Site-Wide Groundwater Monitoring Plan
Motors Liquidation Company
Dr. Martin Luther King Jr. Boulevard Site
Anderson, Indiana
RCRA Corrective Action
IND 980 700 801

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ACRONYMS AND ABBREVIATIONS

AOC	area of concern
AOI	areas of interest
cis-1,2-DCE	cis-1,2-dichloroethene
CLP	contract laboratory program
CM	corrective measures
CMP	corrective measures plan
CRA	Conestoga-Rovers & Associates
EI	Environmental Indicator
ENVIRON	ENVIRON International Corporation
FMG	Field Method Guideline
GM	General Motors Corporation
IDEM	Indiana Department of Environmental Management
IM	Interim Measure
MCL	Maximum Contaminant Level
MLC	Motors Liquidation Company
MLK	Martin Luther King Jr.
MNA	natural attenuation parameters
RCRA	Resource Conservation and recovery Act
RFI	RCRA Facility Investigation
RISC	Risk Integrated System of Closure
TCE	trichloroethene
TCL	target compound list
US EPA	United States Environmental Protection Agency
VC	vinyl chloride
VOC	volatile organic compound
WWTP	wastewater treatment plant

1. Introduction

This document presents a site-wide groundwater monitoring plan to be implemented concurrent with the final corrective measures at the former Motors Liquidation Company (MLC) Dr. Martin Luther King Jr. Boulevard (MLK) facility, Anderson, Indiana (IND 980 700 801). This plan is submitted to the Indiana Department of Environmental Management (IDEM) in support of ongoing Resource Conservation and Recovery Act (RCRA) Corrective Action at the site. A draft version of this plan was submitted to the IDEM in March 2008. This final version of the plan includes revisions recommended by the IDEM in correspondence dated May 2, 2008 and March 16, 2010 and additional sampling agreed to by MLC and the IDEM.

1.1 OBJECTIVES

The objectives of the proposed groundwater monitoring are to:

1. evaluate the effectiveness of the proposed in-situ corrective measures (CM) for groundwater; and
2. monitor the stability of the two volatile organic compound (VOC) plumes.

1.2 REPORT ORGANIZATION

Section 2 of this plan provides site background relevant to the current status of groundwater monitoring, including a summary of previous groundwater monitoring activity. Section 3 presents the proposed site-wide monitoring plan. Section 4 summarizes data evaluation procedures. Section 5 discusses data reporting.

2. Background

2.1 SITE DESCRIPTION

The MLC MLK Boulevard site is located in the northwest quarter of Section 23, T19N, R7E, on the southwest side of Anderson, Madison County, Indiana (Figure 2-1). Formerly, the site comprised approximately 3,000,000 square feet of manufacturing area situated on 234 acres. MLK Boulevard divides the site in a north-south direction. MLC (formerly known as General Motors Corporation) previously conducted manufacturing operations in plants on both sides of MLK Boulevard. The former east manufacturing areas (Plants 6 and 9) are bounded by MLK Boulevard on the west, by a railroad on the south, by 29th Street on the north, and by Madison Avenue on the east (Figure 2-2).

The manufacturing facilities west of MLK Boulevard, referred to as the Main Plant, were bounded on the west, south and southeast by railroad tracks, and on the north by 25th Street. Facility parking areas were located west of the westernmost railroad, and north of 25th Street. Developed areas of the property were largely covered with asphalt or concrete. Small areas near former administrative buildings and along property borders were maintained in short grass cover. Land use surrounding the site varies from residential and commercial on the north and east, to residential and recreational on the south, and to agricultural on the west. The Meadowbrook Golf Course is located southeast of the site (Figure 2-2).

Operations at the MLK Boulevard facility began in 1929. Manufacturing plants were expanded several times, generally proceeding from the north end of the Main Plant southward and eastward. East of MLK Boulevard, Plant 9 construction commenced in 1969, and building additions were performed in 1973, 1977, 1981, 1985, 1986 and 1989. Manufacturing operations at the site ceased in 2006. All facilities west of MLK Boulevard were demolished during the period late 2007 to early 2009. The demolition included the removal of all concrete building slabs and many areas of pavement around the immediate Main Plant building area. Following demolition, the area was regraded and covered with varying thicknesses of crushed concrete. A soil and vegetative cover was applied during the summer of 2009.

The former Plant 6 and 9 properties and a lot east of Madison Avenue were sold by GM soon after manufacturing operations ceased there in 1997. The remaining portions of the property were held by GM until its bankruptcy in June 2009. As part of the bankruptcy**,** these assets remained the property of "old" GM, which is now known as MLC in the role of debtor-in-possession. Figure 2-2 shows the current MLC property boundary. The term "site", as used throughout this report, refers to the aggregate of current and former MLC properties.

2.2 HYDROGEOLOGY

Detailed hydrogeologic cross sections are presented in both the Stage II RFI Data Report (Earth Tech, March 30, 2005) and the RFI Final Report (Earth Tech and ENVIRON, September 28, 2007). Figure 2-3 presents a generalized, schematic hydrogeologic cross section of the unconsolidated materials at the site showing monitoring well completion intervals.

The unconsolidated deposits range from less than 20 to over 160 feet in thickness and overlie an irregular bedrock surface. Bedrock beneath the site consists of carbonate rocks of Silurian age. Five distinct geologic units are recognized in the unconsolidated surficial soil materials. These units are identified from top to bottom as Units 1 to 5.

Unit 1 is a heterogeneous fill material consisting of silty clay loam, silty clay, sandy clay, sandy clay loam, and loam texture soil intermixed, in places, with debris consisting of wood, brick, glass, concrete, coal fragments, and cinders. The unit consists of fill material placed at various times during the developmental history of the property and is generally no more than a few feet in thickness.

In places, the lower portion of the Unit 1 fill is saturated and a localized perched groundwater zone occurs. The clayey diamicts in Unit 2 form an underlying confining unit resulting in this perched groundwater condition. Saturated conditions have been observed in the basal portion of Unit 1 in several shallow AOC 1 – South Court Area soil borings.

Unit 2 is a glacial diamict of silty clay loam, silty clay, and loam texture with occasional thin, interbedded sand and gravel deposits. Sand and gravel lithologies make up a small percentage of the unit. Unit 2 is thin in southern and eastern parts of the site, but thickens to the north and west.

Unit 3 consists of stratified sand and gravel and forms the uppermost aquifer beneath the site. In places, a diamict occurs within Unit 3 and is identified as the Unit 3 Confining Bed. At some locations the confining bed is represented by a distinctive silty texture and laminated structure. The confining bed is hydrologically significant because it separates the Unit 3 aquifer into an upper portion (Unit 3S) and lower portion (Unit 3D). Unit 3 is generally only 10 to 20 feet thick in the eastern part of the site. The unit thickens appreciably in the western part of the site where it forms the major portion of the unconsolidated deposits.

Unit 3 is almost entirely within the phreatic zone and is the uppermost aquifer unit at the site. Groundwater may exist in the unit under both confined and unconfined conditions. Where the base of Unit 2 is relatively high in elevation, the upper few feet of Unit 3 are unsaturated, and unconfined conditions occur. At locations where the base of Unit 2 is relatively low in elevation, the top of Unit 3 is saturated, and confined conditions occur.

Unit 3 has been divided into upper (Unit 3S) and lower (Unit 3D) parts. In those places where there is no physical separation between the upper and lower parts of the unit provided by the Unit 3 Confining Bed, the designations 3S and 3D merely provide a convenient way to refer to the upper and lower portions of the Unit 3 aquifer, and the monitoring wells completed therein. Where a physical separation occurs due to the presence of the Unit 3 Confining Bed, Unit 3S refers to that portion of the aquifer above the confining layer and Unit 3D refers to that portion below the confining layer. Locally, the Unit 3 Confining Bed induces a downward vertical gradient within the Unit 3 aquifer. Where the confining bed is absent, water levels in Units 3S and 3D are comparable.

The lateral groundwater gradient in Unit 3S is directed to the northeast in AOC 1 - South Court Area. Locally there are significant variations in the magnitude and direction of the gradient related, in part, to the presence or absence of the Unit 3 Confining Bed. An east-southeast oriented potentiometric trough in Unit 3S persistently occurs in the vicinity MW 40, 42, and 68 where the confining bed is absent. In this area groundwater flow in Unit 3S appears to drain easterly into a relict northeast - southwest oriented glacial meltwater valley. Former Plant 9 and the Meadowbrook Golf Course are located in the glacial meltwater valley.

The hydraulic gradient for Unit 3D is more consistent and the potentiometric surface for this unit suggests an eastward gradient in the South Court Area and along MLK Boulevard. The relict meltwater valley at former Plant 9 and the Meadowbrook Golf Course appears to induce a hydraulic gradient to the south along its axis. Contaminants in the lower portion of Unit 3 would be expected to move generally eastward and then southward near the former WWTP area.

Unit 4 consists of hard diamict of loam or clay loam texture. The unit forms a confining bed between Unit 3 and Silurian carbonate bedrock. The unit is absent from the eastern part of the area at Plant 9 and portions of the adjacent Meadowbrook Golf Course.

Two deep bedrock borings at the north end of the site (MW 62 and MW 71) encountered a bed of cobbles above the bedrock surface. This zone is referred to as Unit 5. The unit was encountered at no other locations.

2.3 PREVIOUS GROUNDWATER MONITORING

Groundwater monitoring has been conducted at the facility since 1992. RCRA Corrective Action monitoring began in 2000 and is described in several previous documents (Earth Tech and ENVIRON, July 31, 2001, January 31, 2007, September 28, 2007, January 31, 2008; AECOM, 26, 2010). The earliest site wells (MW 1 to MW 17) were installed in 1992 and 1993 for the purposes of evaluating a suspected waste oil leak at Area 1 – Former Waste Oil Tank (SWMU 16) (Figure 2-2). The longest monitoring history exists for these wells. Most of the 1992 – 1993 wells were installed in Unit 3S. No evidence of a significant waste oil leak was found at SWMU 16, but elevated concentrations of VOCs, primarily trichloroethene (TCE), cis-1,2-dichloroethene (cis-1,2-DCE) and vinyl chloride (VC) were detected in several wells in this area. These wells are now known to be located in and around a source area for the Area 1 – South Court VOC plume.

Work associated with RFI Stage I in 2000 – 2001 included installation of 19 new monitoring wells (MW 18 to MW 37) and collection of 85 groundwater samples from new and existing wells. The new wells were completed in Units 1, 3S, and 3D. The Stage I investigations partially delineated a groundwater VOC plume extending north and east from AOC 1 - South Court. This plume was found to overlap several previously-defined AOIs and was referred to as *Area 1.* The Stage I RFI investigations identified concentrations of TCE, cis-1,2-DCE, and VC above screening criteria based on state and federal maximum contaminant levels (MCLs). A Stage I RFI report was completed in 2001, and this report included a work plan for additional ground water delineation work in both on and off-site areas (Earth Tech and ENVIRON, July 31, 2001).

Stage II RFI investigations began in late 2003 upon IDEM approval of the plan for additional work described in the Stage I report. Work associated with RFI Stage II in 2003 – 2005 included installation of 47 monitoring wells (MW 38 to MW 84) and collection of 182 groundwater samples from both new and existing wells. Area 1 was expanded to include former Plant 9 as well as off-site areas including Meadowbrook Golf Course. Seven wells (MW-1 to MW-7) were installed on the golf course by others in 2003. Sampling of MW-4 in October 2003 indicated that high concentrations of cis-1,2-DCE and VC were present. Additional wells (MW 56, 57, 58 and 77) were installed by GM on the golf course in 2004 to delineate the VOC plume southeast of MW-4 (Figure 2-2). Sampling at these and other RFI Stage II monitoring wells delineated the concentrations of TCE, cis-1,2-DCE, and VC above MCLs both on and off-site (Earth Tech and ENVIRON, September 28, 2007).

From October 2005 until October 2007, MLC conducted quarterly monitoring of a selected group of monitoring wells in accordance with an interim site-wide groundwater monitoring plan (Conestoga-Rovers & Associates, September 20, 2005). This work was scheduled for nine consecutive quarters terminating in October 2007. The interim monitoring program was replaced by a revised site-wide program in March 2008. Summary results from this monitoring have been provided in the 2006, 2007, 2008, and 2009 Annual Groundwater Monitoring Reports referenced in Section 6.

2.4 INTERIM MEASURES

MLC previously implemented interim measures (IMs) related to soil and groundwater at the site. One interim measure included the removal of soil at the MW 31 area of AOC 1 – South Court that contained TCE concentrations that were an order of magnitude greater than the soil concentrations in other portions of the site. In addition to removing the soil in this area, perched groundwater in Unit 1 fill was treated with HRC® as an additional source reduction measure for TCE, cis-1,2-DCE, and VC in the underlying Unit 3 aquifer. During the IM, monitoring well MW 31 completed in the fill soil was removed. Following the IM, a replacement well (MW 31R) was installed at the former MW 31 well location.

The second interim measure implemented by MLC included the abandonment of two potable wells at the Meadowbrook Golf Course and subsequent connection of the golf course to public water supply. In addition, MLC and the owners of the Meadowbrook Golf Course have entered into an access agreement that prohibits the use of groundwater under the golf course property. The agreement does allow use of surface water from a pond on the site for irrigation purposes. Samples from this pond are regularly collected and analyzed for VOCs.

The third interim measure implemented by MLC included the abandonment and plugging of five former groundwater production wells on site. This work was completed during the period April 30 to September 4, 2007 in accordance with Indiana Department of Natural Resources (IDNR) well abandonment rules (312 IAC 13). Abandonment activities including electrical disconnect, pump motor and pump column removal, and well grouting. The work followed a written work plan for well abandonment (Earth Tech, July 27, 2006) and was conducted by a licensed State of Indiana water well drilling contractor. The work is summarized in Earth Tech (November 16, 2007).

2.5 PROPOSED CORRECTIVE ACTION

MLC has proposed corrective measures (CMs) for groundwater at the site. The goal of the corrective measures is to ensure that groundwater VOC concentrations continue to remain at levels protective of current and reasonably expected future uses. The approach for achieving this goal will be in-situ groundwater treatment to reduce existing plume concentrations, groundwater use restrictions, and groundwater monitoring to confirm the CMs goals are achieved.

2.6 CURRENT STATUS OF GROUNDWATER MONITORING

2.6.1 VOC Plume Areas

The groundwater contaminate plumes at the MLK site are associated with *Area 1 – South Court and Related Areas*. Figure 2-4 to Figure 2-9 show the concentrations of the principal VOC constituents TCE, cis-1,2-DCE and VC in groundwater for hydrogeologic Units 3S and 3D (AECOM, April 26, 2010). The data posted on the maps are the most recent validated analytical data for each well. Since the Unit 3S confining unit is absent in the area of former Plant 9 and portions of the Meadowbrook Golf Course, and Unit 3 is relatively thin in these areas, the VOC data from wells in these areas are shown on both the Unit 3S and 3D isoconcentration maps. Each isoconcentration map also shows the relevant Unit 3S or 3D potentiometric surface as determined from April 28, 2009 water level data.

The isoconcentration maps indicate that there are two separate VOC plumes at the site. Both VOC plumes exist in Units 3S and 3D. One plume is associated with AOC 1 – South Court. The AOC-1 South Court plume extends beneath the former Main Plant building in a north-northeast direction. The plume orientation is apparently oblique to the Unit 3S hydraulic gradient shown in Figure 2-4 to Figure 2-6. This plume affects several Unit 3S monitoring wells including, from south to north, MW 79, MW 60, and MW 51. In contrast, an arc of Unit 3S monitoring wells to the east of these, including from south to north, MW 46, MW 16, MW 17, MW 84, MW 59, and MW 29 have not shown any significant VOC contamination. The predominant VOCs detected in this area are TCE, cis-1,2-DCE, and vinyl chloride. The highest reported concentrations of TCE in this plume are found in the South Court at MW 3 and MW 15 (Unit 3s) and MW 31R (Unit 1). Perched groundwater in Unit 1 appears to serve as a source of VOCs in Unit 3. These VOCs are present in both the 3S and 3D portions of Unit 3, but concentrations are generally higher in the upper portion of the unit. The Unit 3D plume originating from AOC 1 – South Court extends west to MW 53 (Figure 2-8), and VOC contamination in this area was likely induced from pumping of former groundwater production wells 11 and 12.

A separate VOC plume, referred to as the former WWTP plume, is located along and east of MLK Boulevard. This plume appears to be associated with the site's wastewater treatment plant (WWTP), or the piping to the WWTP formerly located in this area. The primary evidence for separation of the plumes comes from several Unit 3S wells located between the plumes where VOCs have not been detected, or detected only at very low levels (Figure 2-2, MW 16, 17, 36, 37, 45, 46, 57 and 84). The former WWTP Area plume extends from an apparent source near MW 68 along MLK Boulevard eastward toward former Plant 9 and southeastward to the Meadowbrook Golf Course. This VOC plume is composed primarily of cis-1,2-DCE in the source area, and the highest reported concentrations occur at MW 40, 41, 68, -4. TCE is a relatively minor component even in the source area of this plume.

The primary VOC component in wells on the perimeter of the former WWTP plume is VC (Figure 2-6 and Figure 2-9). The highest reported concentrations for VC in the former WWTP plume occur at MW-4 on the Meadowbrook Golf Course. The edge of the plume east of MLK Boulevard is marked by persistent occurrences of VC in Plant 9 Unit 3 wells MW 58, 64, 66, and 80. The extent of the plume to the southeast is defined by non-detect or only low level VOC values at MW 56, MW 57, MW-2, and MW-3.

An unusual aspect of the former WWTP plume is its unusual width (north-south) versus length (east-west). From the apparent plume source near MW 68 a steep hydraulic gradient along the edge of the Unit 3 Confining Bed directs the plume eastward into the meltwater valley (Figure 2-6). The north-south gradient component within the meltwater valley is very low (Figure 2-9) resulting in a lateral spreading of the plume. At the same time, a westerly hydraulic gradient in the area east of MW 58 (the eastern portion of the glacial meltwater valley) effectively limits the migration of the plume to the east (Figure 2-9).

Typically, the lowest groundwater level in the former WWTP plume within the meltwater valley occurs at MW 58 on the Meadowbrook Golf Course (Figure 2-11). However, irrigation pumping during dry conditions, as occurred in 2007, may result in lower water levels observed in the golf course pond at locations Pond Intake and Culvert 1. The higher water levels at MW 66 compared to MW 58 indicate a consistent south gradient within the meltwater valley in the southern part of Plant 9 (Figure 2-11). North of MW 65 the north-south gradient component is very low. Generally, water levels at MW 65 and MW 80 are about the same, but the level at MW 61 to the north is usually higher (Figure 2-12) suggesting a slight southward gradient in the northern portion of Plant 9. A groundwater divide beneath Plant 9 may exist separating groundwater discharge to the south along Stanley Ditch and Prairie Creek versus discharge to the north toward White River in Anderson. Additional monitoring wells in the northern part of Plant 9 were proposed in the 2009 annual groundwater monitoring report to further evaluate this situation (AECOM, April 26, 2010).

It not readily apparent from the Unit 3S potentiometric contour mapping shown in Figure 2-4 to Figure 2-6 why the plume separation exists. The potentiometric mapping shown in Figure 2-4 to Figure 2-6 indicates, for example, that MW 16, MW 17, MW 59, and MW 84, are potentially downgradient of the affected, MW 18 / MW 19, MW 23, and MW 79 wells. Yet, VOCs do not occur in these wells. This discrepancy appears to be related to the well data used to generate the potentiomentric contours. Only wells MW 46, MW 51, and MW 79 are in the current site-wide groundwater monitoring well system where water level data are routinely obtained. Data from the other wells are not generally obtained during routine monitoring. Using only wells MW 46, MW 51, and MW 79 for developing the Unit 3S potentiometric contours omits a significant potentiometric detail.

Figure 2-10 shows hydrograph records for the former Main Plant building monitoring wells referenced above. The time series plots for the unaffected wells (MW 16, 29, 46, MW 59, and MW 84) are shown using a solid symbol and a dashed line. The affected wells in the plume are plotted with a solid line and open well symbol. Inspection of the figure indicates that the unaffected wells east of the AOC 1 – South Court plume generally have higher water levels than the affected wells to the west. This is particularly evident in the July 2007 monitoring event when the levels in all the wells were measured. The persistent groundwater ridge that occurs along the arc between MW 46 and MW 29 is a likely reason why the VOC contamination from the AOC-1 South Court plume to the west has not affected wells MW 46, MW 16, MW 84, MW 59, and MW 29 and is not connected to the former WWTP Area plume. Additional water level monitoring of Unit 3S wells MW 16, 29, 59, and 84 was proposed in the 2009 annual groundwater monitoring report to further evaluate this situation (AECOM, April 26, 2010).

Statistical trend analysis for the principal VOC contaminants has been conducted annually, as last reported in the 2009 Annual Groundwater Monitoring Report (AECOM, April 26, 2010). Long term trend analysis results are shown by color coding in Figure 2-4 to Figure 2-9. The color codes represent decreasing trends (green - greater than 90% confidence level), increasing trends (red – greater than 90% confidence level) or no trend (blue).

2.6.2 Metals

Several historic chromium metal plating conveyors formerly existed in Main Plant building. These areas are shown in Figure 2-2. During the RFI, chromium (total and dissolved) and hexavalent chromium were analyzed in March and April 2004 samples from monitoring wells MW 38 to MW 49 located along the CSXT property and MLK Boulevard. No chromium MCL exceedences were noted, and hexavalent chromium was not detected in any of the samples.

MW 60, MW 78, and MW 79 were sampled for chromium (total and dissolved) and hexavalent chromium in January 2005. The US EPA maximum contaminant limit (MCL) of 0.1 mg/L for chromium was not exceeded by any of these wells. Further, hexavalent chromium was not detected in any of the samples.

The only chromium MCL exceedences for any groundwater samples at the site have been for 2001 samples at MW 16 and former monitoring well MW 31. Total chromium values at MW 16 in 2001 were 171 and 312 ug/L. Dissolved chromium was measured in one of these samples and was not detected. A total chromium value of 227 ug/L was measured in a 2001 sample at MW 31, but the dissolved chromium value was only 16 ug/L.

IDEM has requested that a follow-up metals analysis at 20 wells at the site be conducted.

2.7 CURRENT STATUS OF SURFACE WATER MONITORING

Water levels and VOC samples have been obtained from the central irrigation pond at the Meadowbrook Golf Course since late 2004. Significant findings from the surface water monitoring include the following.

1. Water levels at the central irrigation pond at Meadowbrook Golf Course track consistently with water levels in adjacent monitoring wells**,** indicating that the pond is groundwater fed.
2. Based on monitoring at adjacent monitoring well MW 85, the golf course irrigation pond appears to be within the former WWTP Area plume.
3. Concentrations of VC and cis-1,2-DCE have occasionally exceeded their MCLs (Figure 2-13) and (Figure 2-14), Criteria A) at both the Pond North and Pond Intake sample locations. However, the pond is not used as a source of drinking water.
4. The concentration of VC at Pond North has exceeded the direct contact criteria one time in December 2009 (Figure 2-14, Criteria C). Historical time-series plots indicate that both VC and cis-1,2-DCE appear at higher concentrations during times of high groundwater levels and / or cold weather conditions. There is also evidence that groundwater enters the pond via a drainage culvert (Pond Culvert 1) at the Pond North location. During the December 2009 sample event, the surface of the irrigation pond was frozen except for the immediate vicinity of the Pond Culvert 1 outfall. The Pond North sample was obtained from this unfrozen area. It is therefore likely that the high VC concentration at Pond North in December 2009 is a localized condition related to the culvert discharge because elevated VC was not present at the Pond Intake location during the December 2009 monitoring event.

3. Groundwater Monitoring Plan

This plan is designed to meet the objectives of the site-wide groundwater monitoring presented in Section 1.1. This plan presents modifications to the March 2008 draft plan based on previous sampling data, IDEM comments, and recommendations provided in previous annual groundwater monitoring reports. The monitoring well network and proposed groundwater sampling program are summarized in Table 3-1. Wells proposed for monitoring are shown in Figure 3-1.

3.1 ROUTINE GROUNDWATER MONITORING

3.1.1 Monitoring Well Network

Table 3-1 lists 31 wells and 2 surface water monitoring points proposed for site-wide groundwater monitoring. Monitoring wells MW 31R, MW 37, and MW 46 have been added based on IDEM comments. The table provides well location information and top-of-casing (TOC) elevation, also as requested by IDEM, the monitored hydrogeologic unit, the associated VOC plume, position of the monitoring point within the plume, and the monitoring schedule. Monitoring points are characterized as *"source"*, *"tail"*, or *"margin"* based on the relative position of the well within either of the VOC plumes. The relative position of a well within either of the plumes may be gauged from the general plume outline shown in Figure 3-1. Within the outlined area, the latest analytical result for at least one VOC exceeds the MCL value.

Monitoring points characterized as a *"source"* area locations monitor the plume very close to the source area and have historically shown high concentrations for at least one VOC parameter (see Figure 2-4 to Figure 2-9). Monitoring points characterized as *"tail"* are located in downgradient areas of the plumes but have a high frequency of detection for at least one VOC parameter. Monitoring points characterized as *"margin"* have a high frequency of non-detect values and serve to define the downgradient plume limits.

3.1.2 Surface Water and Semiannual Monitoring

To evaluate effectiveness of in-situ corrective measures and stability of the contaminant plumes, sixteen Unit 3S, 3D, and 3I wells will be monitored on a semiannual basis (Figure 3-1, wells highlighted in blue and red). Wells will be sampled in spring and fall. Two surface water monitoring points on the Meadowbrook Golf Course will be monitored three times per year (i.e., spring, summer, and fall). The surface water and semiannual monitoring network may be summarized as follows.

- Monitoring of Unit 1 will be conducted at MW 31R.
- Monitoring of Unit 3S will be conducted at MW 3, MW 8, MW 14, MW 40, MW 42, MW 49, MW 51, MW 68, and MW 79.
- Monitoring of Unit 3D will be conducted at MW 28, MW 41, MW 66, MW 85, and MW-4.
- MW 12, an intermediate Unit 3I well west of the Main Plant building will be monitored.
- Monitoring will continue at the two surface water monitoring points (Pond Intake and Pond North) on the Meadowbrook Golf Course.

The surface water monitoring data from the Pond Intake and Pond North locations will be used to confirm that the pond continues to be an acceptable source of non-potable irrigation water.

Wells deleted from the interim quarterly monitoring program include MW 5, MW 15, MW 21, MW 29, MW 31R, MW 54, and MW 62. MW 21 and MW 54 are upgradient Unit 3S and Unit 3D wells that were monitored during the interim site-wide program to provide information on VOC concentrations upgradient from the site. Neither of these wells showed any significant upgradient VOC contribution during any of the nine interim monitoring events. Continued upgradient monitoring would not appear to be necessary.

Monitoring wells MW 5, MW 15, MW 31R were monitored during the interim program to provide information on the effectiveness of the AOC 1 South Court IM initiated in 2005. Since the HRC® agent used as a source reduction measure for TCE has a useful life of only two years continued monitoring on these wells is not necessary.

Wells added for semiannual monitoring program are MW 49, MW 51, MW 65, MW 79, and MW 85. These wells are added to provide more comprehensive monitoring of the boundary areas of each VOC plume (Table 3-1).

3.1.3 Annual Monitoring

An annual sampling and analysis of twelve wells used to define the boundaries of the plumes will be made (Figure 3-1, wells highlighted in green). The annual monitoring well network may be summarized as follows.

- Monitoring of Unit 3S will be conducted at MW 37, MW 46, and MW 76.
- Monitoring of Unit 3D will be conducted at MW 56, MW 57, MW 58, MW 61, MW 64, MW 65, MW 75, MW 80, and MW-2.
- Monitoring of bedrock wells will be conducted at MW 81, MW 82, and MW 83.

Monitoring well MW 62 is the only well deleted from the interim annual monitoring well network. VOCs were not detected in this well during any of four interim sampling events. MW 61 is a clustered Unit 3D well at this location. This well offers better definition for the northward extent of VC east of MLK Boulevard and is proposed as the replacement for MW 62 (Figure 3-1).

Monitoring well MW-2 which was added to the monitoring well network in July 2007 will continue to be sampled.

The monitoring well completion diagrams for all wells proposed for sampling in the site-wide groundwater monitoring plan are presented in Attachment A.

3.2 ADDITIONAL GROUNDWATER INVESTIGATIONS

The additional groundwater investigations described in this section have been requested by the IDEM and / or recommended in previous annual groundwater monitoring reports, as noted in Section 2.6. These investigations will serve to address specific hydrogeologic concerns and are considered to be one-time, rather than long-term, ongoing, monitoring efforts.

3.2.1 New Monitoring Well Installation and Sampling

Three additional monitoring wells in the northern part of former Plant 9 were proposed in the 2009 annual groundwater monitoring report to further evaluate groundwater gradients and VOC plume delineation (AECOM, April 26, 2010). The proposed new well locations are shown on Figure 3-1. Well locations are pending site access and utility clearance. At each location a monitoring well will be installed in the lower portion of the Unit 3 sand. Well depths of 20 to 25 feet are anticipated to reach to bottom of the Unit 3 sand at bedrock, or Unit 4 if that unit is encountered. It is assumed that these wells may be installed under the terms of the current access agreement with the owner of former Plant 9. The wells will be installed by hollow stem auger techniques, provided with flush mount covers, and developed prior to sampling.

Each monitoring well will be sampled one time for US EPA target compound list (TCL) VOCs. The sampling will occur during the first sampling event after the wells are installed.

3.2.2 Groundwater Sampling for Target Metal Parameters

IDEM has requested a one-time sampling of 20 monitoring wells for target metal parameters to address potential groundwater impacts associated with past metal plating operations.

The 20 monitoring wells proposed for sampling will include 15 of the 16 semiannually sampled wells in Table 3-1 plus MW 16, MW 29, MW 50, MW 65, and MW 84. Semiannual well MW 12 is excluded from the metals sampling list because: 1) it is located in an upgradient position, 2) chromium was not detected in two samples collected from this well in 2001, and 3) VOC contaminants present in this well resulting from gradient reversals associated with past production well pumping have shown a statistically significant decreasing trend (AECOM, April 26, 2010).

Parameters for the one-time metal sampling event will include those metals known to have been associated with past metal platting operations at the site and will include chromium, copper, lead, nickel, zinc, hexavalent chromium, and total and amenable cyanide. The metals sampling will be conducted on a total and dissolved basis. It is anticipated that the one-time metals sampling and analysis will be conducted during the October 2010 monitoring event.

3.2.3 Site-Wide Hydraulic Monitoring Event.

The investigations will include the measurement of water levels in all accessible site monitoring wells (a site-wide hydraulic monitoring event) during the October 2010 sampling event.

3.3 FIELD METHODOLOGIES

The following sections present a summary of the field procedures that will be followed during the site-wide groundwater monitoring program. Field activities will be conducted in accordance with the approved Field Method Guidelines (FMGs) established for use at MLC sites. Generic FMGs related to sample collection, field quality control samples, sample handling and shipping, field instrument use and calibration, and equipment decontamination are provided in Attachment B.

3.3.1 Water Level Monitoring

Prior to groundwater sampling and during each semiannual sampling event a round of water levels will be collected from all wells included in the site-wide groundwater monitoring plan (Table 3-1). Additionally, water levels will be measured during each semiannual event at Unit 3S wells MW 16, 29, 59, and 84, as proposed in the 2009 annual groundwater monitoring report, to provide additional potentiometric detail between the AOC-1 South Court and former WWTP area VOC plumes. FMGs related to water level measurement are presented in Attachment C.

3.3.2 Monitoring Well Network Maintenance

Concurrent with water level measurements, the condition of the wells will be evaluated on a semiannual basis. On an annual basis, a complete inspection of the monitoring well network will be performed. A monitoring well inspection checklist, to be completed on an annual basis, is presented in Attachment D.

3.3.3 Groundwater Sampling

Groundwater samples will be collected using the low-flow sampling procedures previously utilized in the site-wide groundwater monitoring programs. Variable speed downhole submersible teflon and stainless steel sampling pumps will be employed for purging and sampling. These pumps will be non-dedicated, but will be decontaminated between each sample collection. Pump discharge will utilize dedicated Teflon®-lined sample tubing. This tubing is installed for each sample event. Between sampling events the tubing is removed, cleaned, and stored off site.

FMGs related to groundwater sampling are presented in Attachment E. A table showing sample containers, preservation, holding times, and shipping and packaging requirements is provided in Table 3-2.

As a slight modification to FMG 6.4, total depth measurements for each well will not be made prior to each sampling event. This is to avoid introduction of turbidity into the well sample. The well total depth measurements will be taken after each well is sampled during the annual well inspection concurrent with the annual sampling event when all wells are sampled.

3.3.4 Surface Water Sampling

Surface water samples will be collected from the central irrigation pond located on the Meadowbrook Golf Course. Samples will be collected at two locations in the pond. Samples will be collected from the irrigation pump intake located at the south end of the pond, as well as from a location at the north end of the pond nearest MW-4. Samples will be collected using a clean sample dipper. FMGs related to surface water sampling are presented in Attachment F.

3.4 LABORATORY ANALYTICAL METHODS

Groundwater samples will be analyzed for the relevant parameters listed in Table 3-3.

1. TCL VOC analysis will be conducted on all samples collected pursuant to Sections 3.1.2, 3.1.3, and 3.2.1 of this plan.
2. A site-specific parameter list of metals (SSPL Metals), including hexavalent chromium, and total and amenable cyanide analyses will be conducted for the one-time samples collected pursuant to Section 3.2.2 of this plan.

3.5 LABORATORY DATA EVALUATION

Independent verification or validation of laboratory data will be conducted. Since it is not anticipated that site closure will be achieved as the result of any groundwater sample collected and analyzed pursuant to Sections 3.1.2 and 3.1.3 of this plan for the foreseeable future, only verification of laboratory data will be conducted for these analyses.

A full laboratory validation will be conducted for the one-time samples collected pursuant to Sections 3.2.1 and 3.2.2 of this plan.

3.5.1 Laboratory Data Verification

Verification of groundwater monitoring data will be performed by Conestoga-Rovers & Associates (CRA) analytical services staff. Each staff member has considerable environmental laboratory experience and extensive data verification experience.

The Quality Assurance/Quality Control (QA/QC) criteria by which data will be assessed are based on the analytical method protocols and the following US EPA CLP guideline documents.

- "USEPA Contract Laboratory Program National Functional Guidelines for Organic Data Review", EPA540/R-99/008, October 1999; and
- "USEPA Contract Laboratory Program National Functional Guidelines for Inorganic Data Review", EPA 540/R-94-013, February 1994.

The following information obtained from the contract laboratory will be reviewed: sample analysis results forms; Chain-of-Custody forms; reported results of analyses for QA/QC blanks, duplicate samples; recovery data for blank, and matrix and surrogate spikes. Raw data may be requested from the contract laboratory to further investigate the cause of outlying quality control results and to determine the impact of these results on the final sample data.

The data verification review process includes the following main areas:

- **Sample Handling**: Sample holding times and preservation criteria are reviewed.
- **Sample Contamination**: Method, trip blanks, and field blanks are reviewed to determine the extent and magnitude of sample contamination (if any) introduced during laboratory or field activities.
- **Analytical Precision**: Laboratory and matrix spike duplicate samples are used to check analytical precision.
- **Sampling Precision:** Results of field and laboratory duplicate analyses are used to assess sampling and analytical precision.
- **Analytical Accuracy**: Blank spikes are used to assess the analytical method efficiency independent of individual sample matrices. Matrix spikes and/or matrix spike duplicates (MS/MSD) assess analytical accuracy on the specific sample matrix of interest. For organic analyses, surrogate compound recoveries are reviewed to determine analytical efficiency.

A QA/QC report will be provided which summarizes all QC issues listed above, the analytical results table with all qualifiers applied and also any applicable tables of outlying QC data.

