESS OTHERWISE NOTED.

NOTES

1) DATA FROM MARCH 1998 SUPPLEMENTAL RFI GROUNDWATER SAMPLING.
2) DATA FROM AUGUST 1998 SUPPLEMENTAL RFI GROUNDWATER SAMPLING.

LEGEND

◕	MONITOR WELL (SHALLOW)
◒	MONITOR WELL (DEEP)
⊕	SOIL BORING
⊘	ACTIVE PRODUCTION WELL
▲	INACTIVE PRODUCTION WELL
OH	OIL HOUSE
BH	BORE HOLE
- - -	FORMER LOCATION OF OIL HOUSE STRUCTURES
▨	APPROXIMATE LOCATION OF CURRENT MORAINE ENGINE TANK FARM

TETRACHLOROETHENE (PCE), TRICHLOROETHENE (TCE), AND CIS-1,2-DICHLOROETHENE (CIS-1,2-DCE) CONCENTRATIONS ARE REPRESENTED IN MICROGRAMS PER LITER

ND NOT DETECTED

ARCADIS GERAGHTY&MILLER

PCE/TCE/CIS-1,2-DCE CONCENTRATIONS IN SHALLOW GROUNDWATER FOR AOI 7 – FORMER OIL HOUSE AREA

GENERAL MOTORS CORPORATION
MORAINE, OHIO

DRAWN R. SMITH	DATE 27MAY99	PROJECT MANAGER J. REID	DRAWING NAME HAR\CRA\AOI7-02
		LEAD DESIGN PROF. J. REID	CHECKED N. GILLOTTI
		PROJECT NUMBER OH0294.01.02	FIGURE NUMBER 3-13

DRAFT

Appendix B

Completion Strategy Supporting Documentation

TABLE B-1: Preliminary Remediation Target Levels

Remediation Target Levels (mg/L) - Upper Aquifer

Point of Compliance	*GM-26*		Constituent of Concern					
Allowable POC Concentration (mg/L):			*PCE* *0.005*	*TCE* *0.005*	*1,1-DCE* *0.007*	*cis-1,2-DCE* *0.070*	*Vinyl Chloride* *0.002*	**monitoring wells**
Estimated Remediation Target Level at AOI 7 (mg/L):			*1.667*	*1.667*	*2.333*	*23.333*	*0.667*	
Distance from AOI 7 (monitoring zone)	**Source Reduction Factor**	**Normalized Remediation Target**	**Remediation Target (mg/L)**	**Remediation Target (mg/L)**	**Remediation Target (mg/L)**	**Remediation Target (mg/L)**	**Remediation Target (mg/L)**	GM-23, GM-29 and GM-30
140 ft (Zone S1)	0.9	300	1.500	1.500	2.100	21.000	0.600	GM-28
1190 ft (Zone S1 to Zone S2)	0.7	233	1.167	1.167	1.633	16.333	0.467	GM-28, ME-6
2240 ft (Zone S2)	0.1	33	0.167	0.167	0.233	2.333	0.067	ME-6, ME-3, GM-31
2940 ft (Zone S2 to Zone S3)	0.04	13	0.067	0.067	0.093	0.933	0.027	ME-6, ME-3, GM-31, GM-22, GM-19S, and EAST
3640 ft (Zone S3)	0.03	10	0.050	0.050	0.070	0.700	0.020	GM-32, GM-21
4430 ft (Zone S3 to GM-10)	0.02	7	0.033	0.033	0.047	0.467	0.013	GM-32, GM-21, GM-8, GM-6, 4S, GM-2, GM-16, GM-17, GM-18, WSU-24, and GM-10
5215 ft (GM-10)	0.008	3	0.013	0.013	0.019	0.187	0.005	GM-10
6370 ft (POC)	0.003	1	0.005	0.005	0.007	0.070	0.002	GM-26

Remediation Target Level (mg/L) - Lower Aquifer

Point of Compliance	*GM-11, GM-15 and GM-20D*		Constituent of Concern					
Allowable POC Concentration (mg/L):			*PCE* *0.005*	*TCE* *0.005*	*1,1-DCE* *0.007*	*cis-1,2-DCE* *0.070*	*Vinyl Chloride* *0.002*	**monitoring wells**
Estimated Remediation Target Level at AOI 7 (mg/L):			*0.556*	*0.556*	*0.778*	*7.778*	*0.222*	
Distance from AOI 7 (monitoring zone)	**Source Reduction Factor**	**Normalized Remediation Target**	**Remediation Target (mg/L)**	**Remediation Target (mg/L)**	**Remediation Target (mg/L)**	**Remediation Target (mg/L)**	**Remediation Target (mg/L)**	GM-23, GM-29 and GM-30
3250 ft (Zone D1)	0.03	3	0.017	0.017	0.023	0.233	0.007	GM-19 and Well 32
4250 ft (Zone D2)	0.02	2	0.011	0.011	0.016	0.156	0.004	GM-1 and GM-3
4900 ft (POC)	0.009	1	0.005	0.005	0.007	0.070	0.002	GM-11, GM-15 and GM-20D