3.5.2 Laboratory Data Validation

It is anticipated that full laboratory data validation will be done for: 1) the VOC analysis of the three new wells scheduled for installation in Section 3.2.1, and 2) the SSPL metals, hexavalent chromium, and total and amenable analyses pursuant to Section 3.2.2 of this plan.

Validation of groundwater monitoring data will also be performed by Conestoga-Rovers & Associates (CRA) analytical services staff.

The Quality Assurance/Quality Control (QA/QC) criteria by which data will be assessed are based on the analytical method protocols and the following US EPA CLP guideline documents.

- "USEPA Contract Laboratory Program National Functional Guidelines for Organic Data Review", EPA540/R-99/008, October 1999; and
- "USEPA Contract Laboratory Program National Functional Guidelines for Inorganic Data Review", EPA 540/R-94-013, February 1994.

The following information obtained from the contract laboratory will be reviewed: sample analysis results forms; Chain-of-Custody forms; reported results of analyses for QA/QC blanks, duplicate samples; calibration data, recovery data for blank, and matrix and surrogate spikes, and all associated raw data. A spot check of all calculations utilized throughout the analysis is performed using the raw data provided.

The data validation review process includes the following main areas:

- **Sample Handling**: Sample holding times and preservation criteria are reviewed.
- **Sample Contamination**: Method, trip blanks, and field blanks are reviewed to determine the extent and magnitude of sample contamination (if any) introduced during laboratory or field activities.
- **Analytical Precision**: Laboratory and matrix spike duplicate samples are used to check analytical precision.
- **Sampling Precision:** Results of field and laboratory duplicate analyses are used to assess sampling and analytical precision.
- **Analytical Accuracy**: Blank spikes are used to assess the analytical method efficiency independent of individual sample matrices. Matrix spikes and/or matrix spike duplicates (MS/MSD) assess analytical accuracy on the specific sample matrix of interest. For organic analyses, surrogate compound recoveries are reviewed to determine analytical efficiency.
- - **Calibration Data**: Initial and continuing calibration data is reviewed to determine acceptability of method linearity and sensitivity throughout the analysis.

4. Data Evaluation

Statistical data evaluation will continue to be conducted to determine whether the contaminant plumes are stable. The contaminant plumes will be considered stable if no statistically significant increases are observed for any of the principal VOC compounds (TCE, cis-1,2-DCE, and VC). Statistically significant trend will be evaluated using the non-parametric Mann-Kendall test following IDEM RISC guidance (IDEM, February 15, 2001, Appendix C). A minimum sample size of four is required for the analysis, and the frequency of detected values should be greater than 75 percent. These criteria are met for all proposed source and tail area wells in Table 3-1 for at least one of the principal VOC compounds. Trend testing will be performed on all wells meeting the above specified criteria as sampling data become available.

Field duplicate values were averaged. Non detected results ("U" flag) will be set at a constant value less than the lowest detected value in the dataset, including detections below the reporting limit ("J" flag) (Gilbert, 1987). Values flagged "J" will be considered detections for the purpose of statistical analysis, and the estimated parameter value will be utilized. Consider the example data set: 0.001 U, 0.00015 J, 0.002 U, and 0.003. Setting the non-detect events at a constant value less than the lowest "J" flag value, say 0.0001, the values used in trend analysis would be: 0.0001, 0.00015, 0.0001, and 0.003.

The Mann-Kendall trend tests will be performed using *WQStat Plus,* or an equivalent statistical evaluation software. Test results may be interpreted in terms of a critical value or probability approach. Probability values for the Mann-Kendall statistic are given by Hollander and Wolfe (1973). The IDEM RISC technical guidance (IDEM, February 15, 2001) for evaluating plume stability utilizes one-tailed test at a significance level of (α) of 0.1.

The test hypotheses at $\alpha = 0.1$ are:

H_o: There is no trend, or a decreasing trend in chemical concentration through time.

H_1: There is an increasing trend in chemical concentration.

5. Data Reporting

Data collected pursuant to routine portions of the site-wide groundwater monitoring program described in Section 3.1 will be summarized and submitted in an annual report to the IDEM. Annual reports will be issued by January 31 of the succeeding year. The reports will be similar to those submitted annually since 2007 and will include:

- a summary of field activities and problems encountered during the monitoring well network inspections;
- potentiometric surface elevation maps;
- a summary of the analytical data, including data box plots and isoconcentration maps
- statistical analysis results.

Data collected pursuant to routine portions of the site-wide groundwater monitoring program described in Section 3.1 will be summarized and submitted initially as an element of the project quarterly reporting. At the end of Section 3.2 investigations MLC will evaluate the data collected and provide IDEM with recommendations regarding modifications to the Section 3.1 routine monitoring program, as appropriate, in the 2010 annual groundwater report.

On an annual basis, the wells included in the site-wide groundwater monitoring program will be assessed to ensure that the monitoring program remains appropriate. All project files including field notes and analytical laboratory reports, will be maintained per the requirements of the QAPP.

6. References

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Hollander, Myles, and Douglas A Wolfe, 1973, *Nonparametric Statistical Methods*: John Wiley and Sons, New York.

Indiana Department of Environmental Management (IDEM), February 15, 2001, *Risk Integrated System of Closure, Technical Guide.*

TABLE 3-1
SITE-WIDE GROUNDWATER MONITORING PROGRAM
MLC MLK BOULEVARD SITE
ANDERSON, INDIANA

Plume Stability and Corrective Measures Monitoring

Sample Location	*Northing SPCS (Feet) NAD83*	*Easting SPCS (Feet) NAD83*	*TOC Elevation (Feet) NAVD88*	*Year Installed*	*Unit Monitored*	*Plume Position (2)*	*3X Per Year Monitoring (3)*	*Semiannual Monitoring*	*Annual Monitoring*
MW 3	1761137.6	317370.2	880.51	1992	3S	AOC 1, Source		X(4)	
MW-4 (1)	1760961.9	318774.8	861.67	2003	3D	WWTP, Tail		X(4)	
MW-2	1760047.1	319467.3	860.08	2003	3D	WWTP, Margin			X(4)
MW 8	1760896.0	317004.4	878.41	1993	3S	AOC 1, Source		X(4)	
MW 12	1761692.8	317141.2	882.78	1993	3I	AOC 1, Tail		X(4)	
MW 14	1761435.2	317520.1	881.36	1993	3S	AOC 1, Tail		X(4)	
MW 28	1761964.9	318819.0	877.44	2000	3D	WWTP, Tail		X(4)	
MW 31R (1)	1761074.5	317365.6	879.71	2000	1	AOC 1, Source		X(4)	
MW 37 (1)	1760543.9	317904.2	869.95	2001	3S	AOC 1, Margin			X(4)
MW 40	1761254.5	318528.4	879.51	2003	3S	WWTP, Source		X(4)	
MW 41	1761575.0	318740.7	878.58	2003	3D	WWTP, Source		X(4)	
MW 42	1761579.2	318742.2	878.54	2003	3S	WWTP, Source		X(4)	
MW 46 (1)	1761002.5	318062.7	873.64	2003	3S	AOC 1, Margin			X(4)
MW 49	1760839.9	317343.2	877.93	2003	3S	AOC 1, Tail		X(4)	
MW 51	1762357.2	318371.7	878.19	2003	3S	AOC 1, Tail		X(4)	
MW 56	1760254.8	318422.3	859.32	2004	3D	WWTP, Margin			X(4)
MW 57	1760357.4	318925.2	862.52	2004	3D	WWTP, Margin			X(4)
MW 58	1760809.8	319598.5	861.46	2004	3D	WWTP, Margin			X(4)
MW 61	1762477.5	319069.9	876.57	2004	3D	WWTP, Margin			X(4)
MW 64	1761475.5	319789.9	863.97	2004	3D	WWTP, Margin			X(4)
MW 65	1761484.8	319399.8	864.22	2004	3D	WWTP, Margin			X(4)
MW 66	1761222.3	319634.4	861.67	2004	3D	WWTP, Tail		X(4)	
MW 68	1761420.8	318459.3	876.98	2004	3S	WWTP, Source		X(4)	
MW 75	1762956.0	318487.3	881.42	2004	3D	AOC 1, Margin			X(4)
MW 76	1762951.8	318492.8	881.11	2004	3S	AOC 1, Margin			X(4)
MW 79	1761750.5	317812.0	881.92	2004	3S	AOC 1, Tail		X(4)	
MW 80	1761928.3	319258.3	865.49	2005	3D	WWTP, Margin			X(4)
MW 81	1761479.0	319399.6	864.38	2005	Bedrock	WWTP, Margin			X(4)
MW 82	1761198.3	317978.6	878.55	2005	Bedrock	AOC 1, Margin			X(4)
MW 83	1761260.1	318746.5	876.23	2005	Bedrock	WWTP, Margin			X(4)
MW 85	1760642.5	319142.0	866.11	2007	3D	WWTP, Tail		X(4)	
POND (Intake)	1760214.4	318958.4	NA	N/A	Surface Water		X(4)		
POND (North)	1760549.0	319173.0	857.79	N/A	Surface Water		X(4)		

Notes:

(1) Well added to the monitoring program based on IDEM review comments 5/2/08

(2) *AOC 1* = VOC plume originating at AOC 1 - South Court
WWTP = VOC plume originating from former WWTP Area
Source = VOC source area well

(3) Locations to be sampled Spring, Summer, and Fall

(4) TCL VOCs: Target Compound List Volatile Organic Compounds

TABLE 3-2
CONTAINER, PRESERVATION, SHIPPING, AND PACKAGING REQUIREMENTS FOR GROUNDWATER SAMPLES
MOTORS LIQUIDATION COMPANY
MLK BOULEVARD FACILITY

Analyses	*Sample Containers*	*Preservation*	*Maximum Holding Time from Sample Collection (1)*	*Volume of Sample*	*Shipping*	*Normal Packaging*
Laboratory Parameters						
TCL VOCs	Three 40-mL glass vials w/Teflon lined septa	HCl to pH<2 Iced, 4 ° C	14 da for analysis	Fill completely, no air bubbles	Overnight courier or hand delivered	Bubble wrap or foam chips
Hexavalent Chromium	250 ml poly	Iced, 4 ° C or: NAOH preservation	24 hrs for analysis 30 days	Fill to bottle neck	hand delivered if not preserved	Bubble wrap or foam chips
Cyanide (Total & Amenable)	250 ml poly	NaOH pH>12 Iced, 4 ° C	14 days for analysis	Fill to bottle neck	Overnight courier or hand delivered	Bubble wrap or foam chips
Site-Specific Parameter List (SSPL) Metals						
(Total Cu, Cr, Pb, Ni, Zn)	250 ml poly	HNO_3 pH<2, Iced 4°C	6 mos.	Fill to bottle neck	Overnight courier or hand delivered	Bubble wrap or foam chips
(Dissolved Cu, Cr, Pb, Ni, Zn)	250 ml poly	HNO_3 pH<2, Iced 4°C 0.45 micron field filter	6 mos.	Fill to bottle neck		

Notes:

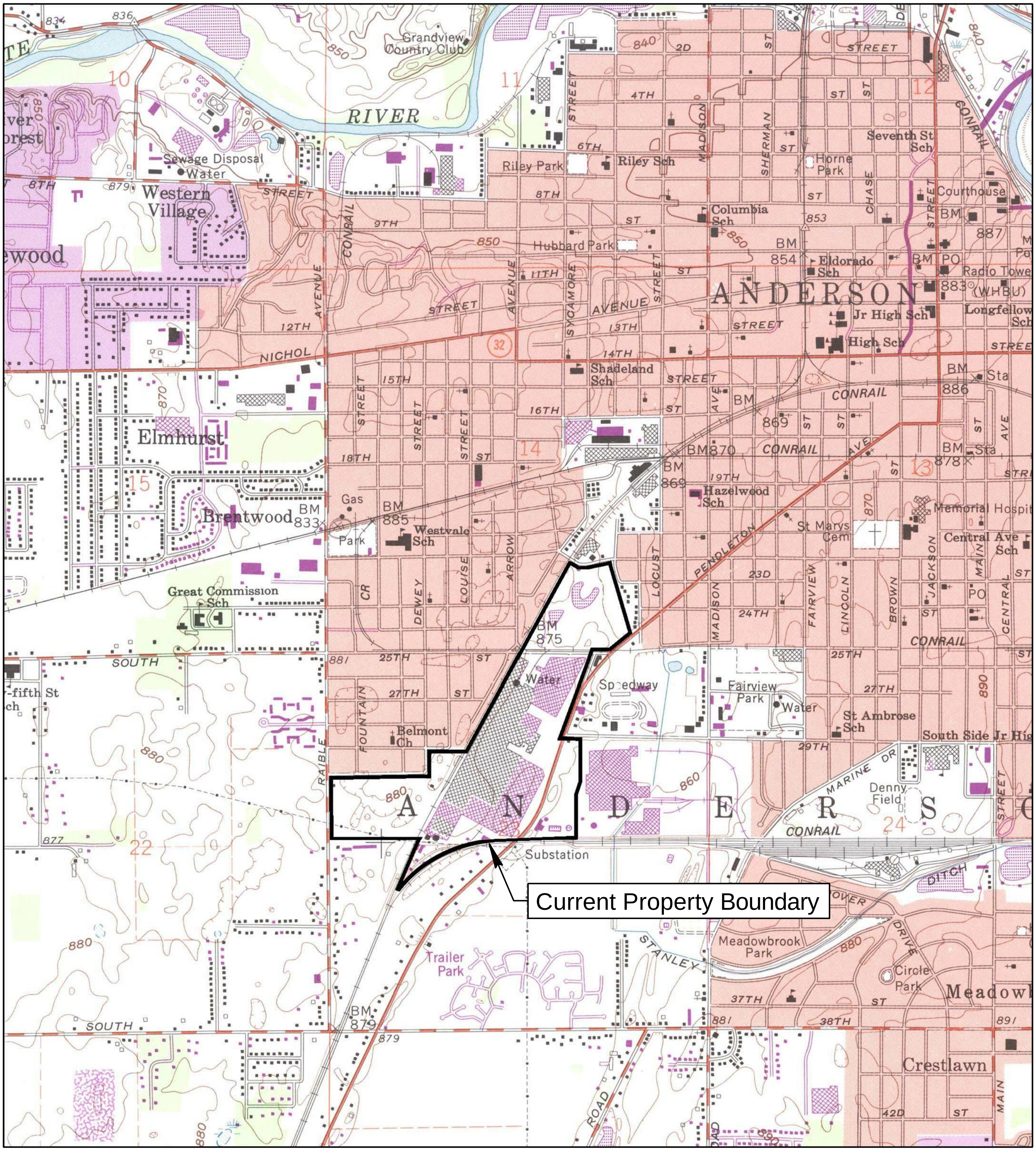
(1) These are technical holding times and are based on time elapsed from time of sample collection.

TABLE 3-3
FIELD AND LABORATORY ANALYTICAL PROCEDURES
MLC MLK BOULEVARD SITE
ANDERSON, INDIANA

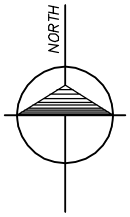
Parameter	Method Number
Field Parameters *(1)*	
pH	(2)
Temperature	(2)
Conductivity	(2)
Oxidation/Reduction Potential (ORP)	(2)
Dissolved Oxygen	(2)
Turbidity	(2)
Laboratory Parameters	
TCL VOCs	Method 8260B
Metals and Cyanide:	
Hexavalent chromium	Method 7196
Total Cyanide	EPA 335.4
Amemable Cyanide	EPA 335.4
SSPL Metals (Total and Dissolved) Copper, Chromium, Lead, Nickel, Zinc	Method 6010B

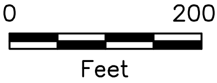
Notes:

Method	Refers to U.S. Environmental Protection Agency SW 846.
EPA	Refers to Methods for Chemical Analysis of Water and Wastes, EPA-600/4-79-020, rev. Mar. 1983
SSPL	Site-specific parameter list.
VOCs	Volatile Organic Compounds
(1)	Field parameters are listed in the order that they are generally expected to stabilize while purging.
(2)	Field parameters measured using a muli-parameter meter and flow-through cell or field test kit. The calibration of meters is checked each day prior to use.



Base taken from USGS Anderson South, Ind. 7.5' Topographic Quadrangle.



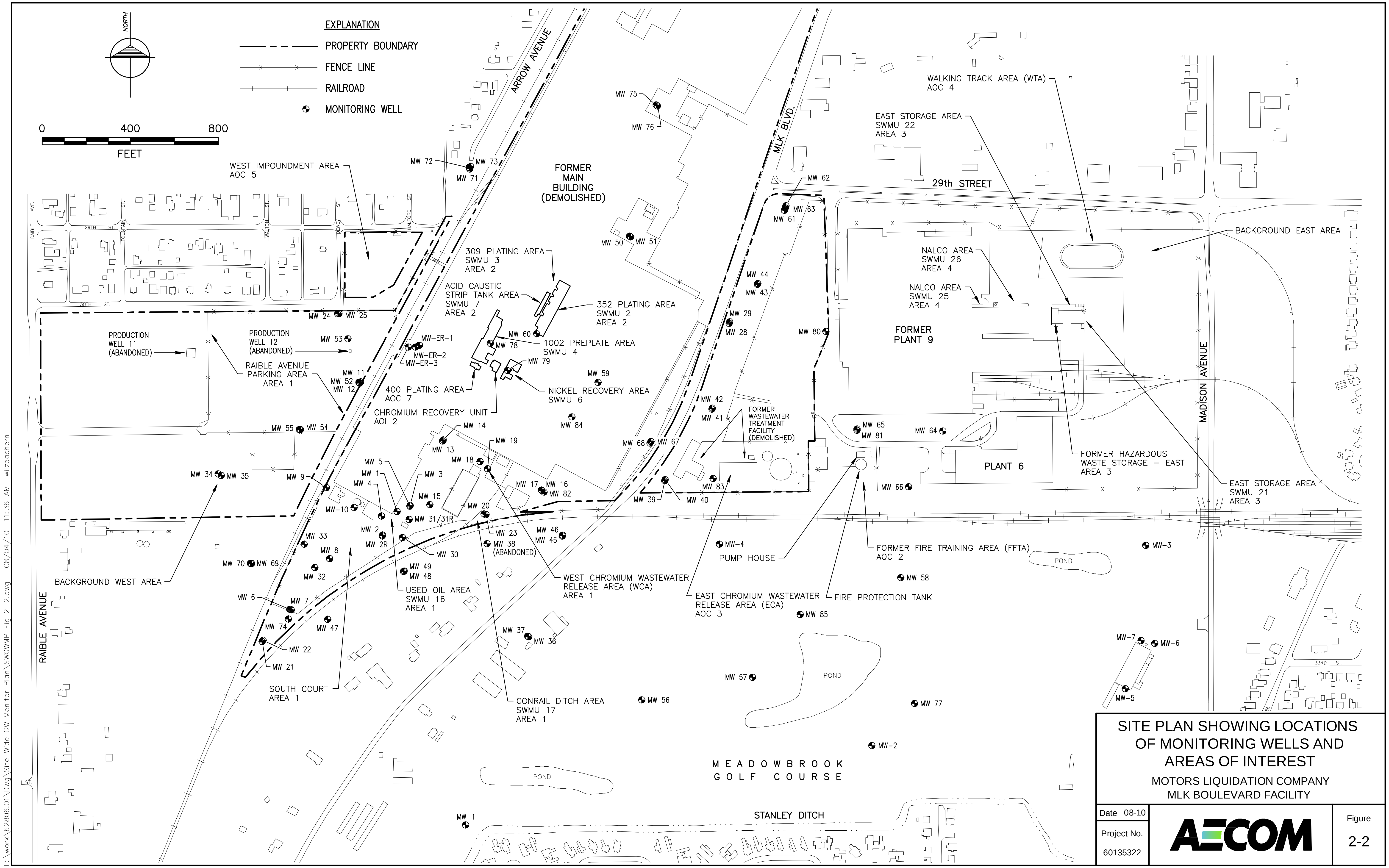


SITE LOCATION MAP

MOTORS LIQUIDATION COMPANY
MLK BOULEVARD FACILITY

Date 08-10		Figure
Project No. 60135322	AECOM	2-1

L:\work\62806.01\Dwg\Site Wide GW Monitor Plan\SWGWMP Fig 2-1.dwg 08/04/10 2:42 PM wilzbachern

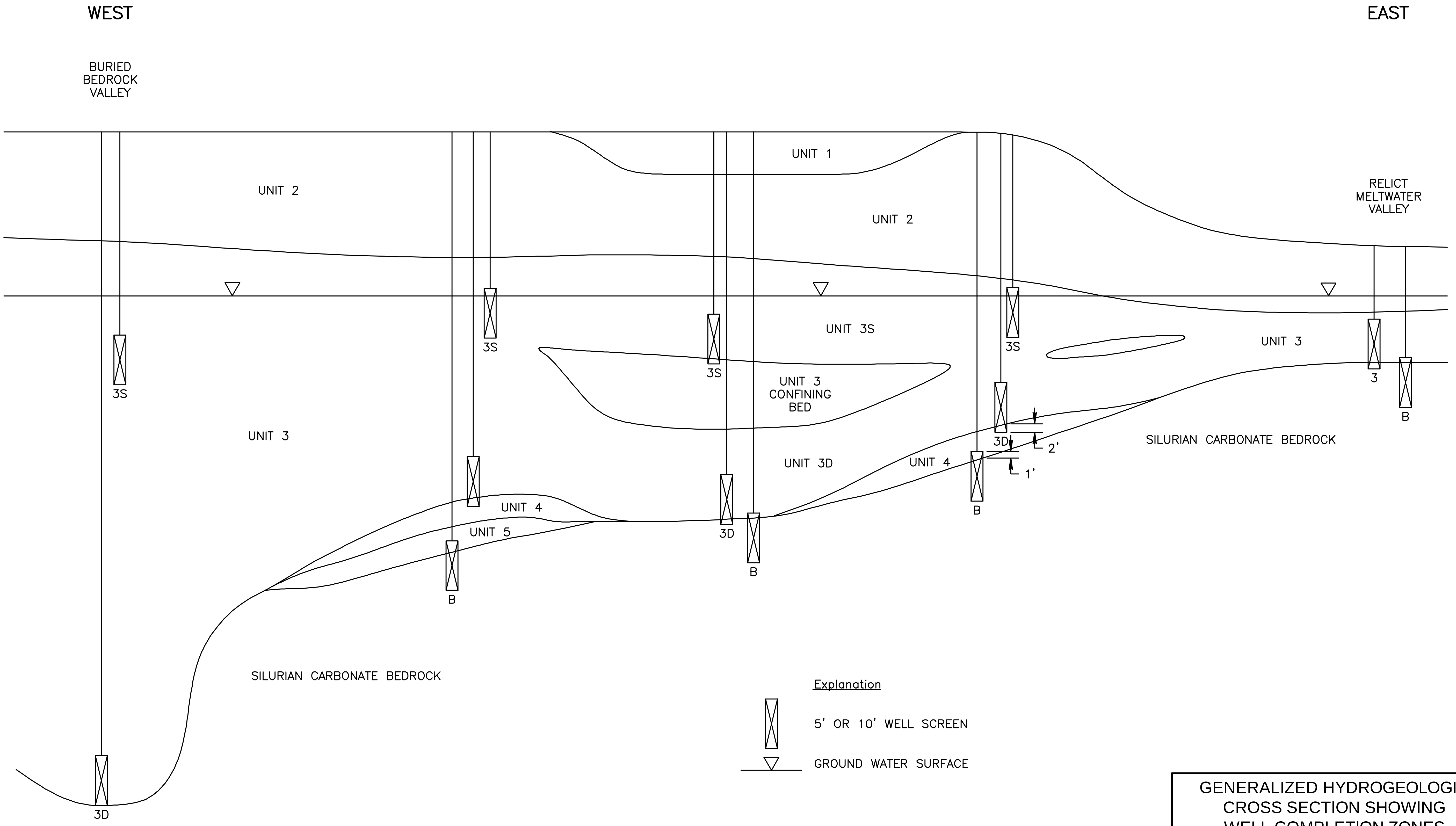


L:\work\62806.01\Dwg\Site Wide GW Monitor Plan\SWGWMP Fig 2-2.dwg 08/04/10 11:36 AM wilzbachern

SITE PLAN SHOWING LOCATIONS OF MONITORING WELLS AND AREAS OF INTEREST

MOTORS LIQUIDATION COMPANY
MLK BOULEVARD FACILITY

Date 08-10	AECOM	Figure
Project No. 60135322		2-2



GENERALIZED HYDROGEOLOGIC CROSS SECTION SHOWING WELL COMPLETION ZONES

MOTORS LIQUIDATION COMPANY
MLK BOULEVARD FACILITY

Date 08-10
Project No.
60135322

AECOM

Figure
2-3

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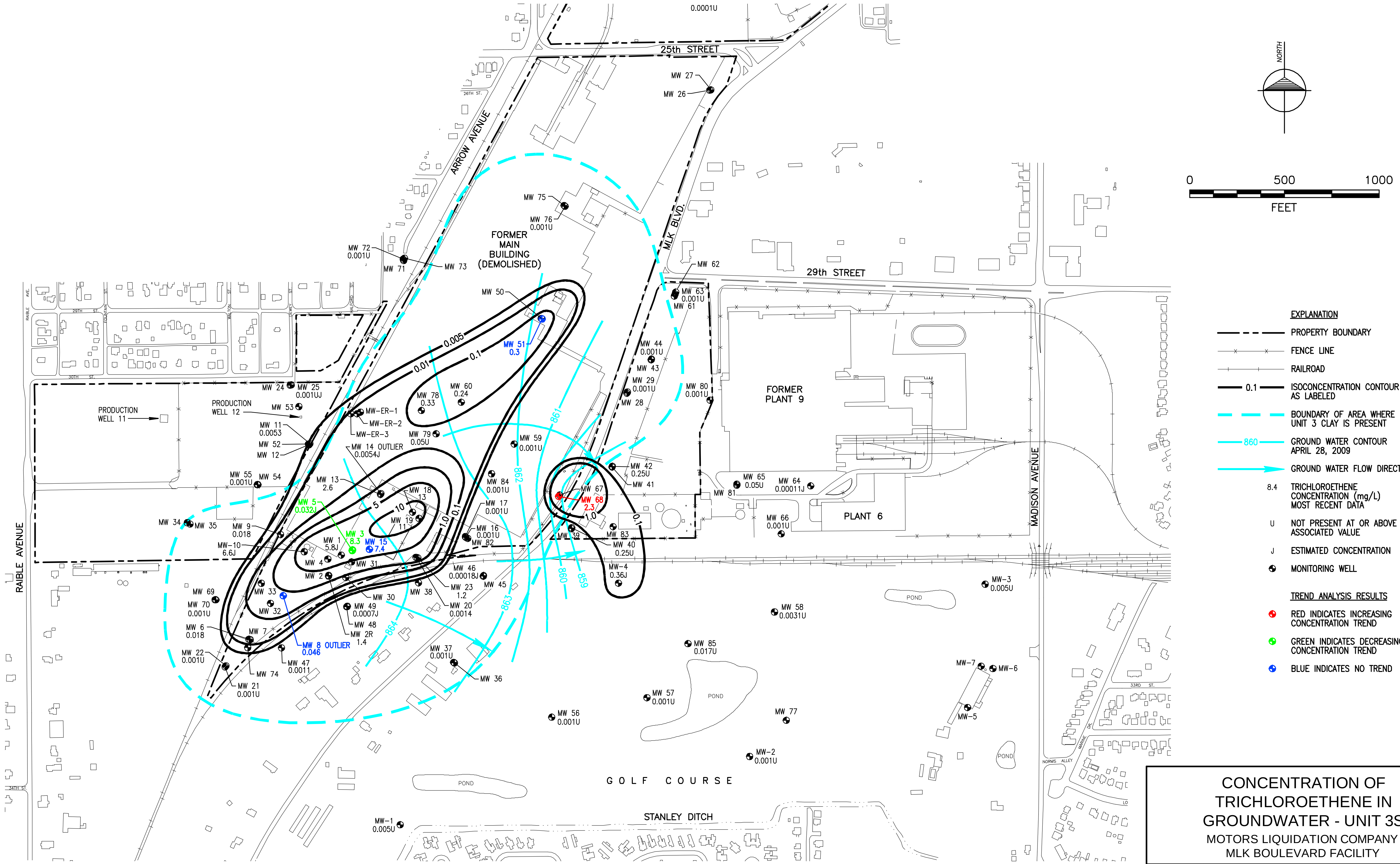


EXPLANATION

▬ ▬ ▬	PROPERTY BOUNDARY
—×—×—	FENCE LINE
—+—+—	RAILROAD
—— 0.1 ——	ISOCONCENTRATION CONTOUR (mg/L) AS LABELED
— — —	BOUNDARY OF AREA WHERE UNIT 3 CLAY IS PRESENT
—— 860 ——	GROUND WATER CONTOUR APRIL 28, 2009
——→	GROUND WATER FLOW DIRECTION
8.4	TRICHLOROETHENE CONCENTRATION (mg/L) MOST RECENT DATA
U	NOT PRESENT AT OR ABOVE THE ASSOCIATED VALUE
J	ESTIMATED CONCENTRATION
●	MONITORING WELL

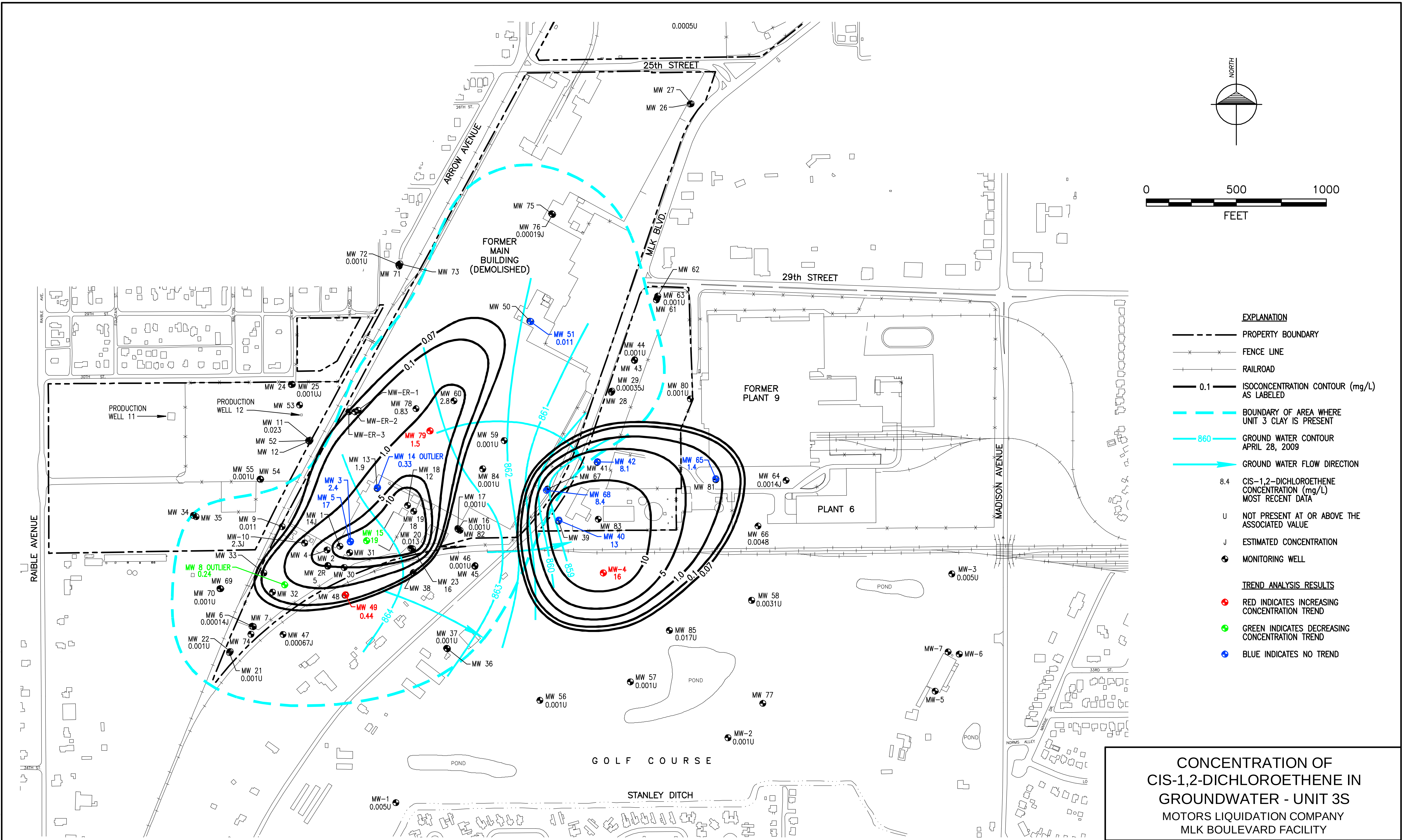
TREND ANALYSIS RESULTS

🔴	RED INDICATES INCREASING CONCENTRATION TREND
🟢	GREEN INDICATES DECREASING CONCENTRATION TREND
🔵	BLUE INDICATES NO TREND

CONCENTRATION OF
TRICHLOROETHENE IN
GROUNDWATER - UNIT 3S
MOTORS LIQUIDATION COMPANY
MLK BOULEVARD FACILITY

Date 08-10
Project No.
60135322

Figure
2-4



CONCENTRATION OF CIS-1,2-DICHLOROETHENE IN GROUNDWATER - UNIT 3S

MOTORS LIQUIDATION COMPANY
MLK BOULEVARD FACILITY

Date	08-10
Project No.	60135322

AECOM

Figure
2-5

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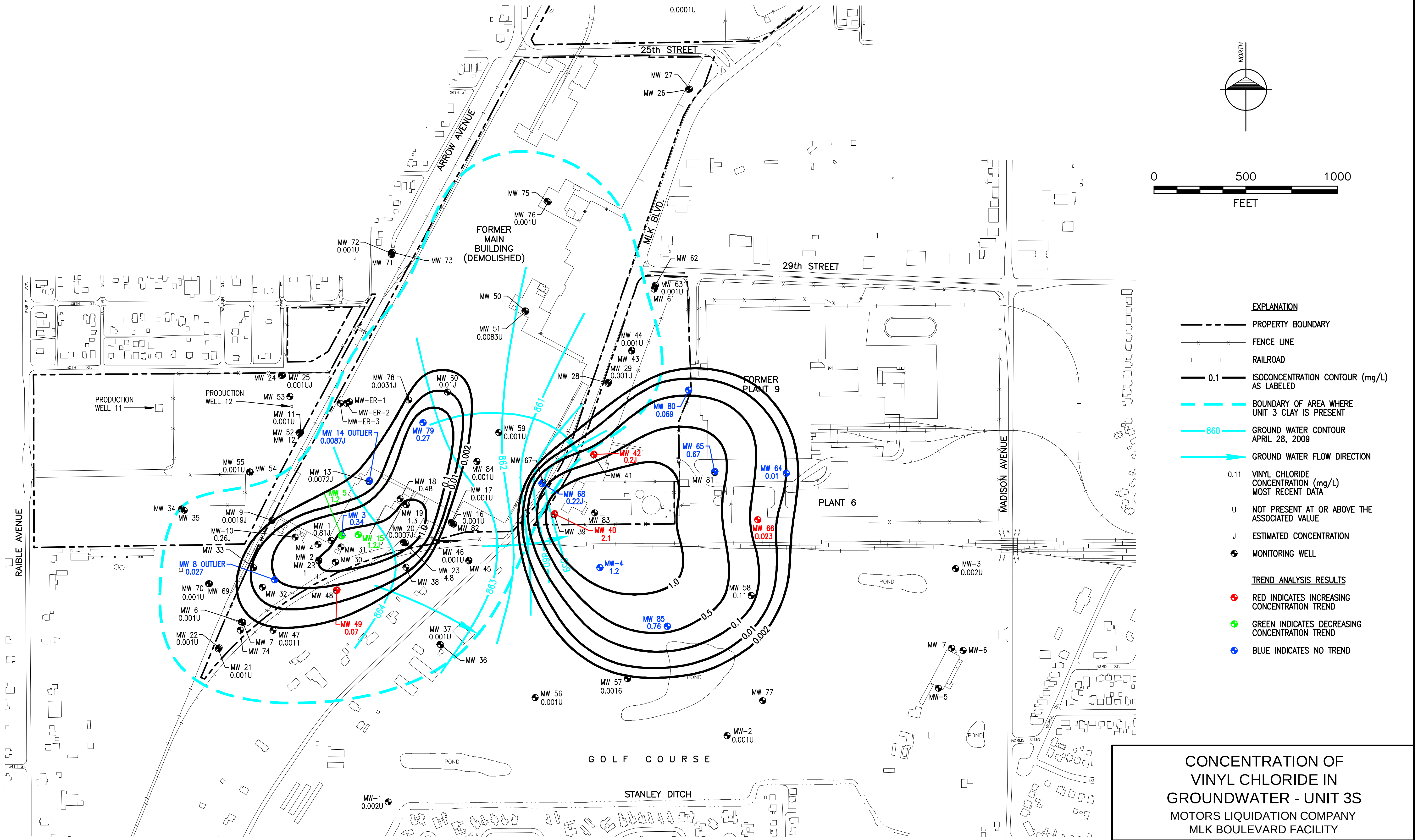

CONCENTRATION OF VINYL CHLORIDE IN GROUNDWATER - UNIT 3S

MOTORS LIQUIDATION COMPANY
MLK BOULEVARD FACILITY

Date 08-10	AECOM	Figure 2-6
Project No. 60135322		

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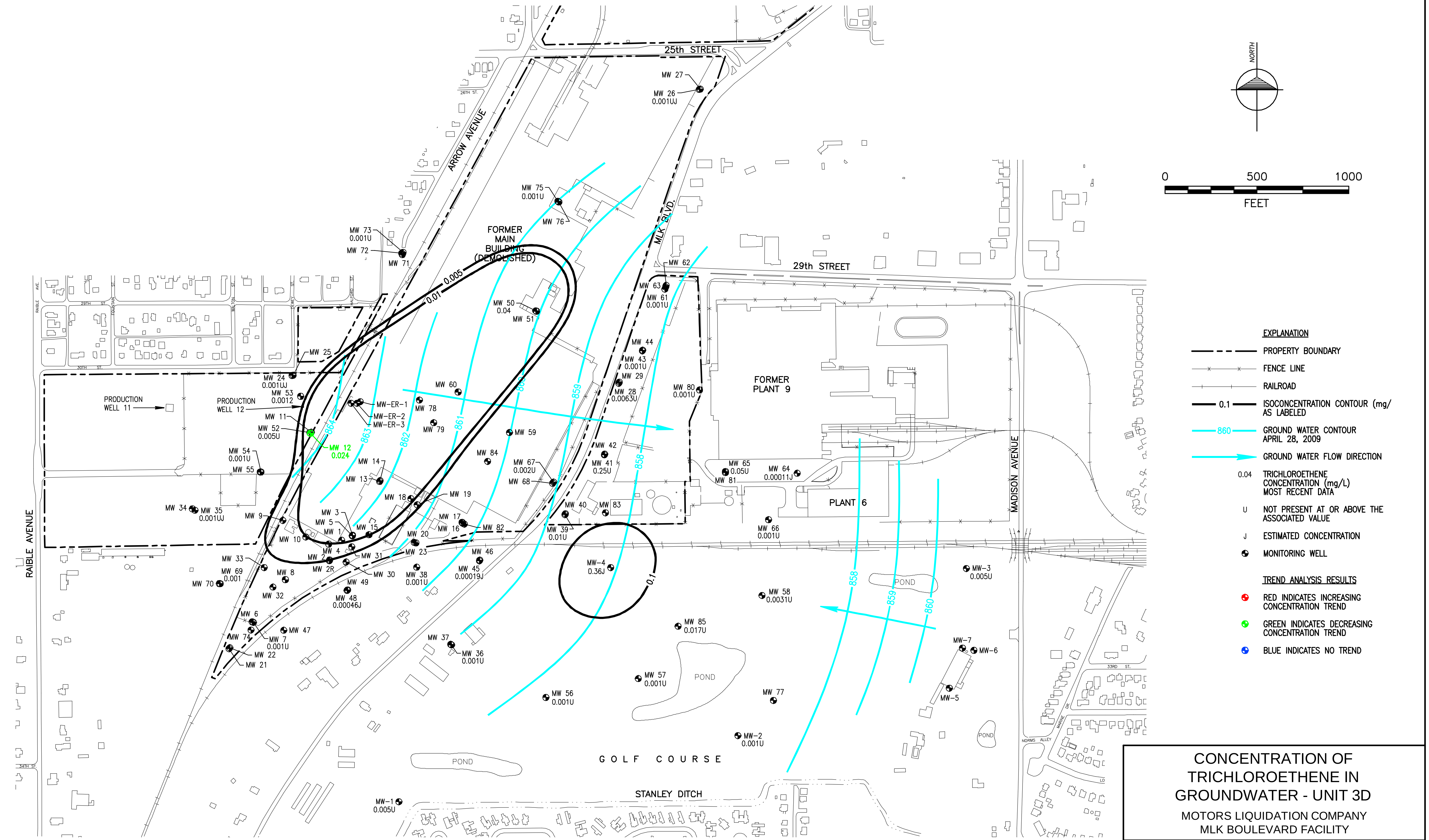


CONCENTRATION OF TRICHLOROETHENE IN GROUNDWATER - UNIT 3D

MOTORS LIQUIDATION COMPANY
MLK BOULEVARD FACILITY

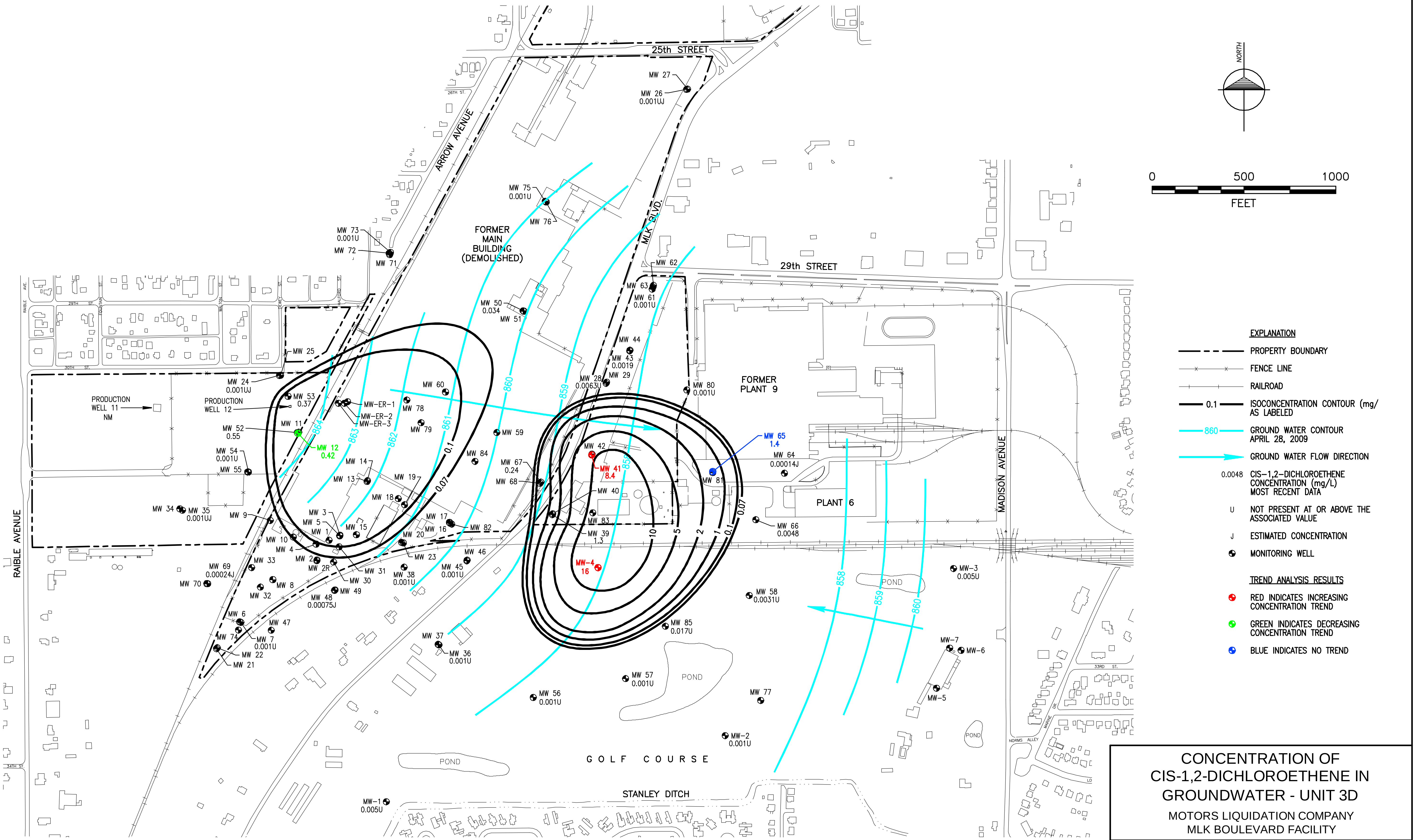
Date 08-10

Project No.
60135322

AECOM

Figure
2-7

L:\work\62806.01\Dwg\Site Wide GW Monitor Plan\SWGWMP Fig 2-7.dwg 08/04/10 11:48 AM wilzbachern

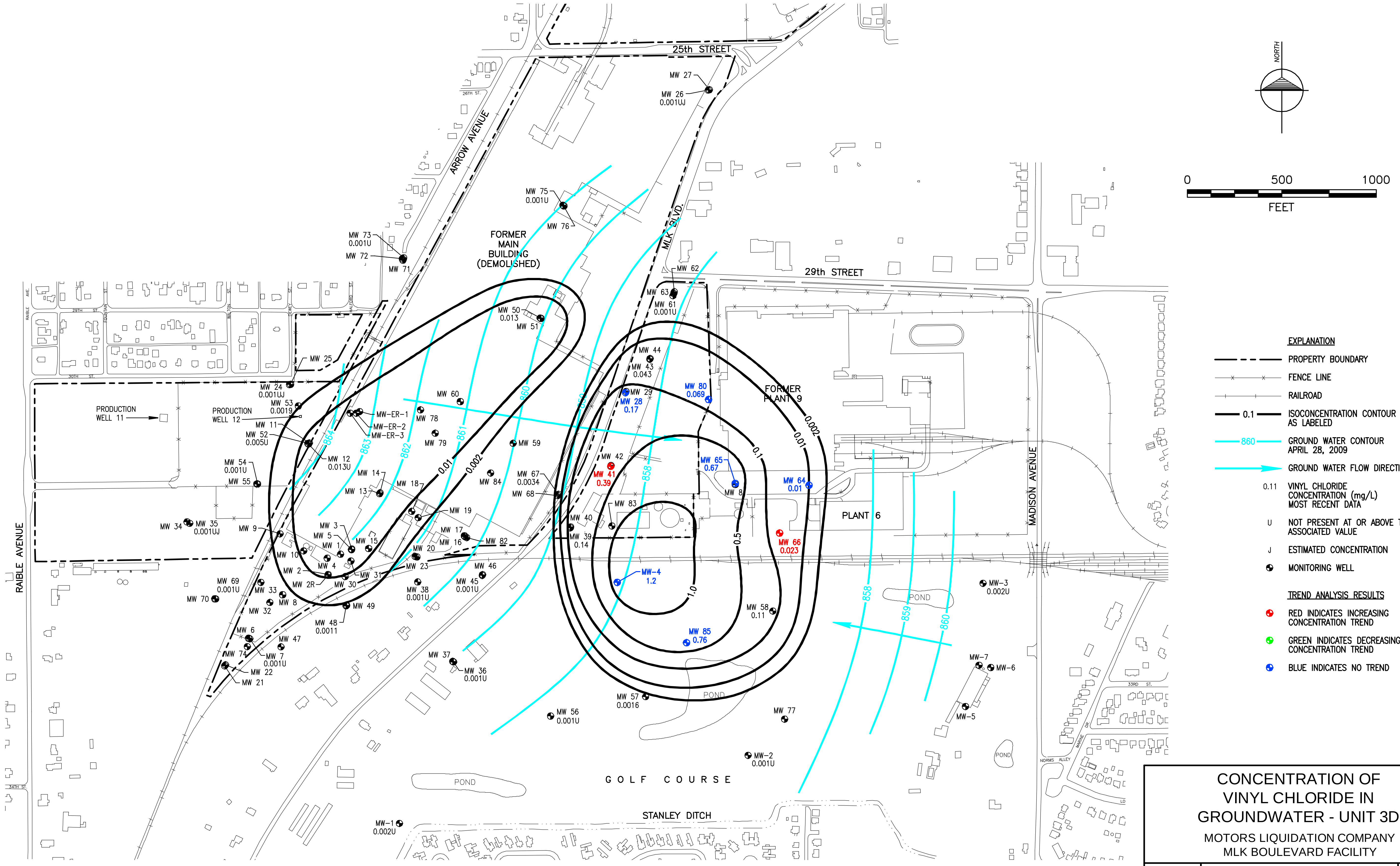


CONCENTRATION OF CIS-1,2-DICHLOROETHENE IN GROUNDWATER - UNIT 3D

MOTORS LIQUIDATION COMPANY
MLK BOULEVARD FACILITY

Date 08-10	AECOM	Figure
Project No. 60135322		2-8

L:\work\62806.01\Dwg\Site Wide GW Monitor Plan\SWGWMP Fig 2-8.dwg 08/04/10 11:51 AM wilzbachern



EXPLANATION

▬ ▬	PROPERTY BOUNDARY
—×—	FENCE LINE
—+—	RAILROAD
— 0.1 —	ISOCONCENTRATION CONTOUR (mg/ AS LABELED
— 860 —	GROUND WATER CONTOUR APRIL 28, 2009
→	GROUND WATER FLOW DIRECTION
0.11	VINYL CHLORIDE CONCENTRATION (mg/L) MOST RECENT DATA
U	NOT PRESENT AT OR ABOVE THE ASSOCIATED VALUE
J	ESTIMATED CONCENTRATION
⊕	MONITORING WELL

TREND ANALYSIS RESULTS

🔴	RED INDICATES INCREASING CONCENTRATION TREND
🟢	GREEN INDICATES DECREASING CONCENTRATION TREND
🔵	BLUE INDICATES NO TREND

CONCENTRATION OF VINYL CHLORIDE IN GROUNDWATER - UNIT 3D

MOTORS LIQUIDATION COMPANY
MLK BOULEVARD FACILITY

Date 08-10
Project No.
60135322

AECOM

Figure
2-9

L:\work\62806.01\Dwg\Site Wide GW Monitor Plan\SWGWMP Fig 2-9.dwg 08/04/10 11:53 AM wilzbachern

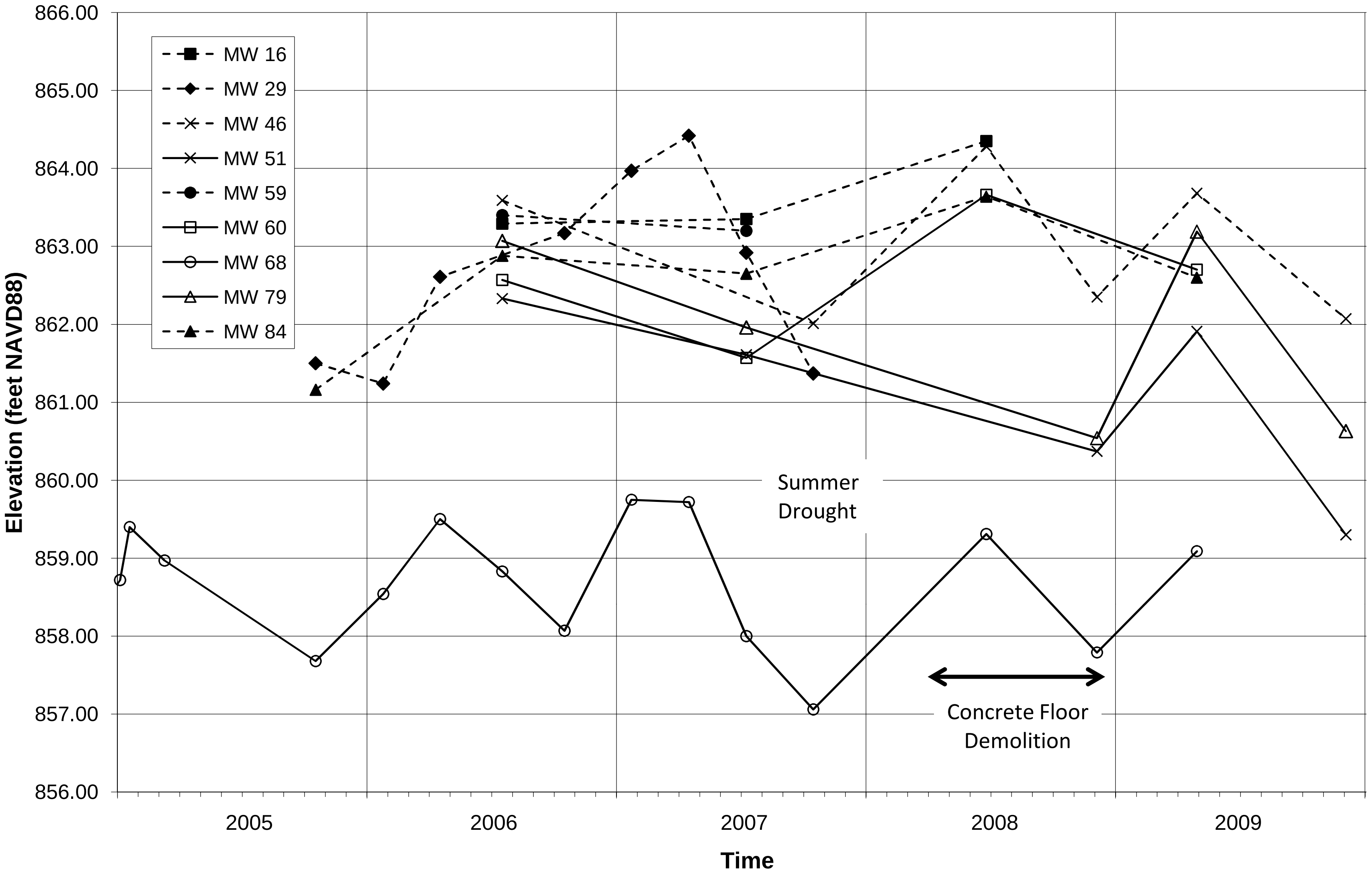


Figure 2-10: Former Main Plant Building Unit 3S Monitoring Point Hydrographs.

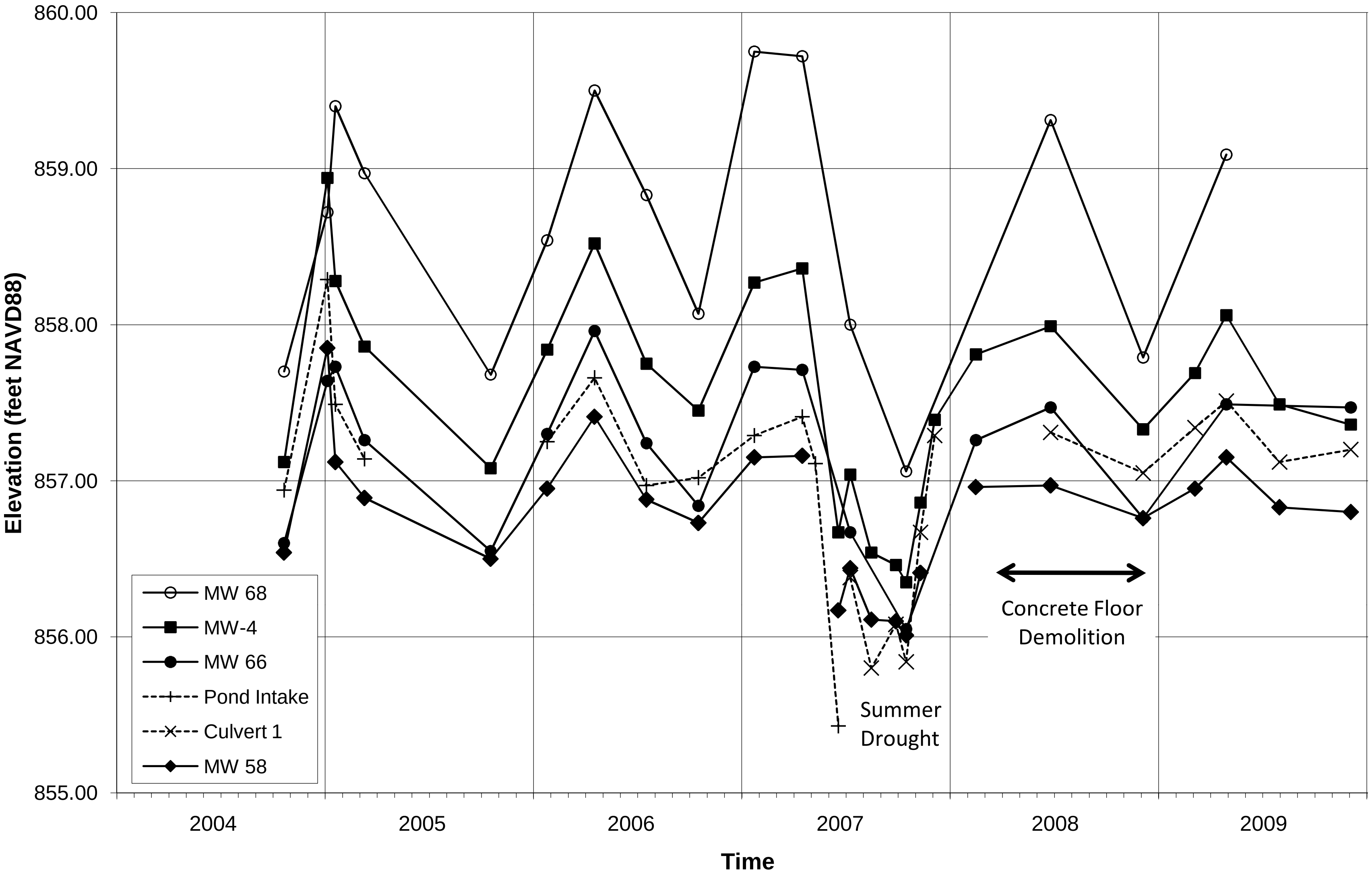


Figure 2-11: Former WWTP Area Plume Monitoring Point Hydrographs.

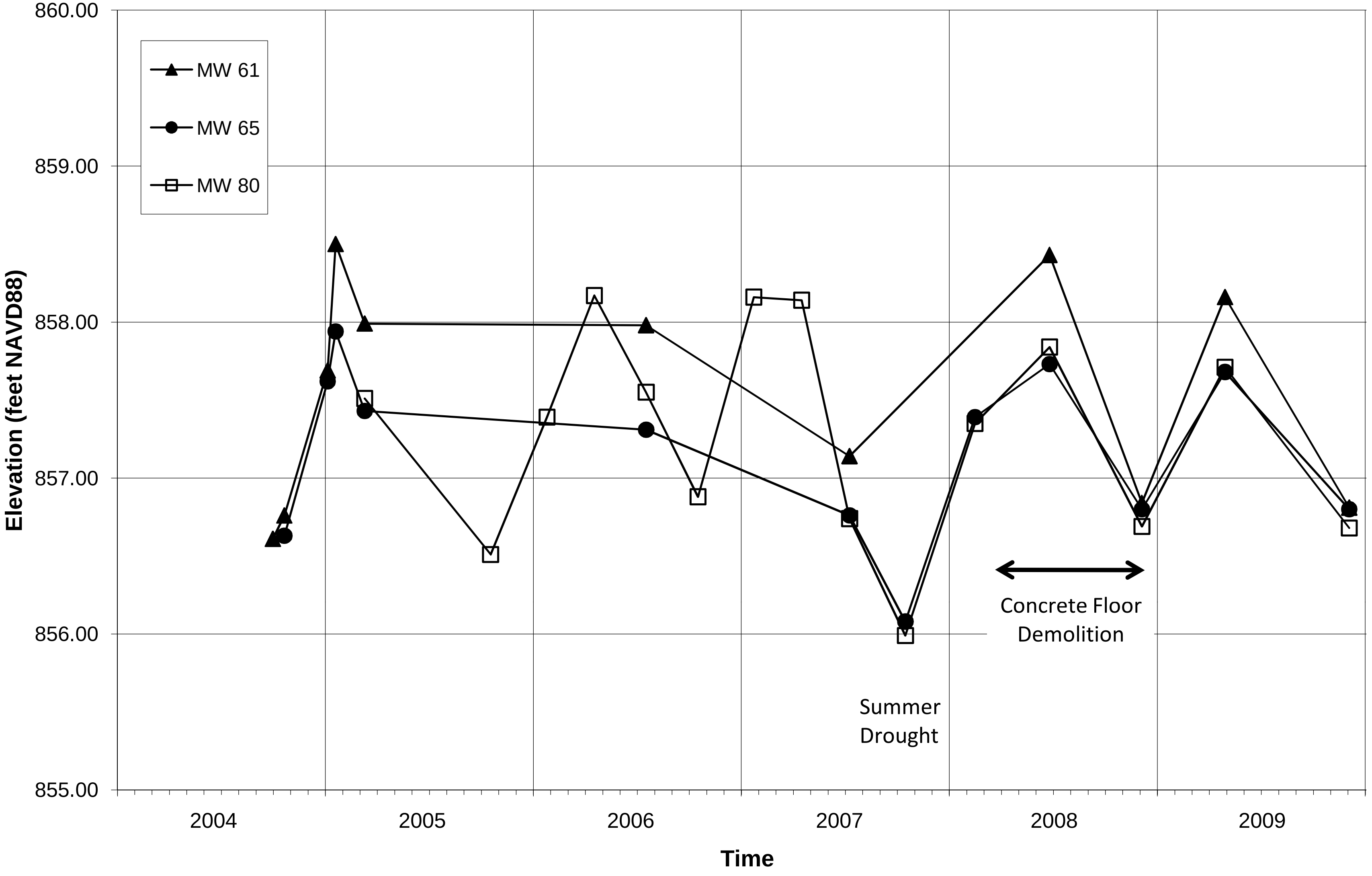


Figure 2-12: Plant 9 Area Monitoring Point Hydrographs.

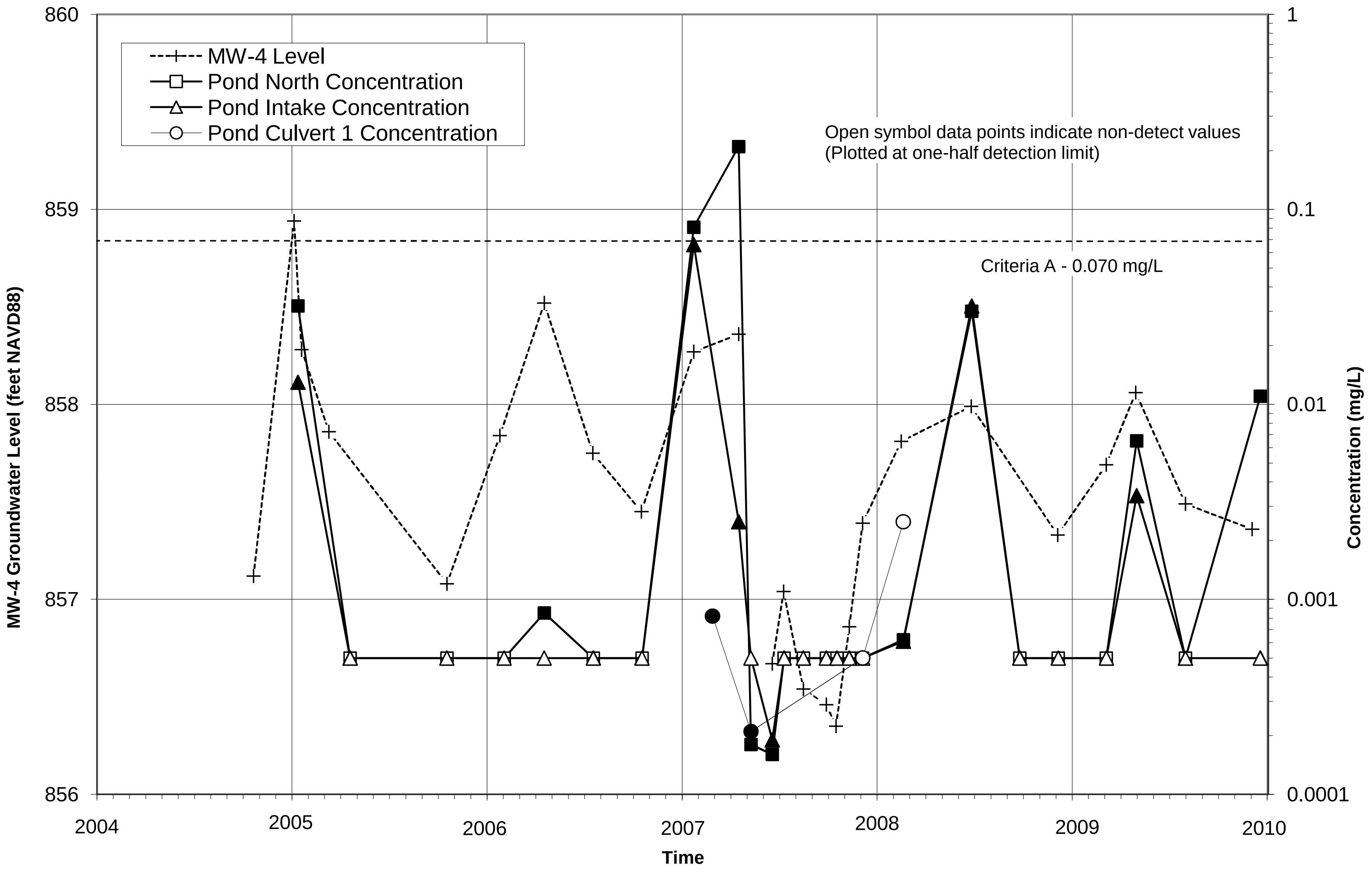


Figure 2-13. Time Series Plots of Cis-1,2-Dichloroethene Concentrations at Pond Sample Locations and Groundwater Level at MW-4.

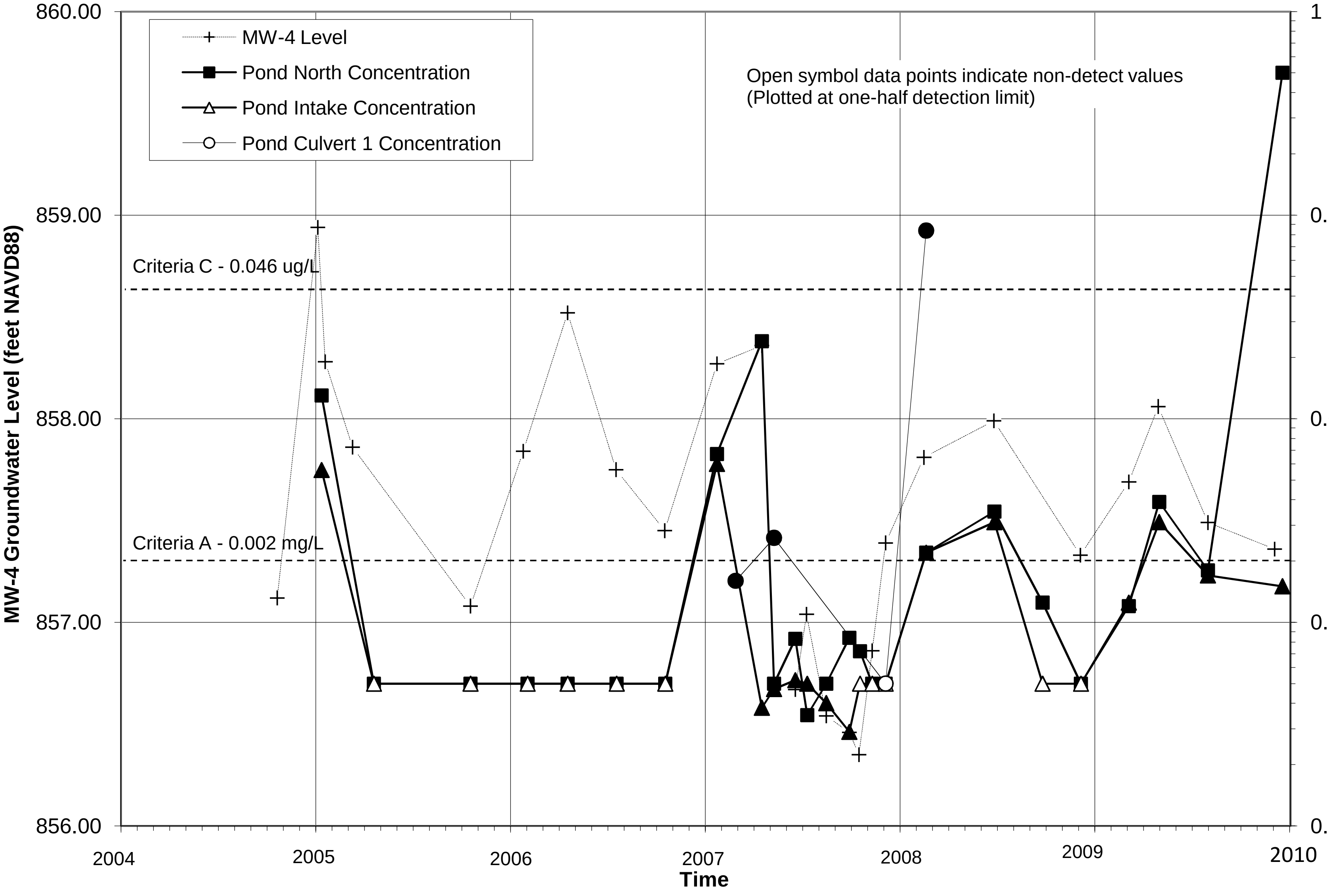
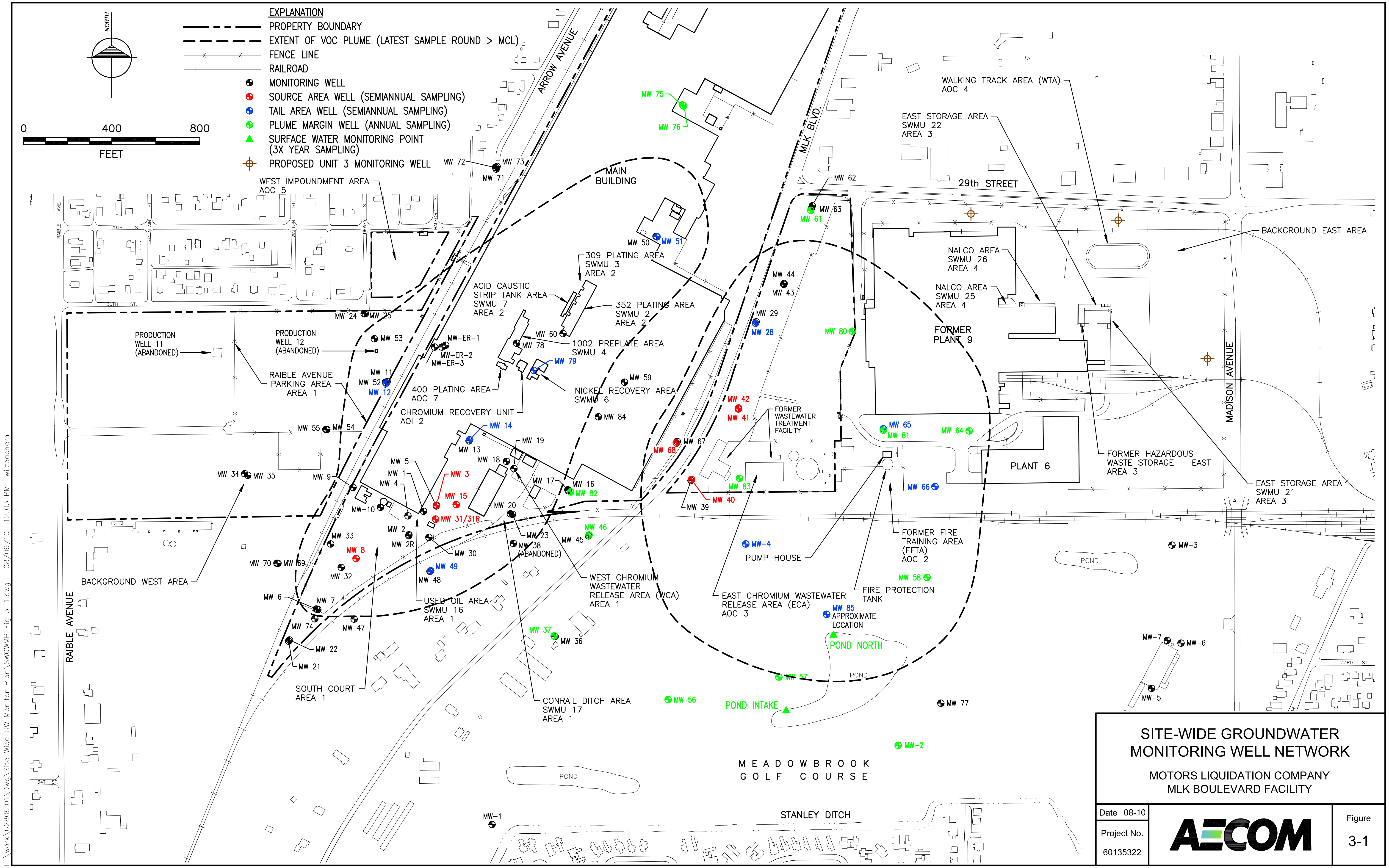


Figure 2-14. Time Series Plots of Vinyl Chloride Concentrations at Pond Sample Locations and Groundwater Level at MW-4.



SITE-WIDE GROUNDWATER
MONITORING WELL NETWORK

MOTORS LIQUIDATION COMPANY
MLK BOULEVARD FACILITY

Date 08-10
Project No.
60135322

AECOM

Figure
3-1

L:\work\62806.01\Dwg\Site Wide GW Monitor Plan\SWGWMP Fig 3-1.dwg 08/09/10 12:03 PM wilzbachern

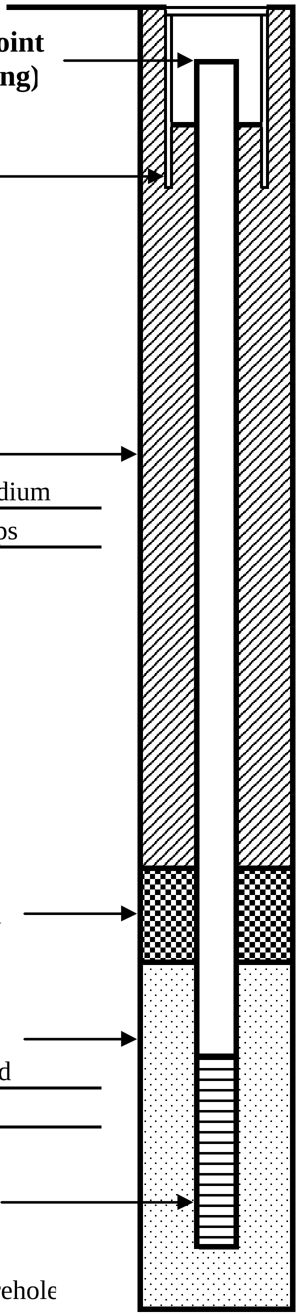
Attachment A
Monitoring Well Completion Diagrams

Earth Tech
A tyco International Ltd. Company

Well Completion Diagram

Well No. MW-3
Project GM Delphi - Inland Fisher Guide
Time & Date: Start 11/20/92 11:00 AM
Completed 11/20/92 12:00 PM

Installed By Omer Cornelius (EEI)
Inspected By JD Bryan



Ground Surface 880.81 FT. (MSL)

Reference Point (Top of Casing) 880.51 FT. (MSL)

Guard Pipe

Drilling Method 4.25" HSA
with Teflon K.O. Plug

Screen:
Type 2" Schedule 40 PVC, threaded
Slot Size 0.010"
Top Blank 0.35'
Bottom Blank 0.75'
Total Screen 4.28'
Total Length 5.38'

Backfill
Gold-Seal Medium
Bentonite Chips

Stand Pipe:
Type 2" Schedule 40 PVC, threaded
Total Length 20.00'

FT.

Bentonite Seal 14 FT.

Granular Pack
#4 Quartz Sand
16.28 FT. 864.53 FT. (MSL)

Well Screen

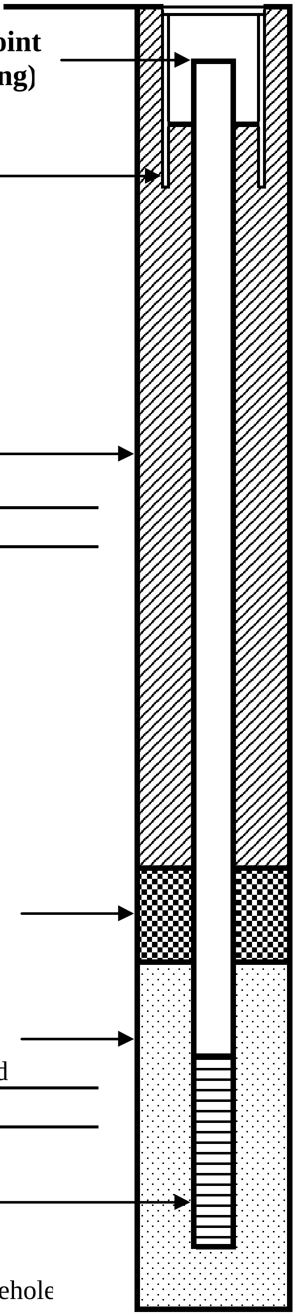
20.56 FT. =	25.38	-	4.37	-	0.75	-	-0.30
	Tot. Pipe		Cut Off		Bot. Blk.		Stick

Bottom of Borehole 20.8 FT.

Well-2.xls

Well Completion Diagram

Well No. MW-8
Project GM Delphi - Inland Fisher Guide
Installed By Omer Cornelius (EEI)
Time & Date: Start 3/25/93 12:10 PM
Inspected By JD Bryan
Completed 3/25/93 1:00 PM



Ground Surface 878.72 FT. (MSL)

Reference Point (Top of Casing) 878.41 FT. (MSL)

Guard Pipe

Backfill

0.0 FT.

Bentonite Seal
Hole Plug
12.0 FT.

Granular Pack
#4 Quartz Sand
14.57 FT. 864.15 FT. (MSL)

Well Screen

24.16 FT. = 25.07 (Tot. Pipe) - 0.82 (Cut Off) - 0.4 (Bot. Blk.) - -0.31 (Stick)

Bottom of Borehole 25.0 FT.

Drilling Method 4.25" HSA
with Teflon K.O. Plug

Screen:
Type 2" Schedule 40 PVC, threaded
Slot Size 0.010"
Top Blank 0.27'
Bottom Blank 0.40'
Total Screen 9.59'
Total Length 10.26'

Stand Pipe:
Type
Total Length

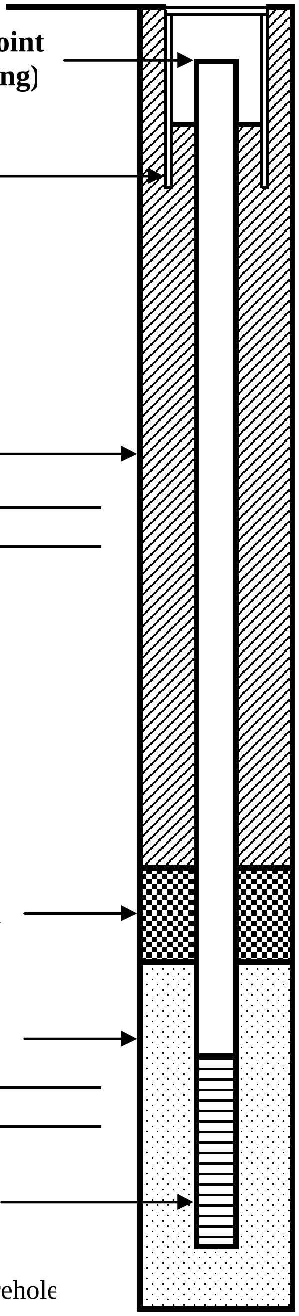
Well Completion Diagram

Well No. MW-12
Project GM Delphi - Inland Fisher Guide
Time & Date: Start 3/25/93 3:30 PM
Completed 3/25/93 5:30 PM

Installed By Omer Cornelius (EEI)
Inspected By JD Bryan

Ground Surface 883.05 FT. (MSL)

Reference Point (Top of Casing) 882.78 FT. (MSL)



Guard Pipe

Backfill

Hole Plug

3.0 FT.

Bentonite Seal Slurry (quick gel)

47.0 FT.

Granular Pack 49.21 FT. 833.84 FT. (MSL)

Natural Cave

Well Screen

53.79 FT. = 55.27 - 1.36 - 0.39 - -0.27

53.79 FT. =	55.27	1.36	0.39	-0.27
	Tot. Pipe	Cut Off	Bot. Blk.	Stick

Bottom of Borehole 55.0 FT.

Drilling Method 4.25" HSA
with Teflon K.O. Plug

Screen:

Type	2" Schedule 40 PVC
Slot Size	0.010"
Top Blank	0.28'
Bottom Blank	0.39'
Total Screen	4.58'
Total Length	5.25'

Stand Pipe:

Type	2" Schedule 40 PVC
Total Length	50.02'

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A tyco International Ltd. Company

Well Completion Diagram

Well No. MW-14

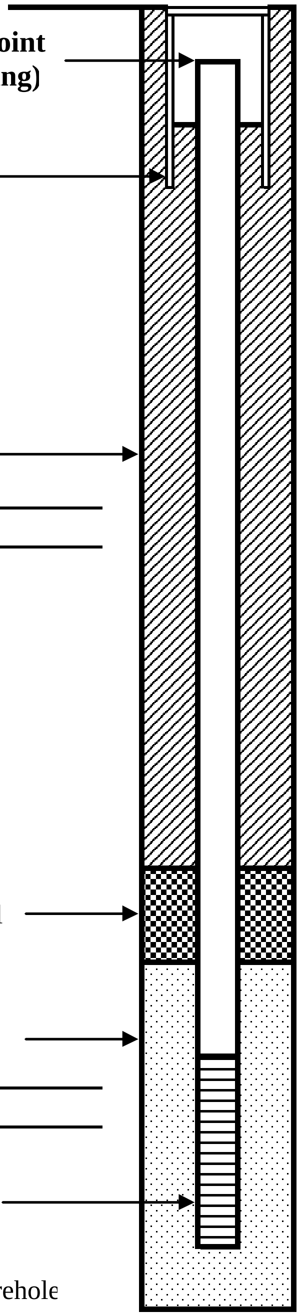
Project GM Delphi - Inland Fisher Guide

Installed By Omer Cornelius (EEI)

Time & Date: Start 3/25/93 7:30 AM

Inspected By JD Bryan

Completed 3/25/93 8:30 AM



Ground Surface 881.76 FT. (MSL)

Reference Point (Top of Casing) 881.36 FT. (MSL)

Guard Pipe

Backfill

2.0 FT.

Bentonite Seal

26.5 FT.

Granular Pack 29.13 FT. 852.63 FT. (MSL)

Well Screen

33.70 FT. = 34.26 (Tot. Pipe) - 0.57 (Cut Off) - 0.39 (Bot. Blk.) - -0.40 (Stick)

Bottom of Borehole 34.0 FT.

Drilling Method 4.25" HSA with Teflon K.O. Plug

Screen:

Type	2" Schedule 40 PVC, threaded
Slot Size	0.010"
Top Blank	0.29'
Bottom Blank	0.39'
Total Screen	4.57'
Total Length	5.25'

Stand Pipe:

Type	2" Schedule 40 PVC, threaded
Total Length	15.0'

Well-2.xls

EarthTech

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Well Completion Diagram

Well No. MW-28

Project GM Pendleton Avenue RFI

Time & Date: Start 11/3/2000

Completed 11/3/2000

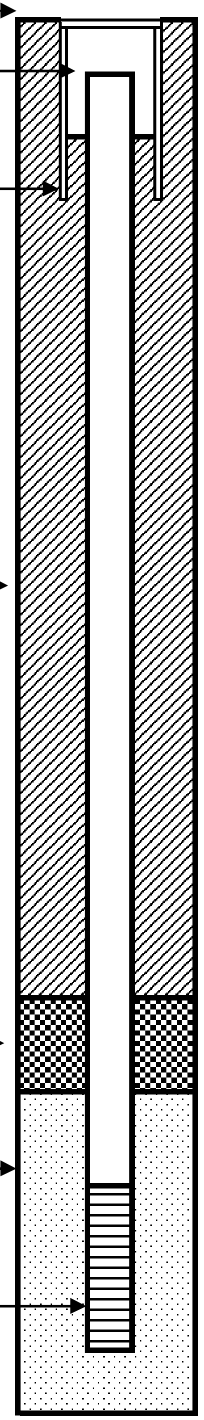
Location: N 1761964.87 E 318819.01

Installed By R. Smith

Inspected By B. Franz

Ground Surface 877.9 FT. (MSL)

Reference Point (Top of Casing) 877.44 FT. (MSL)



Drilling Method HSA

Borehole Diameter 4.25"

Guard Pipe

	Backfill	Surface Seal/Pad
Material	Bentonite	Concrete
Size	Grout	Slurry
Volume (calc.)		
Volume (actual)	80 gal.	160 gal.
Placement Method		

Guard Pipe:

Type Flush Mount

Diameter 8"

Length 12"

Closure Type Expandable cap

Casing:

Type Schedule 40 PVC

Diameter 2 inch

Joint Type Threaded

Total Length 45.07

Backfill

	Filter Pack	Annular Seal
Material	Qtz Sand	Bentonite
Size	#5	Chips
Volume (calc.)		
Volume (actual)	300 lbs.	100 lbs.
Placement Method		

Screen:

Type Schedule 40 PVC

Diameter 2 inch

Slot Size 0.010

Joint Type Threaded

Top Blank 0.09 '

Bottom Blank 0.44 '

Total Screen 9.74 '

Total Length 10.27 '

39.5 FT.

Development:

Method Pumping

Volume Discharged 90 gal.

Turbidity at Completion 0

Annular Seal

41.5 FT.

Filter Pack

43.52 FT.

Well Screen

53.26 FT. = 55.34 - 2.12 - 0.44 - -0.48

Tot. Pipe	Cut Off	Bot. Blk.	Stick
55.34	2.12	0.44	-0.48

Bottom of Borehole 53.7 FT.

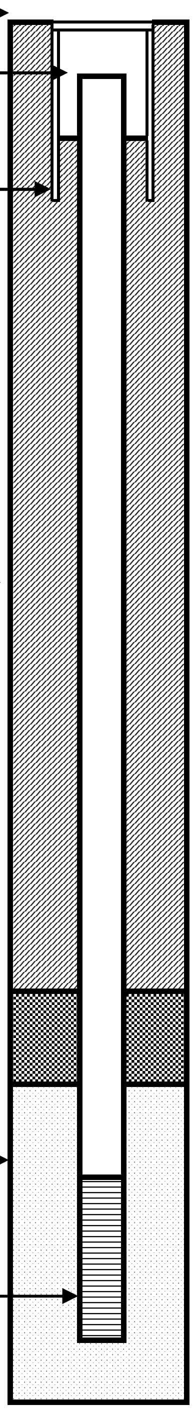
WCDMSTR.XLS

EARTH TECH

Well Completion Diagram

Well No. MW 31R 62806.01
Project MLK Blvd. Stage II RFI
Time & Date: Start 12:30 7/25/2005
Completed 15:17 7/25/2005
Location: N 1761074.5 E 317365.6

Installed By S. Phillips EE
Inspected By M. Lytle ET



Ground Surface 879.9 FT. (MSL)

Reference Point (Top of Casing) 879.71 FT. (MSL)

Drilling Method 4.25" HSA
Borehole Diameter 8"

Guard Pipe

Guard Pipe:
Type Flush Mount
Diameter
Length 12"
Closure Type Bolt lid

	Backfill	Surface Seal/Pad
Material	Bentonite	Concrete
Size	Chip	2x2 Ft.
Volume (calc.)		
Volume (actual)	2 Bags	2 Bags
Placement Method	Drop	Pour

Casing:
Type Schedule 40 PVC
Diameter 2 inch
Joint Type Flush threaded
Total Length 10.08 '

Backfill

	Filter Pack	Annular Seal
Material	Quartz Sand	Bentonite
Size	#4	Pellet
Volume (calc.)		
Volume (actual)	4 Bags	1 Bucket
Placement Method	Drop	Drop

Screen:
Type Stainless Steel
Diameter 2 inch
Slot Size 0.010"
Joint Type Flush threaded
Top Blank 0.25 '
Bottom Blank 0.05 '
Total Screen 4.68 '
Total Length 4.98 '

4.00 FT.

Annular Seal

Development:
Method Surged
Volume Discharged NA
Turbidity at Completion

6.00 FT.

Filter Pack

8.32 FT. 871.6 FT. (MSL)

Well Screen

13.00 FT. =	15.06	-	2.20	-	0.05	-	-0.19
	Tot. Pipe		Cut Off		Bot. Blk.		Stick

Bottom of Borehole 13.0 FT.

WCDMSTR.XLS

EARTH TECH

Well Completion Diagram

Well No. MW-37
Project GM Pendleton Avenue RFI
Time & Date: Start 2/12/2001 15:00
Completed 2/12/2001 16:15

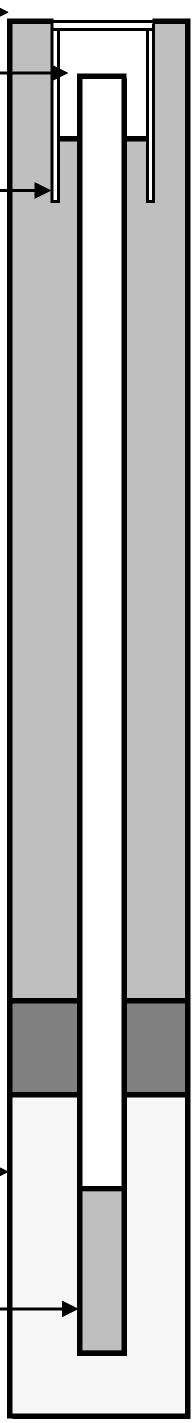
Installed By EEI
Inspected By K. Fallowfield

Ground Surface 870.44 FT. (MSL)

Reference Point (Top of Casing) 869.95 FT. (MSL)

Drilling Method HSA
Borehole Diameter 4.25"

Guard Pipe



	Backfill	Surface Seal/Pad
Material	Bentonite	Concrete
Size	Grout	Slurry
Volume (calc.)		
Volume (actual)	~ 30 gallons	160 lbs.
Placement Method		

Guard Pipe:
Type
Diameter
Length
Closure Type

Casing:
Type Schedule 40 PVC
Diameter 2 inch
Joint Type Threaded
Total Length 10

Backfill

	Filter Pack	Annular Seal
Material	Quartz Sand	Bentonite
Size	#5	Chips
Volume (calc.)		
Volume (actual)	200 lbs.	50 lbs.
Placement Method		

Screen:
Type Schedule 40 PVC
Diameter 2 inch
Slot Size 0.010"
Joint Type Threaded
Top Blank 0.41
Bottom Blank 0.47
Total Screen 4.74
Total Length 5.62

6.1 FT.

Development:
Method Double stage whale pump
Volume Discharged ~ 20 gallons
Turbidity at Completion < 5 NTU

Annular Seal

8.1 FT.

Filter Pack

9.70 FT.

Well Screen

14.44 FT. =	15.62	-	1.20	-	0.47	-	-0.49
	Tot. Pipe		Cut Off		Bot. Blk.		Stick

Bottom of Borehole 14.9 FT.

WCDMSTR.XLS

EarthTech

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Well Completion Diagram

Well No. MW 40 (SB 208) 62806.01

Project GM Pendleton Ave. Stage II RFI

Installed By Ernie Dixon EEI

Time & Date: Start 11/21/2003 13:00

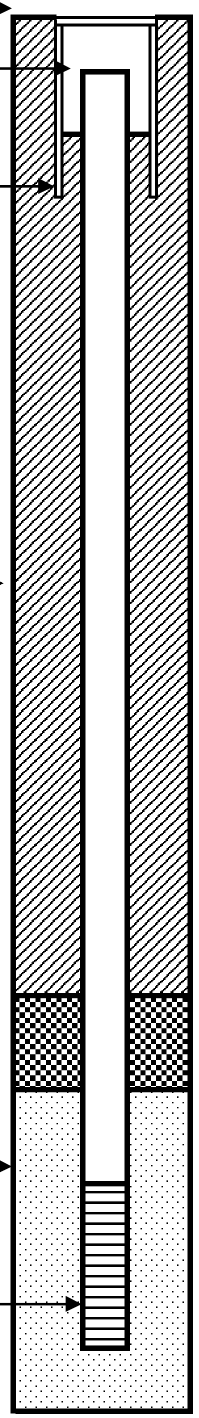
Inspected By J. Duwelius ET

Completed 11/21/2003 14:55

Location: N 1761254.51 E 318528.40

Ground Surface 880.00 FT. (MSL)

Reference Point (Top of Casing) 879.51 FT. (MSL)



Drilling Method 4.25" HSA w/K.O. Plug

Borehole Diameter 8"

Guard Pipe

	Backfill	Surface Seal/Pad
Material	Bentonite	Concrete
Size	Slurry	2x2
Volume (calc.)		
Volume (actual)		
Placement Method	Tremie Pipe	Pour

Guard Pipe:

Type Flush Mount

Diameter 8"

Length 12"

Closure Type J-Plug

Casing:

Type Schedule 40 PVC

Diameter 2 inch

Joint Type Threaded

Total Length 30.06 '

Backfill

	Filter Pack	Annular Seal
Material	Silica Sand	Bentonite
Size	Global #4	3/8" Tablets
Volume (calc.)		
Volume (actual)		
Placement Method	Pour	Pour

Screen:

Type 304 Stainless Steel

Diameter 2 inch

Slot Size 0.010"

Joint Type Threaded

Top Blank 0.23 '

Bottom Blank 0.05 '

Total Screen 9.73 '

Total Length 10.01 '

22.10 FT.

Development:

Method Overpump and surge

Volume Discharged 25 gal

Turbidity at Completion 75 NTU

Annular Seal

25.75 FT.

Filter Pack

28.63 FT.

Well Screen

38.36 FT. =	40.07	-	2.15	-	0.05	-	-0.49
	Tot. Pipe		Cut Off		Bot. Blk.		Stick

Bottom of Borehole 38.5 FT.

WCDMSTR.XLS

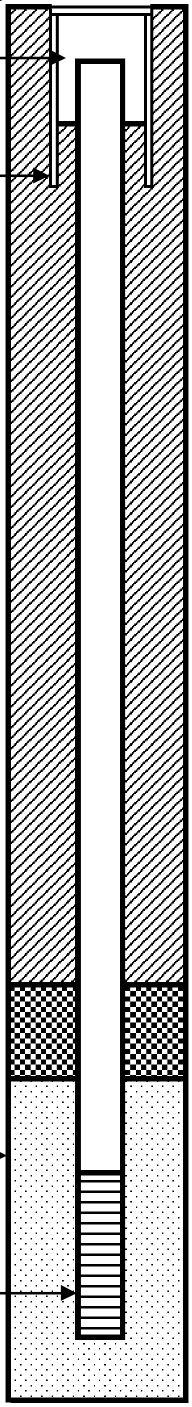
EarthTech
A tyco International Ltd. Company

Well Completion Diagram

Well No. MW 41 (SB 210) 62806.01
Project GM Pendleton Ave. Stage II RFI
Time & Date: Start 11/24/2003 10:00
Completed 11/24/2003 12:45
Location: N 1761575.05 E 318740.73

Installed By Ernie Dixon EEI
Inspected By J. Duwelius ET

Ground Surface 878.87 FT. (MSL)
Reference Point (Top of Casing) 878.58 FT. (MSL)



34.00 FT.
36.75 FT.
39.24 FT.
43.95 FT. = 45.03 Tot. Pipe - 1.32 Cut Off - 0.05 Bot. Blk. - -0.29 Stick
Bottom of Borehole 44.0 FT.

Drilling Method 4.25" HSA w/K.O. Plug
Borehole Diameter 8"

Guard Pipe:
Type Flush Mount
Diameter 8"
Length 12"
Closure Type J-Plug

	Backfill	Surface Seal/Pad
Material	Bentonite	
Size	Slurry	
Volume (calc.)		
Volume (actual)		
Placement Method	Tremie Pipe	

Casing:
Type Schedule 40 PVC
Diameter 2 inch
Joint Type Threaded
Total Length 40.04 '

	Filter Pack	Annular Seal
Material	Silica Sand	Bentonite
Size	Global #4	3/8" Tablets
Volume (calc.)		
Volume (actual)		
Placement Method	Pour	Pour

Screen:
Type 304 Stainless Steel
Diameter 2 inch
Slot Size 0.010"
Joint Type Threaded
Top Blank 0.23 '
Bottom Blank 0.05 '
Total Screen 4.71 '
Total Length 4.99 '

Development:
Method Overpump and surge
Volume Discharged 75 gal
Turbidity at Completion 157 NTU

WCDMSTR.XLS

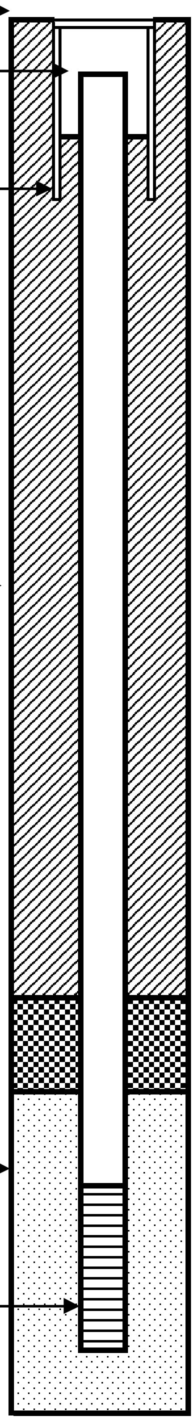
EarthTech
A tyco International Ltd. Company

Well Completion Diagram

Well No. MW 42 (SB 210) 62806.01
Project GM Pendleton Ave. Stage II RFI
Time & Date: Start 11/24/2003 13:36
Completed 11/24/2003 15:00
Location: N 1761579.24 E 318742.21

Installed By Ernie Dixon EEI
Inspected By J. Duwelius ET

Ground Surface 878.83 FT. (MSL)
Reference Point (Top of Casing) 878.54 FT. (MSL)



Drilling Method 4.25" HSA w/K.O. Plug
Borehole Diameter 8"

Guard Pipe

Guard Pipe:
Type Flush Mount
Diameter 8"
Length 12"
Closure Type J-Plug

	Backfill	Surface Seal/Pad
Material	Bentonite	
Size	Slurry	
Volume (calc.)		
Volume (actual)		
Placement Method	Tremie Pipe	

Quick Concrete

Backfill

Casing:
Type Schedule 40 PVC
Diameter 2 inch
Joint Type Threaded
Total Length 25.04 '

	Filter Pack	Annular Seal
Material	Silica Sand	Bentonite
Size	Global #4	3/8" Tablets
Volume (calc.)		
Volume (actual)		
Placement Method	Pour	Pour

Screen:
Type 304 Stainless Steel
Diameter 2 inch
Slot Size 0.010"
Joint Type Threaded
Top Blank 0.23 '
Bottom Blank 0.05 '
Total Screen 9.73 '
Total Length 10.01 '

18.99 FT.

Development:
Method Overpump and surge
Volume Discharged 30 gal
Turbidity at Completion 14 NTU

Annular Seal

21.00 FT.

Filter Pack

23.90 FT.

Well Screen

33.63 FT. = 35.05 - 1.66 - 0.05 - -0.29

Tot. Pipe	Cut Off	Bot. Blk.	Stick
35.05	1.66	0.05	-0.29

Bottom of Borehole 34.0 FT.

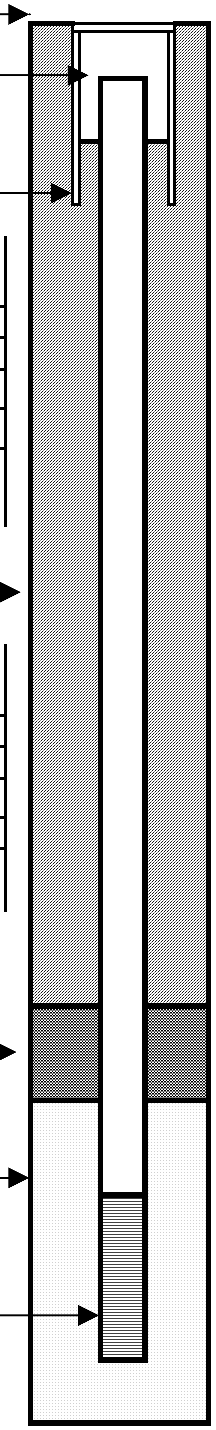
WCDMSTR.XLS

EARTH TECH

Well Completion Diagram

Well No. MW 46 (SB 204) 62806.01
Project GM Pendleton Ave. Stage II RFI
Time & Date: Start 11/26/2003 11:59
Completed 11/26/2003 13:19
Location: N 1761002.51 E 318062.71

Installed By Ernie Dixon EEI
Inspected By J. Duwelius ET



Ground Surface 874.20 FT. (MSL)

Reference Point
(Top of Casing) 873.64 FT. (MSL)

Guard Pipe

	Backfill	Surface Seal/Pad
Material	Bentonite	Concrete
Size	Slurry	2x2
Volume (calc.)		
Volume (actual)	50 lbs.	100 lbs.
Placement Method	Tremie Pipe	Pour

Quick Concrete

Backfill

	Filter Pack	Annular Seal
Material	Silica Sand	Bentonite
Size	Global #4	3/8" Tablets
Volume (calc.)		
Volume (actual)	100 lbs.	25 lbs.
Placement Method	Pour	Pour

10.00 FT.

Annular Seal
1/2 bucket 12.00 FT.

Filter Pack 14.57 FT.
Global #4 50/bag

Well Screen

19.28 FT. =	20.02	-	1.25	-	0.05	-	-0.56
	Tot. Pipe		Cut Off		Bot. Blk.		Stick

Bottom of Borehole 19.30 FT.

Drilling Method 4.25" HSA w/K.O. Plug
Borehole Diameter 8"

Guard Pipe:
Type Flush Mount
Diameter 8"
Length 12"
Closure Type J-Plug
(Expandable Cap)

Casing:
Type Schedule 40 PVC
Diameter 2 inch
Joint Type Threaded
Total Length 15.03 '

Screen:
Type 304 Stainless Steel
Diameter 2 inch
Slot Size 0.010"
Joint Type Threaded
Top Blank 0.23 '
Bottom Blank 0.05 '
Total Screen 4.71 '
Total Length 4.99 '

Development:
Method Overpump and surge
Volume Discharged 40 gal
Turbidity at Completion 60 NTU

WCDMSTR.XLS

EarthTech
A tyco International Ltd. Company

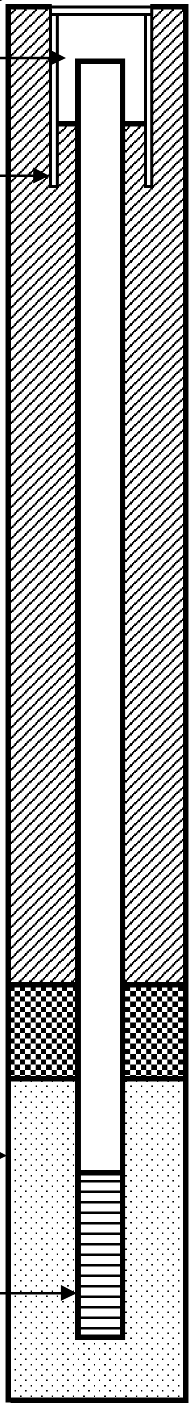
Well Completion Diagram

Well No. MW 49 (SB 205) 62806.01
Project GM Pendleton Ave. Stage II RFI
Time & Date: Start 09:30 12/2/2003
Completed 11:40 12/2/2003
Location: N 1760839.93 E 317343.16

Installed By Ernie Dixon EEI
Inspected By J. Duwelius ET

Ground Surface 878.54 FT. (MSL)

Reference Point (Top of Casing) 877.93 FT. (MSL)



Guard Pipe

	Backfill	Surface Seal/Pad
Material	Bentonite	Concrete
Size	Slurry	2x2
Volume (calc.)		
Volume (actual)	50 lbs.	100 lbs.
Placement Method	Tremie Pipe	Pour

Backfill

	Filter Pack	Annular Seal
Material	Silica Sand	Bentonite
Size	Global #4	3/8" Tablets
Volume (calc.)		
Volume (actual)	200 lbs.	25 lbs.
Placement Method	Pour	Pour

17.50 FT.

Annular Seal

19.75 FT.

Filter Pack 22.85 FT.

Well Screen

32.56 FT. =	35.02	-	3.02	-	0.05	-	-0.61
	Tot. Pipe		Cut Off		Bot. Blk.		Stick

Bottom of Borehole 32.5 FT.

Drilling Method 4.25" HSA w/K.O. Plug
Borehole Diameter 8"

Guard Pipe:
Type Flush Mount
Diameter 8"
Length 12"
Closure Type J-Plug

Casing:
Type Schedule 40 PVC
Diameter 2 inch
Joint Type Threaded
Total Length 25.03 '

Screen:
Type 304 Stainless Steel
Diameter 2 inch
Slot Size 0.010"
Joint Type Threaded
Top Blank 0.23 '
Bottom Blank 0.05 '
Total Screen 9.71 '
Total Length 9.99 '

Development:
Method Overpump and surge
Volume Discharged 100 gal
Turbidity at Completion 184 NTU

WCDMSTR.XLS

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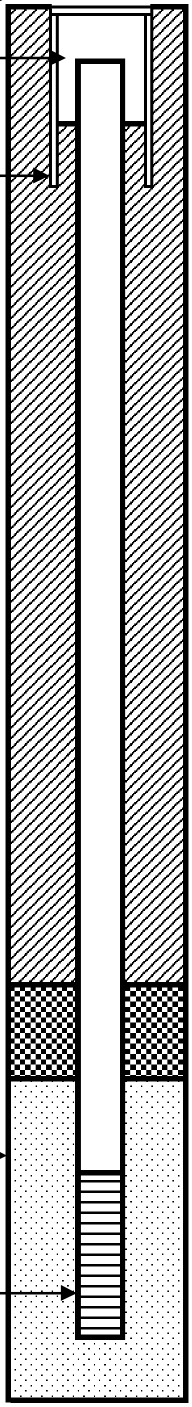
Well Completion Diagram

Well No. MW 51 (SB 213) 62806.01
Project GM Pendleton Ave. Stage II RFI
Time & Date: Start 13:30 12/3/2003
Completed 14:30 12/3/2003
Location: N 1762357.18 E 318371.66

Installed By Ernie Dixon EEI
Inspected By J. Duwelius ET

Ground Surface 878.74 FT. (MSL)
Reference Point (Top of Casing) 878.19 FT. (MSL)



Drilling Method 4.25" HSA w/K.O. Plug
Borehole Diameter 8"

Guard Pipe

Guard Pipe:
Type Flush Mount
Diameter 8"
Length 12"
Closure Type J-Plug

	Backfill	Surface Seal/Pad
Material	Bentonite	Concrete
Size	Slurry	2x2
Volume (calc.)		
Volume (actual)	75 lbs.	
Placement Method	Tremie Pipe	

Casing:
Type Schedule 40 PVC
Diameter 2 inch
Joint Type Threaded
Total Length 25.03 '

Backfill

	Filter Pack	Annular Seal
Material	Silica Sand	Bentonite
Size	Global #4	3/8" Tablets
Volume (calc.)		
Volume (actual)	150 lbs.	25 lbs.
Placement Method	Pour	

Screen:
Type 304 Stainless Steel
Diameter 2 inch
Slot Size 0.010"
Joint Type Threaded
Top Blank 0.23 '
Bottom Blank 0.05 '
Total Screen 4.73 '
Total Length 5.01 '

17.67 FT.

Development:
Method Overpump
Volume Discharged
Turbidity at Completion 0 NTU

Annular Seal

20.0 FT.

Filter Pack 22.81 FT.

Well Screen

27.54 FT. =	30.04	-	3.00	-	0.05	-	-0.55
	Tot. Pipe		Cut Off		Bot. Blk.		Stick

Bottom of Borehole 27.6 FT.

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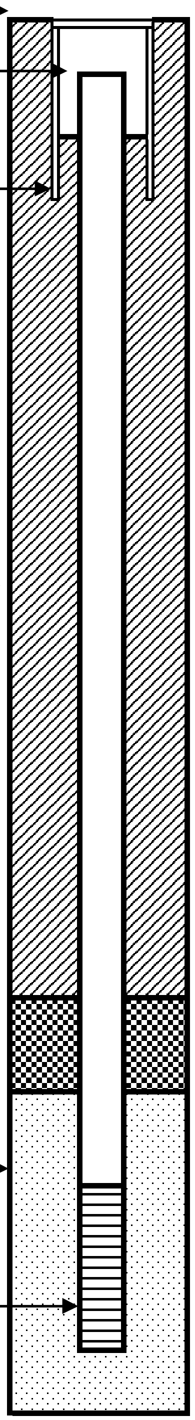
Well Completion Diagram

Well No. MW 56 (SB 259) 62806.01
Project MLK Blvd. Stage II RFI
Time & Date: Start 16:10 9/2/2004
Completed 20:45 9/2/2004
Location: N 1760254.76 E 318422.25

Installed By N. Ingram Al Tech
Inspected By J. Duwelius ET



Ground Surface 859.80 FT. (MSL)
Reference Point (Top of Casing) 859.32 FT. (MSL)
Guard Pipe
Backfill
1.40 FT.
Annular Seal
2.35 FT.
Natural soil collapse to 2.35'
Filter Pack 11.87 FT. 847.93 FT. (MSL)
Well Screen
21.53 FT. = 30.32 - 8.99 - 0.28 - -0.48

	Tot. Pipe	Cut Off	Bot. Blk.	Stick
21.53 FT. =	30.32	8.99	0.28	-0.48

Bottom of Borehole 27.0 FT.

	Backfill	Surface Seal/Pad
Material	Bentonite	Concrete
Size	3/8" Chips	2x2
Volume (calc.)		
Volume (actual)	50 lbs.	100 lbs.
Placement Method	Pour	Pour

	Filter Pack	Annular Seal
Material	Silica Sand	Bentonite
Size	Global #5	3/8" Chips
Volume (calc.)		
Volume (actual)	150 lbs.	50 lbs.
Placement Method	Pour	Pour

Drilling Method 4.25" HSA w/K.O. Plug
Borehole Diameter 8"

Guard Pipe:
Type Flush Mount
Diameter 8"
Length 12"
Closure Type Expandable cap

Casing:
Type Schedule 40 PVC
Diameter 2 inch
Joint Type Flush threaded
Total Length 20.04 '

Screen:
Type 304 Stainless Steel
Diameter 2 inch
Slot Size 0.010"
Joint Type Flush threaded
Top Blank 0.34 '
Bottom Blank 0.28 '
Total Screen 9.66 '
Total Length 10.28 '

Development:
Method overpump
Volume Discharged 370 gal
Turbidity at Completion 25 NTU

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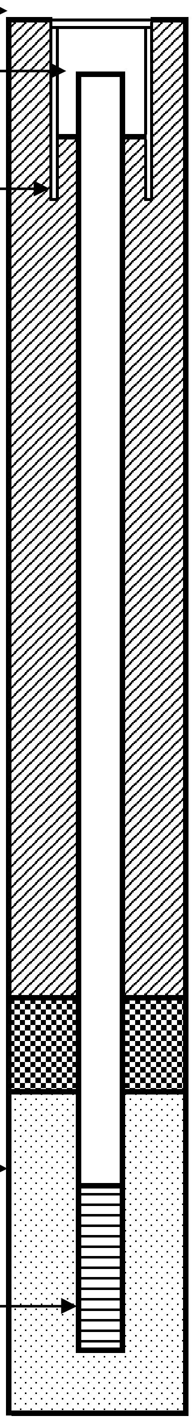
Well Completion Diagram

Well No. MW 57 (SB 260) 62806.01
Project MLK Blvd. Stage II RFI
Time & Date: Start 22:37 9/2/2004
Completed 01:30 9/3/2004
Location: N 1760357.35 E 318925.21

Installed By N. Ingram AlTech
Inspected By J. Duwelius ET



Ground Surface 862.83 FT. (MSL)

Reference Point (Top of Casing) 862.52 FT. (MSL)

Drilling Method 4.25" HSA w/K.O. Plug
Borehole Diameter 8"

Guard Pipe

Guard Pipe:
Type Flush Mount
Diameter 8"
Length 12"
Closure Type Expandable cap

	Backfill	Surface Seal/Pad
Material	Bentonite	Concrete
Size	3/8" Chips	2x2
Volume (calc.)		
Volume (actual)	100 lbs.	100 lbs.
Placement Method	pour	Pour

Casing:
Type Schedule 40 PVC
Diameter 2 inch
Joint Type Flush threaded
Total Length 20.08 '

Backfill

	Filter Pack	Annular Seal
Material	Silica Sand	Bentonite
Size	Global #5	3/8" Chips
Volume (calc.)		
Volume (actual)	100	50 lbs.
Placement Method	Pour	Pour

Screen:
Type 304 Stainless Steel
Diameter 2 inch
Slot Size 0.010"
Joint Type Flush threaded
Top Blank 0.28 '
Mid Blank 0.38 '
Bottom Blank 0.35 '
Total Screen 9.30 '
Total Length 10.31 '

3.00 FT.

Natural soil collapse to 5.0'

Annular Seal

Development:
Method Overpump
Volume Discharged 690 gal
Turbidity at Completion 20 NTU

5.00 FT.

Filter Pack 20.15 FT. 842.68 FT. (MSL)

Well Screen

29.45 FT. =	30.39	-	0.90	-	0.35	-	-0.31
	Tot. Pipe		Cut Off		Bot. Blk.		Stick

Bottom of Borehole 32.0 FT.

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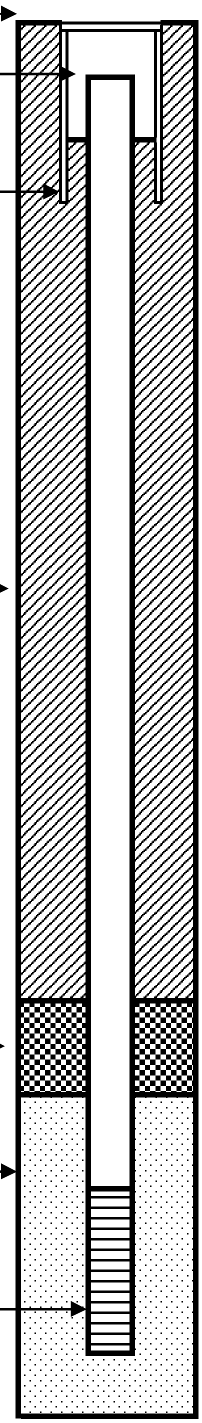
Well Completion Diagram

Well No. MW 58 (SB 251) 62806.01
Project MLK Blvd. Stage II RFI
Time & Date: Start 02:30 9/3/2004
Completed 03:40 9/3/2004
Location: N 1760809.76 E 319598.52

Installed By N. Ingram Al Tech
Inspected By J. Duwelius ET



Ground Surface 861.75 FT. (MSL)
Reference Point (Top of Casing) 861.46 FT. (MSL)
Guard Pipe

	Backfill	Surface Seal/Pad
Material	Bentonite	Concrete
Size	3/8" Chips	2x2
Volume (calc.)		
Volume (actual)	50 lbs.	100 lbs.
Placement Method	Pour	Pour

Backfill

	Filter Pack	Annular Seal
Material	Silica Sand	Bentonite
Size	Global #5	3/8" Chips
Volume (calc.)		
Volume (actual)	50 lbs.	50 lbs.
Placement Method	Pour	Pour

2.00 FT.
Annular Seal
4.15 FT.
Natural soil collapse to 4.15'
Filter Pack 7.40 FT. 854.35 FT. (MSL)
Well Screen
12.06 FT. = 15.39 (Tot. Pipe) - 3.23 (Cut Off) - 0.39 (Bot. Blk.) - -0.29 (Stick)
Bottom of Borehole 13.5 FT.

Drilling Method 4.25" HSA w/K.O. Plug
Borehole Diameter 8"

Guard Pipe:
Type Flush Mount
Diameter 8"
Length 12"
Closure Type Expandable cap

Casing:
Type Schedule 40 PVC
Diameter 2 inch
Joint Type Flush threaded
Total Length 10.06 '

Screen:
Type 304 Stainless Steel
Diameter 2 inch
Slot Size 0.010"
Joint Type Flush threaded
Top Blank 0.28 '
Bottom Blank 0.39 '
Total Screen 4.66 '
Total Length 5.33 '

Development:
Method Overpump
Volume Discharged 260 gal
Turbidity at Completion 27 NTU

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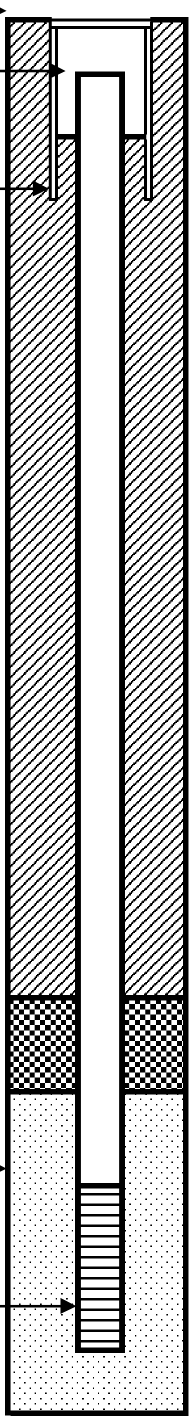
Well Completion Diagram

Well No. MW 61 (SB 264) 62806.01
Project MLK Blvd. Stage II RFI
Time & Date: Start 09:30 9/14/2004
Completed 15:15 9/14/2004
Location: N 1762477.48 E 319069.90

Installed By C. Neilson EE
Inspected By M. Lytle ET

Ground Surface 876.96 FT. (MSL)

Reference Point (Top of Casing) 876.57 FT. (MSL)



Drilling Method 4.25" HSA
Borehole Diameter 8"

Guard Pipe

Guard Pipe:
Type Flush Mount
Diameter 8"
Length 12"
Closure Type Expandable cap

	Backfill	Surface Seal/Pad
Material	Benseal	Concrete
Size	Slurry	2' x 2' Pad
Volume (calc.)		
Volume (actual)		
Placement Method	Tremie	Pour

Casing:
Type Schedule 40 PVC
Diameter 2 inch
Joint Type Flush threaded
Total Length 55.23 '

Backfill

	Filter Pack	Annular Seal
Material	Silica Sand	Bentonite
Size	Global #4	3/8" Chips
Volume (calc.)		
Volume (actual)		
Placement Method	Pour	Pour

Screen:
Type 304 Stainless Steel
Diameter 2 inch
Slot Size 0.010"
Joint Type Flush threaded
Top Blank 0.23 '
Bottom Blank 0.35 '
Total Screen 9.71 '
Total Length 10.29 '

47.50 FT.

Annular Seal

Development:
Method Overpump
51.50 FT.
Volume Discharged 175 gal
Turbidity at Completion 27 NTU

Filter Pack 53.85 FT. 823.11 FT. (MSL)

Well Screen

63.56 FT. =	65.52	-	2.00	-	0.35	-	-0.39
	Tot. Pipe		Cut Off		Bot. Blk.		Stick

Bottom of Borehole 63.9 FT.

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Well Completion Diagram

Well No. MW 64 62806.01

Project MLK Blvd. Stage II RFI

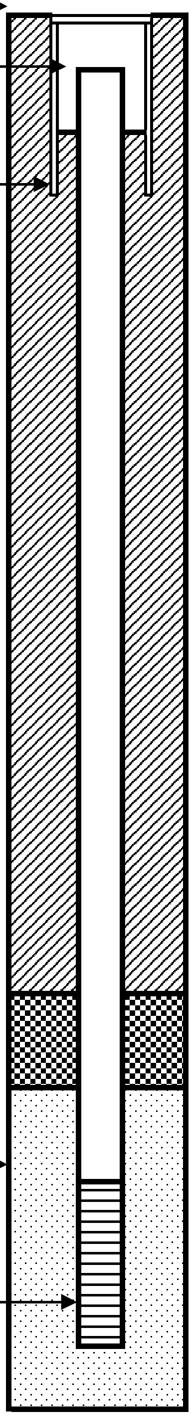
Time & Date: Start 12:30 9/13/2004

Completed 14:15 9/13/2004

Location: N 1761475.47 E 319789.86

Installed By C. Nielsen EE

Inspected By M. Lytle ET



Ground Surface 864.23 FT. (MSL)

Reference Point (Top of Casing) 863.97 FT. (MSL)

Guard Pipe

	Backfill	Surface Seal/Pad
Material	Bentonite	Concrete
Size	3/8" Chips	2' x 2' Pad
Volume (calc.)		
Volume (actual)		
Placement Method	Pour	Pour

Backfill

	Filter Pack	Annular Seal
Material	Silica Sand	Bentonite
Size	Global #4	3/8" Chips
Volume (calc.)		
Volume (actual)		
Placement Method	Pour	Pour

Drilling Method 4.25" HSA

Borehole Diameter 8"

Guard Pipe:

Type Flush Mount

Diameter 8"

Length 12"

Closure Type Expandable cap

Casing:

Type Schedule 40 PVC

Diameter 2 inch

Joint Type Flush threaded

Total Length 10.52 '

Screen:

Type Schedule 40 PVC

Diameter 2 inch

Slot Size 0.010"

Joint Type Flush threaded

Top Blank 0.23 '

Bottom Blank 0.35 '

Total Screen 9.66 '

Total Length 10.24 '

7.50 FT.

Development:

Method Overpump

Volume Discharged 210 gal

Turbidity at Completion 7 NTU

Annular Seal 9.15 FT.

Filter Pack 11.01 FT. 853.22 FT. (MSL)

Well Screen

20.67 FT. =	20.76	-	0.00	-	0.35	-	-0.26
	Tot. Pipe		Cut Off		Bot. Blk.		Stick

Bottom of Borehole 21.5 FT.

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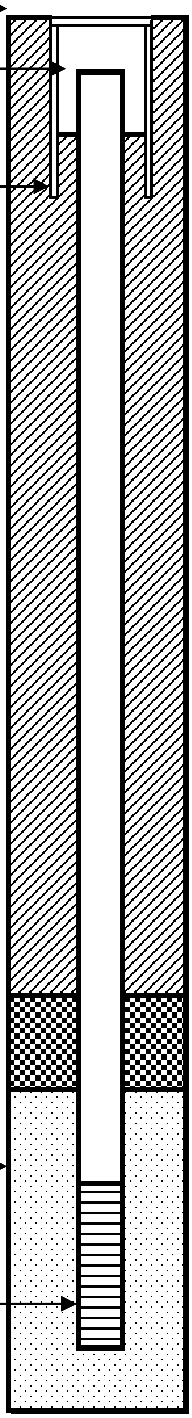
Well Completion Diagram

Well No. MW 65 62806.01
Project MLK Blvd. Stage II RFI
Time & Date: Start 14:30 9/13/2004
Completed 16:00 9/13/2004
Location: N 1761484.84 E 319399.81

Installed By C. Nielsen EE
Inspected By M. Lytle ET

Ground Surface 864.65 FT. (MSL)
Reference Point (Top of Casing) 864.22 FT. (MSL)



Drilling Method 4.25" HSA
Borehole Diameter 8"

Guard Pipe

	Backfill	Surface Seal/Pad
Material	Bentonite	Concrete
Size	3/8" Chips	2' x 2' Pad
Volume (calc.)		
Volume (actual)		
Placement Method	Pour	Pour

Guard Pipe:
Type Flush Mount
Diameter 8"
Length 12"
Closure Type Expandable cap

Casing:
Type Schedule 40 PVC
Diameter 2 inch
Joint Type Flush threaded
Total Length 10.52 '

Backfill

	Filter Pack	Annular Seal
Material	Silica Sand	Bentonite
Size	Global #4	3/8" Chips
Volume (calc.)		
Volume (actual)		
Placement Method	Pour	Pour

Screen:
Type Schedule 40 PVC
Diameter 2 inch
Slot Size 0.010"
Joint Type Flush threaded
Top Blank 0.23 '
Bottom Blank 0.35 '
Total Screen 9.67 '
Total Length 10.25 '

7.50 FT.

Annular Seal

Development:
Method Overpump
Volume Discharged 125 gal
Turbidity at Completion 14 NTU

9.15 FT.

Filter Pack 11.18 FT. 853.47 FT. (MSL)

Well Screen

20.85 FT. =	20.77	-	0.00	-	0.35	-	-0.43
	Tot. Pipe		Cut Off		Bot. Blk.		Stick

Bottom of Borehole 21.5 FT.

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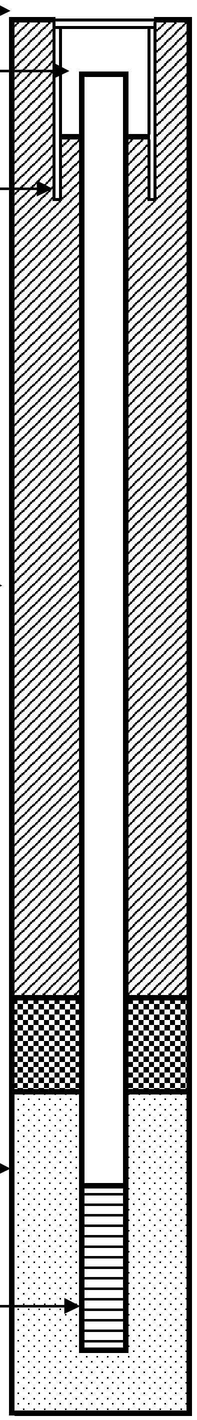
Well Completion Diagram

Well No. MW 66 62806.01
Project MLK Blvd. Stage II RFI
Time & Date: Start 12:30 9/13/2004
Completed 14:15 9/13/2004
Location: N 1761222.31 E 319634.36

Installed By C. Nielsen EE
Inspected By M. Lytle ET



Ground Surface 862.27 FT. (MSL)
Reference Point (Top of Casing) 861.67 FT. (MSL)
Guard Pipe
Backfill
6.00 FT.
Annular Seal
7.00 FT.
Filter Pack 8.54 FT. 853.73 FT. (MSL)
Well Screen
18.25 FT. = 17.70 - 0.00 - 0.05 - -0.60

	Tot. Pipe	Cut Off	Bot. Blk.	Stick
18.25 FT. =	17.70	0.00	0.05	-0.60

Bottom of Borehole 18.2 FT.

	Backfill	Surface Seal/Pad
Material	Bentonite	Concrete
Size	3/8" Chips	2' x 2' Pad
Volume (calc.)		
Volume (actual)		
Placement Method	Pour	Pour

	Filter Pack	Annular Seal
Material	Silica Sand	Bentonite
Size	Global #4	3/8" Chips
Volume (calc.)		
Volume (actual)		
Placement Method	Pour	Pour

Drilling Method 4.25" HSA
Borehole Diameter 8"

Guard Pipe:
Type Flush Mount
Diameter 8"
Length 12"
Closure Type Expandable cap

Casing:
Type Schedule 40 PVC
Diameter 2 inch
Joint Type Flush threaded
Total Length 7.70 '

Screen:
Type Schedule 40 PVC
Diameter 2 inch
Slot Size 0.010"
Joint Type Flush threaded
Top Blank 0.24 '
Bottom Blank 0.05 '
Total Screen 9.71 '
Total Length 10.00 '

Development:
Method Overpump
Volume Discharged 245 gal
Turbidity at Completion 8 NTU

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Well Completion Diagram

Well No. MW 68 62806.01

Project MLK Blvd. Stage II RFI

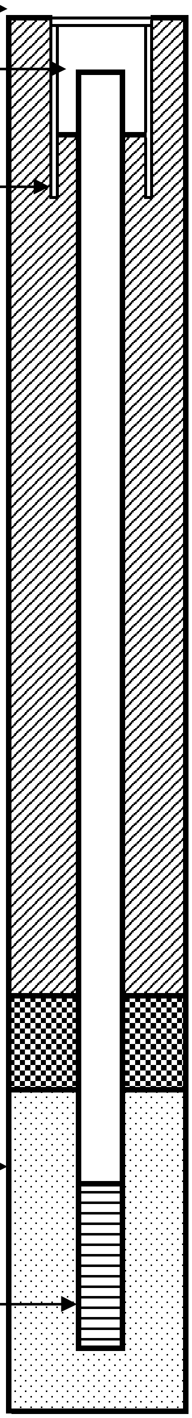
Time & Date: Start 09:50 9/16/2004

Completed 12:30 9/16/2004

Location: N 1761420.80 E 318459.32

Installed By C. Nielson EE

Inspected By M. Lytle ET



Ground Surface 877.58 FT. (MSL)

Reference Point (Top of Casing) 876.98 FT. (MSL)

Drilling Method 4.25" HSA

Borehole Diameter 8"

Guard Pipe

Guard Pipe:

Type Flush Mount

Diameter 8"

Length 12"

Closure Type Expandable cap

	Backfill	Surface Seal/Pad
Material	Bentonite	Concrete
Size	3/8" Chips	2' x 2' Pad
Volume (calc.)		
Volume (actual)		
Placement Method	Pour	Pour

Casing:

Type Schedule 40 PVC

Diameter 2 inch

Joint Type Flush threaded

Total Length 30.00 '

Backfill

	Filter Pack	Annular Seal
Material	Silica Sand	Bentonite
Size	Global #4	3/8" Chips
Volume (calc.)		
Volume (actual)		
Placement Method	Pour	Pour

Screen:

Type 304 Stainless Steel

Diameter 2 inch

Slot Size 0.010"

Joint Type Flush threaded

Top Blank 0.23 '

Bottom Blank 0.35 '

Total Screen 4.66 '

Total Length 5.24 '

26.00 FT.

Annular Seal

Development:

Method Overpumped

29.00 FT.

Volume Discharged 150 gal

Turbidity at Completion 50 NTU

Filter Pack

30.83 FT. 846.75 FT. (MSL)

Well Screen

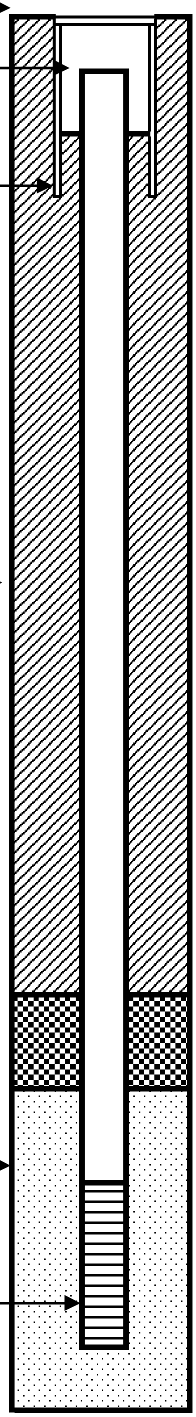
		Tot. Pipe		Cut Off		Bot. Blk.		Stick
35.49 FT.	=	35.24	-	0.00	-	0.35	-	-0.60

Bottom of Borehole 36.0 FT.

Well Completion Diagram

Well No. MW 75 62806.01
Project MLK Blvd. Stage II RFI
Time & Date: Start 13:30 10/19/2004
Completed
Location: N 1762956.02 E 318487.35

Installed By J. Mathis EE
Inspected By M. Lytle ET



Ground Surface 881.72 FT. (MSL)
Reference Point (Top of Casing) 881.42 FT. (MSL)

Drilling Method 4.25" HAS
Borehole Diameter 8"

Guard Pipe

Guard Pipe:
Type Flush Mount
Diameter 8"
Length 12"
Closure Type Expandable cap

	Backfill	Surface Seal/Pad
Material	Bentonite	Concrete
Size	Slurry	2' x 2' Pad
Volume (calc.)		
Volume (actual)	270 gal	
Placement Method	Tremie	Pour

Casing:
Type Schedule 40 PVC
Diameter 2 inch
Joint Type Flush threaded
Total Length 80.08 '

Backfill

	Filter Pack	Annular Seal
Material	Silica Sand	Bentonite
Size	Global #4	3/8" Pellets
Volume (calc.)		
Volume (actual)	350 lbs	50 lbs
Placement Method	Pour	Pour

Screen:
Type 304 Stainless Steel
Diameter 2 inch
Slot Size 0.010"
Joint Type Flush threaded
Top Blank 0.23 '
Bottom Blank 0.34 '
Total Screen 9.68 '
Total Length 10.25 '

75.75 FT.

Development:
Method Overpump
Volume Discharged 180 gal
Turbidity at Completion 33 NTU

Annular Seal

78.00 FT.

Filter Pack 80.41 FT. 801.31 FT. (MSL)

Well Screen

90.09 FT. = 90.33 - 0.20 - 0.34 - -0.30
Tot. Pipe Cut Off Bot. Blk. Stick

Bottom of Borehole 94.0 FT.

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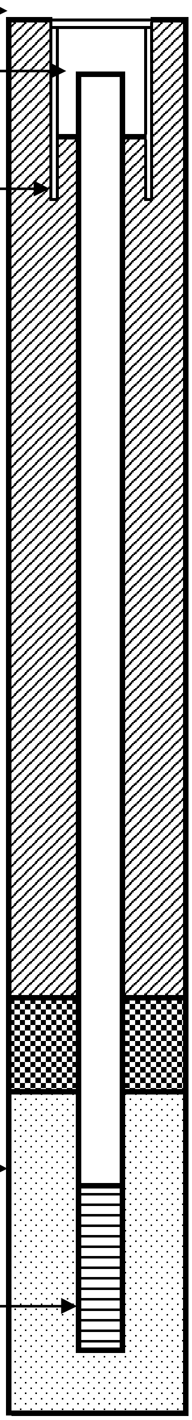
Well Completion Diagram

Well No. MW 76 62806.01
Project MLK Blvd. Stage II RFI
Time & Date: Start 12:30 10/20/2004
Completed 17:00 10/20/2004
Location: N1762951.84 E 318492.81

Installed By J. Mathis EE
Inspected By M. Lytle ET

Ground Surface 881.66 FT. (MSL)
Reference Point (Top of Casing) 881.11 FT. (MSL)



Drilling Method 4.25" HAS
Borehole Diameter 8"

Guard Pipe

	Backfill	Surface Seal/Pad
Material	Bentonite	Concrete
Size	Slurry	2' x 2' Pad
Volume (calc.)		
Volume (actual)		
Placement Method	Tremie	Pour

Guard Pipe:
Type Flush Mount
Diameter 8"
Length 12"
Closure Type Expandable cap

Casing:
Type Schedule 40 PVC
Diameter 2 inch
Joint Type Flush threaded
Total Length 50.15 '

Backfill

	Filter Pack	Annular Seal
Material	Silica Sand	Bentonite
Size	Global #4	3/8" Pellets
Volume (calc.)		
Volume (actual)	250 lbs	50 lbs
Placement Method	Pour	Pour

Screen:
Type 304 Stainless Steel
Diameter 2 inch
Slot Size 0.010"
Joint Type Flush threaded
Top Blank 0.12 '
Bottom Blank 0.35 '
Total Screen 9.63 '
Total Length 10.10 '

45.00 FT.

Annular Seal

Development:
Method Overpump
Volume Discharged 375 gal
Turbidity at Completion 30 NTU

47.50 FT.

Filter Pack 49.69 FT. 831.97 FT. (MSL)

Well Screen

59.32 FT. = 60.25 (Tot. Pipe) - 1.13 (Cut Off) - 0.35 (Bot. Blk.) - -0.55 (Stick)

Bottom of Borehole 59.5 FT.

WCDMSTR.XLS

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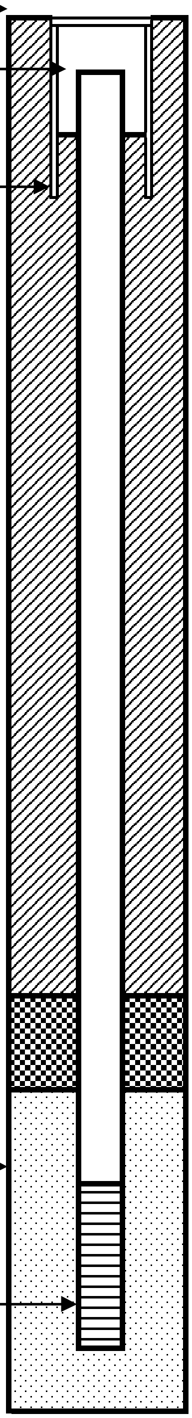
Well Completion Diagram

Well No. MW 79 62806.01
Project MLK Blvd. Stage II RFI
Time & Date: Start 09:00 12/15/2004
Completed 02:00 12/15/2004
Location: N 1761750.49 E 317811.99

Installed By J. Upcraft IP
Inspected By M. Lytle ET

Ground Surface 882.19 FT. (MSL)
Reference Point (Top of Casing) 881.92 FT. (MSL)



Guard Pipe

	Backfill	Surface Seal/Pad
Material	Bentonite	Concrete
Size	Chip	1' x 1' Pad
Volume (calc.)		
Volume (actual)	10 Bags	1 Bag
Placement Method	Drop	Pour

Backfill

	Filter Pack	Annular Seal
Material		Bentonite
Size		Chip
Volume (calc.)		
Volume (actual)		1Bag
Placement Method	Natural Cave	Drop

Annular Seal

Filter Pack

Well Screen

Bottom of Borehole 45.0 FT.

Drilling Method 4.25" HAS w/KO Plug
Borehole Diameter 8"

Guard Pipe:
Type Flush Mount
Diameter 8"
Length 12"
Closure Type Bolt Lid

Casing:
Type Schedule 40 PVC
Diameter 2 inch
Joint Type Flush threaded
Total Length 40.00 '

Screen:
Type 304 Stainless Steel
Diameter 2 inch
Slot Size 0.010"
Joint Type Flush threaded
Top Blank 0.23 '
Bottom Blank 0.05 '
Total Screen 4.73 '
Total Length 5.01 '

FT.

Development:
Method Overpump
Volume Discharged 120 gal
Turbidity at Completion 50 - 100 NTU

24.00 FT.

40.50 FT. 841.69 FT. (MSL)

45.23 FT. = 45.01 - 0.00 - 0.05 - -0.27

Tot. Pipe	Cut Off	Bot. Blk.	Stick
45.01	0.00	0.05	-0.27

WCDMSTR.XLS

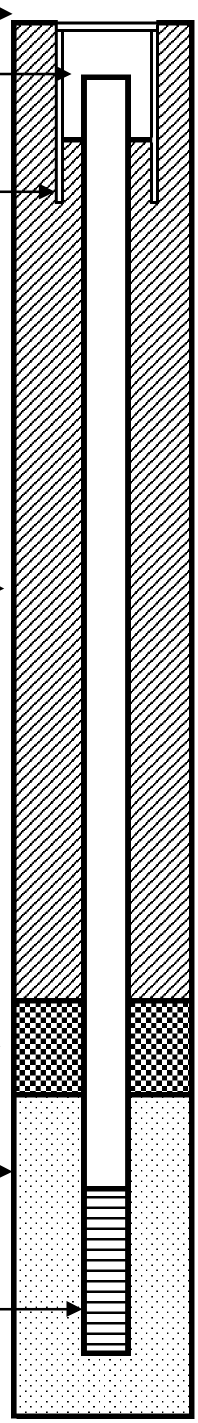
EarthTech
A tyco International Ltd. Company

Well Completion Diagram

Well No. MW 80 62806.01
Project MLK Blvd. Stage II RFI
Time & Date: Start 12:30 2/10/2005
Completed 14:30 2/10/2005
Location: N 1761928.33 E 319258.30

Installed By J. Mathis EE
Inspected By M. Lytle ET

Ground Surface 865.87 FT. (MSL)
Reference Point (Top of Casing) 865.49 FT. (MSL)



Guard Pipe

	Backfill	Surface Seal/Pad
Material	Bentonite	Concrete
Size	Chip	2' x 2' Pad
Volume (calc.)		
Volume (actual)	5 Bags	
Placement Method	Pour	Pour

Backfill

	Filter Pack	Annular Seal
Material	Quartz Sand	Bentonite
Size	#4	Chip
Volume (calc.)		
Volume (actual)	2 Bags & Cave	1Bag
Placement Method	Pour	Pour

Annular Seal
Filter Pack
Well Screen
Bottom of Borehole

Drilling Method 4.25" HAS
Borehole Diameter 8"

Guard Pipe:
Type Flush Mount
Diameter 10"
Length 12"
Closure Type Bolt Top

Casing:
Type Schedule 40 PVC
Diameter 2 inch
Joint Type Flush threaded
Total Length 24.80 '

Screen:
Type 304 Stainless Steel
Diameter 2 inch
Slot Size 0.010"
Joint Type Flush threaded
Top Blank 0.2 '
Bottom Blank 0.35 '
Total Screen 4.70 '
Total Length 5.25 '

FT.

Development:
Method Overpump
Volume Discharged 150 gals
Turbidity at Completion 15 NTU

23.10 FT.
24.33 FT. 841.54 FT. (MSL)

29.03 FT. = 30.05 - 1.05 - 0.35 - -0.38

Tot. Pipe	Cut Off	Bot. Blk.	Stick
30.05	1.05	0.35	-0.38

29.5 FT.

WCDMSTR.XLS

EarthTech
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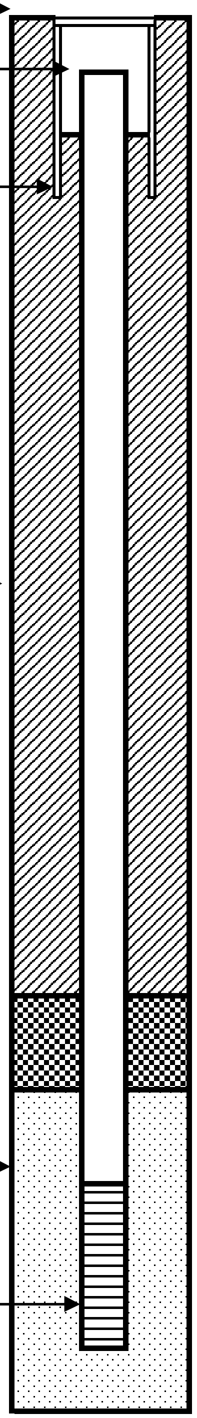
Well Completion Diagram

Well No. MW 81 62806.01
Project MLK Blvd. Stage II RFI
Time & Date: Start 13:45 2/11/2005
Completed 15:20 2/11/2005
Location: N 1761479.01 E 319399.60

Installed By J. Mathis EE
Inspected By M. Lytle ET



Ground Surface 864.66 FT. (MSL)
Reference Point (Top of Casing) 864.38 FT. (MSL)

Drilling Method 4.25" HAS/Tricone
Borehole Diameter 6.25"/3.5"

Guard Pipe

Guard Pipe:
Type Flush Mount
Diameter 10"
Length 12"
Closure Type Bolt Lid

	Backfill	Surface Seal/Pad
Material	Grout	
Size	Powder	
Volume (calc.)		
Volume (actual)	2 Bags	
Placement Method	Tremie	

Casing:
Type Schedule 40 PVC
Diameter 2 inch
Joint Type Flush threaded
Total Length 24.90 '

Backfill

	Filter Pack	Annular Seal
Material	Quartz Sand	Bentonite
Size	#4	Pellet
Volume (calc.)		
Volume (actual)	1.5 bags	1 Bucket
Placement Method	Pour	Pour

Screen:
Type 304 Stainless Steel
Diameter 2 inch
Slot Size 0.010"
Joint Type Flush threaded
Top Blank 0.25 '
Bottom Blank 0.05 '
Total Screen 9.70 '
Total Length 10.00 '

17.00 FT.

Development:
Method Overpump
Volume Discharged 320 gals
Turbidity at Completion 17 NTU

Annular Seal
24.00 FT.

Filter Pack
25.08 FT. 839.58 FT. (MSL)

Well Screen

34.78 FT. = 34.90 - 0.35 - 0.05 - -0.28

Tot. Pipe	Cut Off	Bot. Blk.	Stick
34.90	0.35	0.05	-0.28

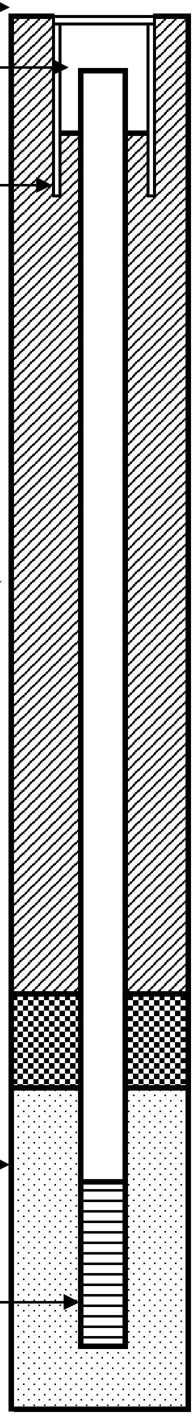
Bottom of Borehole 36.0 FT.

WCDMSTR.XLS

Well Completion Diagram

Well No. MW 82 62806.01
Project: GM Pendleton Ave. Stage II RFI
Time & Date: Start 2/28/2005 14:15
Completed 2/28/2005 16:45
Location: N 1761198.31 E 317978.59

Installed By J. Mathis EE
Inspected By J. Duwelius ET



Ground Surface 878.76 FT. (MSL)
Reference Point (Top of Casing) 878.55 FT. (MSL)
Guard Pipe
Backfill
88.00 FT.
Annular Seal
94.00 FT.
Filter Pack
96.49 FT.
Well Screen
106.22 FT. = 109.32 Tot. Pipe - 3.26 Cut Off - 0.05 Bot. Blk. - -0.21 Stick
Bottom of Borehole 107.0 FT.

	Backfill	Surface Seal/Pad
Material	Bentonite	Concrete
Size	Slurry	2'x2'
Volume (calc.)		
Volume (actual)	150 gals	
Placement Method	Tremie	Pour

	Filter Pack	Annular Seal
Material	Silica Sand	Bentonite
Size	#4	3/8" Pellets
Volume (calc.)		
Volume (actual)	100 lbs.	50 lbs.
Placement Method	Pour	Pour

Drilling Method 4.25" HSA / 4" Tricone
Borehole Diameter 8" / 4"

Guard Pipe:
Type Flush Mount
Diameter 10"
Length 12"
Closure Type Expandable locking cap

Casing:
Type Schedule 40 PVC
Diameter 2 inch
Joint Type Threaded
Total Length 99.31 '

Screen:
Type 304 Stainless Steel
Diameter 2 inch
Slot Size 0.010"
Joint Type Threaded
Top Blank 0.23 '
Bottom Blank 0.05 '
Total Screen 9.73 '
Total Length 10.01 '

Development:
Method Overpump
Volume Discharged 350 gal
Turbidity at Completion 14 NTU

WCDMSTR.XLS

EarthTech
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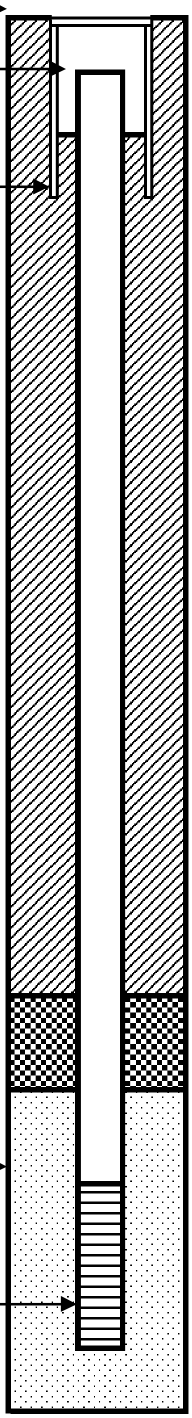
Well Completion Diagram

Well No. MW 83 62806.01
Project: GM Pendleton Ave. Stage II RFI
Time & Date: Start 3/3/2005 16:00
Completed 3/4/2005 10:20
Location: N 1761260.12 E 318746.50

Installed By J. Mathis EE
Inspected By M. Lytle ET

Ground Surface 876.63 FT. (MSL)
Reference Point (Top of Casing) 876.23 FT. (MSL)



Drilling Method 3.25" HSA / Casing Advance / Tricone
Borehole Diameter 7" / 4.5" / 3.5"

Guard Pipe

	Backfill	Surface Seal/Pad
Material	Bentonite	
Size	Grout	
Volume (calc.)		
Volume (actual)	100 gals	
Placement Method		

Guard Pipe:
Type Flush Mount
Diameter 6"
Length 10"
Closure Type Expandable cap

Casing:
Type Schedule 40 PVC
Diameter 2 inch
Joint Type Threaded
Total Length 74.6 '

Backfill

	Filter Pack	Annular Seal
Material	Silica Sand	Bentonite
Size	#4	
Volume (calc.)		
Volume (actual)	2 bags	
Placement Method		

Screen:
Type 304 Stainless Steel
Diameter 2 inch
Slot Size 0.010"
Joint Type Threaded
Top Blank 0.3 '
Bottom Blank 0.05 '
Total Screen 9.65 '
Total Length 10.00 '

68.00 FT.

Development:
Method Overpump
Volume Discharged 400 gal
Turbidity at Completion 4 NTU

Annular Seal
73.00 FT.

Filter Pack
75.05 FT.

Well Screen

84.70 FT. =	84.60	-	0.25	-	0.05	-	-0.40
	Tot. Pipe		Cut Off		Bot. Blk.		Stick

Bottom of Borehole 85.0 FT.

WCDMSTR.XLS

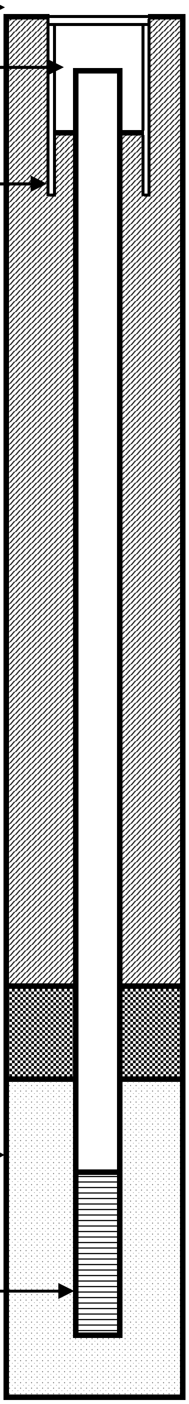
EarthTech
A tyco International Ltd. Company

Well Completion Diagram

Well No. MW 85 62806.01
Project MLK Blvd. Stage II RFI
Time & Date: Start 13:45 12/13/2007
Completed 15:46 12/13/2007
Location: N 1760642.5 E 319142.0 IN SPCS NAD83

Installed By S. McGee - IPS
Inspected By J. Duwelius - ET

Ground Surface 866.52 FT. (MSL)
Reference Point (Top of Casing) 866.11 FT. (MSL)



Guard Pipe

	Backfill	Surface Seal/Pad
Material	Cement / Bentonite	Concrete
Size	Slurry	12" Dia.
Volume (calc.)		
Volume (actual)		2 Bags
Placement Method	Tremie	Pour

Backfill

	Filter Pack	Annular Seal
Material	Quartz Sand	Bentonite
Size	#6	Pellet
Volume (calc.)		
Volume (actual)	5 Bags	1 Bucket
Placement Method	Pour	Pour

Drilling Method 4.25" HSA
Borehole Diameter 8"

Guard Pipe:
Type Flush Mount
Diameter 6"
Length 12"
Closure Type Bolt

Casing:
Type Schedule 40 PVC
Diameter 2 inch
Joint Type Flush threaded
Total Length 14.92 '

Screen:
Type Schedule 40 PVC
Diameter 2 inch
Slot Size 0.010"
Joint Type Flush threaded
Top Blank 0.21 '
Middle Blank 0.55 '
Bottom Blank 0.53 '
Total Screen 8.96 '
Total Length 10.25 '

11.00 FT.

Development:
Method Overpump
Volume Discharged 70 Gallons
Turbidity at Completion 33 NTU

Annular Seal
13.00 FT.

Filter Pack
14.90 FT. 851.62 FT. (MSL)

Well Screen

		Tot. Pipe		Cut Off		Bot. Blk.		Stick
24.41 FT.	=	25.17	-	0.64	-	0.53	-	-0.41

Bottom of Borehole 25.0 FT.

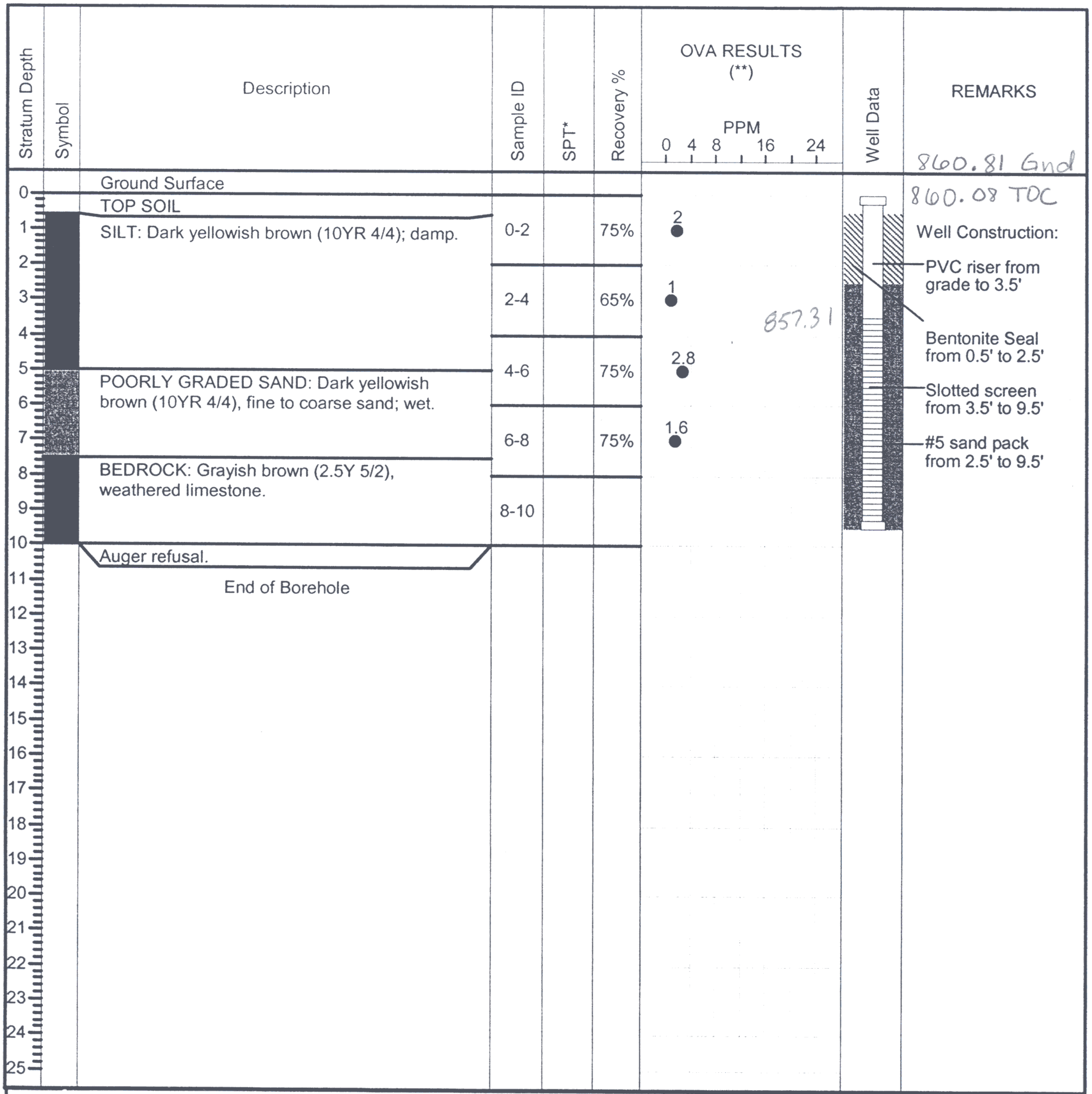
WCDMSTR.XLS

HydroTech
Environmental Consulting & Engineering

Location: Anderson, Indiana
Client: 3429 S. Madison
Project No.: 9526474
Logged By: Neal Graham
Driller: EFS-Billy
Date: 6/24/03

Log of Borehole: MW-2

Boring Diameter / Method: 8"/HSA
Casing Type: Schedule 40 PVC
Casing Diameter: 2"
Slot Size: 0.01



Stratum Depth	Description	Sample ID	SPT*	Recovery %	OVA RESULTS (**) PPM
0	Ground Surface				
0	TOP SOIL				
0.5	SILT: Dark yellowish brown (10YR 4/4); damp.	0-2		75%	2
		2-4		65%	1
5	POORLY GRADED SAND: Dark yellowish brown (10YR 4/4), fine to coarse sand; wet.	4-6		75%	2.8
		6-8		75%	1.6
7.5	BEDROCK: Grayish brown (2.5Y 5/2), weathered limestone.	8-10			
10	Auger refusal.				
	End of Borehole				

REMARKS

860.81 Gnd
860.08 TOC

Well Construction:
- PVC riser from grade to 3.5'
- Bentonite Seal from 0.5' to 2.5'
- Slotted screen from 3.5' to 9.5'
- #5 sand pack from 2.5' to 9.5'

BORING METHODS

HSA - Hollow Stem Auger
HA - Hand Auger
CFA - Cont. Flight Auger

NOTES: (*) Blows 6 inches -- in 3 6-inch increments
Rec % Sample Recovery %
(**) OVA - Organic Vapor Analyzer
PPM - Parts Per Million
NDO - No Discernible Odor

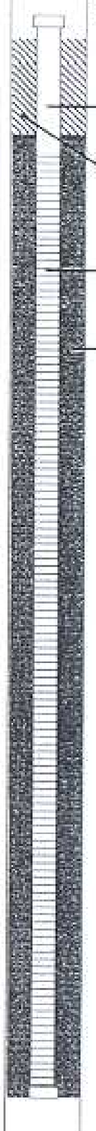
HydroTech
Environmental Consulting & Engineering

Location: Anderson, Indiana
Client: 3429 S. Madison
Project No.: 9526474
Logged By: Neal Graham
Driller: EFS-Billy
Date: 6/25/03

Log of Borehole: MW-4

Boring Diameter / Method: 8"/HSA
Casing Type: Schedule 40 PVC
Casing Diameter: 2"
Slot Size: 0.01

Description	Sample ID	SPT*	Recovery %	OVA RESULTS (**) PPM 0 4 8 16 24
Ground Surface				
TOP SOIL: Very dark gray (10YR 3/1), clay with organics in the form of rootlets; slightly damp.	0-2		70%	
SILTY CLAY: Dark grayish brown (2.5Y 4/2), clay with some silt and degraded gravel to 1" diam.; slightly damp.	2-4		100%	859.08
POORLY GRADED SAND: Grayish brown (2.5Y 5/2), fine to coarse sand with trace subrounded gravel to 1.5" diam.; dry.	4-6		40%	
POORLY GRADED SAND WITH GRAVEL: Grayish brown (2.5Y 5/2), fine to coarse sand with som subangular to subrounded gravel to 3/4" diam. and trace silt; wet.	6-8		50%	
POORLY GRADED SAND AND GRAVEL: Grayish brown (2.5Y 5/2), fine to coarse sand with subangular to subrounded gravel to 1.5" diam.; wet.				
POORLY GRADED SAND: Grayish brown (2.5Y 5/2), fine to coarse sand with little subangular to subrounded gravel; wet.	9-11		50%	
CLAYEY SAND: Olive gray (5Y 4/2), fine to coarse sand and clay; moist.	11-13		100%	
POORLY GRADED SAND: Olive (5Y 4/4), fine to coarse sand and fine gravel to 1/2" diam.; wet.				
POORLY GRADED SAND WITH GRAVEL: Olive (5Y 5/3), fine to coarse sand with little subrounded gravel to 1" diam.; wet.	13-15		70%	
POORLY GRADED SAND WITH GRAVEL: Same as above except olive gray (5Y 4/2).	15-17		100%	
POORLY GRADED SAND: Olive gray (5Y 4/2), fine to coarse sand with trace gravel; wet.	17-19			
POORLY GRADED SAND: Same as above except fine sand and no gravel.	19-21		100%	
POORLY GRADED SAND WITH GRAVEL: Olive gray (5Y 4/2), fine to coarse sand with some subrounded gravel to 1" diam.; wet.				
POORLY GRADED SAND: Gray (5Y 5/1), fine sand; wet.	21-23		20%	839.08
End of Borehole				



REMARKS

862.08 Gnd

861.67 TOC

Well Construction:

PVC riser from grade to 3'

Bentonite Seal from 1' to 2.5'

Slotted screen from 3' to 23'

#5 sand pack from 2.5' to 17'

BORING METHODS

HSA - Hollow Stem Auger
HA - Hand Auger
CFA - Cont. Flight Auger

NOTES: (*) Blows 6 inches -- in 3 6-inch increments
Rec % Sample Recovery %
(**) OVA - Organic Vapor Analyzer
PPM - Parts Per Million
NDO - No Discernible Odor

Attachment B
Field Method Guidelines
Generic Sampling Techniques

REMEDIATION SECTION	FIELD METHOD GUIDELINE NO.: FMG 6.9
WORLDWIDE FACILITIES GROUP	EFFECTIVE DATE: NOVEMBER 20, 2001
GENERAL MOTORS CORPORATION	
REVISION NO.: 0	REVISION DATE:

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PROCEDURAL GUIDELINES 1

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REMEDIATION SECTION	FIELD METHOD GUIDELINE NO.: FMG 6.9
WORLDWIDE FACILITIES GROUP	EFFECTIVE DATE: NOVEMBER 20, 2001
GENERAL MOTORS CORPORATION	
REVISION NO.: 0	REVISION DATE:

FIELD QUALITY CONTROL SAMPLES

INTRODUCTION

This section describes the preparation and frequency of analysis of field quality control blanks, replicates, and interlaboratory splits for water and solids sampling.

PROCEDURES REFERENCED

- FMG 6.4 - Groundwater.
- FMG 6.10 - Sample Handling and Shipping.

PROCEDURAL GUIDELINES

Not all of the field quality control samples may be required for a given project. The specific field quality control samples will be specified in the project work plan, field sampling plan (FSP), or quality assurance project plan (QAPP).

As part of the QA/QC program, all field quality control samples will be sent blind to the laboratories. To accomplish this, the samples will be sent in the same form as regular samples, including all containers, sample numbers, and analytes. The sample ID for field quality control samples should allow data management and data validation staff to identify them as such. Under no circumstances should the laboratory be allowed to use reference materials, rinsate blanks, or trip blanks for matrix spike and matrix spike duplicate analysis. The laboratory should be instructed to contact the project QA/QC coordinator when a laboratory quality control sample is not specified on the sample analysis request form for a sample digestion group so that one can be assigned.

All field quality control samples will be packaged and shipped with other samples in accordance with procedures outlined in FMG 6.10 - Sample Handling and Shipping. Sample custody will be maintained in accordance with procedures outlined in FMG 6.10 - Sample Handling and Shipping.

Field quality control samples will be prepared at least once per sampling event, and certain types will be prepared more often at predetermined frequencies. If the number of samples taken does not equal an integer multiple of the intervals specified in the project work plan, field sampling plan (FSP), or quality assurance project plan (QAPP), the number of field quality control samples is specified by the next higher multiple. For example, if a frequency of 1 quality control sample per 20 is indicated and 28 samples are collected, 2 quality control samples will be prepared.

WATER SAMPLING

Table 6.9-1 lists the quality control sample types and suggested frequencies for surface water and groundwater sampling programs. Because groundwater quality control sampling may require assessment of drill rig cross-contamination, additional blanks of the solids sampling type may be required. A detailed explanation of each quality control sample type with the required preparation follows.

TABLE 6.9-1

FIELD QUALITY CONTROL SAMPLE REQUIREMENTS FOR WATER SAMPLING

Quality Control Sample Name	*Abbreviation*	*Preparation*		*Frequency*[a]
		Location	*Method*	
Bottle blank	BB	Field	Unopened bottle	1 per sample episode, 1 per bottle lot, 1 per bottle type
Travel blank	TTB	Laboratory	Deionized water and preserved, if necessary	1 per sample episode, 1 per preservative
Trip blank	TB	Laboratory	Deionized water and preserved	1 pair per cooler or VOA samples
Equipment rinsate (unfiltered)	ER-U	Sampling site	Deionized water collected after pouring through and over decontaminated equipment	1 per 20 samples, 1 per preservative
Equipment rinsate (filtered)	ER-F	Sampling site	Deionized water from collection container, filtered and preserved	1 per 20 samples, 1 per preservative
Replicate	DUP or TRIP	Sampling site	Natural sample	1 replicate per 20 samples
Laboratory split	LS	Sampling site	Natural sample	1 per 20 samples
Reference material	RM	Field laboratory (in large container), sample bottle filled at site	RM ampules for each analyte group	1 set per 50 samples, 1 per episode to alternate laboratory

[a] Frequencies provided here are general recommendations; specific frequencies should be provided in the project work plan, field sampling plan, or quality assurance project plan.

Bottle Blank

The bottle blank is an unopened sample bottle. One bottle blank per bottle lot is included in the sample chain for each sampling episode. If more than one type of bottle will be used in the sampling (e.g., poly or glass), then a bottle blank should be submitted for each type of bottle.

To prepare a bottle blank in the field, set aside one unopened sample bottle from each bottle lot sent from the analytical laboratory. If bottles are purchased directly from a supply house, all bottles should first be cleaned in accordance with FMG 6.10 - Sample Handling and Shipping. Label the bottle as "Bottle Blank" on the sample label, and send the bottle to the laboratory with the field samples in accordance with FMG 6.10 - Sample Handling and Shipping.

Travel Blank

The travel blank is a sample bottle prepared in the laboratory containing deionized water and preservative. This blank is carried to each sample site with the other filled sample bottles. One travel blank is sent to the laboratory. The travel blank is prepared at the laboratory by filling a sample bottle with deionized water and adding appropriate preservative (i.e., for metals samples use a 10 percent nitric acid solution to bring sample pH to 2 or less). In the field, label the bottle as "Travel Blank" on the sample label, place the travel blank sample in a cooler or other sample-receiving container for transport to each sample site during a sampling episode, and send the travel blank to the laboratory in accordance with FMG 6.10 - Sample Handling and Shipping.

Trip Blank

Trip blanks will be used to help identify cross-contamination in the shipment of water samples for analyzing volatile organic compounds (VOCs) only. Trip blanks will be prepared in the laboratory by pouring deionized water into two 40 mL VOC vials and tightly closing the lids. Each vial will be inverted and tapped lightly to ensure no air bubbles exist.

The blanks will be transported unopened to and from the field in the cooler with the VOC samples. One trip blank pair will be sent with each cooler of samples for analyzing VOCs. The exception is high-flow tributary sampling, which requires that the trip blank be prepared after the samples have been brought in from the field.

Equipment Rinsate Blank

Equipment rinsate blanks will be used to help identify possible contamination from the sampling environment or from improperly decontaminated sampling equipment. Equipment rinsate blanks will be prepared by processing a representative amount of laboratory deionized water through the decontaminated sample collection equipment, then transferring the water to the appropriate sample containers and adding any necessary preservatives. Equipment rinsate blanks will be prepared for all inorganic, organic, and conventional analytes at least once per sampling event.

The actual number of equipment rinsate blanks prepared during an event will be determined on a case-by-case basis by the project QA/QC coordinator.

Low-Flow Tributary Sampling

Because the sampling container for low-flow sampling is a laboratory-cleaned, amber glass jug, the only piece of equipment that is likely to contribute to contamination is the Teflon®/ polyethylene sample intake. The intake will be thoroughly decontaminated using industrial detergent, methanol, and hexane. After the intake is air-dried, it will be screwed into a newly opened 2.5 L jug of deionized water (the deionized water containers supplied by the laboratory are identical to those used for sampling). The deionized water will be poured through the intake into the appropriate sample containers, which will be preserved as needed. Because the intake tube extends to the back of the jug, not all of the deionized water in the jug can be transferred to the sample containers. When water can no longer pour through the intake, the jug will be replaced with a full one; any remaining water in the old jug will be discarded. When preparation of the rinsate blank is completed, the intake will be removed from the jug and placed in a sealable bag or screwed onto a sampling jug and covered with a plastic bag.

High-Flow Tributary Sampling

Before high-flow tributary sampling begins, a test run on one of the ISCO automatic samplers that will double as an equipment rinsate blank will be performed. Preparation of the blank will consist of running deionized water through the ISCO sampler and into a set of sampling containers at predetermined intervals.

Groundwater Sampling

GM-preferred protocols for groundwater sampling are presented in FMG 6.4 - Groundwater.

Field Replicates

Field replicate (duplicate or triplicate) samples are co-located samples collected in an identical manner over a minimum period of time to provide a measure of the analytical (field and laboratory) variance, including variance resulting from sample heterogeneity. Field replicates will consist of two or three samples collected consecutively at the same location and placed in different bottles for separate analysis. The exception to this is high-flow tributary sampling, which requires the procedure given below. Each replicate will have a unique sample number to distinguish it from the others. The replicate samples will be sent to the laboratory and analyzed for identical chemical parameters but will not be distinguishable by the laboratory as being replicates. Field replicates will be collected at a minimum frequency of 1 per 20 samples or once per sampling event, whichever is more frequent.

High-Flow Tributary Sampling

Collection of field replicate samples for high-flow events will differ from the other elements because of the nature of the sample preparation, which requires the samples to be homogenized before replication. Replicates will always be made from the composited portion of the sample because the grab sample does not provide enough sample volume for all the parameters. For each analyte group, a composite sample will be prepared using the six flow-weighted aliquots in the same manner that a regular sample is prepared. To prepare the replicates, the container with the composited sample will be inverted three times for proper mixing (very lightly for organic compounds) and split evenly into two to three identical containers. This process will be repeated until sufficient volume is obtained.

1. At the appropriate frequency during sample collection, collect an adequate volume of sample at the sample site to accommodate duplicate samples. For example, if 40 mL water samples are taken and two sample bottles are required for analysis of all parameters, collect a total of at least six additional water samples (i.e., two 40 mL samples for each of the triplicate samples).
2. Label one bottle as a normal field sample and label the other bottles according to the numbering sequence described in the sample identification system in the SAP.
3. Send the bottles to the primary CLP laboratory with the field samples in accordance with FMG 6.10 - Sample Handling and Shipping.

Reference Material

Reference materials are materials of known composition that have been prepared by and obtained from EPA-approved sources and that have undergone multilaboratory analyses using a standard method. Reference material samples provide a measure of analytical performance and/or analytical method bias of the laboratory. Several reference materials may be required to cover all analytical parameters.

SOLIDS SAMPLING

Table 6.9-2 lists the quality control sample types and frequencies to be incorporated into a solids sampling program. A detailed explanation of each quality control sample type with the required preparation follows.

TABLE 6.9-2

FIELD QUALITY CONTROL SAMPLE REQUIREMENTS FOR SOLIDS SAMPLING

Quality Control Sample Name	*Abbreviation*	*Preparation*		*Frequency*
		Location	*Method*	
Bottle blank	BB	Field	Unopened bottle	1 per sample episode, 1 per bottle lot
Travel blank	TTB	Laboratory	Opened at sample site and closed	1 per sample episode
Trip blank	TB	Laboratory	Deionized water and preserved, if necessary	1 pair per cooler or VOA samples
Equipment rinsate blank	ER-5	Sample site	Deionized water collected after pouring through/over decontaminated equipment	1 per 20 samples
Field cross-contamination blank	CCB	Sample site	Filter wipe with decontaminated collection equipment	1 per 20 samples
Field external contamination blank	ECB	Sample site	Unused material used for CCB	1 per 20 samples
Replicate	DUP or TRIP	Sample site	Natural sample	1 replicate per 20 samples
Laboratory split	LS	Sample site	Natural sample	1 per 20 samples
Reference material	RM	Sample site	RM	1 set per 40 samples, 1 per episode to alternate laboratory

[a] Frequencies provided here are general recommendations; specific frequencies should be provided in the project work plan, field sampling plan, or quality assurance project plan.

Bottle Blanks

The bottle blank is an unopened sample bottle. One bottle blank per bottle lot is included in the sample chain for each sampling episode. Bottle blanks are prepared in the field by setting aside one unopened sample bottle from each bottle lot sent from the analytical laboratory. If bottles are purchased directly from a supply house, all bottles should first be cleaned in accordance with FMG 6.10 - Sample Handling and Shipping. Label the bottle "Bottle Blank" on the sample label, and send the bottle to the laboratory with field samples in accordance with FMG 6.10 - Sample Handling and Shipping.

Travel Blank

The travel blank is an unopened sample bottle carried to each sample site with the other filled sample bottles. The bottle is then opened at a single site for a short period to reflect the sampling time. The purpose of this blank is to evaluate possible contamination from sample bottle handling and transport and from airborne materials. The travel blank is prepared by labeling one bottle as "Travel Blank" on the sample label and placing the travel blank bottle in the sample receiving container for transport to each sample site during each sampling episode. At a single sample site, preferably the one with the highest potential for airborne contamination, open the bottle for a time equal to that required to fill a sample bottle with solids. Cap the bottle and place it in the sample-receiving container. Send the bottle to the laboratory with the field samples in accordance with FMG 6.10 - Sample Handling and Shipping.

Trip Blank

Trip blanks will be used to help identify cross-contamination in the shipment of water samples for analyzing volatile organic compounds (VOCs) only. Trip blanks will be prepared in the laboratory by pouring deionized water into two 40 mL VOC vials and tightly closing the lids. Each vial will be inverted and tapped lightly to ensure no air bubbles exist.

The blanks will be transported unopened to and from the field in the cooler with the VOC samples. One trip blank pair will be sent with each cooler of samples for analyzing VOCs. The exception is high-flow tributary sampling, which requires that the trip blank be prepared after the samples have been brought in from the field.

Equipment Rinsate Blank

Equipment rinsate blanks will be used to help identify possible contamination from the sampling environment or from improperly decontaminated sampling equipment. Equipment rinsate blanks will be prepared by processing a representative amount of laboratory deionized water through the decontaminated sample collection equipment, then transferring the water to the appropriate sample containers and adding any necessary preservatives. Equipment rinsate blanks will be prepared for all inorganic, organic, and conventional analytes at least once per sampling event. The actual number of equipment rinsate blanks prepared during an event will be determined on a case-by-case basis by the project QA/QC coordinator.

Field Cross-Contamination Blank

The field cross-contamination blank is a sample bottle prepared at the sample site that contains filter wipes of decontaminated field collection equipment. This blank will check the effectiveness of the decontamination procedures. At the appropriate frequency during sample collection, prepare a field cross-contamination blank at the sample site by vigorously rubbing the sample collection equipment with two clean filter blanks. Do no use Kimwipes® because they contain significant impurities. Place the filters in the sample bottle and label it as the "Cross-Contamination Blank" on the sample label. Send the bottle to the laboratory with the field samples in accordance with FMG 6.10 - Sample Handling and Shipping.

Field External Contamination Blank

The field external contamination blank is a sample bottle prepared at the sample site containing a single unused filter wipe used for the field cross-contamination blank. At the appropriate frequency during sample collection, prepare a field external contamination blank at the sample site by placing a clean, unused filter blank from the same lot used for the cross-contamination in a sample bottle. Label the bottle "External contamination Blank" on the sample label, note filter name and lot number in the field logbook, and send the bottle to the laboratory with the field samples in accordance with FMG 6.10 - Sample Handling and Shipping.

Replicates

A replicate (duplicate or triplicate) sample consists of two or three samples taken from the same location and time and placed in different sample bottles for separate analysis. Each replicate will be analyzed for all chemical parameters. The laboratory split sample bottles are also filled at this time (see below). At the appropriate frequency during sample collection, collect an adequate volume of sample at the sample site to accommodate the replicate and laboratory split samples per the appropriate SAP; process the samples per the SAP for each replicate; and send the bottles to the laboratory with the field samples in accordance with FMG 6.10 - Sample Handling and Shipping.

Laboratory Split

The laboratory split sample is sent to the referee laboratory. The sample is taken with the replicate sample. As with the replicates, the laboratory split will be analyzed for all chemical parameters. To prepare the laboratory split, follow sample bottle filling and processing instructions for replicates above, label the bottle "Laboratory Split" on the sample label, and send the bottle to the referee CLP laboratory in accordance with FMG 6.10 - Sample Handling and Shipping.

Reference Material

Reference materials are materials of known composition that have been prepared by and obtained from EPA-approved sources and that have undergone multilaboratory analyses using a standard method. Reference material samples provide a measure of analytical performance and/or analytical method bias of the laboratory. Several reference materials may be required to cover all analytical parameters.

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SAMPLE HANDLING AND SHIPPING

INTRODUCTION

Sample management is the continuous care given to each sample from the point of collection to receipt at the analytical laboratory. Good sample management ensures that samples are properly recorded, properly labeled, not lost, broken, or exposed to conditions which may affect the sample's integrity.

All sample submissions must be accompanied with a chain-of-custody (COC) document to record sample collection and submission.

The following sections provide the minimum standards for sample management.

PROCEDURAL GUIDELINES

Field Handling

Prior to entering the field area where sampling is to be conducted, especially at sites with defined exclusion zones, the sampler should ensure that all materials necessary to complete the sampling are on hand.

If samples must be maintained at a specified temperature after collection, proper coolers and ice/cool-packs must be brought out to the field. Consideration should be given to keeping reserve cooling media on hand if sampling events will be of long duration. Conversely, when sampling in extremely cold weather, proper protection of water samples, trip blanks, and field blanks must be considered.

Personnel performing groundwater sampling tasks must check the sample preparation and preservation requirements to ensure compliance with the Work Plan QAPP. Typical sample preparation may involve pH adjustment (i.e., preservation), sample filtration and preservation, or simply cooling to 4°C. Sample preparation requirements vary from site to site and vary depending upon the analytical method for which the samples will be analyzed.

The sampling personnel must also confirm before the sample event, the amount of bottle filling required for the respective sample containers. VOC samples must not have any headspace within the sample collection vial; whereas when collecting select analytes (i.e., metals) a headspace must be provided to allow addition of the required preservative.

Sample Labeling

Samples must be properly labeled as soon as practical after collection.

Note that the data shown on the sample label is the minimum data required. The sample label data requirements are listed below for clarity.

i) Project name.
ii) Sample number.
iii) Sampler's initials.
iv) Date of sample collection.
v) Time of sample collection.
vi) Analysis required.
vii) Preservatives.

The Work Plan Quality Assurance/Quality Control (QA/QC) specification should be reviewed to determine any additional requirements.

Quite often the analytical laboratory supplying the containers will provide blank sample labels. If these are adequate and convenient they can be used.

Under certain field conditions it is impractical to complete and attach sample labels to the container at the point of sample collection. However, to ensure that samples are not confused, a clear notation should be made on the container with a permanent marker indicating the last three digits of the sample number. If the containers are too soiled or small for marking, the container can be put into a zip-lock bag which can then be labeled.

No one sample number format is adequate for every type of sampling activity. Prior to the start of every project or sub-sampling event within the project, Project Managers and field personnel should devise a sample number format. Sample number formats should be as simple and short as possible. Simple number formats will reduce transcription errors by both Consultants and lab personnel. The sample number format should be comprehensive enough to allow for easy location of detailed sample data within the Site log books. Sample format must also be consistent with any future data management activities.

Unless otherwise instructed, labels should not contain specific names of the sample source (i.e., "Well No. 16"). Provision of such specific data on the label can produce biased lab results.

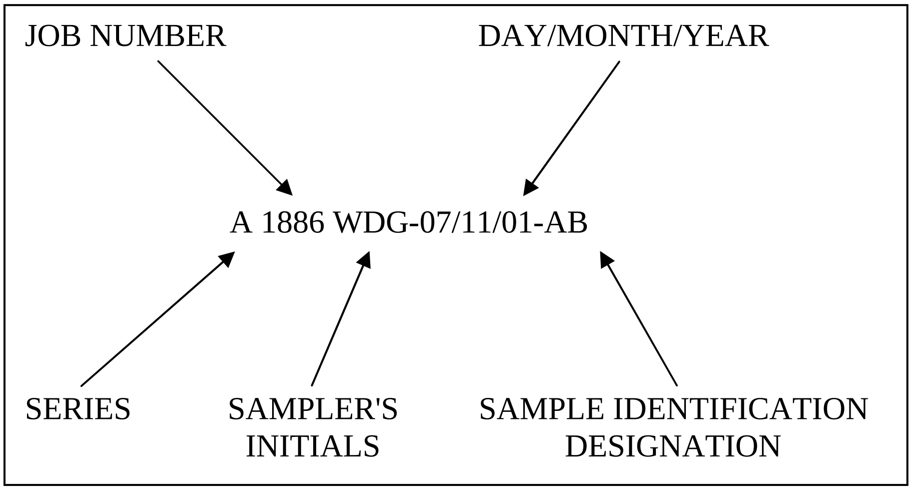
Sample Labels/Sample Identification

All samples must be labeled with:

- A unique sample number (never to be re-used, nor likely to be).
- Date and time.
- Parameters to be analyzed.
- Job number.
- Sampler's initials.

Labels should be secured to the bottle and should be written in indelible inks. It is also desirable to place wide clear tape over the label before packing in a cooler for label protection during transportation.

The unique sample identification number may follow the format recommended below, or a specific sample protocol for labeling may be specified in the project Work Plan.



This format has been selected to maximize the information content of the sample number. Minor modifications are certainly reasonable.

i) Series is a letter which designates a group of samples. This might include sample round, or might designate sample type (e.g., sediment, soil, volatile analysis, Round 2 Lower Aquifer wells), or sample source. For example, "A" might mean samples of influent to some treatment system, "B" might mean samples of effluent. Letters should be used, not numbers. Series is optional.

ii) Job number together with the series number, will allow easier tracking of samples.

iii) Sampler's initials will allow identification of the sampler, and so allow all project personnel to contact the correct person for information regarding that sample and its collection. The use of three initials is requested. Special arrangements will need to be made if two individuals have the same initials.

iv) Sample date will allow monitoring of actual holding time of samples and should ensure that all sample numbers are unique, even if sample location designation is used in a system, as opposed to assigned at random.

v) Sample identification designation will identify the sample, and can be any numerical or letter designation.

The decision of how to assign sample numbers should be made at the beginning of a job or phase, and should be consistent throughout the job.

Packaging

When possible, sample container preparation and packing for shipment should be completed in a well organized and clean area, free of any potential cross-contaminants.

Sample containers should be prepared for shipment as follows:

i) Containers should be wiped clean of all debris/water using paper towels (paper towels must be disposed of with other contaminated materials).

ii) Clear, wide packing tape should be placed over the sample label for protection.

While there is no one "best" way to pack samples for shipment, the following packing guidelines should be followed.

i) Plan time to pack your samples (and make delivery to shipper if applicable). Proper packing and manifesting takes time. A day's worth of sampling can be easily wasted due to a few minutes of neglect when packing the samples.

ii) Always opt for more coolers and more padding rather than crowd samples. The cost associated with the packing and shipment of additional coolers is usually always small in comparison with the cost of having to re-sample due to breakage during shipment.

iii) Do not bulk pack. Each sample must be individually padded.

iv) Large glass containers (1 L and up) require much more space between containers.

v) Ice is not a packing material due to the reduction in volume when it melts.

The following is a list of standard guidelines which must be followed when packing samples for shipment.

i) When using ice for a cooling media, always double bag the ice in zip-lock bags.

ii) Double-check to ensure trip and temperature blanks have been included for all shipments containing VOCs, or where otherwise specified in the QA/QC plan.

iii) Enclose the COC form in a zip-lock bag.

iv) Ensure custody seals (two, minimum) are placed on each cooler. Coolers with hinged lids should have both seals placed on the opening edge of the lid. Coolers with "free" lids should have seals placed on opposite diagonal corners of the lid. Place clear tape over custody seals.

v) Ensure that all "Hazardous Material" stickers/markings have been removed from coolers being used which previously contained such materials.

Note: Never store sterile sample containers in enclosures containing equipment which use any form of fuel or volatile petroleum based product. An alternate means of secure storage must be planned for.

When conducting sampling in freezing conditions at sites without a heated storage area (free of potential cross contaminants), trip blanks and temperature blanks not being used in a QA/QC role should be isolated from coolers immediately after receipt. Trip and temperature blanks should be double-bagged and kept from freezing.

Chain-of-Custody

COC forms will be completed for all samples collected. The form documents the transfer of sample containers.

The COC record, completed at the time of sampling, will contain, but not be limited to, the sample number, date and time of sampling, and the name of the sampler. The COC document will be signed and dated by the sampler when transferring the samples.

Each sample cooler being shipped to the laboratory will contain a COC form. The COC form will consist of four copies which will be distributed as follows: The shipper will maintain a copy while the other three copies will be enclosed in a waterproof envelop within the cooler with the samples. The cooler will then be sealed properly for shipment. The laboratory, upon receiving the samples, will complete the three remaining copies. The laboratory will maintain one copy for their records. One copy will be returned to the Field QA/QC Officer upon receipt of the samples by the laboratory. One copy will be returned with the data deliverables package.

COC records are legal documents. They must be completed and handled accordingly.

The following list provides guidance for the completion and handling of all COCs.

i) COCs used should be Consultant standard forms or those supplied by the analytical laboratory. Do not use any COC forms from other labs, even if the heading is blocked out.

ii) COCs must be completed in black ball-point ink only.

iii) COCs must be completed neatly using printed text.

iv) If a simple mistake is made, line out the error with a single line and initial and date next to it.

v) Each separate sample entry must be sequentially numbered.

vi) The use of "Ditto" or quotation marks to indicate repetitive information in columnar entries should be avoided. If numerous repetitive entries must be made in the same column, place a continuous vertical arrow between the first entry and the next different entry.

vii) When more than one COC form is used for a single shipment, each form must be consecutively numbered using the "Page ___ of ___" format.

viii) If necessary, place additional instructions directly onto the COC. Do not enclose separate loose instructions.

ix) Include a contact name and phone number on the COC in case there is a problem with the shipment.

x) Do not indicate the source of the sample as this may produce a biased lab result.

xi) Before using an acronym on a COC, define clearly the full interpretation of your designation [i.e., Polychlorinated Biphenyls - (PCBs)].

Shipment

In all but a few cases the QA/QC plan for the field work will require shipment of samples by overnight carrier. A great many problems can be avoided by proper advance planning.

Prior to the start of the field sampling, the carrier should be contacted to determine if pickup can be made at the field site location. If pickup at the field site can be made, the "no-later-than" time for having the shipment ready must be determined.

If no pickup is available at the site, the nearest pickup or drop-off location should be determined. Again, the "no-later-than" time for each location should be determined.

Sufficient time must be allowed not only for packaging but also for delivery of samples if this becomes necessary. Driving at high rates of speed in order to make the drop time is unacceptable.

Sample shipments must not be left at unsecured or questionable drop locations (i.e., if the cooler will not fit in a remote drop box do not leave the cooler unattended next to the drop box).

Some overnight carriers do not in fact provide "overnight" shipment to/from some locations. Do not assume; call the carrier in advance before the start of the field work.

Copies of all shipment manifests must be maintained in the field file.

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(Following Text)

FMG 8.0-01 INSTRUMENT CALIBRATION RECORD

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FIELD INSTRUMENTS – USE/CALIBRATION

INTRODUCTION

A significant number of field activities involve usage of electronic instruments to monitor for environmental screening and heath and safety purposes. It is imperative the instruments are used and maintained properly to optimize their performance and minimize the potential for inaccuracies in the data obtained, and to insure worker's health and safety is not compromised.

This FMG provides guidance on the usage, maintenance and calibration of electronic field equipment, whether for equipment owned by the Consultant or Contractor, or equipment obtained from a rental agency.

PROCEDURES REFERENCED

- FMG 1.4 - Data Recording – Field Books/Digital Recording.

PROCEDURAL GUIDELINES

- All monitoring equipment will be in proper working order, and operated for the purpose for which it was intended, in accordance manufacturer's recommendations.
- Field personnel will be responsible for insuring the equipment is maintained and calibrated in the field to extent practical, or returned for office or manufacturer maintenance or calibration if warranted. Calibration is discussed in greater detail below.
- A copy of the Operating Instructions, Maintenance and Service Manual for each instrument used on a project will be kept on site at all times.
- Instruments will be operated only by personnel trained in the proper usage and calibration. In the event certification of training is required, personnel will have documentation of such certification with them on site at all times.
- Personnel must be aware that certain instruments are rated for operation within a limited range of conditions such as temperature and humidity. Usage of such instruments in conditions outside these ranges will only proceed with proper approval by a project manager and/or health and safety supervisor as appropriate.

- Instruments that contain radioactive source material, such as x-ray fluorescence analyzers or moisture-density gauges require specific transportation, handling, and usage procedures that are generally associated with a license from the Nuclear Regulatory Commission (NRC) or an NRC-Agreement State. Under no circumstance will operation of such instruments be allowed on site unless by properly authorized and trained personnel, using the proper personal dosimetry badges or monitoring instruments.

Calibration

Calibration of an electronic instrument is critical to insure it is operating properly for its intended use. Such instruments are often sensitive to changes in temperature or humidity, or chemical vapors in the working atmosphere, and as a result their response and ability to monitor conditions and provide data can change significantly.

Calibration of instruments shall be performed in accordance with the manufacturer’s recommendations. This includes the following parameters:

- Frequency.
- Use of proper calibration gases or chemical standards.
- Requirements for factory calibration.

Instrument calibration shall be performed in accordance with the following manufacturer recommendations or the suggested "minimum" calibration frequency:

Instrumentation Classification/Group		***Instrumentation***	***Representative Manufacturer Recommended Calibration Frequency***	***Minimum Recommended Calibration Frequency***
Health and Safety	Air Monitoring (Real-Time):	PID, FID, compound-specific or multi-gas meter (typ.), etc.	No Recommendation, Daily or As Needed	Daily
	Air Sampling (non-Real-Time):	Flow meter, personal air sampling device, etc.	Per Manufacturer's Recommendations	Per Manufacturer's Recommendations
Other Monitoring	Water Sampling:	pH, Cond., Temp., ORP, DO, etc.	Per Manufacturer's Recommendations	Daily, or As Needed
	Physical Parameters:	Velocity/flow meter, pressure transducer, water level meter, oil-water interface probe, etc.	Per Manufacturer's Recommendations	Per Manufacturer's Recommendations
	Other:	Miscellaneous (Troxler nuclear density, etc.)	Per Manufacturer's Recommendations	Per Manufacturer's Recommendations

Notes:

1. Some instrumentation requires factory calibration only.
2. If a significant change in conditions occurs, or in dangerous atmosphere conditions, more frequent calibration should be performed.

Calibration Gas Safety

Several instruments such as photoionization detectors (PIDs), flame ionization detectors (FIDs), oxygen meters, explosimeters, combustible gas indicators, and many others require use of calibration gasses contained in compressed gas cylinders. Many of these gases are combustible or explosive. Care shall be taken to minimize the potential for injury from the use of such compressed gases. Transport, handling, and storage of cylinders, where necessary, shall be performed in accordance with applicable DOT regulations and site requirements.

Calibration will only be performed in areas free of sources of spark, flame, or excessive heat. Smoking will not be allowed in the vicinity of calibration gas usage areas.

Documentation of Calibration

Instrument calibration activities will be documented. Form FMG 8.0-01 - Instrument Calibration Record shall be used to record applicable calibration and maintenance activities. In addition, protocol for documentation outlined in FMG 1.4 - Data Recording - Field Books/Digital Recording shall be followed.

Intrinsically Safe Requirements

Certain work locations may be such that dangerous, ignitable, or explosive conditions exist. In such cases, it may be necessary to utilize only equipment that is rated as "Intrinsically Safe". Intrinsically safe instrumentation is designed with limited electrical and thermal energy levels to eliminate the potential for ignition of hazardous mixtures.

For site work requiring operation of monitoring instruments in Class I, Division I locations [as defined by the National Fire Protection Agency (NFPA)] only instrumentation rated as Intrinsically Safe will be used. Such equipment (including all accessories and ancillary equipment) must be rated to conform to Underwriters Laboratories (UL) Standard 913, for use in a Class I, Division 1, Groups A, B, C, and D locations. It is also recommended the equipment conform with CSA Standard 22.2, No. 157-92.

Upon completion of the field activities, equipment shall be returned to the possession of the Consultant, Contractor, or Rental Agency accompanied by a written summary of any problems encountered with its use or calibration.

Equipment shall be properly prepared for shipping, including insuring that residual gases (if applicable) are removed from the instrument, and accompanying containers of compressed gases or fluids are properly labeled and sealed.

Equipment Decontamination

Equipment that comes in contact with Site media (water level meters, water quality meters) must be cleaned **before** removal from the site to ensure that chemicals are not transferred to other sites. It is the responsibility of the person who requisitioned the equipment to ensure appropriate cleaning before returning the equipment. Equipment decontamination procedures are typically site specific for unique site compounds.

EQUIPMENT/MATERIALS

- Monitoring equipment specific to work plan tasks.
- Manufacturer's instructions, operation and maintenance information.
- Associated calibration gases, aqueous standards, etc.
- Appropriate shipping containers to facilitate transport without damage to equipment.

REFERENCES

Underwriters Laboratories, Inc. (http://www.ul.com/hazloc/define.htm) Standard UL 913.

National Fire Protection Agency (http://www.nfpa.org/).

Canadian Standards Association (CSA) (http://www.csa.ca) Standard 22.2 No. 157.

Form FMG 8.0-01

INSTRUMENT CALIBRATION RECORD

PROJECT ______________________ **PROJECT MANAGER** ______________________

LOCATION ______________________ **FIELD REP.** ______________________

CLIENT ______________________ **DATE** ______________________

Instrument	Date Calibrated	By	Standard Used	Decontamination, Maintenance, or Repair Performed	Remarks

Other Remarks: ______________________

FMG MODIFICATIONS MUST BE ACCOMPANIED BY A REVISION REQUEST FORM APPROVED BY THE PROJECT MANAGER

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EQUIPMENT DECONTAMINATION

INTRODUCTION

This procedure describes decontamination of field equipment potentially exposed to contaminants. Proper decontamination is required to reduce the risk of transfer of contaminants from areas of contamination to other areas and to minimize the potential for cross-contamination that would compromise sample quality. The degree of decontamination required will be dependent on the nature of the activity, equipment used, and on the amount of exposure to contaminants.

PROCEDURES REFERENCED

- FMG 2.0 - Subsurface Investigations.
- FMG 5.0 - Aquifer Characterization.
- FMG 6.0 - Sample Collection for Laboratory Analysis.
- FMG 8.0 - Field Instruments – Use/Calibration.
- FMG 10.0 - Waste Characterization.

PROCEDURAL GUIDELINES

Decontamination activities must be performed in a controlled area outside any exclusion zones established on the site. Care must be taken to minimize the potential for transfer of contaminated materials to the ground or onto other materials. Regardless of the size or nature of the equipment being decontaminated, the process will utilize a series of steps that involve removal of gross material (dirt, grease, oil, etc.), washing with a detergent, and multiple rinsing steps. In lieu of a series of washes and rinse steps, steam cleaning with low-volume, high-pressure equipment (i.e., steam cleaner) is acceptable.

Drill rigs, backhoes, and other exploration equipment must be decontaminated prior to initiating site activities, in between exploration locations to minimize cross-contamination potential, and prior to mobilizing off site after completion of site work. Heavy equipment is generally best deconned with a combination of steam-cleaning equipment and detergent scrubbing. Particular attention should be paid to parts in direct contact with contaminants, e.g., shovels, tires, augers, drilling decks, etc.

Control and containerization of all decontamination fluids is critical. A decontamination pad must be constructed that is appropriate for the size and type of equipment being decontaminated. At a minimum, the decontamination pad will have the following elements:

- An impermeable barrier capable of containing decontamination fluids.
- A low point where fluids will collect and can be pumped into appropriate containers.
- Durability to withstand equipment such as vehicle and foot traffic.
- Appropriate ancillary equipment such as racks to place decontaminated equipment to drain without further exposure to contaminated fluids.
- Labels to alert personnel as to the potential presence of contaminated materials.

Decontamination of Specific Sampling Equipment

The following specific decontamination procedure is recommended:

- Brush loose soil off of equipment.
- Wash equipment with laboratory grade detergent (i.e., Alconox or equivalent).
- Rinse with tap water (three rinses minimum).
- Rinse equipment with reagent grade methanol for VOC samples (this requirement may not be appropriate for sites where methanol is a contaminant of concern).
- Rinse equipment with nitric acid for metal samples (especially important for sites with potentially high metals concentrations.
- Rinse equipment with distilled water.
- Allow water to evaporate before reusing equipment

Decontamination of Monitoring Equipment

Because monitoring equipment is difficult to decontaminate, care should be exercised to *prevent* contamination. Sensitive monitoring instruments should be protected when they are at risk of exposure to contaminants. This may include enclosing them in plastic bags allowing an opening for the sample intake. Ventilation ports should not be covered.

If contamination does occur, decontamination of the equipment will be required; however, immersion in decontamination fluids is not possible. As such, care much be taken to wipe the instruments down with detergent-wetted wipes or sponges, and then with deionized water-wetted wipes or sponges.

Disposal of Wash Solutions and Contaminated Equipment

All contaminated wash water, rinsates, solids and materials used in the decontamination process that cannot be effectively decontaminated (such as polyethylene sheeting) will be containerized and disposed of in accordance with applicable regulations and GM requirements. All containers will be labeled with an indelible marker as to contents and date of placement in the container, and any appropriate stickers required (such as PCBs).

Sampling of containerized wastes will be performed immediately upon completion of the investigations to minimize storage time on site. Storage of decontamination wastes on site will not exceed 90 days under any circumstances.

EQUIPMENT/MATERIALS

Decontamination equipment and solutions are generally selected based on ease of decontamination and disposability.

- Polyethylene sheeting.
- Metal racks to hold decontaminated equipment.
- Soft-bristle scrub brushes or long-handle brushes for removing gross contamination and scrubbing with wash solutions.
- Large galvanized wash tubs, stock tanks, or wading pools for wash and rinse solutions.
- Plastic buckets or garden sprayers for rinse solutions.
- Large plastic garbage cans or other similar containers lined with plastic bags can be used to store contaminated clothing.
- Contaminated liquids and solids should be segregated and containerized in DOT-approved plastic or metal drums, appropriate for off-site shipping/disposal if necessary.

REFERENCES

ASTM D5088 - Practice for Decontamination of Field Equipment Used at Non-Radioactive Waste Sites.

Attachment C
Field Method Guidelines
Water Level Measurement

Form FMG 5.1-01

GROUNDWATER LEVEL MONITORING REPORT

WELL NUMBER

Page **of**

PROJECT ______________________ **PROJECT MANAGER** ____________

LOCATION ______________________ **FIELD REP.** ____________

CLIENT ______________________ **DATE** ____________

ELEVATION REFERENCED TO: ______________________

Date	Time	Elapsed Time (days)	Depth of Water from ( ) in ft	Elevation of Water	Remarks	Read By

FMG MODIFICATIONS MUST BE ACCOMPANIED BY A REVISION REQUEST FORM APPROVED BY THE PROJECT MANAGER

Attachment D
Field Forms

Revised 08/10/10

MOTORS LIQUIDATION COMPANY
MLK BLVD SITE-WIDE GROUNDWATER MONITORING
GROUND WATER QUALITY MONITORING
STATIC GROUND WATER LEVEL RECORD

DATE ________________
OPERATOR ________________
INSTRUMENT ________________
WEATHER ________________

			S	***D***			***V***		***T***		***VS***	
Well No.	**Datum El.[1] (ft msl)**	**Stick Up (feet)**	**Top of Screen[2] (feet)**	**Well Depth[2] (feet)**	**Mid-Scr. Depth[2] (feet)**	**Casing Diameter (inches)**	**Volume per foot (liters)**	**Time**	**Tapedown (feet below Datum)**	**Water Elevation (ft. msl.)**	**Screen Volume (liters)**	**Well Head PID (ppm isobutylene)**
Monitoring Wells												
MW 1	880.70		16.20			2	0.662					
MW 2R	879.68	-0.34	15.22	20.11	17.36	2	0.662				3.24	
MW 3	880.51	-0.30	15.98	21.01	18.12	2	0.662				3.33	
MW 4	880.78		14.81			2	0.662					
MW 5	880.54	-0.27	27.61	37.76	32.81	2	0.662				6.72	
MW 6	878.22	-0.40	13.42	23.45	18.23	2	0.662				6.64	
MW 7	878.18	-0.38	42.78	47.76	45.07	2	0.662				3.30	
MW 8	878.41	-0.31	14.26	24.25	19.06	2	0.662				6.61	
MW 9	881.65	-0.45	15.34	25.32	20.15	2	0.662				6.61	
MW 10	880.88		14.58			2	0.662					
MW 11	882.68	-0.39	21.20	31.20	26.00	2	0.662				6.62	
MW 12	882.78	-0.27	48.94	54.01	51.42	2	0.662				3.36	
MW 13	881.25	-0.45	15.17	25.13	19.99	2	0.662				6.59	
MW 14	881.36	-0.40	28.73	33.69	31.02	2	0.662				3.28	
MW 15	879.67	-0.39	14.55	24.55	19.37	2	0.662				6.62	
MW 16	878.65	-0.28	14.64	24.62	19.45	2	0.662				6.61	
MW 17	878.30	-0.86	25.00	29.97	27.29	2	0.662				3.29	
MW 18	878.88	-0.57	20.00	24.97	22.37	2	0.662				3.29	
MW 19	878.54	-0.27	19.79	24.94	22.15	2	0.662				3.41	
MW 20	877.70	-0.36	25.20	30.38	27.79	2	0.662				3.43	
MW 21	878.74	1.95	27.82	33.00	30.18	2	0.662				3.43	
MW 22	879.11	2.19	17.44	22.64	19.82	2	0.662				3.44	
MW 23	877.68	-0.28	16.97	22.14	19.56	2	0.662				3.42	

NOTES: (1) **-** Datum elevation is mark on top of PVC riser pipe.
(2) **-** Depth below datum elevation mark.

VS = V * (D - MAX [S or T])

MOTORS LIQUIDATION COMPANY
MLK BLVD SITE-WIDE GROUNDWATER MONITORING
GROUND WATER QUALITY MONITORING
STATIC GROUND WATER LEVEL RECORD

DATE ____________________
OPERATOR ____________________
INSTRUMENT ____________________
WEATHER ____________________

			S	***D***			***V***		***T***		***VS***	
Well No.	**Datum El.[1] (ft msl)**	**Stick Up (feet)**	**Top of Screen[2] (feet)**	**Well Depth[2] (feet)**	**Mid-Scr. Depth[2] (feet)**	**Casing Diameter (inches)**	**Volume per foot (liters)**	**Time**	**Tapedown (feet below Datum)**	**Water Elevation (ft. msl.)**	**Screen Volume (liters)**	**Well Head PID (ppm isobutylene)**
Monitoring Wells												
MW 24	882.77		78.99			2	0.662					
MW 25	882.85		29.10			2	0.662					
MW 26	883.09		42.44			2	0.662					
MW 27	883.04		29.89			2	0.662					
MW 28	877.44	-0.46	43.06	52.78	47.93	2	0.662				6.43	
MW 29	877.53	-0.36	15.33	25.06	20.20	2	0.662				6.44	
MW 30	878.50		9.86			2	0.662					
MW 31R	879.71	-0.19	8.13	12.86	10.47	2	0.662				3.13	
MW 32	878.88		6.89			2	0.662					
MW 33	880.01		6.96			2	0.662					
MW 34	883.67		25.29			2	0.662					
MW 35	883.96	2.71	52.35	62.15	57.02	2	0.662					
MW 36	870.09	-0.35	19.12	24.32	21.49	2	0.662				3.44	
MW 37	869.95	-0.49	9.21	14.42	11.58	2	0.662				3.45	
MW 38	877.65	-0.29	31.23	40.96	36.06	2	0.662				6.44	
MW 39	879.51	-0.47	43.22	53.00	48.09	2	0.662				6.47	
MW 40	879.51	-0.49	28.14	37.92	33.01	2	0.662				6.47	
MW 41	878.58	-0.29	38.95	43.71	41.31	2	0.662				3.15	
MW 42	878.54	-0.29	23.61	33.39	28.48	2	0.662				6.47	
MW 43	876.00	-0.34	57.14	61.92	59.51	2	0.662				3.16	
MW 44	876.02	-0.35	22.28	32.05	27.14	2	0.662				6.47	
MW 45	873.72	-0.58	39.95	49.73	44.82	2	0.662				6.47	
MW 46	873.64	-0.56	14.01	18.77	16.37	2	0.662				3.15	

NOTES: (1) **-** Datum elevation is mark on top of PVC riser pipe.
(2) **-** Depth below datum elevation mark.

VS = V * (D - MAX [S or T])

Revised 08/10/10

MOTORS LIQUIDATION COMPANY
MLK BLVD SITE-WIDE GROUNDWATER MONITORING
GROUND WATER QUALITY MONITORING
STATIC GROUND WATER LEVEL RECORD

DATE
OPERATOR
INSTRUMENT
WEATHER

			S	***D***			***V***		***T***		***VS***	***VC***
Well No.	**Datum El.[1] (ft msl)**	**Stick Up (feet)**	**Top of Screen[2] (feet)**	**Well Depth[2] (feet)**	**Mid-Scr. Depth[2] (feet)**	**Casing Diameter (inches)**	**Volume per foot (liters)**	**Time**	**Tapedown (feet below Datum)**	**Water Elevation (ft. msl.)**	**Screen Volume (liters)**	**Well Head PID (ppm isobutylene)**
Monitoring Wells												
MW 47	880.27	-0.46	23.28	28.05	25.64	2	0.662				3.16	
MW 48	877.96	-0.46	39.00	43.76	41.46	2	0.662				3.15	
MW 49	877.93	-0.61	22.24	32.00	27.10	2	0.662				6.46	
MW 50	878.27	-0.40	38.35	43.12	40.71	2	0.662				3.16	
MW 51	878.19	-0.55	22.26	27.04	24.63	2	0.662				3.16	
MW 52	882.69	-0.30	85.58	95.35	90.44	2	0.662				6.47	
MW 53	881.43	-0.41	123.16	132.86	127.99	2	0.662				6.42	
MW 54	880.37	-0.39	59.82	69.60	64.69	2	0.662				6.47	
MW 55	880.28	-0.36	28.86	38.64	33.73	2	0.662				6.47	
MW 56	859.32	-0.48	11.39	21.33	16.22	2	0.662				6.58	
MW 57	862.52	-0.31	19.84	29.14	24.49	2	0.662				6.16	
MW 58	861.46	-0.29	7.11	12.16	9.44	2	0.662				3.34	
MW 59	882.00	-0.20	29.23	34.21	31.60	1	0.30				1.51	
MW 60	881.77	-0.42	33.82	38.90	36.16	1	0.30				1.54	
MW 61	876.57	-0.39	53.46	63.52	58.32	2	0.662				6.66	
MW 62	876.70	-0.37	93.05	103.10	97.90	2	0.662				6.65	
MW 63	876.53	-0.54	30.35	35.12	32.71	2	0.662				3.16	
MW 64	863.97	-0.26	10.75	20.76	15.58	2	0.662				6.63	
MW 65	864.22	-0.43	10.75	20.77	15.59	2	0.662				6.63	
MW 66	861.67	-0.60	7.94	17.70	12.80	2	0.662				6.46	
MW 67	877.03	-0.60	41.34	46.40	43.68	2	0.662				3.35	

NOTES: (1) - Datum elevation is mark on top of PVC riser pipe.
(2) - Depth below datum elevation mark.

VS = V * (D - MAX [S or T])

MOTORS LIQUIDATION COMPANY
MLK BLVD SITE-WIDE GROUNDWATER MONITORING
GROUND WATER QUALITY MONITORING
STATIC GROUND WATER LEVEL RECORD

DATE ____________
OPERATOR ____________
INSTRUMENT ____________
WEATHER ____________

			S	***D***			***V***		***T***		***VS***	***VC***
Well No.	**Datum El.(1) (ft msl)**	**Stick Up (feet)**	**Top of Screen(2) (feet)**	**Well Depth(2) (feet)**	**Mid-Scr. Depth(2) (feet)**	**Casing Diameter (inches)**	**Volume per foot (liters)**	**Time**	**Tapedown (feet below Datum)**	**Water Elevation (ft. msl.)**	**Screen Volume (liters)**	**Well Head PID (ppm isobutylene)**
Monitoring Wells												
MW 68	876.98	-0.51	30.23	35.24	32.56	2	0.662				3.32	
MW 69	882.08	3.17	48.18	53.20	50.52	2	0.662				3.32	
MW 70	881.82	2.91	31.84	41.85	36.67	2	0.662				6.63	
MW 71	878.16	-0.28	116.21	126.22	121.03	2	0.662				6.63	
MW 72	877.74	-0.38	29.88	40.03	34.78	2	0.662				6.72	
MW 73	877.96	-0.32	80.39	90.40	85.22	2	0.662				6.63	
MW 74	881.10	3.34	62.29	72.38	67.16	2	0.662				6.68	
MW 75	881.42	-0.30	80.11	90.13	84.95	2	0.662				6.63	
MW 76	881.11	-0.55	49.14	59.12	53.96	2	0.662				6.61	
MW 77	862.77	-0.44	11.10	20.78	15.92	2	0.662				6.41	
MW 78	882.25	-0.44	26.77	31.55	29.14	2	0.662				3.16	
MW 79	881.92	-0.27	40.23	45.01	42.62	2	0.662				3.16	
MW 80	865.49	-0.38	23.95	29.00	26.48	2	0.662				3.34	
MW 81	864.38	-0.28	24.80	34.55	29.68	2	0.662				6.45	
MW 82	878.55	-0.21	96.28	106.06	101.17	2	0.662				6.47	
MW 83	876.23	-0.40	74.65	84.35	79.50	2	0.662				6.42	
MW 84	881.95	-0.25	32.98	37.70	35.47	2	0.662				3.12	
MW 85	866.11	-0.41	14.49	24.43	18.97	2	0.662				6.58	
MW-ER-1	881.93	-0.23	13.77	23.77	18.77	1	0.30				3.03	
MW-ER-2	881.96	-0.23	9.77	19.77	14.77	1	0.30				3.03	
MW-ER-3	882.09	-0.20	9.80	19.80	14.80	1	0.30				3.03	

NOTES: (1) - Datum elevation is mark on top of PVC riser pipe.
(2) - Depth below datum elevation mark.

VS = V * (D - MAX [S or T])

MOTORS LIQUIDATION COMPANY
MLK BLVD SITE-WIDE GROUNDWATER MONITORING
GROUND WATER QUALITY MONITORING
STATIC GROUND WATER LEVEL RECORD

DATE ______________
OPERATOR ______________
INSTRUMENT ______________
WEATHER ______________

			S	***D***			***V***		***T***		***VS***	
Well No.	**Datum El.$^{(1)}$ (ft msl)**	**Stick Up (feet)**	**Top of Screen$^{(2)}$ (feet)**	**Well Depth$^{(2)}$ (feet)**	**Mid-Scr. Depth$^{(2)}$ (feet)**	**Casing Diameter (inches)**	**Volume per foot (liters)**	**Time**	**Tapedown (feet below Datum)**	**Water Elevation (ft. msl.)**	**Screen Volume (liters)**	**Well Head PID (ppm isobutylene)**
Monitoring Wells												
MW-1	859.18	-0.49	3.51	11.51	7.51	2	0.662				5.30	
MW-2	860.08	-0.73	2.77	8.77	5.77	2	0.662				3.97	
MW-3	862.68	-0.38	2.62	11.32	6.97	2	0.662				5.76	
MW-4	861.67	-0.41	2.59	22.59	12.59	2	0.662				13.24	
MW-5	871.01	-0.48	4.52	17.52	11.02	2	0.662				8.61	
MW-6	868.92	-0.38	6.62	24.62	15.62	2	0.662				11.92	
MW-7	869.69	-0.32	5.68	25.68	15.68	2	0.662				13.24	
Surface Water												
Culvert 1	857.79											

NOTES: (1) - Datum elevation is mark on top of PVC riser pipe.
(2) - Depth below datum elevation mark.

VS = V * (D - MAX [S or T])

MONITORING WELL PURGING AND SAMPLING
FIELD DATA

PROJECT MLC Anderson DATE ______ PERSONNEL ______

WELL DATA (from records)

Well I.D. ______ Datum Id. ______ Total Depth ______
Csg. Vol./Ft. ______ Datum Elev. ______ Top Screen ______

WELL DATA (field-determined)

Tapedown ______ Time ______ Operator ______
Screen Vol. ______ Csg. Vol. ______ Total Depth ______

SETUP

Intake Depth ______ Equipment ______
Operator ______ Decon record ______

INSTRUMENT CALIBRATION RECORD

Time	Std. Lot No.	Standard Value	Conductivity Initial / Recal. (mS/cm)	pH Init. / Recal. (s.u.)	Turbidity Initial / Recal. (NTU)	Temp. C°	D.O. mg/L	ORP mV	Discharge (record units)

PURGE WATER QUALITY RECORD

Time	Tape-Down	No. of Volumes	Conductivity (mS/cm)	pH (s.u.)	Turbidity (NTU)	Temp. C°	D.O. mg/L	ORP mV	Discharge (record units)
			START PURGING						

FIELD WATER QUALITY RECORD

	START SAMPLING	
	COMPLETED SAMPLING	
CONDITION OF SAMPLE WATER:		
REACTION TO PRESERVATIVE:		

Discharged water: volume ______ disposition ______

Motors Liquidation Company
MLK Boulevard Site-Wide Groundwater Monitoring
Well Inspection Log Summary

Date ____________________ **Personnel** ____________________________

Monitoring Well Identification	Date/ Time	Well I.D. Marked?	Mark Present?	Standing/ Ponded Water Present?	Evidence of Collision Damage?	Evidence of Casing Damage?	Casing Lock In Place?	Evidence of Well Erosion/ Subsidence?	Well Head PID ppm as Isobutylene	Notes

Attachment E
Field Method Guidelines
Groundwater Sampling

WELL DEVELOPMENT AND STABILIZATION FORM

PROJECT NAME: ____________________ PROJECT NO.: ____________

DATE OF WELL DEVELOPMENT: ____________________

DEVELOPMENT CREW MEMBERS: ____________________

PURGING METHOD: ____________________

SAMPLE NO.: ____________________

SAMPLE TIME: ____________________

WELL INFORMATION

WELL NUMBER: ____________________

WELL TYPE (diameter/material) ____________________

MEASURING POINT ELEVATION: ____________________

STATIC WATER DEPTH: ____________________ ELEVATION: ____________

BOTTOM DEPTH: ____________________ ELEVATION: ____________

WATER COLUMN LENGTH: ____________________

SCREENED INTERVAL: ____________________

WELL VOLUME: ____________________

Note: For 2-inch diameter well: 1 foot = 0.14 gallons (Imp) or 0.16 gallons (US)
1 meter = 2 liters

	UNITS	*1*	*2*	*3*	*4*	*5*	*TOTAL/ AVERAGE*
VOLUME PURGED (volume/total volume):							
FIELD pH:							
FIELD TEMPERATURE:							
FIELD CONDUCTIVITY:							
CLARITY/TURBIDITY VALUES:							
COLOR:							
ODOR:							
COMMENTS:							

COPIES TO: ____

FMG MODIFICATIONS MUST BE ACCOMPANIED BY A REVISION REQUEST FORM APPROVED BY THE PROJECT MANAGER

REMEDIATION SECTION	FIELD METHOD GUIDELINE NO.:	FMG 6.4
WORLDWIDE FACILITIES GROUP	EFFECTIVE DATE:	NOVEMBER 20, 2001
GENERAL MOTORS CORPORATION		
REVISION NO.: 4	REVISION DATE:	APRIL 14, 2003

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REFERENCES 10

LIST OF FORMS

(Following Text)

FMG 6.4-01 WELL PURGING FIELD INFORMATION

FMG 6.4-02 SAMPLE COLLECTION DATA SHEET

FMG 6.4-03 MONITORING WELL RECORD FOR LOW-FLOW PURGING

FMG MODIFICATIONS MUST BE ACCOMPANIED BY A REVISION REQUEST FORM APPROVED BY THE PROJECT MANAGER

REMEDIATION SECTION	FIELD METHOD GUIDELINE NO.:	FMG 6.4
WORLDWIDE FACILITIES GROUP	EFFECTIVE DATE:	NOVEMBER 20, 2001
GENERAL MOTORS CORPORATION		
REVISION NO.: 4	REVISION DATE:	APRIL 14, 2003

GROUNDWATER SAMPLING

INTRODUCTION

This procedure is for the collection of groundwater samples for laboratory analysis.

The objective of most groundwater quality monitoring programs is to obtain samples that are representative of existing groundwater conditions, or samples that retain the physical and chemical properties of the groundwater within an aquifer.

One of the most important aspects of groundwater sampling is acquiring samples that are free of suspended silt, sediment, or other fine grained particulates. Fine grain materials may often have a variety of chemical components sorbed to the particle or have the ability to sorb chemicals from the aqueous phase to the particle which will bias the subsequent analytical results.

Constituents known to have an affinity for fine grained particulates are: polychlorinated biphenyls (PCBs), semivolatile organic compounds (SVOCs), and inorganics. Monitoring programs where these constituents are suspected or known to be prevalent must employ sampling methods that minimize particulate presence.

The sampling method of "preference" for GM sites where particulate sorption is an issue is the "low stress/low flow" technique described within this FMG. Experience has shown that the "low stress/low flow" technique typically achieves representative groundwater samples with minimal particulate interference. In addition to the "low stress/low flow" technique, a "typical sample method" has been presented for the collection of constituents less sensitive to particulates presence (i.e., VOCs), or "direct-push sample methods" generally employed as a "pre-screening tool" to evaluate VOC presence. Direct-push sample procedures will result in groundwater samples with particulates present.

Lastly, in "extreme" cases "ultra-low flow" techniques have been employed at select sites where "low stress/low flow" methods were used, yet particulate-sensitive constituents continue to bias the analytical results. Ultra-low flow techniques are conducted at purging rates below 100 mL per minute, and should only be utilized after careful review and a procedural variance has been approved.

PROCEDURES REFERENCED

- FMG 1.4 - Data Recording - Field Books/Digital Recording.
- FMG 5.1 - Water Level Measurements.
- FMG 8.0 - Field Instruments - Use/Calibration
- FMG 9.0 - Equipment Decontamination.

PROCEDURAL GUIDELINES

The following describes three techniques for groundwater sampling: "Low Stress/Low Flow Methods", "Typical Sample Methods", and "Direct-Push Methods".

"Low Stress/Low Flow Methods" will be employed when it is critical to collect groundwater samples truly representative of the groundwater present, and to minimize the impact of sediment/ colloid presence. Analysis typically sensitive to turbidity/sediment issues are PCBs, SVOCs, and inorganic constituents.

The "Typical Sample Methods" will be employed where the collection of parameters less sensitive to turbidity/sediment issues are being collected (VOCs and general chemistry).

The "Direct-Push Methods" are typically employed for pre-screening areas for chemical presence to aid in determining well placement, or the need for further study.

Note: If non-aqueous phase liquids (NAPL) (light or dense) are detected in a monitoring well, groundwater sample collection will not be conducted and the Project Manager must be contacted to determine a course of action.

If deemed necessary to sample groundwater from below a LNAPL layer, a suggested sampling procedure has been presented at the end of this Procedural Guidelines section.

Preparatory Requirements

- Verify well identification and location using borehole log details and location layout figures. Note the condition of the well and inform the Project Manager of any required repair work.
- Prior to opening the well cap, measure the breathing space above the well casing with a PID to establish baseline levels. Repeat this measurement once the well cap is opened. If either of these measurements exceeds the air quality criteria in the Health and Safety Plan, field personnel should adjust their PPE accordingly.
- Prior to commencing the groundwater purging/sampling tasks, water level and total well depth measurements must be obtained to determine the volume of water in the well. Refer to

FMG 5.1 - Water Level Measurements for details. In some settings it maybe necessary to allow time for the water level to equilibrate. This condition exists if a water tight seal exists at the well cap and the water level has fluctuated above the top of screen; creating a vacuum or pressurized area within the well casing. Three water level checks will verify static water level conditions or changing conditions.

- Calculate the water volume in the well. Typically overburden well volumes consider only the quantity of water standing in the well screen and riser; bedrock well volumes are calculated on the quantity of water within the open corehole and within the overburden casing.
- Estimate the natural groundwater flow rate into well to determine the approximate pumping rate for purging/sampling activities.

Well Purging and Stabilization Monitoring (Low Stress/Low Flow Method)

- The GM method of preference for groundwater sampling will be the low stress/low flow method described below.
- Bladder pumps/submersible variable rate pumps (i.e., Grundfos™ Rediflo or equivalent) or peristaltic pumps are typically employed.
- Slowly lower the pump, safety cable, tubing and electrical lines into the well to the depth specified by the project requirements. The pump or tubing should be placed in the well as early as possible before sampling is initiated (this is to minimize well disturbance). In some programs it may be necessary to install the pumping equipment/tubing approximately 24 hours prior to purging. Peristaltic tubing placement should include a tubing "clamp" at the well head, to minimize vibration transfer into the water column. The pump or tubing intake must be at the mid-point of the well screen to prevent disturbance and resuspension of any sediment in the screen base. Bedrock well sampling may require pump/tubing placement in specific fracture zone areas or other areas which will be identified within the project Work Plan.
- Before starting the pump, measure the water level again with the pump in the well leaving the water level measuring device in the well when completed.
- Purge the well at 100 to a maximum of 500 milliliters per minute (mL/min). During purging, the water level should be monitored approximately every 5 minutes, or as appropriate. A steady flow rate should be maintained that results in drawdown of 0.3 feet or less. The rate of pumping should not exceed the natural flow rate conditions of the well being sampled. Care should be taken to maintain pump suction and to avoid entrainment of air in the tubing. Record adjustments made to the pumping rates and water levels immediately after each adjustment.
- Calibrate field instrument and document calibration activity. Calibration shall be performed in accordance with manufacturer's recommendations and FMG 8.0 - Field Instruments - Use/Calibration.

- During the purging of the well, monitor and record the field indicator parameters (pH, temperature, conductivity, oxidation-reduction (redox) reaction potential (ORP), dissolved oxygen (DO), and turbidity) approximately every 5 minutes. Stabilization is considered to be achieved when the final groundwater flow rate is achieved, and three consecutive readings for each parameters are within the following limits:

- pH	±0.1 pH units of the average value of the three readings;
- temperature	±3 percent of the average value of the three readings;
- conductivity	±0.005 milliSiemen per centimeter (mS/cm) of the average value of the three readings for conductivity <1 mS/cm and ±0.01 mS/cm of the average value of the three readings for conductivity >1 mS/cm;
- ORP	±10 millivolts (mV) of the average value of the three readings;
- DO	±10 percent of the average value of the three readings; and
- turbidity	±10 percent of the average value of the three readings, or a final value of less than 5 nephelometric turbidity units (NTU).

- Should stabilization not be achieved for all field parameters, purging is continued until a maximum of 20 well screen volumes have been purged from the well. Since low-flow purging (LFP) likely will not draw groundwater from a significant distance above or below the pump intake, the screen volume is based upon a 5-foot (1.4 m) screen length. After purging 20 well screen volumes, purging is continued if the purge water remains visually turbid and appears to be clearing, or if stabilization parameters are varying slightly outside of the stabilization criteria listed above and appear to be approaching stabilization.
- If low-turbidity samples are critical to the project goals, purging will be extended until turbidity has been reduced to 5 NTU or less.
- The pump must not be removed from the well between purging and sampling.

Well Purging and Stabilization Monitoring (Typical Method)

- Typically peristaltic pumps or bladder pumps or submersible pumps are preferred. In most cases bailer use is not desirable due to the "surging" action of bailer entry and removal. Exception is noted for VOC sampling where bailers are often used.
- The pump intake/tubing is typically placed at the mid-point of the screen within overburden wells. Bedrock well sampling may require pump/tubing placement in specific fracture zone areas or other areas which will be identified within the project Work Plan.
- Purge the well until three consecutive well volume measurements of temperature and specific conductivity are approximately plus or minus 10 percent and if the pH values are within 1 pH unit of the last three value averages, and the groundwater turbidity values are less than the project Work Plan requirements. If stabilization has not occurred within the first five well volumes removed, continue purging and monitoring until eight well volumes have been pumped. Purging rates should not exceed the natural flow rate of groundwater into the well.

Elevated purging rates may result in excessive drawdown of the water column, introducing sediment/particulate presence.

- Groundwater turbidity may be evaluated by a visual examination for sediment/silt presence or use of a nephlometer. Work Plan-specific goals may exist for turbidity values which may require extending the purging, or require an alternate pumping system.
- Purging and stabilization activities using a bailer are generally performed at the top of the water column, within the riser piping/above the well screen. This will minimize sediment disturbance/suspension in the screen area, and move water from the formation into the well screen/riser area in an effort to remove stagnant groundwater within the well. Bottom-loading bailers are generally employed. The lowering and removal actions are performed slowly to minimize well disturbance. Once stabilization has been attained, the sample aliquots are collected directly from the bailer.
- In the event the well goes dry (poor yielding formations), the purging activities will be performed on 3 consecutive days, noting the field stabilization parameters on each day. After the third day of purging is complete, the sample collection will be performed once sufficient groundwater recharge has occurred.

Direct-Push Sampling Technique

Generally, the direct-push sampling methods are employed for "pre-screening" groundwater quality (typically VOCs) in selected areas. This method is generally used to evaluate the need for permanent monitoring wells, or determine the need for further study. The sampling technique is a direct-push protected-screen sampling technique as described in ASTM D6001 (Standard Guide for Direct Push Water Sampling for Geoenvironmental Investigations). The direct-push sampling technique is summarized as follows:

- Advance borehole to the target depth below the groundwater table.
- Remove the drill rod, assemble the direct–push sample tool and attach it to the drill rod.
- Lower the sample device to the bottom of the borehole using the drill rod.
- Advance the sample device approximately 3 feet into the bottom of the borehole by hydraulically pushing the drill rod.
- Withdraw the drill rods approximately 1 to 2 feet to retract the screen sleeve and to expose the sampler screen to the formation.
- Alternatively a number of direct-push tools exist that do not require an advance borehole, and can be driven directly to the target depth and retracted for sample collection.
- Allow at least 15 minutes from exposing the sampler screen to sample collection to allow silt in the sampler to settle. In tight formations, a longer wait time may be required to allow sufficient groundwater to enter the screen. In some clays the sample device may not collect sufficient water volume to obtain a sample.

- Lower a small bailer into the sampler, discard initial bail (to acclimate bailer), and collect a water sample. A few bailer volumes may be required to obtain a sufficient volume of water sample. Alternatively, a "Waterra" check ball affixed to tubing maybe employed to collect a groundwater sample, or a peristaltic pump.
- Remove and clean the sampler device after completion of sample collection. Decontaminate sampler for next sample event.

This sampling technique is prone to sediment presence due to the lack of a screen sandpack and the limited purging performed before sample collection. A project variance will be required if non-VOC constituents are being considered for analysis.

<u>Sampling Techniques</u>

- If an alternate pump is utilized (i.e., typical method), the first pump discharge volumes (or bailer volumes) should be discarded to allow the equipment a period of acclimation to the groundwater.
- Samples are typically collected directly from the pump with the groundwater being discharged directly into the appropriate sample container. Avoid handling the interior of the bottle or bottle cap and don new gloves for each well sampled to avoid contamination of the sample.
- Order of sample collection:
    - VOCs;
    - SVOCs and PCBs;
    - Total organic carbon (TOC);
    - Total organic halogens (TOX);
    - Extractable organics;
    - Total metals;
    - Dissolved metals;
    - Phenols;
    - Cyanide;
    - Sulfate and chloride;
    - Nitrate and ammonia; and
    - Radionuclides.
- For low stress/low flow sampling, samples should be collected at a flow rate between 100 and 250 mL/min and such that drawdown of the water level within the well does not exceed the maximum allowable drawdown of 0.3 feet.
- The pumping rate used to collect a sample for VOCs should not exceed 100 mL/min. Samples should be transferred directly to the final container 40 mL glass vials completely full and topped with a teflon cap. Once capped the vial must be inverted and tapped to check

for headspace/air presence (bubbles). If air is present the sample vial will be discarded, and re-collected until free of air.

- Field filtration will be performed if dictated by the project Work Plan. Sediment presence can interfere or bias sample results; false positive findings have been observed when turbid samples for hexavalent chromium (and other analytes) are analyzed. Field filtration can eliminate this concern; generally applicable to only inorganic/PCB analysis. In-line disposable filter cartridges are generally the easiest and quickest method for field filtration.
- Sample labels/sample identification. All samples must be labeled with:
  - A unique sample number;
  - Date and time;
  - Parameters to be analyzed;
  - Project Reference ID; and
  - Sampler's initials.
- Labels should be secured to the bottle(s) and should be written in indelible inks.

<u>Groundwater Sampling Techniques Below LNAPL Layers</u>

Sampling and analysis of groundwater below a LNAPL layer is typically discouraged, and not performed at REALM/ENCORE sites. The rationale for avoiding groundwater analysis below a LNAPL layer is as follows:

- The potential for sample "contamination" with a trace amount of NAPL is very possible; analytical data will be biased "high" based upon this concern.
- Analytical data generated from this scenario does not represent "dissolved" constituent presence in groundwater. Dissolved constituents are "best" determined in downgradient locations.

In some instances it may be required to perform groundwater sampling and analysis below a LNAPL layer, possibly at the request of a regulatory group. If absolutely necessary, this type of sampling may be accomplished in accordance with the following:

- Determine the LNAPL depth and thickness using an interface probe or clear bottom loading bailer.
- Determine the sampling depth, selecting a sample point as far away as possible from the LNAPL interface.
- Using a "capped" outer tube or piping (i.e., 1-inch diameter polyethylene), insert the outer tube to the selected sample interval. The cap should be a slip-on cap affixed to the outer tube using a short "leash" (i.e., stainless steel wire or equivalent). This allows cap recovery once the sampling is complete.

- Insert the sample line (3/8-inch diameter tubing) into the outer tube and "push out" the end cap for sample line entry into the sampling interval.
- Perform purging and sampling using a peristaltic pump.
- Monitor the groundwater level and/or the NAPL level to ensure the LNAPL layer is not drawn to sampling depth. If LNAPL drawdown occurs evaluate the need to proceed further, and consider terminating sampling activity.
- This sample should not be referred to on any analysis as a groundwater sample. It should always be referred to as a groundwater/NAPL mixture (GW/NAPL designation).

EQUIPMENT/MATERIALS

- pH meter, conductivity meter, nephlometer, ORP meter, DO meter, temperature gauge.
- Field filtration units (if required).
- Purging/sampling equipment:
  - Peristaltic pump (not suitable for VOCs[1]/SVOCs, or drawing water from depths greater than 25 feet[2]);
  - Suction pumps (not suitable for LFP, VOCs/SVOCs, or depths greater than 25 feet);
  - Submersible pumps (suitable for VOCs/SVOCs only at low flow rates);
  - Air lift pumps (not suitable for VOCs/SVOCs);
  - Bladder pumps (suitable for LFR and VOCs/SVOCs);
  - Inertia pumps (gaining acceptability for VOCs/SVOCs, generally not suited for GM programs); and
  - Bailers.
- Water level probe.
- Sampling materials (containers, log book/forms, coolers, chain-of-custody).
- Project Work Plan.
- Health and Safety Plan.

Note[1]: Peristaltic pump use for VOC collection is acceptable on select EPA/RCRA sites; this technique has gained acceptance in select areas. Where it is permissible to collect VOCs using a peristaltic pump, collection must be performed at a low flow rate (Michigan allows VOC sampling with the peristaltic pump).

Acceptability of the collection of VOCs using the peristaltic pump should be evaluated before the sampling program commences, commonly performed during the project Work Plan development and approval process.

Note[2]*: Exception is noted in locations that the suction line can be placed at the desired sample depth (i.e., 100 feet), and the natural recharge maintains a water level within 25 feet of the ground surface.*

Field Notes

Field notes must document field activities and measurements collected during the sampling activities. FMG 1.4 - Data Recording - Field Books/Digital Recording describes the data/recording procedure for field activities. The log book/field file should document the following for each well sampled:

- Identification of well.
- PID readings before and after well opening (if required).
- Well depth.
- Static water level depth and measurement technique.
- Sounded well depth.
- Presence of immiscible layers and detection/collection method.
- Well yield – high or low.
- Purge volume, pumping rate, and final disposition.
- Time well purged.
- Measured field parameters and meter calibration records.
- Purge/sampling device used.
- Well sampling sequence.
- Sample appearance.
- Sample odors.
- Sample volume.
- Types of sample containers and sample identification.
- Preservative(s) used.
- Parameters requested for analysis.
- Field analysis data and method(s).
- Sample distribution and transporter.
- Analytical laboratory.
- Chain-of-custody number for shipment to laboratory.
- Field observations on sampling event.
- Name(s) of sampling personnel.

- Climatic conditions including air temperature.
- Problems encountered and any deviations made from the established sampling protocol.

A standard log form for documentation and reporting groundwater purging and sampling events are presented on Form FMG 6.4-01 - Well Purging Field Information, Form FMG 6.4-02 - Sample Collection Data Sheet, and Form FMG 6.4-03 - Monitoring Well Record for Low-Flow Purging.

Groundwater/Decontamination Fluid Disposal

The project Work Plan will identify the required disposal procedures for groundwater and decontamination fluids. Groundwater disposal methods will vary on a case-by-case basis but may range from:

- Off-site treatment at private treatment/disposal facilities or public owned treatment facilities.
- On-site treatment at Facility-operated facilities.
- Direct discharge to the surrounding ground surface, allowing groundwater infiltration to the underlying subsurface regime.
- Direct discharge to impervious pavement surfaces, allowing evaporation to occur.

Decontamination fluids should be segregated and collected separately from wash waters/groundwater containers. Often small volumes of solvents used during the day can be allowed to evaporate if left in an open pail. In the event evaporation is not possible or practical, off-site disposal arrangements must be made.

REFERENCES

ASTM D5474 - Guide for Selection of Data Elements for Groundwater Investigations.

ASTM D4696 - Guide for Pore-Liquid Sampling from the Vadose Zone.

ASTM D5979 - Guide for Conceptualization and Characterization of Groundwater Systems.

ASTM D5903 - Guide for Planning and Preparing for a Groundwater Sampling Event.

ASTM D4448 - Standard Guide for Sampling Groundwater Wells.

ASTM D6001 - Standard Guide for Direct Push Water Sampling for Geo-Environmental Investigations.

USEPA Low-Flow (Minimal Drawdown) Ground-Water Sampling Procedures (EPA/540/S-95/504).

USEPA RCRA Groundwater Monitoring: Draft Technical Guidance (EPA/530-R-93-001).

WELL PURGING FIELD INFORMATION FORM

JOB# ______ - ___

SITE/PROJECT NAME: ____________________

WELL# ______

WELL PURGING INFORMATION

PURGE DATE (MM DD YY)

SAMPLE DATE (MM DD YY)

WATER VOL. IN CASING (LITRES/GALLONS)

ACTUAL VOLUME PURGED (LITRES/GALLONS)

PURGING AND SAMPLING EQUIPMENT

PURGING EQUIPMENT.........DEDICATED Y N (CIRCLE ONE)

SAMPLING EQIPMENT.........DEDICATED Y N (CIRCLE ONE)

PURGING DEVICE ☐ A - SUBMERSIBLE PUMP · D - GAS LIFT PUMP · G - BAILER · X- ________ PURGING OTHER (SPECIFY)

B - PERISTALTIC PUMP · E - PURGE PUMP · H - WATERRA®

SAMPLING DEVICE ☐ C - BLADDER PUMP · F - DIPPER BOTTLE · X- ________ SAMPLING OTHER (SPECIFY)

PURGING DEVICE ☐ A - TEFLON · D - PVC · X- ________ PURGING OTHER (SPECIFY)

B - STAINLESS STEEL · E - POLYETHYLENE

SAMPLING DEVICE ☐ C - POLYPROPYLENE · X- ________ SAMPLING OTHER (SPECIFY)

PURGING DEVICE ☐ A - TEFLON · D - POLYPROPYLENE · F - SILICONE · X- ________ PURGING OTHER (SPECIFY)

B - TYGON · E - POLYETHYLENE · G - COMBINATION TEFLON/POLYPROPYLENE

SAMPLING DEVICE ☐ C - ROPE · X- ________ (SPECIFY) · X- ________ SAMPLING OTHER (SPECIFY)

FILTERING DEVICES 0.45 ☐ A - IN-LINE DISPOSABLE · B - PRESSURE · C - VACUUM

FIELD MEASUREMENTS

WELL ELEVATION	(m/ft)		GROUNDWATER ELEVATION	(m/ft)
DEPTH TO WATER	(m/ft)		WELL DEPTH	(m/ft)

pH	TURBIDITY	CONDUCTIVITY	ORP	DO	SAMPLE TEMPERATURE
(std)	(ntu)	(µm/cm) AT 25°C	(mV)	(mg/L)	(°C)
(std)	(ntu)	(µm/cm) AT 25°C	(mV)	(mg/L)	(°C)
(std)	(ntu)	(µm/cm) AT 25°C	(mV)	(mg/L)	(°C)
(std)	(ntu)	(µm/cm) AT 25°C	(mV)	(mg/L)	(°C)
(std)	(ntu)	(µm/cm) AT 25°C	(mV)	(mg/L)	(°C)

FIELD COMMENTS

SAMPLE APPEARANCE: ________ ODOR: ________ COLOR: ________ TURBIDITY: ________

WEATHER CONDITIONS: WIND SPEED ________ DIRECTION ________ PRECIPITATION Y/N OUTLOOK ________

SPECIFIC COMMENTS ________

I CERTIFY THAT SAMPLING PROCEDURES WERE IN ACCORDANCE WITH APPLICABLE GM PROTOCOLS

DATE ________ PRINT ________ SIGNATURE ________

FMG MODIFICATIONS MUST BE ACCOMPANIED BY A REVISION REQUEST FORM APPROVED BY THE PROJECT MANAGER

SAMPLE COLLECTION DATA SHEET - GROUNDWATER SAMPLING PROGRAM

PROJECT NAME ______________________________ PROJECT NO. ______________

SAMPLING CREW MEMBERS ______________________________ SUPERVISOR ______________

DATE OF SAMPLE COLLECTION ______________________________

[Note: For 2" dia. well, 1 ft. = 0.14 gal (imp) or 0.16 gal (us)]

Sample I.D. Number	**Well No.**	**Measuring Point Elev. (ft. AMSL)**	**Bottom Depth (ft. btoc)**	**Water Depth (ft. btoc)**	**Water Elevation (ft. AMSL)**	**Well Volume (gallons)**	**Bailer Volume No. Bails**	**Volume Purged (gallons)**	**Field pH**	**Field Temp.**	**Field Cond.**	**Time**	**Sample Description & Analysis**

Additional Comments: ______________________________

____

Copies to: ______________________________

____

____

FMG MODIFICATIONS MUST BE ACCOMPANIED BY A REVISION REQUEST FORM APPROVED BY THE PROJECT MANAGER

MONITORING WELL RECORD FOR LOW-FLOW PURGING

Project Data:

Project Name:
Ref. No.:

Date:
Personnel:

Monitoring Well Data:

Well No.:
Measurement Point:
Constructed Well Depth (ft):
Measured Well Depth (ft):
Depth of Sediment (ft):

Screen Length (ft):
Depth to Pump Intake (ft)(1):
Well Diameter, D (in):
Well Screen Volume, V_s (mL)(2):
Initial Depth to Water (ft):

Time	*Pumping Rate (mL/min)*	*Depth to Water (ft)*	*Drawdown from Initial Water Level (3) (ft)*	*pH*	*Temperature °C*	*Conductivity (mS/cm)*	*ORP (mV)*	*DO (mg/L)*	*Turbidity (NTU)*	*Volume Purged, V_p (mL)*	*No. of Well Screen Volumes Purged (4)*

Notes:

(1) The pump intake will be placed at the well screen mid-point or at a minimum of 2 ft above any sediment accumulated at the well bottom.

(2) The well screen volume will be based on a 5-foot screen length, $V_s = p*(D/2)^2*(5*12)*(2.54)^3$

(3) The drawdown from the initial water level should not exceed 0.3 ft.

(4) Purging will continue until stabilization is achieved or until 20 well screen volumes have been purged (unless purge water remains visually turbid and appears to be clearing, or unless stabilization parameters are varying slightly outside of the stablization criteria and appear to be stablizing), No. of Well Screen Volumes Purged= Vp/Vs.

Attachment F
Field Method Guidelines
Surface Water Sampling

REMEDIATION SECTION	FIELD METHOD GUIDELINE NO.: FMG 6.3
WORLDWIDE FACILITIES GROUP	EFFECTIVE DATE: NOVEMBER 20, 2001
GENERAL MOTORS CORPORATION	
REVISION NO.: 0	REVISION DATE:

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REMEDIATION SECTION	FIELD METHOD GUIDELINE NO.: FMG 6.3
WORLDWIDE FACILITIES GROUP	EFFECTIVE DATE: NOVEMBER 20, 2001
GENERAL MOTORS CORPORATION	
REVISION NO.: 0	REVISION DATE:

SURFACE WATER

INTRODUCTION

Surface water sampling locations for water quality studies may be selected based on many factors, including: study objectives; the location of point source discharges, non-point source discharges and tributaries; the presence of structures (bridges, dams, etc.), and accessibility.

PROCEDURES REFERENCED

- FMG 9.0 - Equipment Decontamination.

PROCEDURAL GUIDELINES

Before any sampling is conducted, the first requirement is to consider suitable sampling locations. Bridges and piers are normally good choices for surface water sampling since they provide access and permit water sampling at any point across the width of the water body. Sampling locations should be selected in accordance with the Work Plan and discussed with the Project Manager.

Wading for water samples in lakes, ponds, and slow-moving rivers and streams must be done with caution since bottom deposits are easily disturbed. Samples must be collected without entrained suspended sediments. All surface water samples are to be collected commencing with the most downstream sample to avoid sediment interference with other samples. A life vest and safety line will be worn in all cases where footing is unstable or where water is fast moving or over 3 feet (0.85 m) in depth. A second person may also be required for most of the sampling scenarios.

Prior to entering select areas it may be necessary to acquire property access permission from the land owner. Access permission must be acquired in advance of the sampling program and may require a written agreement.

Rivers, Streams, and Creeks

Surface water samples should usually be collected in areas of the surface water body that are representative of the surface water body conditions. Representative samples can usually be collected in portions of the surface water body that have a uniform cross section and flow rate. Since mixing is influenced by turbulence and water velocity, the selection of a site immediately downstream of a riffle area (e.g., fast flow zone) will ensure good vertical mixing. These locations are also likely areas for deposition of sediment since the greatest deposition occurs where stream velocity slows.

A site that is clear of immediate point sources (e.g., tributaries and industrial and municipal effluents) is preferred for the collection of surface water samples unless the sampling is being performed to assess these sources.

Tributaries should be sampled as near the mouth as is feasible. However, it is important to select the sample location taking into consideration the impact that the downstream receiving water body has on the tributary flow and sediments. The downstream water body may change the water quality (salinity), temperature, or turbidity in the tributary near its mouth.

Sediment samples shall be collected along a cross-section of a river or stream in order to adequately characterize the bed material or as described in the Work Plan. A common procedure is to sample at quarter points along the cross-section of the sampling site selected. Samples may be composited as described in the Work Plan. Samples of dissimilar composition should not be combined.

In some instances sediment sampling may be performed along the shore only; depending upon the study needs.

Lakes, Ponds, and Impoundments

The water in lakes, ponds, and impoundments has a much greater tendency to stratify than water in rivers and streams. The lack of mixing may require that more samples be obtained. An extreme turbidity difference may occur where a highly turbid river enters a lake. Therefore, each layer of the stratified water column may need to be considered separately. Stratification is caused by water temperature differences; the cooler, heavier water is beneath the warmer water.

Sample selection also should adequately represent the conditions of the lagoon or settling pond. Attention must be given to identify intakes and outflows within the lagoon or settling pond which may provide biased sample representation. Sample locations with adjacent structures (i.e., banks, piers, etc.) may also provide biased samples within active lagoons or settling ponds, as the potential for boundary flow and eddies exist.

The number of water sampling sites on a lake, pond, or impoundment will vary with the purpose of the investigation, as well as the size and shape of the basin. In ponds and small impoundments, a single sample should be collected at the deepest point. In naturally formed ponds, the deepest point is usually near the center. In impoundments the deepest point is usually near the dam.

In lakes and larger impoundments, several subsamples may be composited to form a single sample. These vertical sampling locations are often taken along a grid.

In lakes with irregular shape, with several bays and coves that are protected from the wind, additional samples may be needed to represent water quality at various points in the lake. Additional samples may be taken where discharges, tributaries, and other such factors are suspected of influencing water quality.

When collecting sediment samples in lakes, ponds, and reservoirs, samples should be collected at approximately the center of the water body or as directed by the Work Plan. This is also the case for reservoirs that are formed by the impoundment of rivers or streams. The coarse grained sediments are deposited near the headwaters of the reservoir, and the fine grained sediments near the center. The shape, inflow pattern, and circulation must be considered when selecting sediment sampling sites in lakes and reservoirs.

In all instances, the sampling locations should be properly documented with field notes and photographs, as appropriate.

Sampling Techniques

Any equipment or sampling technique(s) used to collect a sample is acceptable as long as it provides a sample which is representative of the stream being sampled and is consistent with the Work Plan. Typically sample aliquots are collected from the area of concern directly, or a compositing approach is considered using a plastic bucket to collect a representative sample, then individual aliquots are collected from the sample bucket.

When collecting surface water samples, direct dipping of the sample container into the stream is acceptable unless the sample bottles contain preservatives. If the bottles are preserved, then precleaned unpreserved bottles should be used to collect the sample. The water sample should then be transferred to the appropriate preserved bottles. When collecting samples, submerse the inverted bottle to the desired sample depth and then tilt the opening of the bottle upstream to fill. When composting across a stream and/or water channel is typically performed using a pre-rinsed 1 to 2 L plastic bottle collecting sub-samples for final mixing sample aliquot collection. Volatile organic compounds (VOCs) must not be collected from the compositing bucket and are sampled directly from the stream cross section.

Wading may cause bottom sediment deposits to be re-suspended and therefore could result in a biased sample. Wading is acceptable if the stream has a noticeable current and the samples are collected directly into the bottle while pointed upstream. If the stream is too deep to wade or if the sample must be collected from more than one water depth, additional sampling equipment will be required. Samples should be collected approximately 6 inches (15 cm) below the surface with the sample bottles completely submerged. This will keep floating debris from entering the sample bottles. Floating debris could result in unrepresentative analytical data.

Sample collection when the flow depth is minimal (i.e., <1 inch (<2.5 cm)) will require special consideration to prevent sediment disturbance. Sampling might be conducted with a container then transferred to the appropriate glassware, or collection may be permissible with a peristaltic pump using a 'fixed' suction line, secured to prevent sediment collection. A small excavation in the stream bed to create a 'sump' for sample collection may be permissible but should be prepared well in advance of the sample collection event to allow sediment settlement.

Teflon bailers may be used for surface water sampling if it is not necessary to collect a sample at a specified interval. A top-loading bailer with a bottom check-valve is sufficient for many studies. As the bailer is lowered through the water, water is continually displaced through the bailer until a desired depth is reached, at which point the bailer is removed. This technique is not suitable where strong currents are encountered (because the ball may not seat effectively), or where a discrete sample at a specific depth is required.

If discrete samples are required from a specific depth, and the parameters to be measured do not require a Teflon-coated sampler, a standard Kemmerer, or Van Dorn sampler may be used. The Kemmerer sampler is a brass cylinder with rubber stoppers that leave the ends of the sampler open while being lowered in a vertical position to allow for passage of water through the cylinder. The Van Dorn sampler is plastic and is lowered in a horizontal position. In each case, a messenger is sent down a rope when the sampler is at the required depth to cause the stoppers to close the cylinder. The sampler is then raised to the surface. Water is removed through a valve to fill respective sample bottles. Dissolved oxygen (DO) sample bottles can be properly filled by allowing overflow using a rubber tube attached to the valve. When performing multiple depth sampling, care should be taken not to stir up the bottom sediment.

A glass beaker or stainless steel scoop may be used to collect samples if the parameters to be analyzed are not interfered with. The beaker or scoop should be rinsed three times with the sample water prior to collection of the sample. All field equipment should follow standard cleaning procedures.

EQUIPMENT/MATERIALS

- Sampling device [plastic bucket, pump, depth integrated sampler (D15)].
- Flow measurement device (velocity meter, survey equipment, measuring tape).

- Sampling materials (sample containers, log book, cooler, chain-of-custody).
- Camera.
- Work Plan.
- Health and Safety Plan.

REFERENCES

ASTM D4841 - Practice for Estimation of Holding Time for Water Samples Containing Organic and Inorganic Constituents

ASTM D4581 - Guide for Measurement of Morphologic Characteristics of Surface Water Bodies

ASTM D5906 - Guide for Measuring Horizontal Positioning During Measurements of Surface Water Depths

ASTM D5073 - Practice for Depth Measurement of Surface Water

ASTM D5413 - Test Methods for Measurement of Water Levels in Open-Water Bodies

Greenberg, A.E., R.R. Trussell, and C.S. Clesceri (eds). 1985. Standard methods for the examination of water and wastewater. 16th Edition. American Public Health Association, Washington, DC. p. 37.

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